

Ecological Infrastructure and Nature-based Solutions

KONGJIAN YU

**Peking University College of Architecture and Landscape
&
Turenscape**

Challenges:

Climate Change +

Over 80% of the Chinese cities suffer air pollution



Flood: annual flood damage cost 100 billion US \$



Draught: 400 of 662 cities in shortage of water



Pollution: 75% of the nation's surface, 64% of underground water



Habitat loss: 50% wetland disappeared in 50 years

Rich wisdom in dealing with the changing environment

are in the stock in those cultures that survived the vagarious nature over thousands of years in general, and the aqua-culture evolved under the monsoon climate in particular.

But such wisdom are **usually buried under layers of modern industrial technology or ignored.**

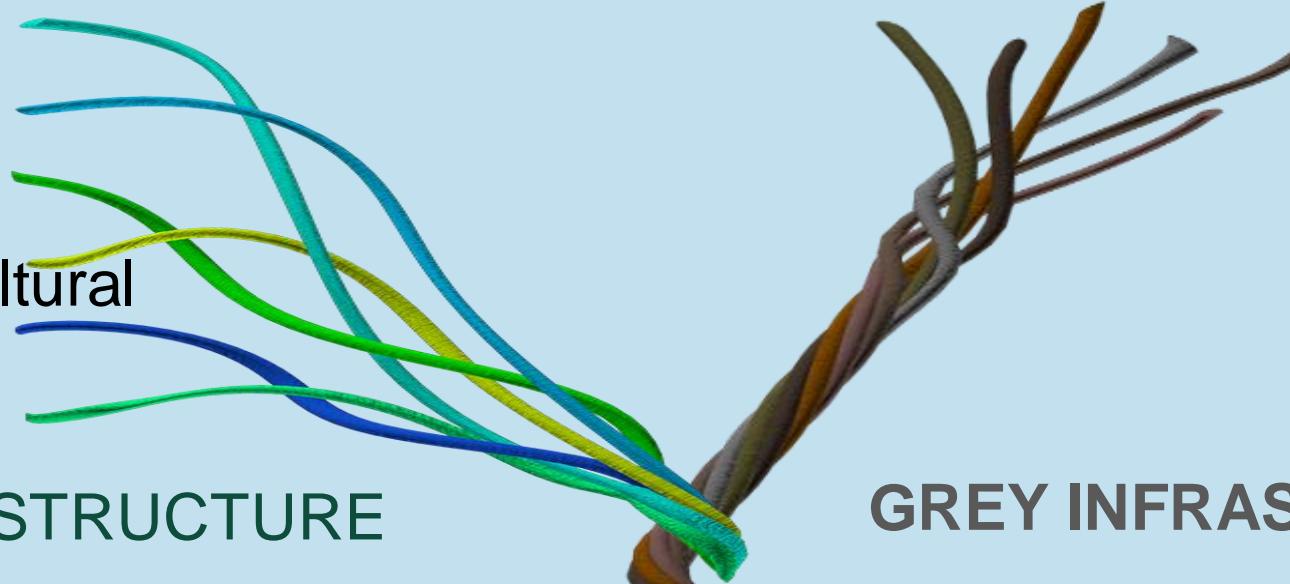
Yet the single-goal minded grey infrastructure built with industrial technology simply lacks resiliency and, in many cases, not sustainable!



The alternative solutions:

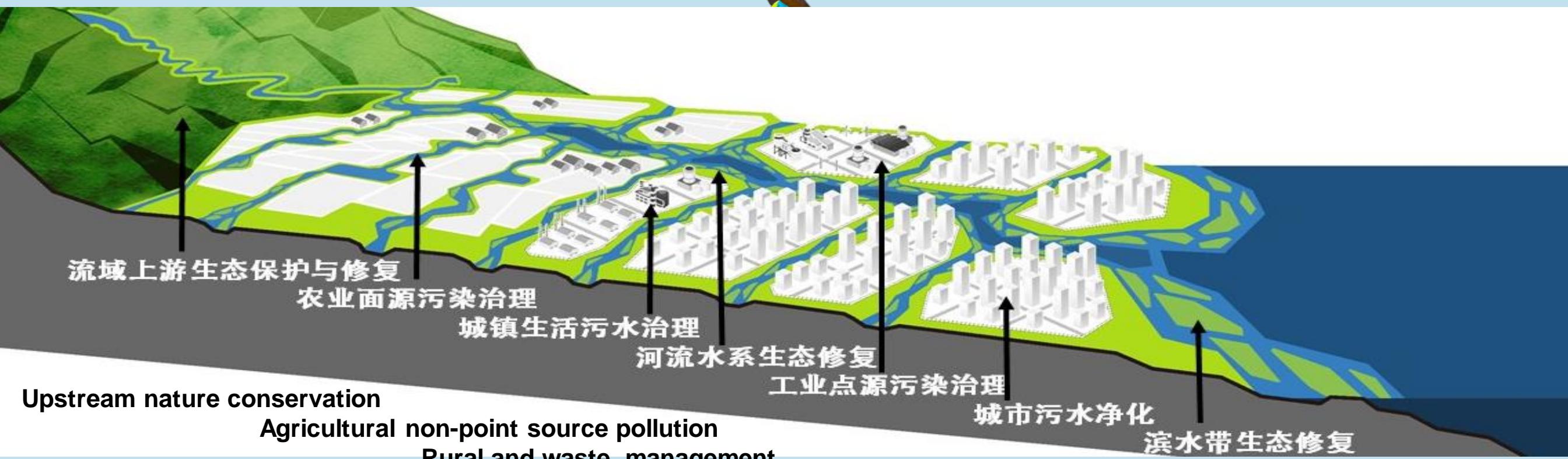
After so much suffering, it is time now to revive the ancient wisdom to develop the nature-based and holist solutions: ecological infrastructure (green infrastructure) that are critical for securing ecosystems services

Provision
Regulation
Life supporting
Spiritual and cultural
services



GREEN INFRASTRUCTURE

GREY INFRASTRUCTURE



Upstream nature conservation

Agricultural non-point source pollution

Rural and waste management

River system restoration

Industrial pollution treatment

Urban sewage treatment

Costal area restoration

Two levels of action

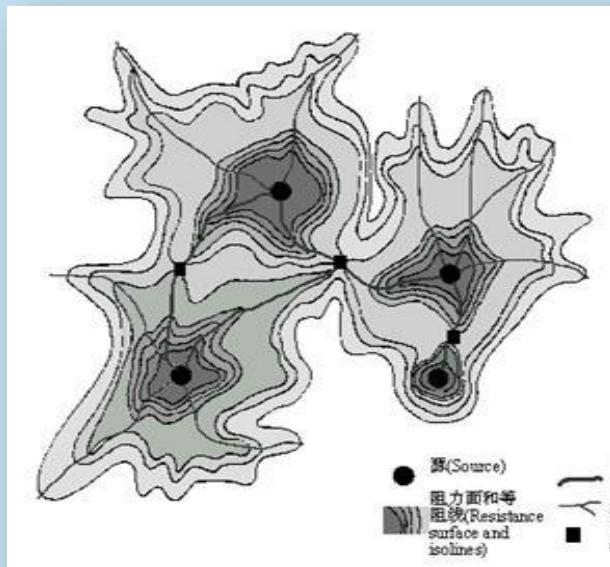
- 1. Planning Ecological Infrastructure across scales**
- 2. Design and engineering to create ecological infrastructure**

Action Elevel-1 Planning green infrastructure across scales

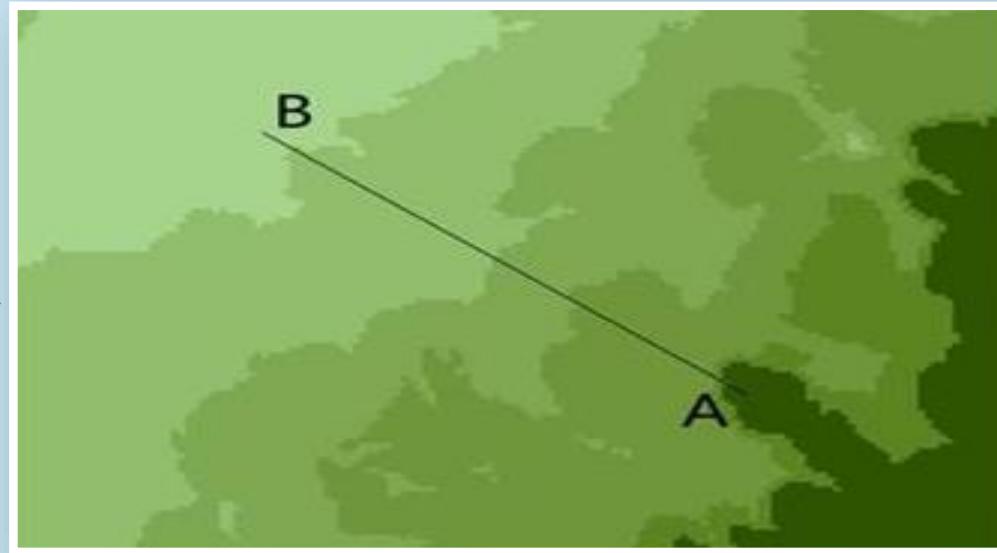
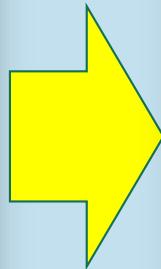


Methodology

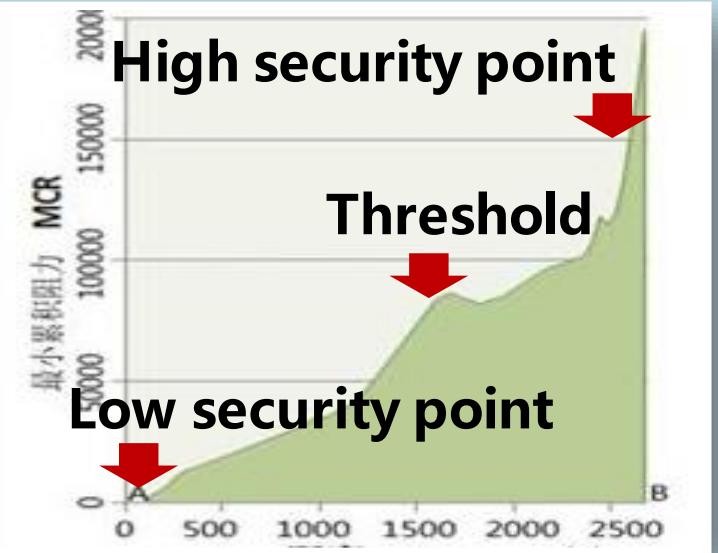
Identifying the ecological security patterns based on the spatial analysis and modeling of the ecological processes



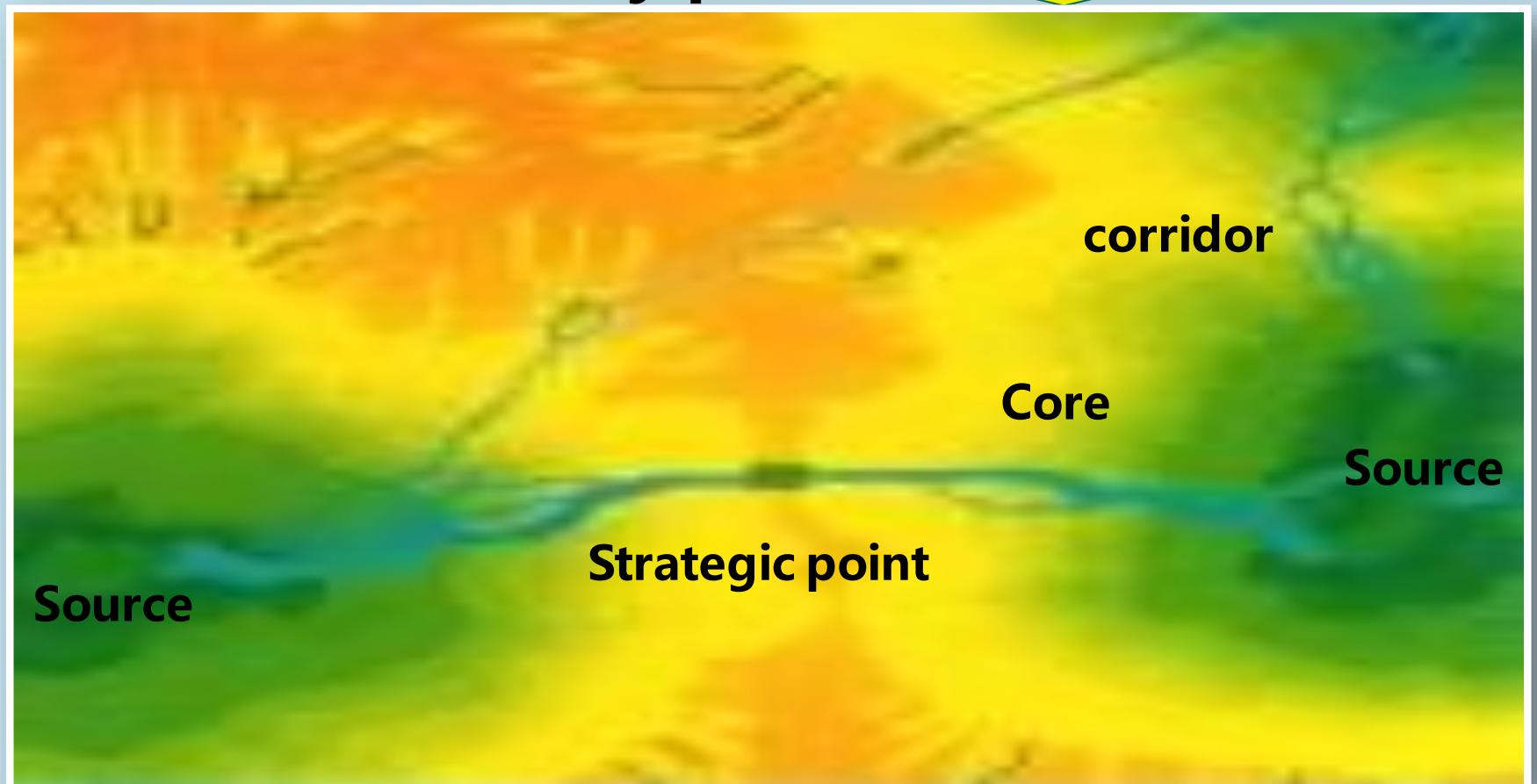
Potential surface



Security point



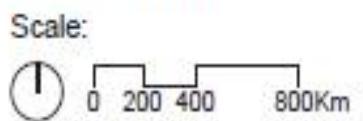
Security pattern



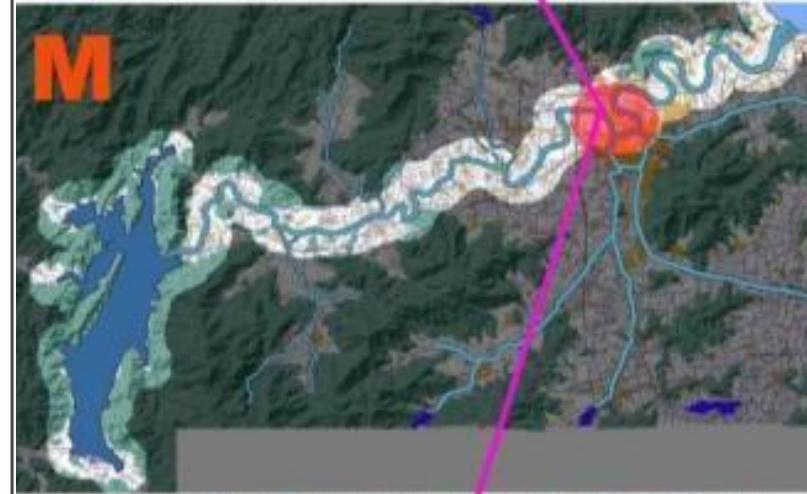
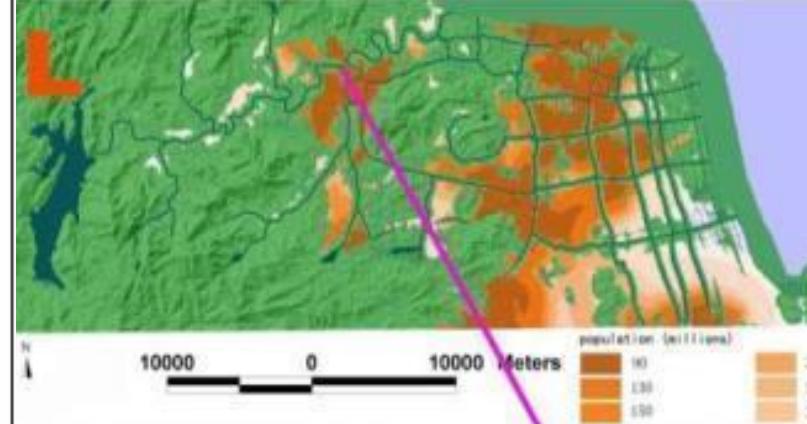


National Integrated Ecological Security Pattern

- ★ National Capital
- ⊙ Provincial Capital
- Provincial Boundary
- Ideal SP
- Satisfied SP
- Minimum



Projection System:
Krasovsky_1940_Albers



Action Level-2 Design and engineering:

Create nature-based engineering models inspired by ancient wisdom

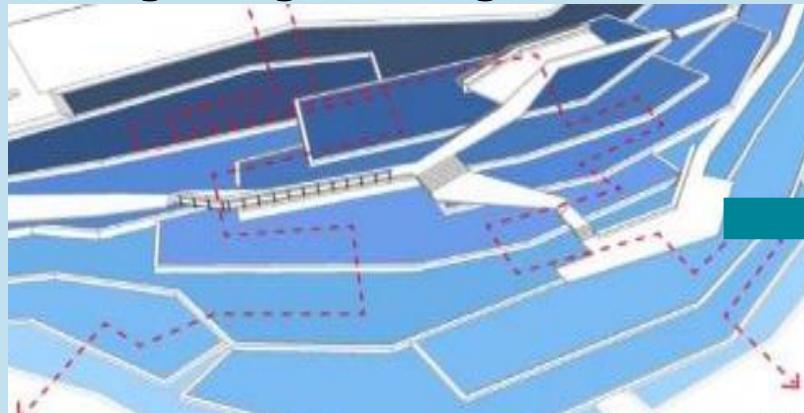
Methodology

Inspired by the ancient farming wisdom, replicable module have been developed to solve the climate change+ problems at a massive scale in an inexpensive way.

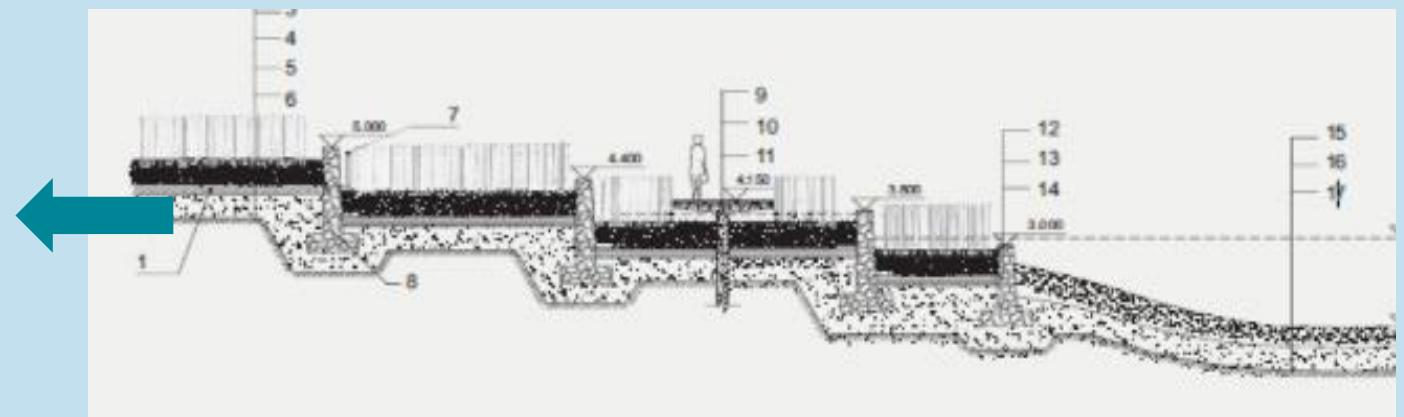
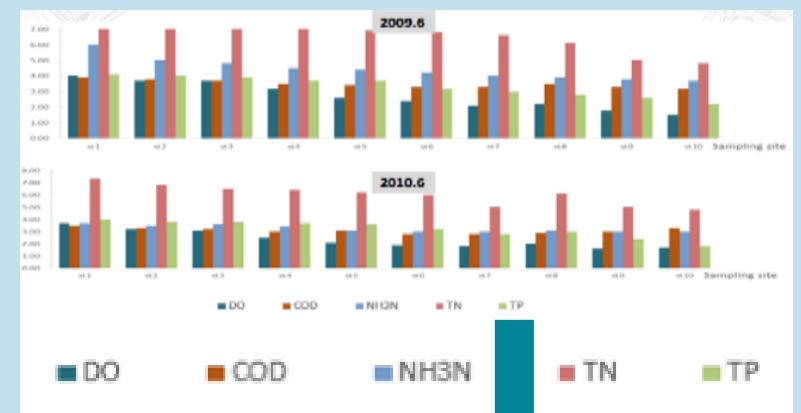
Traditional wisdom



Design engineering module



Post operational test



Modern ecological engineering

Replicable modules

For over 20 years, we have tested and built over 500 projects in 200 plus cities and showcased numerous replicable models for healing and transforming our land at various scales



• #1 Make friends with Floods

• Turn grey infrastructure into green

- 100\$ billion lost, 10 million people affected each year.
- All Rivers in China are dammed and channelized with concrete flood walls, what is the alternative?

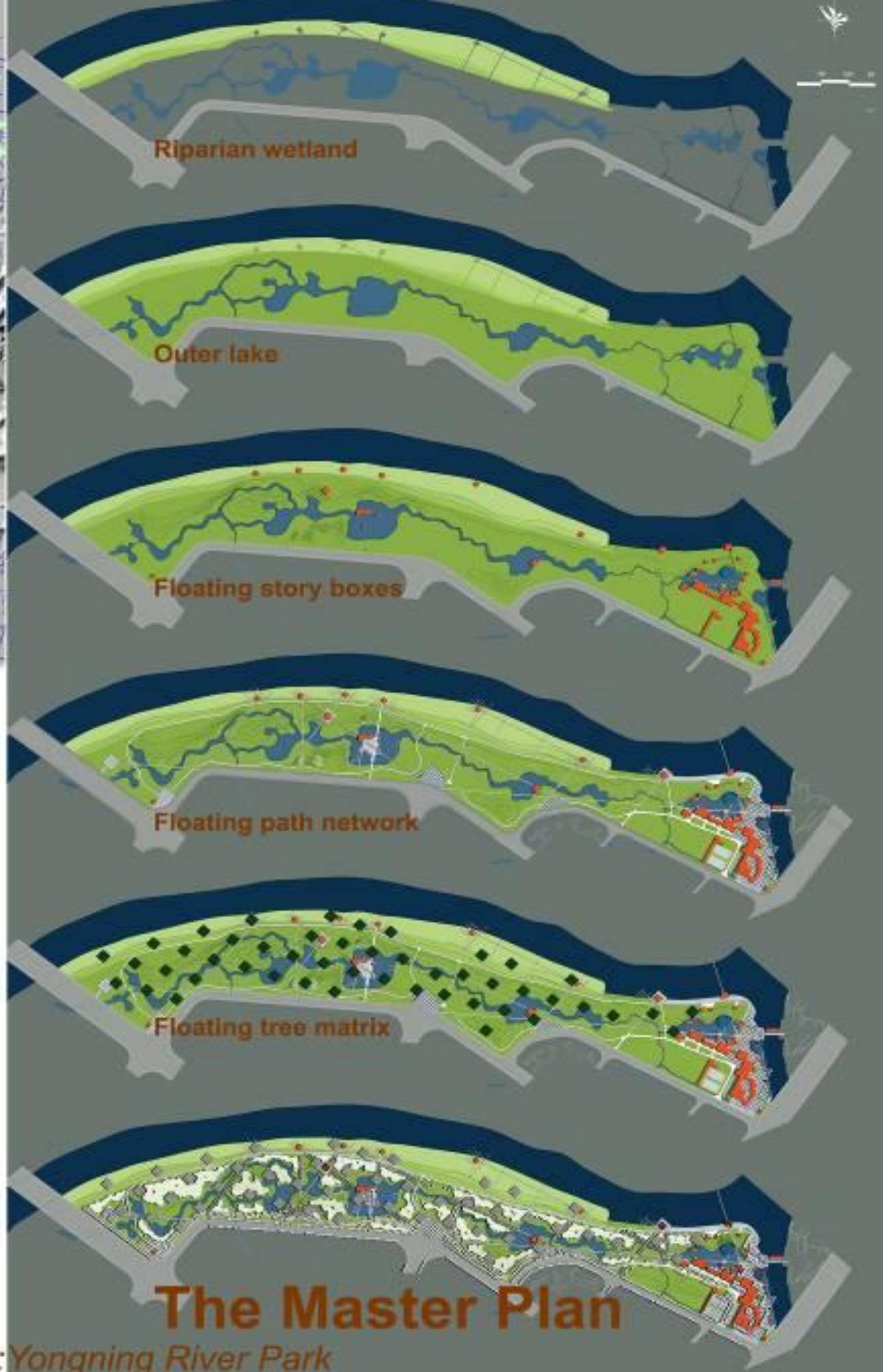
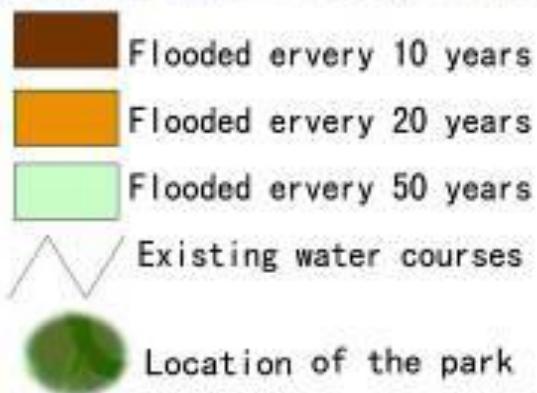
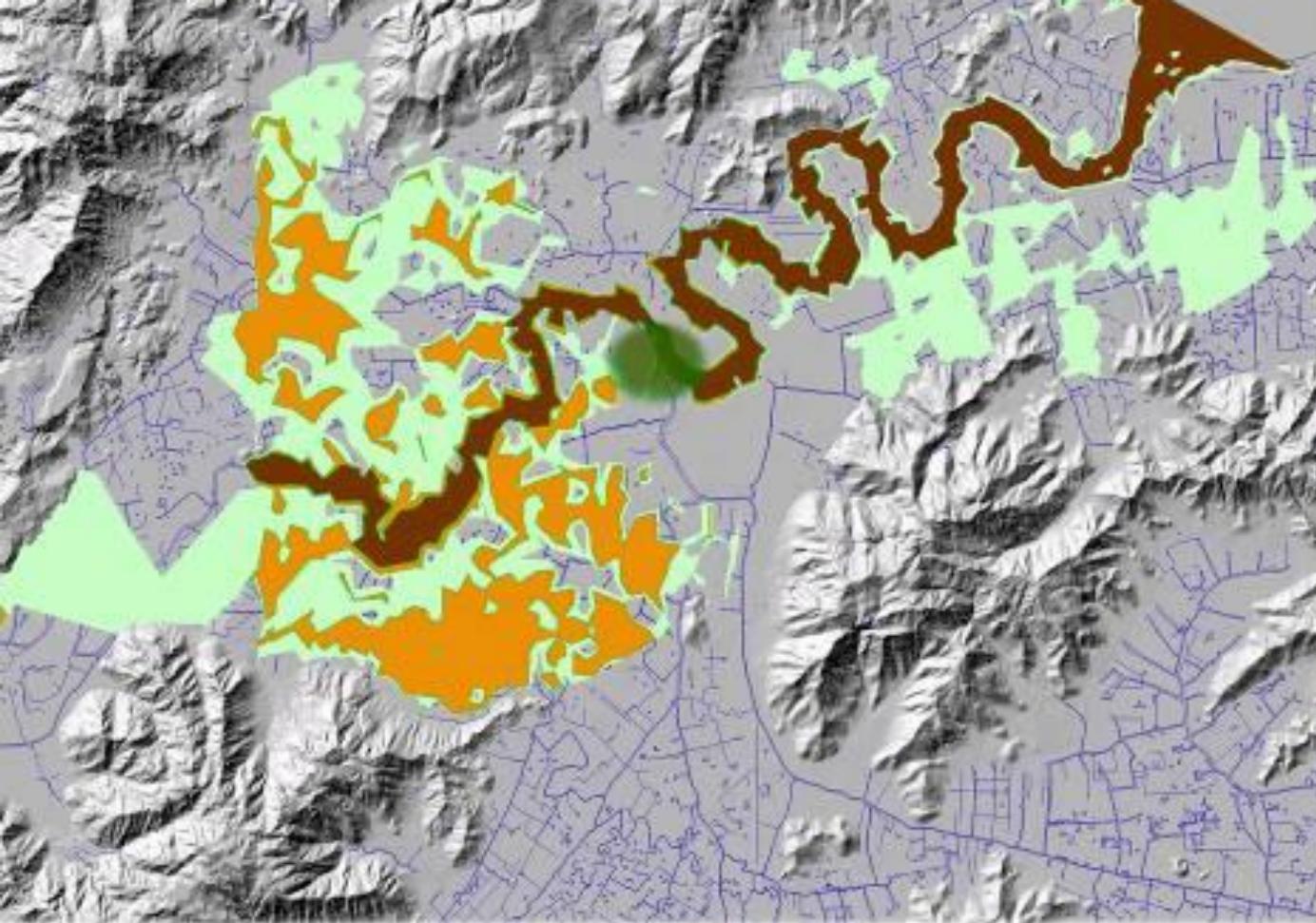
Number of dams (height > 15m)

World total: 49,697

China: 25,800

USA: 8,724





The ecological approach for storm water management was proposed by the landscape architect as an alternative to the commonly used concrete embankment and channelization. This proposal was finally been accepted. As a result, the former engineering approach was stopped, and the concrete lined river was to be ecologically recovered. The Yongning River Park was, therefore, set up an example for ecological recovering of the whole river.

Flood Analysis

The Master Plan

The Floating Gardens: Yongning River Park

Designed experiment: Yongning Park, Zhejiang, China, 2003

This project demonstrates an ecological approach to flood control and storm water management, while also educating people about alternative solutions to flood control beyond engineering.





Designed experiment: Yanweizhou, Jinhua, Zhejiang Province





20 Year Flood



Dry season



An aerial view of the park during the dry season, note the lush tall grasses covering the terraces on the embankment. The terraces are enriched by silt deposited during the flood season (view is toward the west, photo: September, 2016)

Performance test:

Such kind of ecological embankment can reduce peak flow at more than half of the flow at the basin's outlet. The maximum daily peak reduction rate can reach **53%-63%**.

How much can be changed if nature based solution is to be implemented nation wide

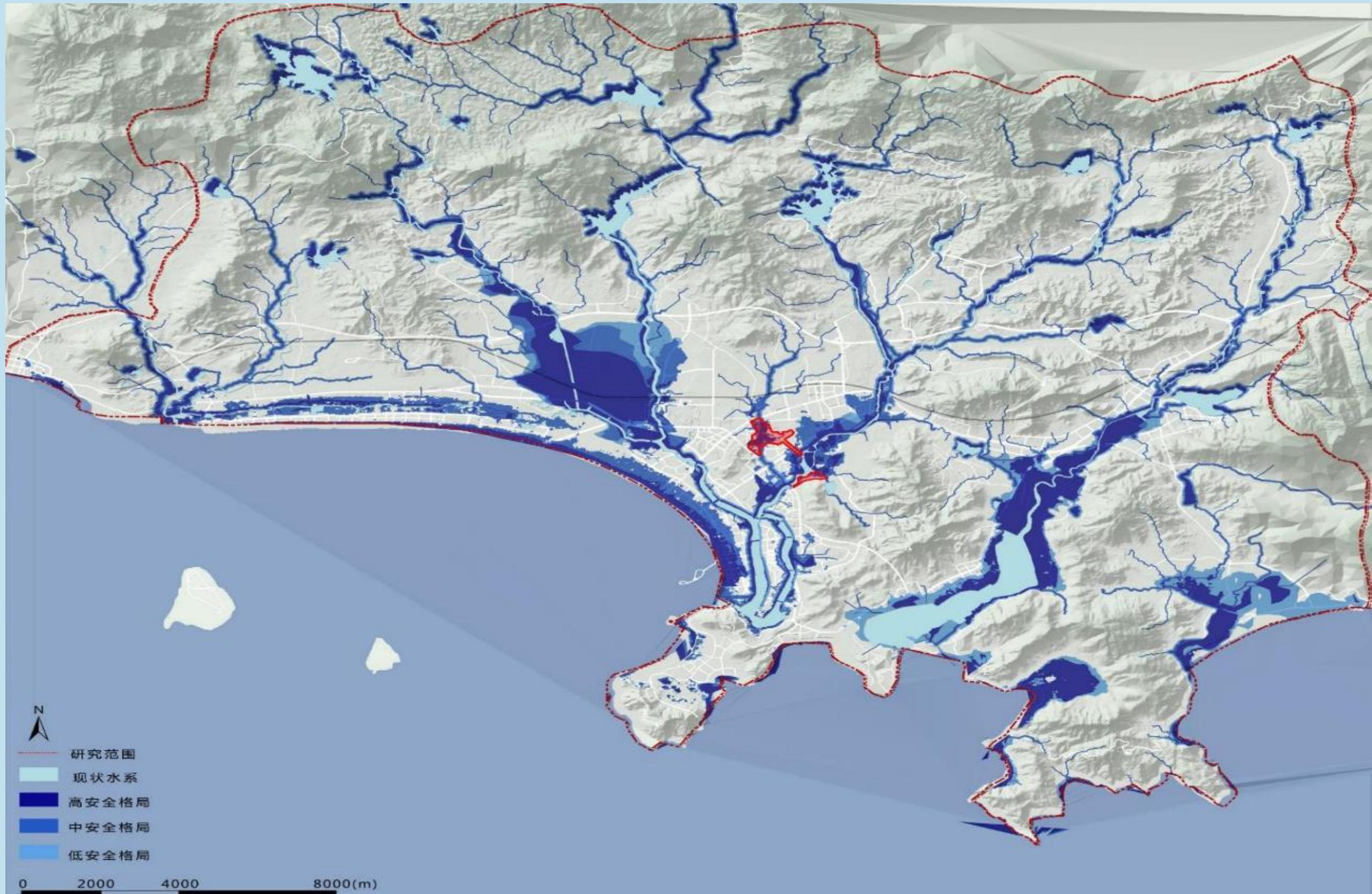


#2 Green Sponge for water resilient City

Sanya, Hainan Island, The First Official Demonstrative project of Sponge City and Ecological Restoration Movement in China



Action level 1 Planning a green sponge system



**Action level 2
Creating Green
Sponge :**

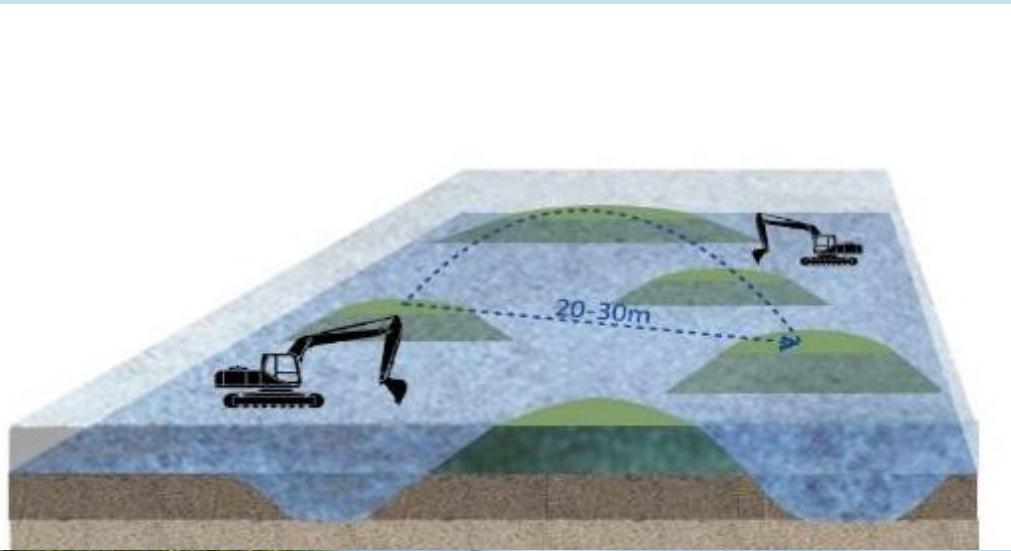


Dong An Wetland

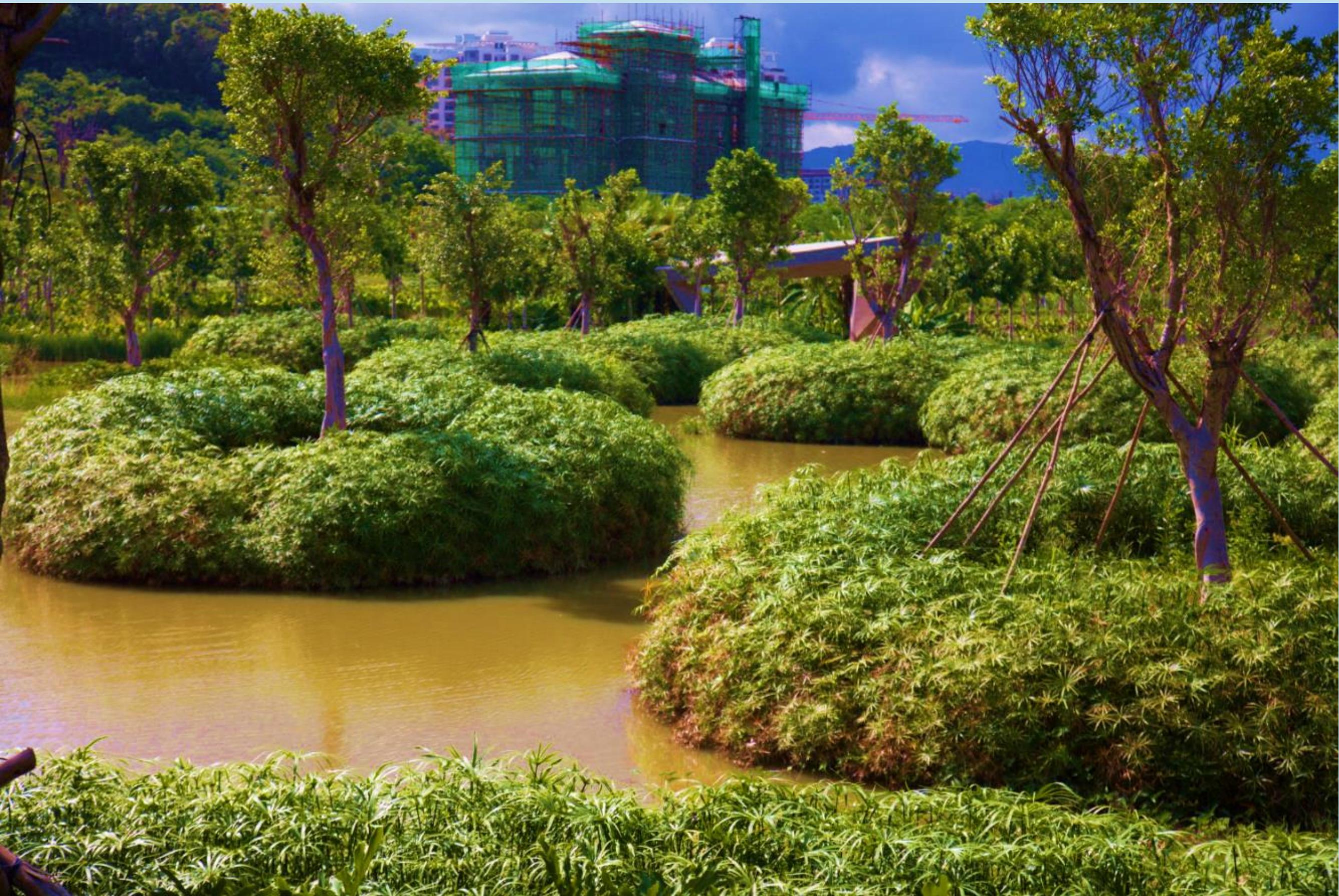
The revival of ancient wisdom: The pond and dyke system



Isles and forest above water to create habitat and public space

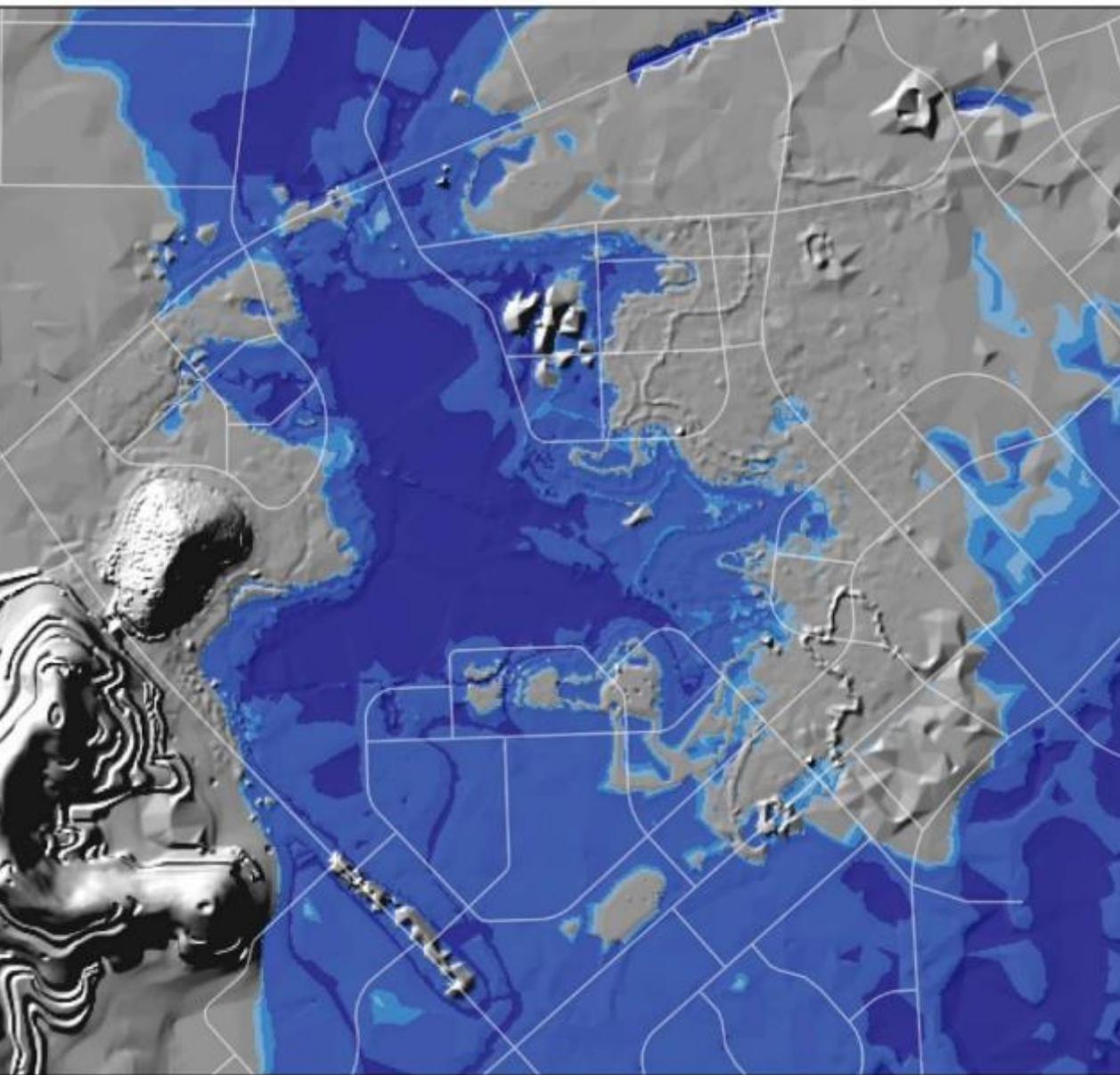




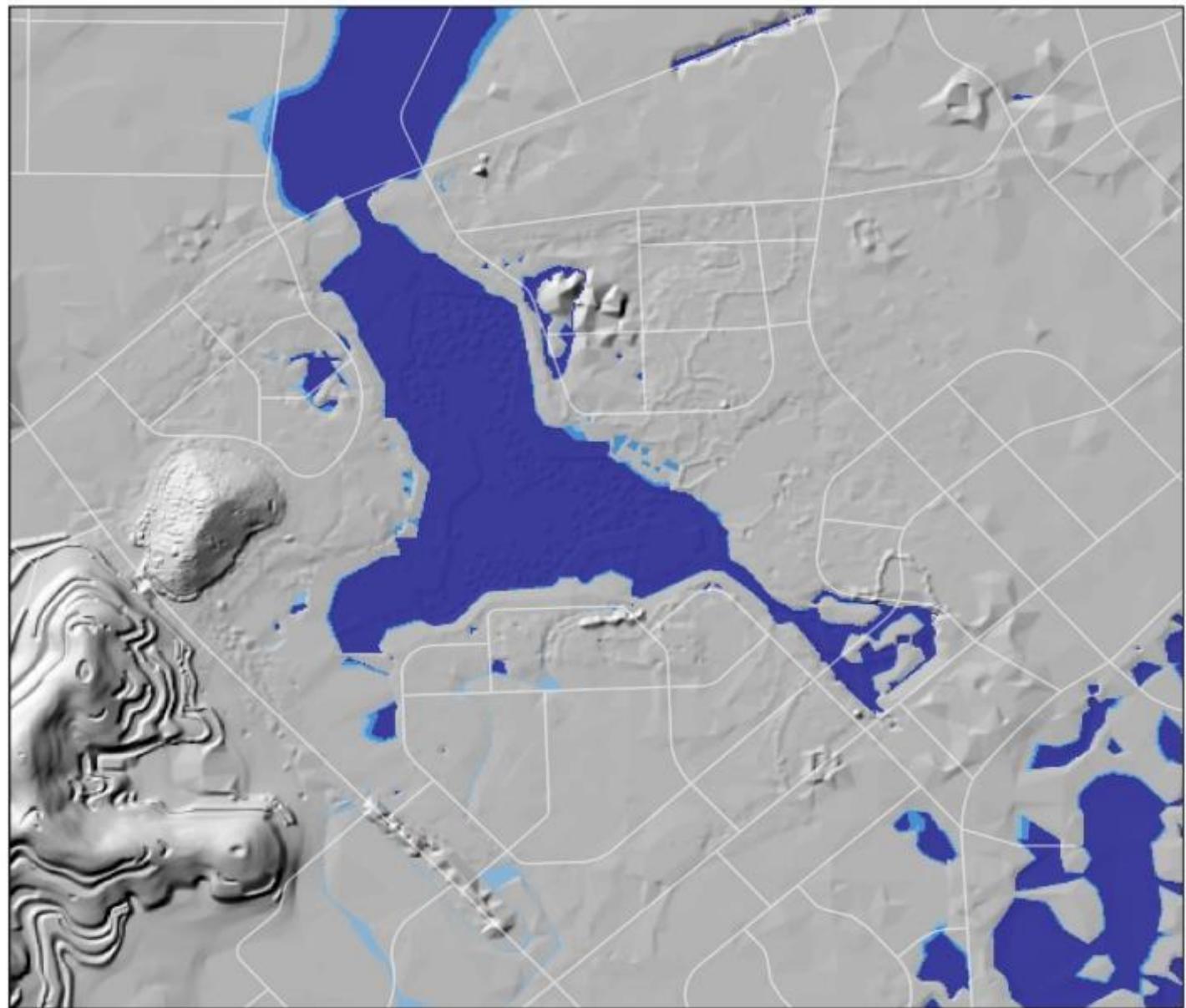




Performance test



BEFORE



AFTER

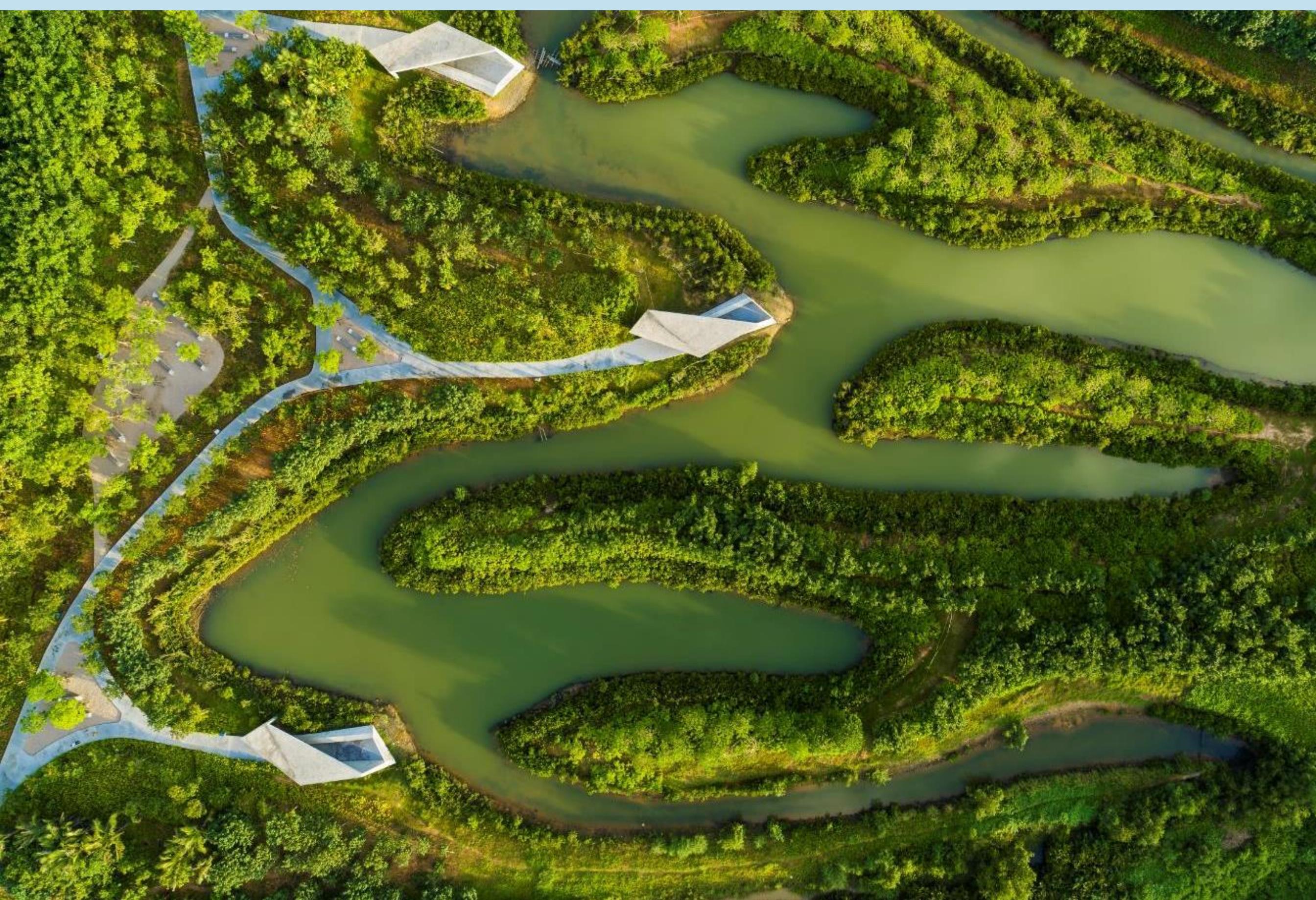
Sanya Mangrove Restoration



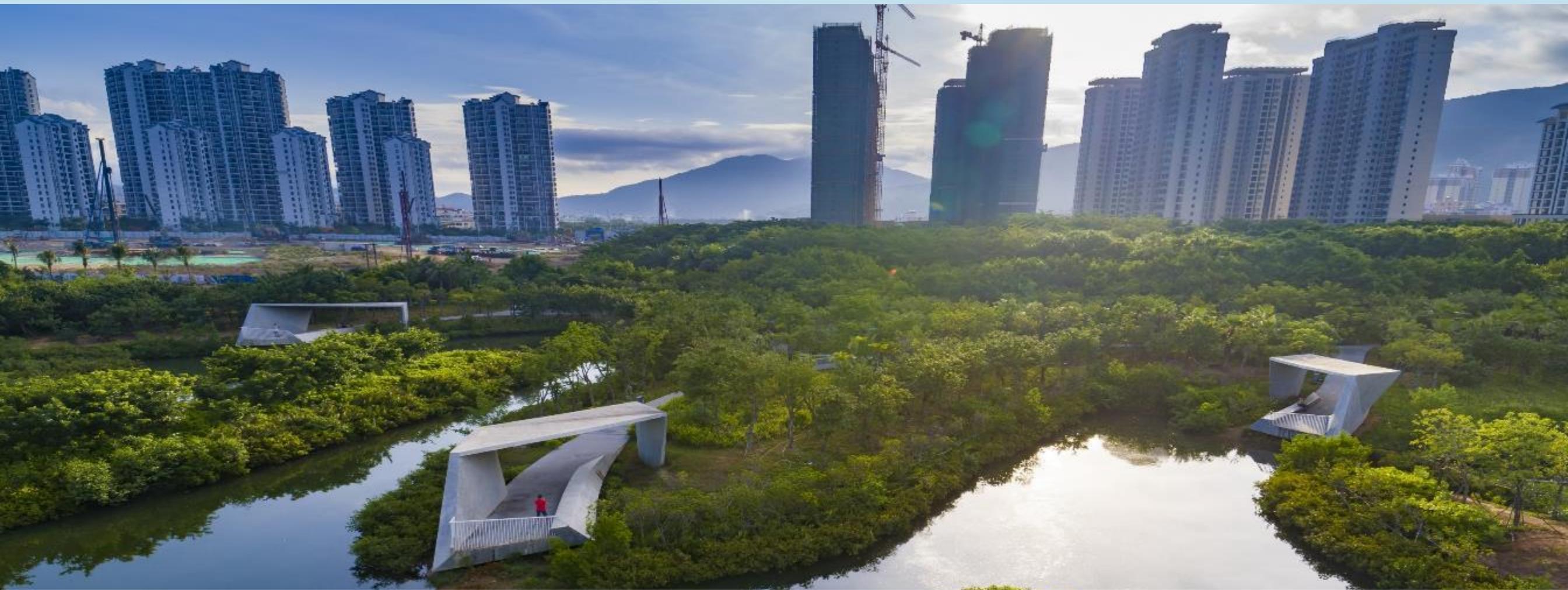
THE GUARDIAN, DECEMBER, 2016

The former land fill of construction debris and concrete materials from the demolition of the flood wall are recycled on site, and by means of cut-and-fill, ecotones of inter-locked fingers are created for diverse fauna and flora, particularly different species of mangroves





•06 Ecotone fingers by the river side are reserved for wild lives, and the urban side are made accessible for recreational uses. Paths and places are designed following terrain. Pavilions for bird watching and resting are strategically positioned





09 The pavilions are strategically located for birdwatching and fishing. They become focal points in the massive green landscape and provide resting places for visitors



•10 One of five pavilions of modulated concrete that are designed to be resistant to tropical storm. They provide shelter and shading in the changeable local weather, and refuges for bird watching (two families are taking shelter in the rain)



15 A skywalk is designed as a ramp to create an experience of walking above the mangrove canopy that connects the urban road with the park

3 Water Cleansing: Landscape as living system

Looking for the Affordable and fast solution to urban water issue

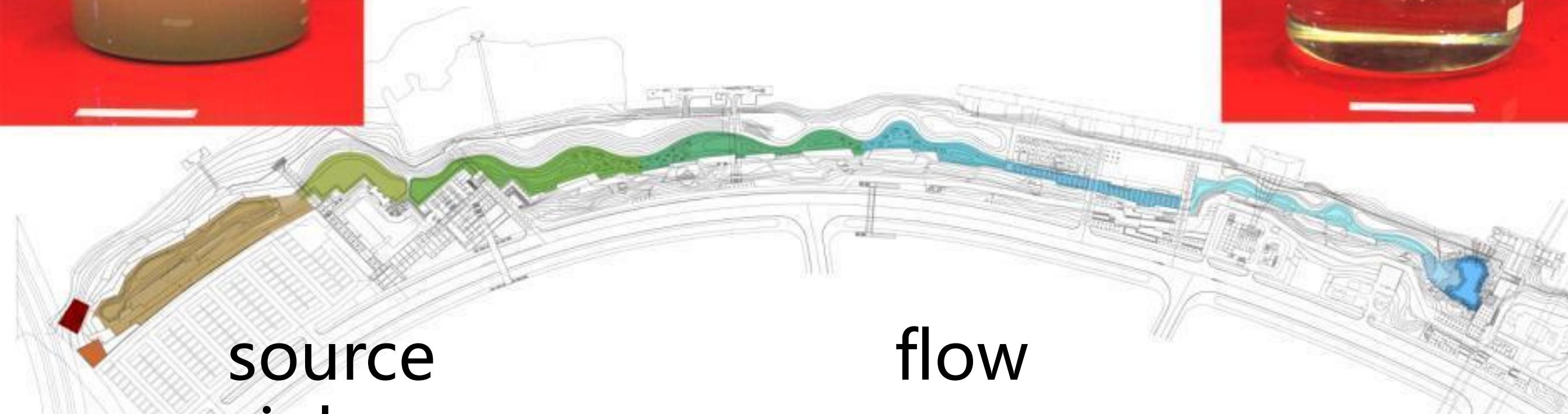
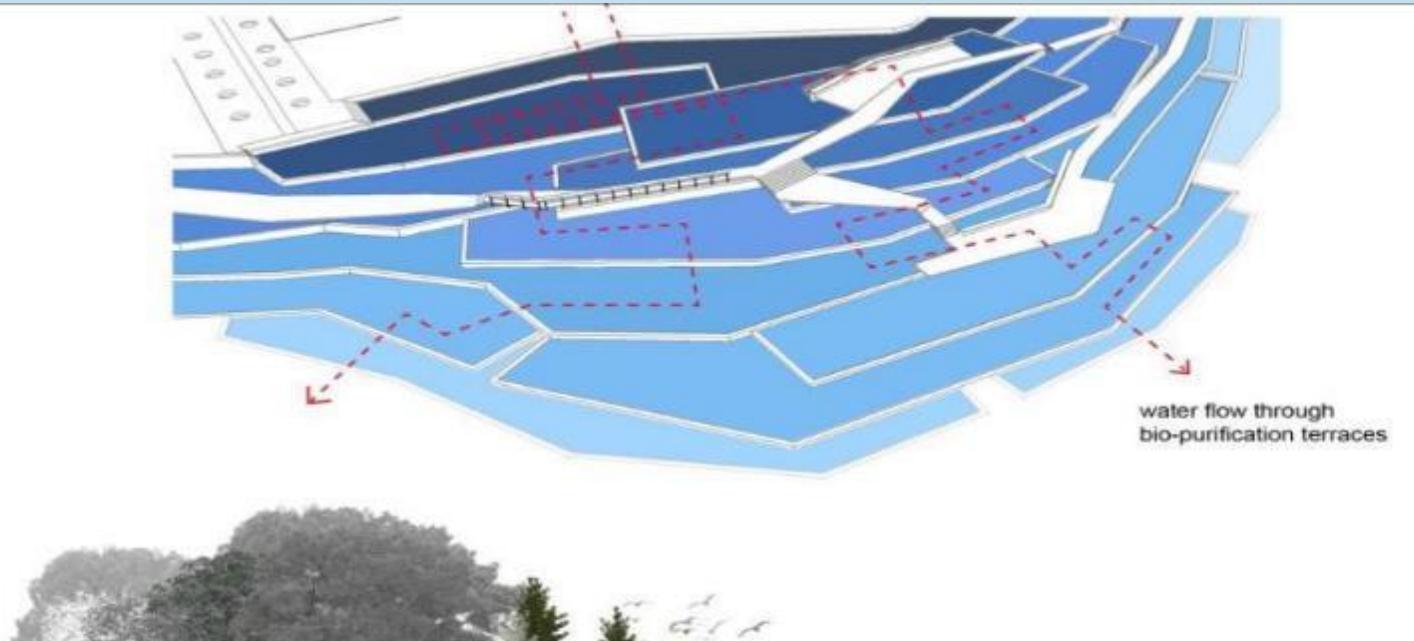


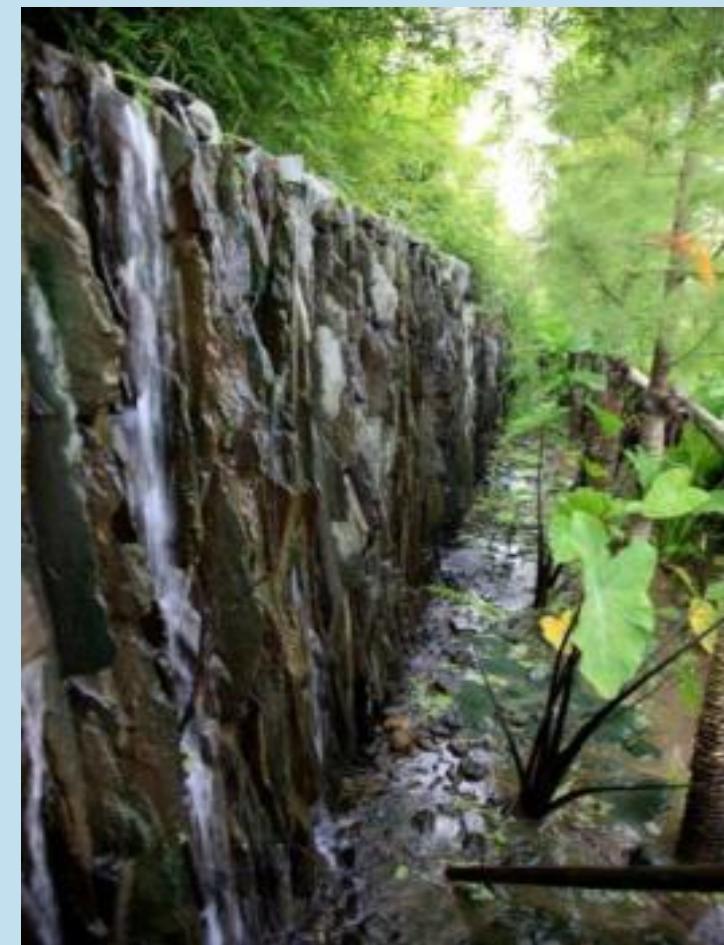
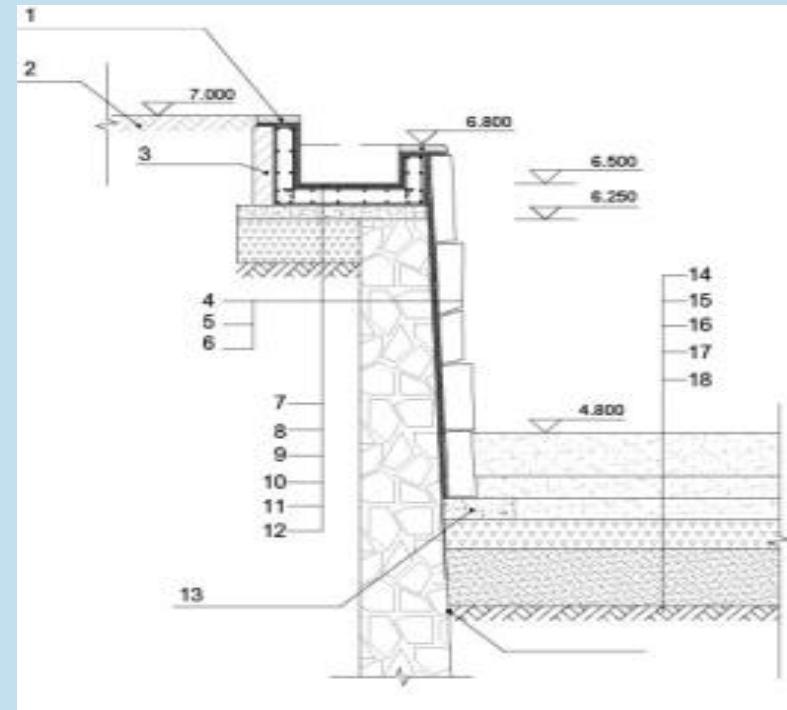
75% surface water contaminated in China



**85% sewage water untreated global wise
(Bangladesh)**

Shanghai Houtan, 2009





Source

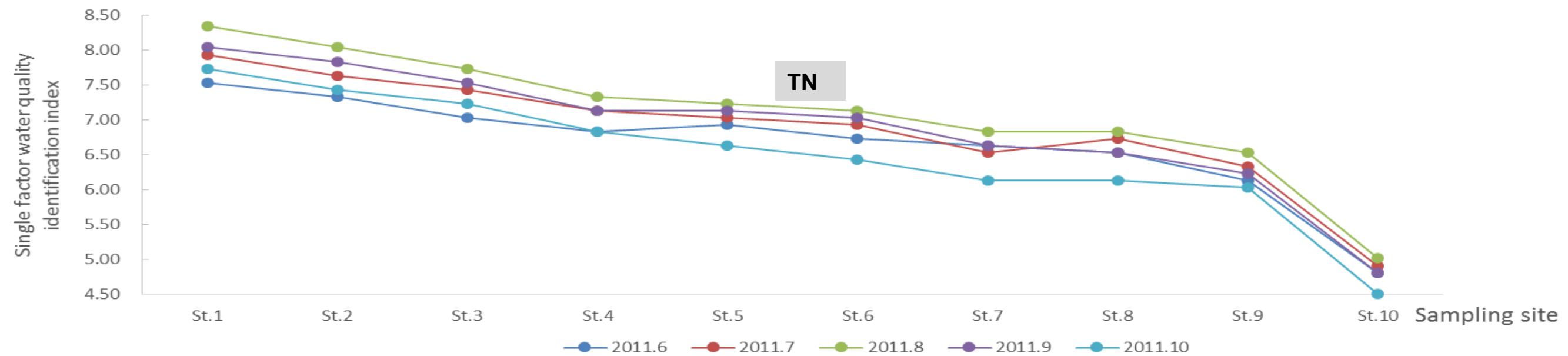
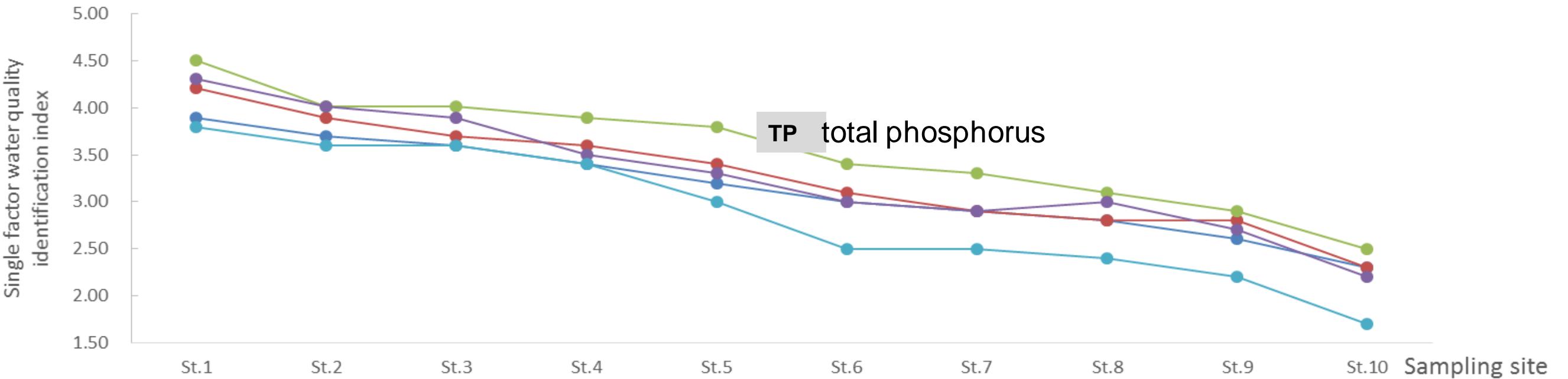
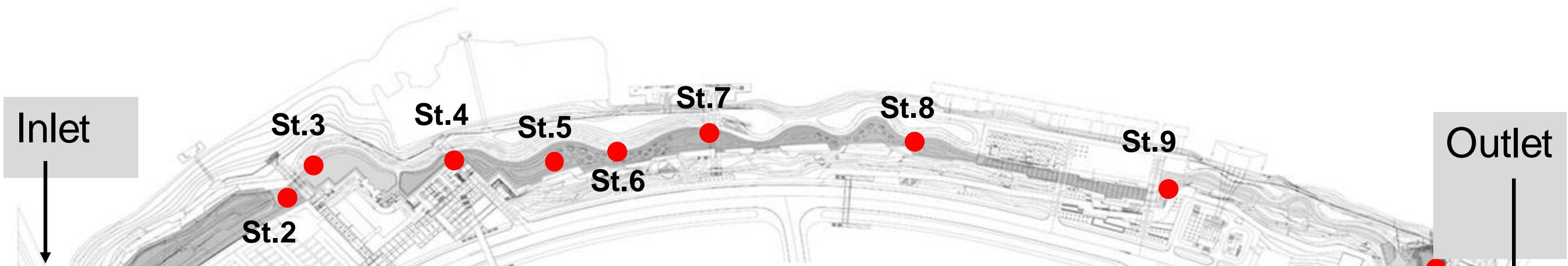






Performance test:

10 hectares., 1700 m long, producing 2400 cubic meter of water per day, water for 5000 people



Created a life supporting system for biodiversity and low maintenance



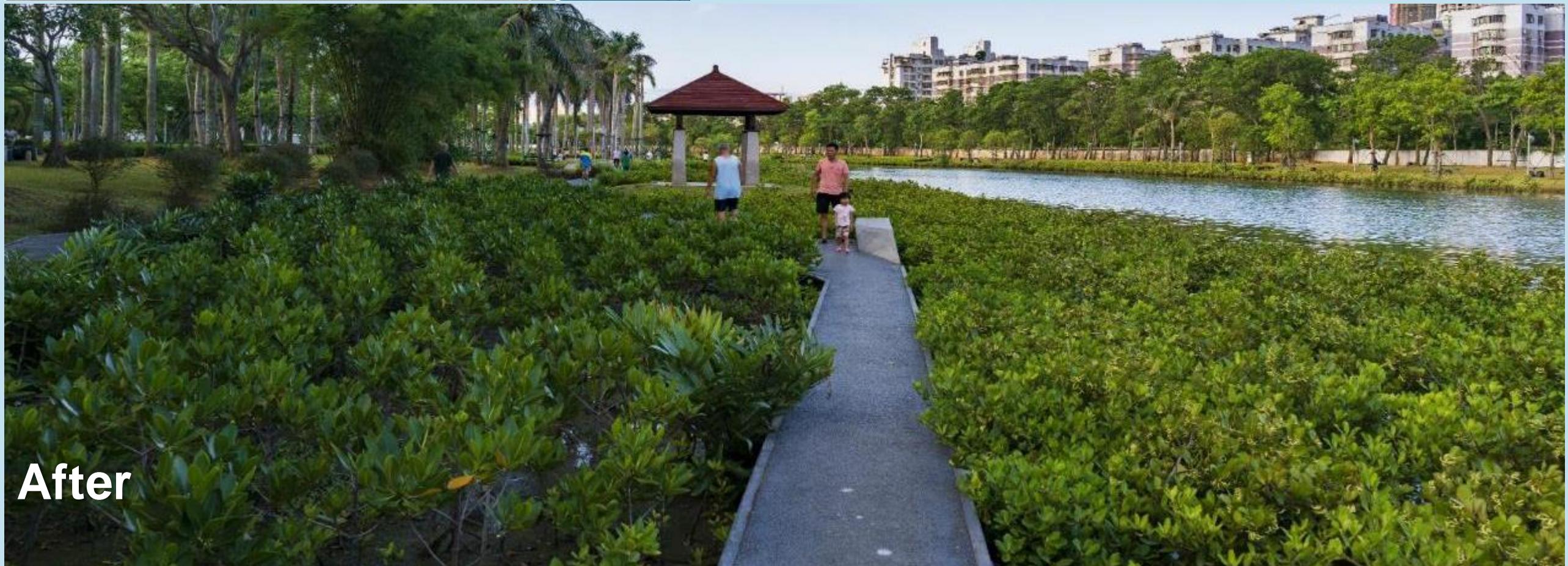


Model Replicated: Meshe River, Haikou, 2017

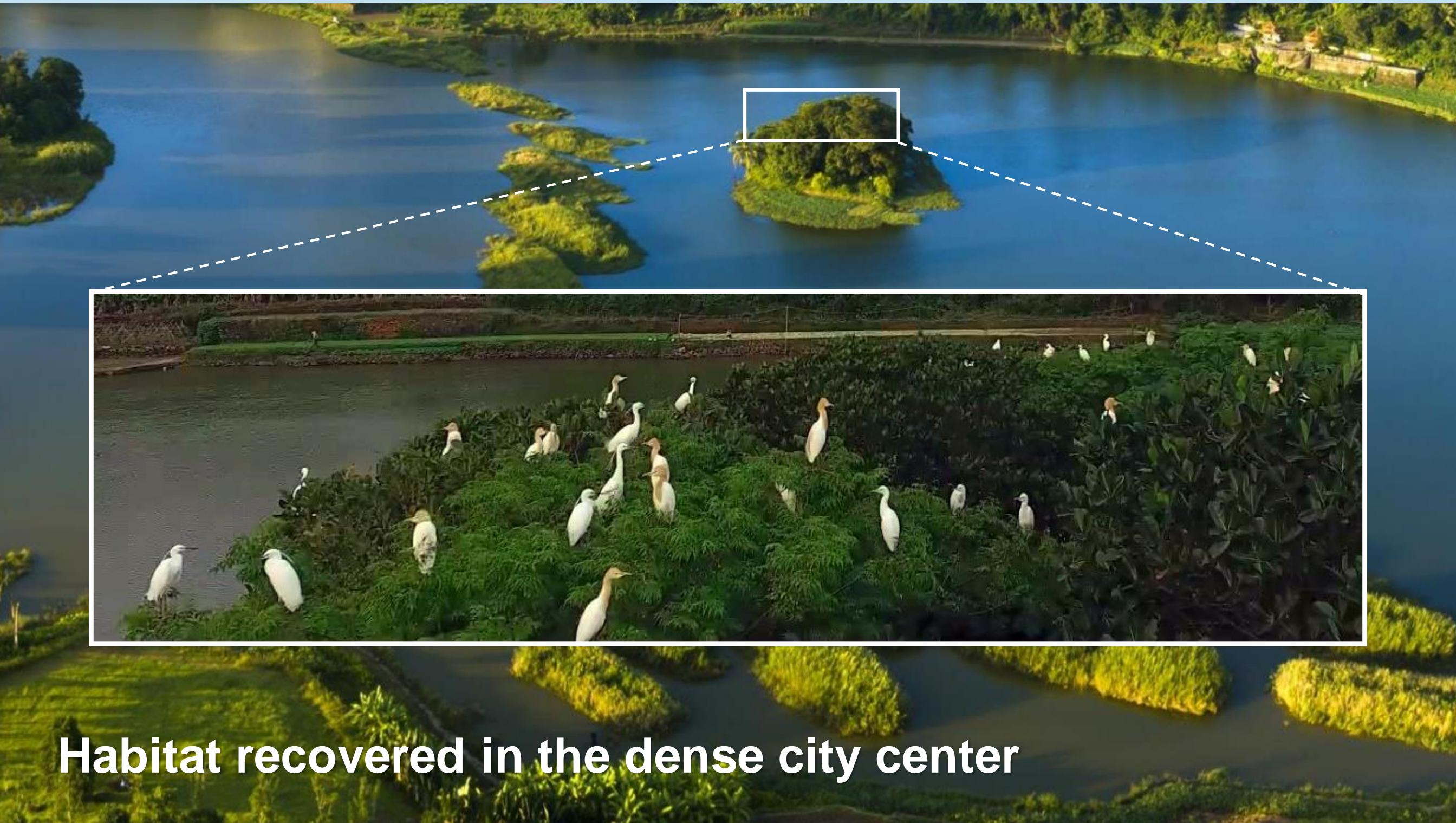












Habitat recovered in the dense city center

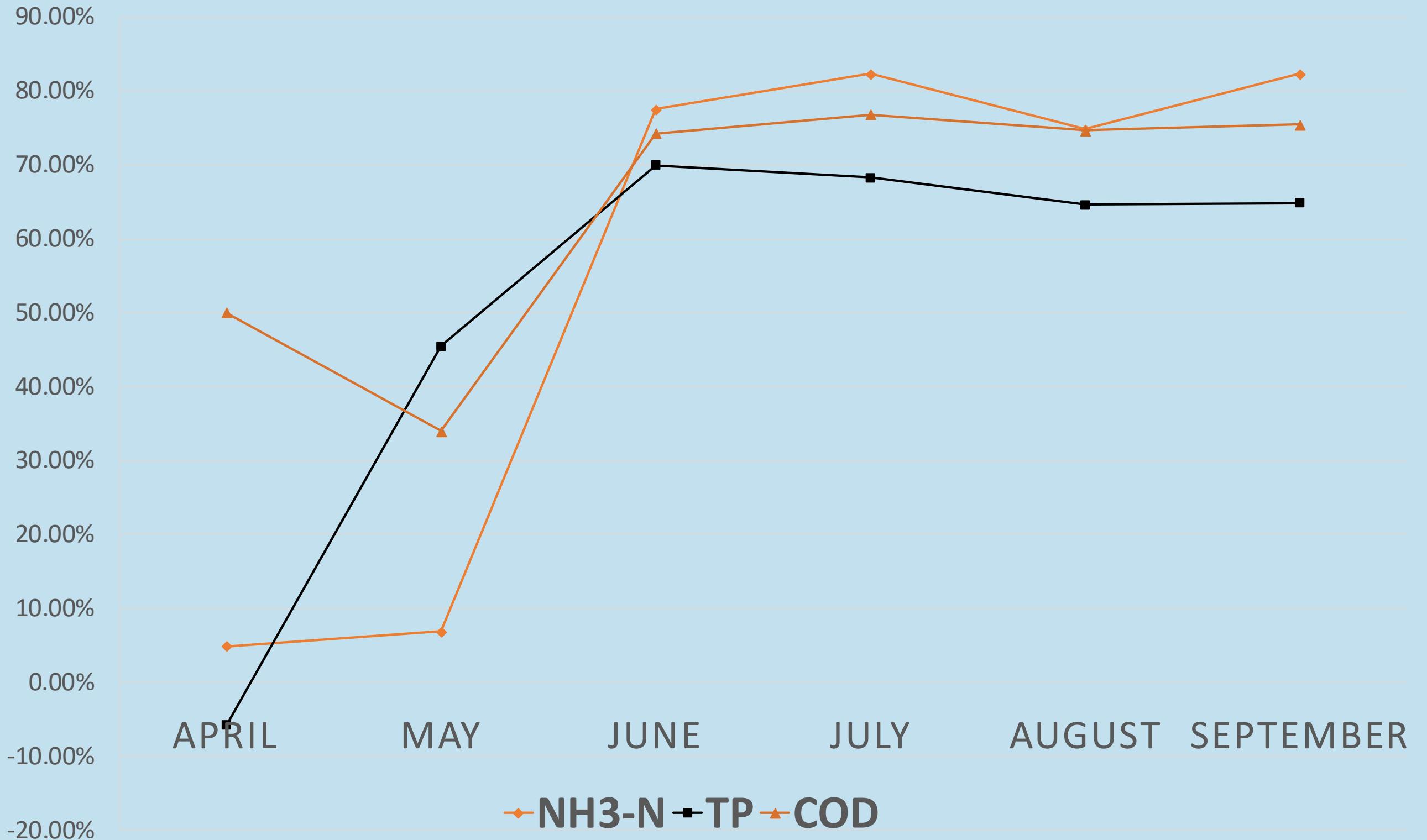


Before, 2015



Today, Fish come back, harvested 300 pounds of fish in one net ,Feb.24, 2019

Removal effect and cumulative removal rate of nutrients



Looking forward....

75% surface water contaminated nationwide

85% sewage water untreated global wise

Taihu, 2445 Square Kilometers, East China



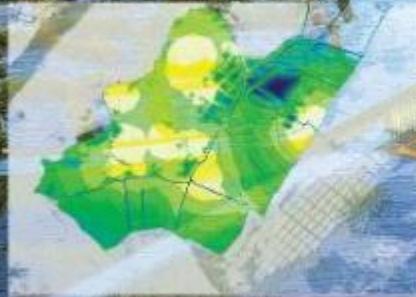
Designed ecologies of Taihu Post-Industrial Agricultural Landscape



water security pattern



biological security pattern



cultural security pattern



cultural security pattern



Bohai Sea, 770, 000 square kilometers



An designed experiment: Qinhuangdao Beach restoration





Before



Before



During construction



4 Soil remediation and habitat restoration

Let Nature do the work: Tianjin Qiaoyuan Park, 2008

60% of urban soil is contaminated in China, convention solution is usually very expensive, what is the alternative?

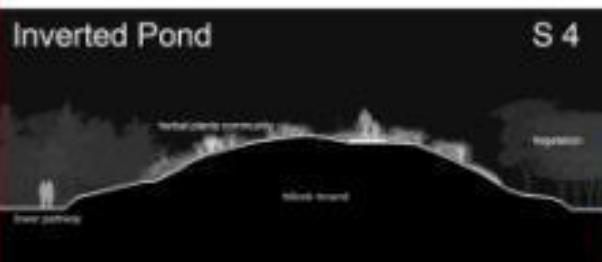
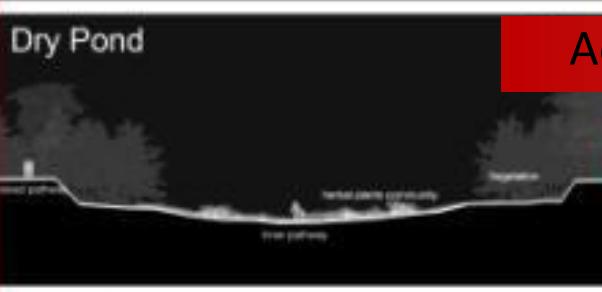
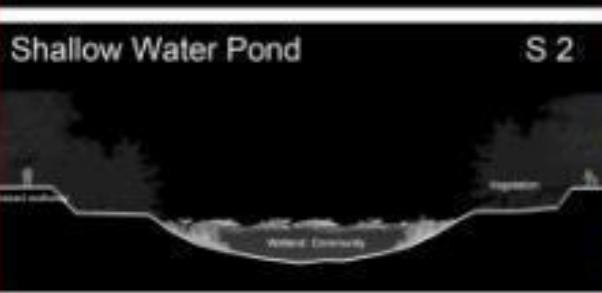
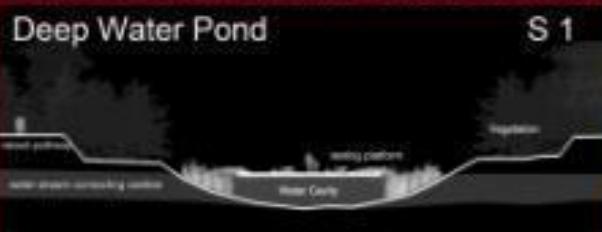
50% of wetland habitat disappeared in the last 50 years, how can we rehabilitate the large brown field in China



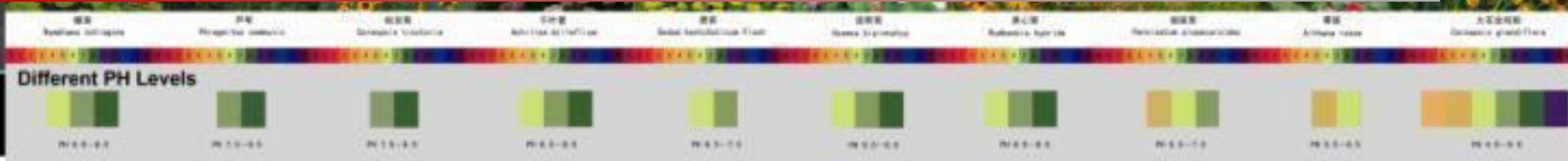


Adaptive Vegetation Communities

Different PH Cleans Different Pollutants Different Pond Depth Allows Different Species



Acid Alkaline



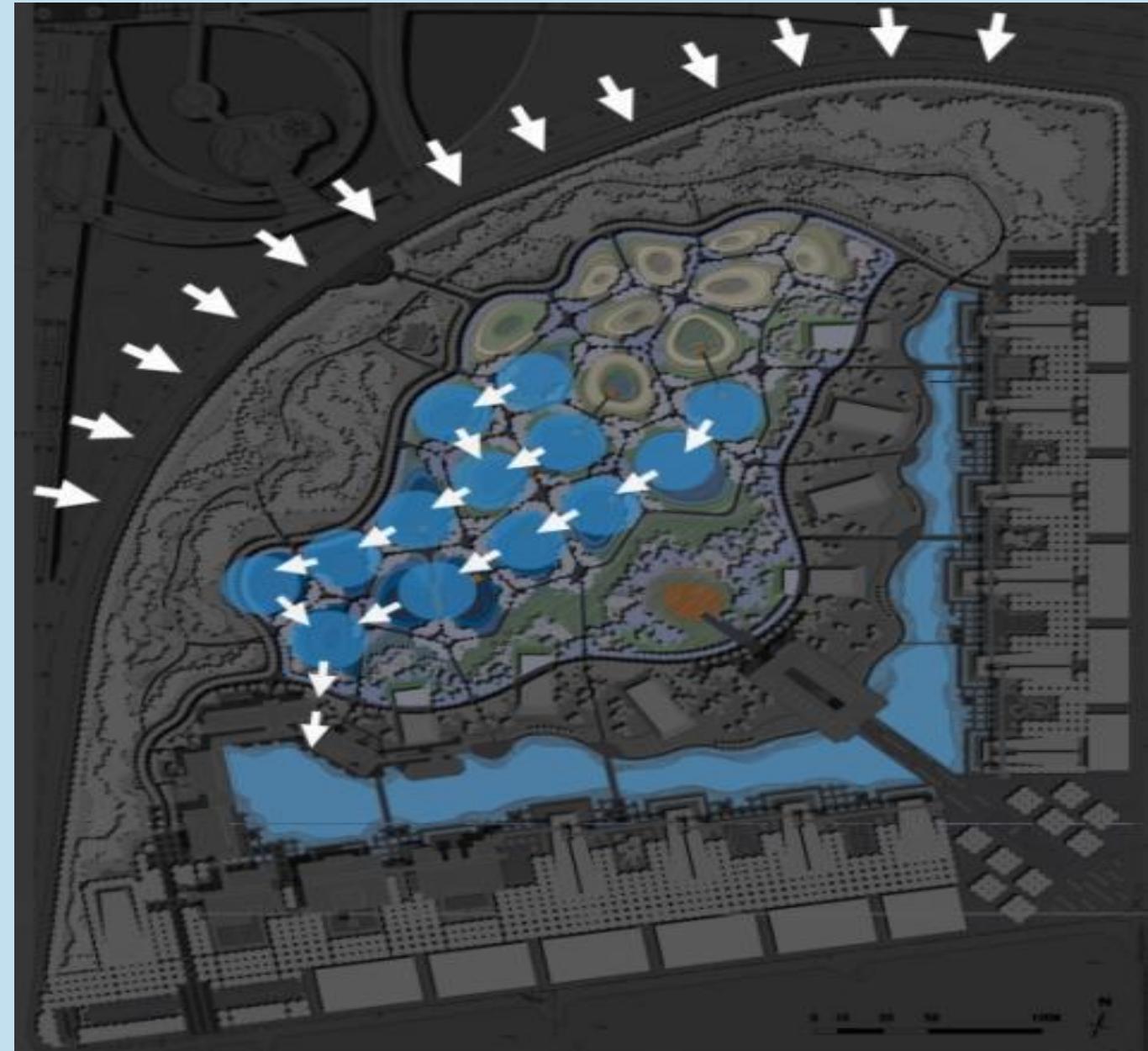
Inspiration: Adaptive vegetation communities that dot the regional landscape in patches sensitive to water and soil PH values

PH value management

Management of PH and water



PH Values



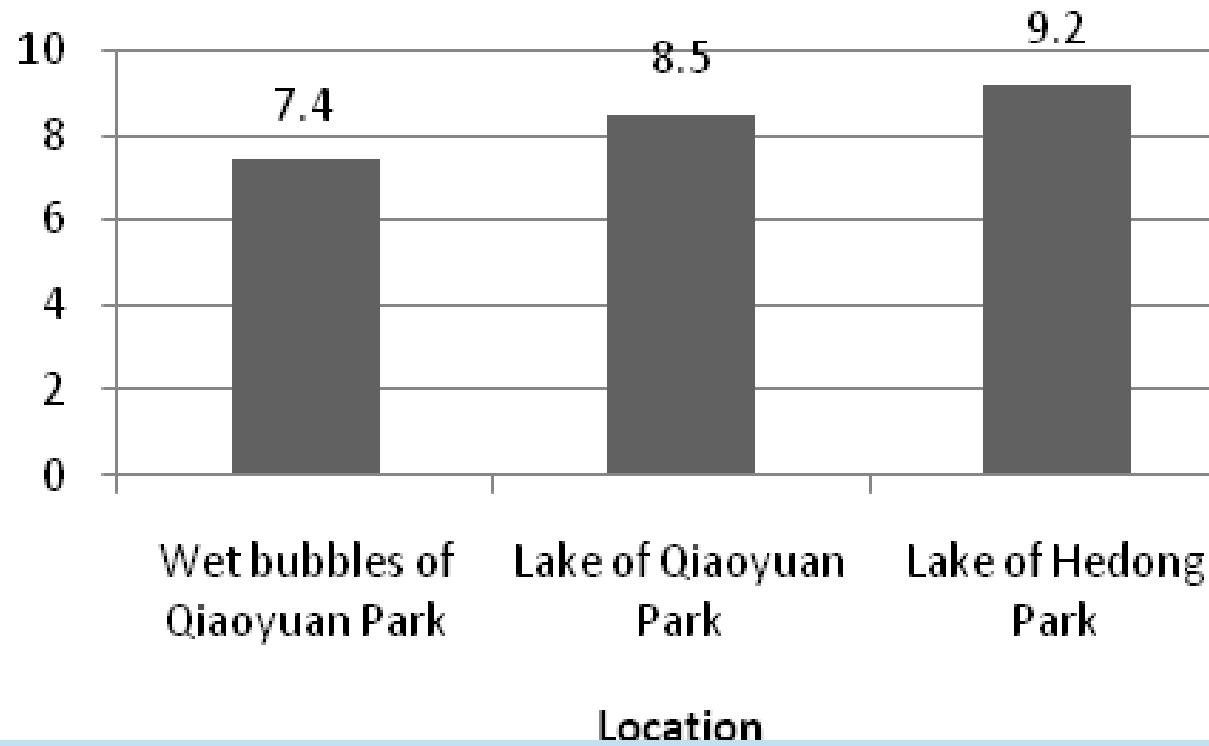
Water Flow



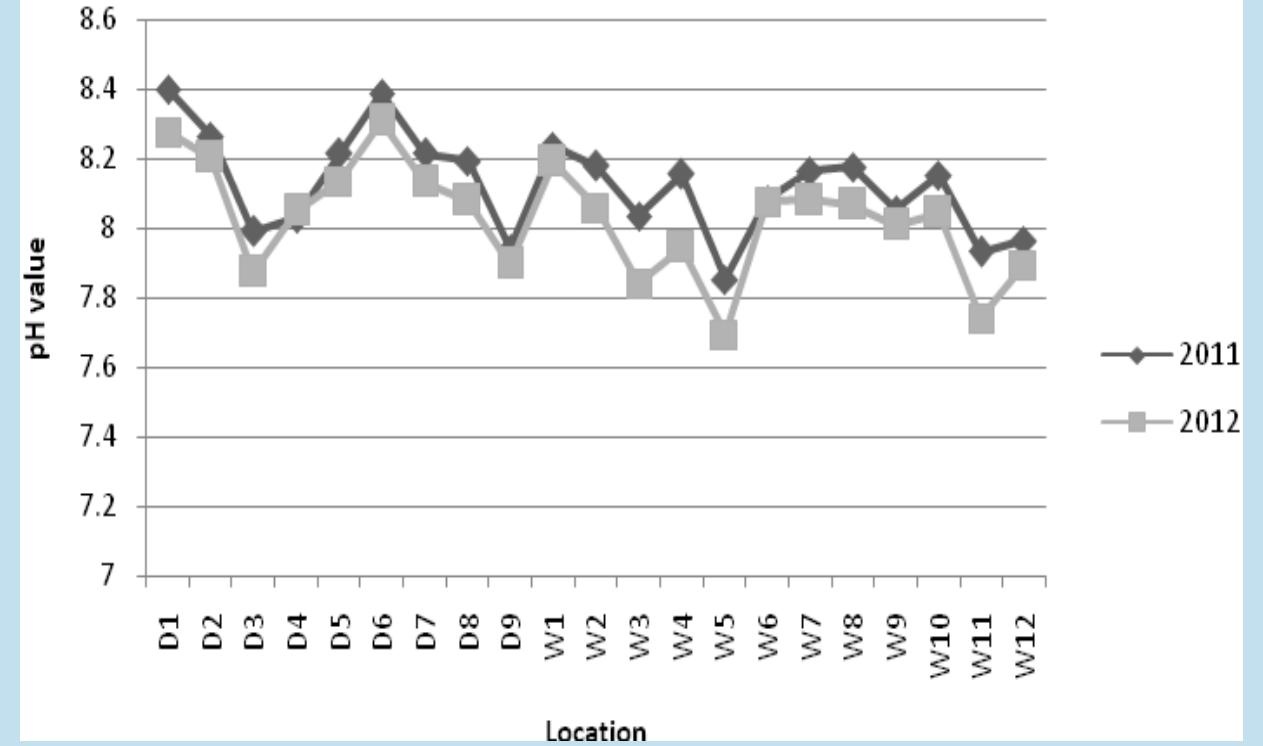


Water and Soil remediation service in Qiaoyuan Park

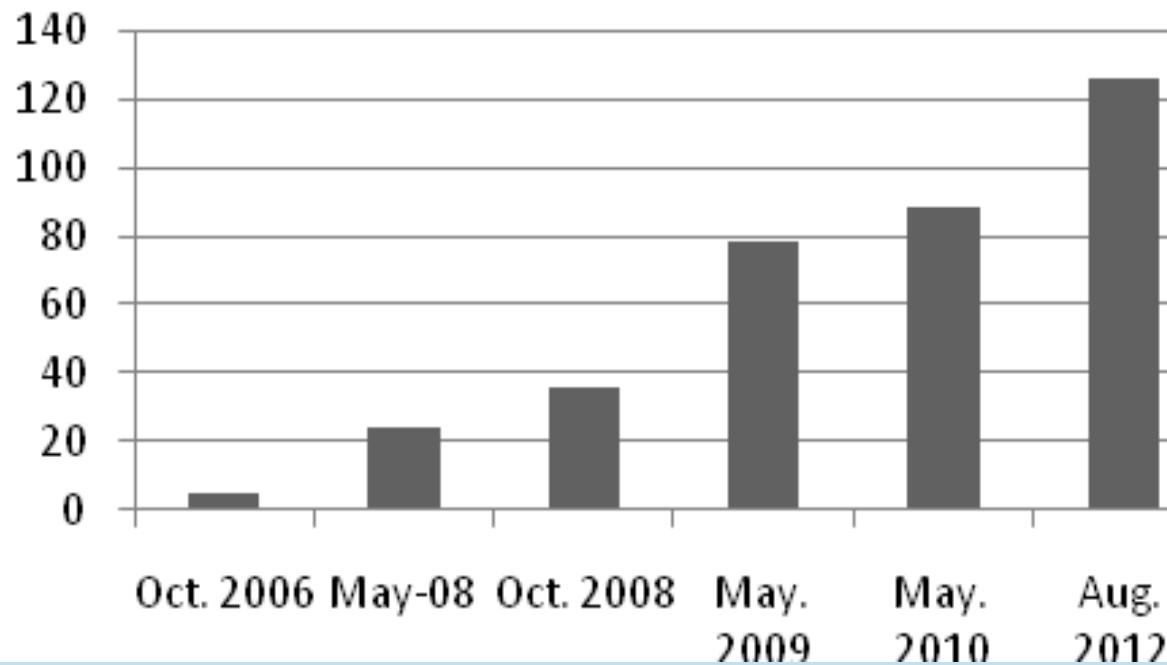
Average water pH



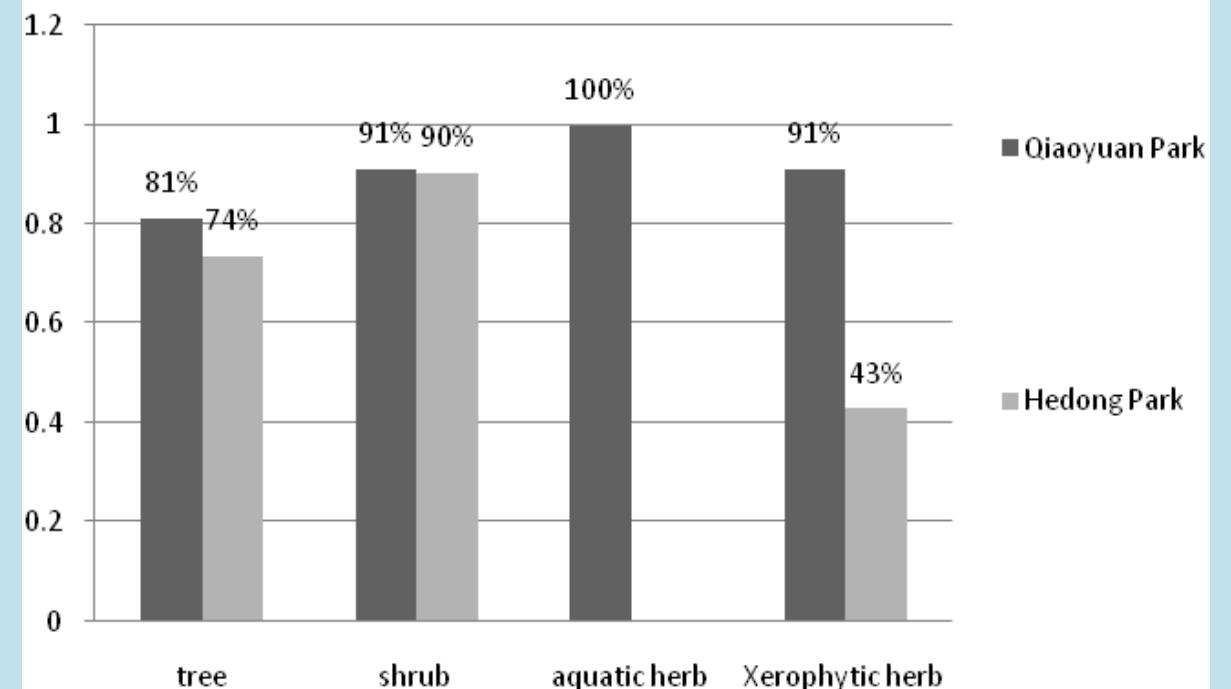
Trends of soil pH



Biodiversity trends



Percentage of native species



"In the expanding enterprise, **landscape design will play a decisive role.** Where environments have been mostly humanized, biological diversity can still be sustained at high levels by the ingenious placement of woodlots, hedgerows, watersheds, reservoirs, and artificial ponds and lakes. Master plans will meld not just economic efficiency and beauty but also the preservation of species and races" (Wilson 1992 p.317).

Wilson, E. (1992). The Diversity of Life. Cambridge, MA., The Belknap Press of Harvard University Press.



Conclusion: An era of new civilization

More than ever, it is clear that we need a **paradigm shift** in planning and designing our city to adapt the changing climate and solving the **multiple urban ecological issues**.

Such a shift calls for a **rethinking of the way we build our cities based on industrial technologies**,

and calls for **the revival of the ancient wisdom of survival: The nature-based solution.**

