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Research Article

Dynamic Comprehensive Evaluation of Ecological Environment of 12 Provinces and Cities in Western China

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ABSTRACT

The problem of ecological environment is a global problem. It is a basic material condition for human beings to survive and engage in various production practices, and has a tremendous impact on our economic and social life and development. In recent years, the overall situation of the ecological environment in western China has been severe. On the one hand, it is because of the inherent fragility of the ecological environment in the western region. On the other hand, it is due to human, economic, and political and legal factors. Therefore, the western region is faced with the dual task of protecting the environment and developing the economy. In the face of these dual tasks, the western region must choose a development model based on the coordinated development of the environment and economy. Therefore, this paper selects data from 12 provinces and cities in the western part of China for 6 years, adopts multiple evaluation methods to conduct a dynamic comprehensive assessment of the western ecological environment, and provides some corresponding countermeasures for the coordinated development of the environment and economy in the western ecologically fragile region.

1. INTRODUCTION[1]

In recent years, China's economy has developed rapidly, and the economic level of the western region has also been greatly improved. The western ecological environment is very fragile, so in the process of development it is necessary to evaluate the development level of existing studies in the west and to find the problems in the development, find a way to develop more efficient and reasonable.

At present, both domestic and international scholars have made some achievements in the ecological environment. Matthew and Luck [1], together with the model of the human ecological footprint model and the ecosystem process model, to get the most important factors that affect the development of the ecosystem, to apply the improved ecological footprint method to the evaluation of the city ecosystem, and to evaluate the ecosystem of 20 major cities in the United States. Li Yu-ping (2007) models the natural-economic-social concept framework. The index system is constructed from three aspects: land natural ecological security, land social ecological security and land economic ecological security. Zhang [2], in the study of ecological environmental assessment of the western region, and the concrete reality of the western provinces, has been building the western eco-environmental evaluation index system on the basis of the environmental support system of the Chinese academy for sustainable development. Chen Yuan-yuan (2010) constructed the evaluation index system from the three aspects of land ecosystem pressure, land ecosystem state and land ecosystem response, fully considering many factors such as nature, economy and society. However, the evaluation accuracy should be affected by the index representativeness and rationality of its weight. Dong Xiao-xiao (2014) in the western ecological fragile zone land ecological condition evaluation and prediction, the article, with the western ecological fragile areas Yuzhong county in Gansu province as the research area, using GIS to study the change of land use, topography, vegetation, landscape pattern and soil erosion are analyzed, and reflects the land ecological risk condition under the influence of single factor. In this paper, a set of appropriate indicators for the evaluation of ecological environment is established, and various methods are used to conduct dynamic comprehensive evaluation of the ecological fragile areas in the west. According to the research results, 12 provinces and cities in the west are comprehensively ranked and corresponding policy recommendations are put forward. Wang et al. [3] divided the ecological environment carrying capacity index system of Shandong peninsula into four levels: natural environment, ecological environment, population environment and pollution environment. Each level I index selected its typical level II index and constructed 17 evaluation indexes as its evaluation system. The weight of each evaluation index was determined by the analytic hierarchy process. Very et al., with the method of coupling analysis based on the analysis of the new quality of urbanization and ecological environment bearing capacity of main indexes, constructing the new urbanization

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quality and ecology environmental bearing capacity of the coupling coordination model, the calculation and the districts and counties in Chongqing from 2000 to 2012 new urbanization quality and ecology environmental bearing capacity of the coupling, evaluating the quality of new urbanization and ecological environment in Chongqing coupling stages and levels. Zhou et al. [5] constructed a coupling and coordinated evaluation system of regional economy, ecological environment and tourism industry. Taking 11 provinces and cities along the Yangtze River economic belt as an example, the weighted TOPSIS method was used to evaluate the comprehensive development level of the three major systems of each province and city in this region. Secondly, based on the coupling coordination model, this paper analyzes the coupling coordination evolution of the three systems in the Yangtze River economic belt from the perspective of space-time. Finally, the grey GM model is used to predict the future coupling coordination degree of the three systems.

2. INTRODUCTION OF DYNAMIC MODEL FOR VARIOUS METHODS

In view of that dynamic and comprehensive evaluation of the ecological environment in western China, three methods are used to combine namely, the gradation method, ideal point method and entropy value method. We apply these three evaluation methods organically to the evaluation of the ecological environment in the west, which can well reflect that we view and deal with the changing things from the perspective of movement, development and objectivity.

2.1. Basic Principles of the Gradation Method

The gradation method is a new method to determine the weight coefficient according to the particularity of the comprehensive evaluation of the time-series three-dimensional data table. It is mostly used in economic management, cadre assessment and other multi-index decision-making problems.

Suppose there are m evaluation objects such as $G_1, G_2, \ldots, G_m$ and there are n evaluation indexes such as $X_1, X_2, \ldots, X_n$. As time goes by $t_1, t_2, \ldots, t_T$. The original sequence of $\{X_{ij}(t_k)\}$, we form a sequence of time-sequenced data tables.

Definition: The comprehensive evaluation problem of the sequential solid data table support, called dynamic comprehensive evaluation problem, can be represented as:

$$y_i(t_k) = F\left\{w_1(t_k), \ldots, w_m(t_k); x_1(t_k), \ldots, x_n(t_k)\right\}$$

where, $y_i(t_k)$ represents the comprehensive evaluation value of the evaluation object of G_i at t_k, F represents the analytic formula of function, and $w_i(t_k)$ represents the weight coefficient of the evaluation index at time.

The gradation method is to take the comprehensive evaluation function

$$y_i = w_1 x_{i1} + w_2 x_{i2} + \ldots + w_n x_{in}$$

The value of w_i to be determined is to make the evaluation object such as $G_1, G_2, \ldots, G_m$, the difference between them is as large as possible, and the difference between evaluation objects can be expressed as $\sigma^2 = \sum_1^m (y_i - \bar{y})^2$. To standardize the raw data, we can get function, $\bar{y} = \sum y_i / m = 0$, at this point we have $\sigma^2 = \sum y_i^2 = Y^T Y = (WX)^T XW = W^T HW$, where,

$$Y = \begin{pmatrix} y_1 \\ y_2 \\ \cdots \\ y_m \end{pmatrix}, W = \begin{pmatrix} w_1 \\ w_2 \\ \cdots \\ w_m \end{pmatrix}, H = X^T X$$

$$X = \begin{pmatrix} x_{11} & \cdots & x_{1n} \\ \cdots & \cdots & \cdots \\ x_{m1} & \cdots & x_{mm} \end{pmatrix} t_k$$

When $\|W\| = 1$ is restricted, that is, when $w_1^2 + \cdots + w_n^2 = 1$ is taken as the eigenvector corresponding to the maximum eigenvalue $\lambda_{\max}(H)$ of W symmetric array H, then σ^2 is taken as the maximum value.

At this time, $\max\{\sigma^2\}\lambda_{\max}(H)$ applies the grading method to the cross-section data of $\{X_{ij}(t_k)\}$, at t_k, respectively, to obtain the weight coefficient such as w_i corresponding to the index such as x_i, and then substitute in the comprehensive evaluation function, $y_i = w_1 x_{i1} + w_2 x_{i2} + \cdots + w_n x_{in}$, to obtain the comprehensive score.

2.2. Basic Principle of Entropy Value Method

After getting evaluation object of G_i in the moments after the comprehensive evaluation value of $y_i(t_k)$, because the importance of different times of t_k, to get the final evaluation result is also different, so to get reasonable evaluation result, science is the key to determine the weight vector time named as $\nu = (\nu_1, \nu_2, \ldots, \nu_r)^T$. Time weight vector, is to show the degree of attention to different times, according to different criteria, the application of different subjective or objective weighting method to determine.

The entropy method [10] is introduced below to determine the time weight vector of ν:

First define the entropy as $I = -\sum_1^r \nu_k \ln \nu_k$

Entropy is a term in thermodynamics. In information theory, it is also called the average amount of information, that is, it is a measure of information. At the same time, the entropy of time weight vector also reflects the degree of information contained in the weight of samples in the aggregation process.

Redefining "time scale" as $\lambda = \sum_1^r \frac{r-k}{r-1} \nu_k$, especially when $\nu = (1, 0, \ldots, 0)$, $\lambda = 1$;

When $\nu = (0, 0, \ldots, 1)$, $\lambda = 0$; when $\nu = \left(\frac{1}{r}, \frac{1}{r}, \ldots, \frac{1}{r}\right)$, $\lambda = 0.5$

The size of "time degree" λ reflects the importance attached to time sequence in the assembly process, as shown in Table 1.

It can be seen from Table 2 that the greater the value of λ is, the less the elevator attaches importance to the distance evaluation time t_r compared with the recent amount data, and the greater the elevator attaches to the distance evaluation time t_r compared with the long-term amount data. When λ is close to 0, the relatively long-term amount data of t_r at the evaluation time have little effect, which is

Table 1 | Scale parameters table of "time degree" λ

Assignment	Instructions
0.1	Very little attention has been paid to recent data
0.3	Less attention to recent data
0.5	Also pay attention to the period data used
0.7	Pay more attention to recent data
0.9	Take recent data very seriously
0.2, 0.4, 0.6, 0.8	Corresponding to the above two adjacent judgments of the middle case

Table 2 | Comprehensive evaluation index system of ecological fragile areas in western China

	Indicator name (unit)
Resources	Forest coverage (%)
	The proportion of nature reserves in the area under jurisdiction (%)
	Soil erosion control area (1000 ha)
	Afforestation area (1000 ha)
	Artificial wetland area (1000 ha)
Environment	Total wastewater discharge (10,000 tons)
	Sulfur dioxide emissions (tons)
	Investment in industrial pollution control (10,000 yuan)
Economic	Total output value of agriculture, forestry, animal husbandry and fishery (10,000 yuan)
	Per capita disposable income of urban households (yuan)
	GDP per capita (yuan/person)
Social	Total population (10,000)
	Household consumption level (yuan)
	Natural population growth rate (%)
	Per capita water resources (m^3/person)

mainly used in the dynamic comprehensive evaluation of the completed tense that has occurred; λ close to 1 time interval evaluation time t_r relatively recent value data is almost useless, this kind of J is mainly used for the future tense with predictive nature of the dynamic comprehensive evaluation of the problem; When $\lambda = 0.5$, it reflects that the evaluator attaches equal importance to each period and does not favor either side.

Finally, the determination criterion is introduced: in order to find the time weight vector suitable for sample assembly under the condition of given "time degree", we use mathematical language to describe the criterion by mining as much as possible the sample information and taking into account the difference information of the evaluated object in time sequence as the standard and solve the following nonlinear programming problem:

$$\begin{cases} \max\left(-\sum_1^r v_k \ln v_k\right) \\ s.t. \lambda = \sum_1^r \dfrac{r-k}{r-1} v_k \\ \sum_1^r v_k = 1,\ v_k \in [0, 1] \\ k = 1, 2, \ldots, r \end{cases}$$

2.3. Basic Principles of the Ideal Point Method

At each point of time, the evaluation value of the static synthetic value of the object and the matrix of the time series of the evaluation is as follows:

$$A = \begin{array}{c} \\ G_1 \\ \vdots \\ G_m \end{array} \begin{array}{c} \begin{array}{ccc} t_1 & \cdots & t_k \end{array} \\ \begin{pmatrix} y_{11} & \cdots & y_{1k} \\ \vdots & \ddots & \vdots \\ y_{m1} & \cdots & y_{mk} \end{pmatrix} \end{array} = (y_{ij})_{m\times k}$$

where y_{ij} represents the static comprehensive evaluation value of evaluation object G_i at time point of t_j.

Let's say the growth matrix is $B = (b_{ij})_{m\times r}$, and

$$b_{ij} \begin{cases} 0, & i = 1, 2, \ldots, m;\ j = 1, 2, \ldots, r \\ \dfrac{y_{ij} - y_{i(j-1)}}{\lfloor y_{i(j-1)} \rfloor}, & i = 1, 2, \ldots, m;\ j = 1, 2, \ldots, r \end{cases}$$

Then b_{ij} represents the growth and change of the comprehensive evaluation value of the evaluation object G_i from time point t_{j-1} to t_j. In addition, in order to ensure that the increase and decrease of b_{ij} are the same as the absolute value added to the denominator here, $b_{i1} = 0$ means that the growth and change of the evaluation value of D_1 in the base period is 0. The change direction of the static comprehensive evaluation value is consistent. By weighting the static comprehensive evaluation matrix A and the growth change matrix B, the required dynamic comprehensive evaluation matrix C can be obtained.

$$C = (c_{ij})_{m\times r}, c_{ij} = \alpha y_{ij} + \beta b_{ij},\ \alpha + \beta = 1$$

where, α and β represent the relative importance of the static evaluation value and the growth change value. When $\alpha = 0$ and $\beta = 1$, only the growth change degree is considered in the evaluation process. When $\alpha = 0$ and $\beta = 0$, only the static evaluation value situation is considered in the evaluation process. Therefore, different values of α and β can more fully consider the content of static evaluation value and dynamic growth and change of evaluation objects. Then, we use the ideal point method to construct an ideal time series and a negative ideal sequence for matrix c:

$$c^+ = c_1^+, c_2^+, \ldots, c_r^+,\ c^- = c_1^-, c_2^-, \ldots, c_r^-$$

where,
$$c_k^+ = \max\{c_{ij} \mid j = 1, 2, \ldots, m\}$$
$$c_k^- = \max\{c_{ij} \mid j = 1, 2, \ldots, m\},\ k = 1, 2, \ldots, r$$

According to the algorithm of the ideal point, the dynamic comprehensive evaluation value of the evaluation object G_k at the time point of t_j is c_{ij} to c^+, and the distance between c^- and c_{ij} is respectively:

$$d_j^+ = \left[\sum_1^r v_j (c_{kj} - c_j^+)\right]^{\frac{1}{2}}, j = 1, 2, \ldots, m$$

$$d_j^- = \left[\sum_1^r v_j (c_{kj} - c_j^+)\right]^{\frac{1}{2}}, j = 1, 2, \ldots, m$$

where v_i represents the weight of time point of t_j, then the relatively close degree between the Kth evaluation object and the ideal solution is:

$$s_k = \frac{d_k^-}{(d_k^+ + d_k^-)}, k = 1, 2, \ldots, m$$

Finally, s_k is taken as the final dynamic comprehensive evaluation value of evaluation object G_k, where $s_k \in [0, 1]$. If the value of s_k is larger, the evaluation object G_k is closer to the ideal point and away from the negative ideal point. At this time, the value of dynamic comprehensive evaluation is higher and the ranking is higher. On the contrary, the closer the evaluation object G_k is to the negative ideal point and away from the ideal point, the lower the value of dynamic comprehensive evaluation will be and the lower the ranking will be.

3. EMPIRICAL ANALYSIS

3.1. Establishment of Index System

Based on the references of Wang Jinye, Cheng Daopin, Hu Xintian, Li Ming, Cao Lianhai, Hao Shilong, Chen Nanxiang [8,9] and others, and combined with the relevant theories and index selection principles of regional ecological evaluation, this paper constructs a set of comprehensive evaluation index system of fragile ecological environment in western China. The system mainly includes four subsystems of resources, environment, economy and society, with a total of 15 indicators, as shown in Table 2. The data collected from the 12 cities and cities of the western part of the country for the last 6 years of 2012–2017 are all from the 2012–2017 statistical yearbook.

3.2. Comprehensive Evaluation of Ecological Fragile Areas in Western China

3.2.1. *Determination of weights of each index at different times based on the method of grading*

The idea of determining the weight coefficient of each index at different time by using the method of grading is as follows: firstly, the original data of each index in 12 provinces and cities in western China from 2012 to 2017 are processed uniformly and dimensionally. Then according to the principle of open class method, get the weight of indexes in different time, in this paper, with the aid of SPSS20.0 standardization of statistical software for data processing, and then through the computer to calculate the weights of each index, and to get the weight coefficient, the analysis in the 6 years of environmental development, the more influence on the environment of the indicators, to the relevant departments to improve environmental quality to provide some measures and policy recommendations. The original data used in this paper are all from the annual statistical yearbook.

Setting: $T = 6$, $m = 12$, $n = 18$. Firstly, the original data of $\{x_{ij}(t_k)\}$ is uniformly and dimensionally indexed, and then the symmetric matrix of $H_k = (X_k)^T X_k (K = 1, 2, 3, 4, 5, 6)$ is calculated.

According to the previous theory, the maximum eigenvalue H_k corresponding to $\lambda_{\max}(k)$ and the corresponding eigenvector $\lambda_{\max}(k)$, namely the weight coefficient vector of each index at different moments, are calculated. Therefore, the weight of each indicator at different times is shown in Table 3.

As can be seen from Table 3, the important trends of these 15 indicators can be divided into four categories according to their importance: the first category is the investment completed in industrial governance, sulfur dioxide emissions, the total output value of agriculture, forestry, animal husbandry and fishery, and the total population. The second category is the natural growth rate of population, afforestation area, forest coverage rate, the proportion of nature reserves in the area under jurisdiction, and the importance of soil erosion area. The third category is the total amount of wastewater discharged, the amount of water resources per capita, and the per capita disposable income of urban households. The fourth category is the consumption level of residents, per capita GDP, artificial wetland area. In this way, it can be seen that industrial pollution and its treatment, as well as ecological factors such as afforestation area and population changes have the greatest impact on the comprehensive development of the western region.

Table 3 | Weight coefficients of indicators at different times

指标	2012	2013	2014	2015	2016	2017
X_1	0.2578	0.2585	0.2696	0.2407	0.2505	0.2185
X_2	0.2494	0.2636	0.2651	0.2516	0.2694	0.2616
X_3	0.2466	0.2648	0.2683	0.2770	0.2851	0.2849
X_4	0.2703	0.2678	0.2808	0.2641	0.2439	0.2701
X_5	0.1014	0.1089	0.1032	0.0868	0.0941	0.1273
X_6	0.2363	0.2282	0.2299	0.2176	0.2320	0.2124
X_7	0.3268	0.3228	0.3178	0.3072	0.3053	0.3132
X_8	0.3467	0.2826	0.2275	0.3072	0.2561	0.2887
X_9	0.3012	0.2923	0.2888	0.2693	0.2740	0.2650
X_{10}	0.2210	0.2301	0.2489	0.2725	0.2835	0.2835
X_{11}	0.1787	0.1988	0.1993	0.2108	0.2059	0.2270
X_{12}	0.3100	0.2935	0.2963	0.2704	0.2753	0.2532
X_{13}	0.1853	0.2405	0.2561	0.2676	0.2601	0.2688
X_{14}	0.2966	0.2995	0.3012	0.3061	0.3077	0.2971
X_{15}	0.2333	0.2495	0.2465	0.2428	0.2580	0.2455

Table 4 | Comprehensive score value $y_1(t_K)$ of 12 provinces and cities in western China from 2008 to 2013

省市	2012	2013	2014	2015	2016	2017
新疆	0.6399	0.4272	0.5860	0.5002	0.3806	0.2280
甘肃	0.9790	0.9217	1.0434	1.0837	0.7820	1.4441
青海	2.2025	1.9871	1.9800	1.9063	1.9298	1.8497
内蒙古	2.4996	2.5714	2.3273	3.0918	2.6406	3.4214
陕西	0.2462	0.9302	1.1598	1.0565	1.1213	0.7548
宁夏	1.4908	1.5750	1.5948	1.5702	1.5076	1.5060
四川	2.7635	2.1274	2.0897	2.0683	1.7431	1.5521
贵州	0.7284	0.9201	0.9652	0.7891	0.8588	0.5017
云南	0.2890	0.3893	0.6080	0.9529	1.0651	1.0101
重庆	0.1221	0.1641	0.0227	0.1418	0.1203	0.0096
广西	1.7542	1.6045	1.5333	0.7069	0.7875	0.6979
西藏	1.6339	1.6277	1.5715	1.8852	1.7785	1.8972

3.2.2. *Comprehensive scores of 12 provinces and cities in western China*

In order to highlight the role of various indicators at different times, this paper adopts the linear weighting method, namely:

$$y_i(t_k) = w_1(t_k)x_{i1}(t_k) + w_2(t_k)x_{i2}(t_k) + \cdots + w_n(t_k)x_{in}(t_k)$$

where $y_i(t_k)$ represents the comprehensive score value of the ith evaluation object at time slot of t_k, $w_i(t_k)$ represents X_i, and the weight of the index at time slot t_k. The comprehensive scores of 12 provinces and cities in western China in different years were obtained, as shown in Table 4.

Table 5 | Comprehensive evaluation ranking of 12 provinces and cities in western China

省市	新疆	甘肃	青海	内蒙	陕西	宁夏	四川	贵州	云南	重庆	广西	西藏
评价值	0.1556	0.5793	0.5735	0.8817	0.3086	0.5015	0.5084	0.1848	0.3968	0.2639	0.3092	0.5958
排名	12	3	4	1	9	6	5	11	7	10	8	2

3.2.3. Entropy value method to determine the time weight vector

In determining the time weight by using the entropy value method, we will determine the value of "time" λ in advance by the opinion of the relevant experts, where we use the linear programming model:

$$\begin{cases} \max(-\sum_1^r \nu_k \ln \nu_k) \\ s.t. \lambda = \sum_1^r \frac{r-k}{r-1}\nu_k \\ \sum_1^r \nu_k = 1, \nu_k \in [0,1] \\ k = 1, 2, \ldots, 6 \end{cases}$$

Using Lingo solution above linear programming model, the time weight vector ν_k = (0.0029, 0.0086, 0.0255, 0.0755, 0.2238, 0.6637) is obtained.

3.2.4. Dynamic comprehensive evaluation results of ecological environment in 12 provinces and cities in western China

According to the previous theory, we know that the static evaluation matrix A is composed of the comprehensive evaluation value (comprehensive score value), and the growth matrix B is obtained according to the calculation formula of the growth matrix. In this case, we consider that the value of the static evaluation is equal to the value of the increasing variation, so $\alpha = \beta = 0.5$, plug in the formula $C = (c_{ij})_{m \times r}$, $c_{ij} = \alpha y_{ij} + \beta b_{ij}$, $\alpha + \beta = 1$ and you get the matrix C.

The matrix C will give you the perfect time sequence and the minus ideal time sequence:

C^+ = (1.3817, 1.8542, 1.1162, 2.6914, 1.2473, 1.8585)

C^- = (0.0610, 0.0473, −0.4194, 0.0839, −0.0156, −0.4553)

Then, the distance formula between c_{kj} and c^+ and c^- of the dynamic comprehensive evaluation value of the evaluation object G_k at time point t_j, namely:

D^+ = (1.8275, 0.9637, 0.9287, 0.2746, 1.5061, 1.0772, 1.0585, 1.6669, 1.2928, 1.9994, 1.5161, 0.8729)

D^- = (0.3367, 1.3273, 1.2488, 2.0464, 0.6724, 1.0839, 1.0948, 0.3778, 0.8504, 0.7167, 0.6784, 1.2865)

From the first k degree of evaluation object and relatively close to the ideal solution formula, namely:

$$s_k = \frac{d_k^-}{(d_k^+ + d_k^-)}, \ k = 1, 2, \ldots, m$$

Finally, the comprehensive ranking of 12 provinces and cities in western China is obtained, as shown in Table 5.

According to the analysis in Tables 3 and 4, the overall ecological environment of 12 provinces and cities in western China from 2012 to 2017 is the best in Inner Mongolia, Tibet, Gansu and Qinghai. The ecological environment of Sichuan, Ningxia, Yunnan and Guangxi is the second. Shaanxi, Chongqing, Guizhou and Xinjiang had the worst comprehensive evaluation. In recent years, with the country's continuous attention to the ecological development of the west, Inner Mongolia's ecological environment has achieved a great reversal. Green lock throat, yellow sand oasis, this is only a microcosm of Inner Mongolia ecological reversal. Due to the continuous economic development and urbanization construction in recent years, Guizhou, which had a good ecological environment before, paid too much attention to economic development and did not pay attention to pollution control, which made it fall behind in the comprehensive ranking among the 12 western provinces. The overall comprehensive sorting is in good agreement with the actual sorting and has some reference value.

4. CONCLUSION

Based on the evaluation theory of ecological environment, this paper establishes a dynamic comprehensive evaluation model of ecological environment, and conducts a comprehensive evaluation study on the ecological environment of 12 provinces and cities in western China from 2012 to 2017. The main research conclusions include the following aspects: (1) according to the relevant evaluation theory system of ecological environment and the actual ecological environment of 12 provinces and cities in western China, a set of evaluation index system suitable for the actual ecological environment of 12 provinces and cities in western China is established, which mainly includes four indexes of resources, economy, environment and society; (2) analyze the establishment of a good index system by using the method of grading apart, and obtain the weight of each index at different times. Through observation and analysis, the impact of industrial pollution and its treatment, ecological factors such as afforestation area and population changes on the comprehensive development of the western region is the largest; (3) finally, entropy value method, ideal point method and other methods are combined to conduct dynamic comprehensive evaluation of the ecological environment of 12 provinces and cities in western China, and they are comprehensively ranked. According to the comprehensive score, Inner Mongolia, Tibet, Gansu and Qinghai have the best ecological environment on the whole. The ecological environment of Sichuan, Ningxia, Yunnan and Guangxi is the second. Shaanxi, Chongqing, Guizhou and

Xinjiang had the worst comprehensive evaluation. Therefore, the following Suggestions are put forward: follow the scientific method and make up the shortage of ecological environment. The comprehensive evaluation of the ecological environment in the 12 western provinces is uneven. We should firmly establish the concept of "environmental protection first, ecological zones", and enforce environmental protection laws. We will strengthen law enforcement for ecological and environmental protection, regulate enterprises in pollution control, and develop green industries. We will control the size and layout of polluting enterprises, reduce waste discharge, adopt advanced technologies and technologies with low energy consumption, improve energy efficiency, and promote the use of clean energy.

CONFLICTS OF INTEREST

The authors declare they have no conflicts of interest.

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