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Ecological Protection Area Impact and Construction Planning Model

Jinye Chen, Yongqi Cai, Wen Ma

School of physics and electronic-electrical engineering, Ningxia University, Yinchuan, Ningxia, 750021, China

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Abstract: The construction of ecological protection sites has a significant impact on reducing greenhouse gas emissions and improving the ecological environment. The provincial-level administrative regions in China are set up from the **ecological environment aspect**, combine the **entropy weight method** and **RSR** to evaluate the ecological environment of all provinces and classify them according to the ecological environment situation, it is concluded that the ecological environment of **six provinces** are poor. From the **economic development aspect**, establish indicators of these six provinces, evaluate and grade according to the urgency of construction. In addition, holds that the comprehensive establishment of ecological reserve can **increase the rate of carbon emission reduction** in China by about **7%**.

1. Introduction

In recent years, global environmental problems have become increasingly serious, and carbon neutrality has become a key point in the discussion of global warming. Over the years, Chinese government has actively built ecological reserves and implemented eco-friendly policies, playing an active leading role in environmental protection in the Asia-Pacific region. Based on the collection of data, this paper develop a mathematical model to determine which geographical locations in China require the construction of eco-zones and to determine the number or size of eco-zones to be constructed; in addition, assess their impact on achieving China's carbon neutrality targets.

2. Model: Planning of Ecological Reserve

2.1 Eco-environmental evaluation model

Using the rank sum ratio comprehensive evaluation method, the relevant data of 31 provincial administrative regions in China over the past three years were averaged and analysed, and the severity of ecological and environmental problems in all provinces were classified according to three levels: "ecologically good", "ecologically average" and "ecologically poor". All provinces were classified according to three levels: "ecologically good", "ecologically average" and "ecologically poor".

(1) Indicator selection

We selected three indicators: average annual fine weather quantity m_1, annual average vegetation coverage m_2, average annual value $PM_{2.5}$ value m_3.

(2) Model building

With n the provinces are evaluated as a unit n_{ij} define the selected evaluation indicators m_{ij} of which $i = 1,2,\cdots,31$, $j = 1,2,3$. Construct a data matrix with positive correlation indicators m_{i1}, m_{i2} ranking from small to large, and negative correlation indicators m_{i3} from large to small to obtain the rank matrix $R = (R_{ij})_{m\times n}$

$$\begin{pmatrix} R_{11} & R_{12} & \cdots & R_{1j} \\ R_{21} & R_{22} & \cdots & R_{2j} \\ \vdots & & \ddots & \vdots \\ R_{i1} & R_{i2} & \cdots & R_{ij} \end{pmatrix} \tag{1}$$

Using the entropy weighting method for indicators m_j The weights result is: $W_1 = 0.304, W_2 = 0.426$, $W_3 = 0.27$.

Since there is a lack of indicator data in Tibet, the non-integer rank sum ratio method is used to overcome the disadvantage of losing quantitative information of indicators when ranking and introducing new quantitative parameters X_{ij} .

For positively correlated indicators

$$R_{ij} = 1 + (n-1)\frac{X_{ij} - \min(X_{1j}, X_{2j}, \cdots, X_{nj})}{\max(X_{1j}, X_{2j}, \cdots, X_{nj}) - \min(X_{1j}, X_{2j}, \cdots X_{nj})} \tag{2}$$

For negatively correlated indicators

$$R_{ij} = 1 + (n-1)\frac{\max(X_{1j}, X_{2j}, \cdots, X_{nj}) - X_{ij}}{\max(X_{1j}, X_{2j}, \cdots, X_{nj}) - \min(X_{1j}, X_{2j}, \cdots X_{nj})} \tag{3}$$

Calculation of rank and ratio

$$\mathrm{WRSR}_i = \frac{1}{n}\sum_{j=1}^{m} W_j R_{ij} \tag{4}$$

The higher the value of the calculation result, the better the evaluation object. The rank is compiled to obtain $WRSR_i$ the frequency distribution table, and then find its corresponding probability unit probit. Using the probit value as the independent variable and $WRSR_i$ is the response variable, calculate the linear regression equation.

$$y = -0.546 + 0.202 * \text{probit} \tag{5}$$

The significance p-value was found by F-test ≤ 0.0001, the level showed significance. For the performance of variable co-linearity, all VIFs were less than 10, so there was no problem of multiple co-linearity in the model and the model is well constructed. Model goodness of fit R^2 is 0.968, and the model performs relatively well.

(3) Evaluation results

Table 1: $WRSR_i$ Classification criteria

WRSR limit	< 0.2609	$0.2609 \leq 0.6643$	≥ 0.6643
Level	3	2	1
Category	Excellent ecology	General ecology	Poor ecology

Finally, according to the $WRSR_i$ the evaluation objects are classified and ranked according to the classification criteria shown in Table 1.

The classification results are shown in Figure 1, in which the calculated results of the classification of Henan and Shanxi provinces deviated from the actual situation, and both were classified as provinces with poor ecological performance based on RSR_Rank. The final classification results were that a total of six provinces, Henan, Shanxi, Tianjin, Shandong, Hebei and Xinjiang, had poor ecological performance scores.

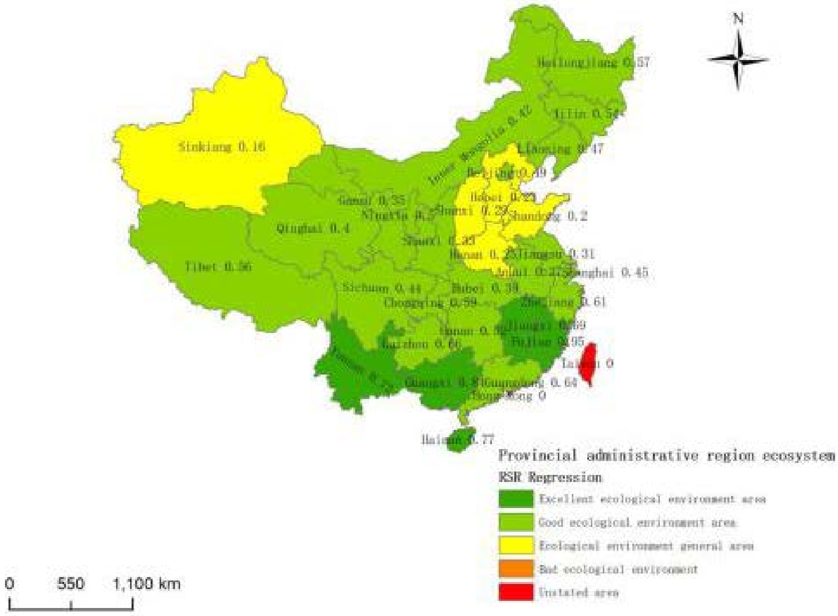

Figure 1: Provincial administrative region ecosystem RSR Regression of China

2.2 Ecological reserve planning evaluation model

Using the rank-sum-ratio comprehensive evaluation method, the relevant data from 31 provincial administrative regions across China over the past three years were averaged and analysed to classify the scale of construction of ecological reserves in all provinces according to three levels: "urgent construction", "priority construction" and "planned construction". The scale of construction of ecological reserves in all provinces was classified according to three levels: "urgent construction", "priority construction" and "planned construction".

(1) Indicator selection

We selected three indicators: Waste gas treatment cost m_1, Forest land proportion m_2, Investment ratio of air pollution control m_3

(2) Model building

Withn the provinces are evaluated as a unit n_{ij} define the selected evaluation indicators m_{ij} of which $i = 1,2,\cdots,6$, $j = 1,2,3,4$. The model construction principle is the same as in section 2.1. Using the entropy weighting method for indicators m_j The weights result is $W_1 = 0.187$, $W_2 = 0.0.623$, $W_3 = 0.12$, $W_4 = 0.07$.

The whole-order rank sum ratio method is used to process the positive and negative correlation indicators and calculate the rank sum ratio. The higher the value of the calculation result, the better the evaluation object. The rank is compiled to obtain RSR_i the frequency distribution table is used to find the corresponding probability unitsprobit .Usingprobit value as the independent variable and $WRSR_i$ is the response variable, calculate the linear regression equation.

$$y = -0.514 + 0.173 * \text{probit} \tag{6}$$

The F-test yielded a significance p-value of 0.025, with the level showing significance. The VIF was less than 10 for all the variables that showed co-linearity, so there was no problem of multiple co-linearity and the model was well constructed. Model goodness of fit R^2 is 0.751, and the model performs relatively well.

(3) Evaluation results

Finally, according to the RSR_i the classification of each evaluation object was ranked, and the classification criteria and results are shown in Table 2. The provinces in urgent need of establishing ecological reserves are Henan, the key provinces are Shanxi and Shandong, and the planned provinces include Tianjin, Hebei and Xinjiang.

Table 2: RSR_i Classification criteria and results

RSR limit	< 0.3512	$0.3512 \leq 0.6108$	≥ 0.6108
Level	3	2	1
Category	Urgent need for construction	Main construction	Planned construction
Province	Henan	Shanxi, Shandong	Tianjin, Hebei, Xinjiang

2.3 Carbon neutralization impact assessment

Statistics on the changes in annual average carbon emissions in the Beijing region in the last three years, carbon emission reduction ratio calculations based on the establishment of ecological reserves near the Beijing region and the carbon emission reduction effect, combined with the evaluation results in section 2.1, different weighting values were assigned to the six provinces based on the volume share of the Beijing region in the total national carbon emissions, in order to assess the short-term carbon emissions of each region after completing the establishment of synergistic nature reserves reduction effect.

Define the carbon emission optimization factor C_r The average value of carbon emissions in Beijing is 0.01 of the national average, and the average value of carbon emissions in Beijing is 0.01 of the national average.

$$C_r = 0.01 * \frac{9300 - 7575}{9300} = 0.1855\% \tag{7}$$

The carbon emission optimization factor for other regions is defined as $C_r{}^i$, and $i = 1,2,3,4,5,6$, defining the weighting factor k_i.

$$C_r{}^i = k_i * C_r \tag{8}$$

Based on the pollution level of the regional industry and the geographical area k_i The carbon emission optimization factors for each province were determined and are shown in Table 3.

Table 3: Carbon emission optimization factors by province

Index	Henan	Shaxi	Shandong	Tianjin	Hebei	Xinjiang
k_i	11	7	5	0.6	9	5
$C_r{}^i$	2.040%	1.298%	0.927%	0.111%	1.669%	0.972%

When all six provinces with poorer ecological conditions are retrofitted with the same benefits as Beijing, it can be assessed that their contribution to the annual average reduction in China's carbon emissions over the next three years will be $\sum_1^6 {C_r}^i = 7.02\%$. This is a significant reduction in annual carbon emissions in China. This is a significant reduction in China's annual average carbon emissions, and will have a significant positive impact on China's ability to achieve its carbon neutrality target.

3. Conclusion

Our model selects indicators from different perspectives for each province, and although the model algorithm is the same for both evaluations, it takes into account both environmental protection and economic development. Our model presents the evaluation results in the form of regional illustrations, which are intuitive and concise.

However, the consideration of the division of the area is simplistic. The environmental and economic situation in the area adjacent to the province and the area adjacent to the state boundary is more complex and a simple division does not help to resolve the actual situation. If the relevant data are available, the area under study should be analysed in further detail. Entropy weighting was used for all objects studied, without taking into account the correlation between the degree of confusion of individual indicators and their actual importance. The calculation method of the weight assignment needs to be refined and improved.

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