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Evaluation of Effectiveness of Water Pollution Prevention and Control Measures by Integrating Artificial Intelligence and Blockchain

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Abstract: Water is the source of human life. It plays an important role in people's daily life, industry and agricultural production. However, at this stage, there is not only a large amount of waste of water resources, but also a serious problem of water pollution, which makes water resources further scarce. Based on this, this paper has studied the prevention and control of water pollution (WP), carried out research from the perspective of evaluation of WP prevention and control effect, and proposed a method for evaluating the effect of WP prevention and control measures, namely, water quality prediction and evaluation method based on blockchain and improved support vector machines (SVM). This paper has analyzed the accuracy of the proposed method, and used the proposed method to evaluate the effect of WP prevention and control measures for river S. The conclusion is as follows: The mean square error generated by the improved SVM method is about 0.1, and the root mean square error generated is about 0.32. This method has good prediction accuracy. The water pollution of river S has improved compared with that before, and its water quality has reached Class III. In addition, this paper has put forward suggestions to optimize WP prevention and control measures by using blockchain technology to improve WP monitoring effect and strengthen supervision.

1. Introduction

With the deepening of human activities, the problem of water pollution is becoming more and more serious. Water pollution is a major environmental problem faced in the process of economic development. Since the current emphasis on the coordinated development of economy and environment, and environmental problems may have certain impact on the development of economy, it is of great importance to focus on solving water pollution problems under the specific needs of economic development and water environmental protection. Scientific WP prevention and control can ensure the safety of industrial, agricultural and domestic water and promote the stability of ecological environment. In this paper, the effectiveness of WP prevention and control is evaluated to determine the effectiveness of WP prevention and control measures and to provide reference for the development and improvement of WP prevention and control measures.

Many scholars have studied water pollution and WP prevention and control. Xu Zuxin proposed a new urban river pollution control scheme, which provides a reference for river pollution in other regions [1]. Suriadikusumah Abraham used the pollution index method to analyze the water pollution of the Cipeusing River in Indonesia. Through experiments, it was proved that the highest pollution index was in the lower reaches of the river [2]. Singh Nirala believed that electrocatalytic oxidation can treat different industrial waste streams, including textile and food waste water. Based on this, the application of electrocatalysis in the remediation of water pollutants was studied [3]. Li Zhou studied the impact of river head system on water pollution reduction, and proved that the implementation of this system can reduce the negative impact of livestock manure on water [4].

Zhang Jinde analyzed the water pollution in the mine, and analyzed the risk factors and different characteristics of water pollution [5]. Wu Gaojie analyzed the typical water pollution incidents in 2014. Through research, it was found that chemical pollution, heavy metal pollution and algal bloom were the main types of pollution, and put forward relevant measures for WP prevention and control [6]. Wang Yubao discussed the situation of industrial water pollution and analyzed the effect of environmental complaint scheme in industrial WP prevention and control [7]. Tian Limei summarized contemporary environmental protection and antifouling technologies and materials into bionic antifouling and non-bionic antifouling strategies, discussed the research direction and existing problems of WP prevention and control in the future, and provided reference for the development of antifouling technology [8]. The above scholars have carried out research based on water pollution and WP prevention and control, and have made valuable achievements.

AI (artificial intelligence) can be effectively applied in water pollution and WP prevention and control. Muhammad Salisu Yusuf proposed a water quality classification model based on machine learning algorithm, analyzed and compared the performance of various classification models and algorithms to determine the important features that are helpful to classify the water quality of the Kinta River in Perak, Malaysia [9]. Hassan Md Mehedi used machine learning algorithm to predict water quality characteristics such as dissolved oxygen, total coliform, and biological oxygen demand, so as to determine the situation of water pollution [10]. Haghiabi Amir Hamzeh investigated the performance of artificial neural network, grouping data processing method and support vector machine in predicting the water quality composition of the Tirei River in southwestern Iran, and proved that support vector machine has higher accuracy through experiments [11]. This paper uses AI and blockchain to study the effect evaluation of WP prevention and control measures.

In order to solve the increasingly serious water pollution problem, ensure the safety of industrial and agricultural water and domestic water in human society, and provide support for the formulation and improvement of WP prevention and control measures, this paper proposes a water quality prediction method and evaluation method based on improved SVM, and evaluates the effect of WP prevention and control measures in river S based on the water quality data and water quality evaluation standards obtained by blockchain technology, and draws relevant conclusions. Compared with other studies, the evaluation method proposed in this paper has higher accuracy of water quality prediction, and the evaluation results obtained have certain reliability.

2. Classification of WP Prevention and Control Measures

WP prevention and control measures are divided into two types: routine and acute, as shown in Figure 1.

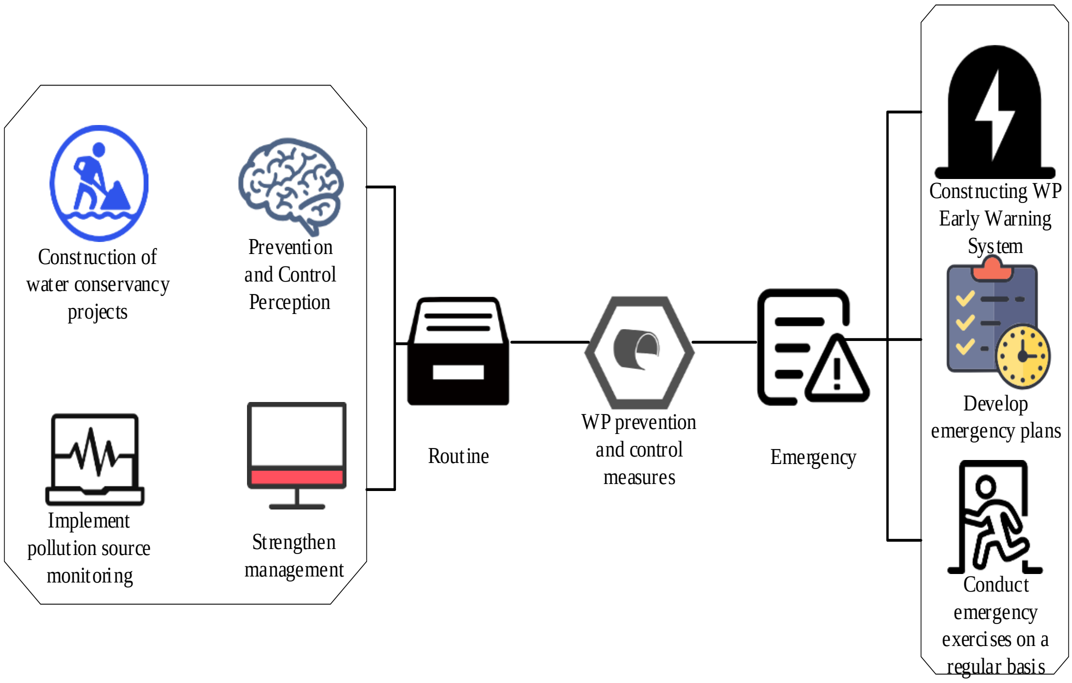


Figure 1. Classification of WP prevention and control measures

2.1. Conventional WP Prevention and Control Measures

Raising awareness of prevention and control: Understanding is the precursor to prevention. In order to ensure the safety of water resources and the sustainable development of water resources, people's inherent concepts and habits need to be changed so that they can fundamentally understand the importance of water resources and actively participate in the work of protecting them. The relevant departments should strengthen the investment and education on water resources, and make use of TV, newspapers, radio and other widely disseminated methods to let the public understand the importance of the water environment.

Strengthen management: To achieve water security, a unified and transparent water resources policy must be established to ensure the integrity of the water environment and ecosystem, and a water pollution control plan must be developed, which is a prerequisite for ensuring the security of the water environment. Scientific technical support and management systems are also essential, such as the establishment of a regional management system, the establishment of water environment and ecological function zoning, and the establishment of a hierarchical WP prevention and control and water security expert support system.

Construction of water conservancy projects, such as improving urban sewers, building barrages, emergency sluices, and establishing wetlands, are the WP prevention and control projects that currently have a more significant effect on intercepting and diverting sewage.

Implementation of pollution source monitoring: pollution source monitoring is an important means to ensure the safety of the water environment, real-time monitoring of the discharge of pollution sources, timely understanding of the pollution situation, to take appropriate control measures to reduce the harm of pollution.

2.2. Acute WP Prevention and Control Measures

Constructing WP early warning system: At present, some places have not yet developed a complete emergency plan and emergency mechanism, and do not have an integrated WP early warning mechanism and emergency monitoring and management system.

Developing an emergency plan: An emergency plan is an important basis and guide in an emergency situation. It can define the behavior of each competent person before, during, and after an incident. After an emergency water pollution incident, the staff can follow the emergency plan to carry out an organized emergency relief, so that the emergency work is carried out in an orderly manner.

Regular emergency exercises: Emergency exercises are designed to simulate water pollution accidents in which individual emergency responders perform tasks according to set situations in emergency command. In terms of experience accumulation, it is difficult to rely solely on actual combat because of the relatively small chance of accidents, which requires the relevant departments to conduct regular emergency drills to summarize their experiences and shortcomings, improve the emergency personnel's resilience and risk awareness, and improve the operability of the emergency plan.

3. Evaluation of WP Prevention and Control Measures Based on Improved SVM

3.1. Improved SVM-based Water Quality Prediction

Set the training sample as:

$$\{(a_1,b_1),(a_2,b_2),\dots,(a_h,b_h)\}\subset U^m * U \tag{1}$$

Map the data to a high-dimensional feature space by nonlinear mapping and performing linear regression in the high-dimensional feature space:

$$g(a)=v*\varepsilon(a)+y \tag{2}$$

Where $g(a)$ is the regression function; ε is the nonlinear mapping.

If the variance of the random error item satisfies the following conditions:

$$\begin{cases} F(\sigma_p)=0,\ p\in[1,h] \\ \operatorname{cov}(\sigma_p,\sigma_q)=\begin{cases}\kappa_p^2,\ p=q\\ 0,\ p\neq q\end{cases}\end{cases} \tag{3}$$

Then σ_p,σ_q are constants.

Under κ_p^2 different conditions, the same position of each parameter during optimization implies the same criteria for considering the penalty for the wrong item, so the results of the standard SVM model are often less satisfactory and the regression curve is often pulled to items with larger variance.

By introducing the weight coefficients, it is possible to obtain:

$$\min \frac{1}{2}\|v\|^2+K\sum_{p=1}^{h}\lambda_p(\rho_p+\rho_p^*) \tag{4}$$

Where ρ_p, ρ_p^* are the slack variables and K is the penalty coefficient.
The constraints are:

$$v \cdot \varepsilon(a_p) + y - b_p \le \rho_p^* + \sigma \tag{5}$$

$$b_p - v \cdot \varepsilon(a_p) - y \le \rho_p + \sigma \tag{6}$$

$$\rho_p, \rho_p^* \ge 0 \tag{7}$$

The pairwise form of the optimization problem is.

$$\max -\frac{1}{2} \sum_{p,q=1}^{h} (x_p - x_p^*)(x_q - x_q^*) C(a_p, a_q) + \sum_{p=1}^{h} (x_p - x_p^*) b_p - \sum_{p=1}^{h} (x_p + x_p^*) \sigma \tag{8}$$

The constraints are:

$$\sum_{p=1}^{h} (x_p - x_p^*) = 0 \tag{9}$$

$$x_p, x_p^* \le \lambda_p K \tag{10}$$

$$x_p, x_p^* \ge 0 \tag{11}$$

Solving for x_p, x_p^* , we can get:

$$g(a) = \sum_{p=1}^{h} (x_p - x_p^*) C(a, a_p) + y \tag{12}$$

According to the Karush-Kuhn-Tucker conditions, then we can get:

$$\begin{cases} \sigma - b_p + g(a_p) = 0 \\ 0 < x_p < \lambda_p K \end{cases} \tag{13}$$

$$\begin{cases} \sigma + b_p - g(a_p) = 0 \\ 0 < x_p^* < \lambda_p K \end{cases} \tag{14}$$

3.2. Water Quality Evaluation Based on Improved SVM

Divide all classes into two subclasses, and then divide them into two subclasses. This cycle is repeated until each node has only one class, which is also a leaf in the binomial tree, thus forming an inverted binomial classification tree. This method also divides the original multi-class problem into two classes, on which the two subclasses are classified using SVM.

In the linear and nonlinear cases, the spacing between samples is:

$$e(a_1,a_2)=\|a_1-a_2\|_2=\sqrt{\sum\left(a_1^p-a_2^p\right)^2} \tag{15}$$

$$e(a_1,a_2)=\|\varepsilon(a_1)-\varepsilon(a_2)\|_2=\sqrt{C(a_1,a_1)-2C(a_1,a_2)+C(a_2,a_2)} \tag{16}$$

The loop scheme for improving SVM is:

A new hyperplane is obtained by using the working set C as training samples. By training the classification hyperplane on B, the distance from the samples in B to the classification hyperplane is obtained, and the classification correctness is obtained as follows.

$$e=e(a_p)*b_p \tag{17}$$

$$e(a_p)=\frac{2}{\|v\|} \tag{18}$$

$$P=\frac{m_1}{m} \tag{19}$$

Where v is the normal vector of the optimal hyperplane.

The samples that least match KKT and the previous support vector samples are placed to C and used as training samples for the next cycle. When the classification correct rate is less than 1, the classification hyperplane is reacquired. When the classification correct rate is 1, the iteration ends.

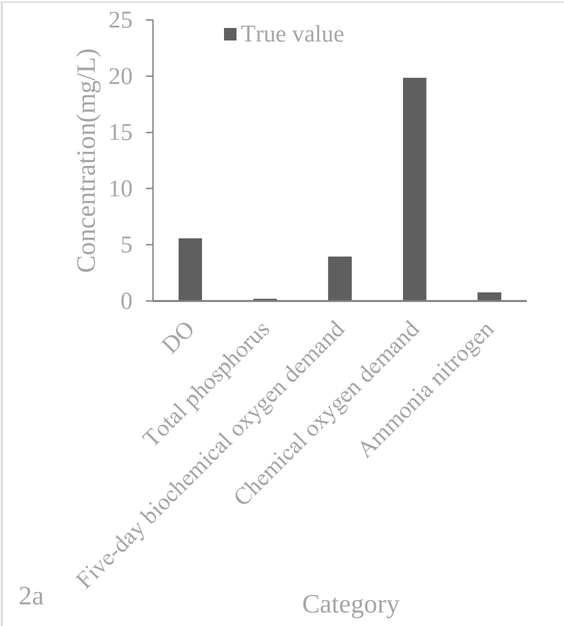
4. Evaluation of WP Prevention and Control Effectiveness Based on Improved SVM and Blockchain

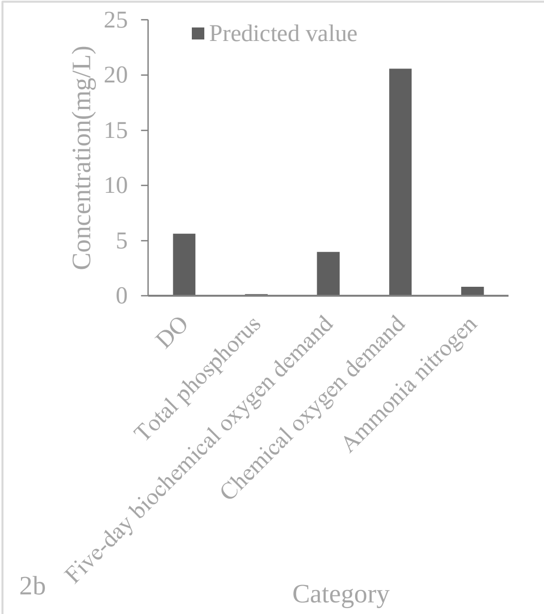
The investigation shows that before the implementation of WP prevention and control measures, the water pollution situation of river S is serious, and the water quality grade is IV. In this paper, we try to improve the SVM water quality prediction and evaluation method to judge the water quality pollution of river S. We use blockchain technology to obtain the water quality data of river S. Firstly, the accuracy of the improved SVM water quality prediction method is analyzed, and then the water quality of river S is judged to evaluate the effect of WP prevention and control. The water pollution evaluation indexes were selected as Dissolved Oxygen (DO), total phosphorus, five-day biochemical oxygen demand, chemical oxygen demand, and ammonia nitrogen. The classification of water quality levels is shown in Table 1.

Table 1. Classification of water quality grade

Evaluation index of water quality(mg/L)	I	II	III	IV	V
DO	7.5	6	5	3	2
Total phosphorus	0.02	0.1	0.2	0.3	0.4
Five-day biochemical oxygen demand	3	3	4	6	10
Chemical oxygen demand	15	15	20	30	40
Ammonia nitrogen	0.15	0.5	1	1.5	2.0

Based on the water quality data obtained by blockchain technology, the improved SVM method is applied to predict the water environment of river S. The prediction results are shown in Figure 2.



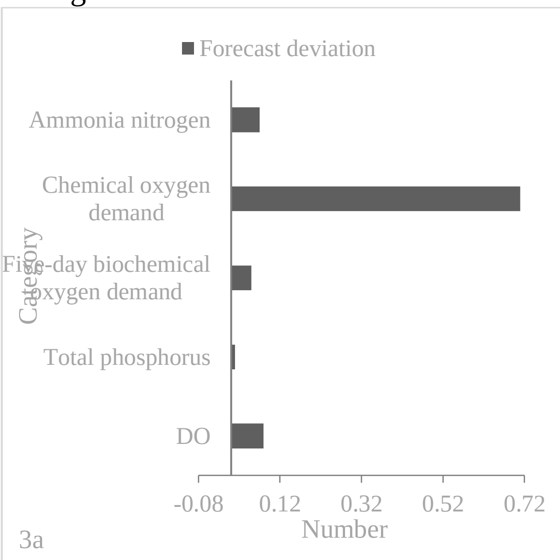


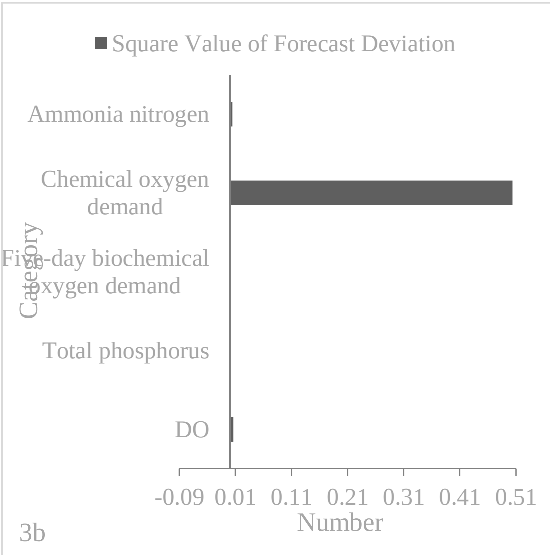
2a: True value *2b: Predicted value*

Figure 2. Prediction results of water environment of river S

As shown in Figure 2, Figure 2a shows the real water quality data obtained, and Figure 2b shows the predicted data obtained by using the improved SVM method. Figure 2a and Figure 2b can show the prediction deviation about five water pollution evaluation indexes such as DO and total phosphorus.

The mean square error and root mean square error were applied to evaluate the accuracy of the improved SVM method. The prediction deviation values and squared prediction deviation values of the five water pollution evaluation indexes under the improved SVM method were obtained, as shown in Figure 3.



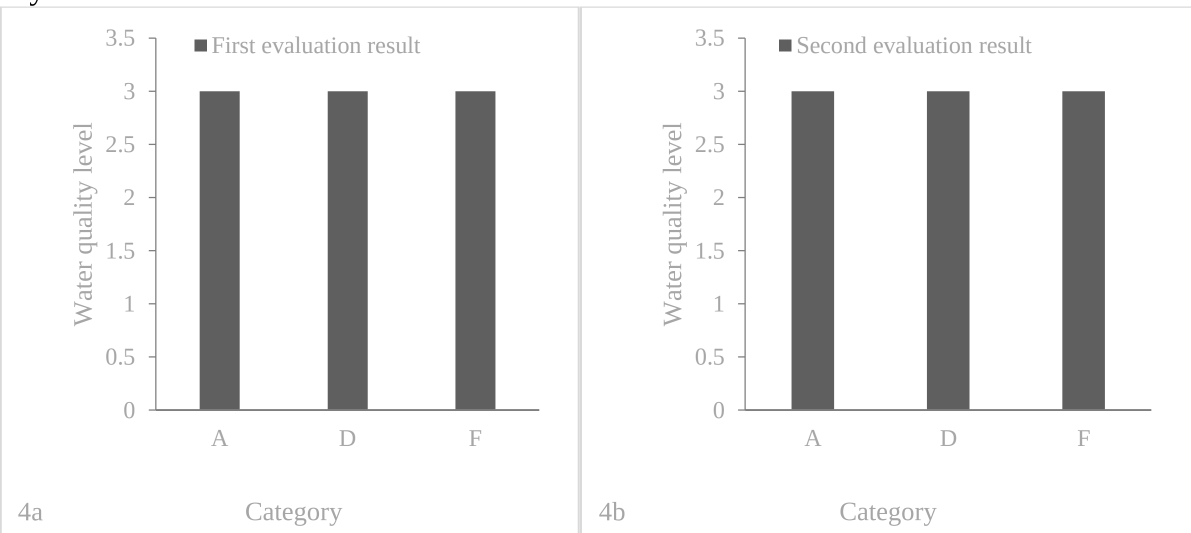


3a: Predicted deviation value *3b: Predicted deviation square value*

Figure 3. Forecast deviation and square value of forecasting deviation of five water pollution assessment indexes

As shown in Figure 3, Figure 3a shows the prediction deviation values of DO and total phosphorus by the improved SVM method, and Figure 3b shows the prediction deviation squared values of DO and total phosphorus by the improved SVM method. The mean squared error is the average of the predicted deviations of DO (0.0064), total phosphorus (0.0001), five-day biochemical oxygen demand (0.0025), chemical oxygen demand (0.5041), and ammonia nitrogen (0.0049). From the above data, the mean square error generated by the improved SVM method is about 0.1. The root mean square error is the open square root of the mean square error, and the root mean square error under the improved SVM method is about 0.32. Through the two error accuracy evaluation criteria of the mean square error and root mean square error, the water quality prediction method based on the improved SVM has better prediction accuracy.

The water quality prediction and evaluation method based on improved SVM is evaluated twice for three locations of river S. The three locations are called A, D and F. The evaluation results are shown in Figure 4, where 1 indicates Class I water quality; 2 indicates Class II water quality; 3 indicates Class III water quality; 4 indicates Class IV water quality; and 5 indicates Class V water quality.



4a: First evaluation result *4b: Second evaluation result*

Figure 4. Evaluation results at three locations

As shown in Figure 4, Figure 4a shows the first water quality evaluation of three locations A, D and F using the water quality prediction and evaluation method based on improved SVM, and Figure 4b shows the second water quality evaluation of three locations A, D and F using the water quality prediction and evaluation method based on improved SVM. From the evaluation results, all three sites of river S belong to class III water quality, and the water quality of river S can be evaluated as class III. Compared with the previous water quality of Class IV, it can be found that the water pollution situation of River S has been alleviated, which indicates that the WP prevention and control measures carried out in the area are effective, but the water quality of River S still has much room for improvement.

5. Suggestions for Optimizing WP Prevention and Control Measures

The optimization of WP prevention and control measures is of great significance for safeguarding people's production and living water as well as ecological balance [12-13]. For the situation that the water quality of river S still has much room for improvement, the following suggestions are made in this paper.

Applying blockchain technology to improve the monitoring effectiveness of WP: The departments concerned must accelerate the construction of a credible monitoring system for the water environment, establish an information sharing platform for the comprehensive improvement of the water environment using blockchain technology, and organize a working group to form a synergy to promote the work. Due to the wide scope and difficulty of the project, relevant departments must establish a working group, develop a project plan, set out a task list, clarify responsibilities and speed up the implementation of the project. It is also necessary to form a technical team of key districts to jointly study the deployment of hardware and software nodes and jointly conduct technical research.

Strengthening supervision: The role of surveillance agencies is very prominent in the WP prevention and control work. In this case, surveillance agencies must take the initiative to fulfill their responsibilities and carry out continuous supervision of WP prevention and control work to ensure that all WP efforts can be put in place and play their best role. Through the monitoring work, the supervisory agencies can identify the specific problems in the current WP prevention and control work and improve them, so that the WP prevention and control program, specific measures and practical operations can be more targeted, thus improving the efficiency of WP prevention and control work and effectively solving problems such as waste of resources. In conclusion, supervision is indispensable in the prevention and control of WP, so it is of great practical significance to actively promote supervision and strengthen it.

Good publicity: let residents understand WP prevention and control knowledge and enhance their awareness of WP prevention and control. Living habits have a profound impact on the amount of domestic wastewater formed, and residents' awareness of water conservation and WP prevention and control has an important impact on their daily water use behavior. In the WP prevention and control work, through community publicity and activities, residents can have a clearer and more comprehensive understanding of WP prevention and control, so that they can better understand the actual value and importance of WP prevention and control. In this way, residents' awareness of WP prevention and control can be significantly increased. As people become more aware, their drinking habits may also change, and in time, they may take the initiative to participate in WP prevention and control efforts. In this way, the prevention and control of WP can be enhanced like never before.

Establishing a scientific WP prevention and control assessment system: In the WP prevention and control work, the relevant departments should conduct research on the water resources planning of the region to understand its prevention and control efforts and to understand the causes of pollution. In this way, more comprehensive and targeted prevention and control measures can be developed based on the causes and status of water pollution. In the infrastructure development combined with the WP prevention and control program, a corresponding evaluation system can be established to make the implementation of the program more practical and thus improve the effectiveness of WP prevention and control.

Doing a good job of coordination: After the implementation of a unified management system, the specific ways, methods, resource utilization and technology application of each department in the actual work can be unified and coordinated, and can meet the corresponding standards. Only in this way can the professionalism and effectiveness of the work be fully reflected. In short, the implementation of the management system under the principle of integration and unification is conducive to significantly improving the effectiveness of WP prevention and control.

Improving the legal system: the relevant departments should strengthen the legal basis of water pollution control work. This may make the work carried out in a standardized and professional manner may be significantly enhanced. By analyzing the actual work, it can be found that WP prevention and control work is not implemented for various reasons due to the inadequacy of laws and regulations, and can only be truly and effectively implemented with the support of laws. In this way, the influence of many unfavorable factors can be reduced, which has important practical significance for the further implementation of WP prevention and control in the future.

Enhancement of prevention and control technologies: in terms of prevention and control technologies, relevant departments can adopt membrane technology, biochar, interception and diversion, algae removal, heavy metal fixation, and other technologies [14-15]. Relevant departments should pay attention to scientific and reasonable technical means, and they should increase investment, accelerate technology research and development, develop more advanced WP prevention and control technologies in a timely manner, and further research on existing technologies.

6. Conclusion

Water is a necessary substance for human beings and other organisms. In view of the existing water pollution phenomenon, this paper studies the effect evaluation of WP prevention and control measures to provide important support for the improvement of WP prevention and control measures. This paper first studies the classification of WP prevention and control measures, and generally divides WP prevention and control measures into two types. Secondly, it puts forward the prediction and evaluation method of WP prevention and control measures based on improved SVM, and evaluates the effect of WP prevention and control measures in river S by combining this method, blockchain technology and water quality evaluation indicators. It is concluded that the water pollution of river S has been improved, but there is still much room for improvement. Finally, this paper puts forward suggestions to optimize WP prevention and control measures, including applying blockchain technology to improve the monitoring effect of WP, strengthening supervision, doing a good job of publicity, and establishing a scientific WP prevention and control evaluation system.

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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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