ISSN 2616-5880 Vol. 4, Issue 5: 12-17, DOI: 10.25236/AJMC.2023.040502

Research on Watershed Water Pollution Control Technologies and Comprehensive Water Quality Improvement Solutions

Tianqi Wei

School of Materials Science and Engineering, Hubei University, Wuhan, Hubei, China
weitianqi11@163.com

Abstract: *Since the reform and opening-up, China has experienced rapid economic and social development with a focus on economic construction. Many regions have relied on their water resources for economic development. However, this has also led to water pollution problems in watersheds, affecting the normal production and livelihood of the people and hindering sustainable development in those areas. In the new era, the comprehensive management of watershed water environment has become an important task. This article explores watershed water pollution control technologies and comprehensive water quality improvement solutions from both technical and managerial perspectives, combining domestic and international advanced experiences. The aim is to provide references for local water pollution control and ecological environment improvement.*

Keywords: *Watershed water pollution control, Comprehensive water quality improvement, Technologies, Solutions*

1. Introduction

Water is the most precious resource in human society. Protecting watershed water resources is an important measure to implement ecological civilization thoughts and promote harmonious coexistence between humans and nature. Since the reform and opening-up, due to the mismatch between economic development and pollution control, many regions have accumulated a large number of environmental issues, especially water pollution in watersheds, which has become a major problem that damages the local ecological environment, pollutes water resources, and affects the normal production and livelihood of the people. In 2020, under the leadership of the Ministry of Water Resources, comprehensive testing and evaluation of water quality were conducted on more than 700 rivers nationwide, revealing that approximately 46% of the rivers in the country were heavily polluted, with water quality only reaching Class IV or V. Among them, 10% were severely polluted, reaching beyond Class V, requiring urgent control measures. In terms of overall scale, river pollution shows a trend from the east to the northwest, from tributaries to main stems, and from regional to watershed diffusion, presenting a very severe situation.

Since the 18th National Congress of CPC, the construction of an ecological China was vigorously promoted. Positive progress has been made in addressing environmental pollution internally. However, the difficulty and slow effectiveness of watershed water pollution control still present a challenging task. Moreover, with different types of watershed water pollution, both domestic and international technologies and management approaches for prevention and control are continuously improving and adjusting. Further research on watershed water pollution control technologies and comprehensive improvement solutions is of great significance for effectively improving watershed ecological environmental governance, the ecological functions of water bodies, and promoting the construction of ecological civilization. [1]

2. Research on Watershed Water Pollution Control Technologies

2.1. Promoting Green Production Processes to Reduce Industrial Pollution Emissions at the Source

Industrial wastewater discharge is the main source of water pollution in watersheds. To strengthen the control of watershed water pollution, it is necessary to enhance technical management at the source

ISSN 2616-5880 Vol. 4, Issue 5: 12-17, DOI: 10.25236/AJMC.2023.040502

and establish a control technology system based on the entire life cycle of pollutants. Specifically targeting industries such as metal, chemical, pharmaceutical, and paper production, efforts should be made to reduce wastewater discharge by focusing on the entire production process. Simultaneously, internal wastewater treatment within the companies should be strengthened to improve their wastewater discharge standards. It is important to focus on international and domestic cutting-edge technologies and actively develop clean production processes such as comprehensive zinc electrolysis processes, ABS composite condensation, fermentation water pollution control technologies, crystallization mother liquor recovery, and evaporation alkali recovery treatment. Additionally, deep wastewater treatment and recycling technologies, such as detoxification of residual pharmaceuticals, pretreatment of organic wastewater detoxification, and utilization of high-salt water resources, should be developed to reduce emissions at the source. By upgrading production technologies comprehensively, energy conservation and emission reduction can be achieved, enhancing efficiency and promoting the coordinated and sustainable development of both the economy and the ecological environment.

2.2. Building a Technical System for Urban Water Pollution Prevention and Control to Strengthen Domestic Wastewater Management

Currently, China's urbanization rate has exceeded 60%. Intensive production and living have brought higher living standards and efficiency but also led to a significant increase in urban domestic wastewater discharge. If not properly and effectively treated, it will pollute urban groundwater and surrounding rivers [2]. Efforts should be made in improving drainage systems, enhancing stormwater and sewage separation, upgrading domestic wastewater treatment standards, and ensuring effective sewage disposal. Technological research and development should be strengthened to achieve these goals. Artificial intelligence and information technology should be actively utilized to establish drainage simulation and modeling systems, strengthen monitoring and repairs of drainage networks, and develop technologies for dredging, desilting, and in-situ repairs of pipelines and channels. For the issue of combined stormwater and sewage in old urban areas, suitable separation methods should be explored, and initial rainwater purification and comprehensive utilization should be actively researched to control the pollution caused by rainfall runoff. For example, in Xianfan Village, Xufan Street, Yiwu, Zhejiang Province, a 130-ton underground PP water storage module has been built to achieve preliminary recycling, resulting in good treatment effects [3]. The urban sewage treatment standards should be improved, and technologies such as pretreatment, suspended fillers, nitrification, denitrification, phosphorus removal, MBR (membrane bioreactor), and control of trace pollutants should be enhanced to improve the quality of sewage discharge. Furthermore, process technologies like low-temperature vacuum dehydration and high-pressure membrane filtration should be developed to effectively enhance sludge treatment. The restoration of urban water bodies in key river areas should be strengthened by formulating targeted measures based on the type of water bodies and pollution sources, aiming to improve river water quality.

2.3. Developing Low-Fertilizer Agriculture Production Processes to Control Agricultural Non-Point Source Pollution comprehensively

Agricultural non-point source pollution, represented by chemical fertilizer use, is also a significant source of water pollution in watersheds. Efforts should be made to promote "green cycle agriculture" based on the "crop-livestock-environment" system, vigorously promote organic fertilizers, reduce chemical fertilizer use, and comprehensively reduce total phosphorus, total nitrogen, and chemical oxygen demand (COD) to mitigate watershed water pollution. In terms of agricultural planting, a "reduced fertilizer use - interception during the process - nutrient recycling - terminal restoration" system should be established [4] to comprehensively control plant non-point source pollution. In livestock farming, regions should take local conditions into account, scientifically coordinate water and soil resources, and actively develop a technological route of "reducing fertilizer use at the source - biological fermentation — comprehensive control throughout the process - multiple treatments - agricultural and livestock recycling" [5]. This includes strengthening the collection and treatment of animal manure to reduce the impact on water environments by fish and marine organisms. It is important to focus on the "Three Clearances and One Improvement" campaign (clearing rural domestic waste, village ponds and ditches, and livestock and poultry manure), explore various technologies such as small-scale septic tanks, activated sludge methods, biofilm methods, fermentation, source separation, and ecological treatment to comprehensively control rural pollution sources.

ISSN 2616-5880 Vol. 4, Issue 5: 12-17, DOI: 10.25236/AJMC.2023.040502

2.4. Perfecting Water Pollution Control and Restoration Technologies for Comprehensive Improvement of Water Ecological Environment

In the previous sections, the overall technical strategies for watershed water pollution prevention and control were discussed from the macro perspectives of industry, urban areas, and agriculture. In this section, we will focus on the micro-level specific water pollution treatment basics.

2.4.1. Physical Treatment

(1) River dredging. Using large-scale mechanical equipment to dredge rivers, lakes, and reservoirs is the simplest and most effective treatment method. It has minimal overall impact on the ecological environment and can effectively reduce water pollution sources, especially the heavy metal substances contained in sediment.

(2) Aeration technology. Aeration, also known as MBR (membrane bioreactor), is a technology that effectively controls membrane fouling. It is widely used in aquaculture, sewage treatment plants, deep well wastewater treatment, and the treatment of black and odorous water bodies. Aeration technology mainly involves promoting long-term oxygen-rich conditions in water through natural waterfalls or artificial aeration, thereby enhancing the decomposition rate of pollutants in water and improving the self-purification capacity of rivers and lakes to prevent water pollution. In sewage treatment, the regulation and control of dissolved oxygen are achieved through blowers and aerators, and the purpose of sewage treatment is achieved through gas-liquid exchange.

2.4.2. Chemical Treatment

(1) Coagulation and precipitation technology. This technology is a combination of physical and chemical treatment methods. It mainly uses certain chemical agents (coagulants) added to the wastewater to achieve treatment through specific chemical reactions. This method is mainly suitable for the treatment of heavy metal pollution and closed environment wastewater treatment. The treated wastewater is not suitable for direct use but can be used as reclaimed water. In recent years, some companies have explored magnetic coagulation and precipitation technology, which adds magnetic separation and recovery to traditional coagulation and precipitation technology, but it has not been widely promoted on a large scale.

(2) Chemical agents for algae removal. Excessive algae and plankton in water bodies can also cause water environmental pollution. Common agents such as bleach, copper sulfate, and sodium hypochlorite can be used to disinfect, remove nitrogen, phosphorus, and various types of algae and plankton, and reduce odor without significantly increasing the water pH index. However, chemical agents also have certain impacts on water bodies and are generally used in emergency situations or small-scale spaces.

2.4.3. Biological Treatment

Biological treatment is the most environmentally friendly method for water pollution control, relying on various plants, organisms, and bacteria to decompose pollutants in water and purify the water without causing secondary pollution. It is scientifically effective but relatively slow in treatment speed.

(1) Biological purification method. First, water plants or organisms are used to consume organic compounds and nutrients in the water, controlling the growth of aquatic plants. Second, bacteria or other specialized aquatic organisms are cultivated to absorb or decompose toxic and harmful substances in the water, converting them into water, carbon dioxide, and other substances.

(2) Biofilm technology. Bacterial communities are attached to the surface of carriers to form biofilms. In the process of contact with pollutants, the bacteria on the biofilm adsorb organic matter from the pollutants, converting it into nutrients and further assimilating organic matter, thereby purifying the pollutants.

3. Comprehensive Research on Watershed Water Quality Improvement Plan

To improve the water quality of the watershed, it is necessary to adhere to the comprehensive principles of "strict control, treatment, and restoration" and implement a comprehensive approach. It is important to focus on both treatment and restoration, reduce pollution sources at the source, strengthen discharge control, promote comprehensive industry governance, and enhance comprehensive water

ISSN 2616-5880 Vol. 4, Issue 5: 12-17, DOI: 10.25236/AJMC.2023.040502

restoration. Persistence and long-term efforts are key.

3.1. Strict Control of Construction Projects Involving Lakes and Rivers, and Strengthening the Governance of Existing Enterprises

Local authorities should strictly review and approve construction projects involving lakes and rivers in accordance with the overall requirements of river and lake protection and development plans. Based on their own development needs, strict control should be exercised over the approval and utilization of projects in river channel shoreline protection areas and lake ecological protection core areas. All types of new projects are strictly prohibited in these areas, except for projects related to flood control safety, ecological restoration, and water supply security. Industrial, commercial, and residential projects are strictly prohibited in the buffer zones of lake ecological protection, as well as pollution-intensive and high-energy-consuming projects. Only projects related to green agriculture, leisure tourism, and health preservation should be approved in green development zones. For existing enterprises along rivers and lakes, efforts should be made to relocate them to other areas. For those temporarily unable to relocate, efforts should be intensified to upgrade pollution control technologies, raise emission standards, and reduce pollution to rivers and lakes.

3.2. Strengthening Comprehensive Control of Watershed Water Pollution

Adhering to target orientation, problem orientation, and results orientation, comprehensive improvement of the ecological environment of the watershed should be achieved by focusing on regional rivers and lakes and coordinating pollution prevention and water environmental protection. Starting from prevention and protection, efforts should be made to comprehensively improve the watershed's ecological environment.

3.2.1. Strengthening the Construction of Watershed Wastewater Treatment Facilities

The urban sewage facilities in the watershed should be upgraded. It is necessary to improve purification standards and the separation of stormwater and sewage, strengthen sewage pipeline network construction, and promote the renovation and impermeable treatment of old pipeline networks. Local authorities should accelerate the construction of sewage treatment facilities in small towns and rural areas, achieving full coverage in the areas surrounding rivers, lakes, and reservoirs. They should also strengthen the construction of sewage collection and centralized treatment facilities in various industrial parks, and improve the level of wastewater discharge. It’s important to promote the construction of sludge treatment facilities in an orderly manner, advance waste incineration and waste sorting, and comprehensively control pollution sources. Flood control, water supply, water ecology, and water environment should be coordinated and the construction of various water ecological projects in the watershed should be promoted.

3.2.2. Strengthening Comprehensive Remediation of Watershed Water Environment

Based on geographical and environmental conditions, efforts should be made in the following areas: First, in terms of agricultural non-point source pollution, adopt appropriate measures such as establishing ecological buffer zones and isolation facilities for rivers and lakes to minimize pollution sources. Second, strengthen the prevention and control of water and air pollution in the upstream and along the rivers and lakes, carry out dredging operations on river and lake beds, and reduce carbon emissions and pollution. Third, actively promote the harmless treatment and comprehensive utilization of agricultural waste, improve rural living environments, and enhance the ecological environment of the watershed. Fourth, focus on the protection of drinking water sources, carry out water source protection projects, strictly control various industrial and agricultural production activities, and ensure water source security.

3.3. Comprehensive Organization of Damaged Water Body Restoration Work

It is important to improve the driving mechanism for the ecological degradation of rivers and lakes, and comprehensively strengthen the upgrading and transformation of ecological strengthening areas, ecological transition areas, and deep purification areas. Local authorities should actively explore technologies such as the construction of ecological integrity of rivers and lakes, the restoration of self-purification capacity of rivers and lakes, and the construction of constructed wetlands, vigorously carry out water restoration projects in river basins, and promote accurate dredging of contaminated sediment. Efforts should be made to improve the water conservation capacity of the upper reaches of

ISSN 2616-5880 Vol. 4, Issue 5: 12-17, DOI: 10.25236/AJMC.2023.040502

rivers and lakes, improve the self-purification capacity of the middle reaches of water bodies, and strengthen the construction of downstream beaches and wetlands. It is necessary to improve the ecological environment, maintain species diversity, and reduce the total value of TN and TP in water. To further strengthen the daily monitoring and maintenance of rivers and lakes in the basin, and implement the main responsibility of management and protection. In addition, it is necessary to timely analyze the causes of water quality change, find out solutions, and do a good job in water management and maintenance.

3.4. Establishing an Intelligent and Efficient Information-based Supervision System

It is necessary to make full use of cutting-edge technologies such as the Internet, artificial intelligence, big data and detection, integrate environmental big data management and mining analysis, water quality target management and risk management and control, and build a systematic platform for river basin water bodies integrating monitoring, tracking, forecasting, management and decision-making. It is of necessity to monitor the water environment of each river basin in real time, form big data, construct the water environment model of the river basin, and conduct comprehensive analysis on a regular basis. Once there is any sign of water pollution, timely analysis, research and judgment shall be carried out, intelligent identification shall be carried out, external behaviors shall be screened, early warning shall be timely given, and law enforcement personnel shall be mobilized for patrol and control. At the same time, it is necessary to carry out risk traceability activities and provide risk management and control scheme for the completed water-related problems.

3.5. Promoting Green, Coordinated, and Sustainable Development of Watersheds

First, it is required to fully implement the principles of ecological priority and green development, rationally plan and use river basin water resources, and limit development and utilization. In areas prohibited by policies and regulations, all construction projects shall be cancelled and all kinds of encroachment on lakes and wetlands shall be resolutely banned. It is necessary to promote the return of farmland to lakes and wetlands in rivers and lakes in an orderly manner and continuously improve the ecological environment. The aim is to achieve a good balance between economic development and green ecology and promote the harmonious coexistence of man and nature. Second, it is necessary to strengthen the comprehensive improvement of the river and lake basin environment, severely crack down on all kinds of damage to the river and lake environment in accordance with the law, and protect the water ecological environment of the basin with "zero tolerance". Third, it is suggested to promote the green development of the industry. It is important to comprehensively promote structural reform on the supply side and develop modern service industries, environment-friendly and resource-saving industries around environmental protection, green and clean. It is necessary to promote the green development of the industrial chain, leap forward in the middle and high end, strictly control enterprises with high pollution and high emissions, and force enterprises to transform.

4. Conclusion

In the new era, the prevention and control of water pollution in watersheds and the comprehensive improvement of water quality are still arduous tasks. It is recommended that relevant departments further clarify the relationship between economic development and the ecological environment of watershed water, adhere to the combination of prevention, control, restoration, and industrial adjustment, implement comprehensive measures, focus on source control, vigorously promote pollution control, promote industrial transformation and upgrading, comprehensively improve the ecological environment, and ensure water security. By taking practical actions to implement President Xi's ecological ideology, we can make solid progress in the comprehensive management of watershed water environments and contribute to the cause.

References

[1] Liu, C. (2022). Assessment of Industrial Pollution Control Technology and Characteristics of Microplastic Pollution in the Taihu Lake Basin. East China Normal University.
[2] Meng, W. (2013). Construction of the Technology System for Water Pollution Control and Water Environment Management in the Liaohe River Basin — Exploration and Practice of the National Major Water Project in the Liaohe River Basin. China Engineering Science, 15(03), 4-10.

ISSN 2616-5880 Vol. 4, Issue 5: 12-17, DOI: 10.25236/AJMC.2023.040502

[3] Li, G., & Zhang, Y. (2021). Foreign Experience in Watershed Water Pollution Control and Its Implications for China. Proceedings of the Conference on Adapting to the Requirements of New Era Water Conservancy Reform and Development and Promoting the Construction of Happy Rivers and Lakes, 122-128.

[4] Xu, Z., Zeng, F., Chen, J., Guo, Q., Ying, G., Hu, Y., Yang, Y., Zha, J., Song, Q., Li, D., Zhao, X., Zhuo, Q., & Gou, T. (2017). Water Pollution Control and Restoration Technology and Integrated Demonstration in the Dongjiang River Basin. Journal of Environmental Engineering and Technology, 7(04), 393-404.

[5] Lai, J. (2015). Research on Rural Non-point Source Pollution Control from the Perspective of Ecological Civilization — A Case Study of Rural Water Pollution Control in the Dianchi Lake Basin. Proceedings of the International Conference on Public Participation Mechanism and Implementation Path in Environmental Governance in Western China, 121-130.