Evaluation Research on Ecological Environment Risk

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Abstract. The risk analysis of ecological environment risk is limited by multi-factors, high dimensional data, small samples and incomplete information. This paper develops a method of risk analysis model of ecological environment, which is combined with the combination with projection pursuit method and the information diffusion theory. This model spreads the risk information of the actual observation data to the properties of the risk threshold in order to explore the nonlinear relationship between them and calculates the risk probability of the whole ecological environment. This paper takes 35 cities as study objects, evaluates the risk grade of ecological environment of each city and estimates the comprehensive risk probability of ecological environment risk in China. The research result shows: most of those cities are in the "less safety" risk grade and "unsafety" risk grade. And the whole ecological environment risk is in high-risk and shows the unstable condition.

Keywords: Ecological environment risk, the risk grade, the projection pursuit method, the information diffusion theory.

1. Introduction

Ecological environment risk reflects that the economy system, social system and natural environment system would be in a harmonious development and orderly circulation of steady situation and could inhibit the unreasonable economic construction and ecological disasters caused by the unreasonable industry development[1], which is possessed the sufficient ability of pollution control, effectively alleviating the impact and pressure of the economic and social activities on the ecological environment, so as to maintain the dynamic balance of the ecological environment and enhance the capacity of sustainable development of ecological environment. In recent years, economy is developing rapidly. Ecological environment risk is looming large, which has become the key to affect the development of economy system. Zhang took the Jiuzhaigou Valley as the study object armed to embody the contradiction between the economy and ecological environment [2]; Chi discussed the contradiction between the economy and the society and the contradiction between the ecological resource development and ecological environment [3]. In the process of economic development, ecological environment must be evaluated to prevent the expansion of contradiction, which is beneficial to the harmonious development of economy with society, ecological as well as other aspects.

Based on the recent research on the ecological environment risk, those researches always faced with such kind situation, which have various inducing factors, lacked of common characteristics and have the higher dimension of study data [4]. This kind of research objects is difficult to evaluate the risk condition of their system. In view of this, this paper introduces the combination with projection pursuit model and the information diffusion theory so as to establish the risk analysis model of ecological environment.

2. The risk evaluation index system of ecological environment risk

Ecological environment risk evaluation is the identification and research to the states of the three systems economy, society and natural environment as well as to the various kinds of impact and pressure caused by the development evolution of the three systems. This paper takes the “the risk identification of ecological environment” and “the health of ecological environment” as the main

constituent elements so as to establish the risk evaluation index system of ecological environment. The specific indexes are referred with table 1.

Table 1 the index system of the risk evaluation index system of ecological environment

Index classification	Index Dimension	No.	Detailed indexes
The health of ecological environment	the basic situation of local ecosystem	1	Built up area green coverage
		2	Equivalent Regional Environmental Noise Level in dB (A)
		3	The number of days of Air Pollution Index (API) Ⅱ level and above
		4	Water resources of per capita
	economy development situation	5	the abundance of ecological resources
		6	the occupancy of ecological resources
		7	the second industry contribution
	the coordination condition	8	the coordination coefficient of economy system and environmental system
		9	the coordination coefficient of environmental system and social system
		10	the coordination coefficient of economy system and social system
		11	the coordination coefficient of environmental system and population system
The risk identification of ecological environment	the impact to ecological environment	12	traffic pressure
		13	the growth rate of the popu;ation
		14	Population spatial density
		15	Population density index
		16	water consumption per GDP
		17	soot emission per GDP
		18	sulfur dioxide emissions per GDP
		19	solid wastes discharge per GDP
		20	Waste water discharge per GDP

3. The risk evaluation model of ecological environment risk

Ecological environment is also a composite system which consists of natural ecological, economic and social security [5]. It is difficult to tease out the changes laws of the internal action of ecological environment and identify the evolution trend of the entire system. Given this, this paper uses the combination with the projection pursuit theory and the information diffusion theory to build the risk analysis model of ecological environment. This model spreads the risk information of the actual observation data to the properties of the risk threshold in order to explore the nonlinear relationship between them and calculate the risk probability of the whole t ecological environment.

Step1: Data preprocessing: It selects the n groups of index elements, each of which have m dimensions $X=\{x(i,j)|i=1,2,\cdots,n;j=1,2,\cdots,m\}$. The risk threshold is $T=\{t(i,j)|i=1,2,\cdots,k;j=1,2,\cdots,m\}$. In this matrix, m is the number of the index dimensions; k is the number of the risk grades; n is the number of the observed objects. $t(i,j)$ Is the threshold value of the I risk grade of the j element. $x(i,j)$ Is the actual value of the I object of the j element. The data of $t(i,j)$ and $x(i,j)$ are normalized in order to calculate the dimensionless value of each element. The matrixes of $t^*(i,j)$ and $x^*(i,j)$ is the normalized values.

Step 2: the dimension reduction used the projection pursuit theory: Used the DPS9.01 software, this paper use the projection pursuit method [6-7] to calculate the optimal projection direction of the index elements. In the same way, the optimal projection direction of the risk threshold is calculated. Based on the optimal projection direction, the matrixes $t^*(i, j)$ and $x^*(i, j)$ are projected into the one-dimensional space in order to calculate the one-dimensional projection value of the actual data $z_T^*(i)$ (refer to formula 1) and the one-dimensional projection value of the risk threshold $z_X^*(i)$ (refer to formula 2).

$$z_T^*(i) = \sum_{j=1}^{m} \alpha^*(j) t^*(i, j) \quad (1)$$

$$z_X^*(i) = \sum_{j=1}^{m} \alpha^*(j) x^*(i, j) \quad (2)$$

Step 3: the risk grade value of the risk threshold: This paper analyzes the map relationship between the one-dimensional projection value of the risk threshold $z_X^*(i)$ and the risk grade $y_T{}^*(i)$ via the data fitting between the two matrixes $z_X^*(i)$ and $y_T{}^*(i)$ .according the research of the data fitting, it builds the function of risk grade value of the risk threshold: $y_T{}^*(i) = f(z_T^*(i))$ .And then, the one-dimensional projection value of the actual data $z_T^*(i)$ is substituted in to the function $y_T{}^*(i) = f(z_T^*(i))$ armed to calculate the risk grade value of the actual data of each study object .

Step 4: the risk information diffusion: The universe of the indexes is defined as $U = \{u_1, u_2, \cdots, u_w\}$. Based on the information diffusion theory[8], the risk information contained by the risk grade value $y_T{}^*(i)$ is diffused to the universe U. the frequency ,which often the study object falls at the u_k, is the risk probability $p(u_k)$.

4. Empirical Study

4.1 Data Sources

To evaluate the ecological environment, this paper is aimed at analyzing the risk situation of the economic development environment in order to promote the sustainable development of the whole city. This paper takes 35 municipalities and prefecture-grade cities of China as the study objects and evaluates their ecological environment situation so as to enhance the realistic significance of the research conclusion. The research data is collected from the relative statistics yearbooks, such as “China to Statistical Yearbook ","China Statistical Yearbook", " Urban Statistical Yearbook”.

4.2 Division of the risk grade

According to certain indexes of national standards and the relevant scholars for the division of risk grade, the evaluation set of this paper is divided into 4 grades, namely {unsafety; less unsafety; relatively safety; ideal safety}. And then, it figures out the thresholds of risk grades to evaluate the risk situation of those cities. Based on the "Evaluation Standard of China Excellent City", "Standard of National Ecological Garden", and the related literature at home and abroad, this paper takes those suggestive values or the minimum requirement values for ecological environment as the “ideal safety" thresholds or the “unsafety” thresholds of some indexes. The “relatively safety” thresholds are floated down 25% of the “ideal safety" thresholds. The “less unsafety” is floated up 25% of the “unsafety" thresholds.

4.3 The risk evaluation of ecological environment

(1)The optimum projection direction. Based on the projection pursuit theory, this paper analyzes the risk grade threshold of ecological environment and measure out the optimum projection direction of each risk index. The optimum projection direction of each risk evaluation indexes reflects the influence degree of each index to ecological environment risk. The greater the value of the optimum projection direction, the more strong the impact is. The indexes of the top three highest impact

strength to ecological environment are: "the coordination coefficient of economy system and environmental system", "population space density", "traffic pressure". It can be seen that the coordinate ability of economy development and the environment system is turned into the primary sensitive factor of the ecological environment: the higher coordination coefficient reflects that the city's economy development could effectively adjust industrial structure, promote the energy conservation and emissions reduction ability, alleviate the impact and pressure of the economic and social activities on the ecological system and maintain the health of ecological environment.

(2) The risk evaluation of ecological environment. The matrix of the optimum projection direction is used into the formula 1 so as to calculate the one-dimension projection values of each risk grade value and builds the regression function $y^* = 0.0212(z_t^*)^4 - 0.1056(z_t^*)^3 + 1.0190(z_t^*) + 1.000$ (Formula 3) in order to observe the map relationship between the matrix y_t^* and the matrix z_t^*.This paper calculates the one-dimension projection values of study data, which collects from 35 study cities. Used the formula 3, the risk grade values of each city is measured out (refer with table 2).

Table 2 the risk grade values of ecological environment healthy

risk grade	city
Ideal Safety	Shen Zhen; Shang Hai; Guan Zhou; Cheng Du
Relative Safety	Da Lian; Xia Men; Fu Zhou; Han Zhou; Qing Dao
Less Unsafety	Chang Sha; Shen Yang; Ning Bo; Shi Jia Zhuang; Xi An; Hu He Hao Te; Ji Nan; Tian Jin;
Unsafety	Wu Han; Chong Qing; Nan Jing; Kun Ming; Chang Chun; Yin Chuan; Gui Yang; Nan Ning; Zheng Zhou; Lan Zhou ;Ha Er Bin; Wu Lu Mu Qi; Tai Yuan; Xi Ning; Bei Jing; Hai Kou; He Fei

Generally speaking, there are few cities being in the “ideal safety” grade. All of them are belonged to the developed and densely populated cities, including four cities, such as Shenzhen, Shanghai, Guangzhou and Chengdu. There are five cities in the “rather safety” grade. These cities concentrate on China's eastern coastal areas, which belong to the emerging cities. These cities have the high quality ecological resource and form the mature and stable markets. The proportion of “less unsafety” cities is bigger, there are 14 cities accounted for 40% of the research objects. This result represents that most of ecological environment of cities have been showing the risk situation. There are nine “unsafety” cities, all of which are concentrated in the central and western regions of our country, belonging to the relatively backward areas in economy system. It is reflected that the rapid development of economy system has not been able to merge into their economy and social system coordinated.

4.4 The risk probability of ecological environment

This paper conducts the information diffusion theory to calculate the risk probability, so as to make a further comprehensive evaluation on the risk situation of the whole ecological environment (refer with table 3). The "ideal safety", "relatively safety" grades of ecological environment is low, while the "unsafety" and "less unsafety" probability are higher. The results show that the probability of environmental risk and ecological crisis is higher. The sustainable development ability of their economy systems is weakened severely. The infrastructure and the function are not perfect. They should focus on solving the bottleneck problem for the sustainable development, improve the ecological system, and enhance infrastructure armed to find a way out for the sustainable development of local city.

Table 3 the risk probability

Risk Grade	Risk Grade			
	Unsafety	Less unsafety	Relatively safety	Ideal safety
Riskprobability	0.27	0.47	0.17	0.09

5. Conclusion

This paper employs the projection pursuit method to obtain the optimum projection direction of the indexes of the ecological environment risk, reduces the dimension of the indexes. And then, the information diffusion theory is used to distribute the risk information contained in study data of observed objects to the universe of the risk grade in order to calculate the risk probability of ecological environment. This paper takes 35 cities as study objects, evaluates the risk grades of ecological environment and estimates the comprehensive risk probability of ecological environment risk in our country. The result shows that most of cities are in the "less safety" risk grade and "unsafety" risk grade, which centralized in the western China and the central region. In contrast, those "safety" and "rather safety" cities are located in advanced economic and social regions. And the whole ecological environment risk is in high-risk and shows the unstable condition.

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