

LETTER TO THE EDITOR

Economic Cost Assessment of Ecological Environmental Pollution Based on Grey Theory

Meiquan Li^{1*}, Rongjing Ding², Chenxia Wang¹

¹School of Finance And Economics, Wuxi Institute of Technology, Wuxi 214000, China

²Financial Office, Wuxi Institute of Technology, Wuxi 214000, China

*Email: lmqamyjerry@163.com

Aiming at the problem that the existing eco-environmental pollution economic cost assessment method has low evaluation accuracy, an ecological cost assessment method based on grey theory is proposed. A grey relational degree function is constructed to analyze the correlation between ecological environmental pollution and economic cost. According to the results of correlation analysis, the factors affecting the economic cost of ecological environmental pollution are ranked according to the degree of correlation. The economic cost assessment framework of ecological environmental pollution based on two-step method is constructed, and the economic cost assessment of ecological environmental pollution based on gray theory is completed. Experimental results show that the accuracy of this method is always above 97%, it shows that the method in this paper has higher evaluation accuracy, and verifies the comprehensive practicability of the method in the evaluation of ecological environmental economic cost.

Grey theory; ecological environmental pollution; economic costs; assess

1 Introduction

Pollution will make the ecological environment lose some or all of its original functions, cause the degradation and devaluation of the environment, and bring harm to human survival and economic development. Monetization of these hazards is to estimate the economic losses caused by pollution and the costs required to restore the ecological environment. In recent years, with people's quantification demand for the harm caused by human's social and economic activities, and the rising call for establishing green national economic accounting system, the research on the economic cost of pollution has been widely concerned. Many research institutes at home and abroad have calculated the economic cost of pollution from different fields and regions respectively, but the scientific results are not satisfactory and the practicality is poor. This is caused by the nonstandard calculation method of pollution loss, imperfect dose-response relationship, unstandardized calculation parameters and vague concept. Environmental pollution incidents occur frequently in China, but the economic cost management of ecological environmental pollution lags behind as a whole. It is not only to be standardized in traditional environmental damage identification, compensation, recovery and other issues, but also in the lack of understanding and practice of environmental damage itself. It is of great significance to expand the composition of environmental pollution damage and unify the concept and method of environmental pollution damage assessment to improve the assessment and management of the economic cost of ecological environmental

pollution in China.

Lina Xu, Hang Song, Yongmei Qian published an article in Ekoloji Issue 106, 2018. The title is: “Integrity Evaluation of Large Diameter Pile Foundation Based on Grey Clustering Theory”. Based on the basic principle and measured data of acoustic pile, this paper determined the acoustic time, sound velocity, amplitude and main frequency as ecological evaluation factors, established the integrity evaluation model of pile foundation with gray clustering theory, and determines the weight of each pile, so the integrity of large diameter pile was analyzed and evaluated. (Gulmezoglu et al. 2017) The higher the integrity and durability of pile, the less negative environmental risk and influence. The method is found to be feasible and applicable by comparing it with the field ultrasonic testing data and fuzzy mathematics evaluation method. However, this paper argues that applying the grey theory to the economic cost assessment of ecological environmental pollution will achieve better results.

Wang et al. proposed a cost-benefit assessment method based on the management measures of non-point source pollution control in the watershed. Aimed at the characteristics of agricultural non-point source pollution in taishitun town, the upstream of miyun reservoir in Beijing, various optimal management measures are designed. Based on the estimation of the economic value of the control effect of non-point source pollution control measures, the cost-benefit relationship of each measure was comprehensively investigated, and various economic factors in the input-output of the selected measures were studied by calculating the cost-benefit ratio, internal rate of return, investment payback period, economic net present value and other economic indicators of different control measures, the comparative analysis of various control measures. The rationality of various control measures was analyzed and evaluated from the perspective of engineering economy, so that the pollution control scheme could not only meet the purpose of improving the environment of the river basin, but also be economically feasible. Ma put forward the evaluation method of economic loss of water environmental pollution in Hebei province. Taked Hebei province as an example, the index system of water environment economic loss assessment was designed. Accorded to all relevant statistical data of the state and Hebei province, the economic loss caused by water environmental pollution is calculated from five aspects: Planting industry, livestock breeding industry, industrial wastewater discharge and urban sewage discharge and human health. The productivity change method, shadow price method, protection expense method and other methods were used to estimate, and the economic loss of water environment pollution in 2017 was finally obtained, However, this method had the problem of low accuracy and is difficult to be applied in practice.

In order to solve the problems existing in the existing methods, an economic cost assessment method of ecological environmental pollution based on gray theory is proposed.

2 Idea Description

2.1 Analysis of economic cost assessment method of ecological environmental pollution based on grey theory

The grey theory comes from the control theory and USES the depth of color to indicate the amount of information. As the basis of analysis, prediction and decision making in the grey system, the ranking analysis in the grey relational analysis is relative, and the main characteristics of the grey system are explained by quantitatively characterizing the degree of correlation among various factors in the system.

Compared with other mathematical statistical methods, the grey relational analysis method has no strict requirements on the irregular pattern of samples and the size of samples, and because of its simple calculation, small workload and no abnormal situation, it makes up for the disadvantages brought by mathematical statistical methods. The purpose of cost analysis is to deduce the unknown from the known. As an important concept in grey relational analysis, relational degree is a measure of the correlation between things and factors. In the actual

analysis, the order of the degree of correlation is mainly used to describe the degree of correlation between the studied objects or among various factors within the objects (Wang 2017). When analyzing the economic cost of ecological environmental pollution, sometimes the nature of things is easily covered by these gray factors because the relationship between the factors that affect it is not clear.

Therefore, according to the grey theory, we should first find the correlation and the measurement of correlation from the random time series, so as to provide the basis for the precision analysis of factor analysis and prediction, provide the basis for the decision making of the system, and make a judgment on the main factors. According to the calculation method, the correlation degree is divided into absolute correlation degree and rate correlation degree. Because the absolute correlation degree is easy to be affected by the extreme value in the data, sometimes it cannot truly reflect the correlation degree between the series, so this paper mainly uses the rate correlation degree to analyze the correlation degree between ecological environmental pollution and economic cost.

2.1.1 Establish correlation function

Let the relative rate of change in $x_1(k)$ be $\frac{\Delta x_1(k)}{x_1(k) \cdot \Delta k}$, The relative rate of change in y is $\frac{\Delta y}{y(k) \cdot \Delta k}$ The

relative rate of change of x_1 is $\frac{\Delta x_1(k)}{x_1(k) \cdot \Delta k}$. If the relative rate of change of x_1 is closer than x_2 to the relative rate of change of y . Therefore, the correlation function between $x(k)$ and $y(k)$ is defined as:

$$\xi(k) = \frac{1}{1 + \left| \frac{\Delta x(k)}{x(k) \cdot \Delta k} - \frac{\Delta y(k)}{y(k) \cdot \Delta k} \right|}, k = 1, 2, 3, \dots, N \quad (1)$$

2.1.2 Calculate correlation

When $x(k)$ and $y(k)$ are discrete sequences, the calculation formula of rate correlation degree is:

$$r_n = \frac{1}{N-1} \sum_{k=1}^{N-1} \xi(k) \quad (2)$$

2.1.3 Correlation analysis

It can be seen from the above analysis that the correlation function sequence reflects the consistency of the relative change rate of two things at each moment. As a comprehensive evaluation standard of the consistency of the relative change rate of two things within the interval, the comprehensive average rate of the interval correlation function sequence is also examined by the correlation degree. The purpose of the correlation analysis is to find the main influencing factors among the factors x_1, x_2, \dots, x_n that affect the ecological cost pollution economic reference series y . That is to say, according to the degree of association of y , the ranks of $x_i (i=1, 2, \dots, n)$ are ranked to complete the task of association analysis.

2.2 Analysis of Economic Cost Assessment Method of Ecological Environment Pollution Based on Two-Step Method

By analyzing the factors affecting the economic cost of ecological pollution, and sorting according to the degree of association. Economic cost assessment is an important technical content for the quantification and management of environmental pollution damage liability (Wang et al. 2018), The basic problem is to determine the physical quantity of environmental pollution damage and the economic cost of ecological restoration. The economic cost

assessment process for ecological environment pollution based on the two-step method is as follows:

- (1) Determine the type of physical loss and the mode of ecological restoration and maximize it;
- (2) Establishing the conversion relationship between the physical quantity and the value of the loss. The physical loss is expressed in monetary form and the ecological environment restoration cost is estimated. The final economic cost assessment result of ecological environment pollution is obtained by adding the two. The above process mainly depends on the specific assessment method adopted. Sometimes, these two processes will be carried out simultaneously to directly obtain the monetary results of ecological environmental pollution. The framework of damage economic cost assessment based on two-step method is shown in figure 1.

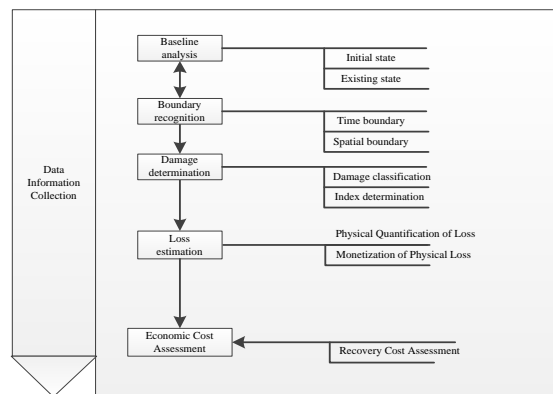


Figure 1 The framework of economic cost assessment of pollution based on two-step method

At present, the loss measurement and environmental value assessment method in environmental economics stipulated in tort liability compensation in China is an important basis for traditional damage and environmental damage assessment as well as ecological environment restoration cost analysis. While assuming the responsibility of ecological and environmental protection, we should pay attention to using market mechanism to promote pollution control and ecological construction. Grasp the relationship between important energy resource price of the product and established can reflect market supply and demand, resource scarcity and environmental damage cost price formation mechanism, perfect and carry out the system of paid use of resources, gradually establish and improve the ecological compensation mechanism, promote enterprise and the whole society to reduce consumption, reduce emissions and protect the environment (Gu et al. 2016).

3 Result

In order to verify the application effect of the grey theory-based eco-environmental economic cost assessment method, it is necessary to conduct an experiment. The experimental platform is Windows 10, and MATLAB software is used to output the evaluation results of ecological environment and economic cost. The method in this paper was selected to compare the evaluation accuracy with the method proposed by Wang et al, and the experimental results are shown in table 1.

Table 1. Compare the evaluation accuracy with the research method proposed by Wang et al.

Number of experiments	Literature [1] method	Method of this paper
10	68.9%	98.6%
20	72.5%	97.9%
40	73.1%	97.7%
60	79.8%	98.1%

80

73.5%

97.1%

It can be seen from the above table that the evaluation accuracy of the method proposed by Wang is as high as 79.5%, while the evaluation accuracy of the method in this paper is always more than 97%, which indicates that the method in this paper has a high evaluation accuracy and verifies the comprehensive practicability of the advantages of the method in the evaluation of economic cost of ecological environment.

4 Discussion

In order to improve the awareness of ecological environmental protection and promote the development of environmental protection work, an economic cost assessment method of ecological environmental pollution based on gray theory was proposed, and experimental tests were carried out to verify the accuracy of the assessment. Experimental results show that compared with the method proposed by Wang et al., the method in this paper has higher evaluation accuracy. The main reason for this difference lies in the fact that the method in this paper firstly constructs the grey relational degree function, and USES the rate relational degree to analyze the correlation between ecological environmental pollution and economic cost factors, and based on the construction of the two-step economic cost evaluation framework of ecological environmental pollution, which can effectively improve the evaluation accuracy of the method in this paper.

5. Conclusion

According to the research on the characteristics of ecological civilization by relevant scholars, ecological civilization has five basic characteristics: the sustainability of economic development, the harmony between human and nature, the excellent and benign ecological quality, the innovation of social management system and mechanism, and the universality of the concept of environmental protection in the whole society. For the construction of ecological civilization, this paper proposes an economic cost assessment method of ecological environmental pollution based on gray theory. So based on the analysis in this paper, in order to reduce the economic losses from the pollution of the environment, to practice the scientific outlook on development and harmonious society concept, build two type society, the transformation of the mode of development, promoting recycling economy, improve ecological environmental quality, set up the concept of ecological civilization, the innovation system mechanism, the international environmental cooperation strategic countermeasures of eight aspects.

References

- Gu J J, Guo P, Huang G H. (2016) Achieving the objective of ecological planning for arid inland river basin under uncertainty based on ecological risk assessment. *Stochastic Environmental Research & Risk Assessment* 30(5):1485-1501.
- Gulmezoglu, N., Aytac, Z., Kutlu, I., Kulan, E. G., & Gozukara, G. (2017). Mapping Boron and Beneficial Heavy Metal Ions for Wheat-Cultivating Soils in Turkey's Boron-Mining Zone. *Applied Ecology and Environmental Research* 15(3): 1119-1130.
- Ma AL. Economic Loss Assessment of Water Environmental Pollution in Hebei Province. *Journal of Jilin University (Science Edition)* 74(1):63-70.
- Wang C Y. (2017) Influence assessment of tourist resource exploitation on ecological environment based on Grey model. *Journal of Discrete Mathematical Sciences & Cryptography* 20(1):65-77.
- Wang K, Mi Z, Wei Y M. (2018) Will Pollution Taxes Improve Joint Ecological and Economic Efficiency of

- Thermal Power Industry in China?: A DEA-Based Materials Balance Approach. *Journal of Industrial Ecology* 43(12):23-29.
- Wang XY, Zhang YF, Ou Y, et al. (2018) Optimization and economic evaluation on cost-benefit of Best Management Practices in nonpoint source pollution control. *Ecology and Environmental Sciences* 18(2):540-548.
- Xu, L., Song, H., & Qian, Y. (2018). Integrity Evaluation of Large Diameter Pile Foundation Based on Grey Clustering Theory. *Ekoloji* 27(UNSP e106116106): 1307-1313.