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Research on Water Pollution Prevention and Control and Countermeasures for Rural and Urban Rivers

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ABSTRACT

Water pollution is one of the major environmental problems facing the world, posing a serious threat to human health and the ecosystem. The sources of water pollution mainly include industrial emissions, agricultural activities, and urban domestic sewage, and its impacts involve drinking water safety and ecosystem destruction. Rural areas are the foundation for building a "Beautiful China" and play an important role in ecological civilization construction; urban rivers are a key link in building urban ecological environments and an important part of urban ecosystems. Therefore, sufficient attention should be given to water pollution problems in rural and urban areas, and effective measures should be taken to continuously optimize the ecological environment. Based on the analysis of the existing problems and causes of water pollution in rural and urban rivers, this article explores the path of water pollution prevention and control from the perspective of sustainable development and summarizes the corresponding prevention and control measures.

KEYWORDS

Water pollution; Sustainable development; Prevention and control; Ecological environment; Ecological civilization.

1. INTRODUCTION

The current water resource issue has become a major topic of global concern. Just like energy, water resources are a fundamental structural element of the national economy, closely related to the development of the national economy and the lives of urban and rural residents. The protection of water resources is a problem that cannot be ignored. At present, China's economy is developing rapidly, and the appearance of rural and urban areas and the lives of residents have undergone earth-shaking changes. In the process of social development, ecological civilization is an inevitable requirement for achieving harmonious development between humans and nature. The construction of ecological civilization is related to the sustainable development of the Chinese nation. How to effectively control and manage environmental pollution in rural and urban areas is related to the development of the national economy. To better carry out the governance of environmental pollution, it is necessary to have a clear understanding of the types and causes of environmental pollution and carry out sustainable governance, exploring a matching path for ecological environmental protection and governance.

2. ANALYSIS OF THE PROBLEMS AND CAUSES OF WATER POLLUTION

2.1. The problems of water pollution in rural areas

2.1.1. The sewage treatment facilities are not complete.

In some villages, the sewage facilities are not complete and cannot fulfill the function of sewage discharge. The domestic sewage is discharged into ditches and the surface of the land, which has a significant impact on the water environment of the villages. Most of the domestic sewage in the villages comes from the kitchens and bathrooms of residents' households. Such sewage has relatively high biodegradability and contains nitrogen and phosphorus elements, with basically no heavy metals or toxic and harmful elements. There is no sewage treatment plant in the villages, nor is there an agricultural water-saving system. This is mainly due to the lack of government investment in the funds for building sewage treatment facilities in the villages, and there are no professionals to guide and supervise the management[1].

2.1.2. Garbage management needs to be improved.

In some villages, all the garbage of the entire community is collected by cleaners and transported to the garbage station for centralized treatment. However, some villagers lack awareness and have not developed the habit. The phenomenon of randomly disposing of household garbage and construction waste still exists. With the continuous improvement of the living standards of rural people, it is necessary to start controlling the production of garbage. Garbage should be classified into organic waste, inorganic waste and hazardous waste. Inorganic waste and toxic and hazardous waste should be collected separately at the unified garbage collection points.

2.2. Causes of rural water pollution

The direct causes of rural water pollution can be classified into two major categories: natural pollution and man-made pollution. "Natural pollution refers to substances that already exist in nature or are part of the biological, geological, and chemical cycles that enter rivers, lakes, and seas through surface runoff during rainfall, thereby altering the natural water quality and causing pollution to the water bodies[2]." However, the pollution that causes significant harm to water bodies is not natural pollution but pollution caused by human activities, namely man-made pollution. Man-made pollution refers to pollutants that are generated during human production and daily life activities, and their concentrations are much higher than those of pollutants input in the natural state[3].

2.2.1. Industrial wastewater pollution

Some enterprises have backward technological levels and relatively primitive production methods. They lack the necessary environmental protection equipment, resulting in industrial wastewater being discharged directly without treatment and the discharge volume constantly increasing. This has led to an expanding area of water pollution in rural areas, seriously damaging the water ecosystem of the countryside[4].

2.2.2. Agricultural runoff pollution

The village's water supply pipeline system is well-developed, but the irrigation water for fruit orchards and vegetable fields can only come from ditches and water wells dug by villagers themselves. During the process of growing vegetables and other crops, pesticides and fertilizers are sprayed, but the utilization rate of pesticides and fertilizers is very low. Only 10% to 20% of the liquid pesticides can adhere to the leaves of plants and take effect, and the utilization rate of solid powder pesticides is even lower. More than 80% of the pesticides will eventually remain in the soil.

The fertilizers used by farmers mainly consist of nitrogen fertilizers and phosphorus fertilizers. The utilization rate of nitrogen fertilizer by crops is slightly higher than that of phosphorus fertilizer. However, the utilization rate of both nitrogen and phosphorus fertilizers by most crops generally does not exceed 35%. The rest will be lost through leaching, seepage, volatilization and other means. Some of the unused nitrogen and phosphorus fertilizers as well as pollutants such as pesticides will pollute surface runoff, and some will flow into the groundwater within the area. The groundwater will be contaminated to a certain extent.

In summary, runoff pollution mainly originates from the fertilizers, pesticides and other agricultural input products used in farmlands. During rainfall or irrigation, the chemical substances that are not fully absorbed by the soil will be washed into water bodies, carrying harmful substances that cause ecological imbalance in the water bodies.

2.2.3. Pollution caused by human and animal waste

The waste discharge from livestock and poultry farms in the village also lacks proper management. The excrement is mostly discharged directly without any treatment, causing certain pollution to groundwater and the environment. Moreover, in some areas, the feces are often used as fertilizer. The pathogenic microorganisms in human and animal feces enter water bodies through rainwater runoff and surface runoff infiltration, thereby polluting the water sources. Organic substances and nutrients such as nitrogen and phosphorus, when entering the water bodies, will promote the growth of algae, leading to eutrophication of the water bodies. This will cause excessive reproduction of algae in the water bodies, consuming the oxygen in the water and causing the death of fish and other aquatic organisms. At the same time, during the decomposition process of dead algae and bacteria, harmful gases such as hydrogen sulfide and methane will be produced, further deteriorating the water quality.

2.2.4. Domestic waste pollution

Due to the relatively backward infrastructure and inadequate management system, the problem of waste disposal is particularly prominent. Moreover, the lack of a long-term management mechanism leads to the random disposal of household waste in fields, near rivers and lakes, or directly into water bodies. During the decomposition process of organic matter in the waste, a large amount of oxygen is consumed, resulting in oxygen deficiency in the water, deterioration of water quality, and adverse effects on the survival of aquatic organisms.

2.2.5. Medical waste pollution

In rural areas, medical facilities are relatively underdeveloped. Small clinics and hospitals usually lack professional medical waste disposal equipment and procedures, and improper handling of medical waste is quite common[5]. Once medical waste is directly discharged into rivers, lakes or underground water sources without proper treatment, the harmful chemicals, microorganisms, heavy metals, toxic organic substances, viruses and bacteria contained in the waste will directly enter the water body, causing adverse effects on aquatic life and the ecological environment[6].

2.3. Analysis of the Causes of Urban River Pollution

2.3.1. The increase in urban population

With the acceleration of urbanization, the amount of urban sewage discharge is also constantly increasing. Urban life generates a large amount of wastewater containing various organic substances, nutrients, and trace elements. If it is discharged into rivers, it will not only have a significant impact on the river water quality, but also cause water environmental problems such as eutrophication and red tides. As the scale of towns continues to expand and the number of town residents keeps increasing, urban rivers will suffer from some destructive human activities. The problem of water pollution is becoming increasingly prominent. For example, in town construction, activities such as mining, reclamation, and land reclamation will cause irreparable damage to the soil, water sources, and

ecological environment, thereby leading to environmental pollution and ecological problems. At the same time as the number of town residents keeps increasing, the industries in towns also develop rapidly. During the industrial production in towns, there will be industrial wastewater and waste gas containing various harmful chemical components and toxic and harmful substances. Once discharged into rivers, it will not only cause the deterioration of river water quality, but also bring adverse effects to the local ecological environment and people's health.

2.3.2. The increase in small and medium-sized industrial enterprises

Small and medium-sized enterprises have a significant demand for water resources. However, not all water sources are of high quality. During the production process of these enterprises, pollutants such as waste gas, wastewater, and waste residue may be generated. If they are illegally discharged into urban rivers, it will cause severe pollution to the river water.

At present, there are strict standards and requirements for industrial wastewater discharge in our country. Small and medium-sized industrial enterprises must meet the corresponding discharge standards before they can discharge wastewater into the external environment. Regarding "small, scattered, unregulated and polluting" enterprises, the government has taken various measures to rectify them and has banned many illegal pollution behaviors. However, some small and medium-sized industrial enterprises still have some problems in controlling the discharge of water pollutants. For example, due to limitations in enterprise scale and funds, some enterprises may lack necessary environmental protection measures; due to outdated processes, they are unable to effectively treat wastewater, resulting in the ineffective treatment of irritating and toxic pollutants in the wastewater and direct discharge into the external environment; The supervision by environmental protection staff was inadequate, and some enterprise managers had a weak awareness of environmental protection, neglecting issues that could cause environmental pollution.

2.3.3. Rainwater pollution

During the process of urbanization, the area of hardened surfaces in cities is constantly expanding, such as roads, buildings, and squares. These hardened areas prevent rainwater from penetrating into the ground and instead cause it to flow directly into the city's drainage system and then be discharged into the city's rivers. The main cause of rainwater pollution is the accumulation of pollutants on the hardened surfaces of cities, which are washed away by rainwater. These pollutants include dust, waste, smoke, oil, chemicals, etc. When rainwater flows over the pavement and buildings, these pollutants are carried into the drainage system and eventually discharged into the city's rivers. The emissions of exhaust gases and wastewater from vehicles in the city also exacerbate rainwater pollution[7]. Rainwater pollution has a significant impact on the ecosystem of city rivers. The continuous accumulation of pollutants leads to eutrophication of water bodies and a decline in water quality, resulting in problems such as excessive algae growth and fish deaths. Pollution also affects human health and production and life. For example, direct contact with polluted water can cause skin diseases and respiratory system diseases; using polluted water to irrigate crops can lead to a decline in agricultural product quality.

3. PRINCIPLES OF WATER POLLUTION CONTROL FROM THE PERSPECTIVE OF SUSTAINABLE DEVELOPMENT

Under the framework of sustainable development, water pollution control should follow a series of principles to ensure environmental friendliness and the sustainable utilization of resources. Among them, the principle of environmental friendliness is an important guiding principle.

3.1. The principle of environmental friendliness

3.1.1. Avoid or minimize the adverse impact on the environment

To effectively prevent water pollution, we must take a series of measures to avoid or minimize its adverse effects on the environment. Therefore, we need to address the issue from multiple aspects, such as source control, adopting eco-friendly technologies and processes, conducting environmental risk assessments, and implementing environmental management plans. Firstly, reducing the discharge of harmful substances is one of the key measures in water pollution prevention. Industrial enterprises should strictly abide by environmental protection regulations and standards, and take measures to reduce pollutant emissions and implement recycling. By improving production processes, installing wastewater treatment equipment, and implementing closed production systems, the amount of harmful substances discharged can be significantly reduced. Secondly, controlling the source of pollution is also very important. This includes strengthening the management and monitoring of agricultural, industrial, and urban wastewater to ensure that its discharge complies with relevant standards. For agricultural activities, promoting scientific and reasonable fertilization methods and the use and management of pesticides can reduce non-point source pollution. For industrial and urban wastewater, it is necessary to build and improve wastewater treatment facilities to ensure that the wastewater is properly treated before discharge. Adopting eco-friendly technologies and processes is also an important way to effectively prevent water pollution. For example, introducing natural system engineering such as biological remediation, wetland treatment, and plant filtration, using the functions of plants and microorganisms to degrade and absorb pollutants, so as to achieve wastewater purification and resource recovery [8]. In addition, developing and promoting low-energy, high-efficiency environmental protection technologies, such as membrane separation and photocatalysis, can improve wastewater treatment effects and reduce energy consumption [9]. Moreover, by implementing environmental risk assessments and environmental management plans, potential environmental risks can be identified, and corresponding preventive and control measures can be taken to reduce adverse effects on the water environment. Environmental risk assessments can conduct a comprehensive evaluation of the surrounding environment, determine potential pollution sources and their impact areas, and thus take targeted measures for prevention and control. At the same time, establishing and improving environmental management plans, including monitoring, reporting, emergency handling, and continuous improvement, can ensure the effective implementation and continuous improvement of environmental protection work.

3.1.2. Explore low-cost and highly efficient environmentally friendly technologies

In the process of water pollution control, it is crucial to actively explore and adopt low-cost and highly efficient environmentally friendly technologies. These technologies not only effectively remove pollutants from water, increase water resource utilization, but also reduce their negative impact on the environment. Firstly, biological treatment methods are widely used environmentally friendly technologies. For example, using biological filter systems, activated sludge methods, and plant wetlands, through the degradation process of microorganisms, organic pollutants can be transformed into more stable and harmless substances. These biological treatment methods have the characteristics of simple operation, low investment cost, and low operating expenses, and are suitable for small-scale wastewater treatment plants and rural areas. Secondly, membrane separation technology is an efficient water treatment technology that can effectively separate suspended solids, colloidal substances, and dissolved organic substances in wastewater. Membrane separation technology includes various forms such as microfiltration, ultrafiltration, nanofiltration, and reverse osmosis, and has the advantages of high efficiency, reliability, small floor area, and simple operation. This technology can be widely applied in water treatment, seawater desalination, wastewater reuse, etc., and improves water resource utilization. Additionally, advanced oxidation technologies are also a treatment method for difficult-to-degrade organic pollutants. This technology generates strong oxidants such as hydroxyl radicals or peroxides to degrade organic pollutants, converting them into

less toxic or non-toxic substances. Common advanced oxidation technologies include ultraviolet photocatalytic oxidation, ozone oxidation, and advanced oxidation technologies, etc. These technologies have the characteristics of high efficiency, no secondary pollution, and wide applicability, and have potential in treating difficult-to-degrade organic pollutants [10]. Moreover, other environmentally friendly technologies also deserve exploration and application. For example, electrochemical technology, adsorption materials, and biochar can all play important roles in water pollution control, and these technologies have the characteristics of low cost, simple operation, and sustainable development, which can effectively remove pollutants, improve water quality, and protect water resources.

3.2. Economic feasibility principle

When dealing with water pollution issues, we need to base our approach on sustainable development while also considering the principle of economic feasibility. This means we need to seek solutions that can both protect water resources and generate economic benefits.

3.2.1. Consider the cost-effectiveness of water pollution prevention measures

We must assess and analyze the cost-effectiveness of various water pollution control measures, including the construction, operation and maintenance costs, as well as the environmental and economic benefits that can be achieved by implementing these measures. By taking a comprehensive approach, we can determine the most cost-effective water pollution control measures and ensure that the invested resources can be utilized to the fullest extent.

3.2.2. Search for sustainable and economically feasible solutions

When determining water pollution control solutions, attention should be paid to sustainability and economic feasibility. Solutions that can meet current needs without sacrificing those of future generations should be adopted. For instance, we can explore ways to use renewable energy to power wastewater treatment facilities, reducing reliance on limited resources and simultaneously lowering energy consumption and emissions. Additionally, the adoption of a circular economy model should be considered. By recycling and reusing valuable substances in wastewater, effective utilization of resources can be achieved, bringing economic benefits to enterprises and society, thereby promoting sustainable development and stimulating economic growth.

4. WATER POLLUTION PREVENTION MEASURES

4.1. Strengthen supervision and management

In order to protect the environment and human health and ensure the sustainable utilization of water resources, the Chinese government has been committed to the governance and prevention of water pollution. To this end, we need to establish a sound legal system, strengthen the source control of water pollution, intensify supervision over polluting enterprises, regulate their discharge behaviors, and ensure that the treated wastewater is discharged up to standard. A sound legal system is an important foundation for ensuring the governance and prevention of water pollution. China has formulated a series of water pollution prevention and control laws and regulations, including the "Water Pollution Prevention and Control Law" and "The People's Republic of China Water Pollution Prevention and Control Law (Amended in 2017)", which provide legal guarantees for water pollution governance and also set good behavioral norms for enterprises [11]. On the basis of the existing laws and regulations, we also need to increase the enforcement of water pollution governance, strictly enforce and punish enterprises and individuals who violate the regulations, so that they dare not pollute the water.

The source control of water pollution should be addressed from three aspects: industry, agriculture, and daily life. Firstly, in the industrial sector, we should restrict the pollution discharge behavior of industrial enterprises and strictly enforce pollution discharge standards to reduce pollutant emissions. At the same time, we should encourage enterprises to adopt advanced production processes and equipment to reduce pollutant generation. Secondly, in the agricultural sector, we should reasonably apply pesticides and fertilizers to reduce the pollution of fertilizers and pesticides to water resources. Finally, in daily life, we should develop good living habits, such as reducing the frequency of car washing and not littering, to prevent water pollution from occurring at the source. In addition, strengthening the supervision of pollution-discharging enterprises and regulating their discharge behavior to ensure compliance with standards is an important guarantee for achieving water pollution control. The Chinese government should establish a sound supervision mechanism for pollution-discharging enterprises and conduct strict law enforcement and supervision. For enterprises that violate pollution discharge regulations, the government should increase penalties and require them to rectify. At the same time, the government should also strengthen technical guidance for pollution-discharging enterprises to help them take effective prevention and control measures and further reduce pollutant emissions.

4.2. Carry out water source protection work and scientifically promote the treatment of various types of wastewater

Firstly, we will continue to promote the improvement of rural environmental conditions. In some areas of the countryside, we will plan drinking water source protection zones and strengthen supervision, prohibiting the construction of chemical plants, livestock farms, and other activities that pollute water sources within these zones . At the same time, we will build and improve rural domestic sewage treatment facilities, conduct centralized treatment of domestic sewage, strengthen the management of medical waste in rural areas, establish professional measures for medical waste disposal, and severely crack down on the illegal dumping of medical waste.

Secondly, scientifically promote the treatment of rural domestic sewage. Strengthen infrastructure construction, establish a complete system for garbage collection, transportation and treatment, promote waste sorting and reduction technologies, enhance farmers' awareness of water source protection, encourage their active participation in protection efforts, and effectively reduce pollution of water sources in rural areas.

4.3. Carry out sewage interception and diversion

The purpose of sewage diversion and separation is to isolate pollution sources from the river through reasonable planning and construction of the river course, thereby reducing the amount and concentration of pollutants flowing into the river, and preventing river pollution. Urban sewage is generally discharged into the river through drainage pipes, so a sound drainage network needs to be established. The urban drainage system should achieve comprehensive coverage of all areas in the urban area, ensure centralized treatment of domestic sewage, and prevent untreated wastewater from directly flowing into the external environment. In the sewage diversion and separation project, the most important step is to direct the treated sewage into the sewage treatment plant for treatment. The sewage treatment plant must have the ability to efficiently remove pollutants such as organic matter, nutrients, and heavy metals, ensure that the effluent meets standards, and also establish a separate rainwater collection system independent of the sewage network to prevent sewage from flowing into the river through the rainwater network.

4.4. Constructing river buffer zones

Vegetation can act as a buffer zone, filtering nutrients, organic matter and harmful substances in surface runoff. By increasing the coverage of riverbank vegetation, it can reduce pollution of river

water bodies. Riverbank vegetation can slow down the flow rate of the river channel, reduce suspended matter in the water, decrease the porosity of the bottom sediment, facilitate sediment deposition, and play a role in improving water quality.

5. CONCLUSION

In conclusion, building an ecological civilization is a major project that concerns people's well-being, the future of the nation, and the national economy. We need both green mountains and clear waters, as well as gold and silver mountains. The prevention and control of water pollution in rural and urban areas is particularly important and represents a challenging and comprehensive task. The government needs to intensify the rectification efforts, accelerate the improvement of sewage treatment infrastructure, strengthen the management of livestock and poultry breeding, establish and improve management and supervision systems based on local conditions, and ensure the normal operation of sewage treatment. Moreover, international cooperation is also crucial because water pollution is a global issue that requires cross-border collaboration to be completely resolved. Only through comprehensive measures and continuous efforts can the goals of healthy water environment protection and sustainable development be achieved.

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