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LETTER TO THE EDITOR

Hydrological Changes and Influencing Factors of Natural Wetland Ecological Environment Based on Improved Neural Network Algorithm

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Application of BP neural network model of zhalong wetland ecological vulnerability is evaluated. 7-2-4 structure was used to sample various wetland types of grid unit it calculated ecologically fragile index E VI value as a training set, through the largest error back propagation training of 1, 000 times, the maximum error was 1.1%, the minimum error is 0. The 7-dimensional evaluation index variable to 1-dimensional variable of zalong wetland was successfully realized, namely the mapping of zalong wetland ecological vulnerability index, and the ecological vulnerability index value of all grid units in the study area was obtained. Using GIS technology, the ecological vulnerability grading map of zhalong wetland was made, and the analysis showed that the moderate and severe vulnerable areas of zhalong wetland accounted for 18% of the whole, and the potential vulnerable areas and slight vulnerable areas accounted for 63% of the whole. From the quantitative point of view, the overall ecological environment of zhalong nature reserve was not optimistic, which provided scientific reference for zhalong wetland ecological environmental protection and management.
Geographic information systems; wetland; ecological vulnerability; neural network

1 Introduction

Wetland is a special ecological system formed by the interaction between water and land. It is the link between the terrestrial ecosystem and the aquatic ecosystem. It is the most productive ecosystem in nature and one of the most important ecological environments for human beings.Wetland ecosystem is of great significance to a region, a country and even the global economic development and human ecological environment. In recent years, wetlands around the world are deteriorating at an alarming rate. For example, the United States has lost 87 million hm^2 of wetlands, accounting for 54% of the total wetland area.In China, for a long time, because the function and value of wetlands to the natural environment and social economy have not been paid attention to by the public, the government and the wetland development department, the area of wetlands in China has been rapidly reduced, the production and ecological functions have been rapidly reduced, and the wetland degradation is serious.

Wetland degradation indicates the existence of wetland ecosystem vulnerability. Currently, when evaluating the ecological vulnerability of wetland system, a tree-like multi-level index system is usually established, which is subdivided from top to bottom, and the calculation results of each index are superposed for analysis, so as to draw a conclusion.In this paper, the regional social, economic and environmental problems are studied to determine the vulnerability of the ecosystem by studying the structure, function and adaptability of the ecosystem. Evaluation indexes are selected to calculate the ecological vulnerability index of the grid cell in the typical research area as sample data.The artificial neural network method is used to establish the neural network model for the calculation of wetland ecological vulnerability index, and the vulnerability index of all grid cells in the research area are calculated.At the same time, GIS method is used to express the calculation results, so as to evaluates the ecological vulnerability of zhalong nature reserve, summarizes the causes of zhalong wetland degradation, and provides a basis for the protection and management of zhalong wetland resources.

Khai Lin Chong, published an article titled "Ecological Effects of Hydrological Process on Time of Concentration" in the journal Ekoloji Issue 107, 2019. This paper focused on Ecological theory and emphasized that source rivers and wetlands were hot spots for terrestrial organic matter metabolism and biogeochemical transformation.The concentration Tc time was defined as the wave propagation time from the most remote hydraulic point to the research point. Tc was an important part of hydrological research, especially in drainage system design and flood arrival time estimation.In the estimation of Tc, the commonly adopted method was based on the motion wave (KW) approximation of surface flow and river path.However, this approximation may not apply to flooded flood plains.The main purpose of this paper is to propose an approximate Tc estimation method for diffusion wave considering flood inundation effect.The method is tested by taking a severe flood disaster in the kelantan river basin in Malaysia in December 2014 as an example.Based on the rainfall-running-submergence simulation, this study compares the estimated Tc value with other estimated values by using the simple correlation method of rainfall and river flood peak flow in different periods.Therefore, the flood inundation DW approximation method proposed in this paper is closer to the estimation of Tc than the other two methods. Experimental results show that the model has high extraction accuracy, but low data extraction efficiency and accuracy.

Feng (2018) put forward research and analysis based on engineering practice and knowledge of roadway support field, applied the improved BP neural network algorithm to prediction of roadway support parameters, determined the main influencing factors of roadway support design, and took typical roadway support engineering cases collected from the site as neural network training samples. Based on the improved BP neural network support parameter prediction model, the method ws applied to predict the support scheme of the roadway in yunjialing coal mine. The prediction error was within the allowable range, which verified the reliability of the method.Experimental results showed that the proposed method had high extraction accuracy, but the data extraction accuracy of this algorithm was not high；Kong et al (2017) proposed the ship shore power technology, which referred to the technology that allowed ships equipped with special equipment to access the land side grid of the terminal during the berth.When the ship arrived at the port, it directly used the land power of the port terminal, which could greatly reduce the operation and maintenance cost of the ship's power supply system and improve the energy utilization efficiency.Based on the analysis of the application of offshore power system in domestic and foreign ports and the problems existing in offshore power technology, an intelligent output control system of offshore power supply for ships was designed based on the internal model controller based on the improved BP neural network algorithm.The function of the intelligent output control system was verified by light load experiment and heavy load experiment respectively.In view of the above problems, this paper proposes a study on hydrological changes and influencing factors of natural wetland ecological environment based on improved neural network algorithm.

2 Idea description

2.1 Data processing method

In this study, the Landsat 7ETM remote sensing image data in 1986 and 2004 in the research area are first used as the basis (Gu, 2017).TM1, TM2, TM3, TM4, TM5, and TM7 bands of the images are processed by radiometric correction, geometric correction, and various enhancement procedures to obtain the synthetic image images of TM432 bands of zhalong wetland in 1986 and 2004, respectively.Based on the medium scale topographic map data of the research area and some other data provided by zhalong nature reserve administration, the above composite image images are enhanced, registered and interpreted to obtain the 1986 and 2004 wetland distribution maps of zhalong wetland as shown in Figure 1 and Figure 2.

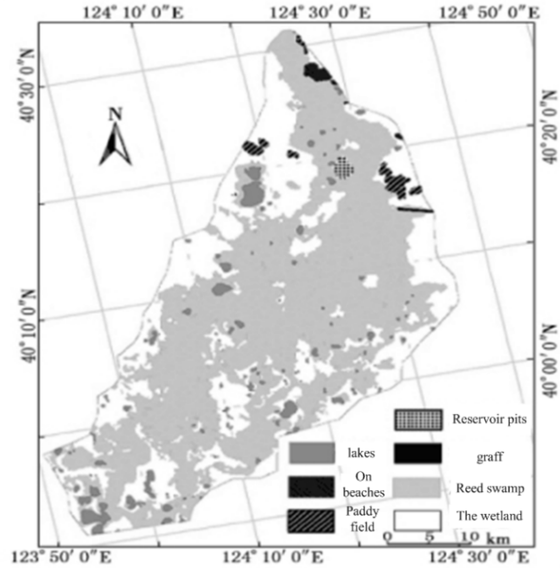

Figure 1 distribution map of zhalong wetland in 1986

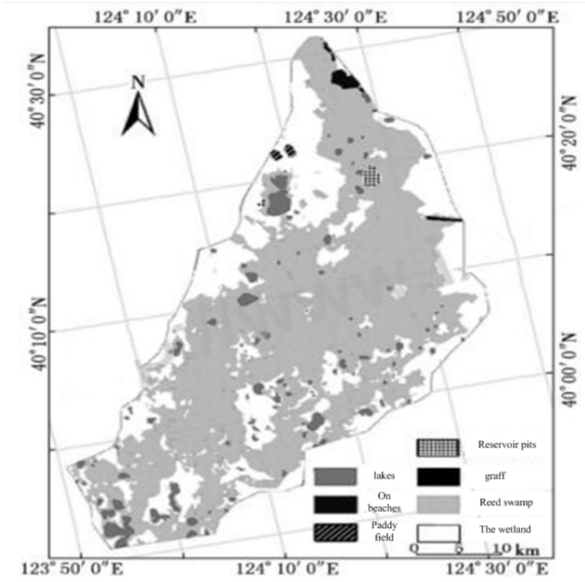

Figure 2 distribution map of zhalong wetland in 2004

2.2 BP neural network method

BP neural network, also known as error back-propagation neural network, is a multi-layer forward neural network. In BP network, the signal is forward propagation, while the error is back propagation. The network model is composed of processing unit, network topology and learning rules .The commonly used BP neural network model is composed of input layer, output layer and hidden layer. Neurons between adjacent layers are connected by weight coefficient, and neurons within the same layer are parallel and connectionless.

BP algorithm can be expressed by mathematical model as follows:

$$\overline{H} = f\left(\overline{w}\overline{X} + \overline{\theta_H}\right), \overline{O} = f\left(\overline{v}\overline{H} + \overline{\theta_O}\right) \tag{1}$$

Where: X, H, and O are the input layer, the hidden layer, and the output layer vector (ie, the node vector);W and v are respectively the connection weight vectors between the input layer and the hidden layer, and between the hidden layer and the output layer; As H and O, in turn, are the activation threshold of neurons in the hidden layer and output layer; Function f (x) is the node action function, and Sigmoid function is usually selected:

$$f\left(x\right) = 1/\left(1+e^{-x}\right) \tag{2}$$

In the learning process of BP neural network, error E is taken as the error objective function of the network：

$$E=\frac{1}{2}\Sigma\left(\overline{O}-\overline{O_0}\right)^2 \tag{3}$$

By calculating the error objective function of the network, BP model adjusts and corrects the connection weight of hidden layer, output layer and input layer successively by gradient descent method until the error sum of the whole sample set meets the network requirements.In order to improve the operation speed of the neural network, this paper improves the BP neural network through the normalization of the training set to make it more suitable for the evaluation and research of zhalong wetland ecological vulnerability (Drayer and Richter 2016, Kearney and Turner 2016; Nergiz and Durmus 2017; Mishra et al. 2017).

3 Results

According to the classification and distribution map of zhalong wetland, this paper selectes typical grid units from the existing wetland types of zhalong wetland, including reed marsh, paddy field, beach, reservoir pit, canal and lake for ecological vulnerability assessment, and takes the evaluation results as sample data set for BP neural network training.In the vulnerability evaluation of the sample raster cell, in order to facilitate the acquisition of data and the expression of results, the 100m 100m raster cell is selected as the data carrier of the evaluation index to extract the data of each evaluation index. Meanwhile, in order to meet the requirements of ecological environment management and decision-making, the press-state-response (PSR) framework model established by OECD (United Nations economic cooperation development agency) is selected as the evaluation model.This model faces both human activities and natural environment, and it can more clearly express the logical relationship between human activities, economic operation and its impact on the environment than the previous tree evaluation model used in similar problems.According to this model, there are three types of first-level evaluation indexes: pressure index, state index and response index. The stress index is calculated by population density and human disturbance index.The state index is calculated by the primary productivity, the wetland tissue index (acreage weighted average patch shape index, patch density, average patch area), the average elasticity of wetlands and the index of wetland water storage.Response index is reflected by the proportion of wetland area change. The results of the ecological vulnerability assessment of the training set's sample grid cells are defined as the ecological vulnerability index.

In the extraction of big data of ecological and environmental hydrological changes by the two algorithms, the accuracy of data extraction shows a fast rising trend as the amount of data increases. The accuracy of data extraction of ecological and environmental hydrological changes by the algorithm in this paper shows a fast rising trend.The accuracy of the algorithm proposed presentes a slow upward trend in data extraction. After that, the extraction accuracy tends to be stable, about 55%, while the data extraction accuracy of the algorithm in this paper is finally stable at about 90%, which is significantly higher than the algorithm proposed.

4 Discussion

Using the above BP neural network model, the final result of zhalong wetland ecological vulnerability index calculation, namely EVI.According to the grading scheme shown in table 1, the zhalong wetland ecosystem vulnerability level is divided into 5 levels according to the ranking of EVI value from low to high. The GIS software is used to visually express the evaluation results, and the zhalong wetland ecological vulnerability assessment grading map is output.

(1) The data extraction accuracy of this algorithm is higher than that of the algorithm proposed by Feng

(2018).This is because the calculation steps are complex, and typical engineering cases of roadway support collected from the field need to be taken as neural network training samples to complete the establishment of the prediction model of support parameters based on the improved BP neural network.As a result, a large amount of data needs to be used, which increases the difficulty of the workload and leads to the data accuracy rate far lower than the algorithm in this paper.
(2) Compared with the algorithm proposed by Kong et al (2017), the data extraction stability of this algorithm is relatively high.This is because in this paper, in the process of data extraction, with the help of the idea of full table comparison, the operations in the database of ecological and environmental hydrological change sources are classified and summarized, so as to realize the incremental extraction of data and improve the extraction efficiency of the algorithm.

5 Conclusions

In this paper, the 100m 100m raster unit is adopted as the data carrier of the index factor and the basic evaluation and analysis unit, and BP neural network is combined with GIS and RS technology to analyze and evaluate the current situation of zalong wetland vulnerability.It can be seen from the above analysis：
(1) BP neural network model is used to analyze the ecological vulnerability of zhalong wetland. The network model adoptes 7-2-4-1 structure.Through maximum 1000 times of error back-propagation training, the mean square error between the actual output value and the expected output value of the network is minimized, and the zhalong wetland population density, human disturbance index, primary productivity, wetland organization index, average elasticity of wetland, wetland water storage and wetland area change ratio are successfully realized. The mapping of the ecological vulnerability index of zhalong wetland from the 7-dimensional variable to the 1-dimensional variable.The calculation results show that the mathematical model has a high evaluation accuracy, and the final output results are not different from the expected results. A good compromise is achieved between the accuracy and complexity of the model, and the evaluation results are scientific and reliable.
(2) The ecological vulnerability index of all raster cells in the study area is obtained through BP neural network modeling and calculation, and the ecological vulnerability grading map of zhalong wetland is made in GIS software.It is found that the potential and mild vulnerable areas with good health status are almost all distributed in reed marsh, while the moderate and severe vulnerable areas with poor health status are mainly paddy fields.In terms of geographical location, the central area of the reserve is less vulnerable than the marginal areas, and its health condition is relatively good.In terms of the overall situation, zhalong wetland's moderately vulnerable and severely vulnerable areas account for 18% of the total, and potential vulnerable areas and slightly vulnerable areas account for 63% of the total.From the quantitative point of view, it shows that the overall ecological environment of zalong nature reserve is not optimistic, which provides a scientific reference for the protection and management of wetland ecological environment.

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