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Original Research Article

Determination of Areas in China that Need to Establish Ecological Reserves Based on Entropy Weight Method

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Abstract: Starting with the factors affecting the ecological environment, this paper selects six factors that have a great impact on the ecological environment, such as the annual average temperature in various regions, the vegetation abundance in various regions of China, and takes 34 provincial administrative regions of China as the research object, and establishes an evaluation model based on Entropy weight method.

Keyword: Entropy weight method; Establish ecological reserves

1. Selection of indicators and data preprocessing

1.1 Selection of indicators

It is required to evaluate which geographical locations in China need to establish saihanba ecological protection model ecological areas, so indicators can be selected from the factors that can reflect the ecological environment of a region. Through literature review and data collection, this paper selected five initial indicators of vegetation abundance, land utilization rate, desert area, annual average precipitation and air quality in each region of China to evaluate each geographical location in China.

1.2 Indicator Description

China regional vegetation abundance: the greater the vegetation abundance in a region, the more complex its structure and the better its ecological stability. Therefore, this index can reflect the ecological stability of a certain area to a certain extent.

Land use efficiency: The higher the land use efficiency of a region, the better the ecological environment of the region. Therefore, this index can reflect the quality of the ecological environment of a region to some extent.

Regional desert area: The larger the desert area of a region is, the more desolate the region is and the worse the ecological environment. Consequently, the index of desert area can reflect the ecological environment of a region to a certain extent.

Regional average precipitation: precipitation can also reflect the quality of the ecological environment of a region to a certain extent. Therefore, this index can reflect the quality of the ecological environment of a certain area to a certain extent.

Air quality: The worse an area is ecologically, the worse its air quality. To a certain extent, air quality can also reflect the quality of the ecological environment in a certain area.

2. Based on the entropy weight method, the evaluation model of the geographical location of ecological protected areas needs to be established in China

Entropy weight method is a comprehensive evaluation method that can be applied to multiple objects and indicators. Its evaluation results are mainly based on objective data, almost not affected by subjective factors, and can avoid the interference of human factors to a large extent.

Subject to evaluating Chinese geographical location which need to create ecological reserves and establish the evaluation model based on entropy weight method, with China as evaluation object, 34 provincial administrative areas in the above the five to rate the specific data to establish the matrix, and finally select a score lower region, is the need to establish ecological reserve of geographic location.

2.1 Establish the evaluation system and construct the index horizontal matrix R

In order to reasonably simplify the model and eliminate some cities with good environment in recent years, 7 regions with poor or fragile ecological environment are selected for analysis, namely Inner Mongolia, Xinjiang, Shanxi, Shaanxi, Gansu, Tibet and Ningxia.

Matrix R has M (7) evaluation objects and N (5) evaluation indexes.

$$R=\begin{bmatrix} r_{11} & \cdots & r_{1n} \\ \vdots & \ddots & \vdots \\ r_{m1} & \cdots & r_{mn} \end{bmatrix}$$

doi: 10.18282/l-e.v10i5.2754

2.2 Standardize the evaluation matrix to obtain the matrix $R' = (r_{ij})_{m*n}$

The relative deviation method is used to standardize the judgment matrix and eliminate the dimension of each index measure value. Calculate the standardized measure value according to the formula r_{ij}

J is a positive indicator: $r_{ij} = 0.998 + \frac{r_{ij} - min\{x_{1j}, x_{2j}, \ldots x_{nj}\}}{max\{x_{1j}, x_{2j}, \ldots, x_{nj}\} - min\{x_{1j}, x_{2j}, \ldots, x_{nj}\}} + 0.002$

J is the backward indicator: $r_{ij} = 0.998 + \frac{max\{x_{1j}, x_{2j}, \ldots x_{nj}\} - r_{ij}}{max\{x_{1j}, x_{2j}, \ldots, x_{nj}\} - min\{x_{1j}, x_{2j}, \ldots, x_{nj}\}} + 0.002$ (1)

The forward indicator refers to the higher the value of this indicator is, the better the expression effect is, which is called the forward indicator; otherwise, the reverse indicator refers to the lower the value of this indicator, the worse the expression effect is, which is called the reverse indicator. In this case, vegetation classification, land utilization rate, air quality and precipitation in each region are positive indicators, while desert area in each region is backward indicators.

Table 1. Index horizontal matrix

area	α_1	α_2	α_3	α_4	α_5	α_6
β_1	0.5010	0.6673	0.6673	0.0020	0.6673	1
β_2	0.0020	0.6673	1	0.0020	0.6673	0.6673
β_3	0.2515	1	0.6673	0.3347	0.0020	0.3347
β_4	0.7505	0.0020	0.3347	1	0.3347	0.6673
β_5	1	1	0.3347	0.0020	0.6673	0.0020
β_6	1	0.0020	0.0020	0.6673	0.3347	0.6673
β_7	0.7505	1	0.6673	0.0020	1	0.6673

2.3 Calculate the entropy of evaluation index H_j

H_j=-k $\sum_{i=1}^{m} f_{ij} * \ln f_{ij}$ (2)

f_{ij} represents the proportion of the ith sample in the JTH index.

2.4 Calculate the entropy weight of the evaluation index

The larger the entropy of an index is, the smaller the entropy weight is, and the less important the index is. And meet $0 \leq w_i \leq 1$ and $\sum_{j=1}^{n} w_j = 1$.

$w_i = \frac{1 - H_j}{n - \sum_{j-1}^{n} H_j}$ (3)

Table 2. Entropy

	1	2	3	4	5	6
1	0.8815	0.8211	0.8862	0.5343	0.8862	0.9003

(1-H)is the difference coefficient of the JTH index, that is, the smaller the entropy value of the JTH index, the greater the degree of variation of the index.

Entropy weight is not the importance coefficient in practical sense but the relative intensity coefficient of each index in the sense of competition. When the evaluation object is determined, the evaluation index can be adjusted, increased or decreased according to the entropy weight, so as to make more accurate and reliable evaluation. At the same time, the entropy weight can be used to adjust the accuracy of some indexes, and the average value and accuracy can be re-determined if necessary.

2.5 Calculate the comprehensive score

F= $\sum_{j=1}^{n} l_j w_j$ (4)

According to F, the evaluation objects are sorted from large to small. The area with a higher score indicates a better ecological environment, while the area with a lower score indicates the need to establish ecological protection areas.

Table 3. Comprehensive scores of different regions

	1	2	3	4	5	6	7
1	0.3955	0.3456	0.4348	0.6399	0.3783	0.4902	0.4815

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