

**LETTER TO THE EDITOR****The Vulnerability Analysis Method of Urban Ecological Environment Based on Communication Network**Lei Wang<sup>1\*</sup>, Shaohua Hu<sup>2</sup><sup>1</sup>Communication Department, Nanjing Vocational College of Information Technology, Nanjing 210046, China<sup>2</sup>School of Electronic & Information Engineering, Nanjing University of Information Science and Technology, Nanjing 210044, China

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In order to prevent the continuous deterioration of the urban ecological environment and the restoration of the degraded ecological environment, it is necessary to analyze the vulnerability of the urban ecological environment. Based on the understanding of the concept of environmental vulnerability and the definition of the concept of urban ecological environment vulnerability, this paper proposes an analysis method of urban ecological environment vulnerability by combining the communication network and analytic hierarchy process. This research is divided into three parts: (1) the communication network and ecological environment vulnerability related theories are elaborated; (2) construction of urban ecological environment information and communication network; (3) analyze the vulnerability of ecological environment with the analytic hierarchy process in order to provide scientific support for the maintenance and improvement of urban ecological environment. communication network; hierarchical analysis; urban ecological environment; vulnerability

**1 INTRODUCTION**

With the growth of urban population and the rapid development of society and economy, the urban ecological environment has gradually deteriorated, various problems have become increasingly prominent, and the outbreak of “urban diseases” has seriously affected the sustainable development of urban ecology, economy and society (Kereselidze et al. 2017, Salas and Yepes 2018). Vulnerability is a hot issue and an important analytical tool and content in the field of global change and sustainability science. The research on vulnerability has become a hot issue in the field of global change and sustainable development research and gradually developed into a basic scientific knowledge system (Zhang 2018).

Fragile ecological environment means that under the specific ecological environment background, the degree of ecological environment degradation has exceeded the existing social, economic and technological level, which can maintain the current level of human utilization and development for a long time. The vulnerability of ecological environment is directly related to the poor nature of natural conditions, but the disadvantages under natural conditions only determine the potential of environmental fragility, and the intensification of this potential hazard into a fragile ecological environment is human destruction, only when it is naturally vulnerable. The degree of adverse effects of factors and humans exceeds the ability of the ecological environment to withstand

and self-repair, leading to the emergence of fragile ecological environment. Therefore, the fragile ecological environment is the result of the interconnection and interaction between natural environmental conditions and human production activities and historical development processes.

In recent years, the fragile ecological environment research and urban ecological environment protection and global change and sustainable development important problems, such as integrated research, has gradually entered a based on the network market economy for observation, the study mainly by means of quantitative and modern information technology and regional sustainable ecological environment system has been established as the goal of the stage.

Bo Shao published an article titled “Modeling and Evaluation of Economic Development Benefits and Natural Ecological Environment under the ‘Internet plus’ Open Platform” in the journal Ekoloji Issue 107, 2019. The article (Shao 2019) pointed out that with the rapid development of the economy, the natural ecological environment was increasingly hindered by economic development, and the natural ecological environment issues closely related to economic development are receiving more and more attention. Therefore, the evaluation model of natural ecological environment and economic development benefit under the “Internet +” open platform was constructed. After the establishment of the “Internet plus” open platform, the evaluation index system and model of natural ecological environment and the evaluation index system and model of economic development benefit were respectively constructed. On the basis of determining the evaluation indexes of natural ecological environment and economic development effect, the data of the two evaluation indexes were standardized, and the weights of the two evaluation indexes were calculated. On this basis, calculated the economic development and natural ecological environment of two kinds of evaluation model of comprehensive benefit, it was concluded that the two kinds of evaluation model of coordination between the coordinated development degree, and the natural ecological environment and economic development coordination degree was divided into which can realize the coordinated development degree, effectively and accurately evaluate the economic benefits of natural ecological environment.

This article analyzed the economics of the ecological environment. Drawing on the ideas and methods of this article, this paper proposes a method to analyze the vulnerability of urban ecological environment by combining communication network and analytic hierarchy process.

## **2 IDEA DESCRIPTION**

### **2.1 Related concept elaboration**

Communication is the communication and transmission of information between people through some kind of media. A network is a data link made up of isolated workstations or hosts connected together by physical links. Communication network refers to the physical connection of each isolated device to realize the link of information exchange among people, people and computers, so as to achieve the purpose of resource sharing and communication (Chen and Wang 2017).

The ultimate purpose of the research on the vulnerability of ecological environment is to prevent the deterioration of the environment, to restore and rebuild the degraded ecological environment system, and to realize the benign development and sustainable utilization of resources and environment. The fragile ecological environment status quo and trend of under the stress of internal and external factors, the possibility of change is analyzed, using vulnerability to quantify the vulnerability, quantitative vulnerability assessment and grading, it to local conditions for the recovery of ecological environment and the sustainable utilization of Marine resources to provide scientific basis, contribute to the decision-making and managers understand the internal and external causes of all kinds of vulnerability, and help them identify the fragility of the space-time distribution, which can

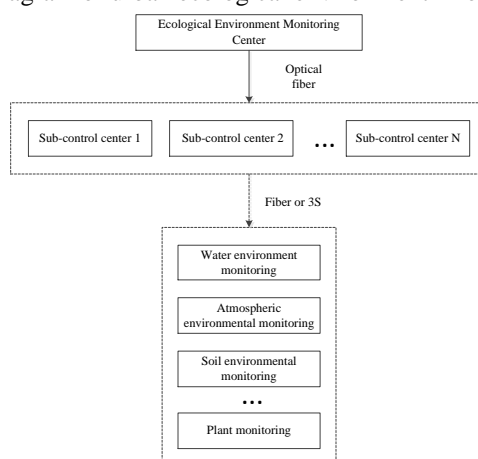
make the ecological environment comprehensive improvement and repair work (Mao and Wang 2017).

Therefore, this paper realizes the exchange and sharing of ecological environment data by means of communication network, and analyzes the vulnerability of urban ecological environment.

## 2.2 A method of vulnerability analysis of urban ecological environment based on communication network

### 2.2.1 Urban ecological environment information and communication network

Fig. 1 shows the schematic diagram of urban ecological environment information communication.



**Fig. 1 Schematic diagram of urban ecological environment information communication**

On this basis, the vulnerability of urban ecological environment is analyzed combined with the analytic hierarchy process.

### 2.2.2 The research method

The analysis of ecological vulnerability mainly involves the sensitivity to negative effects and the adaptability to positive responses. The vulnerability of urban ecological environment system ( $V$ ) refers to: Due to the sensitivity of the urban ecological environment system to disturbances inside and outside the system and the lack of coping ability, the city is an attribute that is not conducive to the sustainable development of the city (Zhang et al. 2018). Sensitivity ( $S$ ) and Resilience ( $R$ ) are the basic characteristics of vulnerability. The vulnerability of the system is formed by the mutual influence, mutual restriction and joint action of the sensitivity and resilience of the system. Vulnerability is reflected by the sensitivity to face and the resilience. It is a function of the interaction between the sensitivity and resilience, that is  $V = f(S, R)$ . Therefore, the vulnerability evaluation model established through the above analysis is as follows:

$$V_i = f(S_i, T_i) = k \frac{S_i}{R_i} \tag{1}$$

Among them,  $V_i$  is the vulnerability index of the ecological environment system of city  $i$ ;  $S_i$  is the sensitivity index of the ecological environment system of city  $i$ ;  $R_i$  is the resilience index of ecological environment system of city  $i$ ;  $i = 1, 2, 3, \dots, n$ . Among them, vulnerability is proportional to sensitivity and inversely proportional to resilience. The stronger the sensitivity, the stronger the vulnerability and the weaker the resilience. At the same time, considering the interaction between the sensitivity and resilience of the system after disturbance, the system will inevitably suffer losses. This loss is proportional to the vulnerability of the system. The greater the loss, the greater the intensity of system vulnerability (Han et al. 2018).

### 2.2.3 Analysis index system and method

According to the connotation of urban ecosystem vulnerability, sensitivity and resilience are two important

indicators of vulnerability. Therefore, six key areas, including water resources, land resources, financial input, energy consumption, environmental pollution and environmental governance, were selected, among which 4 were used to describe the ecological environment sensitivity index, 9 were used to describe the resilience index, and a total of 13 indicators were used. The vulnerability evaluation index system was established as shown in Table 1.

**Table 1 Urban ecological environment vulnerability analysis index system**

Target	Guidelines	Indicators
Urban ecological environment system	Sensitivity ( <i>S</i> )	Per capita water consumption
		Per capita energy consumption
		Industrial exhaust emissions
		Industrial wastewater discharge
	Restoring force ( <i>R</i> )	Per capita water resources
		Per capita green area
		Per capita cultivated area
		Greening rate of urban built-up areas
		Sewage centralized treatment rate
		Harmless treatment rate of domestic garbage
		Proportion of fiscal environmental protection expenditure
		Comprehensive utilization rate of industrial solid waste
		Three waste comprehensive utilization output value

In the measurement of comprehensive index system, the main methods to determine the weight of indicators are subjective weighting method and objective weighting method. Analytic hierarchy process and entropy method were used to determine the weight. Generally speaking, the higher the information entropy is, the more balanced the system structure is, the smaller the difference is, or the slower the change is. On the contrary, the lower the information entropy is, the more unbalanced the system structure will be, the greater the difference will be, or the faster the change will be. Therefore, the weight can be calculated according to the entropy value. The main steps are as follows:

(1) Non-negative data processing. When the dimension reduction is realized by principal component analysis, the data need to be nonnegatized by data translation. For convenience, the data of non-negation is  $x_{ij}$ .

Where,  $j$  is the  $j$  th index of city  $i$ ,  $j = 1, 2, 3, \dots, n$ ;

(2) Calculate the proportion  $p_{ij}$  of item  $j$  of city  $i$  in this index;

(3) Calculate the entropy value  $E_j$  and information utility value  $D_j$  of the  $j$  th index;

(4) Define the weight  $W_j$  of the  $j$  th indicator:

$$W_j = \frac{D_j}{\sum_{j=1}^n D_j} \tag{2}$$

(5) Calculate the weighted sum of each indicator and calculate the comprehensive score value  $Q_j$  of each

indicator:

$$Q_j = \sum_{j=1}^n W_j \times p_{ij} \quad (3)$$

(6) Results of vulnerability analysis. The product of the weighted value of the  $j$ th indicator and the normalized value of the indicator is used as the analytical evaluation value of the index, and the sensitivity and resilience analysis value is obtained by weighted summation, and finally based on sensitivity, resilience, and vulnerability. The functional relationship and mathematical model between the three sexes are used to obtain the analytical value of the vulnerability of the urban ecological environment system.

According to the above analysis results, on the basis of summarizing the classification of related sustainable development and risk disaster evaluation standards and combining with the actual situation of cities, the ecological environment vulnerability is divided into three standards, as shown in Table 2.

**Table 2 Vulnerability rating**

Level	Low vulnerable	Moderately vulnerable	Strong fragile
Value of the composite vulnerability score	< 1	1-2	> 2

In summary, the analysis of urban ecological environment vulnerability based on communication network is realized.

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