Title

Wei River Dynamic Regeneration: A Resilient and Synergic Approach

Project Brief Statement

The Yellow River is the 2nd largest river of China, but the “mother river” has been suffering from enormous environmental pressure in recent years, because of human activities. Continuous threats from flooding, rapid ecological degradation, water pollution, water shortage and social development inequality are just some of the major issues that need to be addressed urgently.

This project serves as an key example for an integrated Green Infrastructure (GI) design, which takes full consideration of the balance between development and preservation. The design showcases the application of a Nature-Based Solution (NBS) on watershed eco-management for Wei River, the biggest tributary of Yellow River. The new landscape has employed a resilient solution that simultaneously controls river floods, purifies stormwater, restores local aquatic environment and assists natural floodplain recovery. Importantly, it has also delivered a effective model based on the cost-benefit assessment that brought back a taste of rural lifestyle and natural experiences for the locals, who has seen the improvements of their living environment in both social identity and economic value.

Table of contents

Project Narrative

1.0 Background: the mother river under pressure

Wei River is the biggest tributary of the Yellow River, both by the size of catchment and the rate of flow. It is also the “mother river” of both Xi’an and Xianyang City, two of the biggest and most important cities within the Yellow River region. But as the urbanization progress of these two cities, the once natural riparian areas of Wei River have gradually been replaced by concrete banks and decorative greenery planting. The constant degradation of the wild riverside landscape has also contributed to the loss of the sense of belonging, for the people who have lived in this rural area for generations. The comprehensive restoration of Wei River forms a key part of the Yellow River Action Plan, which focuses on the sustainable management of its watershed.

The brief of our project was to restore **landscape resilience** to a section of Wei River’s floodplain outside of Xianyang City. The site was one of the few naturally flooded river sections that remained. It is approximately 3200m long and 470m wide, with a total area of 125ha.

Image 01: site location, existing conditions upstream and downstream

2.0 Issues: water pollution, ecological degradation and the gradual loss of rural landscape

The project site had several major issues: The once natural floodplain of the Wei River immediate upstream had been replaced by engineered concrete banks, which put more flood pressure on the site. The adjacent area downstream had also been urbanized but with decorative planting, causing a major loss of local habitat and biodiversity. There were several roughly dug ditches across the site carrying stormwater run-off (and sometimes leaked sewage) from the city to the river, which has polluted not only the river itself but also the riparian aquatic environment (local sampling showed riparian water quality worse than Class V of the National Surface Water Standards). Finally, local residents had reclaimed a large area of the site for lotus ponds and vegetable farming, which showed a demand for the lost rural lifestyle.

Image 02: site before – existing earth dyke, deserted floodplain, stormwater ditch and reclaimed vegetable farms

3.0 Overall Strategy: Creating A Resilient and Synergic Approach based on NBS

To solve the issues described above, the comprehensive restoration and reconstruction of the local floodplain ecosystem was set as the main goal for the project. A plan was developed to create urban Green Infrastructure through a series of strategies including adaptive flood control, stormwater management, water quality improvement, waste water reuse and biodiversity restoration, which would transform the site into an urban park that provides multiple values on environment and people.

Image 03: overall strategy

Image 04: the master plan

Image 05: bird-eye view impression

Image 06: the result – a reconstructed natural floodplain wetland park

3.1 Creating resilient, flood adaptive landscape

Frequent urban flooding due to climate change has become a global issue in recent years and Wei River has also suffered from increasing pressure from flooding, which is the project's priority. In order to restore the resilience of flood retention and utilize the floodplain spaces, an adaptive landscape was created based on the existing topography: the lowest areas were designed to be floodable natural wetlands, areas of lower flood risk were used for constructed wetlands and the highest areas on site were designated for recreational and leisure spaces.

Bioengineering techniques were used on all flood control banks inside the park except

the existing outer bank along the northern boundary (built for one in a hundred year flood event). Techniques such as willow mattress revetment, riprap, gabions, and grassed slope were used for flood protection, biodiversity restoration and habitat protection.

Image 07: grassed banks for one in five-year flood protection

Image 08: riprap banks for one in twenty-year flood protection

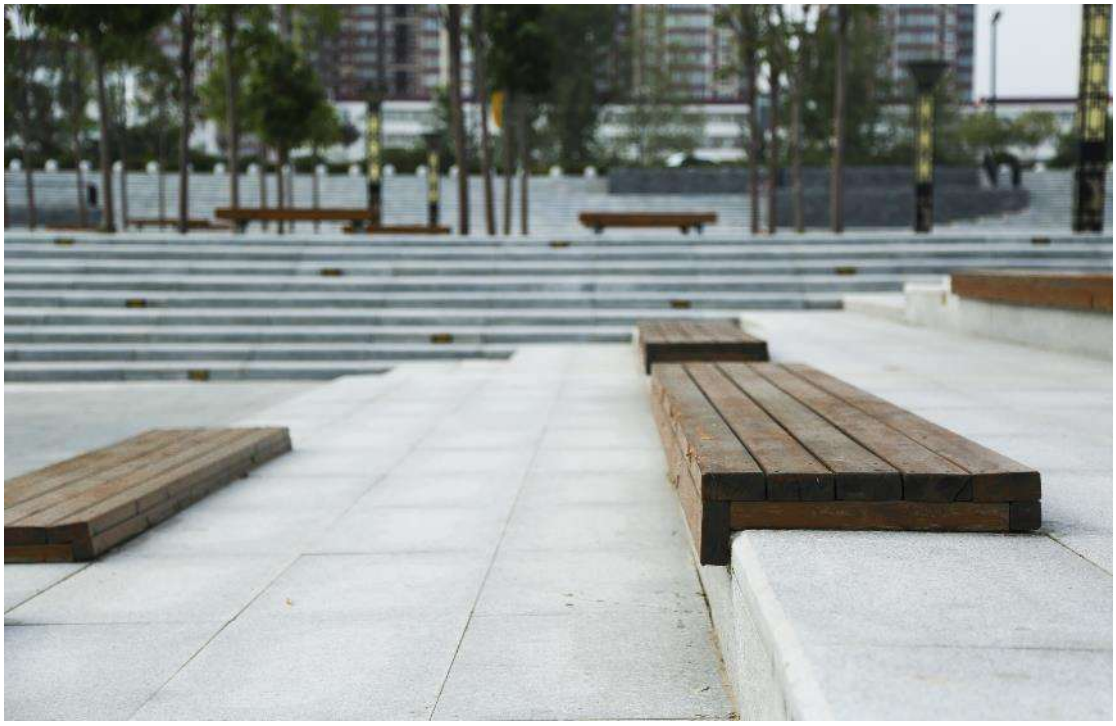

Image 09: the outside bank and associated level change was utilized to create tiered gathering and leisure spaces

3.2 Purifying waste water for reuse

In order to remove water pollutants and reuse waste water at the same time, a buffer belt of constructed wetlands was created between the city and the river. All polluted water from the drainage channels that ran through the site was firstly collected into WWTP. The constructed wetlands were designed for treating outlet water from a WWTP, and producing recycle water that meet Class III-IV standards using for landscape irrigation, the aquatic playground and finally directed to replenish the natural floodplain wetlands.

The design of the constructed wetlands was based on the post-treatment water quality targets of Class IV standards and used subsurface wetlands primarily with supplementary surface wetlands. Oxidation lagoons were also added to the process for flood buffering, reoxygenation and water distribution.

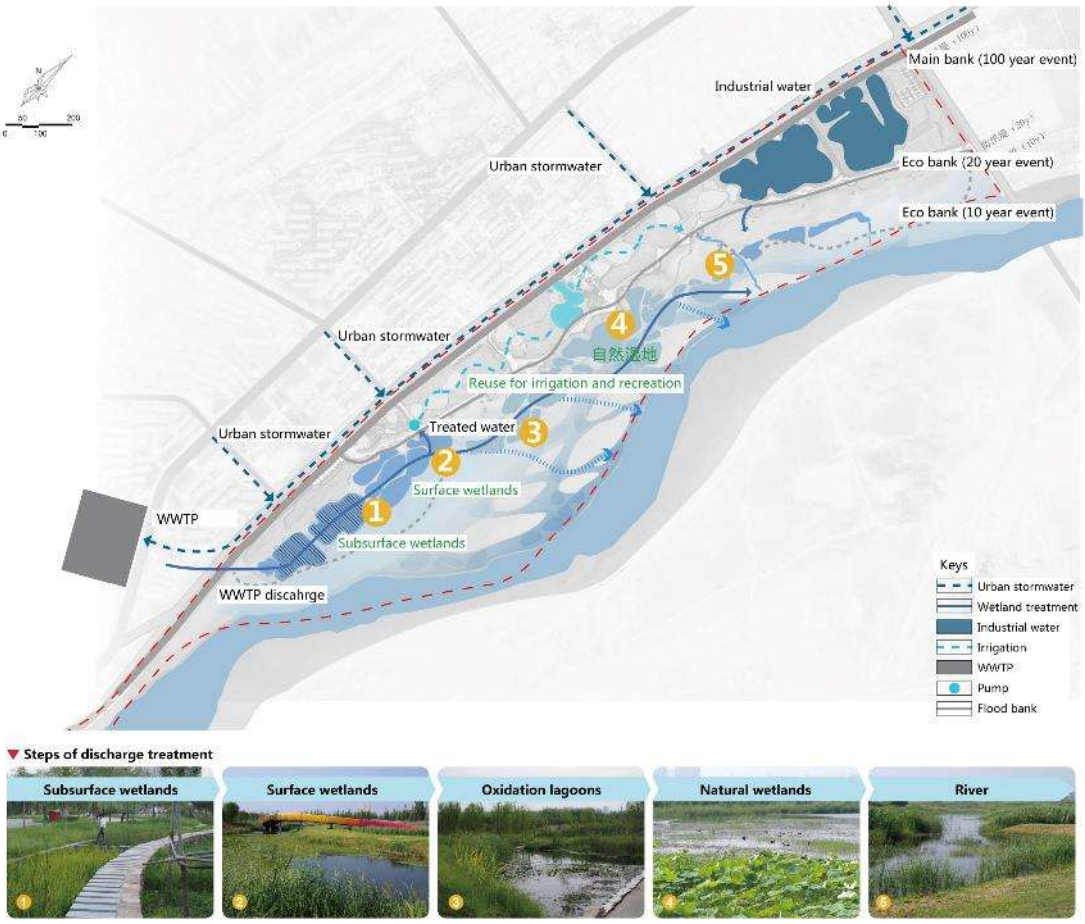

Image 10: a comprehensive water management plan

Image 11: constructed wetlands also provide opportunities for environmental education and experiences.

3.3 Assisting natural recovery process

The key for a successful habitat restoration is utilizing nature's own regenerative power. After removing most of on-going human disturbances such as rubbish dumping and sand dredging, the project set its goal on recreating a diverse local habitat. Using existing trees and wild reed ponds as a foundation, the design applied minor earth shaping and careful replanting of local trees, shrubs and aquatic plants to restore shelters and habitats for aquatic life, amphibians and birds.

Image 12: the power of nature's own ability to recover

Image 13: recreating natural riparian wetlands by minor earth shaping

Image 14: return of local birds after habitat reconstruction

3.4 Returning of rural lifestyle and natural experiences

In order to satisfy local demands for rural and natural activities, leisure areas such as

civil squares, aquatic playgrounds, urban farms and rustic fitness zones were included in the park with a touch of local cultural elements. Using water as the main theme, the design gave nearby residents and park visitors plenty of opportunities to return and experience the restored floodplain area.

Image 15: children were having fun in the aquatic playground

Image 16: wetlands were the best places for exploring nature

Image 17: many visitors were attracted by the wetlands everyday

Image 18: small dams re-oxygenates water for the wetland and at the same time became a play feature

Image 19: there were larger spaces designed for gathering and resting within the park

3.5 Reusing the original dyke for green corridor

The main spine of the park was a green corridor that moved through the center of the park. It was built upon an existing earth dyke flanked by willow trees. The trees were all retained and quickly became a unique scenic feature of the new park.

Image 20: change existing earth dyke into the central green corridor

Image 21: retained existing trees flanking the central corridor make a unique scenic feature of the new park

3.6 Regenerating artistic and interactive experience in nature

One of the artistic elements was expressed through two colorful bridges in the wetland area. The two intertwining structures raised and lowered through the landscape, forming boardwalks, bridges and viewing platforms, which symbolized the integration of water and the local culture.

Image 22: colorful landscape bridges at night

Image 23: intertwining bridges symbolizes the integration of water and local culture

Image 24: design details of the bridge and boardwalk

3.7 Re-evaluating the cost-benefit of sustainable landscape

Social and economic benefits were carefully considered at the very beginning of the

project, which aimed at maximizing the project's benefits while keeping the construction and maintenance costs down. After the completion of the project, a thorough evaluation process was carried out in conjunction of Beking University, in order to determine the environmental and social performances of the park and provide valuable experiences for similar projects in the future.

One year after the its completion, water quality monitoring spots across the park all reported results better than the Class III-IV standards. Comparing to water sample took from the original stormwater ditches on site before the construction of the park. The levels of COD, NH^3-N, TP and TN in the water had shown a reduction of 89.6%, 98.4%, 96.6% and 79.5 respectively while the total quantity of water reused after treatment reached $2.4x10^6m^3$ per annum.

Cost-benefit study showed the average construction cost for the park was RMB80 per m^2, which was less than one third of similar local parks in Xianyang. As regarding the environmental benefits of the project, in addition to the improvements in water quality mentioned above, the average scores for different areas of the park on the Shannon-Widener Index (measuring local biodiversity) were improved to 1.57-1.91 for herbaceous plant community and 2.11-2.33 for trees community. The social benefits of the park were reflected in the results of a public survey: out of the 462 valid questionnaires received, the overall satisfaction rate for the new park was 94%, in which the satisfaction rates for comfort, experiences of nature, children's recreation and leisure activities for the elderlies were 90%, 86%, 77% and 80% respectively. Lastly, nearby residents reported an increase in real-estate values of the adjacent areas after the park's completion, though actual economic benefits of the park were less measurable at this stage.

Image 25: summary of key findings from the evaluation

4.0 Conclusion

Integrated Green Infrastructure is a systematic approach for providing comprehensive eco-services with multiple benefits. Combined with a natural-based solution as a major tool, our project integrated adaptive flood management, constructed wetland and habitat restoration techniques within the same space, making a floodable natural zone, a stormwater management wetland and an urban park all into one resilient floodplain. It showcases a **cost-effective** solution for environmental protection and habitat restoration on the background of sustainable rural-urban development process, and more importantly, paved the way to **an innovative and resilient strategy** for the eco-management of Wei River and the Yellow River.