Research Progress in Water Quality Improvement

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Abstract. Rivers play an important role in flood control, sewage discharge, ecology, and so on. However, the intensification of water pollution leads to the river water quality to gradually decline, and pollution control cannot be delayed. This article analyzes the water environment from water quality improvement method. The water pollution treatment and improvement are analyzed and it points out the advantages and disadvantages from physics, chemistry and biology. The article also combs and summarize the issues and development trends in the river water quality improvement method in order to provide scientific reference for the improvement water quality assessment and comprehensive treatment of water pollution of rivers.

1. Introduction
Rivers play an important role in many aspects such as flood control, sewage discharge and ecology. With the rapid social and economic development of Beijing, the discharge of domestic sewage and industrial waste water increases, and the amount of sewage in rivers far exceeds its bearing range. The water quality is getting worse and worse. For example, Wenyu River, as the mother river of Beijing, which is a strategic backup water source and plays an important role in city development. However, its water quality is deteriorating and many river functions disappeared. In order to alleviate water stress, reduce water pollution in rivers, and realize the overall allocation of water resources, the governance and improvement of river water quality is of great significance.

Through understanding the present situation of water pollution and the achievements of scholars in water quality assessment and water pollution control, the methods of water quality improvement are discussed, and the existing problems and development trends are summarized. In order to improve the river water quality evaluation, comprehensive treatment of water pollution to provide a scientific reference.

2. Progress in Research on Water Quality Improvement

2.1. Water Pollution Current Status
In recent years, due to rapid population growth, water resources, land resources are becoming increasingly tight, river ecosystem is deteriorating day by day, the quality of water environment in China is not optimistic, the improvement of water quality is urgent. Water quality improvement refers to the treatment of polluted, domestic and produced waste water by physical, chemical and biological methods, so that its water quality index can reach the corresponding standard. As early as the 1950s and 1960s, there were water pollution incidents such as water mites caused by methyl mercury pollution and bone pain caused by cadmium pollution in Japan. In 1980, 80% of all diseases in the world were due to improper water supply or water is not clean. Before 1987, about 65.4% of the population had drinking water sources in China, and there were turbid, bitter, salty or fluorine-containing, arsenic poisons, or industrial pollution [1]. Wenyu river is also one of the polluted rivers, many water quality indicators of Wenyu river are excessive, and the environment around the
river became worse than before. Ecological restoration of rivers and wetlands has become a worldwide phenomenon since 1990's. With the deep understanding of river function and the importance of urban water system to people's life, regional water quality improvement has been widely carried out at home and abroad. Among them, Chengdu Funan River Park in Sichuan Province was an early and successful case in China. It is an eco-environmental protection park with the theme of water quality improvement. It draws the polluted water from Funan River and carries on natural ecological purification through the constructed wetland system of the park, and then flows back to Funan River after the water quality reaches the standard.

The bulletin on environmental conditions in China pointed out in 2015 that the Yellow River, the Yangtze River, the Songhua River, the Pearl River, the Haihe River, the Huaibei River, the Liaohe River, and the northwest rivers, the southwest rivers, the Zhejiang and Fujian rivers, and other 700 state-controlled sections, the pollution of Haihe River Basin is the most serious, the proportion of inferior V water is close to 40%, and the pollution of Liaohe, Haihe and Huaibei River basins is also serious, the proportion of I-III water is about 50%. Secondly, with the rapid development of economy in China, the pollution problem of urban rivers is becoming more and more serious, and people need to improve the water quality of urban rivers more and more urgently. From the overall situation of water quality improvement in urban rivers in recent years, the problem of water pollution in urban rivers in China will still exist for some time in the future, and even the water quality of the local rivers will be further deteriorated.

2.2. Pollution Causes
According to the types of harmful substances released by the sources it can be divided into inorganic or organic, biological sources (such as bacteria or toxins). According to the distribution characteristics of pollution sources it can be divided into point pollution sources such as municipal sewage, industrial and mining enterprises and sewerage vessels), surface pollution sources (e.g. surface runoff of rain water, soil erosion and drainage of large areas of farmland), diffuse pollution sources (air pollutants by sedimentation or sedimentation into water bodies, such as radioactive deposits, acid rain).

2.3 Brief Introduction of Water Quality Improvement Methods
With the development and improvement of water treatment technology, the purification and improvement of river water quality is becoming more and more mature. The effects of various water treatment techniques are stable and economic performance is good. These methods can be divided into three types according to their purification principles: physical method, chemical method and biological method. All kinds of methods have their own technical characteristics and application conditions, and the practical value of each technology is determined by the different conditions.

2.3.1. Physical Method.
   a. Water Diversion Dilution. The water diversion dilution is mainly applied to the improvement of the eutrophic river water and lake water, and it is also an effective method for the water pollution control of the extremely slow rivers. In Lake Buffalo pound, Canada, the dominant species in the lake were transformed from green algae to macrophyte by adding water dilution with low nutrient content [3]. The principle can be summarized as three points: (1) The pollutants are transported to the lower reaches of the river in a short time through the diversion of water into the upstream channel, thus reducing the concentration of pollutants in the whole river and achieving the purpose of purifying the water quality; (2) In the process of water diversion and injection, the increase of river water velocity and the increase of water and air contact area in some areas make the content of dissolved oxygen increase, the water quality changes from hypoxia to aerobic, and the self-purification ability of the river is further improved; (3) The injection of foreign water enhances the fluidity of the river and exchanges the polluted rivers in different regions and reduces the concentration of pollutants in the
seriously polluted areas.

It should be noted that the concentration of pollutants in the river is reduced by dilution, but the total amount of pollutants remains unchanged, which is only a physical process, and the pollutants in the lower reaches of the river will increase with the diversion of water. Therefore, before using this method to purify the water quality, it is necessary to carry out scientific calculation and analysis and implement it carefully on the premise of not exceeding the carrying capacity of the lower reaches of the river.

b. Artificial Aeration. Organic pollutants enter rivers and are oxidized and decomposed by aerobic microorganisms in water. The continuous development of this process makes the river reoxygenation rate less than the aerobic rate, the dissolved oxygen in the water is consumed, and finally the river water becomes hypoxia or anaerobic. Due to the serious shortage of dissolved oxygen, the ecosystem of rivers will be destroyed, aquatic organisms will die of hypoxia, and the purification capacity of rivers will be greatly reduced or even lost. Therefore, the artificial aeration of the river can effectively improve the dissolved oxygen concentration and improve the water quality of the river. In the treatment of the Rhine River in Germany, in addition to the river closure and pollution control, the tributary Mein River is also supplied with liquid oxygen to the section of about 60km of river[15]. The Suzhou River in Shanghai supplied oxygen to the tributaries in 1998, increasing the dissolved oxygen content from 0.2mg/L to 2mg/L[4-6].

c. Sediment Dredging. The sediment of the river bed is the main source of internal pollution of river water. Under certain conditions (certain temperature and pH), a large number of pollutants are released in the sediment, which seriously affects the water quality of the river. By dredging the river regularly, the polluted matter in the river sediment can be reduced effectively, and the water quality of the river can be improved. In the course of dredging, a reasonable and effective dredging method should be chosen according to the pollution condition of the river and the structural conditions of the river, so that both the river course can be dredged and the degree of pollutant diffusion can be reduced to the minimum. The ecological conditions of rivers should be considered to minimize the damage to river ecosystems. The experimental study on the sediment dredging by Zhong Chengsheng et al. showed that sediment dredging has a good control effect on the release of endogenous phosphorus and nitrogen pollutants in the river, at the same time; it has important influence on denitrification, microbial activity and community diversity of sediment[7].

2.3.2. Chemical Method.

a. Chemical algae removal. For eutrophic rivers and lakes, algae growth is controlled by adding chemical algae remover agent. Chemical algae removal can eliminate algae pollution in a short period of time, but at the same time, the input of chemical agent will also have a negative impact on the growth of other organisms in the water and cannot fundamentally eliminate algae pollution. Therefore, the chemical algae removal method can only be used for emergency use in water purification improvement. In the course of Dianchi's governance, chemical algae removal has shown a good effect on water quality improvement[8].

b. Flocculation Sedimentation. The coagulant is added to the polluted water body to precipitate the colloidal substance and suspended organic matter in the water body to achieve the purpose of purifying water. This method can effectively reduce the phosphorus-containing pollutants in water. The commonly used coagulants are inorganic flocculants (aluminum salts and iron salts) and high molecular flocculants (polyacrylamides).

c. Heavy Metal Fixation. The sediment in the river bed contains not only organic pollutants but also heavy metal pollutants. Under certain conditions, heavy metals will enter the water body in some specific forms and cause pollution to the water body. The principle of heavy metal fixation is to combine heavy metals in sediment, reduce the amount of diffusion to water, and reduce the pollution of heavy metals in water. The heavy metals in fixed water are mainly fixed by adjusting pH value, so that all kinds of heavy metals exist in the form of precipitation at the bottom of the river, and they are usually fixed by alkaline substances such as slag and steel slag.
2.3.3. Biological Method.

a. Inoculation Method. Microorganisms play an important role in the process of self-purification of rivers. If the effective microbes in the river are reduced or disappeared, the river's self-purification capacity will also decrease. Inoculation method is to put effective microorganisms into the river water to enhance the self-purification ability of the river, thereby promoting the degradation of organic pollutants in the river water body and achieving the purpose of improving the river water quality. Of course, the bacteria to be inoculated need not contain pathogens, do not harm other microorganisms, and can adapt to the environment of the river, which requires time to cultivate and screen efficient strains, which is also a disadvantage of the method. Zengyu et al. used photosynthetic bacteria to purify the water quality of Funan River. The results showed that the removal rate of CODcr reached more than 90% with the addition of bacteria. This shows that the use of microorganisms to control water pollution is promising [9].

b. Phytoremediation Technology. Phytoremediation technology is a method to use plant roots to absorb pollutants in water and finally harvest plants to achieve the purpose of water purification. Sun Lianpeng et al. used biological floating bed to remove nitrogen pollutants in Pearl River Basin [9]. This method has the advantages of good water purification effect, low cost, no need for energy consumption and operation cost, and cannot cause secondary pollution to water body. It can also improve the landscape and beautify the environment. It is a promising water purification technology.

c. Biological Manipulation Technology. The predation, competition, and interdependence between aquatic and plant populations and colonies play an important role in water quality regulation. Therefore, regulating and controlling the species and quantity of aquatic organisms can improve the purification ability of water and then improve the water quality [10]. The process of biological manipulation is to reduce the fish feeding on plankton in order to increase the number of zooplankton and to increase its intake of phytoplankton so as to reduce the number of phytoplankton and improve the water quality.

d. Constructed Wetland Technology. Constructed wetland is a wetland-like water purification system composed of fillers, plants and microorganisms. Through the synergistic action of physics, chemistry and biology in natural ecosystem, pollutants in water are filtered and absorbed to realize the purpose of water purification. For example, the microorganisms in the wetland system can effectively degrade the organic matter in the sewage. The plant roots can not only bring oxygen into the water, but also absorb the nitrogen and phosphorus pollutants from the sewage, and the soil layer can filter the suspended matter in the sewage [12].

3. Conclusion

The water quality detection of the river reach is a process of large amount of data, multi-level target and strong synthesis. It is necessary to correctly and accurately process and analyze the measured data and experimental results, and then establish the index system and determine the improvement method. In the background of increasing water demand and increasing water pollution, through consulting literature, this paper enumerates a variety of water quality improvement methods, and combs and summarizes the existing problems and development trends in the method. With the perfect implementation of monitoring, data accumulation and correct analysis, and finally make a reasonable evaluation and formulate specific treatment programs, it is believed that the river water quality will be greatly improved and the Beijing's mother river Wenyu will become better and better.

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