Study on Water Ecological Restoration Technology of River

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Abstract. Based on the historical review and summary of river water ecological restoration, the overall strategy and key technologies of water ecological restoration of polluted river water quality in river water for ecological restoration are analyzed. At present, physical, chemical and biological composite technologies are mainly used to carry out ecological restoration of spatial form, water quality, bottom silt, flora and fauna habitat and riparian buffer strips in river ecosystem. It is pointed out that constructed wetlands, biological floating islands and other bioremediation technologies are gradually being paid attention to, and become the main direction of the development of river water ecological remediation technology in the future. The purpose is to provide scientific reference for river ecological environment management.

1. Introduction

Strengthen ecological regulation of rivers, actively carrying out ecological transformation of river revetments, and promoting ecological control of rivers; Accelerating the implementation of advanced technologies such as riparian wetland, nitrogen and phosphorus interception and absorption, aeration oxygenation, ecological floating bed, and restoring and rebuilding the benign river ecosystem. It is of great significance to study the key water ecological restoration technology of river, to repair damaged rivers and to improve the ecological carrying capacity of rivers for the continuous improvement of the water environment quality of rivers.

The ecological restoration of near-natural river is not only to solve the problems of the river itself, but also to achieve the harmonious coexistence between man and nature in the whole river basin, surrounding areas and even beyond [1]. River ecosystem is a complex, changeable and non-linear system, which increases the difficulty of river ecological restoration. Many scholars have made a lot of theoretical and practical researches on how to really restore the river ecosystem, and have obtained a lot of achievements and rich experience. River ecological restoration technology refers to the selection of various methods to repair the damaged aquatic ecosystem's biological populations and ecological structure, strengthen the main functions of aquatic ecosystem, rebuild healthy ecological water body, and make the ecosystem achieve a virtuous circle of self-sustainment and self-coordination based on the principle of ecosystem [1~2].
2. A survey of research on river ecological restoration

In 1938, Seifert [4], a German scholar, first put forward a river regulation scheme which was close to nature, economical, practical and keeps beautiful. In the 1950s, Germany put forward the concept of "near-natural river regulation project" in which river regulation should be plantified and life-emphasized. In the 1970s, Britain, France, the Netherlands, Switzerland, Germany, Austria and other countries began to apply ecological engineering technology to urban river management, namely “multi-natural river ecological restoration technology”. In the 1980s Japan began to formulate and implement “the plan of creating multi-natural rivers”. In the 1990s, the United States began to implement the restoration of concrete rivers. With the practice of urban river ecological engineering technology, the corresponding theory has been further developed. In the 1990s, the United States, Japan and Australia published monographs on river restoration to guide practical work.

In addition, many countries also incorporate the near-nature concept of river ecological restoration into the national policy management system, and formulate relevant laws and regulations, standards, technical manuals and so on. New South Wales, Australia, has established the Healthy Rivers Commission, which was responsible for advising the government on the development of healthy water quality, quantity and other water-related goals for rivers. New Zealand has established river ecosystem health standards and Austria has carried out a river restoration project (LIFE plan) [5].

Measures for ecological restoration of near-natural rivers are as follows: (1) Respect history, respect the current situation of rivers, pay attention to the utilization of surface soil. (2) Following the natural processes of rivers, restoring biodiversity and returning to nature. (3) Emphasis on multi-objective, multi-scale design; (4) Natural rehabilitation activities after small-scale river engineering; (5) Integrate various management measures and coordinate related plans. However, at present, there are few studies on the ecological processes and mechanisms of ecosystem restoration, and there is a lack of theoretical and experimental evidence on how to self-regulate the damaged river ecosystem in the process of ecosystem restoration.

Relevant scholars have done some research on the design of near-naturalized river regulation. Various geomorphological types of near-natural rivers are the result of the long-term effects of natural flow processes, and their structures and forms are compatible with the hydrological processes of natural rivers [6]. A good design should actively follow the natural process of the river, actively protect and utilize the natural geomorphologic structures of the river. Gao Yang, et al. (2007) introduced a variety of near-nature restoration measures and their ecological functions. He took the comprehensive renovation of Huaiju river in Huairou district of Beijing as an example to explain the specific operation of various restoration measures, so as to provide reference for the near-nature restoration of other rivers [7]. Zhu Wei, et al. (2015) proposed a "near-nature river" governance model for the improvement of water quality and transitional treatment of rural river [8]. In terms of ecological slope protection, "key technologies and ecological functions of river ecological slope protection" proposed three types of ecological slope protection technologies on the basis of practice. They are the whole series of ecological slope protection, soil biological engineering and complex biological stabilization technology [9]. Yang Zongxuan, et al. (2018) proposed the concept of the near-nature river governance and ecological governance methods by referring to the idea of the river channel near natural governance, providing references for urban river channel near natural governance projects [10]. In addition, Meng Fanchao, et al. (2010) adopted riprap plants, geotextile combination plants, natural material fabric pad and natural prototype to observe the change rule of the biodiversity and stability of the river bank in terms of plant slope protection technology [11].

River water ecological restoration is a multi-disciplinary and complex system engineering, which requires ecological theories and methods to carry out river water ecological restoration.

3. Key technologies for river ecological restoration

The treatment and restoration of polluted river water quality is a complex and systematic project. At present, the river restoration and management technologies studied or put into use can be classified
into three categories: physical restoration, chemical restoration and biological restoration. On the whole, relevant researches mainly focus on the restoration of spatial morphology, water quality, bottom silt, flora and fauna habitat and riparian buffer zone in the river ecosystem [12-14].

Physical restoration mainly takes various engineering measures such as building hydraulic structures, mechanical algae removal, dredging river sediment, water diversion and dredging, water diversion and dilution. It can improve the hydrological conditions and sediment environmental conditions of polluted rivers, so as to achieve the purpose of river ecological restoration. Physical restoration in river restoration technology is often simple and effective, but it is also prone to side effects, resulting in the destruction of the ecosystem, cannot by taking measures both the symptoms and root cause.

Chemical remediation is to inject chemical modifiers into polluted rivers, through chemical reactions between chemicals and pollutants to produce neutral substances without pollution to the environment, so as to remove pollutants in the water and repair the ecological environment of rivers. Chemical remediation has a good effect on the treatment and restoration of sudden water pollution, but it is only temporary and significant, not a permanent remediation measure. Chemical repair has a good treatment and recovery effect on sudden water pollution, but it is only temporary and significant, not a permanent repair measure. Because it only changes the forms of heavy metals in rivers and retains metal elements in rivers. Chemical remediation is only an important supplementary remediation measure in the process of ecological restoration of rivers.

Bioremediation technology utilizes plants, microorganisms and some aquatic animals to absorb, degrade and transform pollutants in water to achieve the goal of water environment purification and water ecological restoration. Bioremediation technology can be a single plant, animal or microbial remediation. It can also be an ecosystem composed of different plants, animals and microorganisms for water ecological remediation. In recent years, bioremediation technology, which combines plant, animal and microorganism remediation through artificial construction of simulated ecosystems (such as artificial floating islands, constructed wetlands, etc.), has been more and more applied to practical projects. It has achieved good economic, environmental and ecological benefits.

3.1 Artificial floating island technology
Artificial floating islands have been widely used in reservoirs with large fluctuations in water level, lakes and marshes of coastal aquatic vegetation belts which were difficult to recover due to wave and ponds and rivers with landscape requirements. This is mainly suitable for eutrophication and organic pollution rivers, with small amount of engineering, easy maintenance, good treatment effect, and no secondary pollution, so that sustainable use of resources [15].

3.2 Constructed Wetland Technology
Deng Futang, et al. (2006) conducted monitoring and research on constructed wetlands built in Dajie river, Jiangchuan county, and found that they had a good effect on the water ecological restoration of the river [16]. During the implementation of an ecological restoration project in Qinghu section of Guanlan River in Shenzhen, the ecological principle and constructed wetland technology measures were fully utilized and good results were achieved [17].

4. Conclusion
In summary, at present, physical, chemical and biological composite technologies are mainly used to carry out ecological restoration of river ecosystem. Compared with traditional technical means such as physical and chemical remediation, bioremediation has the advantages of low investment and maintenance cost, convenient operation, no secondary pollution to river courses. Bioremediation can improve the ecological environment of urban rivers to a certain extent, and it also has good economic and social benefits. Therefore, constructed wetlands, biological floating islands and other bioremediation technologies were more in line with the requirements of environmental protection, and are gradually being paid attention to, becoming the main direction of the development of river
ecological remediation technology in the future.

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