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# Research on the Construction of Ecological Environmental Protection Area based on Evaluation Model

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## Abstract

**This paper through studies Saihanba influence on ecological environment, and to build ecological environment protected areas for different countries determine the location choice and scale, mainly uses the analytic hierarchy process (AHP) and entropy weight method, Grey correlation analysis model and TOPSIS comprehensive analysis, cluster analysis K-means clustering model to solve the issues raised, Comprehensive use of MATLAB, EXCEL and other software programming solution, the conclusion should be based on the air pollution rate, forest coverage rate and carbon neutrality of the three indicators of the establishment of ecological environmental protection areas. In view of the first problem, the model is established by using Analytic Hierarchy Process (AHP) and entropy weight method, and more accurate indicators are selected by collecting relevant data of Saihanba to evaluate the impact of Saihanba on the ecosystem. Firstly, analytic hierarchy process (AHP) is used to calculate the weight of each index. Compared with information entropy method, AHP can better eliminate the influence of data on the results. Next to the collected data preprocessing, we through the observation of the data, the choice of Saihanba climate conditions, biodiversity and soil conditions as Saihanba impact on the ecological system of the secondary indexes, compare improve scores before and after the improvement of different years, we concluded that Saihanba in improving the ecological system is to improve the quality of the first 28 times. For question 2, using the gray correlation analysis model and the entropy weight method approach to problem solving, first preprocessing of the model, using the information entropy method to calculate the weight of each index impact on Beijing's ability to resist sand, after using Grey correlation model of impact on Beijing's ability to resist sand optimal vector, comparing different years data and correlation between the optimal vector, It is concluded that the wind and sand resistance capacity of Beijing in 2018 has increased by two times compared with 1983. For question 3, we choose Grey correlation analysis model, energy consumption by each province part of the year and stand area, we established the carbon neutral rate of the index, nearly five years of carbon neutral rate as the main index, and selected the available area, and the air pollution rate as other indicators, using entropy method to calculate the weight of each index and ranking of the provinces, It is concluded that Sichuan, Shaanxi, Gansu and Ningxia need to build 28607 hectares of ecological environment protection zone in Hanzhong Guangtian and area of southern Shanxi. In view of question 4, the degree of air pollution is regarded as the standard for selecting countries in the Asia-Pacific region. We choose Bangladesh as the research object, collect the air quality index of cities in the country, establish the cluster analysis model, classify the cities in the country, and regard the class center as the location of ecological protection zone that should be built. It is concluded that a 20029-hectare eco-environmental protection zone should be constructed in Finisadar, Bangladesh. In view of question 5, combining with the model established above, we summarize the model and put forward feasible suggestions. Finally, error analysis, evaluation and extension of the model are carried out.**

## Keywords

**Analytic Hierarchy Process; Entropy Method; Ecological Environment; Evaluation Model; MATLAB.**

## 1. Restatement of the Question

### 1.1. Background and Significance

Saihanba miracle, Saihanba spirit, the story of Saihanba widely circulated, Saihanba forest farm in China after being broken once again presents the state of the desert, since 1962, a group of young man came to Saihanba - once the castle peak, they through generation after generation efforts, let this slice of yellow sand land construction become the world's largest plantation, Saihanba provides 137 million cubic meters of clean water, sequesters 747,000 tons of carbon and releases 545,000 tons of oxygen every year for Tianjin and Beijing. Saihanba has contributed its share to the sustainable development strategy by preventing desertification. The forest coverage rate of Saihanba has reached 80%, which has made a great contribution to promoting the transformation of economic and social development to all-round green growth. At present, people pay more and more attention to ecology, and how to comprehensively promote the development of green city has been listed and implemented.

Saihanba main role for windbreak and sand-fixation, from the point of view of the world in many areas all need Saihanba such an ecological reserves to improve ecological environment, so the reference Saihanba ecological reserve in improving the ecological environment of the city, and those cities or regions need to reserve, and how to select the construction in ecological reserve for location and size, In the process of data selection, data should be standardized and checked first, and the rationality of data should be verified. Then, a model should be established to evaluate the selected indicators and years, so as to evaluate the impact of Saihanba on the city. Thus, the establishment of ecological protection areas against wind and sand, desertification and other aspects have played a great role.

Saihanba Forest Farm has become a green and friendly farm with stable wind and sand resistance function, which plays an immeasurable role in water purification, carbon fixation, oxygen release and other aspects. Even though people pay more and more attention to the ecological environment at present, the situation of ecological environment in many areas is still grim. Therefore, how to promote a friendly green farm like Saihanba to the whole country and even the world needs to judge the location and scale of the ecological environment through the establishment of the model, so as to jointly build a green and friendly global village with people from all over the world.

### 1.2. Relevant Data

1. Data of indicators in selected years (see Appendix I)
2. Results of entropy weight information and correlation coefficient (see Appendix II)
3. Energy consumption data of provinces in different years and related data (see Annex III)
4. Relevant data of air quality and latitude and longitude of cities in Bangladesh (see Annex III)

### 1.3. Specific Issues

Problem 1: Establish the ecological environment evaluation model of Saihanba.

Problem 2: Construct a mathematical model of the influence of Saihanba on the wind-proof and sand-resistant capacity of Beijing, and quantitatively evaluate its effect.

Question 3: By establishing a mathematical model to evaluate which areas of China need to build ecological reserves, determine the scale of construction, and evaluate the impact of the

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successful establishment of ecological reserves on the realization of China's carbon neutrality goal.

Question 4: Select a country to collect relevant data and establish a mathematical model to judge which areas of the country need to build ecological protection areas and the size of the construction, and evaluate the impact of ecological protection areas on carbon emission reduction and greenhouse gas absorption.

Question 5: Describe the model established by the above questions, and provide feasible solutions and suggestions.

## 2. Analysis and Countermeasures of Problems

Question 1: In order to study the impact of Saihanba on the ecological environment, we choose the analytic hierarchy process to solve the problem. We collect A representative sample of the 3 years of data, the first step according to the need to solve the influence factors on the results of stratified, choose three influence factors of ecological environment (A) target layer as the criterion layer B, paired comparison matrix is established by using exponential scale method to solve the index weight, use of MATLAB software to solve the eigenvalue and eigenvector of the matrix, Then the weight of each index is obtained, and the consistency test is carried out next. Then, three indicators were selected as criterion layer C respectively and the weight was calculated. Similarly, the weight of each indicator could be obtained. The collected data were normalized and the comprehensive weight was calculated after the consistency test was passed. Then, through TOPSIS comprehensive analysis model was established to calculate the object choice and the positive and negative ideal solution is relatively close to draw in each of the ratings, namely Saihanba's influence on the ecological environment, in view of Saihanba back to quantitatively evaluate the impact of the bad border issues, by grading obtain the quantitative relationship between the multiple.

Question 2: It is required to build an evaluation model to solve the influence of Saihanba on Beijing's anti-sandstorm ability, and conduct a quantitative analysis on the effect of Saihanba on Beijing's anti-sandstorm ability. We first construct a matrix and standardize the data in the matrix, and then obtain the weight of each indicator by entropy weight method. Secondly, a Grey relational model is established to determine the optimal data in the evaluation system, that is, the optimal vector. The Grey relational coefficient formula is used to calculate the correlation coefficient between the evaluation index and the optimal vector. Finally, the correlation degree between each index and anti-sandstorm ability is calculated and the final score is obtained.

Question3: Question 3 requires us to collect relevant data and establish a mathematical model to solve the problem of site selection and construction scale of Saihanba ecological protection model to be extended to the whole country, and evaluate the impact of the establishment of ecological protection area on the realization of China's carbon neutrality goal. In view of the third ask, we choose Grey correlation analysis model, part of the year's energy consumption is obtained by collecting the related data as well as forest area, calculated the annual carbon uptake and carbon emissions, so as to calculate the rate of carbon neutral, collect vintage select five years carbon neutral rate as the main index, based on the influence of material and financial resources and resource constraints, The available area of a city and the annual proportion of air pollution are also listed as influencing factors, which are calculated as indicators. After the selection of indicators, the matrix is first transformed into standardization through modular transformation, the weight of each indicator is obtained and evaluated, and the cities that need and have conditions to build ecological protection areas are selected according to the score ranking. Finally, the forest size is calculated by calculating the difference between the carbon

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neutralization rate of the selected city and the city ranked first (which can be used for reference).

Question 4: Question 4 requires us to discuss which countries need to establish ecological reserves by collecting data and building models, and determine the scale of ecological reserves. First we through online information collection, selection of Bangladesh as needed to research, in the website of the national urban air quality index, and then clustering analysis model is established to find the country's need for environmental protection of the city as well as the land area, these cities into plane coordinates, through clustering algorithm to coordinate clustering analysis, The class center is regarded as the actual location of the ecological protection area, and then the forest coverage rate is determined according to the percentage of carbon neutralization rate in this area, and then the size and quantity of the forest are calculated. Finally, the results of carbon dioxide absorption after the establishment of the ecological protection area are analyzed.

Question 5: Summarize the above models for different problems, write non-technical reports and propose feasible suggestions.

## 3. Assumptions of the Model

1. Assume that sandstorms in Beijing mainly come from Inner Mongolia
2. It is assumed that the state of the ecological environment is only affected by climatic conditions, biodiversity and soil conditions
3. Assume that each province's carbon dioxide emissions are caused by its energy consumption
4. It is assumed that the improvement of ecological environment is the result of Saihanba forest

## 4. Noun Explanation and Symbol Explanation

**Table 1.** Main scalar symbols and their meanings

| The serial number | Symbol | Symbol description |
|---|---|---|
| 1 | A | Status of ecological environment (Target layer) |
| 2 | B1,B2,B3 | Indicators of three factors affecting ecological environment (Criterion layer) |
| 3 | C1,C2,C3,C4,C5,C6,C7,C8,C9 | Three groups of factors affecting the three indicators of the criterion layer (indicator layer) |
| 4 | D,R,V | The decision matrix of ecological environment condition, the matrix after modeling treatment and the weighted decision matrix |
| 5 | $V^+, V^-$ | Positive and negative ideal solution of ecological environment |
| 6 | $S_i^+, S_i^-, C_i^+$ | The (Euclidean) distance between the tectonic scheme and the positive ideal solution, the (Euclidean) distance between the tectonic scheme and the negative ideal solution, and the relative proximity of the ecological environment |
| 7 | X,Y | The original matrix and standardized matrix of Beijing sandstorm evaluation standard |
| 8 | e | Information entropy of matrix X attribute |
| 9 | G | Optimal sequence of Beijing sandstorm evaluation matrix |
| 10 | Γ | Correlation degree between evaluation index and optimal vector |
| 11 | H | Carbon neutral rate |

| | | |
|---|---|---|
| 12 | Z,U | The original matrix of regional pollution status and the decision matrix after modular treatment |
| 13 | T | Optimal sequence of regional air condition evaluation matrix |
| 14 | α | Influence regional air condition index and its optimal sequence correlation degree |
| 15 | $hm^2$ | The scale of ecological protection areas to be established |
| 16 | $\xi_i$ | Take the air quality index of cities in Bangladesh |
| 17 | S | Take the urban areas of cities in Bangladesh |
| 18 | § | Take the forest coverage of cities in Bangladesh |
| 19 | θ | The clustering center |
| 20 | $\phi_i$ | Percentage improvement in urban air quality in selected cities in Bangladesh |
| 21 | ΔS | The area of Bangladesh's urban eco-zones that should be established |

## 5. The Establishment and Solution of Model

### 5.1. The Establishment and Solution of the Model for Problem 1

(1)Analysis of Question 1

In order to study the impact of Saihanba on the ecological environment, we choose the analytic hierarchy process to solve the problem. In view of the problem, A relatively typical 3 years of data, we collect the first layers, according to the factors affecting the eco-environment of A target layer select three indicators as the criterion layer B, paired comparison matrix is established by using exponential scale method for each index weight, use of MATLAB software to solve the eigenvalue and eigenvector of the matrix, namely it is concluded that the weight of each indicator, And then consistency check. Again, then three indicators respectively to three index as the index layer C calculating weight, the same can be concluded that the weight of each index, normalized processing of the collected data, the consistency check are calculated through the synthesis weights, and TOPSIS comprehensive analysis model is established, through calculation to choose object and relative close degree of the positive and negative ideal solution obtained in each of the ratings, That is, the impact of Saihanba on the ecological environment is obtained. For the quantitative evaluation of the impact on the environment after the restoration of Saihanba, the quantitative relationship is obtained through the multiple of the scores.

The evaluation model of Saihanba's impact on ecological environment is shown in the figure below:

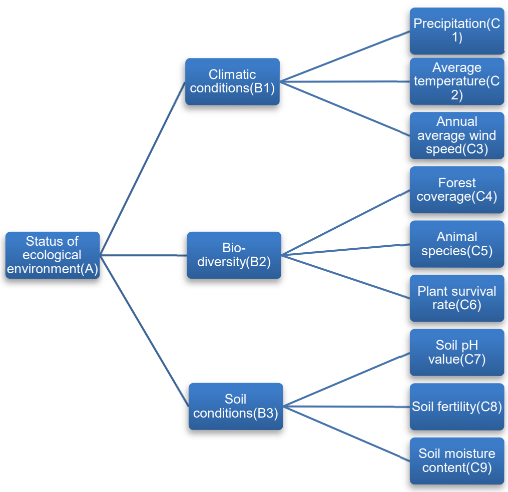


**Fig 1.** Evaluation model of Saihanba's impact on ecological environment

The solution idea of problem 1 is shown as follows:

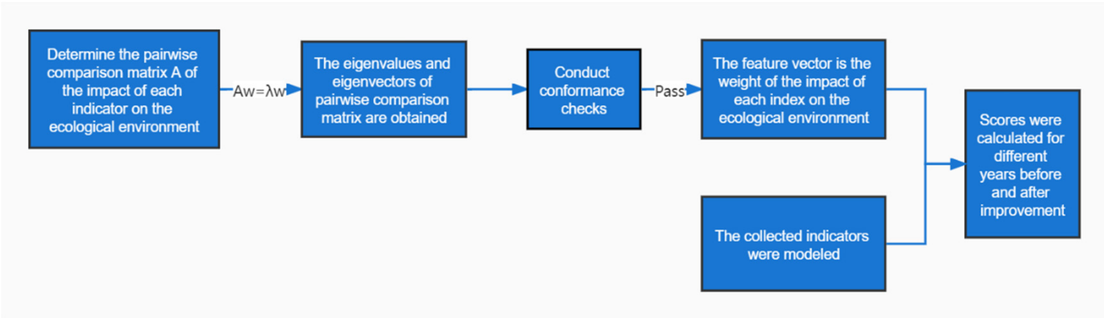


**Fig 2.** Solution idea of problem 1

(2)Solution to problem 1

Model Ⅰ -- Analytic Hierarchy Process (AHP)

The analytic hierarchy Process is mainly used for quantitative analysis of qualitative decision-making problems. Its basic idea is to determine evaluation indicators according to the problems to be solved, and give each indicator a weight by constructing a judgment matrix as the scoring standard of the problem to be solved, followed by consistency test. The consistency index $CI = \frac{L_{max}-n}{n-1}$. Compare the size of $CR = \frac{CI}{RI}$ and 0.1. If the consistency ratio CR is less than 0.1, it is proved that the matrix meets the consistency requirements.

1)Preparation of the model

Establish the analytic hierarchy Process model for ecological environment analysis:

Climate condition (B1), biodiversity (B2) and soil condition (B3) were selected as the secondary evaluation indexes of eco-environmental state A. Based on the index scale, relative importance of each part can be obtained more accurately compared with the traditional 1-9 scale. Therefore, the pairwise comparison matrix using the index scale was constructed. In the same way, three influencing factors were selected as three-level evaluation indexes to construct a pairwise comparison matrix to judge the weight of each three-level index, that is, to calculate the weight of precipitation (C1), average temperature (C2) and annual average wind speed (C3) on climate conditions (B1). The weights of plant density (C4), animal species (C5) and plant survival rate (C6) on biodiversity (B2), and the weights of soil PH (C7), soil fertility (C8) and soil water content (C9) on soil condition (B3).

**Table 2.** Scale values and meanings of exponential scale

| category | Scale value |
|---|---|
| $a_i$ and $a_j$ equally important | $e^{0}/_{4}$ |
| $a_i$ ratio $a_j$ slightly important | $e^{2}/_{4}$ |
| $a_i$ ratio $a_j$is quite important | $e^{4}/_{4}$ |
| $a_i$ ratio $a_j$ strongly important | $e^{6}/_{4}$ |
| $a_i$ ratio $a_j$ extremely important | $e^{8}/_{4}$ |
| $a_i$ *ratio* $a_j$ the importance of lies between the above descriptions | $e^{1}/_{4}, e^{3}/_{4}, e^{5}/_{4}, e^{7}/_{4}$ |
| $a_i$ ratio $a_j$ unimportant description | Reciprocal of the corresponding scale value |

RI is the random consistency ratio of the corresponding exponential scale

**Table 3.** Random consistency ratio of the index scale

| The matrix order | RI |
|---|---|
| 1 | 0 |
| 2 | 0 |
| 3 | 0.58 |
| 4 | 0.90 |
| 5 | 1.12 |
| 6 | 1.24 |
| 7 | 1.32 |
| 8 | 1.41 |
| 9 | 1.45 |
| 10 | 1.49 |
| 11 | 1.51 |

If CI< 0.1, then the matrix meets the consistency requirements

2) Model establishment and solution

Each element with a downward membership relationship is called the first element of the judgment matrix (ecological environment status), and the elements belonging to it are sequentially arranged in the first row and the first column to establish the paired comparison matrix of the exponential scale about the ecological environment status.

The judgment matrix has the following properties

(1)$a_{ij} > 0$

(2)$a_{ij} = 1/a_{ji}$

(3)$a_{ii} = 1$

Based on the eigenvalue method to find the weight of the matrix, we use MATLAB software to solve the weight, that is, to find the maximum eigenvalue and the corresponding eigenvector.

First, the pairwise comparison matrix is established:

$$A = \begin{bmatrix} 1 & \frac{1}{e^{2}/4} & e^{2}/4 \\ e^{2}/4 & 1 & e^{4}/4 \\ \frac{1}{e^{2}/4} & e^{4}/4 & 1 \end{bmatrix}$$

Secondly, the eigenvalue and eigenvector are obtained by the formula $AW = \lambda W$. The eigenvector obtained is the eigenvector corresponding to the weight of each part solved and the maximum eigenvalue Lmax $W = \begin{bmatrix} 0.5053 \\ 0.3088 \\ 0.1859 \end{bmatrix}$ the $a_{ij} = \frac{w_i}{w_j}$

The calculation results are as follows

**Table 4.** Judgment matrix of target layer A and weight of each indicator

| A | B1 | B2 | B3 | Weight(W) |
|---|---|---|---|---|
| B1 | 1 | $e^{2}/4$ | $e^{4}/4$ | 0.5053 |
| B2 | $\frac{1}{e^{2}/4}$ | 1 | $e^{2}/4$ | 0.3088 |
| B3 | $\frac{1}{e^{4}/4}$ | $\frac{1}{e^{2}/4}$ | 1 | 0.1859 |

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Maximum eigenvalue =3.0077

Next, the consistency test is carried out to calculate the consistency ratio:

$$CI = \frac{L_{max} - n}{n - 1}$$

$$CR = \frac{CI}{RI}$$

Results: CI=0.0038, CR=0.0066, through the consistency test, meet the consistency requirements.

Similarly, the judgment matrix of criteria layer B1 and the weight of each index can be obtained, as shown in the following table.

**Table 5.** Judgment matrix of criteria layer B1 and weight of each indicator

| B1 | C1 | C2 | C3 | Weight(W) |
|---|---|---|---|---|
| C1 | 1 | $e^{2/4}$ | $\frac{1}{e^{2/4}}$ | 0.3072 |
| C2 | $\frac{1}{e^{2/4}}$ | 1 | $\frac{1}{e^{4/4}}$ | 0.1863 |
| C3 | $e^{2/4}$ | $e^{4/4}$ | 1 | 0.5065 |

The calculation results are as follows:

$$\text{The feature vectors } W = \begin{bmatrix} 0.3072 \\ 0.1863 \\ 0.5065 \end{bmatrix}$$

Maximum eigenvalue =3.0000

Conduct conformance checks

The results are as follows :$CI$=0, $CR$=0<0.1,Pass the consistency test and meet the consistency requirements

The judgment matrix of criterion layer B2 and the weight of each indicator are shown in the following table.

**Table 6.** Judgment matrix of criterion layer B2 and weight of each indicator

| B2 | C4 | C5 | C6 | Weight(W) |
|---|---|---|---|---|
| C4 | 1 | $e^{1/4}$ | $\frac{1}{e^{1/4}}$ | 0.3265 |
| C5 | $\frac{1}{e^{1/4}}$ | 1 | $\frac{1}{e^{2/4}}$ | 0.2543 |
| C6 | $e^{1/4}$ | $e^{2/4}$ | 1 | 0.4192 |

The calculation results are as follows:

$$\text{The feature vectors } W = \begin{bmatrix} 0.2119 \\ 0.2119 \\ 0.5761 \end{bmatrix}$$

Maximum eigenvalue =3.0000

Conduct conformance checks

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The results are as follows :$CI$=0, $CR$=0<0.1,Pass the consistency test and meet the consistency requirements.

Comprehensive weight = product of corresponding coordinates of each weight, namely:

$$\lambda = W_{Bi} \times W_{Cj}$$

The comprehensive weight of indicator layer C is shown in the following table:

**Table 7.** Comprehensive weight of indicator layer C

| Target layer A | criteria layer B and weight | index layer C and weight (W) | index layer C |
|---|---|---|---|
| | | C1(0.3072) | 0.15522816 |
| | B1(0.5053) | C2(0.1863) | 0.09413739 |
| | | C3(0.5065) | 0.25593445 |
| | | C4(0.3265) | 0.1008232 |
| The state of the ecosystem | B2(0.3088) | C5(0.2543) | 0.07852784 |
| | | C6(0.4192) | 0.12944896 |
| | | C7(0.2119) | 0.03939221 |
| | B3(0.1859) | C8(0.2119) | 0.03939221 |
| | | C9(0.5761) | 0.10709699 |

Model Ⅱ -- TOPSIS comprehensive analysis method

TOPSIS analysis method can make full use of the information of original data and accurately reflect the gap between evaluation schemes, which is also known as the superior and inferior solution distance method. Its basic process first unification processing the original data into positive matrix, and standardizing the purpose is to eliminate the influence of various index dimension and find for plan, the optimal scheme and the worst of the evaluation object and the optimal scheme and proximity between the worst scheme as a basis for the evaluation of advantages and disadvantages.

1)Preparation of the model

At first, standardize should identify indicators for profitability attribute or expense type attributes, this article selected 9 index of level 3, the annual average wind speed for the cost index, so it is necessary to convert the index in standardization, the most commonly used method is the reciprocal value of the attribute value, after completing the data conversion to get decision matrix D, Pass the matrix D($d_{ij}$) through the formula:

$$r_{ij} = \frac{d_{ij}}{\sqrt{\sum_{i=1}^{m} d_{ij}^2}}$$

The matrix is obtained after modularization

$$R = (r_{ij})_{m\times n},$$

$$R = \begin{bmatrix} 0.491695449 & 0.572621448 & 0.656003214 \\ 0.465333 & 0.589589 & 0.660189 \\ 0.25837 & 0.454181 & 0.852622 \\ 0.100319 & 0.645913 & 0.756791 \\ 0.092214 & 0.621834 & 0.777701 \\ 0.063482785 & 0.639033589 & 0.766554635 \\ 0.673333 & 0.562648 & 0.479635 \\ 0.143171 & 0.563401 & 0.813684 \\ 0.070128 & 0.520179 & 0.851173 \end{bmatrix}^T$$

$$V = \begin{bmatrix} 0.07632498 & 0.08888698 & 0.101830172 \\ 0.043805234 & 0.055502384 & 0.062148492 \\ 0.066125859 & 0.116240615 & 0.218215336 \\ 0.010114467 & 0.065122973 & 0.076302121 \\ 0.007241387 & 0.048831303 & 0.06107117 \\ 0.008217781 & 0.082722234 & 0.0992297 \\ 0.026524082 & 0.022163959 & 0.018893867 \\ 0.005639819 & 0.022193598 & 0.032052813 \\ 0.007510506 & 0.055709581 & 0.091158105 \end{bmatrix}^T$$

2) Model establishment and solution

Then, the ranking method closest to the ideal solution (TOPSIS method for short) was used to evaluate the ecological environment of Saihanba Forest farm before (1960) and after (2000 and 2020) improvement. Decision matrix R and comprehensive weight W were used to construct weighted decision matrix V, in which the formula of element $v_{ij}$in V was as follows:

$$v_{ij} = r_{ij} w_{ij}$$

To obtain:

Positive and negative ideal solution of ecological environment $V^+ = \{v_1^+, v_2^+, \cdots, v_m^+\}, V^- = \{v_1^-, v_2^-, \cdots, v_m^-\}$ Are:

$$V^+ = \begin{bmatrix} 0.101830172 \\ 0.062148492 \\ 0.218215336 \\ 0.076302121 \\ 0.06107117 \\ 0.0992297 \\ 0.026524082 \\ 0.032052813 \\ 0.091158105 \end{bmatrix}^T$$

$$V^- = \begin{bmatrix} 0.07632498 \\ 0.043805234 \\ 0.066125859 \\ 0.010114467 \\ 0.007241387 \\ 0.008217781 \\ 0.018893867 \\ 0.005639819 \\ 0.007510506 \end{bmatrix}^T$$

The (Euclidean) distance between the scheme and the positive ideal is calculated as $S_i^+$, and the (Euclidean) distance between the scheme and the negative ideal is calculated as $S_i^-$:

$$S_i^+ = \sqrt{\sum_{j=1}^{3} (v_{ij} - v_j^+)^2} \quad (i = 1,2,\cdots,m)$$

$$S_i^- = \sqrt{\sum_{j=1}^{3} (v_{ij} - v_j^-)^2} \quad (i = 1,2,\cdots,m)$$

The calculation formula of the relative proximity degree of ecological environment is as follows:

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

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The calculation results are as follows:

$$S_i^+ = \begin{bmatrix} 0.217656579 \\ 0.11194033 \\ 0.007630215 \end{bmatrix}^T$$

$$S_i^- = \begin{bmatrix} 0.007630215 \\ 0.125381649 \\ 0.217656579 \end{bmatrix}^T$$

$$C_i^+ = \begin{bmatrix} 0.033868898 \\ 0.52831874 \\ 0.966131102 \end{bmatrix}^T$$

The status of ecosystem in each year can be ranked according to the size of $\mathrm{C_i}$value. As can be seen from the $\mathrm{C_i}$ value, the order of ecosystem status is 2020>2000>1960, compared with 1960, the improvement ratio of ecological environment in 2020 is 28.52561399.

## 5.2. The Establishment and Solution of the Model of Problem 2

(1)Analysis of Question 2

Problem two requirements to build evaluation model of solving the problem of Saihanba impact on Beijing's ability to resist storms, effect on Saihanba quantitatively analysis the ability of resistance to dust storms in Beijing, we first construct indicators for standardization of matrix and matrix, then the weight of each index is obtained through the entropy weight method, secondly by Grey correlation model is set up to determine the optimal data in the evaluation system is the optimal vector, The Grey correlation coefficient formula is used to calculate the correlation coefficient between the evaluation index and the optimal vector, and finally the correlation degree between each index and the anti-sandstorm ability is calculated to get the final score.

(2) Solution to problem 2

Model Ⅲ -- Grey relational analysis model

Grey correlation analysis model for quantitative description and comparison situation, development and change of a system by determining the reference sequence similarity to determine the effects of various factors on the results, first determine analysis sequence of selection of index, the second to select the data dimensionless processing, correlation coefficient, then to calculate the correlation degree, finally, the correlation order to come to the conclusion.

1) Preparation of the model

The annual occurrence times (days) of sandstorms in Beijing, windy days (days) in Beijing, air particle concentration (microgram meters) and vegetation coverage rate were selected as indicators and relevant data were collected to obtain the original matrix X

$$\mathrm{X} = \begin{bmatrix} 268.5 & 29 & 730 & 0.484 \\ 163.8 & 16 & 389.5 & 0.6151 \\ 36.5 & 11 & 213.6 & 0.7318 \\ 2.3 & 3 & 177 & 0.8101 \end{bmatrix}$$

I'm standardizing the indices in the X matrix,

Efficient data processing:

$$\mathrm{Y} = \frac{\mathrm{X} - \mathrm{X_{min}}}{\mathrm{X_{max}} - \mathrm{X_{min}}}$$

Cost based data processing:

$$\mathrm{Y} = 1 - \frac{\mathrm{X} - \mathrm{X_{min}}}{\mathrm{X_{max}} - \mathrm{X_{min}}}$$

Where $X_{max}$ is the maximum value in matrix X, $X_{min}$ is the minimum value in matrix X.After standardization, the matrix Y is obtained:

$$Y = \begin{bmatrix} 0 & 0 & 0 & 0 \\ 0.393313298 & 0.5 & 0.615732369 & 0.402023919 \\ 0.871525169 & 0.692307692 & 0.933815552 & 0.759889604 \\ 1 & 1 & 1 & 1 \end{bmatrix}$$

The entropy weight method was used to get the weight of the index, and the probability distribution of information was defined as each column vector of the decision matrix Y obtained by the above steps$(y_{1j}, y_{2j}, \cdots, y_{mj})^T$ $(j = 1,2, \cdots, n)$,According to the definition of entropy, the entropy of attribute $X_j$ in each year is:

$$e_j = -k \sum_{i=1}^{m} y_{ij} \ln y_{ij} \quad k = \frac{1}{\ln m} \qquad (j = 1,2, \cdots, n)$$

Generally, the greater the difference of attribute value $y_{ij}$ is, the smaller $e_j$ is, and the more obvious the function of $X_j$ to distinguish the merits and demerits of schemes is, so the definition is given

$$d_j = 1 - e_j \,, 0 \leq e_j \leq 1$$

Is the discrimination degree of attribute $X_j$, then the weight $w_j$ of attribute $X_j$is

$$w_j = \frac{d_j}{\sum_{j=1}^{n} d_j} \,, j = 1,2, \cdots, n$$

The information entropy of each indicator is shown in the following table:

**Table 8.** Information entropy of indicators

| Information entropy of each influencinfactor | index e |
|---|---|
| Number of sandstorm year (day) | 0.634 |
| Beijing Gale Day (Sun) | 0.711 |
| Air particle concentration (MCM) | 0.541 |
| Vegetation coverage | 0.748 |

2) Model establishment and solution

Firstly, the optimal data in the evaluation system is determined, that is, the optimal vector parent vector is

$$G = (g_1, g_2, \cdots, g_n)^T$$

Then

$$g_i = \max(y_{i1}, y_{i2}, \cdots, y_{in})$$

The optimal vector is:

$$G = (0, 0.615732369, 0.933815552, 1)^T$$

The grey correlation coefficient formula is used to calculate the correlation coefficient $F(y_j, G)$ between the evaluation index and the optimal vector, and the calculation formula is as follows:

$$F(y_j, G) = \frac{\min_i \min_j |y_{ij} - g_i| + \rho \max_i \max_j |y_{ij} - g_i|}{|y_{ij} - g_i| + \rho \max_i \max_j |y_{ij} - g_i|} \quad (0 < \rho < 1)$$

ρ is the resolution coefficient, 0<ρ<1, Generally, ρ=0.5

The correlation degree Γ is then calculated by the following formula, the calculation formula is as follows:

$$\Gamma = \sum_{j=1}^{n} w_j \times F(y_j, G)$$

The correlation coefficient and correlation degree, single parameter scores of influencing factors and evaluation scores of Saihanba on Beijing's sandstorm resistance in each year are calculated by MATLAB, as shown in the following table:

**Table 9.** Evaluation scores of each year

| year | Number of sandstorm year (day) | Beijing Gale Day (Sun) | Air particle concentration (MCM) | Vegetation coverage | correlation | The sorting |
|---|---|---|---|---|---|---|
| 1983 | 1 | 1 | 1 | 1 | 1.210648774 | 4 |
| 1994 | 0.388094381 | 0.337148323 | 0.737278337 | 0.337148323 | 1.375430619 | 3 |
| 2010 | 0.333333333 | 0.650513681 | 0.50878159 | 0.650513681 | 1.451164114 | 2 |
| 2018 | 0.702589016 | 0.411724782 | 0.621449946 | 0.411724782 | 2.634 | 1 |
| | | | | | | |

It can be seen from the above table that Saihanba's effect on wind prevention and sand fixation in Beijing. Quantitative analysis shows that the improvement ratio of ecological environment in 2018 compared with 1983 is 2.17569294792017.

## 5.3. The Establishment and Solution of the Model of Problem 3

(1)Analysis of Question 3

Question 3 requires us to collect relevant data and establish a mathematical model to solve the problem of site selection and construction scale when the ecological protection model of Saihanba is extended to the whole country, and to evaluate the impact of the establishment of the ecological protection area on the realization of China's carbon neutrality goal. In view of the third ask, we choose grey correlation analysis model, part of the year's energy consumption is obtained by collecting the related data as well as forest area, calculated the annual carbon uptake and carbon emissions, so as to calculate the rate of carbon neutral, collect vintage select five years carbon neutral rate as the main index, based on the influence of material and financial resources and resource constraints, The available area of a city and the proportion of annual air pollution are also listed as influencing factors, namely as indicators. After the index selection, first by a transformation converts matrix to standardization, and calculating the weight of each index, and to evaluate its, according to the score sorting to select the need and conditional construction of ecological reserve, selected cities and through calculation of the score first for reference (city) the rate of carbon neutral difference and then calculate the size of ecological reserve.

(2)Solution to problem 3

Model Ⅳ -- Grey relational analysis model

The basic idea of the Grey correlation analysis model is to judge the closeness and order of the relationship between the main factor sequence (that is, the sequence of the target result) and each behavior factor sequence (that is, the sequence of the influencing factors) by calculating the Grey correlation degree between the main factor sequence (that is, the sequence of the influencing factors). The larger the grey correlation coefficient between the main factor sequence and the behavior factor sequence is, the stronger their relationship degree is, the greater the influence of the behavior factor sequence on the main factor sequence, that is, the greater the influence of factors on the results, and vice versa.

1) Model preparation

Collect the relevant data to get part of the year energy consumption as well as forest area, then converts the data to the annual carbon uptake by calculation P Q and carbon emissions, carbon neutral means through afforestation and other means to offset directly or indirectly from greenhouse gas emissions, in general, refers to make ends meet carbon dioxide emissions, The carbon neutralization rate H refers to the ratio of annual carbon absorption P to carbon emission Q. The carbon neutralization rate can directly reflect the relationship between regional greenhouse gas absorption and emissions. Therefore, we choose the average carbon neutralization rate of five years as one of the important indicators, and the formula of carbon neutralization rate H is as follows:

$$H = \frac{P}{Q} \ , \ H = \begin{cases} 1, P > Q \\ \frac{P}{Q}, P < Q \end{cases}$$

Considering the limitation of the city's own available resources and the city's own atmospheric conditions, we took the city's available area and annual air pollution proportion as evaluation indicators. After the selection of indicators, the matrix was first standardized.

Processing of positive indicators:

$$Z = \frac{X - X_{min}}{X_{max} - X_{min}}$$

Negative index processing:

$$Z = 1 - \frac{X - X_{min}}{X_{max} - X_{min}}$$

Then the decision matrix U is obtained by modularization of the matrix

$$u_{ij} = \frac{z_{ij}}{\sqrt{\sum_{i=1}^{m} z_{ij}^2}}$$

The entropy weight method was used to get the weight of the index, and the probability distribution of information was defined as each column vector of the decision matrix U obtained by the above steps$(u_{1j}, u_{2j}, \cdots, u_{mj})^T$ $(j = 1,2,\cdots,n)$According to the definition of entropy, the entropy of attributes in each year$Z_j$ is:

$$e_j = -k \sum_{i=1}^{m} u_{ij} \ln u_{ij} \quad k = \frac{1}{\ln m} \qquad (j = 1,2,\cdots,n)$$

In general, the greater the difference between $y_{ij}$ and $e_j$, the smaller the $e_j$, the more obvious the role of $Z_j$ in distinguishing the merits and demerits of the scheme, thus the definition

$$d_j = 1 - e_j, 0 \le e_j \le 1$$

Is the discrimination degree of the attribute $U_j$, then the weight of the attribute $w_j$ is

$$w_j = \frac{d_j}{\sum_{j=1}^{n} d_j}, j = 1,2,\cdots,n$$

2) Model establishment and solution

Firstly, the optimal data in the evaluation system is determined, that is, the optimal vector parent vector is

$$T = (t_1, t_2, \cdots, t_n)^T$$

Among them

$$t_i = \max(u_{i1}, u_{i2}, \cdots, u_{in})$$

The optimal vector is obtained, and the grey correlation coefficient formula is used to calculate the correlation coefficient $F(u_j, T)$ between the evaluation index and the optimal vector. The calculation formula is as follows:

$$F(u_j, T) = \frac{\min_i \min_j |u_{ij} - t_i| + \rho \max_i \max_j |u_{ij} - t_i|}{|u_{ij} - t_i| + \rho \max_i \max_j |u_{ij} - t_i|} \quad (0 < \rho < 1)$$

ρ is the resolution coefficient,0<ρ<1,Generally, ρ=0.5

Then the correlation degree α is calculated by the following formula:

$$\alpha = \sum_{j=1}^{n} \alpha_j \times F(u_j, T)$$

MATLAB software was used to calculate correlation coefficient and correlation degree, single parameter score of influencing factors and evaluation of each index in each year for each province.

After obtaining the score of each province, set the score of each province as β and carbon emission as carbon, then the established forest scale $hm^2$ (hectare) can be expressed as

$$hm^2 = \frac{(\beta - \beta_i)}{1000} \times \text{carbon}$$

Where β is the province of the referenced province and$\beta_i$is the score of the selected province.

According to the above calculation results, Sichuan, Shaanxi, Gansu and Ningxia have the lowest score, that is, the ecological environment pollution is serious. Considering the actual situation of these regions, that is, the area needed for the construction of ecological areas, a large ecological area should be established in Hanzhong Guangtian area in southern Shanxi, so as to improve the environment around the ecological protection areas. The difference between the scale of the ecological protection area and the carbon neutralization rate after the establishment of the ecological protection area and the original carbon neutralization rate can be obtained, that is, the impact of the ecological protection area on the carbon neutralization goal of China. The quantitative analysis results are as follows: The scale of the required forest is 28,607 hectares, and the ecological reserve has a positive impact on China's carbon neutrality goal, which pushes China forward to achieve carbon neutrality goal.

## 5.4. The Establishment and Solution of the Model of Problem 4

(1) Analysis of Question 4

Question 4 requires us to discuss which countries need to establish ecological reserves by collecting data and establishing models, and determine the scale of ecological reserves. First we through online information collection, selection of Bangladesh as needed to research, in the website of the national urban air quality index, and then clustering analysis model is established to find the country's need for environmental protection of the city as well as the land area, these cities into plane coordinates, through clustering algorithm to coordinate clustering analysis, The class center was regarded as the actual location of the ecological protection area, and then the forest coverage rate was determined according to the percentage of carbon neutralization rate needed to be improved in this area, so as to obtain the scale and quantity of the forest. Finally, the results of carbon dioxide absorption after the establishment of the ecological protection area were analyzed.

(2) Solution to problem 4

Model V -- Clustering analysis (K-means clustering)

Clustering analysis is used for samples for unknown categories, divided into high class cluster by partitioning similarity and similar types of clusters, so as to get the sample in between the nature of the contact between each other, the process of clustering, including preparing data,

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select features, feature extraction, construct the distance function to the proximity measure, grouping, clustering results evaluation to the final.

1)Model preparation

Firstly, the selected cities in Bangladesh and the data of related indicators are counted. Firstly, the relevant data of each city on the air quality index are collected, and the air quality index of each city is $\xi_i$, the urban area is S, and the forest coverage rate is §, then

$$\bar{\xi_i} = \frac{1}{n}\sum_{i=1}^{n}\xi_i$$

Therefore, the air quality index of the selected city should be lower than the average air quality index of all cities.

2)The establishment and solution of model

The clustering center θ is obtained according to the clustering model, then θ is the construction location of the ecological area. To determine the scale of the ecological area, the improvement percentage of air quality in each city $\phi_i$ needs to be determined first

$$\phi_i = \frac{\xi_i - \bar{\xi_i}}{\xi_i} \times 100\%$$

That is, the urban ecological area can be obtained ΔS as

$$\Delta S_i = S_i \S_i (1 + \phi_i) - S_i \S_i$$

By analyzing the results of the above table and calculating the size of the forest to be built, we concluded that the ecological environment protection zone should be established in Finisadar, Bangladesh, with a construction area of 20,029 hectares.

## 5.5. Solution of Problem 5

The report

The main methods used in this paper include analytic hierarchy Process (AHP), TOPSIS comprehensive analysis, Grey correlation analysis model, entropy weight method and cluster analysis, and the conclusions are as follows:

1. Through the selection of multiple impact indicators, the model was established to obtain the weight of factors affecting the ecological environment and a comprehensive score of the ecological environment in each year, and the multiple of ecological environment improvement was accurately obtained as 28.52561399.

2. Obtain the correlation degree between each index and the optimal vector of Beijing's sandstorm resistance ability, and quantitatively obtain the multiple relationship between each year.

3. Carbon neutralization rate is selected as an important indicator, and other related indicators are selected. The correlation degree between the selected indicators and the optimal vector is calculated by the model to evaluate each province, and the specific scoring value is obtained. And then the impact of ecological reserves on China's carbon neutrality goal.

4. Cluster analysis is conducted to determine the location of ecological protection areas to be established, and the scale of forest to be established is determined by the percentage of air quality improvement.

The scientific management method of this article is as follows:

1. Cities with low scores are preferentially selected and governed.

2. The locations of selected cities should be close to each other, so as to maximize the cost of establishing ecological protection areas while ensuring benefits.

Recommendations made:

1. Popularize the use of the above models

2. It is suggested that selected cities cooperate to establish protected areas

## 6. Error Analysis

Based on the collected data of the workload is bigger, use in data processing and error may arise, such as the first topic using the analytic hierarchy process (AHP) to solve the weight of each index, because of the large selection of index factor, the number and types of data need to collect more, resulting in data processing and data and compatibility of the model may appear some problems, Although each index passed the consistency test, it had some influence on the results.

## 7. Evaluation and Extension of the Model

### 7.1. Evaluation of the Model

1. The advantages

(1) When the analytic hierarchy Process is used to evaluate the status of the ecological environment, the selected index factors are diverse, so the evaluation and quantitative analysis of the ecological environment are relatively accurate.

(2) It is novel to select carbon neutralization rate as evaluation and calculation index when determining the scale of ecological protection areas to be established in cities.

(3) After solving the problem by establishing a model and obtaining the specific value of the score, quantitative analysis is carried out through the multiple relationship between the scores.

### 7.2. The Shortcomings

(1) In order to make the results more idealized, we have carried out necessary processing for some data, such as discarding abnormal data, which will bring a certain degree of error.

(2) Analytic hierarchy Process (AHP) selects a large number of index factors, which are vulnerable to the influence of subjective evaluation factors. Although consistency analysis is carried out, the results may still be affected.

Second, the extension of the model

Analytic hierarchy process (AHP) is widely used in the analysis and implementation of economic, cultural and other aspects of the project, and is often used to solve such problems as comprehensive evaluation, selection of decision-making schemes, estimation and prediction, allocation of input and so on.

## 8. Model Improvements

Because there are still some errors in data processing, more attention should be paid to the difficulty of relevant data collection when selecting indicators, and the results may be more accurate.

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