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Riverfront Landscape Based on the Idea of River Restoration: A Case Study of the Riverfront Landscape of Duoba New District in Xining City

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Abstract

With social progress and economic development, flood protection, water storage, and pollution absorption of urban rivers have been improved, but at the same time negative effects have been brought about. In urban areas, due to canalization or occupation of river, and forcible alteration of course of rivers, river waters area has been reduced. Natural capacity of rivers is seriously lacking, and the ecosystem services of rivers are gradually weakening. For planning, design and construction of urban landscapes, the concept of ecological restoration must be applied to protect and rationally utilize river landscapes. This paper takes the landscape belt of Huangshui River in Doba New City of Xining as an example to study the Huangshui River. Based on the theory of river course restoration, a "dynamic growth" river restoration system is established, and the restoration process of nature itself is as little as possible. In order to improve the water quality of Huangshui River, control the flow velocity and build the ecological environment, a set of perfect and self-repairing system is created for Huangshui River.

Keywords

River Restoration, River Ecological Restoration, Riverfront Landscape, Huangshui Riverfront Landscape

1. Introduction

1.1. Overview of River Restoration Research

People cannot survive without water. People have been advocating the construc-

tion of water conservancy projects and seeking development for long time. During the "Thirteenth Five-Year Plan" period, the "most stringent water resources management system" has been used to manage water resources [1]. Water development has always been an essential part of China. In order to divert irrigation, prevent floods, make the river channel rigid, some people even forcefully transform the flow direction of rivers, so that the river cannot penetrate into the ground, with the result that the groundwater cannot be supplied in time. Therefore, the entire river and coastal ecosystem are destroyed, which seriously damages balance of biodiversity in regional environment.

1.2. Research Status Review about River Course Restoration at Home and Broad

The earliest research on river course restoration commenced in Europe. In 1938, Seifer [2], a German professor, proposed concept of "Natural River Management" to restore damaged river course to their natural state. In the 1950s, German experts [3] made great efforts to use ecological methods to restore river course, and introduced vegetation restoration methods to recover through its own restoring capabilities. From 1976 to 2000, the United States took a series of restoration measures for ecological restoration of the Kissimmee River. After restoration, Kissimmee River course restored its original natural state. This series of restoration strategies has also received people's attention. In addition, for some countries in Asia, Australia, and South Africa related work on river ecosystem restoration has also been conducted, which achieved good results. These successful cases are worth learning. In China, studies on river restoration are still relatively weak, which only stay at the exploratory stage. Great priority should be paid to successful cases in foreign countries. For example Zhao Jianfen [4] and so on through the sewage slow rate leachate land treatment system research indicated that the plant and the soil coupling action can quickly purify the water quality and is suitable for popularizing. Zhang Chaolanet *et al.* [5] have carried out indoor experiments on the construction of small aquatic ecosystems and proved that aquatic organisms can effectively remove different pollutants in water. Wang Yi-chao [6] and others selected nitrogen cycling bacteria from the Jinshui Bay of Taihu Lake that included native ammoniation, nitrification, nitrification and denitrifying bacteria, which were immobilized in porous carriers. This technique can effectively reduce the load of nutrient salt in the lake channel in autumn and winter, which is helpful to control the eutrophication of lake and water source, and has some reference value.

1.3. The Innovation of This Article

In this paper, through the qualitative and quantitative analysis of the Huangshui River in the Xining city of Duoba new town, combined with the analysis data of the GIS, the river ecological restoration theory is used to reduce the artificial intervention and repair means as far as possible to create a suitable environment

for the autonomous restoration of the nature and make the Huangshui River form a dynamic restoration system in the whole of the new area. In the process of evolution, the river's dynamic restoration is accomplished through the coordination of plants, water bodies and microorganisms.

2. Status of the Huangshui River in Duoba New District, Xining

2.1. Project Introduction

This project is located in Duoba New District on the west side of Xining City. the as capital of Qinghai Province, Xining City is the largest city on the Qinghai-Tibet Plateau. Xining City, known as the "traffic artery of Qinghai and Tibet" is a necessary road for the ancient "Silk Road" and "Old Tang and Taoist Road." It is also a major transportation artery and military center in the northwest. As a key support for the "Silk Road Economic Belt", the Duoba New District has a strategic importance for the development of Xining City.

2.2. Base Status

2.2.1. Climate and Precipitation Analysis

The location of the site is a plateau semi-arid climate with low average temperature, large temperature difference, high light intensity, strong ultraviolet radiation, dry climate, and large evaporation. The annual precipitation ranges from 360 - 400 mm (as show in **Figure 1**). The annual evaporation is 1729.12 mm. The maximum annual evaporation is 2095.8 mm, while the minimum annual evaporation is 1535.9 mm (as show in **Figure 2**).

2.2.2. Hydrological Analysis

The Huangshui River is a primary tributary of the upper reaches of the Yellow River, originating from the southern foothills of Osaka Mountain. The largest two tributaries, the Beichuan River and the Sinai River, have a total length of 335 kilometers and a total water collecting area of 16,120 square kilometers. The highest water level in the Huangshui River generally occurs from July to October, and the water level is the highest in August and September. The average water level is 2207.17 meters, while the highest historical water level is 2209.99 meters above sea level. The lowest water level is 2206.74 meters above sea level. Flood water level of a-30-year-return period is 2227.25 meters. The flood level of a-hundred-year-return period is 2215.49 meters. After analyzing a series of hydrological analysis of the Qinshui River by GIS, it is possible to clearly see the catchment of its rainwater and basin area. It is easy to see where the soil erosion has occurred in the base by the superposition of the slope of the catchment river (as shown in **Figure 3**, **Figure 4**).

2.2.3. Water Pollution

Natural water content of Huangshui River is high. If the water body encounters soil, minerals, rocks, soluble matter in the water dissolves in the water, resulting

in increased mineralization. In addition, Huangshui River is located in areas with frequent floods. The soil erosion at the upper reaches of mountain is more serious. The rivers have more silt and sediment. The sediment not only blocks rivers and reservoirs, affects benefits of water conservancy project, but also leads to inconvenience for industries such as industry, agriculture and animal husbandry.

In addition, artificial pollution of the Huangshui River is also very serious. Because most of upper reaches of the Huangshui River are farmland, water conservancy irrigation is more abundant, and the pollution caused by pesticides and fertilizers is mostly caused by the residue of pesticides and fertilizers that blend with water. Middle reaches of the city are the center of the city. The surrounding population is relatively dense, and there is only one sewage treatment plant. If the domestic sewage is not sufficiently treated, it will be discharged directly into muddy water, causing some pollution. Downstream is point source pollution. The industrial production layout is concentrated. The utilization rate of water resources in the river basin is high and the industrial wastewater discharge is serious.

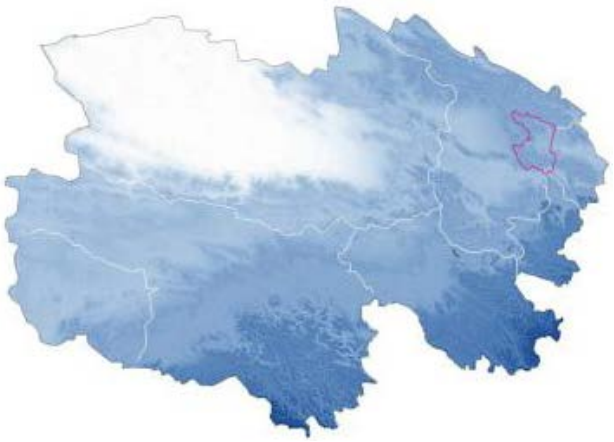

Figure 1. Precipitation distribution map of Xining City in 2015.

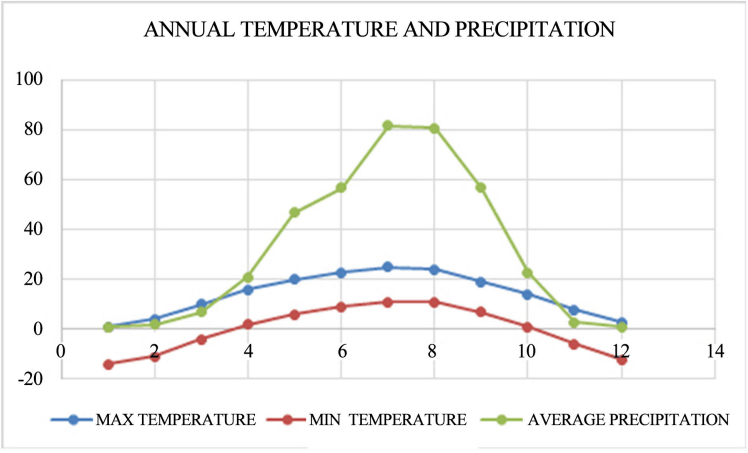

Figure 2. Temperature and precipitation Curve of Xining City in 2015.

Figure 3. Related hydrological analysis.

Figure 4. Huangshui river catchment area.

2.3. Existing Problems in Huangshui River

2.3.1. Destruction of Natural River Course and Hard Canalization

The development of upper reaches of rivers in the base is low, and the river still maintains original natural river course, but the river bank is a hard revetment of concrete. River courses in the middle reaches of the river are severely channe-

lized, and natural curved riverway changes the shape of rivers, which becomes a hardened straight riverway to promote the development of cities. Due to the lack of vegetation, the destruction of plant and animal habitats and the decrease of hydrophilicity, the river water cannot penetrate into the ground, the groundwater cannot be recharged, and the water supply in the new city of Toba is urgent.

2.3.2. Serious Shortage for Canalization of Rivers, Reserve Capacity of River's Natural Reserves

Some river courses in the middle reaches of the Huangshui River are channelized, and discharge capacity of the river itself is reduced. In addition, as greenhouse effect, global warming exacerbate, precipitation increases year by year, and excessive water in the city cannot be drained in time, causing widespread water logging.

2.3.3. Serious Water Pollution

The natural pollution source of the Huangshui River is attributed to high content of water salinity. When the water body encounters soil, minerals, rocks, etc., soluble matter dissolves in the water, causing increasing content of mineralization. As the largest tributary of the Yellow River, it has high sediment content and serious deposition. As a result, the riverbed has been rising year by year, and the water quality has become unclear, producing a certain influence on the ecological diversity of the Huangshui River. Human pollution is due to the fact that the industries on both sides of the Huangshui River are relatively densely distributed, and industrial waste water is discharged directly into muddy water without treatment. Serious pollution of the Huangshui River's water quality will be brought about together with domestic sewage in the city.

2.3.4. Less Hydrophilic

The provincial Highway 103 divides the urban area and rivers of the Duoba New District into two parts. The difference in elevation created by hard embankments made of concrete, mortar, masonry and bricks will make human activities isolate from the Huangshui River. It cannot satisfy people's needs for hydrophilicity.

3. The Practice of Ecological Restoration in the Huangshui River

3.1. Planning and Design Concept

Adhering to the concept of self-restoration of river course, it interferes with the self-restoration of rivers as little as possible, and only conducts some technical measures to create environment for restoration of the river itself. During the long-term erosion process of rivers, restoration system can be gradually improved to fully achieve ecological civilization concept of "respect nature, return to nature, conform to nature, protect nature" to meet the "landscape and water culture cycle development".

During the process of river management, according to the design, it calls for

the restoration of natural rivers and riverbanks, and abandonment of the original hard waterway to meet the rivers' infiltration and supplement of groundwater, so that the urban water demand can be effectively protected. This must consider whether the abandonment of the original hard revetment will affect urban regulation and discharge of floods. Therefore, for the design, it is necessary to consider restoration of the natural river revetment of the Huangshui River, and also satisfy the function of rivers to adjust and discharge floods. In this way, it is necessary to have a certain degree of safety and meet its functionality, and fully consider Binhe ecological effect.

3.2. Design Method

According to site mechanism and urban functions, the base is divided into three parts: the upstream natural farmland area, which has farmland experience and farmland sightseeing; the middle urban living area which mainly meets the needs of urban residents' hydrophilicity; the downstream wetland landscape area, which forms a beautiful wetland landscape in the downstream through the ecological restoration of the upper and middle reaches. For river rehabilitation, from upstream to downstream, it is divided into five different parts in order: dynamic river bend, scouring and river bend, dynamic river network, rainwater collection and treatment, establishment of artificial floating islands. River courses are restored by using different methods. It makes the Huangshui River form a beautiful wetland environment in the delta area where it meets with the Xinachuan River, providing beautiful habitats for its animals and plants, rich biodiversity. Through the function of wetland itself, the water body is purified, so that the Huangshui River flows down to Xining City, offering citizens with a clean and safe drinking water source.

3.2.1. Dynamic River Bend

The water form at the upper part of the base basically maintains its natural form, but the river bank is a hard cement river bank. During the design process, the original river channel is preserved, and a small amount of sediment is deposited on the river, which makes the river evolve dynamically. The river bend can be well developed to form a dynamic river bend. To break the original hard cement river bank, surface of the river bank is panned and replaced with planting soil. Soil bio-engineering technology is used to reinforce outer river bank so that it will gradually return to the natural barge bank (as show in **Figure 5**).

3.2.2. Scouring and River Bend

Bioengineering technology is used to strengthen revetment of the river bed. Flowing through the dynamic river bend, the river then flows into the smaller river bend. Because the river bend is small, the flow velocity reduces. Due to long-term scouring deposition, covering layer at the river bank changes soil. Plants planted on the river bank spontaneously colonize where the water flow is impacted, thus effectively alleviating the flushing of river bank by the flood (as show in **Figure 6**).

3.2.3. Dynamic River Network

For canalized river part, we must first restore river's natural channels, and connect them to form a diamond grid by using intricate channels of farmland irrigation channels, which provides new flow options for rivers. During long-term scouring and flowing, sediment is deposited in a diamond grid and gradually forms oasis where green plants can be planted. Growing plants has a good effect on sediment settlement, river flow rate reduction, mudslide reduction and other natural disasters and moral damage (as show in **Figure 7**).

3.2.4. Rainwater Collection and Treatment

With existence of global warming, it has been frequent occurrence of urban water inundation. People are paying more and more attention to the collection and treatment of rainwater. Byanalyzing GIS catchments, a rainwater garden is designed in areas where river water is part of the middle reaches of rivers, and micro-environmental treatment is conducted on rainwater and the domestic sewage of residents. Treated rainwater and sewage are discharged into the river again. The design of Rainwater Garden not only helps to reduce the heat island effect in the city, ease the urban hustle and bustle, form the ecological diversity of cities' environment, sequester carbon and clean the air, but also provides the public with a place to visit. It can also serve as an education demonstration base (as show in **Figure 8**).

3.2.5. Artificial Floating Island Establishment

For the latter part of the middle reaches of the river, its drainage area is open [7]. Artificial floating islands are set up on the river water to form artificial wetlands. On the one hand, plant roots with a large surface area can be utilized to form a dense net in water, and adsorb a large amount of nutrients in the water body. As a result, it becomes nutrients for plants, which then become food for fish and shrimp in water through the growth of plants. Plants on floating islands at the same time can supply habitation for birds. Roots of the lower plants form a habitat for fish and aquatic insects, making it a recyclable ecosystem. On the other hand, floating islands can effectively prevent occurrence of "blooms" and sunlight from shining onto large areas. The result is that algae in the water cannot grow, and phytoplanktons settle by effects of touching and sedimentation, so as to achieve the purpose of improving the water quality and transparency of the river. It is replaced by a blue river (as show in **Figure 9**).

3.2.6. Meandering Natural Wetlands

After a series of treatment and deceleration, the Huangishui River finally forms a natural wetland in the downstream delta of the Xinachuan tributary, where existing vegetation can grow naturally, ecosystem of the river is restored, which forms a beautiful habitat for animals and plants. Wetlands not only provide citizens with natural recreational oxygen bars, recreational parks and popular science bases, but also ensure flexible development of species in wetlands. They increase biodiversity, and maintain the sustainable development of species. Riv-

ers that pass through the clean system flow down the river, then and flow into the city of Xining, providing relatively clean drinking water for residents in Xining City. In the same way, the river banks still use replacement planting soils. River banks are built upby means of bioengineering technology to meet flood discharge function of rivers (as show in Figure 10).

Figure 5. Dynamic river bend.

Figure 6. Scouring and river bend.

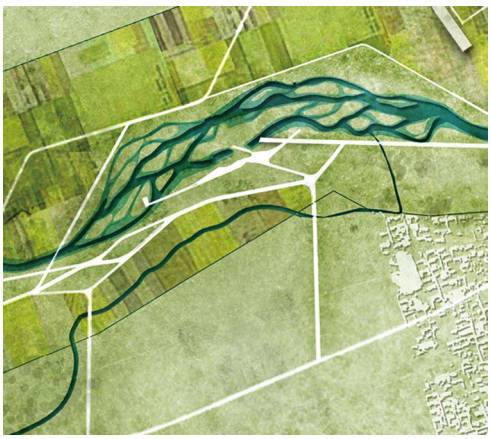

Figure 7. Dynamic river network.

Figure 8. Rainwater collection and treatment.

Figure 9. Artificial floating island establishment.

Figure 10. Meandering natural wetlands.

4. Conclusion

As people's living standards continue to improve, people have higher and higher demands for quality of life. People are giving high priority to restoration of river courses. The design for riverfront landscape is also taken into deep consideration. It is necessary not only to eliminate harsh environment of the river, but al-

so hope that ecological restoration of the riverfront landscape has also become the city spirit card for urban environmental construction. A comprehensive and complete set of river restoration methods has been formulated, which not only satisfies the essential function of rivers, but also integrates rivers and landscapes perfectly. Under this condition, the city will enjoy a beautiful and open leisure space to meet people's needs and enhance people's living quality. Therefore, people will make more contribution to development of the city.

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Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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