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Construction of Urban Water Pollution Prevention Planning Based on Remote Sensing Technology

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Abstract: Water is an important part of human survival and an essential material for life, because in some areas, water pollution (WP) has become an important cause that directly affects human health due to insufficient ecological functions. In order to realize the sustainable development of society and urban economy, measures must be taken to improve urban WP. According to the current trend, there is now a basic health and environmental protection system to enable cities to effectively improve WP. Formulating a sound WP control plan is an important measure to solve urban WP problems and protect and purify water resources. Therefore, this paper analyzed the categories, objectives and processes of WP prevention and control planning, and then analyzed the application of remote sensing technology in WP prevention and control planning. Finally, the realization ideas of WP prevention and control construction were put forward. Through comparison, the water quality monitoring effect of the new WP prevention and control plan was 19.8% higher than that of the traditional WP prevention and control plan, and the pollution prevention and control effect was 18.1% higher than that of the traditional WP prevention and control plan. In short, remote sensing technology can improve the monitoring effect of WP.

1. Introduction

The city is the product of human development and the place where people produce and consume materials and engage in social and cultural activities. With the acceleration of industrialization, it develops rapidly, but the development of the city also brings serious environmental problems. WP should be effectively controlled and water resources improved through scientific and rational planning. More efficient use of water resources on the basis of high protection is a priority for

governments around the world, so controlling urban WP has become a top priority for environmental protection.

Many scholars have studied the prevention and control of WP. Xu Zuxin improved water quality by clearing sediments, minimizing the discharge of hazardous chemicals and materials, reducing the proportion of untreated wastewater by half, and significantly improving global recovery and safe reuse [1]. He Mingjing discussed the application of bio-coal in the context of sustainable development in urban wastewater treatment, industrial wastewater treatment and rainwater management to solve the problem through adsorption, deposition, surface oxidation reaction, reduction and catalytic decomposition [2]. He Xiaodong used surface water, spring water, Quaternary sedimentation, soil and rock in the middle of the Loess Plateau to quantitatively evaluate surface WP and its main influencing factors. The existence and potential sources of chromium in surface water and related health risks were studied in detail [3]. Sharma Rohit took different rivers in India as an example to analyze the water quality parameters for five years, highlighting the water quality of Indian rivers and the current pollution model of Ganges River [4]. In order to help formulate WP control policies in response to the rapid expansion of cities in African countries, Chen Sophia Shuang believed that an economically feasible initial surface water quality monitoring method should be adopted [5]. Tang Yankui analyzed the literature on new pollutants, focusing on the generation, detection methods, environmental fate and ecotoxicity of new pollutants. He studied how to solve the WP problem, focusing on practical considerations, new processes and new decision-making strategies [6]. Ahmed Shahid studied the understanding of young people in Delhi on WP, causes, health effects and solutions, and suggested that an appropriate waste management system should be established to treat waste before it enters rivers and water [7]. The above studies have described the role of WP prevention and control, but have not used virtual technology for research.

At present, many new technologies have been used in the prevention and control of WP. The overview of Pinheiro Paula C showed the overall situation of these hybrid nanostructures, especially the important aspects of the application of magnetic plasma nanostructures in water analysis [8]. Li Yunqin developed a virtual reality experimental platform for wastewater treatment, which is used for remote field practice, long-term experimental process, on-site disability, variable process parameters, accident treatment and other possible scenarios. A virtual reality experimental system for wastewater treatment was developed [9]. Lee Chang-Gu alleviated performance inhibition through the ability of symbiotic organics to remove oxidation, which reduced the electrical energy of each reaction sequence required to remove such endocrine disruptors in the presence of oxidants to remove/inhibit organics [10]. Martini Sri introduced the latest development of membrane and wastewater treatment technology, and combined membrane technology with other water treatment technologies, such as adsorption, advanced oxidation process and biological activated sludge [11]. Obinna Isiuku Beniah believed that heavy metals and organic pollutants are common environmental pollutants that affect soil, water and air quality. He briefly reviewed the research progress and practical application of phytoremediation in water resources in recent years [12]. The above studies have described the use of new technologies in WP prevention and control, but there are still some deficiencies.

In order to study the application effect of remote sensing technology in WP prevention and control planning, this paper analyzed the adaptability and selection probability in WP prevention and control planning and design through genetic algorithm. Through experiments, the supervision strength and sewage discharge rate were analyzed. Finally, it was found that the water quality monitoring effect and pollution prevention and control effect of the WP prevention and control plan of remote sensing technology were better than the traditional WP prevention and control. Compared with other literatures, this paper focused on the use of comparative experiments to analyze the water

quality monitoring effect of WP.

2. Thoughts on Urban WP Prevention and Control Planning

2.1. Categories of Urban WP

With the continuous development of science and technology and the increasing requirements for all aspects, it is a very complex process to formulate a reasonable plan for urban WP prevention and control, which must be applied to comprehensive prevention measures and research systems. Through continuous analysis and synthesis, the best urban WP prevention plan can be obtained to meet the needs of society. River pollution is a huge problem because it not only affects the health of human beings and animals, but also affects the economic development of the whole society [13]. Urban WP can be divided into natural and human causes, as shown in Figure 1. The natural cause of pollution is the change of natural mode and the pollution of some minerals to urban waters. With the acceleration of urbanization, the development of industrialization is of great importance. Industrial development is accompanied by a large increase in industrial water and a gradual increase in wastewater, which has a significant impact on urban water resources. At the same time, domestic water consumption has gradually increased, and domestic sewage discharge has reached hundreds of millions of tons. Therefore, the discharge of urban domestic and industrial wastewater has become the two main factors of urban WP. In recent years, with the continuous improvement of urban living standards, the quantity of urban domestic sewage has been increasing.

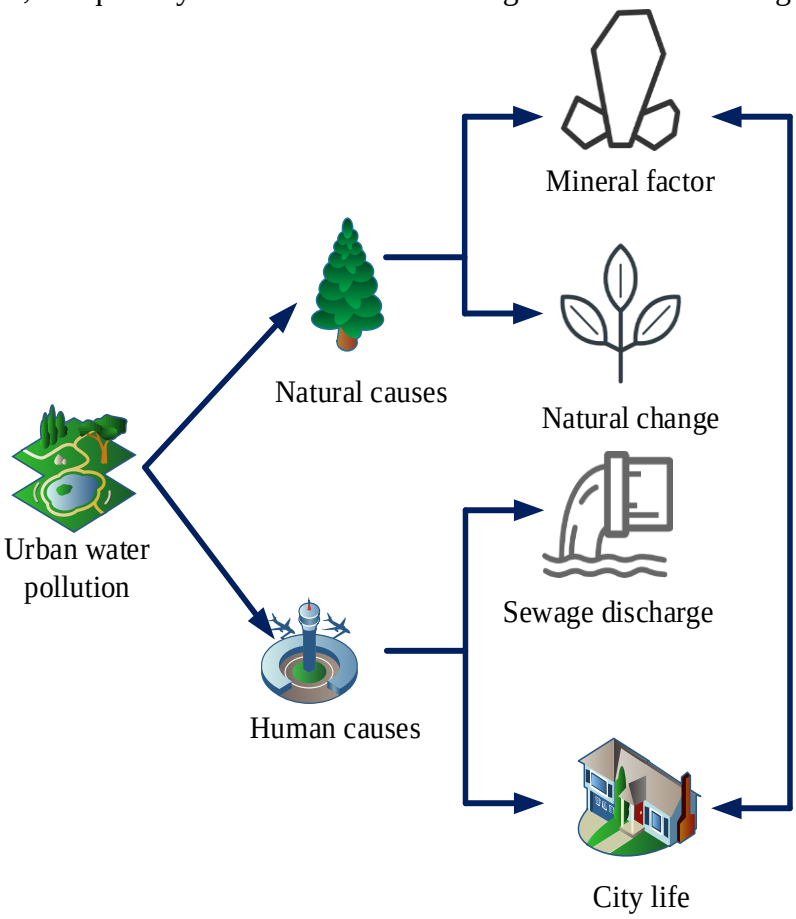


Figure 1. Categories of urban water pollution

2.2. Objectives of Urban WP Prevention and Control Planning

The prevention and control of WP should adhere to the environmental quality as the bottom line, and promote the unified prevention and control of WP, so as to thoroughly implement the WP prevention and control action plan. It is necessary to take continuous improvement of water environment quality as the core, and adhere to the principles of reducing source planning, blocking process and final control to reduce environmental pollution. For accelerating industrial, agricultural recovery and household pollution sources, and systematically promoting urban WP prevention and control, the construction objectives of urban WP prevention and control planning should be divided into three stages, as shown in Figure 2. The first is the short-term goal. The WP control system is basically in place, the river pollution is significantly reduced, and the water quality control system is significantly reduced. Pollution has been effectively controlled, and the deterioration trend of water quality in urban and rural rivers and lakes has been reversed. Pollutant emission and accumulation is one of the main pressure sources threatening urban surface water and hindering urban water ecosystem services [14]. The second is the medium-term goal. It is necessary to further improve and effectively operate the urban protection and management system, and effectively control and manage WP, so as to further reduce the discharge of river pollutants and strictly control the limit range. The third is the long-term goal. The long-term protection and reconstruction system of cities is basically sound, and the long-term protection and reconstruction of urban WP control would be realized. It is necessary to update the WP control system and management capacity, and fully comply with the river pollutant discharge control indicators. By improving the management of rivers and lakes and building a beautiful and healthy city, people can benefit from the green achievements of urban protection and management.

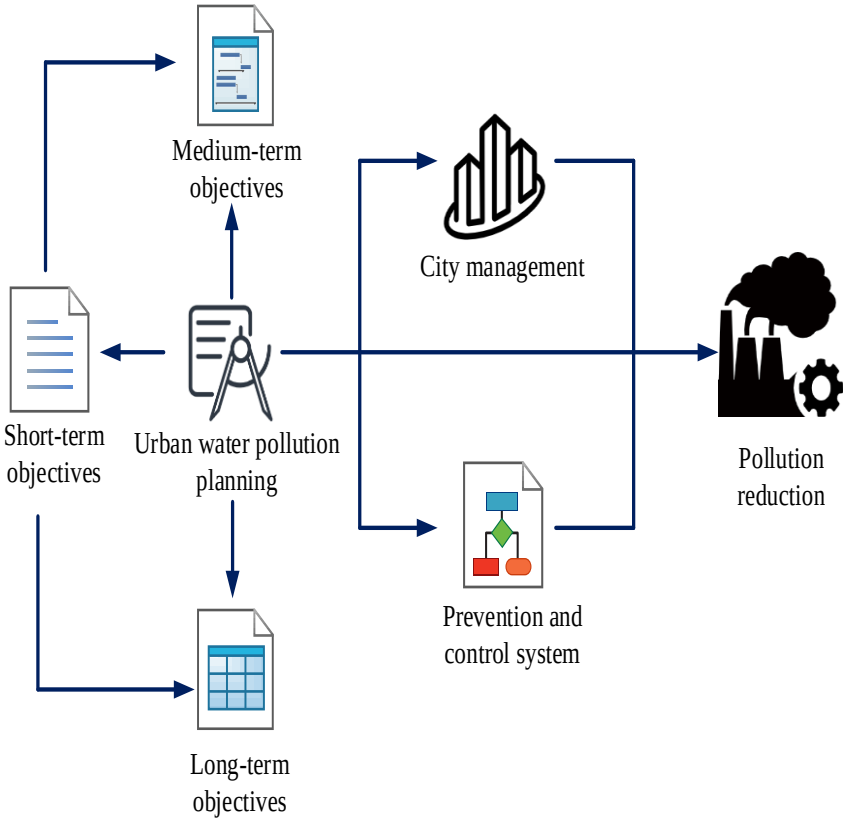


Figure 2. Construction objectives of urban water pollution prevention and control plan

2.3. Process of Urban Water Pollution Prevention and Control Planning

Water resources planning can be divided into three levels: urban planning, spatial planning and facility planning, as shown in Figure 3. Regardless of the planning stage, it is generally the target planning, model construction, optimization modeling and decision evaluation stages. These stages usually cross each other to generate various possible options as needed during the planning process, and finally optimize through re-demonstration and coordination. The plan must be complete and subjective, with status and vision, economy and environment, needs and capabilities, which are often reflected in the coordination and consistency between various departments and levels of society. The whole planning process is actually the process of coordinating the above contradictions, achieving unity, and seeking the best compromise between technology and management.

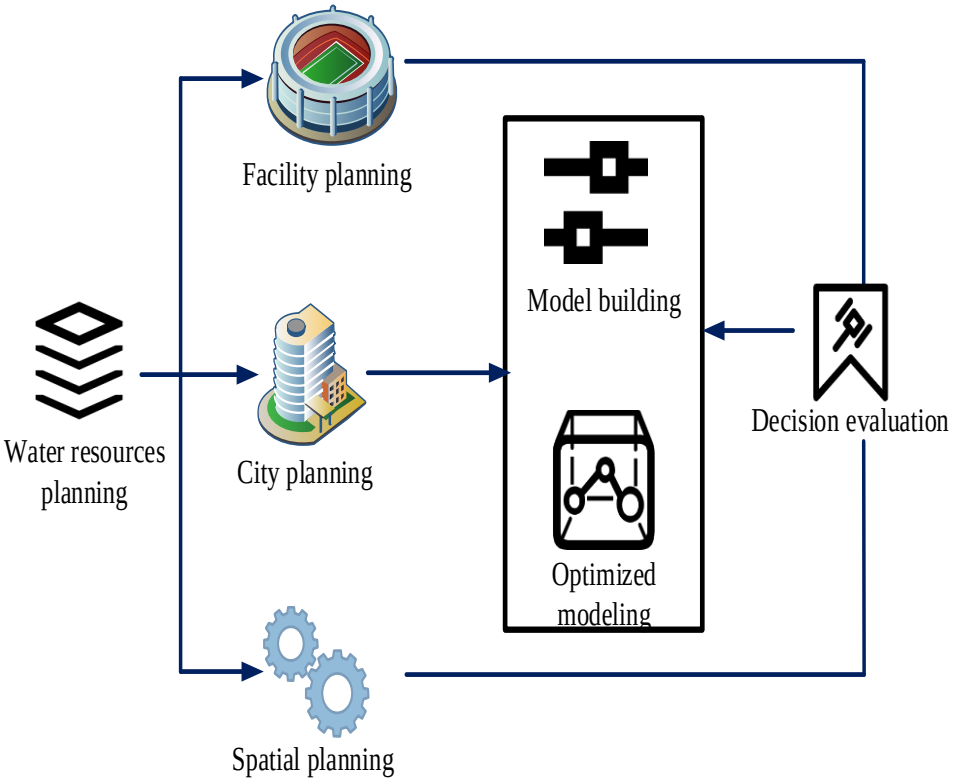


Figure 3. Process of urban water pollution prevention and control planning

3. Application of Remote Sensing Technology in Urban Water Pollution Prevention and Control Planning

3.1. Application of Remote Sensing Technology in Urban Water Pollution Monitoring

As time goes by, the water quality control methods are constantly updated and improved, which fully reflects the different requirements for water quality in different periods. The original water quality monitoring and remote monitoring technology have some similarities in the monitoring process, but there are also obvious differences. As the standard of variables, this monitoring technology is very difficult in practical application. In order to collect accurate water quality monitoring data, the water quality monitor must use relatively advanced analysis methods compared with high-precision instruments, and the water quality sampling range is limited. This water quality monitoring method requires a lot of human, material and financial resources, but the final value is far from the actual value. This technology is seriously affected by climatic conditions,

hydrogeology and ecological factors. It is difficult to obtain specific information of water quality changes in time by using this method to monitor water quality.

The use of remote sensing to monitor water quality is very effective. This detection method can quickly obtain accurate and continuous information about water quality changes in industrial enterprises. The feedback can include the accurate distribution of WP coefficient and pollutant types, which can analyze the source and transmission characteristics of pollutants. This technology provides real-time monitoring of water quality sustainability and supports monitoring of agricultural pollutants, which provides a reference for the Ministry of Environment to formulate laws and regulations on water resources protection.

3.2. Implementation of Urban WP Prevention Planning and Construction Based on Remote Sensing Technology

Using remote sensing technology to monitor water quality is helpful to accurately study and analyze the composition of algae and suspension in water. On this basis, a spectrogram is made to enable the water quality supervisor to study the water quality in the area more intuitively. The thinking of urban WP prevention planning and construction under remote sensing technology can be analyzed from the following aspects.

3.2.1. Scientific Planning and Renovation Objectives

In urban WP planning, in-depth research should be carried out according to practical principles, and scientific and reasonable objectives should be formulated according to water quality and ecological, economic and social development of the basin. The functional department of the aquatic environment is an important part of realizing the comprehensive management, rational utilization and development of the aquatic environment. It should start from the protection of water resources. The implementation rules should be easy to use and manage. The functional distribution of water should remain unchanged and have a certain period of time. The short-term goal of water quality is the original physical restoration. With the passage of time, to achieve the long-term goal of chemical and biological asset restoration, it is necessary to meet the water quality indicators of multi-functional water bodies or parts of them more and more strictly, and these indicators must meet the most stringent functional requirements. In order to protect water resources, appropriate standards, countermeasures and necessary technical support must be formulated.

3.2.2. Strengthening the Construction of WP Prevention Facilities

Modern water supply, sanitation and wastewater systems are important infrastructure for urban economic activities, life and health. Due to the large population and small industrial scale, cities need more water. In the process of production and living, urban residents produce wastewater according to the amount of water used. Therefore, the WP system of the city is the health of the city. Strengthening the construction of urban drinking water and sanitation facilities is crucial to the construction of large wastewater treatment plants, the acceleration of wastewater treatment, the protection of water resources and the maintenance of ecological balance.

3.2.3. Publicity of the Benefits of Water Conservation

By strengthening people’s capacity building in various ways, people’s awareness of water resources protection can be improved, water saving and water cycle can be encouraged, and the discharge of wastewater at source can be reduced. When planning WP, cities must protect the

natural environment and combine industrial development technology with WP. Local governments should reduce the pollution of fertilizer sources and increase efforts to prevent fertilizer from polluting surface water [15]. The construction of urban wastewater treatment plants should be considered for the filtration and recycling of wastewater in large cities, and the natural environment should be fully utilized in small cities to develop ground wastewater treatment systems, so as to effectively solve the problem of urban domestic wastewater treatment. Through the use of intercity technology, the utilization rate of water resources and the level of wastewater treatment can be improved.

4. Application of Genetic Algorithm in WP Control Planning

In order to study the specific application effect of remote sensing technology in WP prevention and control planning, this paper analyzed the optimization criteria function in WP prevention and control planning through genetic algorithm. The fitness function in WP prevention and control planning was analyzed, and the selection probability of WP prevention and control planning was finally obtained. Firstly, the optimization criteria function of WP prevention and control planning is calculated as Formula (1):

$$\min A = S(\alpha_1, \alpha_2, \alpha_3) + \sum_{i}^{3} k_i(b) \tag{1}$$

Among them, A is the optimization criterion function, and α_i is the optimization variable. $k_i(b)$ is the planned penalty. After that, the fitness function of remote sensing technology for WP prevention and control planning is calculated as Formula (2):

$$P_i = \frac{f_i}{\sum_{j=1}^{n} n f_i} \tag{2}$$

Among them, n is the number of planning strategies for WP prevention and control planning.

5. Experiment of Remote Sensing Technology in WP Prevention Planning and Construction

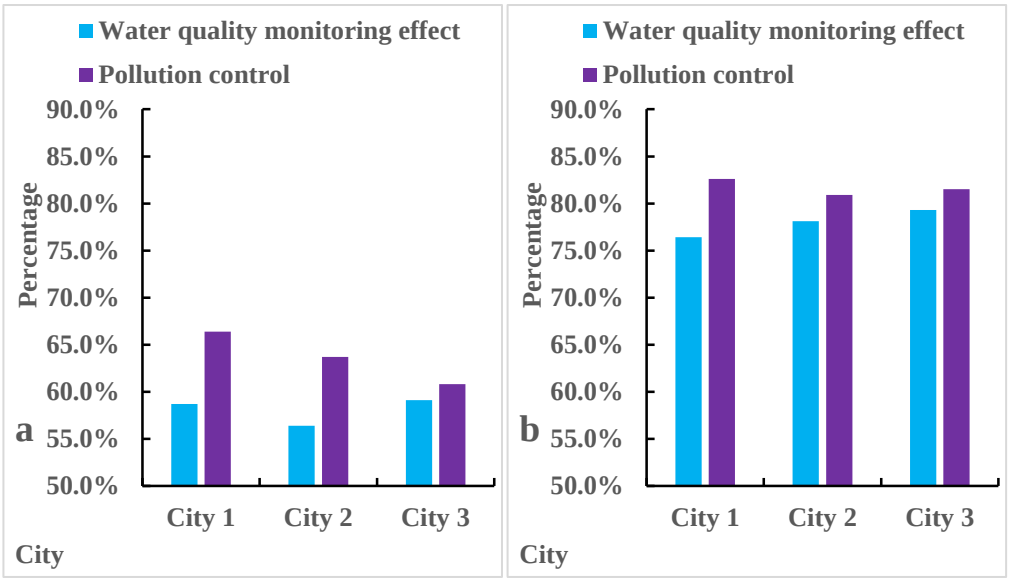
In order to study the specific effects of remote sensing technology in the planning and construction of WP prevention and control, this paper analyzed the supervision strength and sewage discharge rate in the planning and design of WP prevention and control. Finally, the water quality monitoring effect and pollution prevention and control effect of remote sensing technology for WP prevention and control planning were compared and analyzed. First of all, this paper investigated and analyzed the supervision of WP prevention and control planning and sewage discharge rate of remote sensing technology in three cities, and compared with traditional WP prevention and control. Specific comparison is shown in Table 1.

According to the data described in Table 1, in the traditional WP prevention and control, the supervision of City 1 was 0.42, and the sewage discharge rate was 0.75; the supervision of City 2 was 0.46, and the sewage discharge rate was 0.79; the supervision of City 3 was 0.45, and the sewage discharge rate was 0.85. In the new WP prevention and control, the supervision of city 1 was 0.81, and the sewage discharge rate was 0.18; the supervision of City 2 was 0.79, and the sewage discharge rate was 0.24; the supervision of City 3 was 0.83, and the sewage discharge rate was 0.34. On the whole, the supervision of traditional WP prevention and control was 0.44, and the

sewage discharge rate was 0.80; the supervision of new WP prevention and control was 0.81, and the sewage discharge rate was 0.25. Through comparison, it can be seen that the supervision of the new WP prevention and control was 0.37 higher than that of the traditional WP prevention and control, and the sewage discharge rate was 0.55 lower than that of the traditional WP prevention and control. Under the remote sensing technology, cities can clearly monitor each discharge area of WP. Under the continuous supervision of government departments, not only the sewage discharge rate has decreased, but also the water quality has been greatly improved. Next, the water quality monitoring effect and pollution prevention and control effect of three cities under the planning and construction of WP prevention and control by remote sensing technology were analyzed. The specific investigation results are shown in Figure 4.

Table 1. Supervision of water pollution prevention and control plan and sewage discharge rate

	Supervision		Sewage discharge rate	
	Traditional pollution prevention	New pollution prevention	Traditional pollution prevention	New pollution prevention
City 1	0.42	0.81	0.75	0.18
City 2	0.46	0.79	0.79	0.24
City 3	0.45	0.83	0.85	0.34



a. Traditional water pollution prevention planning

b. New water pollution prevention and control plan

Figure 4. Water quality monitoring effect and pollution prevention and control effect of three cities under the planning and construction of water pollution prevention and control by remote sensing technology

Figure 4a shows the traditional WP prevention and control, and Figure 4b shows the new WP prevention and control. According to Figure 4a, in the traditional WP prevention and control, the water quality monitoring effect of City 1 was 58.7%, and the pollution control effect was 66.4%; the water quality monitoring effect of City 2 was 56.4%, and the pollution control effect was 63.7%;

the water quality monitoring effect of City 3 was 59.1%, and the pollution control effect was 60.8%. It can be seen from Figure 4b that in the new WP prevention and control, the water quality monitoring effect of City 1 was 76.4%, and the pollution control effect was 82.6%; the water quality monitoring effect of City 2 was 78.1%, and the pollution control effect was 80.9%; the effect of water quality monitoring and pollution control in City 3 was 79.3% and 81.5% respectively.

On the whole, the water quality monitoring effect of traditional WP control was 58.1%, and the pollution control effect was 63.6%; the water quality monitoring effect in the new WP control was 77.9%, and the pollution control effect was 81.7%. Through comparison, the water quality monitoring effect of the new WP prevention and control plan was 19.8% higher than that of the traditional WP prevention and control plan, and the pollution control effect was 18.1% higher than that of the traditional WP prevention and control plan.

6. Conclusion

Prevention and control of WP is an important part of urban environmental protection and management. All levels should attach great importance to the prevention and control of WP, and assume the primary responsibility for the prevention and control of WP. Efforts should be made to prevent WP in river basins and strengthen organizational support, financial investment and scientific and technological support. It is necessary to actively promote the application of prevention technology and effectively implement prevention measures, so as to orderly promote key urban WP projects and ensure the realization of WP prevention and control objectives. Using remote sensing technology to monitor water quality can timely measure the content and nature of pollutants in water. Formulating corresponding implementation strategies can promote the realization of the onerous objectives of comprehensive management.

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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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