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Evaluation Model of Regional Water Resources Sustainable Utilization Based on Neural Network

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Abstract: With the growth of population and the rapid development of science and technology and economy, how to sustainably utilize limited WR to support the rapidly increasing population, ensure human water demand, and ensure the sound development of society, economy and ecological environment has long been become one of the hotpots in WR research. Therefore, this paper studies the evaluation model (EM) of regional water resources (WR) sustainable utilization based on neural network. In this paper, city A is taken as an example to study the model of sustainable utilization of WR. Based on deep learning theory, an EM of sustainable utilization of WR—probabilistic neural network (PNN) model is constructed. The research results show that the evaluation results of the PNN model are accurate and reasonable.

1. Introduction

With the rapid development of my country's economy, the problem of water shortage is becoming more and more serious [1]. The spatial and temporal distribution of WR is uneven, floods occur from time to time, the utilization of existing WR is reduced, water pollution is serious, and water problems emerge one after another [2]. WR are the foundation of social and economic development, and are important to people's production and life [3]. Various macro factors such as economy and environment are important components of sustainable utilization of WR. In order to jointly realize the sustainable use of regional waters, it is necessary to comprehensively consider all elements and coordinate the relationship between them. Sustainable development is the ultimate goal of WR management [4-5]. The sustainable utilization of WR is closely related to the development of the economy, the protection and restoration of the ecological environment, and the improvement of people's living standards [6].

With the development of economy, many experts and scholars have studied the rating model of sustainable utilization of WR, and achieved many research results [7-8]. For example, Kumar R constructed an evaluation method for sustainable utilization of WR based on variable fuzzy set model, and introduced the evaluation method in detail by taking the Nansi Lake Basin in my country as an example. The example shows that the evaluation index system constructed in this paper is easy to understand and easy to understand. operation, the results are highly credible, and the evaluation results have positive significance for the sustainable management of WR [9]. When experts and scholars such as C Sánchez-Sánchez determine the weight of each evaluation index, the entropy theory of information theory is introduced into the model, and the sustainable utilization of regional WR is evaluated from the social, economic, ecological and environmental WR evaluation index system [10]]. At present, there are few researches on the sustainable EM of WR based on neural network.

The innovation of this paper is to construct an EM for sustainable water resource utilization based on neural network, and to provide reliable suggestions for the sustainable development of WR by constructing an EM of WR. The main content of this paper can be divided into three parts: the first part is to explain the regional WR allocation, and to briefly introduce the WR allocation through the amount of surface ground WR and water use structure; the second part is to analyze the current situation of WR, from the perspective of WR The current situation of WR in City A is analyzed in detail in terms of sustainable management, WR ecological carrying capacity and WR ecological pressure index; the third part is to build and analyze the model.

2. WR Allocation

2.1. Surface and Ground WR

This paper takes A city as an example to study the sustainable utilization of regional WR. From the current situation of WR development and utilization, it can be seen that the water sources available for city A in the future mainly include surface water, groundwater, external water and other waters [11-12]. In this study, the water supply and demand simulations were carried out according to the water resource guarantee rates of 95%, 75%, and 50%, respectively, and the water shortage in City A was analyzed. Table 1 shows the amount of surface WR and ground WR under different guarantee rates in City A. It can be seen from Table 1 that the surface and ground WR under the 95% guarantee rate are 36.58 and 55.76 respectively, and the WR are the lowest among all guarantee rates. Therefore, the parameters in the status quo continuation plan and the WR allocation plan are all the simulation is carried out according to the surface and ground WR under the 95% guarantee rate.

Table 1. Results of surface and ground WR under different guarantee rates

Guaranteed rate	95%	75%	50%
Surface water resources	36.58	49.65	55.76
Ground water resources	55.76	81.65	86.79

2.2. Structure of WR and Water Use

In terms of water use structure, the following analyzes the changes and reasons for changes in WR structure in City a in 2022 compared with 2021. The water use structure in 2022 and 2021 is shown in Figure 1. In 2022, the proportion of water use in the primary industry (51%) under the 95% guarantee rate will be reduced by two percentage points compared with the proportion of water in the primary industry in 2021 (53%). The improvement of water-saving facilities in the primary industry and the improvement in the utilization rate of water use in the primary industry; the second largest proportion of water use is in the secondary industry. The proportion of water use in the secondary industry (24%) dropped by 3 percentage points in 2018, which is in line with the expected development of the industry. Although the added value of the secondary industry will increase in the future, with the emphasis on water conservation, the water consumption of the secondary industry has increased. In terms of domestic water use, the proportion of domestic water use (17%) in 2022 will be higher than that in 2021 (15%) under the 95% guarantee rate. This is due to the increase in urbanization rate. People's living standards have also improved, and living costs such as water consumption will also increase accordingly. In terms of the tertiary industry and ecology, in 2022, the proportion of water use in the tertiary industry (5%) and the proportion of ecological water use (3%) will be basically the same as in 2021 under a 95% guarantee rate. With the improvement of ecological water replenishment methods and engineering In terms of the comprehensive coverage of water-saving and greening facilities, the proportion of ecological water consumption has stabilized at 3%. Overall, the forecast results of water supply and demand in 2022 and the optimal allocation of WR are in line with the actual development of City A and have practical reference significance.

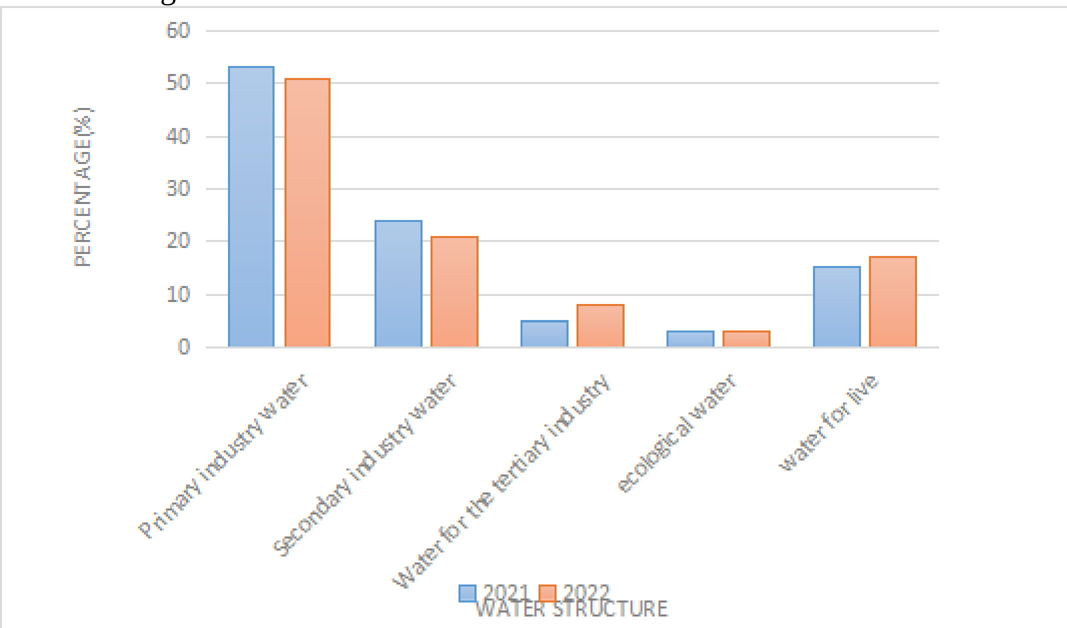

Figure 1. A map of water use in city A

3. Analysis of the Current Situation of WR

3.1. Sustainable Management of WR

The sustainable utilization of WR cannot exceed people's understanding level, living standards and demand conditions, and cannot be separated from the actual situation of regional social and economic development and WR conditions [13]. It should be achieved by applying science and technology according to local conditions and adopting human intervention measures such as planning, construction and management [14]. Use the comprehensive index evaluation method to manage WR sustainably. The calculation steps are as follows.

(1) Calculation of the harmony degree value of the system layer

$$S = \sum_{k=1}^{m} S_k \times R_k \tag{1}$$

In the formula, S—the value of the harmony degree of the water resource management system; Sj—the sub-harmony degree value of the jth water resource evaluation index; Wj—the weight of the jth water resource evaluation index; m—the water resource evaluation index number of indicators.

Calculation of comprehensive harmony degree of sustainable WR management

$$RS = \sum_{d=1}^{m} S_d \times R_d \tag{2}$$

In the formula, RS—the comprehensive harmony degree of regional sustainable WR management; Sd—the harmony degree value of the d-th water resource management system; Rd—the weight of the d-th water resource management system; m—the number of subsystems

3.2. Ecological Carrying Capacity of WR

As can be seen from Figure 2, the ecological carrying capacity of WR in City A generally shows an increasing trend. From 2016 to 2021, the carrying capacity increases steadily, from 6.8×104hm2 in 2016 to 9.2×104hm2 in 2021. This phenomenon is related to A City rainfall is basically the same. The results analyzed from Figure 2 show that rainfall will affect the ecological carrying capacity of WR in City A. In 2019, City A suffered from severe drought, and there was no large-scale heavy rainfall throughout the flood season. This is also the ecological carrying capacity of WR in City A in 2019. Lowest main reason.

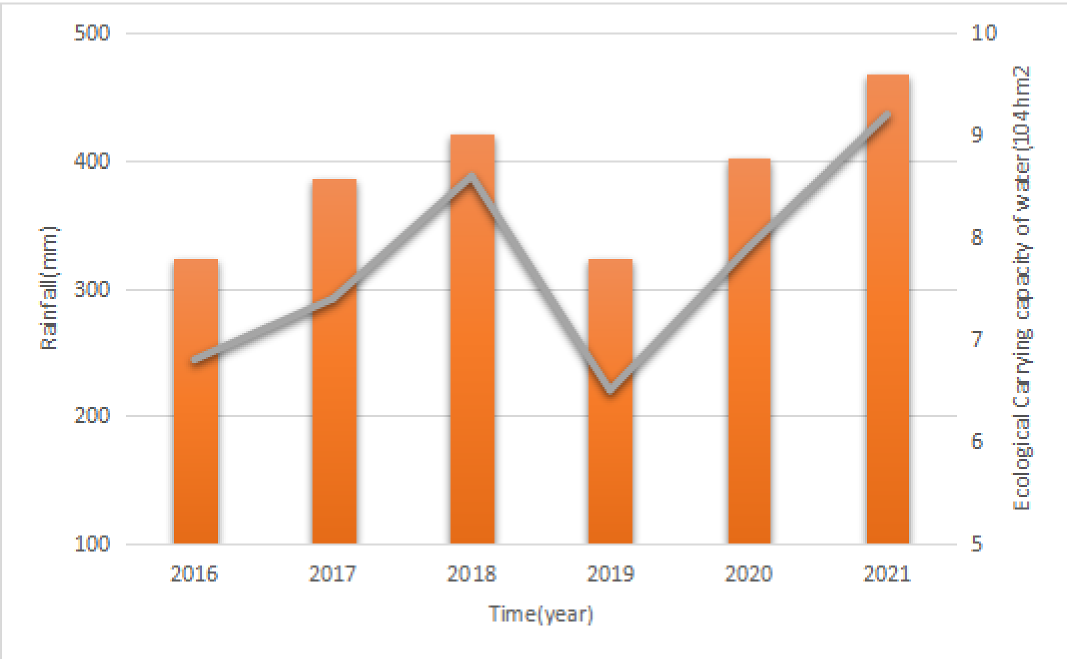

Figure 2. Relationship between the ecological carrying capacity of WR and rainfall

3.3. Ecological Pressure Index of WR

It can be seen from Figure 3 that the ecological pressure index of WR in City A from 2016 to 2021 is much greater than 1, indicating that WR have been in an “unsafe” state for a long time, but the ecological pressure index of WR in City A shows a downward trend, from 17 in 2016 to 6 in 2021, down 11, or 65%. Among them, the ecological pressure index declined the most from 2019 to 2021, decreasing by 9. This shows that the social and economic pressure of city A on water demand is gradually decreasing.

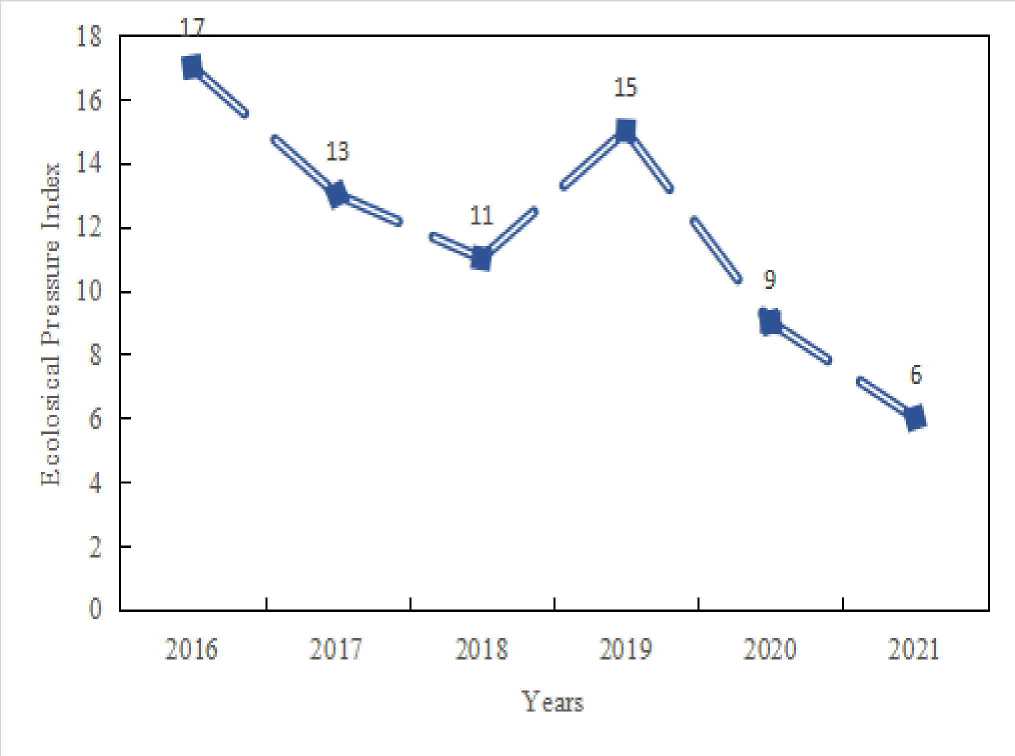

Figure 3. Changes in the ecological pressure index of WR in City A

4. Construction and Analysis of the EM

4.1. Construction of PNN WR Sustainable Utilization EM

This paper combines ISSAWRU in city A to build a PNN EM. PNN based on statistical learning theory is a neural network model with better pattern classification function [15-16]. The construction of a PNN water resource sustainable utilization EM is actually to determine the standard mode of network learning according to the evaluation criteria of WR sustainable utilization, thereby obtaining the standard mode vector Q and the target output vector R[17-18]. where R is the identity matrix vector, so that the network weight vector can be determined, namely:

$$SW = Q' \tag{3}$$

$$NW = R \tag{4}$$

In the formula, S and N represent the pattern vector of the pattern layer and the output layer respectively, the corresponding Q and R represent the target output vector, and W represents the weight vector.

The core of constructing the PNN WR sustainable utilization EM is to use the evaluation criteria to determine the standard mode of network learning. The system block diagram of the PNN WR sustainable utilization EM is shown in Figure 4.

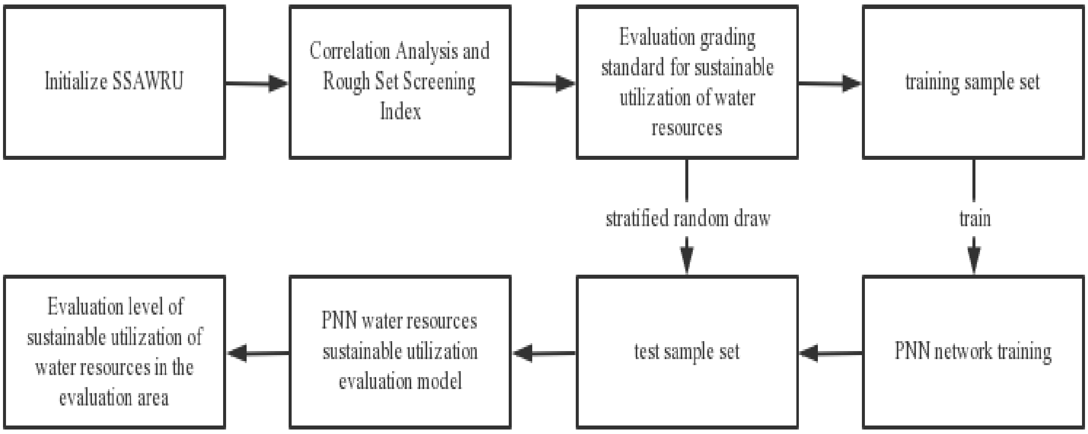

Figure 4. PNN EM system structure diagram

4.2. Comparative Analysis of Model Results

The following is to illustrate the rationality and accuracy of the graded evaluation of the regional WR sustainable utilization capacity by the PNN EM. In this paper, the same sample set is selected to train the PNN EM and the BP EM respectively, and then the measured data of the evaluation indicators of the six districts and counties in City A from 2019 to 2021 are input into the model, and the evaluation levels are divided into special, strong, medium, The evaluation results of the two models are shown in Table 2.

Table 2. Comparison table of measured data evaluation results

Area	PNN EM			BP EM		
	2019	2020	2021	2019	2020	2021
Area K	IV	IV	III	III	III	III
Area F	V	V	V	IV	IV	V
Zone L	III	III	III	III	II	II
County S	II	III	III	II	II	II
County C	III	IV	IV	III	III	III
County W	II	I	I	I	I	I

As can be seen from Table 2, the evaluation results of the two models are quite different. The PNN model evaluates the WR sustainability of the K area for three consecutive years as level 5 (very weak), while the result in the BP EM for two consecutive years is level 4 (weak); the L area is in the PNN model. All three years are classified as 3 (moderate), and 2020 and 2021 are classified as 2 and (strong) in the BP neural network model. Judging from the individual evaluation indicators and related WR reports, the natural conditions of WR in Area K are relatively poor. The current high degree of urbanization and rapid economic development have caused great pressure on WR, and the contradiction between water supply and demand is prominent. Therefore, the PNN model will Its sustainability rating of 5 (very poor) is more in line with reality. The development and utilization rate of WR in the L area is relatively high, and the supply and demand of WR are not balanced, but the amount of WR in the region is medium, which indicates that the sustainable utilization of WR in the region is basically balanced. more reasonable. From the analysis of the overall evaluation results, it can be seen that the classification results of the PNN EM for the sustainable utilization of WR in City A are more reasonable and accurate than the results of the BP EM. Therefore, the evaluation results obtained by using the PNN WR sustainable utilization EM in this paper will provide a great reference value for the future planning, development and utilization of WR in City A.

4.3. Management Strategies for Sustainable Use of WR

In order to realize the sustainable utilization of WR in the current region, we must first change the concept, vigorously adjust the industrial structure of the project, actively ensure industrial projects with less water consumption and high benefits, and promptly ban projects with high water consumption, small benefits and high pollution, and prevent the continued use of WR. Excessive development, limit the blind growth of economic water use, strictly prohibit the national economic water use from further squeezing the reasonable water consumption of the ecological environment, build a green industrial economic and social system with high efficiency, water saving and anti-pollution, achieve the goal of harmony between people and water, and continue to use WR. On the basis of achieving sustainable economic and social development.

5. Conclusion

With the growth of population, the sustainable utilization of WR is very important for agriculture, industry, human life, etc. Therefore, this paper studies the EM of sustainable utilization of WR based on neural network, and realizes the sustainable utilization of WR by constructing an EM. use. In this paper, the PNN model is used to evaluate the sustainable utilization of WR in City A. However, due to the limited level of the author and the rush of time, there are still many shortcomings. For example, the probabilistic neural network has achieved a lot of achievements in scientific research in other fields. Comprehensive and systematic study and research, and it is expected that in-depth and comprehensive research can be carried out in future scientific research work.

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Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

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