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Fusion Genetic Algorithm in Water Pollution Prevention and Control Planning

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Abstract: At present, with the acceleration of industrialization and urbanization, the pollution of water resources is becoming increasingly prominent. Water resources are seriously polluted, which would cause the degradation of water body function, or even lose its function. This would not only lead to serious water shortage in areas with less water, but also lead to "water quality" water shortage in areas with more water. Water pollution (WP) has become the most prominent problem in the current water environment. In the face of this situation, this paper studies the prevention and control planning of WP, and puts forward the suggestion of applying genetic algorithm to the prevention and control planning of WP. The research shows that under the condition that the water quality is not polluted, genetic algorithm (GA) can save the cost of prevention and control planning more than particle swarm optimization in WP prevention and control planning, and can save 77 million yuan, 584.4 million yuan and 2565 million yuan in S, T and R regions respectively. At the same time, compared with particle swarm optimization algorithm, most respondents believe that GA has the characteristics of high efficiency and strong practicability.

1. Introduction

With the deepening of human activities, the problem of WP becomes more and more prominent. Reasonable WP prevention and control planning can not only ensure the safety of industrial water, agricultural water and domestic water, but also ensure the ecological environment of the water basin. However, due to the different levels of WP and ecological conditions in different regions at this stage, corresponding planning and measures must be taken before implementation to ensure the effectiveness of WP. In the face of this situation, this paper studies the optimization measures of WP control planning and explores the application of GA in WP control planning.

At present, many scholars have studied WP and its control. Li Z. H. O. U. discussed the impact of river head system on reducing water environment pollution, and proved that the implementation of this system can reduce the negative impact of livestock manure on water environment [1]. He Xiaodong has studied the surface water, spring water and other water environment of a plateau, and analyzed the relevant factors affecting the surface WP [2]. Sheng Jichuan described the WP control in the South-to-North Water Transfer Project, and pointed out its existing problems and potential solutions [3]. Rawat K.S. used GIS to assess the groundwater quality in Kanchipuram District, India, and believed that the water environment in the area was damaged by human activities, and appropriate management plans were needed to control the further pollution of groundwater in the area [4]. Chen Sophia Shuang carried out water quality analysis of four typical urban rivers in Tanzania using the up-city and down-city gradient assessment method. Through the study, the following conclusions were reached: with the rapid growth of population, the pollution trend is becoming increasingly serious [5]. ZHANG Jinde analyzed the water environment of the mine and the risk factors and different characteristics of WP [6]. Wang Yubao discussed the situation of industrial WP and analyzed the role of environmental complaint scheme in the prevention and control of industrial WP [7]. Xu Zuxin studied the river pollution situation in developing countries. He believed that the development rate of the sewer system in developing countries did not catch up with its own urbanization rate, which caused serious consequences for the water quality of urban rivers [8]. The above scholars have carried out research on WP and its prevention and control, and put forward valuable suggestions.

Genetic algorithm can play a certain role in the prevention of WP. Xia Xuemin proposed a robust method of hyperparametric adjustment to better identify underground WP. In addition, he proved through experiments that compared with the traditional hyperparametric GA, the proposed hyperparametric tuning method can provide more suitable parameters for the operation of the GA, and thus more effectively identify the underground WP [9]. Abba S. I. investigated the potential of GA in predicting the level of dissolved oxygen content in the Jinta River basin in Malaysia to monitor the water quality of the basin [10]. Picos Alain evaluated the effectiveness of GA in predicting the electro-oxidation of the pressure reactor, so as to treat according to the type of waste and avoid the WP phenomenon caused by the untreated discharge of industrial wastewater into open waterways [11]. In this paper, genetic algorithm is used to study WP control planning.

In order to ensure the effectiveness of the WP prevention and control plan and the safety of regional water environment and industrial and agricultural water use, this paper studies the WP prevention and control plan, analyzes the problems existing in the WP prevention and control plan, such as the low reliability of the data of the WP control plan, and the insufficient scientific nature of the WP prevention and control plan, and puts forward relevant measures to solve the problems, including paying attention to the WP prevention and control planning technology, improving the water resources management and supervision mechanism Strengthen financial security, etc. Compared with other studies, this paper studies the application of GA in WP control planning and analyzes the effect of GA in WP control planning.

2. Problems in WP Prevention and Control Planning

This paper summarizes the problems in WP prevention and control planning, as shown in Figure 1.

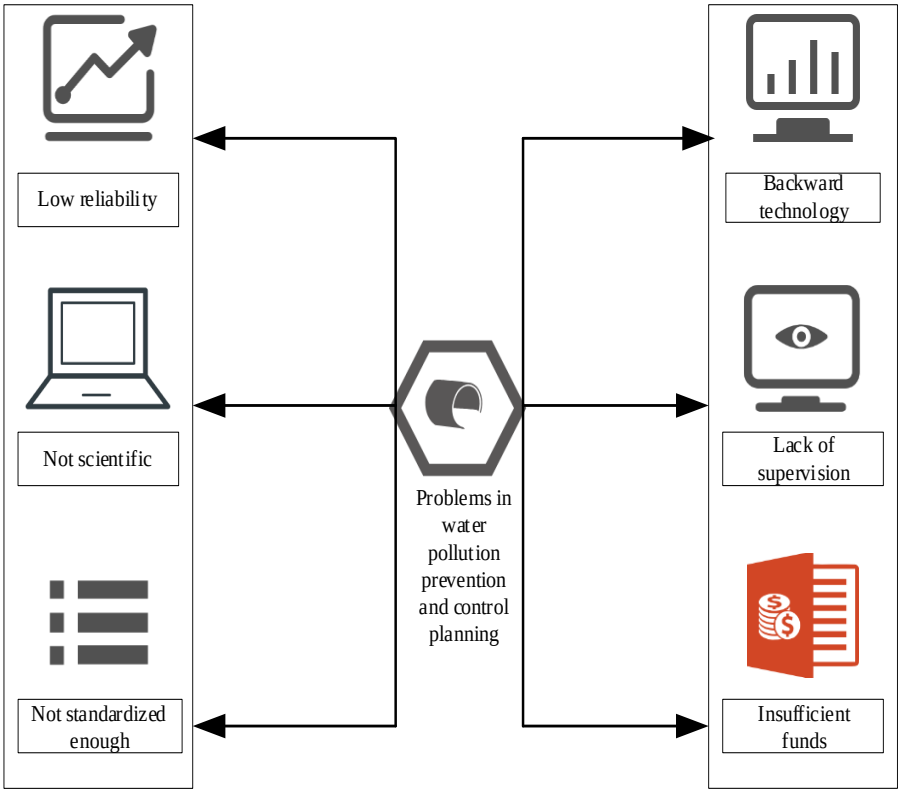


Figure 1. Problems in WP prevention and control planning

The reliability of WP control plan data is not high: at present, there are certain differences between the relevant departments in the pollution declaration data of industrial pollution sources, the environmental statistical yearbook and other data, and the statistical caliber and calculation methods are different. So far, a set of accurate statistical data has not been formed [12]. In addition, due to the lack of long-term monitoring and investigation of urban domestic pollution sources and agricultural pollution sources, the prediction model of non-point source pollution load has not been established, and the model data is insufficient. Therefore, the current pollution control plan only uses the emission factor method to estimate the non-point source load. The current pollution control plan is only limited to point source pollution control, and the non-point source pollution load accounts for a large proportion of the total pollution of the whole basin, This has led to the use of some non-point source pollution loads as emission reduction indicators during the implementation of the plan, which makes the control of point source pollution more difficult and affects the enforceability of the plan.

The WP prevention and control plan is not fully scientific: the relevant departments did not fully consider the implementation difficulty of the plan when preparing the WP control plan. This is mainly because the goal of the planning is often based on the analysis of the environmental pollution situation, using the trend forecast and other means to predict the future social and economic development and pollutant emissions, and according to the personal would of experts and government leaders to determine, and does not fully take into account the implementation difficulties and financial needs of the planning.

The planning and management of water resources are not standardized enough: chemical oxygen demand and ammonia nitrogen are the main control indicators, and there is little research on other pollutants. The current water environment quality standards are also not perfect, mainly in the form of concentration control, and the relevant management systems such as sewage charges, supervision

and monitoring are also carried out in strict accordance with the concentration standards, which can no longer meet the total amount control requirements in the current WP prevention and control plan.

The planning technical means are backward: due to the inadequate supporting work in the planning, design, construction and other aspects of the urban sewage collection system, the goal of "full collection of receivables" cannot be achieved, resulting in the total amount of sewage that can be discharged less than the design scale, resulting in low equipment operation efficiency and poor sewage treatment effect. Some grassroots monitoring centers are short of instruments and equipment, outdated, poor water quality monitoring ability, and low monitoring frequency, which cannot meet the needs of WP prevention and control. Lack of high-quality monitoring technology to support the plan.

Lack of necessary supervision: there are many problems in the supervision of water resources control planning, as shown in Figure 2.

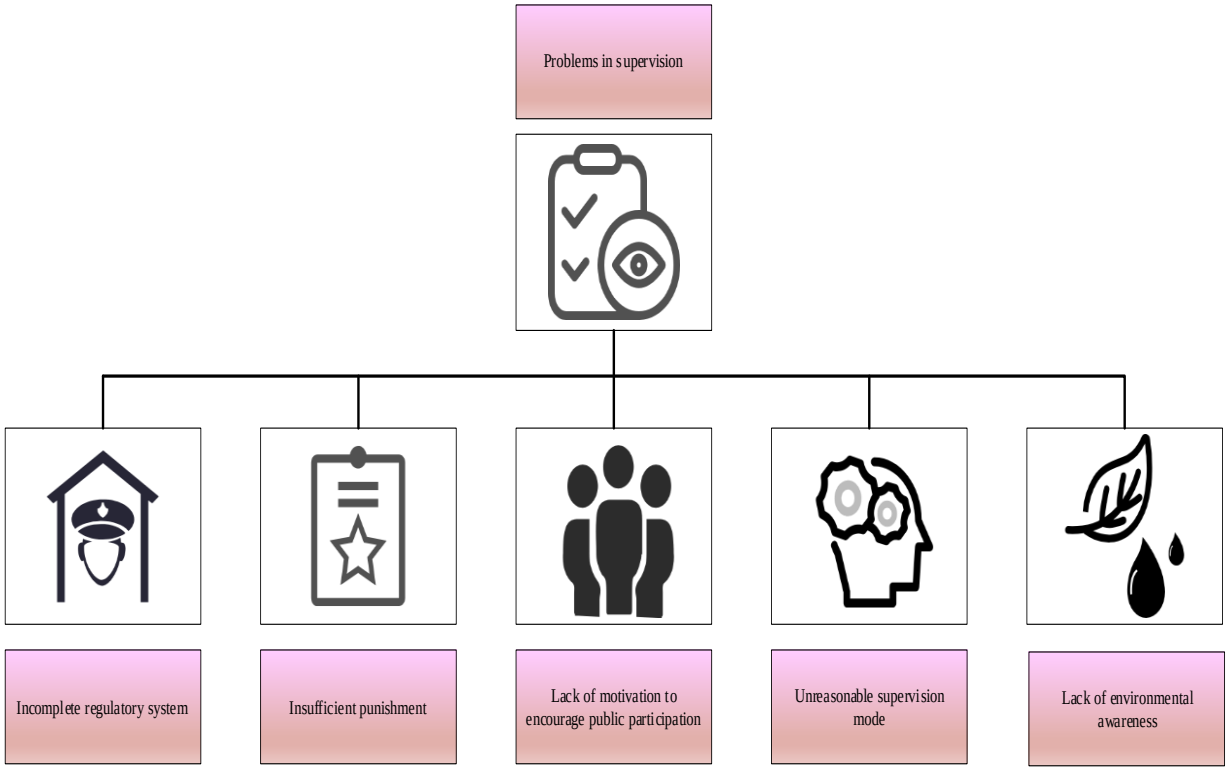


Figure 2. Problems in planning supervision

For example, the law enforcement force of water environment protection is weak, the regulatory system is imperfect, and various security systems have superficial and formal problems [13]. Another example is that the punishment is insufficient and does not play the role of warning and urging. In addition, the government lacks the motivation to encourage public participation and supervision. In order to achieve tax revenue and development, local governments, driven by the concept of political achievements, often adopt the supervision mode of "supervision without punishment, punishment without sealing". In the implementation of the plan, the implementation of the plan would deviate due to the lack of environmental awareness, the lack of would to implement, and the measures taken by the stakeholders.

Lack of funds: At present, some cities have a shortage of funds for environmental protection and water pollution control. The government and relevant departments have not paid enough attention to this problem and cannot provide corresponding funds for major cities, resulting in equipment shortage and backward technology in some places. At the same time, due to the relatively fragile

capital chain, some cities even need to borrow money from other countries, but still can not completely alleviate the situation of capital tension.

3. Optimize the Impact of WP Prevention and Control Plan

At present, many problems encountered in the formulation, implementation and final evaluation of WP prevention and control plan have become an important factor restricting the prevention and control of WP and improving the quality of water environment. In order to make the WP prevention and control plan better play its due role, the following aspects must be improved, as shown in Figure 3.

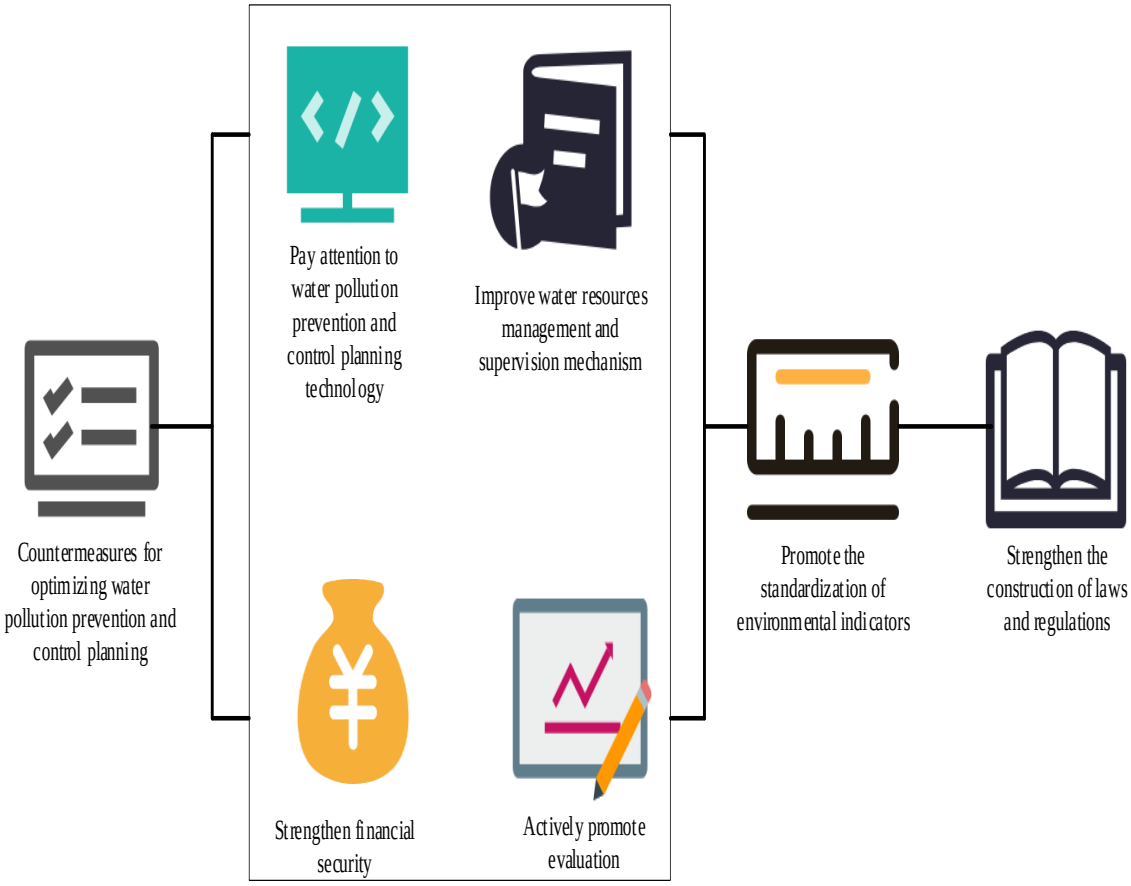


Figure 3. WP prevention and control planning countermeasures

3.1. Pay Attention to WP Prevention and Control Planning Technology

First of all, relevant departments should start from the technical means of planning and design, apply new theories and methods to practice, and make full use of new technologies such as GIS technology, non-point source simulation, multi-level optimization model, etc. Secondly, relevant departments should establish a technical system for the verification of pollutant emissions at three levels of river basin, region and pollution source to obtain accurate data of pollutant emissions; Finally, the relevant departments should establish a reasonable planning hierarchy, divide the whole plan into different levels of divisions, coordinate it with the management functions of each level, and facilitate the implementation and supervision of the plan. Among them, in the first-level planning of river basins, the total emission control plan of each branch river basin or provincial

level shall be determined according to the requirements of water quality management at the provincial boundary; According to the total emission control indicators of the region, the WP prevention and control plan of the region is prepared and combined with pollution sources and wastewater treatment to achieve the purpose of water environmental protection [14-15].

In this paper, genetic algorithm is used to study the control planning of WP, and the overall optimization model of WP control planning is set as:

$$\min I = \sum_{p=1}^{m} K_p(m_p), 0 \le m_p \le 1 \tag{1}$$

$$s.t\begin{cases} UL + N \le L_5 \\ VL + M \ge O_5 \\ L \ge 0 \end{cases} \tag{2}$$

Among them, K_p is the sewage treatment cost of the pth sewage treatment plant.

The constrained minimum problem is:

$$s.t\begin{cases} h_p(a) \le 0 \\ l_q(a) = 0 \end{cases} \tag{3}$$

$h_p(a)$ is the inequality constraint of the function.

Set $G_c(m)$ as the fitness function of the objective function and $G_k(m)$ as the weight constraint fitness function of the function, and the expression formula is:

$$G_c(m) = \begin{cases} 1 & h_c(m) \le 0 \\ 1 - \dfrac{|h_c(m)|}{h_{\max}(m)} & h_c(m) > 0 \end{cases} \tag{4}$$

$$G_k(m) = \sum_{c=1}^{n} v_c G_c(m) \sum_{c=1}^{n} v_c = 1 \tag{5}$$

By introducing genetic algorithm, if there are 4 outlets in a certain area, the total cost of sewage treatment in that area is:

$$\min R = a + bi_1^{\,2} + ci_2^{\,2} + di_3^{\,2} + ei_4^{\,2} \tag{6}$$

$i_1, ..., i_4$ are the sewage treatment efficiency.

Simulate the five-day biochemical oxygen demand and dissolved oxygen molecular content in this area, and obtain:

$$L_k(a) = L_o(p)\exp\left(-\frac{c_1 + c_3}{u}a\right) \tag{7}$$

Based on the relationship between the concentration of wastewater before and after treatment and the treatment efficiency i, the control variable in the constraint equation is converted to i, and the corresponding constraint conditions are obtained by using the water quality constraints.

3.2. Improve Water Resources Management and Supervision Mechanism

It should improve the water resources and water environment governance system, strengthen the participation of the government and all sectors of society, and strengthen the supervision and guarantee of planning. Relevant departments should improve the pollution permit system, declaration system, pollution charge system, reward and punishment system, and multi-sector information sharing mechanism, improve the water quality monitoring technology level and online monitoring level, and stimulate the enthusiasm of public participation, so as to realize the scientific and dynamic management of planning implementation. For example, for units that meet the total emission index and significantly improve the emission performance, they can be rewarded by bank loans and the use of central centralized emission fees. On the contrary, the government should implement strict control in terms of approval and loans.

3.3. Strengthen Financial Guarantee

As an important part of social and economic development and improvement of people's livelihood, WP prevention and control plan should broaden financing channels more widely: control the emission of pollutants through the price, tax and fee policies formulated by the government, and provide funds for WP treatment; According to the characteristics of different water environments, a relatively complete compensation system is formulated; Define the position and responsibility of local governments in financial financing, define the economic burden of local governments in WP prevention and control, and formulate corresponding laws and regulations to ensure its implementation; Encourage and support various social forces to participate in the prevention and control of WP; It should make rational use of interregional assistance to ensure the use of special funds.

3.4. Actively Promoting Evaluation

Relevant departments should not only pay attention to the evaluation of project technology, but also strengthen the evaluation of strategic plan and policy management, so as to improve the evaluation mechanism of WP prevention and control plan, and realize the overall control and control of all stages and links of the plan. At the same time, relevant departments should carefully evaluate the implementation effect of the plan and analyze its causes, so as to provide a basis for the future prevention and control of WP. At this stage, the urgent work to be carried out is as follows: to strengthen the construction of expert team for planning implementation and evaluation; Strictly plan and implement the evaluation system, incorporate it into relevant environmental protection laws and regulations, and list its post-implementation evaluation and stage evaluation as the focus of pollution control.

3.5. Promoting Standardization of Environmental Indicators

The construction of environmental standardization is an important basis for the quantification of WP, and also an important basis for the evaluation of WP prevention and control plan. Relevant departments can take the following measures to promote the standardization of environmental indicators: first, relevant departments should strengthen local environmental standards, especially pollutant discharge standards, on the basis of the overall standards, so as to achieve the connection between the two; The second is that relevant departments should combine environmental standards and technologies with the best technology from the perspective of environmental capacity, environmental background value and economic level, and promote the standardization of

environmental indicators from the legal level, so as to achieve the harmony and unification of water environmental standards, water environmental regulations, economy and technology, so as to enhance the implementation effect of environmental standards.

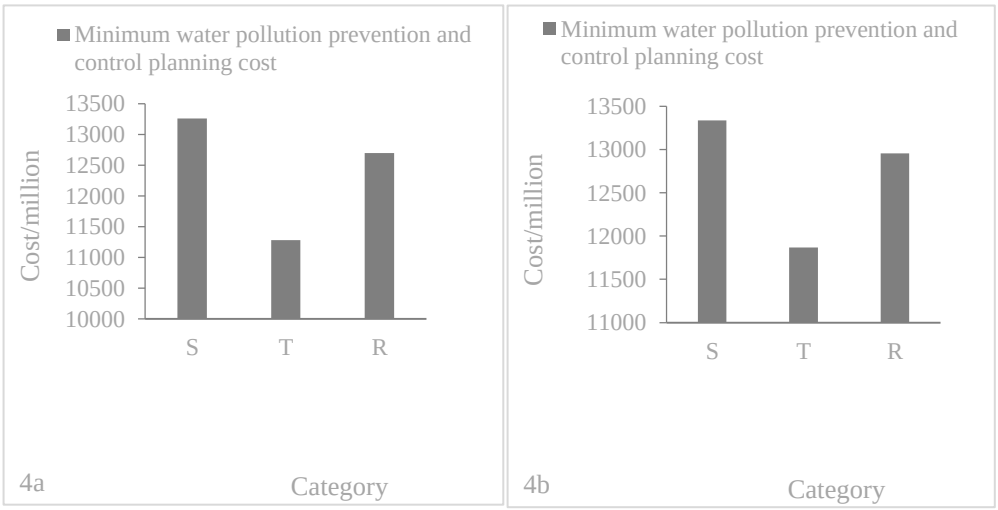
3.6. Strengthen the Construction of WP Laws and Regulations

From the perspective of laws and regulations, relevant departments should ensure the status and binding force of laws and regulations on WP prevention and control planning, and timely adjust the applicability of laws and regulations on WP prevention and control planning. In the process of updating and improving the laws and regulations of the WP prevention and control plan, the relevant departments should take into account the gap between the objectives of the WP prevention and control plan and the actual planning environment, taking into account the suggestions of all social personages. At the law enforcement level, the relevant departments should cultivate a large number of excellent law enforcement talents to ensure the effectiveness of the implementation of laws and regulations on WP prevention and control planning.

4. Application Effect of Genetic Algorithm

The genetic algorithm and particle swarm optimization algorithm proposed in this paper are respectively used to study the cost objectives of WP prevention and control planning, that is, to analyze which algorithm can obtain the lowest prevention and control planning cost under the premise of ensuring that the water quality is not polluted. In addition, this paper investigated the WP prevention and control technicians to understand their use tendency and recognition of the two algorithms.

Two algorithms are used to solve the cost objectives of WP prevention and control planning in three regions, and the three regions are called S, T and R respectively. The results are shown in Figure 4.



4a. WP control planning cost under the condition of genetic algorithm

4b. WP control planning cost based on particle swarm optimization

Figure 4. WP prevention planning cost under two algorithms

As shown in Figure 4, it can be observed from Figure 4a that under the condition of genetic algorithm, the minimum planning cost of WP control in S, T and R regions is 13258.9 million yuan,

11283.3 million yuan and 12698.6 million yuan respectively. It can be observed from Figure 4b that under the condition of particle swarm optimization, the minimum cost of WP prevention and control planning in S, T and R regions is 13335.9 million yuan, 11867.7 million yuan and 12955.1 million yuan respectively. From the above data, it can be calculated that compared with particle swarm optimization, applying genetic algorithm to WP prevention and control planning can save the cost of prevention and control planning on the premise of ensuring that the water quality is not polluted. Region S, Region T and Region R can save 77 million yuan, 584.4 million yuan and 256.5 million yuan respectively.

Investigate 30 WP prevention and control technicians to understand their satisfaction with the two methods. See Table 1 for the specific results.

Table 1. Satisfaction of water pollution prevention technicians with the two methods

	Genetic algorithm	Particle Swarm Optimization
Satisfied	26	23
Basically satisfied	3	5
Dissatisfied	1	2

As shown in Table 1, in terms of genetic algorithm, 26 people are satisfied with genetic algorithm. They said that genetic algorithm is often used in WP prevention and control planning, and believe that it has the characteristics of high efficiency and strong practicability. Three people are basically satisfied with genetic algorithm. They think that genetic algorithm can play a certain role in WP prevention and control planning, but its effect is relatively general. One person was not satisfied with genetic algorithm. The respondent believed that genetic algorithm was random and its application efficiency in WP prevention planning was not high. In terms of particle swarm optimization, 23 people were satisfied with the algorithm. They said that the algorithm was often used in WP prevention and control planning, and believed that its search had the characteristics of clear direction, high accuracy and high efficiency. Five people are basically satisfied with the algorithm. They think that although the algorithm can play a certain role in WP prevention and control planning, it can not play the expected effect. Two people are dissatisfied with the algorithm. They think that the local optimization ability of the algorithm is poor and the application effect in WP prevention planning is poor.

5. Conclusion

WP prevention and control planning is a systematic project with a long way to go. Relevant departments should focus on the prevention and control objectives of WP in the basin, strengthen capital investment and supervision, actively apply the local advanced technology of WP prevention and control, and encourage the public to participate in the supervision to ensure the effective implementation of various prevention and control measures. In order to ensure the effect of WP prevention and control planning and ensure the safety of regional water body, industrial water and agricultural water, this paper analyzes the problems in WP prevention and control planning, puts forward suggestions for optimizing WP prevention and control planning, and discusses the application of genetic algorithm in WP prevention and control planning. Through experiments, it is proved that genetic algorithm has better effect of WP prevention and control planning than particle swarm optimization.

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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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