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Environmental quality comprehensive assessment of 31 provinces in China based on principal component Analysis

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ABSTRACT

In order to evaluate the environmental quality scientifically, selecting 14 indicators that are the important factors about the regional environmental quality, and establishing index evaluation system. Using the principal component analysis, extracting common factor, orthogonal rotation, getting management, pollution, compensation and foundation main factors, and calculating the comprehensive scores of each province. The results revel that the comprehensive score is higher, the municipal environment quality is higher. China must persist in the policy that the economic development, population growth and environmental protection keep coordinated development. Take the road of sustainable development.

KEYWORDS

Comprehensive assessment; Principal component analysis; Environmental quality; Index system; Factor score.

INTRODUCTION

Environment is the basic condition for the survival of human society, also is the human society development foundation, environmental quality is closely linked with the development of human society[1-5]. However, the modern human activities in creating great material civilization and spiritual civilization, at the same time, has also brought environmental pollution and ecological damage[6]. Soil erosion, land desertification, poisonous gas and so on, these are the direct results of the rapid deterioration of the global environment quality, and more harm to human health.

With the rapid development of China's economy and urbanization, environment pollution and destruction are more and more serious. PM2.5, haze become the focus at one's leisure talk unknowingly. The environmental quality of the city is safe or not, attracted the attention of many researchers. Yang Wendong, a comprehensive evaluation of atmospheric environmental quality by using fuzzy comprehensive evaluation method[7]; Wang Yinggang put forward the city environment quality of multi-level fuzzy comprehensive evaluation[8]; Li Yanli put forward the application of analytic hierarchy process and fuzzy comprehensive evaluation method in evaluation of city ecosystem health[9]; Wang Dechun class the indicators of water quality based on fuzzy comprehensive evaluation method[10].

However, due to the complexity of environmental system, so far, The literature of our country about the comprehensive assessment of environmental quality most limited in discussion on the concept, index selection and individual city practice research and so on. And relates to the environmental quality evaluation of nationwide rarely, therefore, scientific evaluation the environmental quality of the provinces and cities in China, the sound and fast economic development and implement the strategy of sustainable development is of great significance.

INDEX SELECTION AND DATA SOURCE

Select 14 environmental quality indicators used to establish the index system, respectively:x1 (sewage emissions),x2(the number of wastewater treatment facilities),x3(industrial waste gas emission),x4(industrial soot emissions),x5(industrial dust emissions),x6(life soot emissions),x7(the number of industrial waste gas treatment facilities),x8 (industrial solid waste emissions),x9(forestry land area), x10(forest coverage rate),x11(forest area of key forestry engineering),x12(forest pest and disease control rate),x13(industrial pollution control projects completed investment this year),x14(forestry investment in fixed assets completed). The original data to see China statistical yearbook 2009.

RESULT AND DISSCUSS

Because the index dimensional existence is different, therefore, first, data standardization processing, and then apply principal component test or not. From the correlation coefficient matrix data easy to get most coefficient is higher than 0.3,suitable for factor analysis. In addition, through the Bartlett spherical test, KMO value is 0.714,Verify again for principal component analysis. Test results are shown in the following table. For details please refer to TABLE 1.

TABLE 1 : Factor Analysis Test

KMO and Bartlett Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		**0.714**
Bartlett Spherical Test of	Approx. Chi-Square	245.624
	df	91

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	Sig.	0.000

The use of SPSS statistical software for processing data on the 14 indices, get the eigenvalues and contribution rate of the table, as shown in TABLE 2. It is not difficult to find, in front of 4 common factors accumulation contribution rate as high as 91.628%, indicating that the amount of information that a total of 4 public factor can reflect the original index 91.628%. Therefore, can think of the original 14 indicators can be integrated into 4 main factors: F_1,F_2,$F_3$and F_4. The 4 common factors and can be used as the Comprehensive variable to evaluate 31 provinces and cities of our country environment quality. For details please refer to TABLE 2.

TABLE 2 : The Cumulative Contribution Rate

Common factor	Characteristic value	Contribution rate(%)	Cumulative contribution rate(%)
F_1	4.343	31.021	31.021
F_2	3.703	26.450	57.471
F_3	2.620	18.714	76.185
F_4	2.162	15.443	91.628

Since the initial load matrix structure is not simple, typical representative of each factor is not very outstanding, it is difficult to explain and naming. In order to make the factor analysis to get better effect, It is necessary to adopt the factor rotation, factor to often have practical significance more vivid, so it is easier to explain. Rotation method: orthogonal rotation, oblique rotation of two class. In this paper, using the orthogonal rotation method, get the matrix orthogonal rotated factor loading, For details please refer to TABLE 3.

TABLE 3 : Rotated Factor Loading Matrix

	Component			
	1	**2**	**3**	**4**
Z score(x7)	.958	-.036	.042	.028
Z score(x2)	.838	-.203	.227	-.186
Z score(x3)	.831	.225	-.188	.260
Z score(x1)	.776	-.240	.199	-.285
Z score(x13)	.731	.081	-.245	.184
Z score(x4)	.673	.360	.067	.368
Z score(x11)	-.010	.936	-.043	.141
Z score(x9)	-.021	.867	.332	-.029
Z score(x10)	.014	-.174	.774	-.079
Z score(x12)	.042	-.274	-.714	.088
Z score(x14)	.055	.382	.543	.166
Z score(x8)	-.091	-.088	.021	.835

Z score(x6)	.165	.355	-.211	.691
Z score(x5)	.445	.102	.419	.508

From TABLE 3, we get 4 main factors can represent the main components of the original index:

Level of management factors $(x1, x2, x7, x13)$, Pollution level factors $(x3, x4, x5, x6, x8)$, Compensation level factors $(x9, x11, x14)$,Basic level factors $(x10, x12)$. In order to evaluate environmental quality of various provinces and cities, getting the areas corresponding to the 4 factor scores respectively, getting the factors' Comprehensive scores and ranking according to the size of the scores, For details please refer to TABLE 4.

TABLE 4 : The Comprehensive Score Ranking

Province	Factor score	Ranking	Province	Factor score	Ranking
Guangdong	1.75909569	1	Hainan	-0.19416793	17
Zhejiangu	0.970943587	2	Gansu	-0.2096224	18
Sichuan	0.944694683	3	Shanghai	-0.21609321	19
Guangxi	0.618313997	4	Jilin	-0.23446461	20
Neimenggu	0.5917781	5	Tianjin	-0.33292188	21
Fujian	0.523388181	6	Xinjiang	-0.37839152	22
Jiangsu	0.483167367	7	Ningxia	-0.38669114	23
Shaanxi	0.35964115	8	Henan	-0.39372593	24
Yunnan	0.356115955	9	Qinghai	-0.47023818	25
Shandong	0.17782008	10	Anhui	-0.4740236	26
Hubei	0.170400527	11	Liaoning	-0.49628374	27
Heilongjiang	0.002140358	12	Chongqing	-0.54276595	28
Xizang	-0.02750916	13	Shanxi	-0.68381822	29
Jiangxi	-0.11050538	14	Guizhou	-0.72285754	30
Hunan	-0.11963292	15	Hebei	-0.8025798	31
Beijing	-0.16120656	16			

CONCLUSIONS

(1) the factor comprehensive score is higher, show that the area of governance, pollution, compensation and foundation level higher, The comprehensive environmental quality competitiveness is stronger. Since the original data standardization processing means that the average level of the whole area of each common factor and comprehensive factor setting to zero, the negative value in table only represents integrated environment quality of this area is lower than the national average level, positive meaning is the opposite. The results show that: Guangdong, Zhejiang 12 provincial environmental quality level above the national average.

(2) the governance factor score of Guangdong, Shandong, Jiangsu, and Zhejiang are higher, This is because the more developed the economy of an area, its population is more, life pollution and industrial pollution is higher, Force the region must improve the ability of pollution control, increase pollution treatment equipment and investment. Therefore, in the development of economy and at the same time, we must further improve ability to deal with pollution.

(3) Hebei, Shanxi, Henan and Inner Mongolia's pollution is very serious, mainly due to the decision of these characteristics of industrial development. This requires the area change in the mode of economic development, reduce pollution and at the same time, increase the intensity of work

environment, pay more attention to basic construction of environmental protection, in order to fundamentally improve the environment.

(4) Sichuan and Inner Mongolia has obvious advantages in the compensation factor score, although Hainan is on the list, mainly due to Hainan's industry is not dominated by the development of forestry, also do not need to improve the environment through the development of forestry.

(5) The Fundamental factor of Beijing, Gansu, Ningxia, Shandong, Jiangsu, Shanghai and Tianjin 7 provinces or municipalities are on the list,shows that the original ecological condition of the area is Relatively poor. In which Ningxia and Gansu should strengthen the protection of the ecological environment, Beijing 5 city should be able to keep the economy sustainable development and at the same time, strengthening the environmental construction, so as to make up for lack of basic environmental conditions.

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