Team Number	apmcm2104271
Problem Chosen	C

Multifaceted and multi-level modeling based on Saihanba model

Saihanba mechanical forest farm is an achievement of ecological civilization construction in China. The subject takes Saihanba Forest Farm as the core and quests about Saihanba Ecological Zone and environment.

In question one, we use analytic hierarchy process to establish evaluation model to evaluate its impact on environment. We take the ecological benefits of a certain type of ecosystem as the core indicator. In addition, we comprehensively considered the indicators such as species richness, water conservation and carbon dioxide solidification, and finally obtained a more comprehensive quantitative evaluation.

In question two, we established a quantitative model for the dust-retention capacity of Saihanba and analyzed its correlation with the dust weather frequency in Beijing to quantitatively evaluate its impact on surrounding cities. Then we established a quantitative model of sediment yield in the sand source area. Finally, the relationship between the dust-retention amount of Saihanba and the sand-blown amount in the sand source area is established, and thus the resistance of Saihanba to dust in Beijing is obtained.

Questions three and four, based on the purpose and conditions for the successful establishment of Saihanba Forest Farm, we determined the indicators used to screen geographical locations in the subsequent models. Through several different mathematical methods such as entropy weight method, we determined the need to establish the number of ecological zones, and expected carbon emissions to achieve carbon neutralization scale.

Finally, in Problem five, we briefly described the model, gave the establishment scheme of ecological zone considering factors such as economic development, and made appropriate supplements to the paper. Throughout the whole modeling process, we used a variety of multi-level models and mathematical methods, through literature data comparison, we got the results of high accuracy.

Key words: saihanba, Ecological zone, dust retention, dust emission

Contents

1 Introduction

1.1 Problem Background

Adhere to the concept that lucid waters and lush mountains are invaluable assets, With the help of the Chinese government and the struggle and sacrifice of several generations, Saihanba Forest Farm has grown from a vast desert in 1962 into a lush forest today, becoming the largest artificial forest in the world. As an ecological green farm, Saihanba Forest Farm plays an extremely important role in windbreak, sand fixation, water conservation and other aspects. It is the windbreak in north China and the green barrier of the capital Beijing.

Since the National Congress of the Communist Party of China. With the growing need for carbon neutrality and "civilization will develop followed with zoology thriving" on its historic mission. The direction of Saihanba Forest farm has turned to ecological restoration, and efforts have been made to make artificial forests closer to natural forests.

1.2 Restatement and Reflection

(1) Problem 1 :

Saihanba Forest farm plays an important role in preventing wind and fixing sand, maintaining ecological balance and stability and protecting ecological environment. The title requires us to establish an evaluation model for the ecological environment of Saihanba and quantitatively analyze the impact of Saihanba on the environment. We need to establish some relevant indicators and collect relevant data to establish this evaluation class model. This model is used to compare the changes of saihanba ecological environment before and after restoration, and the results are obtained.

(2) Problem 2 :

When Saihanba was built, it was an important barrier for Beijing in the north and played an important role in resisting sandstorms. The problem 1 requires us to establish an evaluation model of the influence of Saihanba on the anti-dust ability of

Beijing. Therefore, we need to select appropriate indicators and collect relevant data to quantitatively evaluate the specific effect of Saihanba in resisting sandstorms in Beijing.

(3) Problem 3 :

Carbon neutrality, windbreak, sand fixation and ecological restoration are all necessary for China's green development in the future. As a typical model ecological area, Saihanba Forest farm has the value of spreading to the whole country. We need to build mathematical models and use relevant data to determine the geographical location suitable for promoting Saihanba type ecological zones in China. Finally, a model was established to determine the number and scale of the proposed ecological zones, and to assess their impact on China's goal of carbon neutrality.

(4) Problem 4 :

In fact, As the largest man-made forest in the world, Saihanba Forest Farm is also an excellent example of ecological restoration worldwide, and it is a model of ecological zone that can be extended to the world. The problem 4 requires us to first identify a country in the Asia-Pacific region suitable for the establishment of saihanba type ecological zone. Then, with the appropriate mathematical model, we need to determine which geographical areas of the country have a need for ecological reserves, and work out the size or number of these ecological reserves. Finally, a model was established to evaluate the contribution of these proposed ecological reserves to greenhouse gas absorption and carbon emission reduction

(5) Problem 5:

The problem 5 requires us to describe our model and write a non-technical report to APMCM. And the report should put forward feasible plans and suggestions for the establishment of ecological protection areas.

1.3 Our Work

·Problem 1

In the problem 1, we establish the evaluation model through the analytic hierarchy process. After data acquisition and data preprocessing, the forest data obtained about Saihanba is the most comprehensive, with high information reliability and great reference value. We finally decided to use these data to obtain a more reliable mathematical model to evaluate part of the impact of Saihanba on the ecological environment. Then, from other indicators, such as species richness, water conservation, air quality, etc., a more comprehensive evaluation model of saihanba's impact on its ecological environment can be obtained.

·Problem 2

In the problem 2, we establish a model to measure the dust retention capacity of Saihanba as an index to measure its anti-wind sand ability, and analyze the correlation between this index and the frequency of dust weather in Beijing, but the final result is not satisfactory.

Because the dust weather in Beijing is actually more strongly correlated with precipitation and temperature in the sand source area. Therefore, we use the dust emission model of sand source to estimate the dust emission of Hunshandake Sandy Land, one of the main sand sources in Beijing.

The Saihanba is located between Beijing and the Hunshandake Sandy Land, so we establish the relationship between the dust retention of the Saihanba forest land and the dust emission of the sand source, and finally get a specific quantitative result.

·Problem 3

In the problem 3, we first determine several factors of Saihanba model ecological zone. For example, the main purpose of establishing ecological zones is windbreak, sand fixation and carbon neutrality, and the main measure is to cultivate plantation forests. After that, the model is established to calculate the demand of each province for sand prevention, and some provinces are screened out. Subsequently, the corresponding provinces and cities were screened by precipitation and altitude. Finally, the quantity of Saihanba type ecological zone is determined by taking the city as the unit, and the forest area of Saihanba type ecological zone is estimated by the model based on carbon neutralization demand.

·Problem 4

In the problem 4, we use entropy weight method to establish mathematical model and screen out countries in the Asia-Pacific region with similar conditions to Saihanba, namely Mongolia. Then we determined the geographical scope of the ecological zone to be established in the middle and east of Mongolia by quantitative analysis of precipitation and landform and other indicators. After that, we calculated the carbon emissions of central and eastern Mongolia based on its population and other factors. Carbon emissions are then used to determine the scale of afforestation needed to achieve carbon neutrality. Finally, the contribution of ecological zones in absorbing greenhouse gases and reducing carbon emissions is calculated.

·Problem 5

In Problem 5, we need to submit a non-technical report to APMCM. In this report, we briefly describe several of our main mathematical models. Subsequently, we put forward some substantive suggestions to APMCM based on some problems encountered in modeling. Then, referring to the construction of Saihanba ecological zone, we propose a preliminary plan for the construction of an ecological zone with the main purpose of sand resistance, which also takes into account the development of ecology, carbon neutrality and economic development. At the same time, some strategies for constructing ecological zones were given for the situations that could not be considered in the model.

2 Model Preparation

2.1 Assumptions

To simplify our model we made the following assumptions:

Assumption 1 : all the data we obtained in this article are authentic.

Assumption 2 : the value of coefficient has little effect on the final result.

Assumption 3 : ignoring the selected relevant variables arem reasonable.

Assumption 4 :the establishment of ecological zones does not need to consider economic factors.

Assumption 5 :the coefficient is less affected by region.

2.2 Notations

name	meaning
S	level I region weight
Pi	value of biodiversity per unit area corresponding to level I.

A	area of level I region.
W	generated weight matrix
CR	generated for each weight matrix
Q	total amount of pollutants retained in the forest farm within a certain time
F	pollutant flux
L	total canopy coverage area of green space
T	time
Vd	dry deposition rate of a specific atmospheric pollutant
C	atmospheric concentration of the pollutant
ψ	forest canopy coefficient
A	forest area of forest farm
δ	ratio of PM2.5 to PM10
r	correlation
W	total emission of particulate matter in dust
E	emission coefficient of dust source
As	dust source area
η	removal efficiency of dust pollution control measures
D	dust factor
τ	climatic factor
K	percentage of TSP in soil dust
I	dust index in sandy land
Λ	ground roughness factor
V	vegetation coverage factor
U	annual average wind speed
PE	santhwaite precipitation - evaporation index
P	annual precipitation
Ta	annual average temperature
μ	contribution rate of dust retention
J	dust fall amount per unit area
Ar	route area from sand source to Beijing
κ	dust routes
Si	evaluation value

3 Problem 1 : Sihanba ecological environment evaluation model

In the first question, we mainly established the ecological evaluation model of Saihanba, which was divided into several sub-projects. By referring to relevant data, we completed the comparative evaluation of the Saihanba ecological environment between 1962 and 2012.

3.1 Establishment of ecological benefit evaluation model for Saihanba

First of all, we analyzed elements that contribute significantly to the ecological environment, and the first thing that comes to mind is the area of tree resources. The reason is that there are obvious differences in the ecological benefits of the ecosystem supported by different types of vegetation cover. Secondly, we added three other evaluation elements related to windbreak and sand fixation, water and soil conservation and water conservation: ecological diversity, water conservation and air quality. We regarded the area of tree resources as the most important index and divided it into secondly indexes: wetland area, woodland area, grassland area and wasteland area. Considering the different types of trees in the secondly index of forestland and their contribution to the environment, the third-level index is divided: forestland area, sparsely forestland area, shrubby woodland area and unforested woodland area.

Contribution analysis of first-level indicators:

1. Ecological diversity: The species diversity of an ecosystem can reflect the robustness of the ecosystem to environmental changes (such as diseases and insect pests), as well as the condition of ecological recovery of this region. We mainly selected species richness (mainly plants), that is, the average number of species per unit area, as the index for evaluation, which was aslo an intuitive comparison of the changes in the number of species in the whole Saihanba area. There is a relatively comprehensive biological analysis of species diversity in a region, and the differentiation of dominant species will also be taken into consideration. Considering the lack of professional knowledge, we will not go further. We used the data of Otindag Sandy Land instead of the data which are not good enough in

Saihanba.

2. Water conservation: Water conservation by vegetation is mainly achieved through interception of rain (snow) water by forest canopy, absorption of water by leaf litter layer, and infiltration of precipitation by forest soil. To do this, we compared and estimated known water conservation with rainfall,evaporation and runoff.

3. Air quality: The issue of air quality has attracted much attention in recent years. We mainly choose the publicly available carbon dioxide solidification amount and air quality index for estimation and comparison.

4. For the area of tree resources, we selected four main regions, and the ecological benefits of these regions decreased successively:

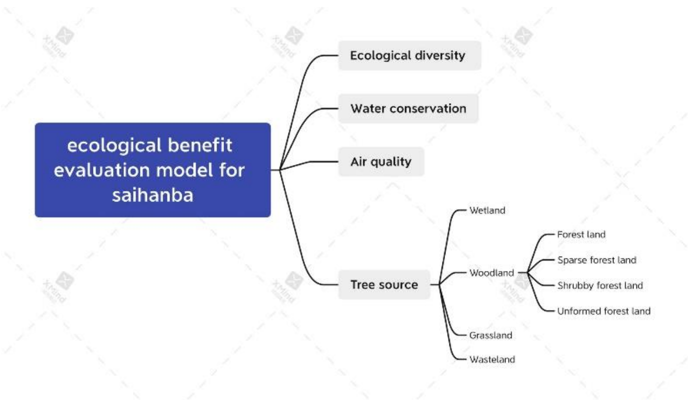
1) Wetlands: Wetlands generally have extremely high ecological benefits, including but not limited to air renewal, water purification, water conservation and high species richness. Although wetlands under different conditions also have obvious differences in ecological benefits, considering that the wetland occupies a small area in the whole mechanical forest farm, no detailed analysis is made.

2) Woodland: as a high-level ecosystem, forest has obvious high ecological benefits, such as climate regulation, water and soil conservation, etc. Although the artificial forest is lacking in species richness, as the main area of Saihanba Forest Farm, it is the biggest change before and after reconstruction. And in terms of the purpose of sand prevention and sand fixation, the effect of forestland is also the most outstanding in each region.

3) Grassland: the ecosystem carried by the meadow has important ecological functions such as windbreak, sand fixation, soil conservation and water conservation. Although the ecological benefits of grassland are lower than those of forest land, grassland restoration is also an important part of saihanba ecological restoration and transformation.

4) Wasteland: including all areas that basically do not produce ecological benefits, such as floating sandy land area, human building area, stone beach rock area, etc.

As the region with the most comprehensive data, forest land is subdivided into four levels, namely, forest land, sparse forest land, shrubby forest land and unformed forest land, which are regarded as the third-level indicators in our evaluation index.



Through the above analysis, we choose the analytic hierarchy Process model that is most consistent with this way of thinking to establish the evaluation model.

First, we established the weight matrix of first-level indicators to measure the contribution of each first-level indicator to the ecological environment.

$i_{1\sim4}$ represents number of resources, ecological diversity, water conservation and air quality respectively. a_{ij} represents that a_j contributes a_{ij} times more to the ecological environment than a_i.

$$A = \begin{pmatrix} 1 & 7 & 5 & 1 \\ 1/7 & 1 & 1/5 & 1/7 \\ 1/5 & 5 & 1 & 1/5 \\ 1 & 7 & 5 & 1 \end{pmatrix}$$

Secondly, we established the weight matrix of the second-level indicators to measure the contribution of each second-level indicator to the area of tree resources, where $i_{1\sim4}$ respectively represent wetland, woodland, grassland and wasteland. b_{ij} represents that b_j contributes b_{ij} times more to tree resource area than b_i.

$$B = \begin{pmatrix} 1 & 2 & 5 & 7 \\ 1/2 & 1 & 4 & 6 \\ 1/5 & 1/4 & 1 & 3 \\ 1/7 & 1/6 & 1/3 & 1 \end{pmatrix}$$

Finally, we built a weight matrix of three-level indicators to measure the contribution degree of each three-level indicator to forest land, where $i_{1\sim4}$ represents forest land, sparse forest land, shrubby forest land and unformed forest land respectively. c_{ij} represents that c_j contributes c_{ij} times more to forestland than c_i.

After setting up the weight matrix, we began to collect different indicators. However, we did not find comprehensive data in different papers and websites of the National Bureau of Statistics. After screening the complete data value, we determined to compare the data of 1962 and 2012, so as to obtain the favorable influence degree after the restoration of Saihanba.

The statistical data of tree resource area are as follows:

Date （year）	2021	2012	2002	1989	1978	1962
wetland	10.3	7.632	1.99	0.98		0.168
woodland	115.1	112.3402	111.6116	94.38525	109	24
grassland		37.6342	38.1316	43.2		100
wasteland		4.6	6.5	13.5	19.5	50

From the data read in the table, we calculated that from 1962 to 2012, the area of wetland increased by 45.43 times, the area of forest increased by 4.68 times, the area of grassland increased by 0.376 times and the area of wasteland increased by 0.092 times. Considering that wasteland also has certain ecological value and human utilization value, this paper does not treat it as a negative value.

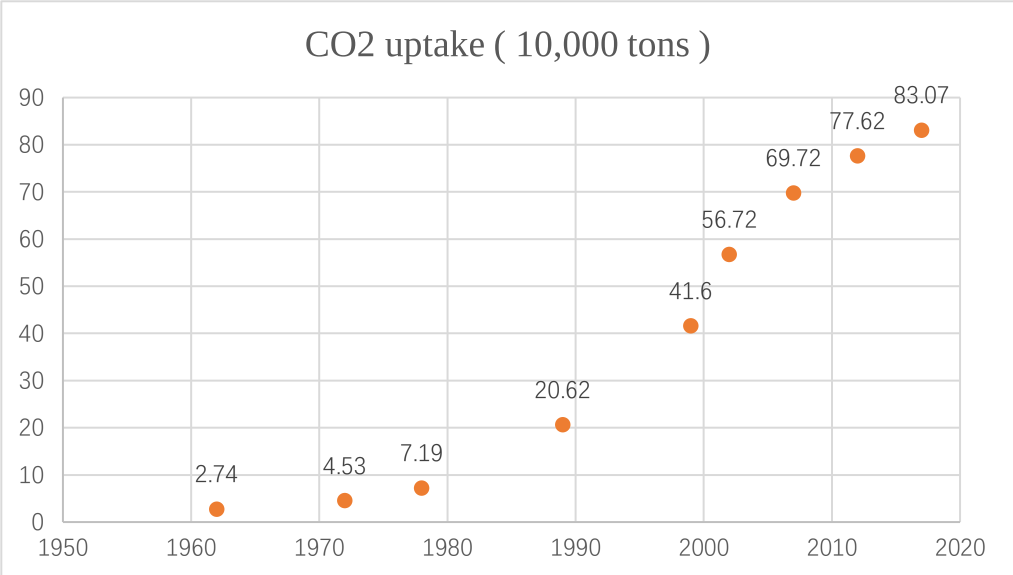
The statistical data of different forest lands are as follows:

Date （year）	2017	2012	2002	1989	1962
forestland	73683.37	68847.58	66012	53207.7	12666.667
Sparse forest land	270.43	597.66	706.4	3607.5	7333.700
Shrubby forest land	1050.22	1097.48	1705.7	88.1	1.000
Unformed forest land	5215.01	4350.74	5983.6	6020.2	2666.800

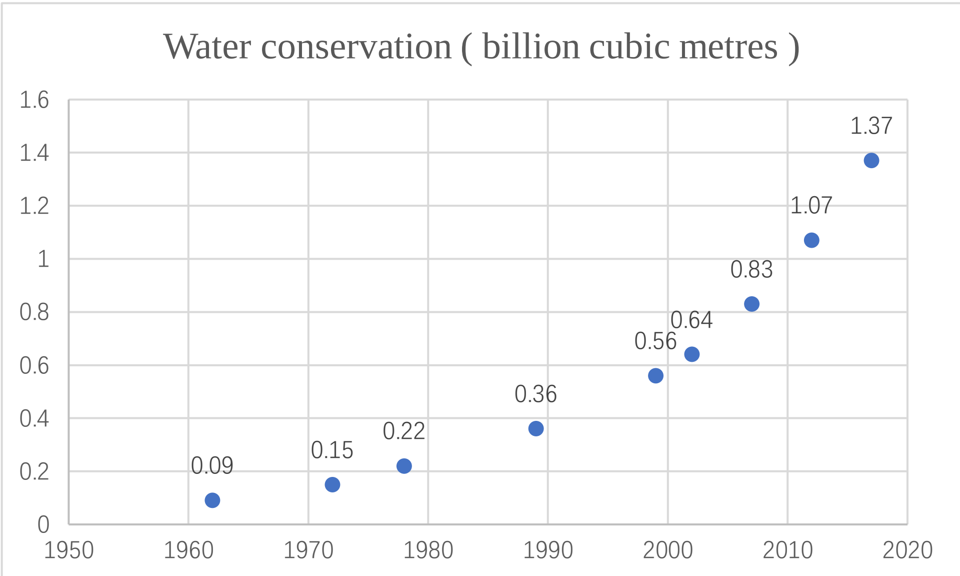
Because the shrub was introduced for windbreak and sand fixation to restore the landform, there were not many or even none before, in order to calculate the need for the value of 1962 as 1 processing.

It can be seen from the table that from 1962 to 2012, the area of forest land was 5.435 times, the area of sparse forest land was 0.0815 times, the area of shrub land was 1097.48 times, and the area of unformed forest was 1.631 times.

As there are many air quality factors, only carbon dioxide absorption is used as its index in this paper, so the statistical data collected are as follows:



Similarly, the statistical water conservation amount is as follows:



It can be concluded that compared with 1962, water conservation in 2017 is 11.89 times of that in previous years, and air quality is 28.33 times of that in previous years.

In the calculation of biodiversity data, the data of species richness in Saihanba Nature Reserve in this paper are referred to because many data cannot be measured.

The species richness was discussed at patch scale: Herb: 9.305; Bush: 1.718; Tree: 1.790

We measured the biodiversity value of the region according to the species richness of the region corresponding to the three patches, which was divided into three levels, and each level had different biodiversity value:Level 1: Grass: 9.305;Level 2: Shrubs: 1.718;Level 3: Woodland: 1.790.

We refer to shannon-Wiener index, which is used to measure species richness, and get the formula:

$$S = \sum P_i, A_i$$

Pi is the value of biodiversity per unit area corresponding to level I. Ai is the area of level I region.

We regard the value of biodiversity at different levels in different years as approximately unchanged, and that of biodiversity at other terranes as approximately equal. Due to its small impact, we only need to compare the changes in the area of $S = \sum P_i, A_i$ to conclude that, Multiple of biodiversity value expansion =9.305*0.376+1.718*1097.48+1.790*4.68=1897.347

After the completion of the statistical data, the weight matrix of the data was established, which was 4*3*3=36. Since only the comparison of 1962 and 2012 data was conducted, each matrix was a 2*2 diagonal square matrix.

By writing the analytic hierarchy function *AHP()*, the feature vector matrix W_i is generated for each weight matrix, and the feature vector matrix W_j is generated for each original data matrix and spliced into the total feature vector matrix W_j. Finally, $W_i \times W_j$ was used to calculate the evaluation factors in 2012 and 1962, which were 0.871 and 0.129 respectively. Therefore, the ecological environment of Saihanba has been optimized by 0.871/0.129=6.7 times in 50 years.

3.2 Program implementation:

Designing AHP function

function [W, Lmax, CI, CR] = AHP(A)

% Input: A is pairwise comparison matrix

% Output: W is the weight vector, Lmax is the maximum eigenvalue, CI is the consistency indicator, and CR is the consistency ratio

```
[V,D] = eig(A);
[Lmax,ind] = max(diag(D));          % Find the maximum eigenvalue and its position
W = V(:,ind) / sum(V(:,ind));       % normalize the eigenvectors corresponding to the maximum eigenvalues
Lmax = mean((A * W) ./ W);          % Calculate the maximum eigenvalue
n = size(A, 1);                     % Matrix rows
CI = (Lmax - n) / (n - 1);          % Calculating consistency indicators
% Saaty，random consistency index value
RI = [0 0 0.58 0.90 1.12 1.24 1.32 1.41 1.45 1.49 1.51];
CR = CI / RI(n);                    % Calculating the consistency ratio
```

3.3 Evaluation of the model

3.3.1 Advantages of the model

This model adopts analytic hierarchy process (AHP) to comprehensively and methodically analyze all indexes that have influence on Saihanba, and to complete the analysis of the ecological environment indexes of Saihanba by elaborating the complex index of tree resource area at different levels. In addition, we restored the condition of the sand flying all over the sky in Saihanba by borrowing the relevant data of the otindag Sandy land with similar conditions, and realized the reasonable and relative authenticity of the data.

3.3.2 Weaknesses of the model

In the Analytical Hierarchy Process, the setting of various weights is completely determined by ourselves, and in order to meet the independence test (CR<0.1), the setting of partial weights has certain limitations, so we can only coordinate the relationship between each weight and objective facts as much as possible.

3.3.3 Accuracy of model

The CR of weight matrix ABC all satisfies CR<0.1, and the final calculation value of more than 6 times of the model is basically true to the actual situation.

3.3.4 Conclusion

From 1962 to 2012, the ecological environment of Saihanba was improved 6.7 times

3.4 Summary

We need to query data of sihanba and set up ecological evaluation model, then we adopt the analytic hierarchy process to establish multiple layers, and establish the the influence factors weight matrix, finally we combined the actual data to complete each weight assignment, and realized the comprehensive evaluation. It is concluded that 1962-2012 6.7 times sihanba optimized the ecological environment.

4. Problem 2 : The contribution of anti-sand capacity of Saihanba to anti-wind-sand work in Beijing

First, we analyzed the correlation between the dust retention amount of Saihanba and the dust weather frequency of Beijing over the years, and found that there was a positive correlation. Secondly, we established a calculation model of dust discharge in sandy land to quantify the contribution of Saihanba to the anti-wind-sand in Beijing.

4.1 Estabilsh the model

4.1.1 Calculation model of dust retention in woodland

First of all, we need to quantitatively analyze the wind-sand resistance capacity of Saihanba and evaluate its effect in the wind-sand resistance work in Beijing. The sand resistance of Saihanba is mainly reflected in two aspects: first, the root system of vegetation has a sand-fixing effect; second, the tree canopy can increase the surface friction and reduce the wind speed and sand blowing.

This paper queries data through academic papers, government information and other channels, and obtains detailed relevant data from 2002 to now, and decides to conduct modeling based on the data. Since 2002, Saihanba area has had a very high vegetation coverage rate and is no longer the source of dust weather in Beijing. In this paper, the dust retention ability of Saihanba forest farm was used as an index to determine its ability to resist sand storms, and the correlation analysis was first made with the dust weather frequency and air quality in Beijing.

However, the windbreak and sand-fixation effect of Saihanba is only one factor to determin the size of sand dust, which is also affected by terrain, wind direction and wind strength, soil desertification degree and other factors. In the paper "Changes of VEGETATION coverage in Sandstorm Source Region -- A Case Study of Beijing", the correlation analysis between vegetation coverage values and the number of sandstorm outbreaks in Beijing was carried out by taking the area near Saihanba where Beijing, Inner Mongolia and Hebei meet, but the results were not satisfactory. In this paper, precipitation and other factors are considered to be the main factors for the occurrence and development of dust weather in Beijing. Recalling the desert scene of Saihanba half a century ago, we must affirm its important contribution to the improvement of dust weather in Beijing in the past decades. Therefore, the changes of precipitation, temperature, frost-free period and other factors in Saihanba can be quantified in a wider time span to the anti-dust work in Beijing. Therefore, we only analyze the correlation between the wind prevention and sand-fixing effect Q of Saihanba and the dust weather Y of Beijing.

Firstly, the model analyzes the correlation between saihanba dust retention capacity and dust weather in Beijing. In 2019, an academic paper "Evaluation of Forest Ecosystem Service Value of Saihanba Mechanical Forest Farm in Hebei Province" calculated the annual dust retention of Saihanba Mechanical Forest Farm at 156,389.65 t based on the average value of relevant indexes in Hebei Province in "Research on Forest Accounting in China under the Framework of Green National Economy". By studying the UFORE model of dust retention in green space, we obtained the dust retention ability index Q used to describe Saihanba forest farm.

$$Q = F \times L \times T \qquad (1)$$

Q is the total amount of pollutants retained in the forest farm within a certain time (g), F is the pollutant flux ($g \times M^{-2} \times S^{-1}$), L is the total canopy coverage area of green space (M^{-2}), and T is time (s).

$$F = Vd \times C \qquad (2)$$

The calculation of pollutant flux F is shown in Formula (2), where Vd is the dry deposition rate of a specific atmospheric pollutant (m/s), and C is the atmospheric concentration of the pollutant (g / m^3).

$$L = A \times \Psi \qquad (3)$$

We estimate the total canopy area of green space with the forest area of Saihanba, set the forest canopy coefficient ψ, and A is the forest area of forest farm (M^2).

Dust weather mainly takes PM 10 as air pollutant. According to relevant papers, the change of dry deposition rate of air pollutant in the same area is not large on time scale, so *Vd* is regarded as a constant in the calculation process.

$$C = C_{PM2.5} \times \delta$$

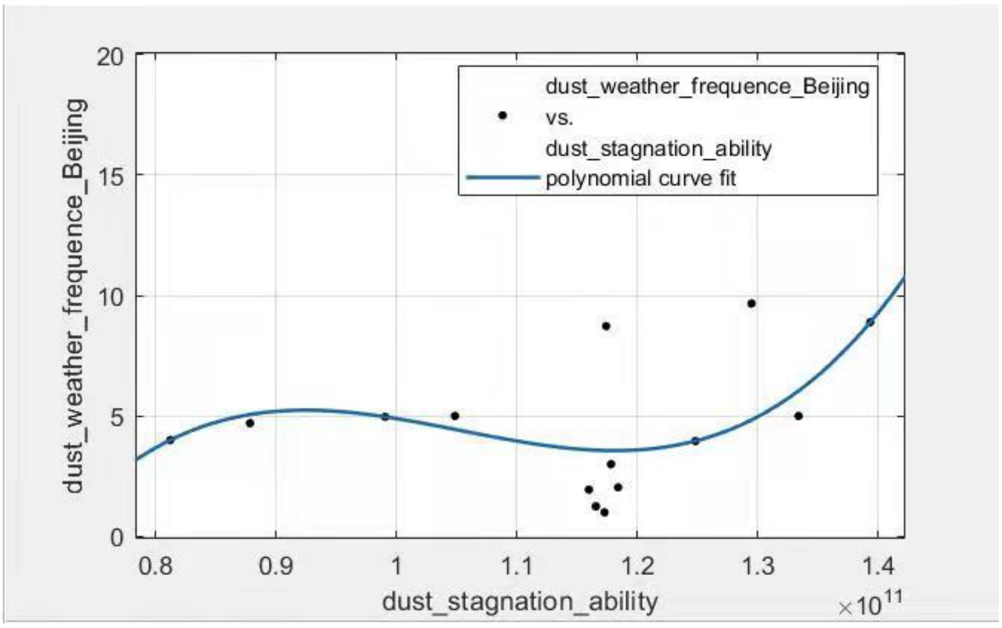
Because the relevant data of PM10 is incomplete, the content of PM2.5 in PM10 has a strong correlation between Beijing and The border of Inner Mongolia,...... According to the data in the paper, the ratio of PM2.5 to PM10 ranges from 0.31 to 0.96, with an average of 0.72. We set the ratio of PM2.5 to PM10 as δ, and $C_{PM2.5}$ (g / m^3)as PM2.5 concentration in the atmosphere.

4.1.2 Correlation between dust retention effect of Saihanba and dust weather frequency in Beijing

Up to now, we have been able to calculate the dust retention ability index Q of the forest farm, which can carry out correlation analysis with the dust weather Y in Beijing.

Firstly, the function $Q = F(t)$ of forest field dust retention ability index Q with time was found. However, only A and $C_{PM2.5}$ parameters in the formula of Q changed with time, so the formula was changed as $Q = c \times A \times C_{PM2.5}$, and c was the parameter to measure other time-invariant indexes.

The data of a few years of the annual dust days Y (day/year) in Beijing are not complete, so the cubic polynomial interpolation method is used to expand the data. Then spearman correlation coefficient is used to estimate the correlation between the two variables Q and Y.The correlation from 2002 to 2018 is compared, and the correlation r=0.4905. That is, there is a strong positive correlation between the two.



Then, Q-Y scatter diagram was made and curve fitting was carried out. Finally, the cubic polynomial fitting function was adopted to reach *R2*=0.5689. It could be seen that there was a certain positive correlation by observing the curve.

4.2 Quantification of the influence of Saihanba on wind-sand resistance in Beijing

4.2.1 Problem reanalysis

Considering that the interpolation method may influence the final correlation coefficient result,and the results of correlation analysis are not ideal, it is not easy to obtain the quantitative relationship between vegetation and dust weather in a large range.

Because the correlation results are not ideal, another feasible scheme is to measure the specific effect of Saihanba on resisting wind-blown sand in Beijing by raising dust from the sand source.

4.2.2 Calculation model of dust volume in sand source area

By reference to the paper "Technical Guide for Compilation of Particulate Matter Emission Inventory from Dust Sources (Trial)"we established a calculation model of dust emission in sandy land:

$$W = E \times As$$

$$E = D \times \tau \times (1-\eta) \times 10^{-4}$$

$$D = K \times I \times \varphi \times \Lambda \times V$$

$$\tau = 0.0504 \times \mu^3 / PE$$

$$PE = 1.099 \times P / (0.5949 + 0.1189 \times Ta)$$

In the model, *W* is the total emission of particulate matter in dust, *t/ A*; *E* is the emission coefficient of dust source, $\frac{t}{m^2 \times a}$; *As* is the dust source area, m^2; η is the removal efficiency of dust pollution control measures (if the demand is analyzed), and the value of spraying dust suppressant is 0.48. *D* is dust factor, $\frac{t}{m^2 \times a \times 10^4}$;

τ is a climatic factor representing the influence of meteorological factors on soil dust. *K* is the percentage of TSP in soil dust 1; *I* is the dust index in sandy land. According to data estimation, mobile sandy land is 114, semi-mobile sandy land is 96, semi-fixed sandy land is 64, fixed sandy land is 34, $\frac{t}{m^2 \times a \times 10^4}$.

Λ is the ground roughness factor, which is 0.5 in the model. As a non-shielding width factor (Λ=0.7 when the non-shielding width is ⩽300m, Λ=0.85 when the non-shielding width is <600m, and Λ=1.0 when the non-shielding width is ⩾ 600m), the model takes Λ=1.0.

V is the vegetation coverage factor, and the value is 0.9. *U* is the annual average wind speed, 4.5m/s; *PE* is the santhwaite precipitation - evaporation index; *P* is annual precipitation, 275mm; Ta is the annual average temperature, 1.5℃

The precipitation - evaporation index of Sunshitwaite in otindag Sandy Land was calculated by the program:

$$PE = \frac{1.099 \times 275}{0.5949 + 0.1189 \times 1.5}$$

4.2.3 A quantitative model of saihanba's contribution to anti-aeolian sand in Beijing

After calculating the amount of dust in Otindag Sandy Land, the most direct source of sand in Beijing, through the model, we established the dust retention/dust removal model in order to quantify the contribution of Saihanba to the anti-aeolian sand in Beijing:

$$\mu = \frac{Q}{\kappa \times W - J \times Ar}$$

μ is the contribution rate of dust retention, %; Q is the dust retention amount of forest farm 156389.65, t/a; κ is direction coefficient of dust in sand source area; W is the amount of dust in the sand source area, t/a; J is dust fall amount per unit area, $\frac{t}{km^2 \times a}$; Ar is the route area from sand source to Beijing, km^2.

Where, κ can be calculated from the historical wind direction statistics of Xilinhot referring to dust routes:

$$\kappa = 0.434928849$$

refer to references, 83.22 $\frac{t}{km^2 \times a}$ was selected in the model as J; Ar is 4.9 * $10^{10} m^2$ (49,000 square kilometers) when scaled up on the map.

Finally, it is calculated that μ=0.1077, that is, the wind-proof and sand-fixing capacity of Saihanba contributes up to 10% to the dustproof work of Beijing.

4.3 Program implementation

When calculating parameter D, we need to consider the different influences of different types of sandy land (including flowing, semi-flowing, fixed and semi-fixed four types) $d_{1\sim4}$, and finally integrate.

4.4 Evaluation of the model

4.4.1 Advantages of the model

The second contribution model is adopted. Because the second model adopts a large number of ready-made mathematical formulas and has a large number of references for parameter setting, the design is reasonable, so the final conclusion is reasonable.

4.4.2 Weaknesses of the model

The first model we used only considered the contribution of a single factor to the sand prevention work in Beijing. Although the correlation and other numerical indicators were ok, the results of the fitting curve were not satisfactory, and there was basically no strong positive correlation.

4.5 Summary of question two

We first calculated the correlation between the sand control capacity of Saihanba and the sand control work of Beijing. However, due to the many influencing factors of sand control, it is difficult to have a strong positive correlation with the sand control capacity of Saihanba. Therefore, we changed our thinking to establish a dust retention/dust removal model to calculate the contribution rate of dust retention, and the final result is satisfactory: Saihanba in Hebei province alone accounts for 10 percent of Beijing's dust control efforts.

5 Problem 3 : Ecological models have been expanded across the country

5.1 Urban screening suitable for establishing ecoregions

5.1.1 Provincial screening and data processing

The important purposes of Saihanba Forest Farm are wind protection and sand fixation, water conservation, carbon neutrality and ecological restoration. Therefore, if the need is to be extended of Saihanba model to places around the country, we should first determine the areas with corresponding conditions and needs. Using these indicators, we adopt hierarchical screening to select the qualified areas in China for layers of screening, and constantly close to the governance areas similar to Saihanba ecological protection zone.

In order to identify the need for wind protection and sand fixation, the distinction was first selected by provinces. We take different types of sand areas as the index, and screen out provinces with no special wind and sand fixation demand. Provinces or regions with major needs for water conservation, soil loss, and ecological restoration can be considered separately. Several provinces with a wide range of regions were subdivided (such as Inner Mongolia and Xinjiang), compared with annual precipitation/evaporation, altitude, annual minimum temperature and survival requirements of several plantation tree species, to identify cities suitable for planting plantations and ecological restoration.

Therefore, the first step is to find the summary table of sand area of each province in 2000 and put it in Schedule 5-1.

Therefore, the first step is to find the summary table of sand area of each province in 2000 and put it in Schedule 5 – 1.

(Data from Western China Environmental and Ecological Science Data Center)

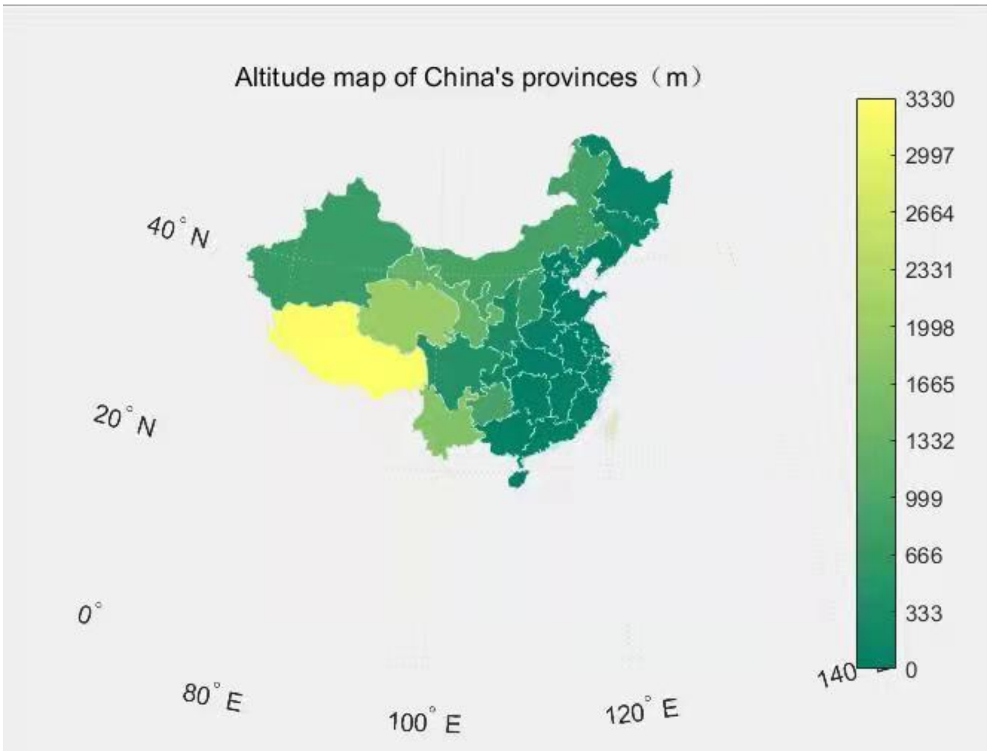
The group also collected and studied the sensitivity of different types of sandy land to wind erosion, and put it in Schedule 5 – 2.

From Appendix Table 5-2, we use the median of erosion modulus of different sandy land to determine its weight. The median of erosion modulus is [11500,10000,5250,1350], which can be normalized to [0.409,0.356,0.187,0.048].

Assuming that $K = A \times w$, the values of each province are divided by the values of Hebei Province to evaluate the necessary factors for the expansion of the Saihanba model. Compute it as a table to obtain Schedule 5-3.

According to Schedule 5-3, data can be obtained the first layer of rough model screening and Xinjiang, Inner Mongolia, Qinghai, Gansu, Shaanxi, Tibet, Ningxia, Jilin eight provinces.

Next, we conducted a secondary screening of the remaining provinces. In the study of the planting area of different trees in Saihanba, it can be obtained that the main tree species are larch, birch, Pinus sylvestris var. mongolica and oak. The survival conditions of different tree species are investigated as follows : larch is generally planted between 300 and 1500 meters above sea level, and the temperature can tolerate the cold below 50 degrees, and can be planted in places with less barren water content. Betula platyphylla can be planted between 1300 and 2700 meters above sea level. Pinus sylvestris var. Mongolica is mainly produced in 400 to 900 meters of Greater Khingan Mountains, cold tolerance and less precipitation ; oak trees are planted below 600 meters in Northeast China and above 800 meters in North China. The average altitude of the remaining provinces is summarized in Tables 5-4.



	Average altitude (m)
Qinghai province	>3000
Shaanxi province	1127
Gansu province	1500
Tibet Province	>4500
Ningxia province	>1000
Inner Mongolia	1580
Jilin province	374
Xinjiang province	-155~8611

Although the forest trees used in the planting of Saihanba are cold-resistant species and can survive at high altitudes, their survival rate will greatly reduce the economic benefits. After that, the group collected the data of the national precipitation distribution in 2020 and drew them in the Appendix 5 – 5.

National Precipitation Distribution in 2020	
Precipitation (mm)	lebensraum
>2000	Southern Anhui, southeastern Hubei, northern Jiangxi, western Zhejiang, northwestern Fujian, northwestern Hunan, and northeastern Guangxi
1200～2000	Middle and lower reaches of the Yangtze River and most areas south of it
400-1200	Northeast, North China, Southeastern Northwest, Huanghuai, Most of Jianghuai, Northern Jianghan, Northeast Inner Mongolia, Southern Qinghai, Eastern Tibet, Most of Sichuan
100～400 or <100	Central Inner Mongolia, most of Ningxia, central Gansu, central Qinghai, central Tibet, northern Xinjiang, south-central Xinjiang, northwestern Qinghai, western Gansu, western Inner Mongolia, western Tibet 部

According to the data in Schedule 5 – 4 and Schedule 5 – 5, it can be obtained that there are also some areas in Inner Mongolia where the Saihanba model is suitable. Therefore, in the second screening, we reserve the areas with wide climatic area in Xinjiang and Inner Mongolia, and exclude Qinghai and Tibet according to the enforceability of economic benefits and altitude.

5.1.2 Quantitative analysis of wind-blown sand demand in cities

In order to quantify the demand of each province to combat wind and sand, we refer to many papers and ' Technical Guidelines for the Preparation of Dust Source Particulate Emission Inventory (Trial) ' to establish a calculation model of dust emission in sandy land :

$$W = E \times As$$

$$E = D \times \tau \times (1-\eta) \times 10^{-4}$$

$$D = K \times I \times \varphi \times \Lambda \times V$$

$$\tau = 0.0504 \times \mu^{3} / PE$$

$$PE = 1.099 \times P / (0.5949 + 0.1189 \times Ta)$$

W is the total emission of particles in dust, t / a ;

E is the emission coefficient of dust source, $\frac{t}{m^2 \times a}$; a is dust source area, m^2 ;

η is the removal efficiency of dust pollution control measures (0 in the model due to the analysis of wind-sand resistance demand), % ;

d is dusting factor, $\frac{t}{m^2 \times a \times 10^4}$;

c is climatic factor, representing the influence of meteorological factors on soil dust ;

k is the percentage of TSP in soil dust ;

i is the wind erosion index of sandy land (by data estimation, mobile sandy land is 1740, semi-fixed sandy land is 928, fixed sandy land is 290), $\frac{t}{m^2 \times a \times 10^4}$

f is the ground roughness factor, 0.5 in the model ;

Λ is the ground roughness factor, which is 0.5 in the model. As a non-shielding width factor (Λ=0.7 when the non-shielding width is ⩽300m, Λ=0.85 when the non-shielding width is <600m, and Λ=1.0 when the non-shielding width is ≥ 600m)

After calculating the dust emission in the program, we determine the different parameter values, and further validate the selected provinces and obtain similar results.

5.1.3 Cities screening and data processing

Then in the six provinces we look for their weather stations and record the wind direction data with bands to approximate the average wind speed of the province and place it in Appendix Table 5-6.

	Average wind speed (m / s)
Qinghai province	omission
Shanxi province	1.94
Gansu province	5.0~6.5
Tibet province	omission
Ningxia province	2~7
Inner Mongolia	6~7
Jilin province	1.6~7.9
Xinjiang province	2~8

5.1.4 Final list of cities

In the six provinces waiting, we summarize the cities with high carbon emissions and large population into Appendix Tables 5 – 7. We conducted a preliminary screening of cities according to precipitation. It is worth noting that cities with an average precipitation of between 400 are retained for reanalysis. Final summary of cities :

Province	City Name	year	CO2	Annual precipitation (mm)
Gansu	Pingliang	2016	9.96147	511.2
Gansu	Qinyang	2016	19.0737	537.5
Gansu	Longnan	2016	8.516924	507
Jilin	Siping	2016	26.98095	650
Jilin	Liaoyuan	2016	9.935659	666.5
Jilin	Tonghua	2016	18.82221	788

Jilin	Baishan	2016	12.57749	883.4
Jilin	Songyuan	2016	16.79781	432
Jilin	yanbian koren autonomous prefecture	2016	21.5487	550
Inner Mongolia	Hulunbeier	2016	80.75446	400.9
Ningxia	Guyuan	2016	14.73439	492.2
Shanxi	Xian	2016	44.25613	1018
Shanxi	Yanan	2016	52.56056	542.6
Shanxi	Hanzhong	2016	11.75481	1129.8
Shanxi	Yuling	2016	55.96349	400
Shanxi	Shangluo	2016	6.969961	786.7
Xinjiang	Yili Kazakh autonomous prefecture	2016	24.82527	880

5.2 Carbon neutrality and plantation size

And Ordos, Altay, Hohhot and Kashgar with relatively large change factors

and the Xilinguole League near Saihanba (where the Hunshandake Sandy Land is located).

Finally, the final city is selected, and its carbon emissions are summarized. The data show how much carbon emissions can be absorbed by each hectare of ecological forest, which is denoted by B. The ecological area to be established is denoted by A. According to the definition of carbon neutralization, AB = carbon emissions.

(Average forest uptake of about 1.83 tonnes of carbon dioxide per cubic metre of tree growth

According to Bao Guoqing, the forest area of the key state-owned forest areas in Daxing 'anling, Inner Mongolia is 837,000 square kilometers, and the total volume of standing trees is 10.33 billion cubic meters. According to the calculation of the average forest absorption of about 1.83 tons of carbon dioxide per cubic meter of trees, the total forest carbon storage in the key state-owned forest area of Daxing ’ anling Mountains in Inner Mongolia is about 1.89 billion tons. At present, the forest area adds about 40 million tons of forest carbon each year, which is a huge “ carbon storage ”.)

5.3 Ecoregions established and their contribution to carbon neutrality in China

From the carbon emissions of the last major cities, the final carbon neutralization amount is about 436 million tons, and the ecological protection area to be established is 193,000 square kilometres. According to the survey data, China 's carbon emissions in 2016 are about 160 million tons, so the carbon neutralization degree increased by2.75 percent.

5.4 Program implementation

The program only needs to be realized by the above mathematical formula.

5.5 Model evaluation

5.5.1 Advantages of model

The model is the continuation of the second mathematical model in question 2. Due to the application of a large number of existing mathematical formulas, reasonable parameters are set, which makes the evaluation of the model more accurate

5.5.2 Disadvantages of model

It is not accurate to estimate the dust retention index only, and more reference variables should be added if possible.

5.6 Summary of Problem Three

Question 3 Completes Urban Screening through Quantitative Model

6 Problem 4 : Extension of ecological models to the Asia-Pacific region.

6.1 Model establishment and brief explanation

The extension of the ecological model to the Asia-Pacific region is similar to the above model. We adopt the hierarchical screening model. First, we preliminarily extract the main countries from the national regions through simple indicators. Then, we collect data from the countries and estimate the entropy weight evaluation model to identify the countries closest to the Saihanba region model, and then select the countries.

6.2 Preliminary screening of Asia-Pacific countries

We look for information on precipitation in various parts of the world and also summarize it and expand it to the Asia-Pacific region to map its national distribution, as shown in Appendix 6-1, 6-2.

6.3 Countries most similar by entropy method

According to the elevation map of the precipitation map and the necessary alignment of the national distribution map, we simply removed many Asian and Pacific countries to reduce the scope of the selection of countries to reduce unnecessary workload and improve some accuracy.

After preliminary screening, we collected the data of the country ’ s sand area, average precipitation, per capita carbon dioxide emissions, and average temperature, and used them as the indicators used in the entropy weight method. The chart is shown in Appendix Tables 6 – 3.

In the process of data collection and processing, we make different assumptions about the data :

1. Due to the large span of Mongolia, we divide it into northern Mongolia and southern Mongolia, and its carbon emissions are replaced by national per capita emissions. Temperature is also used as the national average temperature contrast. Due

to the variability of temperature, there are significant differences in annual average precipitation between the two places, so the annual average precipitation is treated separately.

2. Due to the small size of land such as Japan and South Korea and the inability to deal with the size of the sandy land, 0.01 million square kilometres are dealt with uniformly in this form

After getting the table data, the entropy weight method is used to calculate its weight, so as to obtain the contribution of different indicators to our evaluation model, and multiply its contribution and its value to obtain the evaluation value.

From the graph we can see that our indicators from left to right are :

$$X_1, X_2, X_3, X_4, X_5$$

$$\text{And} \quad X_1 = \{x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8, x_9\}$$

After standardization of each data index, it is :

$$Y_1, Y_2, Y_3, Y_4, Y_5$$

$$\text{now} \quad Y_{ij} = \frac{Xij - \min(Xi)}{\max(Xi) - \min(Xi)} \quad \text{(When the positive index is)}$$

$$Y_{ij} = \frac{\max(Xi) - Xij}{\max(Xi) - \min(Xi)} \quad \text{（When the negative index is）}$$

If the variation degree of each index is P, there are :

$$P_{ij} = \frac{Yij}{\sum_{i=1}^{9} Yij}, \text{i=1,2……9;j=1,2,…5.}$$

Suppose the information entropy is *E*, its weight is ϖ , and the evaluation value is *S*. According to the definition of information entropy:

$$E_j = -\ln(n)^{-1} \sum_{i=1}^{9} Pij \ln Pij$$

$$\varpi = \frac{1-Ej}{k-\sum Ej}(j=1,2,...,5)\text{,Here k = 5。}$$

$$Si = \sum_{j=1}^{5} \varpi j * Pij$$

According to the calculation, the evaluation values of different countries are as follows :

	S
Northern Mongolia	0.08016291
Australia	0.448227533
Indonesia	0.062072154
Malaysia	0.088888639
Korea	0.048074713
Republic of Korea	0.067248974
Japan	0.068550662
New zealand	0.060631413
Southern Mongolia	0.076143002

Since the previous evaluation value of the Saihanba is 0.08, it can be obtained that the establishment of the Saihanba ecological protection model in northern Mongolia is the best choice.

6.3.1 Selection of ecological zones in Mongolia

According to the data query of the international version of the Belt and Road, Mongolia is a mountainous country with relatively small plain area. the mountainous area is 777,000 square kilometers, accounting for one-half of the total area ; the Gobi Desert covers an area of 400,000 square kilometres, or a quarter of the total area ; as the situation in Mongolia gradually becomes gentle from west to east and has 250,000 square kilometres of eastern plains in the east, we will further the selected area to the northeast or east of central Mongolia.

Since the trees in Saihanba are all cold-resistant species, the frost-free period brought by the northern cold wave on the side of Mongolia has little effect on it. Considering that the temperature in the central and eastern regions is about 20 degrees, and the terrain is flat, and the urban distribution map of Inner Mongolia is compared, we delimit the selected area in the Gobi area of Guqinguerban in Zag, Suji and Nomin. The distribution of Mongolian cities is shown in Tables 6 – 4.

According to the survey data, more than 60 per cent of people live in the Middle East of Mongolia, so in 2021 their carbon emissions from urban waste gas fuel combustion, etc. are approximately = projected total population * 0.6 * per capita emissions (excluding subsistence) = 3121772 * 7.0882 * 0.6 * 0.5 = 6632516.791 (metric tons)

6.3.2 Results of carbon neutralization

Each cubic meter of trees can absorb 1.83 tons of carbon dioxide, so it is necessary to plant 0.030.28 million square kilometres of trees. It can reduce about 6.63 million tons of carbon dioxide, which has a great impact on carbon neutralization. About 30 % increase in Mongolian carbon neutrality.

6.4 Program implementation

```
[n,m]=size(x);
[X,ps]=mapminmax(x',0,1);
ps.ymin=0.002;
ps.ymax=0.996;
ps.yrange=ps.ymax-ps.ymin;
X=mapminmax(x',ps);
% mapminmax('reverse',xx,ps);
X=X';
for i=1:n
    for j=1:m
        p(i,j)=X(i,j)/sum(X(:,j));
    end
end
k=1/log(n);
for j=1:m
    e(j)=-k*sum(p(:,j).*log(p(:,j)));
end
d=ones(1,m)-e;
w=d./sum(d);
s=w*p';
```

6.5 Model evaluation

6.5.1 Advantages of model

The entropy weight method can effectively balance the relationship between various indicators, so that we can find out several countries with high similarity through the original data of multiple irrelevant indicators, and then complete the Q of this problem

6.5.2 Disadvantages of model

Some data are not very accurate, which weakens the evaluation effect of this model. If more parameters and more accurate original data can be introduced.

6.6 Summery of problem4

Question 4 Completed the screening of countries and their territories through quantitative models

7 Problem 5 :

Model of Ecological Zone Based on Saihanba Forest Farm

Summary report of mathematical model

ACPMCM

Nov . 29 , 2021

China is carrying out the strategy of sustainable development with the concept of green water and green mountains. Since ancient times, the Chinese people have embraced the sustainable concept similar to the law of nature and the unity of nature and man, which is close to ecological environmental protection, and follow the green environmental protection philosophy of respecting nature and living in harmony with nature. Nowadays, China ' s ecological protection construction, insisting on saving priority, protection priority and natural recovery priority, takes into account China ' s future carbon neutral demand and the spirit of sustainable development in the new era, and promotes the economic and social development to the economic development of comprehensive green environmental protection. China has made continuous efforts in the improvement of the overall coordination mechanism of ecological civilization and the construction of ecological civilization system, and has become unique in the world, showing the responsibility of major countries on climate and environmental protection issues.

Saihanba mechanical forest farm is a great monument in the history of ecological and environmental protection construction in China. Half a century of efforts and the sacrifice of generations have created the green ocean in northern China. Nowadays, under the call of the new era, Saihanba plantation is slowly planning to cultivate natural forests, realize further ecological restoration, and lead the ecological construction and carbon neutralization in the new era.

Taking Saihanba Forest Farm as a reference, we have established several models, which can be divided into the following three categories :

The first model is based on the ecological benefits of the ecosystem carried by various environments of the Saihanba to evaluate the impact of the Saihanba on the ecological environment before and after the transformation. The main implementation method of this model is the analytic hierarchy process. The purpose of the model is to quantitatively evaluate the impact of ecological restoration of Saihan Dam on the environment.

The second model is based on the quantitative analysis of the dust retention capacity of the Saihanba and the dust emission of the main sand source areas in Beijing. By establishing the relationship between the two, the quantitative effect of the Saihanba on the wind-resistant sand in Beijing is obtained. The purpose of this model is to quantitatively evaluate the effect of Saihanba on dust resistance in Beijing.

The third model is based on the Saihan Dam as a reference, considering the purpose and conditions for the construction of ecological zones, selecting the appropriate geographical location through mathematical means for the construction of ecological zones, and determining the scale of ecological zones with carbon neutralization as the goal.

Regarding the construction of ecological protection zones, we have the following suggestions :

1.We should fully consider the local climate and hydrology, altitude and soil sand content and other indicators to determine the main tree species of plantations ;

2.In addition to artificial forest, specific varieties of shrubs and herbaceous vegetation in reasonable auxiliary measures, the windbreak and sand fixation effect is still excellent, can adapt to more extreme environment, can refer to the experience of Saihanba to create ecological zone.

3.In addition to the demand of windbreak and sand fixation as the main ecological protection areas, the establishment of ecological areas with the main needs of protecting water sources, maintaining water and soil, maintaining biodiversity and restoring excessive damaged vegetation can also refer to the operation and development model of Saihanba.

For reference Saihanba model to establish the ecological zone, we have specific programs are as follows :

(1) Detailed research, statistical data and modelling of the geographical areas planned to establish an ecological zone ;

(2) The vegetation suitable for cultivation in different regions of the geographical area is calculated through the established model ;

(3) Short-term planning for planting and construction of ecological zones in 5 years and long-term planning for construction of ecological zones in 20 years ;

(4) Submit the plan to the government and apply for funds, while publicizing and raising funds to the society ;

(5) The early construction of the ecological zone, such as the establishment of a real-time digital detection mechanism for the whole region of the ecological zone ;

(6) The first-stage construction of the ecological zone is carried out according to the plan, and the objectives and plans are revised through the current data in the medium term ;

(7) After the construction of the ecological zone has reached a certain level, open tourism business, promote and attract traffic through variety shows, establish projects such as green parent-child activities, attract target groups such as families and students to the ecological zone for forest construction and cost recovery ;

(8) looking for enterprise cooperation and developing characteristic industries ;

(9)The establishment of long-term planning, with the requirements of the new era, new long-term planning ;

Considering that some countries in the Asia-Pacific region are rich in precipitation, but the population pressure is too large, the pollution is serious, and the soil fertility loss is serious, so it is necessary to construct ecological protection zones. As a supplement to the mathematical model in this paper, a scheme of ecological protection zones for secondary forests and artificial forests in tropical rainforest regions is given :

(1) Closed cultivation of secondary forests in tropical rainforests, strengthening protection of natural rainforest areas and developing corresponding tourism. The aim is to protect existing rainforest resources ;

(2) At the level of national economic development, dependence on exports of primary products such as natural resources should be reduced, such as joining the Belt and Road, developing emerging industries and services. The aim is to reduce the systematic destruction of ecological zones by the State ;

(3) Dealing with population pressure should vigorously promote the employment rate of nationals and improve their living standards, while strengthening education and cultivating awareness of environmental protection. The aim is to fundamentally reduce population pressure, while reducing theft and extensive farming.

8 Summery

Based on the ecological model of Saihanba, this paper quantitatively analyzes the environmental restoration of Saihanba according to the survey data, and analyzes its favorable values for the surrounding cities (taking Beijing as an example). Through the obtained favorable results, the ecological model of Saihanba is further promoted. The analytic hierarchy process (AHP) is often used in the establishment of the analysis and evaluation model. In different topics, the expert scoring method and the entropy weight method are used in the analysis of different index weights. From this, it is concluded that the environment before and after the establishment of Saihanba is improved by 127.4 times, and the northern Mongolia in many Asia-Pacific countries is closer to the ecological model of Saihanba.

From the analysis of the models and different methods used in this paper, it can be seen that the major aspect is that the consideration of different indicators is limited, the model is not closely related to the actual situation, and the indicators of analytic hierarchy process cannot be comprehensive. For example, when selecting regions in China and Asia-Pacific countries, economic factors do not give too much weight. In small aspects, there are limitations of different index weights. Expert scoring method is too subjective, entropy weight method is too objective, one method is too dependent on subjective judgment, and the other is completely related to objective data, which leads to low accuracy of the model. However, not many data collected in this paper still have relatively objective quantitative values. It can be seen that analytic hierarchy process still has a certain use value when analyzing the influence of multiple factors.

According to the data obtained in this paper, the establishment of the Saihanba model has great quantitative value for wind prevention and sand fixation maintaining ecological balance, and is conducive to the improvement of water sources and air quality in surrounding cities, so as to develop this ecological model.

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