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Ecological Protection Construction and Its Impact Assessment on the Environment

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Abstract: *This paper selects Saihanba Nature Reserve in 1989 and 2017 and 18 nature reserves around Beijing as research objects for horizontal comparison, and constructs an ecological environment evaluation system, use TOPSIS and entropy weight method to calculate eco-environmental index. The results show that, after nearly 30 years of development, the eco-environmental index of Saihanba area has risen from 0.52 to 0.91, which means that the local environment has been greatly improved. An optimization model aiming at ecological benefits and costs was constructed, and the location, area, ecological benefits and costs of the 13 protected areas were obtained by solving with particle swarm optimization.*

Keywords: *TOPSIS Model, Regional Disaster Risk Assessment System, Particle Swarm Optimization Algorithm*

1. Establishment of Ecological Environment Assessment Model

In order to build an evaluation model of ecological and environmental impact on the time scale, this paper selects several nature reserves around Beijing as a horizontal comparison reference. Include ye yahu, hanshiqiao, miyun reservoir, beidagang, qi lihai, dahuangbao, Tuan Bowa, changli gold coast, Luan he estheria, henghui lake, Haixing, Baiyangdian, Beidaihe Coast and Saihanba.

Firstly, this paper constructs the index system of ecological environment impact.

Table 1: Ecosystem impact system.

<table>
<tr><th>Primary indicators</th><th>Secondary indicators</th><th colspan="2">Third level index</th></tr>
<tr><td rowspan="17">Ecological impact index system</td><td rowspan="3">weather</td><td>temperature</td><td>humidity</td></tr>
<tr><td>rainfall</td><td>evaporation capacity</td></tr>
<tr><td>wind force</td><td>Gale days</td></tr>
<tr><td rowspan="3">pollute</td><td>Air index API</td><td>Carbon dioxide absorption</td></tr>
<tr><td>Oxygen release amount</td><td>Water pollution index</td></tr>
<tr><td>Soil pollution index</td><td></td></tr>
<tr><td rowspan="3">soil</td><td>Desertification area</td><td>soil types</td></tr>
<tr><td>water content</td><td>saltness</td></tr>
<tr><td>Nutrient index</td><td></td></tr>
<tr><td rowspan="2">hydrology</td><td>Water area</td><td>volume of runoff</td></tr>
<tr><td>pH value</td><td>Water conservation capacity</td></tr>
<tr><td rowspan="2">vegetation</td><td>percentage of forest cover</td><td>Forest accumulation</td></tr>
<tr><td>Total forest farm area</td><td>Plantation area ratio</td></tr>
<tr><td rowspan="3">Biodiversity</td><td>Animal richness</td><td>Plant richness</td></tr>
<tr><td>Species endemism</td><td>Abundance of threatened species</td></tr>
<tr><td>Invasion degree of alien species</td><td></td></tr>
</table>

This paper further uses TOPSIS and entropy weight method to calculate the ecological system comprehensive index to quantitatively calculate the ecological environment improvement index in Saihanba area in the past 30 years.

According to the above process and the attribution of indicators, the weight of three-level indicators can be calculated. The evaluation index of eco-environmental impact can be obtained by bringing in the obtained 20 groups of data.

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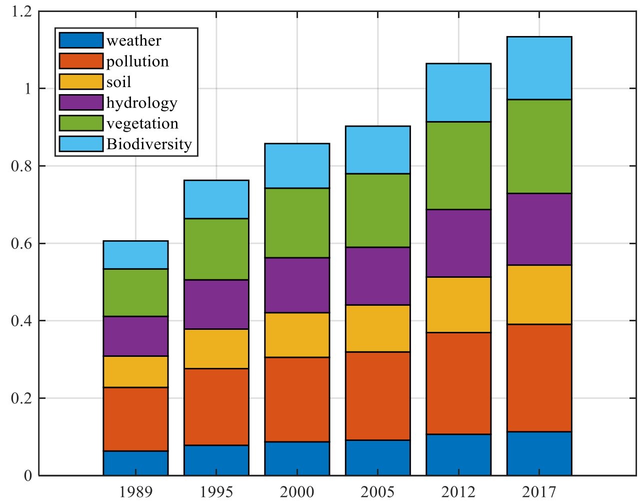

Figure 1: Trend of score change with time in Saihanba area.

In the figure, the change trends of scores in Saihanba area at different times are drawn respectively, and the scores of eco-environmental impact index gradually increase with time. These results show that through nearly 30 years of continuous development, the natural environment index of Saihanba area has increased by 80%, which strongly confirms the outstanding achievements of Saihanba area.

2. Regional Disaster Risk Assessment System

Firstly, this paper counts out the areas where potential serious climate problems such as sandstorms occur, and constructs a regional disaster risk assessment system based on the development of the affected areas.

Table 2: Regional disaster risk assessment system.

Primary indicators	Secondary indicators	Third level index	
Regional disaster risk assessment score	Natural disaster factors	Extreme temperature difference	Average wind power
		Number of sandstorms	rainfall
		evaporation capacity	Air index API
	Local environmental factors	Desertification area	Species richness
		percentage of forest cover	Biodiversity
	Economic factors	Gross GDP	Per capita income
		Proportion of primary industry	Proportion of secondary industry
		Proportion of tertiary industry	
	Social factors	human population	Town area
		population density	population structure

Southeast Tibet, eastern Qinghai, southern Gansu, the whole of Ningxia, Shaanxi, Shanxi, northern Hebei and eastern Inner Mongolia are covered by large areas of sandy land. It is worth noting that the population distribution in eastern Gansu, central Xi 'an, central and southern Hebei and Beijing is very concentrated. In order to improve the ability of these areas to resist sandstorms, it is necessary to build ecological zones to alleviate natural disasters. However, different areas have different vegetation to build ecological zones, and their improvement ability is also different, the influence factors of vegetation types in southeast provinces are significantly higher than those in northwest provinces, while those in northern provinces, Shanxi, Hebei and Shandong are higher, while those in Qinghai, Gansu and Ningxia are lower due to the natural environment, which is consistent with the actual situation.

In order to determine the location and benefits of constructing ecological protection areas, this paper constructs a double-objective optimization model to balance the construction cost while ensuring high ecological benefits of ecological protection areas.

(1) Quantitative calculation of ecological benefits.

The benefits of constructing ecological protection areas can be calculated by calculating the difference of disaster risk assessment scores in affected areas before and after constructing ecological

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protection areas. If the change of risk assessment score is δ s, the change of risk assessment score can be calculated as

$$\Delta S = A \times K_p \times K_w \times (d_{\max} - d) \times X \quad (1)$$

Where, A represents the area of the ecological protection zone, $K_p$represents the influencing factor of vegetation types, and $K_w$represents the influencing factor of wind direction, which is closely related to the wind direction. If the wind direction in this area directly affects the affected areas, then K_w= 1; if it does not affect at all, then K_w= 0.

(2) Quantitative calculation of construction cost.

Due to the need to consider the cost when constructing ecological protection areas, this is the main influencing factor to limit the number and area of ecological protection areas. This cost includes the cost of manpower and material resources, etc., and is also affected by the local traffic and desertification degree. If the cost is C, it can be calculated as

$$C = dK_a C_1 + A(C_2 + C_3) \quad (2)$$

Where, C_1represents the transportation cost of personnel and materials per kilometer, K_a represents the geographical location influencing factor, C_2represents the labor cost per unit area, and C_3represents the cost of land, vegetation and necessary materials per unit area.

(3) Double-objective optimization model.

According to the above analysis, the constructed bi-objective optimization model can be shown as

$$\begin{cases} \max \Delta S \\ \min C \end{cases} \quad (3)$$

Firstly, this paper determines the formation path of sandstorm, and then constructs ecological protection areas on the main path of sandstorm formation. In this way, only the air duct distance between the ecological protection area and the target area and the area of the ecological protection area need to be calculated, which greatly simplifies the solving difficulty. The Pareto solution of the optimization model can be obtained by using the particle swarm optimization algorithm.

According to the above method, the positions of 13 ecological protection zones can be calculated, as shown in the figure. Among them, the blue dot is the ecological protection zone that has been built or is under construction.

Table 3: Area, ecological benefit and construction cost of ecological protected areas.

serial number	Area (hm2)	Ecological benefits	construction cost
1	21421	0.2647	98.4811
2	5181	0.1390	20.4999
3	5751	0.1201	24.8912
4	7072	0.1569	25.8544
5	10395	0.2330	48.8340
6	3511	0.1498	12.0520
7	5485	0.1278	19.0938
8	3109	0.1513	11.3232
9	14090	0.1541	32.6131
10	16321	0.2175	82.2550
11	24123	0.3489	104.8779
12	13098	0.1709	48.1482
13	2134	0.0993	10.6646

3. Conclusions

The evaluation system constructed in this paper comprehensively considers various factors such as meteorology, pollution, animals and plants, etc., and can accurately evaluate local environmental changes. The risk reduction of sandstorm in Beijing is not only the independent function of a single protected area, but also the interaction of natural wind directions, which influence each other. When determining the

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nature reserve to be constructed, the differences of plant species planted in different geographical locations are considered, and the influence factors of vegetation species are introduced to quantify.

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