Scholar Publishing Group
Water Pollution Prevention and Control Project
https://doi.org/10.38007/WPPCP.2021.020105
ISSN 2790-2730 Vol. 2, Issue 1: 42-52

Evaluation of Water Pollution Prevention Planning Based on Urban and Rural Integration Based on BP Neural Network

Lohr Christoph*

Univ Chem & Technol Prague, Prague 16628, Czech Republic

**corresponding author*

Keywords: Water Pollution Prevention and Control, Planning and Evaluation, Back Propagation Neural Network, Urban-rural Integration

Abstract: In recent years, Water Pollution (WP) has not only caused a serious impact on the ecological environment, but also has a certain constraint effect on the social and economic development. The planning and evaluation of WP prevention and control on the basis of urban-rural integration is very necessary for the current water environment protection, and it needs to be further studied. Many researchers have provided new ideas for the application research of urban and rural integrated WP prevention and control planning evaluation. This paper was based on this as the research direction and basis. This paper analyzed the evaluation of urban and rural integrated WP prevention and control planning, and carried out academic research and summary on the development trend of urban and rural integrated WP prevention and control system planning; the algorithm model was established, and relevant algorithms were proposed to provide theoretical basis for the evaluation of WP prevention and control planning based on the integration of urban and rural areas under the Back Propagation Neural Network (BPNN); at the end of the paper, the simulation experiment was carried out, and the experiment was summarized and discussed; the degree of prevention and control of WP in cities and villages in a region was evaluated by score. Five rivers in cities and villages were selected, and 450ml of water in each river was collected as experimental samples; finally, the WP prevention and control progress of the five samples in cities was about 49%-71%, while the WP prevention and control progress of the five samples in villages was about 69%-91%. It could be seen that the progress of WP prevention and control in cities was lower than that in rural areas due to the large population carrying capacity, dense industrial parks, complex traffic engineering and other problems. At the same time, with the in-depth study of BPNN, the application research of WP prevention and control system planning also faced new opportunities and challenges.

1. Preface

In recent years, the problem of WP has become more and more serious. On the one hand, the increase of living water consumption of urban residents leads to the increase of urban drainage area and the increase of urban sewage treatment costs; on the other hand, the increasing living water consumption of urban residents makes agricultural water increasingly scarce; the amount of fertilizer used in agricultural production is increasing year by year, and the problem of non-point source pollution is increasingly prominent. The relationship between urban residents' living water consumption and agricultural production is not harmonious, which not only makes urban water supply tense, but also leads to serious WP.

The researches on the evaluation of WP prevention and control planning for urban-rural integration are as follows: Xu Zuxin studied that the development of sewage system not caught up with the urbanization rate of developing regions, which caused serious consequences for the water quality of urban rivers [1]. Sarker Bijoyee tried to fundamentally discuss the causes and impacts of urbanization and industrialization on surface water and ground WP, and also solved the control problems and challenges in South Asia [2]. Qu Jiuhui believed that in the past few decades, many urban sewage treatment work made great progress, thus basically realizing the disposal of sewage [3]. Bei Er studied that water supply was a binary system, which reflected the gap between urban and rural communities. Both urban and rural water supply were affected by water shortage and pollution. The shortage of water resources was mainly solved through long-distance water transport projects [4]. Qiao Yu's research found that riparian areas produced a variety of ecosystem services, which played an important role in the natural-human coupling system. In the planning framework of riparian green space, the consideration of riparian ecosystem and the balance of ecological and social aspects of ecosystem would help to achieve the comprehensive goal of urban and rural sustainability [5]. Wang Jian studied collection, transportation, transportation and treatment of industrial wastewater and rainwater of the urban sewage pipe network, which occupied a pivotal position in the construction of urban infrastructure [6]. The above studies achieved good results. However, with the continuous updating of technology, there were still some problems.

The evaluations of BPNN in urban and rural WP prevention and control are as follows: Wu Junhao believed that the collection and transmission of urban sewage pipe network was an important part of urban infrastructure construction. The quality of drainage facilities was directly related to the development, landscape and sanitation of the city [7]. Lv Chungming first established the regional water cycle health evaluation index system, and on this basis built the comprehensive evaluation BPNN model of water cycle health [8]. Through the use of scientific and technological means, Tekin Senem analyzed the factors affecting WP. Differential activation was also used to reverse transfer artificial neural networks, its differential operation was very simple and could continuously reduce the speed of the operation [9]. Sheng Liming proposed a water quality prediction method based on optimal classification. Since these three prediction models could take into account the different characteristics of water quality data, an optimized classifier was established to integrate the back propagation neural network, support vector machine for regression and long-term short-term memory [10]. Guo Qiaozhen believed that surface WP was one of the serious environmental pollution problems and posed a threat to human beings and other organisms. Surface water extraction, change detection and environmental assessment were prerequisites for water resources management [11]. Kalawapudi Komal used artificial neural network to model the groundwater quality of sanitary landfill for solid waste treatment in the research [12]. These studies showed that the application of BPNN had a positive effect, but there were still some problems.

This paper studied the application of WP prevention and control planning evaluation based on urban-rural integration under BPNN. First, it analyzed the evaluation of WP prevention and control planning based on urban-rural integration, and then gave its relevant content. The development trend in the planning of urban-rural integration WP prevention and control system was analyzed. The relevant algorithms were used to provide theoretical basis for the experiment. Finally, the BPNN was used to compare and analyze the WP prevention and control system planning in a region before and after the experiment, thus providing reference significance for such research.

2. Evaluation of WP Prevention and Control Planning for Urban-rural Integration

2.1. Causes of WP

Pesticides, chemical fertilizers, industrial wastewater, living wastewater, hospital wastewater and other harmful substances enter the water body, thus exceeding its own treatment capacity, which have a physical and chemical impact on the natural water bodies. There are two types of WP: One is caused by geological erosion, rainwater leaching, ground scouring and other reasons; the second is man-made pollution, namely industrial wastewater, living sewage, pesticides and fertilizers. The latter is more serious but can be effectively controlled. The destruction of surface vegetation and the drainage of wetlands would reduce the infiltration of surface water and reduce the surface water level. Due to the development of cities and villages, people often pump clean water out as production and living water and industrial water, and then discharge it in the form of surface wastewater, thus further lowering the water level of the water body. Regular irrigation can strengthen the infiltration and make the surface of the subsurface layer rise continuously. In arid areas, due to the abnormal evaporation of water, the salt in the groundwater is deposited, and the soil becomes a saline-alkali land that is not suitable for farming.

2.2. Investigation on Evaluation Methods

This paper summarized several aspects of research on evaluation and analysis methods, as shown in Figure 1:

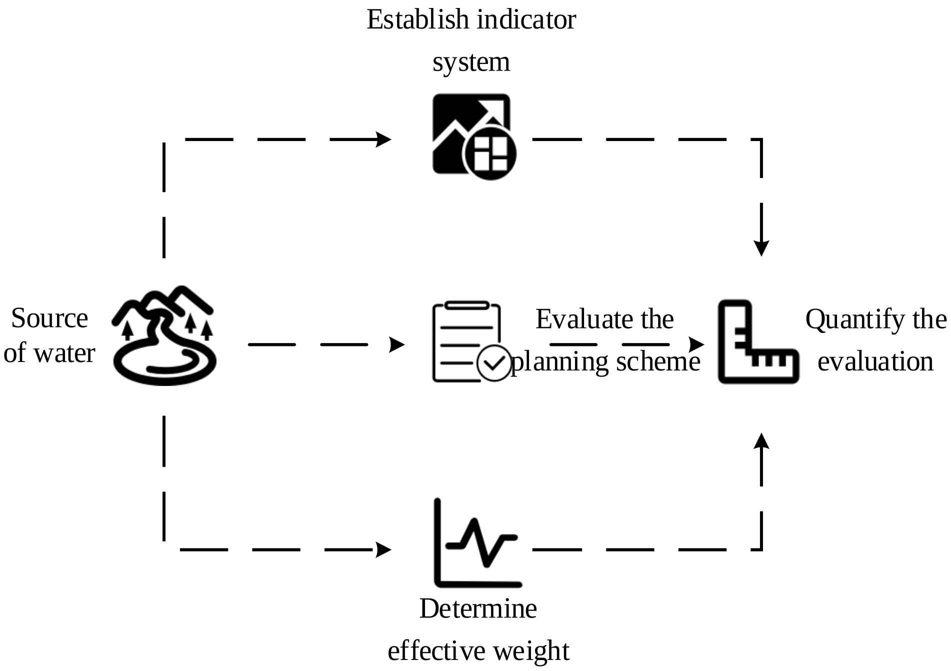

Figure 1. Study on Evaluation and analysis method

2.2.1. Establishment of Indicator System

A scientific WP prevention and control evaluation index system should be built on the basis of dynamic and static state. On this basis, combined with the characteristics of the WP control plan itself and its impact on the economy, society, ecology and other aspects, the specific implementation perspective is discussed. On this basis, the factors that have the greatest impact on environmental protection projects should be selected.

2.2.2. Evaluation of Planning Scheme

When evaluating the urban WP prevention and control planning scheme, the weight of each indicator is determined by using the analytic hierarchy process. Each indicator is scored by using the Delphi method, questionnaire and other methods, and then each impact factor is evaluated by using the weighted comparison method. This method is more operable while overcoming the one-sidedness of a single method. The disadvantage is that the subjective attributes of experts would affect the objective results of evaluation.

2.2.3. Determination of Effective Weight

Analytic hierarchy process is an effective method to determine the weight, which is divided into several objectives or criteria and expressed quantitatively according to their relevance. The overall objective is to evaluate the WP prevention and control plan, and the relative importance of each indicator is carried out by means of investigation, expert consultation, etc. Finally, statistics and consistency tests are carried out for each indicator, and the weight of each indicator at the overall target level can be obtained.

2.2.4. Quantification of Evaluation

At present, the evaluation of WP prevention and control planning in many regions lacks the corresponding legal basis, and cannot give corresponding scores according to the legal evaluation standards. A method based on hierarchical scoring method is proposed to quantify the indicators. According to the difference between the actual situation of the base year and the planned value of the plan year, the corresponding evaluation results can be obtained by evaluating the WP control planning indicators in each region.

2.3. Measures to Strengthen WP Prevention and Control

This paper summarized several measures to strengthen the prevention and control of WP, as shown in Figure 2:

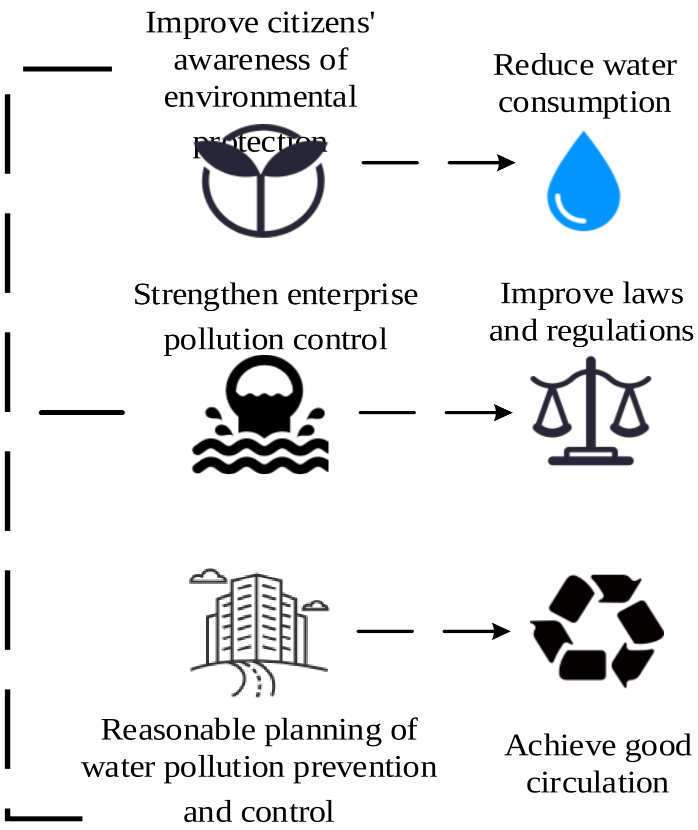

Figure 2. Measures to strengthen WP prevention and control

2.3.1. Improvement of Citizens' Awareness of Environmental Protection

Environmental protection is not only a basic strategy for the region, but also a strategy for sustainable development. Compared with some developed regions in the world, many enterprises and units use more water resources than developed countries, which is an important factor causing increasingly serious WP and violates the basic strategy of environmental protection. Therefore, relevant units should reduce water consumption. In addition, local governments should strengthen the publicity of environmental protection, and enhance public awareness of the environment, so as to advocate multiple uses of one water and strengthen the prevention and control of living sewage to effectively control WP [13].

2.3.2. Strengthening of Enterprise Pollution Control

Since the main source of WP is industrial waste water, the region should strengthen the prevention and control of its pollution discharge. If it does not meet the standard and discharges without authorization, it would be forced to stop production, so as to promote its normal production and supervise its reasonable discharge of sewage. At the same time, the system of laws and regulations related to WP should be constantly improved, and the environmental protection laws and regulations should be improved to strengthen supervision, so that the laws must be followed and the violations must be prosecuted, so as to achieve the goal of WP control.

2.3.3. Reasonable Planning of WP Prevention

Water resources planning plays a key role in the prevention and control of WP. It is necessary to achieve the best effect through reasonable regional planning and urban planning, and organically combine it with other anti-pollution measures. At the same time, before the implementation of the plan, the water quota should be determined according to the water supply to avoid the depletion of surface water sources and the decline of freshwater resources, so as to truly realize the rational development and comprehensive utilization. While controlling and preventing urban WP, it is necessary to achieve a good cycle of sewage recycling to promote the harmonious development of economy and environment [14].

3. Evaluation of the Development Trend in the Planning of Urban-rural Integrated WP Prevention and Control System

The main pollutants discharged from urban sewage are various detergents, garbage, excrement, etc., of which inorganic salts are the main pollutants. The rich content of nitrogen, phosphorus, potassium and other nutrients is necessary for plant growth. Urban living sewage is the main source of water and fertilizer for farmland. The traditional farming habit is to return fertilizer to the field and irrigate it with water, which is an important reason why the fertility of the land has not declined after thousands of years of development.

In the past hundred years, sewage irrigation technology has been implemented in various regions of the world and remarkable results have been achieved. However, it would be difficult to realize the popularization of sewage irrigation if the high pollution industrial wastewater is mixed with urban living sewage. Therefore, the utilization of urban sewage must be classified and resourced. The key to the prevention and control of urban and rural WP is to solve the problem of WP between urban and rural areas while taking into account the reduction of pollutants [15].

Rural WP control can effectively reduce the cost of urban living sewage and alleviate the impact of rural living water on agricultural production; for irrigation areas, the application of wastewater and organic fertilizer can significantly reduce the amount of irrigation water and fertilizer, which is conducive to ecological irrigation; through reasonable wastewater irrigation, the amount of fertilizer is reduced, which can reduce the pollutants in the river water and improve the ecological conditions of rivers and lakes.

4. Introduction of BPNN Related Algorithms

The BP network is divided into the input layer, the hidden layer, and the output layer. The input layer and the output layer each contain one, while the hidden layer can be multiple. There are thousands of neurons in the networks at each level, but the network nodes at the same level are not connected. Since there is no coupling relationship between nodes of the same level, the neurons at each level are more sensitive to the input of the previous node; the output of each neuron would only affect the output of the next stage.

Input layer represents the number of inputs to a network with the number of processing units determined by specific problems. A linear transformation function is used:

$$f(n) = n \tag{1}$$

Hidden layer is the interaction between the individual input processing units. The number of processing units depends on network debugging and empirical formulas:

$$L = (I + J)/2 \tag{2}$$

$$L = (I * J)^{1/2} \tag{3}$$

Among them, L is the number of hidden layer nodes; I is the number of input layer nodes; J is the number of output layer nodes.

Output layer represents the output of a network and uses a nonlinear number transformation function. In these methods, the most common are the two curves.

$$f(n)=\frac{1}{1+e^{n}} \tag{4}$$

In the formula, when the independent variable n tends to be positive or negative, the function value tends to be constant, and its value range is [0,1].

First, $N=(n_1,n_2,...,n_l)$ passes through the nodes of each hidden layer from the input layer, and then carries out the operation to get the final output layer $N=(n_1,n_2,...,n_l)$.

$$f(N)=M \tag{5}$$

In this example, there is some correspondence U between the full input of the sample and the number of samples to output:

$$U(N_k)=M_k^* \tag{6}$$

5. Discussion on Evaluation of WP Prevention and Control Plan

Based on the above analysis of the evaluation of WP prevention and control planning for urban-rural integration, the degree of WP prevention and control in cities and villages in a certain region was evaluated by score. Five rivers in cities and villages were selected, and 450ml of water in each river was collected as experimental samples. If the WP prevention and control progress reached 90-100%, 10 points would be given; 80%-90% would be 8 points; 70%-80% would be 6 points; 60%-70% would be 4 points; 50%-60% would be 2 points; less than 50% was 1 point. The statistics were shown in Figure 3:

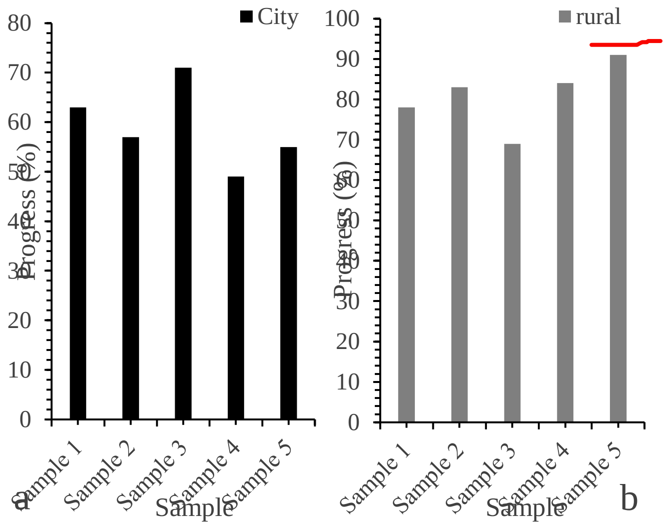

Figure 3a. Progress of urban WP prevention and control

Figure 3b. Progress of rural WP prevention and control

Figure 3. Progress of WP prevention and control in both urban and rural areas

Figure 3a showed the WP prevention and control progress of five samples in cities, and Figure 3b showed the WP prevention and control progress of five samples in rural cities. It could be seen from Figure 3 that the WP prevention and control progress of five samples in cities was about 49%-71%, while the WP prevention and control progress of five samples in villages was about 69%-91%. It could be seen that the progress of WP prevention and control in cities was lower than that in rural areas due to the large population carrying capacity, dense industrial parks, complex traffic engineering and other problems.

Through the control progress values in two different regions, the progress of urban sample 1 was 63%, and that of sample 2 was 57%. The progress of sample 3 was 71%, and that of sample 4 was 49%. The progress of sample 5 was 55%, and the total score was 15 points. The progress of rural sample 1 was 78%, and that of sample 2 was 83%. The progress of sample 3 was 69%, and that of sample 4 was 84%. The progress of sample 5 was 91%, and the total score was 36 points. It could be seen that the progress of prevention and control of WP in rural areas was far higher than that in cities. However, in some rural areas, there would be irrational farming methods, chemical fertilizers and other pesticides littered, and poor rural environment. There would still be some samples with low prevention and control progress. Therefore, this paper considered integrating urban and rural areas to jointly carry out WP prevention and control planning. Table 1 showed the results of the five samples in the region:

Table 1. Results detected from the regional 5 samples

	PH value	Total organic carbon (mg/L)	Turbidity (mg/L)	Total oxygen demand (mg/L)
Sample 1	7.81	2.6	5.6	1.1
Sample 2	7.76	2.9	5.1	1.4
Sample 3	7.83	3.2	5.2	0.9
Sample 4	7.93	2.4	5.7	1.3
Sample 5	7.69	1.9	5.9	1.5

It could be seen that the progress of separating urban and rural WP prevention and control work was relatively slow. Therefore, the following would continue to take the region as an example and take BPNN as the basis to combine the urban and rural areas of the region for comprehensive WP prevention planning and management, and then evaluated its social, economic, ecological and cultural benefits before and after use, as shown in Figure 4.

Figure 4a showed the four types of benefit evaluation of the area before use, and Figure 4b showed the four types of benefit evaluation of the area after use. It could be seen from Figure 4 that the evaluation index of social benefits in the region before use was the highest, but the evaluation index was only 6. The evaluation index of ecological benefits was the lowest, and the evaluation index was 3; after use, the ecological evaluation index of the region was the highest, reaching 9. The evaluation index of human benefits was the lowest, and the evaluation index was 7.

It could be calculated that the difference of social benefit evaluation index before and after use was 2, and the difference of economic benefit evaluation index was 3. The evaluation index difference of ecological benefits was 6, and the evaluation index difference of human benefits was 3. It was obvious that the progress of urban and rural integrated WP prevention and control was greatly improved after the use of BPNN method and provided preparation for the improvement of ecological environment.

To sum up, this paper discussed the evaluation of WP prevention and control planning based on the integration of urban and rural areas under the BPNN. First, it analyzed the progress of urban and rural WP prevention and control in a region. Based on this, it was concluded that the benefit value under the BPNN method was greatly improved by combining urban and rural areas, and it laid a foundation for improving the ecological environment.

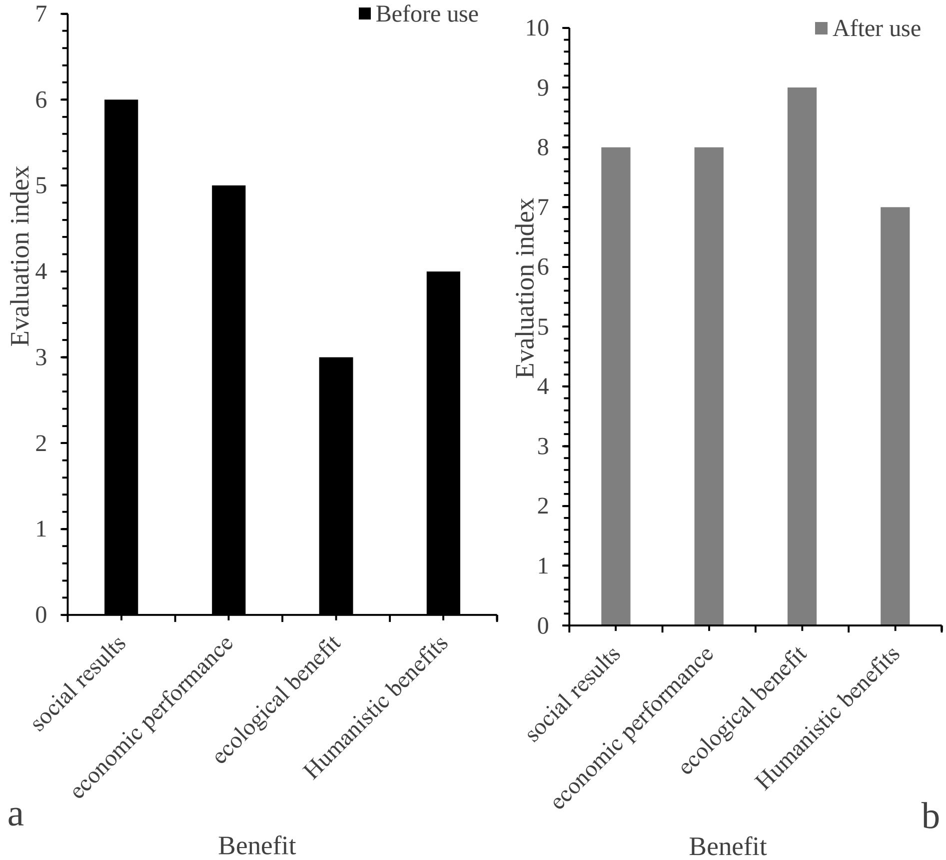

Figure 4a. Evaluation of regional benefits before use

Figure 4b. Evaluation of regional benefits after use

Figure 4. Comparison of regional benefit evaluation before and after use

6. Conclusion

WP is a major environmental problem faced by many regions. At present, many institutions have carried out research on the eutrophication of river water, which can accurately evaluate the river water condition and provide scientific basis for the quality management and control of river water environment. However, due to the complex chemical reaction and mutual influence between various pollutants in the water, it is a very difficult problem to carry out WP prevention and control planning. This paper used BPNN as a method to evaluate the WP prevention and control planning of urban-rural integration. By selecting five river samples from urban and rural areas in a region for research, it was concluded that the WP prevention and control progress of five samples from urban areas was about 49%-71%, while the WP prevention and control progress of five samples from rural areas was about 69%-91%. The evaluation indexes before and after use were compared based on BPNN.

Funding

This article is not supported by any foundation.

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.

References

[1] Zuxin Xu. Urban river pollution control in developing countries. Nature Sustainability. (2019) 2(3): 158-160. https://doi.org/10.1038/s41893-019-0249-7

[2] Sarker Bijoyee. Surface and ground water pollution: causes and effects of urbanization and industrialization in South Asia. Scientific Review. (2021) 7(3): 32-41. https://doi.org/10.32861/sr.73.32.41

[3] Jiuhui Qu. Emerging trends and prospects for municipal wastewater management in China. ACS ES&T Engineering. (2021) 2(3): 323-336. https://doi.org/10.1021/acsestengg.1c00345

[4] Bei Er. A tale of two water supplies in China: finding practical solutions to urban and rural water supply problems. Accounts of chemical research. (2019) 52(4): 867-875. https://doi.org/10.1021/acs.accounts.8b00605

[5] Yu Qiao. Mapping Supply-Demand of Riparian Ecosystem Service for Riparian Greenspace Planning on Mul-tiple Spatial Scales. China City Planning Review. (2020) 29(4): 6-17.

[6] Jian Wang. Current status, existent problems, and coping strategy of urban drainage pipeline network in China. Environmental Science and Pollution Research. (2021) 28(32): 43035-43049. https://doi.org/10.1007/s11356-021-14802-9

[7] Junhao Wu, Zhaocai Wang, Leyiping Dong. Prediction and analysis of water resources demand in Taiyuan City based on principal component analysis and BP neural network. Journal of Water Supply: Research and Technology-Aqua. (2021) 70(8): 1272-1286. https://doi.org/10.2166/aqua.2021.205

[8] Chunming Lv. Regional water circulation health evaluation system based on artificial neural network. International Journal of Design & Nature and Ecodynamics. (2020) 15(2): 211-217. https://doi.org/10.18280/ijdne.150211

[9] Tekin Senem, Tolga Çan. Slide type landslide susceptibility assessment of the Büyük Menderes watershed using artificial neural network method. Environmental Science and Pollution Research. (2021) 29(31): 47174-47188.

[10] Liming Sheng. Water quality prediction method based on preferred classification. IET Cyber - Physical Systems: Theory & Applications. (2020) 5(2): 176-180. https://doi.org/10.1049/iet-cps.2019.0062

[11] Qiaozhen Guo. An integrated study on change detection and environment evaluation of surface water. Applied Water Science. (2020) 10(1): 1-15. https://doi.org/10.1007/s13201-019-1109-3

[12] Kalawapudi Komal, Ojaswikrishna Dube, Renuka Sharma. Use of neural networks and spatial interpolation to predict groundwater quality. Environment, Development and Sustainability. (2020) 22(4): 2801-2816. https://doi.org/10.1007/s10668-019-00319-2

[13] Fadaei Masoumeh, Bijan Rahmani, Jamileh Tavakolinia. Environmental Analysis of Villages on the Skirt of Farsan City based on the Urban and Rural Relationship. Journal of Research and Rural Planning. (2021) 10(4): 59-76.

[14] Rui Guo, Yong Sun, Jie Fan. Policies on Categorized Governance of China's Urban Agglomerations in 14th Five-Year Plan. Bulletin of Chinese Academy of Sciences (Chinese Version). (2020) 35(7): 844-854.

[15] Xinqiang Liang. Promoting Construction of Zero-direct Discharge Engineering for Agricultural Wastewater from Paddy Fields in Yangtze River Delta Region. Bulletin of Chinese Academy of Sciences (Chinese Version). (2021) 36(7): 814-822.