

Analysis on Urban River Ecological Restoration and Landscape Reconstruction Methods --Taking Baima River of Fuzhou as an Example

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Abstract: Urban rivers form an important part of urban ecology, and restrict the development of a city to a great extent. Since the twenty-first century, many cities have focused on the comprehensive treatment of urban river pollution, but few satisfactory results have been achieved. The effects of pollution control cannot last long. Based on ecological restoration, this paper explores the comprehensive application of bioremediation, physical mediation and other engineering methods to control the pollution of urban rivers, and emphasizes the restoration of the self-regulation abilities of water system to achieve the benign cycle of ecosystem. The aim of these methods is to purify the water quality of urban rivers, optimize the ecological environment of revetments and beautify the landscape of urban rivers.

1. Introduction

Human beings have tended to inhabit by the water since ancient times. Rivers have witnessed the construction and flourish of many cities around the world. Water is closely related to the development of cities; according to relevant record, the first batch of cities in our country is built in Yellow River basin. The development of Fuzhou city depends on Minjiang River, which passes through the city, and its rich inland water system; the dense waterway net carries the historical context of Fuzhou for more than 2000 years. [1] However, with the process of urbanization and industrialization, a large number of domestic sewage and industrial wastewater are produced and cause serious damage to urban water environment. Although many cities have focused on the comprehensive treatment of urban river pollution, few satisfactory results have been achieved. The effects of pollution control cannot last long.

In 1930s, developed countries in Europe put forward to a river management concept of "close-to-nature", and applied the ecological engineering technology to urban river management in 1970s to realize "the ecological restoration of multiple natural rivers". With the practice and application of ecological engineering technology, related theories also developed. [2] Although there are many researches on river ecological restoration abroad, there are few theoretical researches and proofs on the self-repair and self-regulation capacities of urban river ecosystems. Related research in China started relatively late, but developed relatively fast. Some academic fruits have been achieved. However, most of these achievements are in primary stage and only focus on the improvement of water quality; researches about the comprehensive improvement of ecosystem are inadequate. [2] On the basis of ecological restoration, this paper tries to find methods which can restore the self-repair and self-regulation abilities of urban rivers, improve the ecological environment of urban water system and realize the benign cycle of urban water ecosystem.

2. The Concept of Urban River Ecological Restoration

An urban river is a complex ecosystem which is composed of water bodies, bank revetments, river banks, river beds, flora, fauna and microorganisms. [1] Chinese and foreign scholars generally believe that the core of ecological restoration is to achieve the benign cycle of ecosystem by restoring its self-regulation and self repairing abilities. The urban rivers ecosystem restoration mainly refers to

the restoration of biological diversity as well as the self-repairing and self-regulating abilities of water ecosystem through the comprehensive application of various means, so as to make urban rivers fully play their ecological adjustment functions, and fundamentally improve the water quality and landscape environment of urban rivers.

3. The Methods of Urban River Ecological Restoration

3.1 Ecological restoration of water body.

The main goals of urban river ecological restoration are purify water quality and optimize urban river landscape. At present, in addition to the self-adaptive, self-organizing and self-regulating capacities of the aquatic ecosystem itself, water quality can be improved through three kinds of artificial techniques: physical remediation, chemical remediation and bioremediation. [3]

Physical remediation. Physical remediation methods can improve the environmental conditions of river sediment and restore the hydrological conditions of river channel through engineering methods, such as the dilution of water and the dredging of sediment. Through these methods, the water quality of urban rivers can be quickly improved in a relatively short period of time. These physical restoration techniques have advantages of clear purpose and quick effects, but they are usually applied to accidental water pollution, or serve as a complementary means in the process of comprehensive regulation of urban rivers, since they may exert negative effects on other water areas. [2]

Chemical remediation. Chemical remediation means to purify water body by chemical means. The main method is to put chemical improvement agents into polluted urban rivers. After the reaction of improvement agents and water body, urban rivers can be purified. For example, the introduction of algaecide can inhibit the propagation of algae; the release of lime can neutralize acidified water. Chemical remediation methods can produce fast and good effects, but with very prominent negative impacts. They can lead to secondary pollution of water environment. For example, some algaecide can kill a large number of microbes while inhibiting the reproduction of algae, and destroy the ecological balance of water body. Therefore, chemical remediation is usually used to deal with sudden water pollution or as an auxiliary means for the comprehensive treatment of water bodies.

Bioremediation. Bioremediation refers to the degradation, absorption and transformation of pollutants in water body through aquatic animals, plants and microorganisms, so as to reduce the concentration of pollutants to standard range, purify water quality, and restore the benign circulation of water ecosystem.

Physical and chemical remediation technologies have shortcomings of high cost as well as temporary and unstable treatment effects; it is impossible for them to solve the problem of urban rivers pollution in essence. Usually, they can only be used to deal with sudden pollution of water body or as an auxiliary means in pollution control. The key to solve the problem of urban river pollution in cities is to alleviate and control the present situation of water pollution quickly, and on that basis, to permanently repair the urban water ecosystem through biological means.

3.2 Methods of constructing ecological revetments along urban rivers.

Traditional watercourse revetments are mainly composed of hard engineering materials such as cement, concrete and asphalt. The sections of revetment slope are usually designed as regular shapes, which makes river banks hard and reduces the biological diversity, thus affecting the balance of the whole river ecosystem. Ecological revetments are mainly composed of natural materials such as wooden poles, stone cages and pebbles. Green, porous and rough slopes should be built to promote the coordination and conservation of soil, water and organisms, to improve and soften the ecological environment of river banks, and to build a good ecological space of water. [4] In addition, ecological methods should also be used to change channelized and hardened river revetments. Main methods include:

The greening of surface layers. The greening of surface layer means to beautify the monotonous masonry or concrete surface of riverbank by combining vigorous green plants with protection slopes,

so as to realize the ecological vegetation restoration of the slope, conserve water and soil, and improve the landscape environment of urban rivers. [5]

Making slope surface rough and porous. As the intermediate transition zone connecting water and land, natural riverbank slopes are the main region of water and soil preserving, and the main habitats of aquatic organisms. Traditional channelization and hardened slopes have poor permeability, which hinders the conservation and exchange of water body and soil, and destroys the ecological environment of the whole river bank. Therefore, on the basis of maintaining the strength of traditional revetment structure, we should also pay attention to porosity and roughness of revetments. For example, concrete fish trough structures can be used to protect the bank and provide good living space for fish; materials with good permeable and large gaps can be used to build frame structures; gravel and cobblestone can be used to fill the gaps; suitable aquatic plants can be planted on the surface of the structure to create good habitats for all kinds of organisms. [5]

Diversifying the state flows in near shore. In order to meet the needs of urban flood control and drainage, the cross sections of urban rivers are usually designed as regular shapes. This hard river section is not conducive to the living of organisms, and seriously affects the biodiversity of urban water environment. It also makes water bodies far away from people's lives. Therefore, it is necessary to diversify the coastal flow states of urban rivers, restore the original texture of rivers and the biodiversity of water body, in order to create an original, ecological river landscape. [6]

4. Present Situation of Baima River Comprehensive Improvement Project

4.1 Introduction to Baima River.

Fuzhou city enjoys 6 major water systems of Baima River, Moyang River, Guangming Port, Jinan River, Xindian Pian and Nantai Island. The rich water resources endow Fuzhou with the natural spirit of Jiangnan and the humanistic atmosphere of seaside. The upstream of Baima River flows from the West Lake of Fuzhou, then passes through the western part of the city and finally flows into Minjiang River. It is an important tributary of Minjiang River.

4.2 The general situation and existing problems of Baima River.

In recent years, with the goal of building a harmonious and livable city, Fuzhou city has focused on the comprehensive treatment of urban rivers. After the comprehensive renovation, the water quality of the Baima River has been greatly improved. But after repeated treatment, the phenomenon of "black and stinky water" reoccurs now and then. The main reasons are as follows:

Insufficient water treatment methods. During the process of Baima River pollution control, physical and engineering means such as watercourse widening, sediment silts cleaning, embankment constructing, as well as river cutting and straightening are taken. These methods control the pollution quickly, but at the same time, they bring many problems and contradictions, including the channelization and hardening of watercourse; these changes encroach, block and destroy the habitats of aquatic animals and plants, and thereby affect the biodiversity of water body, and destroy the integrity of ecosystem. [8] For example, in order to build livable landscape along Baima River and construct Baima River Park, plants grown on riverbanks should be transformed in order to build an artificial garden. In the process of transformation, the embankment is also solidified. In addition, in the process of urban planning and construction, in order to integrate urban land usage and improve the rate of land use, natural rivers which are composed of shallow bays and deep pools should be cut off and straightened. In order to meet the needs of flood control and drainage of cities, river channels are designed as narrow, trapezoid channels. These modifications change the direction of water flow and the ecological hydrological process, which destroys the benign cycle of urban water ecology.

Urban point source pollution seriously affects urban water bodies. At present, the drainage system of Fuzhou adopts the diversion of rain and sewage water. It is a reasonable and perfect drainage system advocated by our country. In principle, the diversion of rain and sewage water should become the aim of pipe network reconstruction in old and new urban areas. Compared with other cities in China, the urban drainage system in Fuzhou is relatively perfect. But in real situation, some old urban

areas in Fuzhou can only take the form of local interception in short term due to limitations in objective environment. Moreover, because of the imperfect construction and management, sewage water is still discharged into urban rivers in some areas, which cause the pollution of urban rivers. As the result, although polluted urban rivers are constantly regulated, the effects cannot last long.

Imperfect supervision and management. The Baima Street is close to Baima River. There are many old communities, large and small shopping malls and retail restaurants on the street; these facilities produce a lot of life and service industry sewage. Some of the residents and merchants change drainage pipes without authorization, making sewage directly flow into urban rivers mixed with rain water, and causing urban river pollution. Though relevant departments have organized the investigation and try to renovate the sewage discharge system, the investigation can only target the area; it is difficult to find out the specific individual who changes the pipe line. And, the speed of emissions is much quicker than the speed of investigation and regulation. Therefore, how to accurately find out the source of pollution and deal with emission is a tricky task in urban river management. [9]

5. Ecological Restoration of Baima River

5.1 Intercepting pollution along the river.

New drainage system in the city should be designed to realize the diversion of rain water and sewage; existing drainage pipeline system should be renewed to achieve the same goal. At the same time, due to the influence of many subjective and objective factors like environment, urban river construction and management, a "pollution control" line must be built along the river. For existing drainage system which fail to separate rain and polluted waters, we should first intercept sewage in the system before the transformation project is completed. After the transformation, the river drainage pipe network system should be converted to collect rain water, thus reducing the load of inland rivers and improve the environment of them. The key point is, when adhering to "rain and sewage diversion" at the starting point of water system, we should also adhere to "intercepting pollution along the river" at the ending point, in order to avoid the input of sewage into urban rivers. [10]

5.2 Ecological restoration of water body.

The ecological restoration of urban rivers should be combined with engineering methods and biological means. On the basis of rapid and effective mitigation of river pollution by physical means, biological means can be used to restore the biological diversity of rivers and restore the self-purification ability of ecosystem. It is the fundamental solution which can solve the problem of "reoccurred pollution" in the process of Baima River management.

Physical means to mitigate the pollution. The ecological restoration of urban rivers must be done from "both inside and outside". While controlling the input of exogenous pollution, it is also necessary to quickly alleviate the pollution status by dredging, oxidizing and covering. For example, ecological dredging, namely the combination of ecological and environmental engineering methods can be used to clean sediment pollutants and remove internal pollution, thus creating a favorable condition for the recovery of water ecosystem. [11] In addition, by introducing water from Minjiang River to dilute polluted urban rivers, and increase the mobility of water body, the water quality of urban rivers can be improved.

Restoring the self-purification capacity of water body through biological means. On the basis of physical means which can quickly alleviate pollution, biological means should also be used to rebuild urban river ecosystem and restore its benign cycle. By the way of introducing reproducible aquatic animals and plants into urban rivers, interactions between aquatic animals, microbes and plankton can be realized. Pollutants in water body can be degraded, absorbed and transformed in the form of food chain. The method can reduce the concentration of pollutants, alleviate or eliminate water pollution, and restore the self-purification ability of water body. When urban rivers restore their self repair abilities, governance cost on river treatment can be reduced to a certain extent. [12]

5.3 Constructing ecological riverbanks.

Ecological riverbank is a new type of revetment which combines plants and civil engineering to protect the slope of watercourse and integrate the functions of flood control and drainage. [13] Through the construction of ecological riverbanks, we can improve the erosion resistance and sliding resistance of the slope, reduce soil erosion, and create a good habitat for aquatic animals, plants and microbes, thus restoring the biological diversity of water body, restoring the self purification capacity of water ecosystem, and realizing the harmony and unity between natural and human living environment.

5.4 Strengthening the management of urban rivers.

Urban rivers regulation should be combined with management. We can achieve the goal of purifying and beautifying the environment through a series of measures such as river pollution controlling, sediment clearing, ecological water supplement, biological engineering and so on. But to realize the sustainability of "clear water, smooth river and beautiful scenery", relevant departments should maintain and manage rivers effectively, promote environmental publicity, strengthen supervision and management, and strictly punish perpetrators of environmental laws. At the same time, through community publicity and education, citizens can consciously improve their awareness of protecting rivers and regulate their behaviors. Only when regulation and management are carried out simultaneously can we really solve the problem of urban rivers pollution and restore the vitality of urban rivers.

6. Riverside Landscape Reconstruction

6.1 Building green space along the river and creating public open space.

The reconstruction of landscape should follow ecological principles and respect regional ecological characteristics; through rational configuration of vegetation and flowers, a stable landscape ecosystem can be created, while maintenance cost can be reduced.

The permeability of Baima River bank is poor, while residents of Fuzhou are not close to water areas. To improve the situation, existing cultural heritage can be combined with landscape techniques to create an urban leisure corridor on the waterfront. The corridor should be equipped fitness space and allow citizens to interact with water. At the same time, urban pedestrian traffic system and waterfront landscape space should be combined to create waterfront walkway, in order to change the situation of pedestrian and vehicle coexistence, improve citizens' walking experience and ensuring traffic safety.

6.2 Developing tourism resources of urban rivers.

Baima River is a river with rich cultural connotation. Adjacent to Three Lanes and Seven Alleys, connected with West Lake and Wushan Mountain, Baima River has witnessed the historical change and development of Fuzhou city. Therefore, we can integrate the historical context of Fuzhou into the construction of urban ecological civilization. Relying on historical culture, an aquatic ecological corridor could be built to develop the tourist resources of rivers. Building ports along the river could alleviate traffic pressure on land. The combination of transportation, leisure, culture and tourism will help to create an ecological tourism destination with local cultural characteristics. The integration of leisure and entertainment can improve the living quality of urban residents. [15]

7. Conclusion

With the development of society, people are gradually getting satisfied with the pursuit of material life. They turn their attention to the quality of living environment, and pursue the healthy ecology as well as high quality leisure and entertainment. Nowadays, urban rivers should not only take the responsibility of "flood control and drainage", but also play a role in urban ecosystem protection. Urban rivers should be regarded as an important part of urban ecology, and be integrated into the

concepts of ecological restoration and landscape construction. Only in that way, can we purify the water quality of urban rivers and beautify river landscape, and improve the living quality of urban residents.

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