ECOLOGICAL RESTORATION PLAN FOR THE LE' AN RIVER IN WUYUAN: A ONE HEALTH PERSPECTIVE

PROJECT BACKGROUND

The Raohe Yuan National Wetland Park
is located in the upper reaches of
the **Le' an River,**
the **source** of the Rao River，
the **mother river** of Wuyuan，
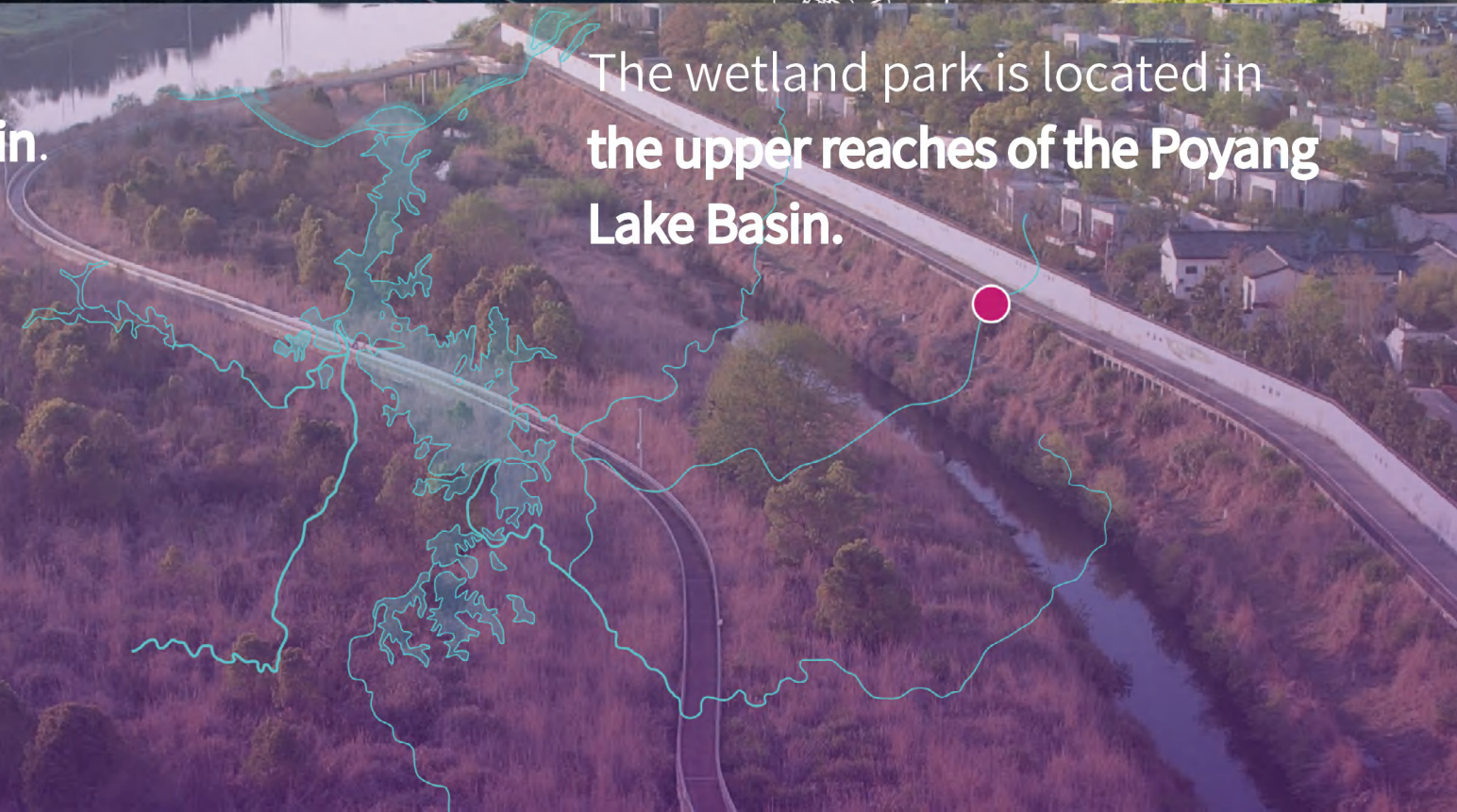the **birthplace** of Huizhou culture

The wetland park covers an area of **348.87** hectares.
The wetland area is **302.72** hectares.
The wetland rate is **86.77%** .

The wetland park is located in
the key ecological area of the Yangtze River Basin.

The wetland park is located in
the upper reaches of the Poyang Lake Basin.

EXISTING CHANLLENGE

The river's natural development is disturbed
Human-induced flood control, illegal sand mining, and encroachment on tidal flats lead to a decrease in the diversity of river morphology and the degradation of tidal flats.

Biodiversity is under threat
The decline in river form diversity and the invasion of alien species such as the golden apple snail have endangered the habitats of wetland plants and animals, disrupted the integrity of healthy food webs, and impacted the stability of the ecosystem as well as the health of the local residents.

Waterfront is limited
Waterfront is limited. Due to the extensive management of river and the lack of a pedestrian-friendly system, the residents' experience of being close to the water is restricted.

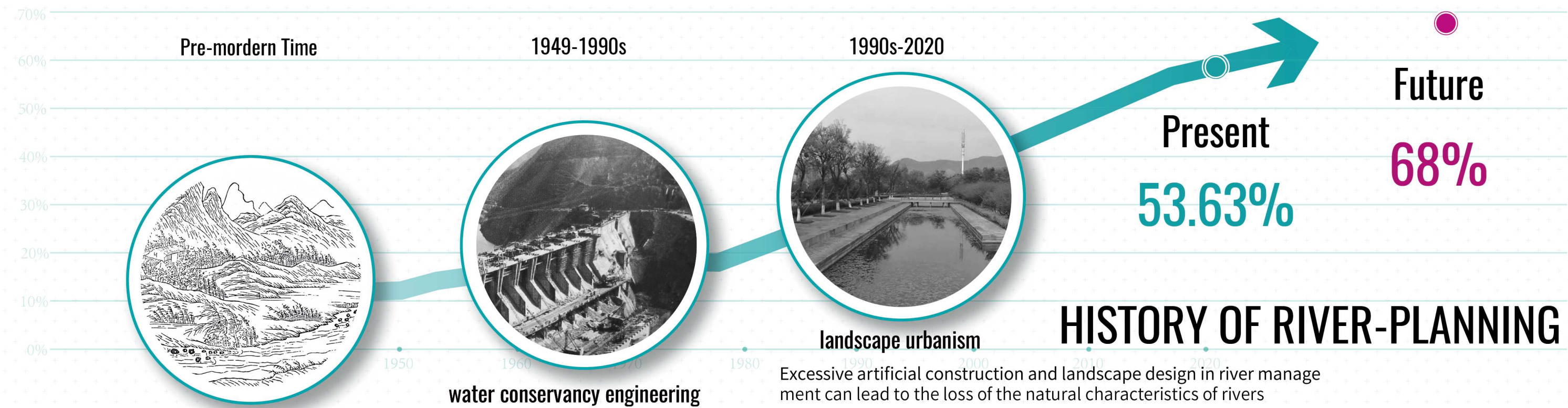The river's natural development is disturbed
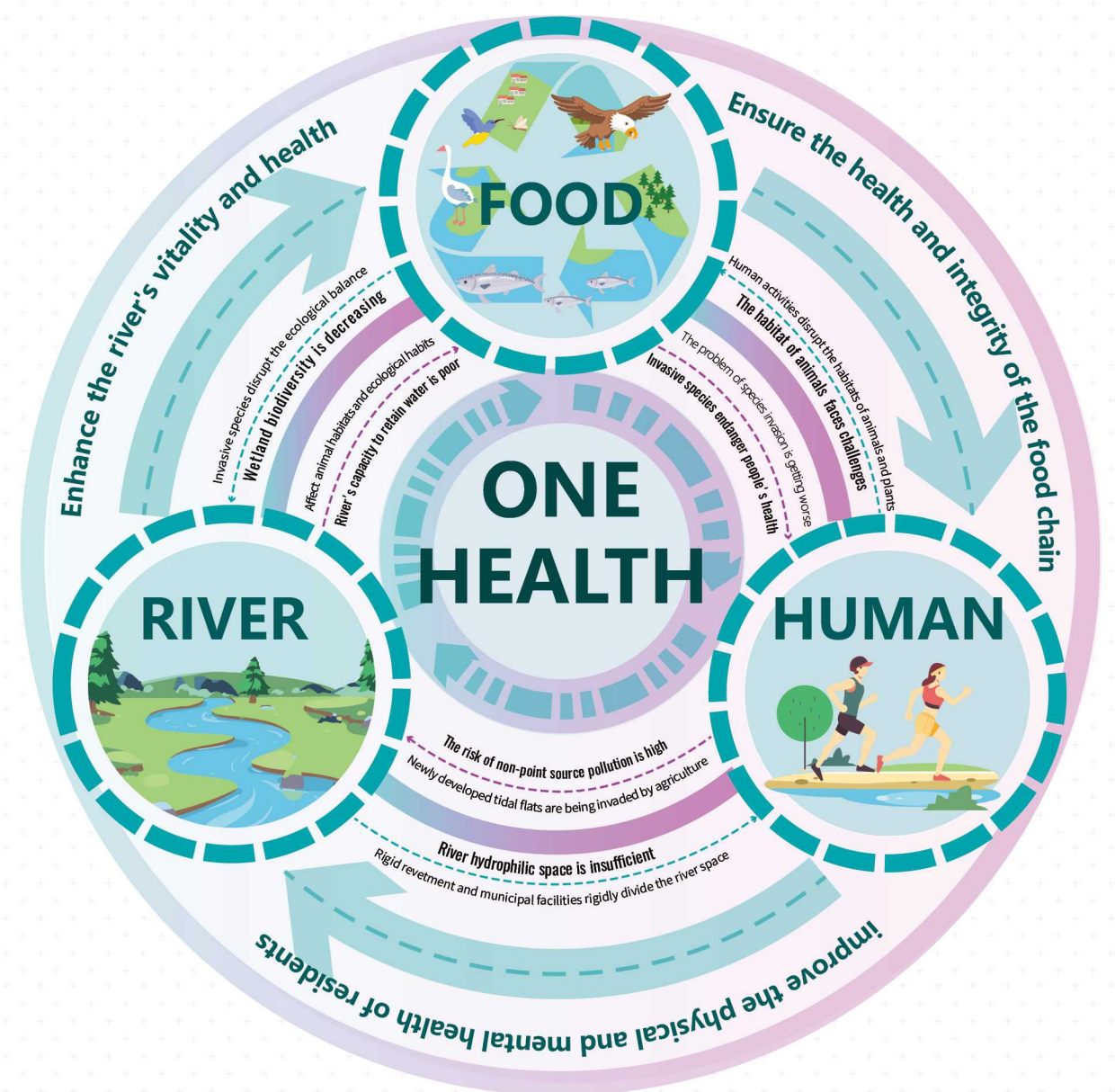
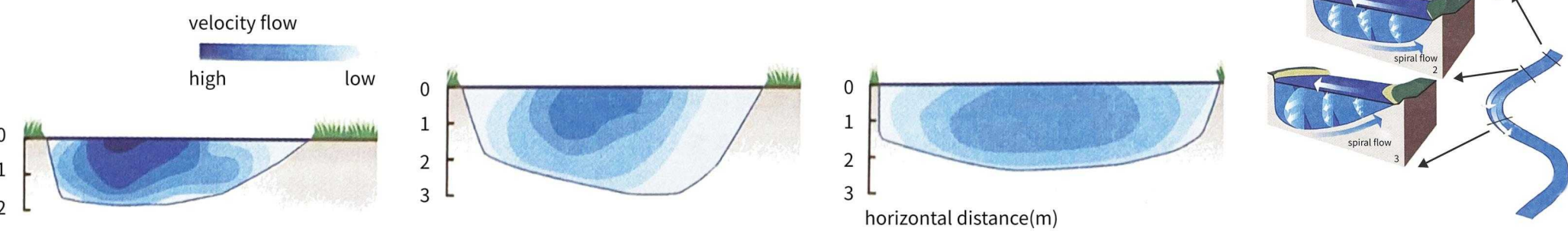Biodiversity is under threat

Waterfront is limited

PROJECT MANIFESTO

Pre-mordern Time

1949-1990s

1990s-2020

Future

Present

68%

53.63%

HISTORY OF RIVER-PLANNING

landscape urbanism

Excessive artificial construction and landscape design in river management can lead to the loss of the natural characteristics of rivers

water conservancy engineering

Water conservancy projects have been constructed to improve people's lives and promote economic development.

river-town in harmony

Wuyuan ancient town - rivers and channels are part of people's life

Key species population recovery

Improved food chain integrity

Waterfront living space sharing
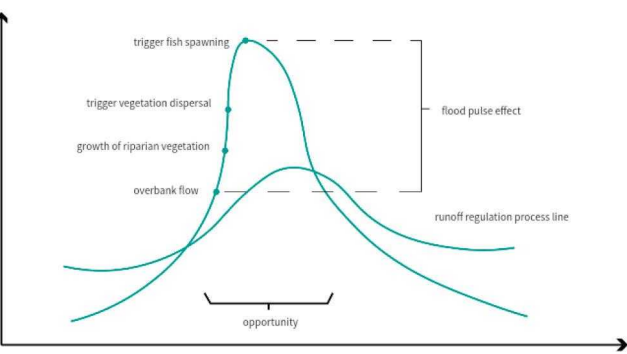
Establishment of a Perceptual Monitoring System

Enhance the river's vitality and health

Ensure the health and integrity of the food chain

FOOD

ONE HEALTH

RIVER

HUMAN

Invasive species disrupt the ecological balance

Wetland biodiversity is decreasing

Affect animal habitats and ecological habits

River's capacity to retain water is poor

Human activities disrupt the habitats of animals and plants

The habitat of animals

The problem of species invasion is getting worse

Invasive species endanger people's health

The risk of non-point source pollution is high

Newly developed tidal flats are being invaded by agriculture

River hydrophilic space is insufficient

Rigid revetment and municipal facilities rigidly divide the river space

improve the physical and mental health of residents

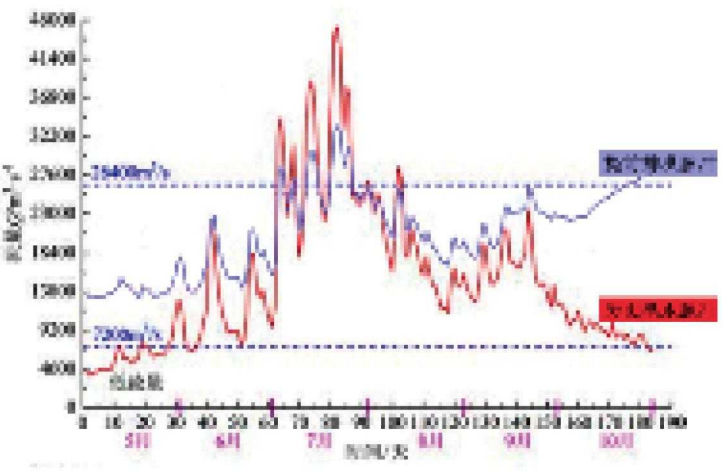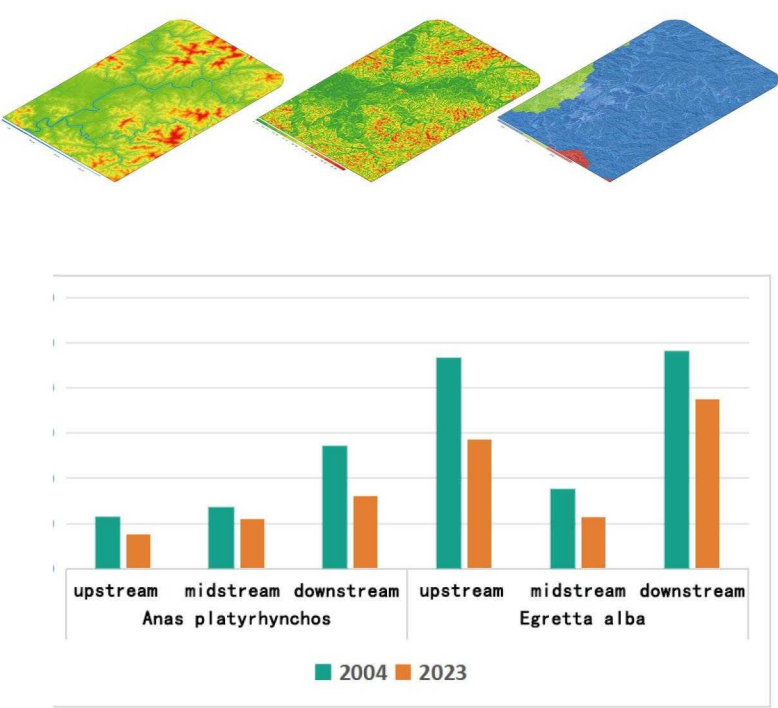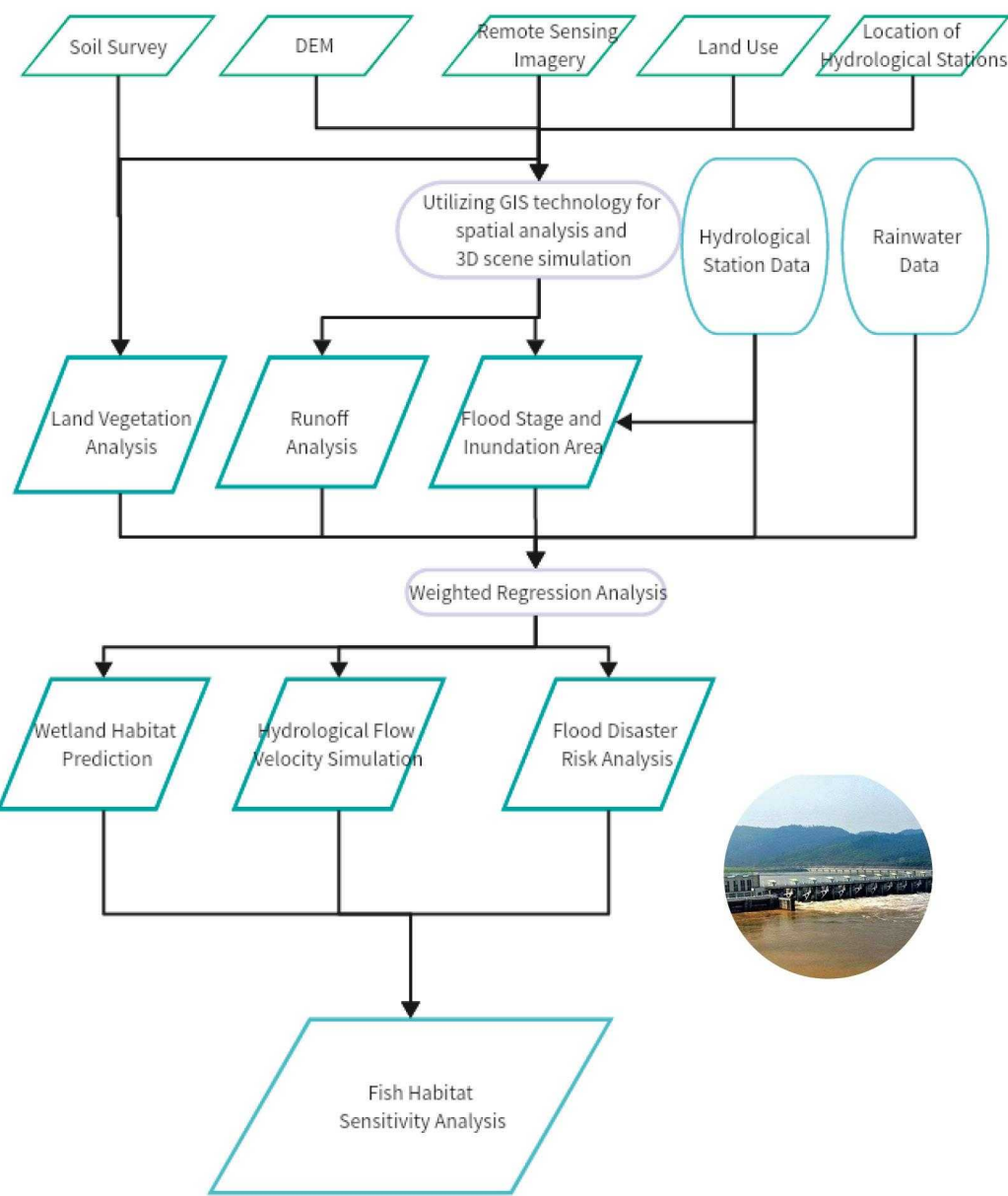# HYDROLOGICAL IMPACT ANALYSIS FOR KEY FISH SPECIES

RIVER PRINCIPLE

Flood pulses bring favorable conditions, infuencing the flow speed and tempreture changes, which stimulating fish spawning behavior changes.
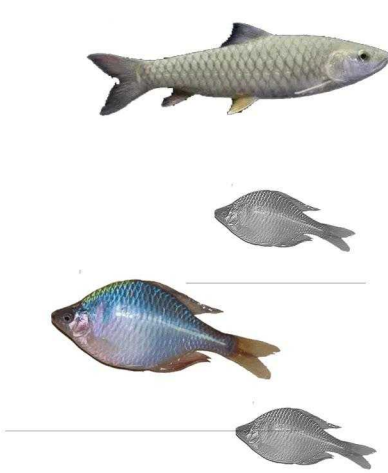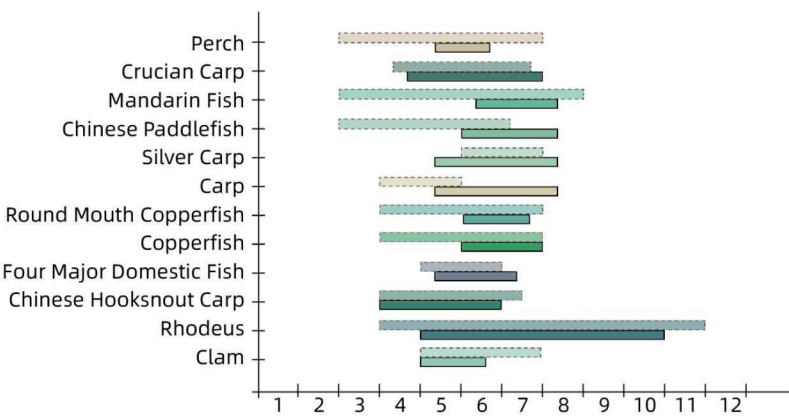
velocity flow

high   low

horizontal distance(m)

Le'An River Pulse Diagram

trigger fish spawning
trigger vegetation dispersal
growth of riparian vegetation
overbank flow

flood pulse effect
runoff regulation process line
opportunity

GIS-BASED ANALYSIS METHODOLOGY

Soil Survey — DEM — Remote Sensing Imagery — Land Use — Location of Hydrological Stations

Utilizing GIS technology for spatial analysis and 3D scene simulation

Hydrological Station Data

Rainwater Data

Land Vegetation Analysis

Runoff Analysis

Flood Stage and Inundation Area

Weighted Regression Analysis

Wetland Habitat Prediction

Hydrological Flow Velocity Simulation

Flood Disaster Risk Analysis

Fish Habitat Sensitivity Analysis

upstream   midstream   downstream
Anas platyrhynchos

upstream   midstream   downstream
Egretta alba

■ 2004   ■ 2023

PREDICTED IMAPCT

Perch
Crucian Carp
Mandarin Fish
Chinese Paddlefish
Silver Carp
Carp
Round Mouth Copperfish
Copperfish
Four Major Domestic Fish
Chinese Hooksnout Carp
Rhodeus
Clam

1 2 3 4 5 6 7 8 9 10 11 12

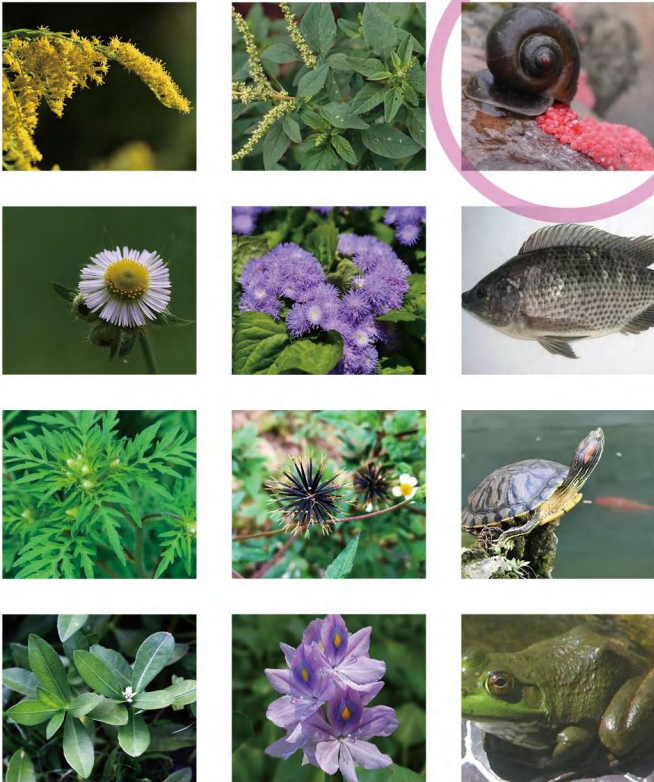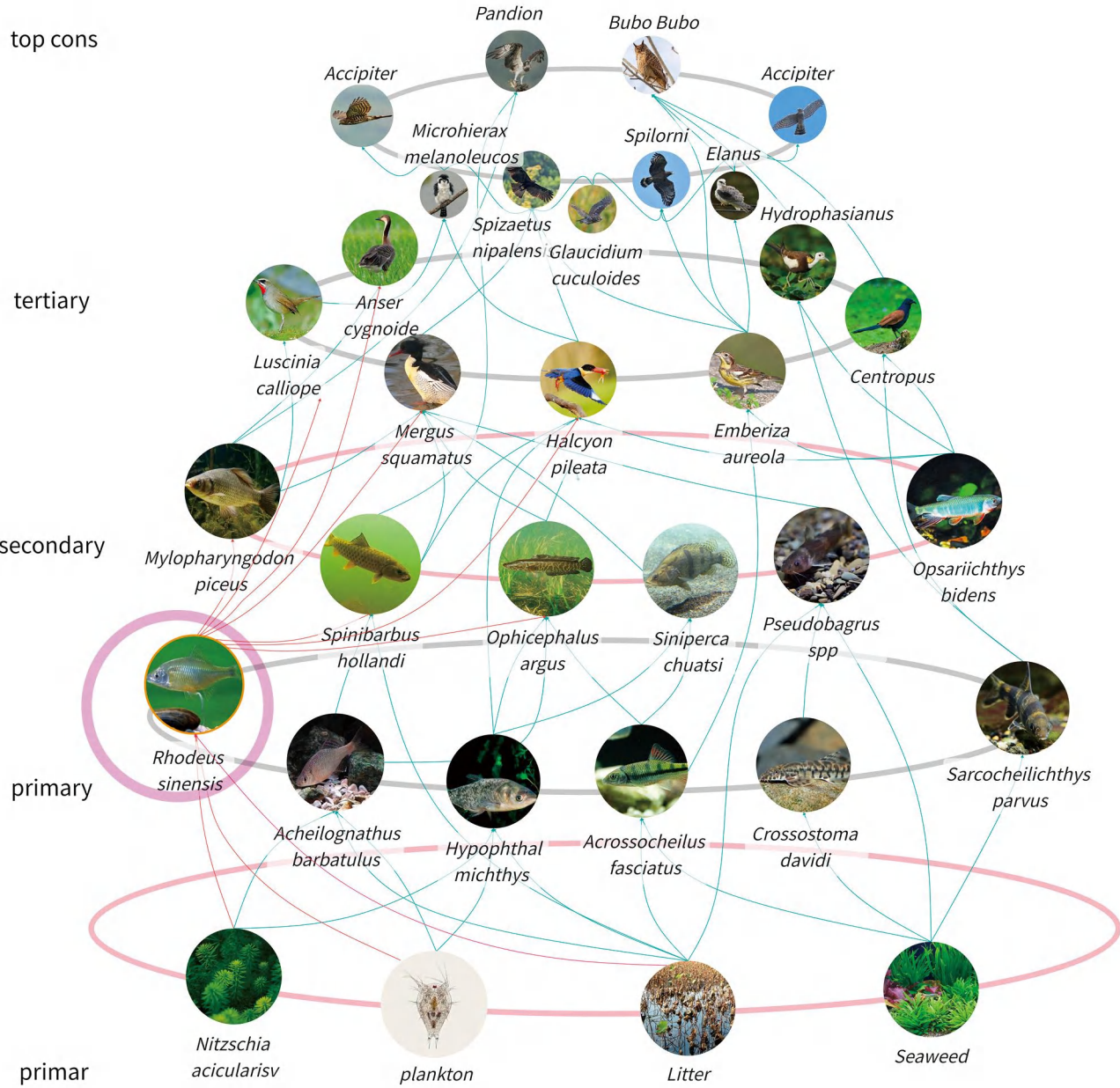OUTPUT

Based on the simulation and prediction of water temperature and flow rate, we have planned and intervened in the reasonable timing and method of water release from the dam. The chart shows the simulated yield over time for important fish species in this project, with the solid line representing the current situation before intervention and the dashed line representing the simulation.
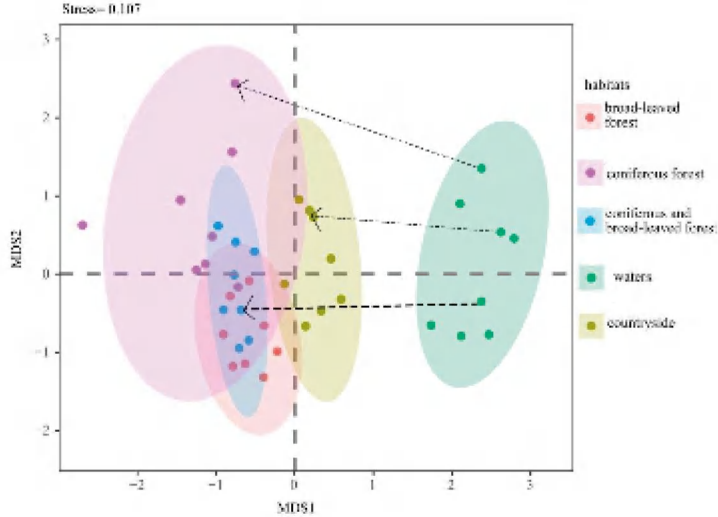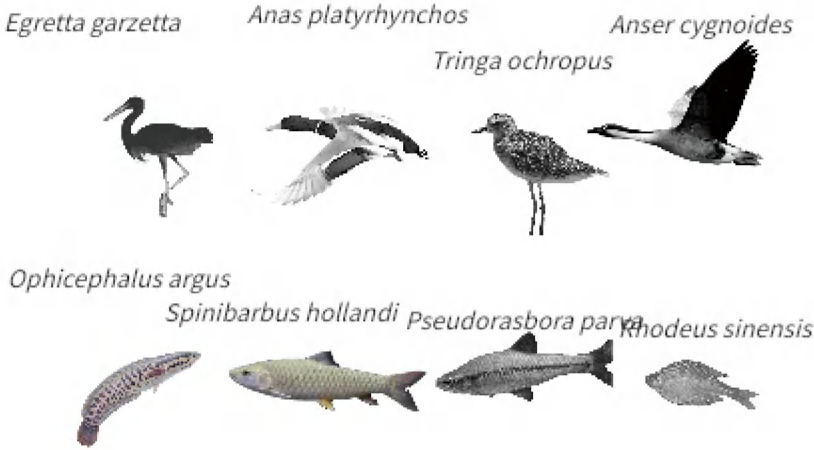
FOODCHAIN ANALYSIS

By analyzing and reasoning the interplay of species at various trophic levels within the entire food chain, we have identified the key populations that most significantly impact the stability of the Le'an River's ecosystem.

FOODCHAIN MAPPING

top cons

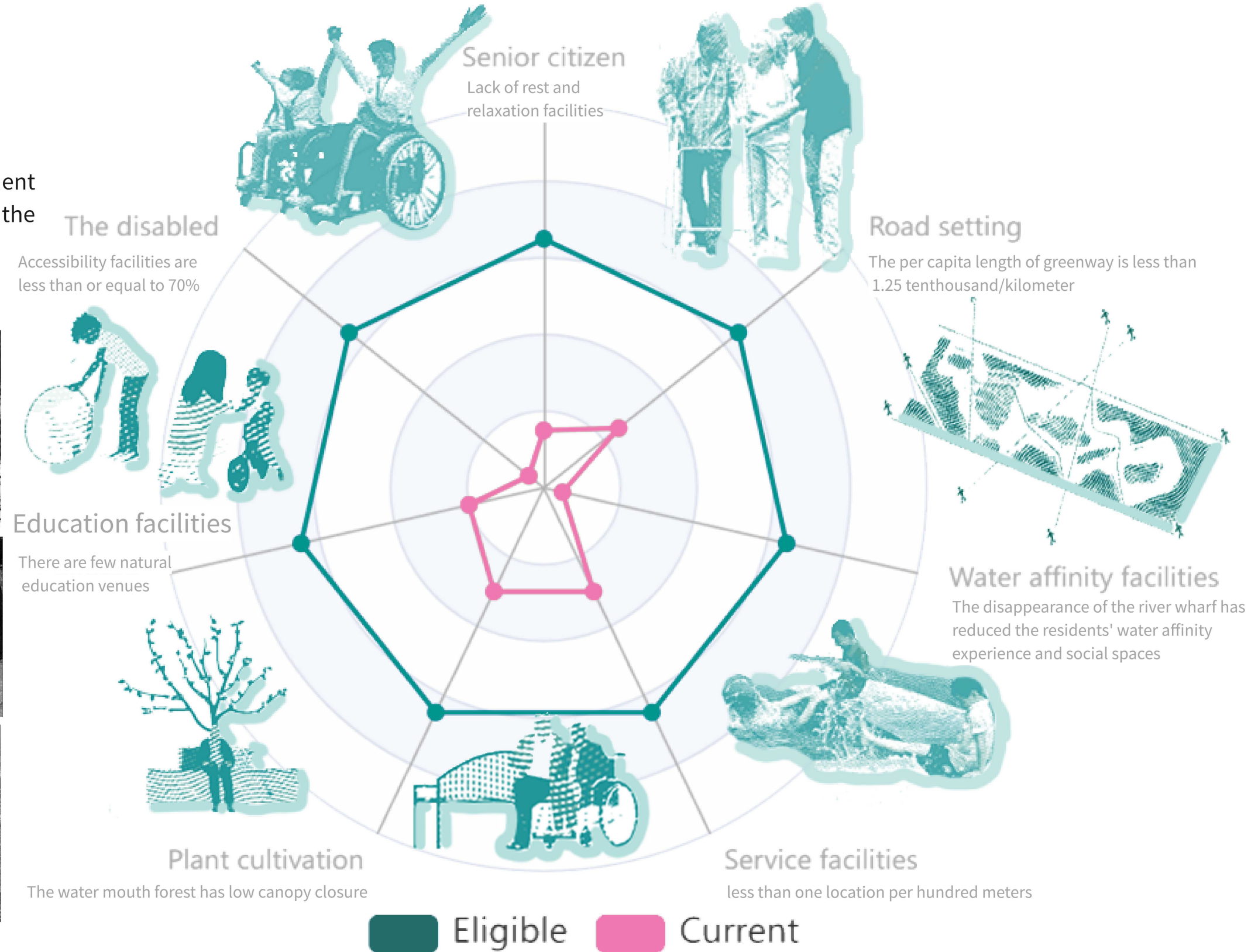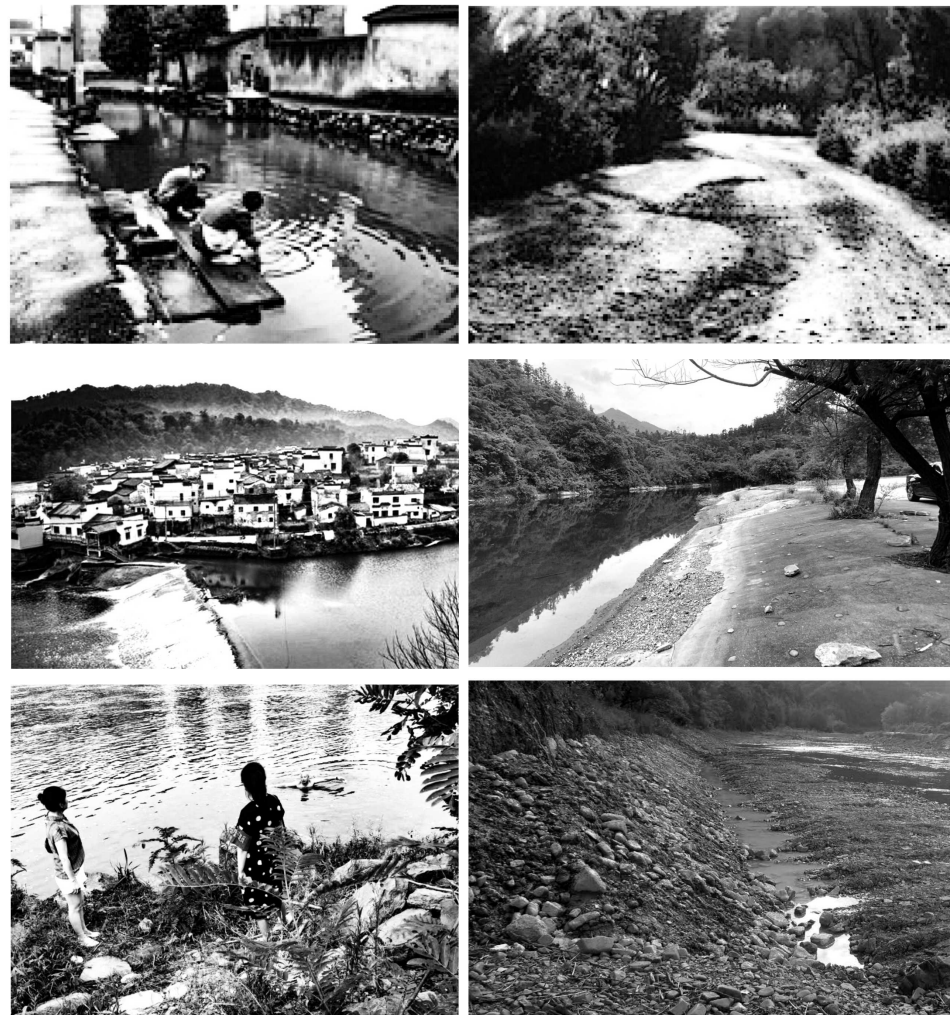*Pandion* *Bubo Bubo*

Accipiter *Accipiter*

Microhierax melanoleucos *Spilorni* *Elanus*

Spizaetus nipalensis *Glaucidium cuculoides* *Hydrophasianus*

tertiary

Anser cygnoide

Luscinia calliope *Centropus*

Mergus squamatus *Halcyon pileata* *Emberiza aureola*

secondary

Mylopharyngodon piceus *Opsariichthys bidens*

Spinibarbus hollandi *Ophicephalus argus* *Siniperca chuatsi* *Pseudobagrus spp*

Rhodeus sinensis

primary

Sarcocheilichthys parvus

Acheilognathus barbatulus *Hypophthal michthys* *Acrossocheilus fasciatus* *Crossostoma davidi*

Nitzschia acicularisv *plankton* *Litter* *Seaweed*

primar

THE THREATEN SPECIES

Egretta garzetta *Anas platyrhynchos* *Anser cygnoides*

Tringa ochropus

Ophicephalus argus *Spinibarbus hollandi* *Pseudorasbora parva* *Rhodeus sinensis*

Stress = 0.107

MDS2 / MDS1

habitats
- broad-leaved forest
- coniferous forest
- coniferous and broad-leaved forest
- waters
- countryside

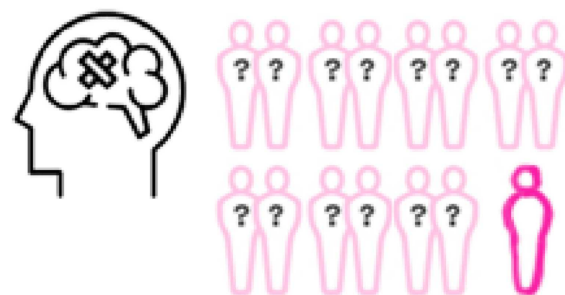|	2017 July				2023 July			
	Species	Individ	Biom	Body Length		Species	Individu	Bioma	Body Length
Cyprinida					Cyprinida				
	Black carp	79	29	1.2-5.1		Black carp	74	154.2	3.7-10.0
	Grass carp	93	66	1.5-5.4		Grass carp	19	10.6	2.6-4.4
	Redfin culter	1	1	4.6-4.6		Redfin culter	5	41.9	5.9-13.6
	Common carp	26	81	3.0-6.2		Common carp	6	41.7	3.5-9.9
	Crucian carp	164	246	1.5-5.3		Crucian carp	12	87.4	1.5-8.9
	Silver carp	22	30.2	2.9-4.9		Silver carp			
	Topmouth gudgeon	1060	326.2	0.9-5.9		Topmouth gudgeon	174	28.4	0.9-4.5
	Snakehead gudgeon	53	29.7	1.5-6.0		Snakehead gudgeon			
	Silver minnow	4	1.3	2.0-3.2		Silver minnow			
	Chinese bitterling	254	68.6	1.0-4.1		Chinese bitterling	176	110.3	1.2-4.1
	Chinese hook-snout carp	63	110.3	4.0-13.4		Chinese hook-snout carp	4	0.9	3.3-3.6
	White Amur bream	80	100.1	1.5-6.6		White Amur bream	30	164.8	2.4-7.0
	Round snout bream	7	4.2	30.-3.6		Round snout bream			
Loach					Loach				
	Chinese spined loach	2	2.6	4.6-4.8		Chinese spined loach	5	1.4	2.3-3.0
						Loach Misgurnus anguillicaudatus	53	42.6	1.7-7.2
Catfish					Catfish				
	Yellow catfish	6	25	2.4-9.2		Yellow catfish	34	161.6	2.6-12.0
Snakehea					Snakehea				
	Northern snakehead	28	17.8	1.7-3.7		Northern snakehead	38	21.6	2.3-5.2
Perch					Perch				
	Mandarin fish	2	0.3	1.7-1.8		Mandarin fish			
	Bigeye mandarin fish	1	0.1	1.3-1.3		Bigeye mandarin fish			

THE INVASIVE SPECIES

THE THREATEN SPECIES

HISTORY OF RIVER MANAGEMENT

Waterfront is limited. Due to the extensive management of river and the lack of a pedestrian-friendly system, the residents' experience of being close to the water is restricted.
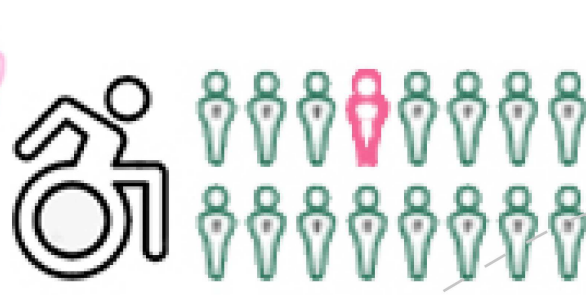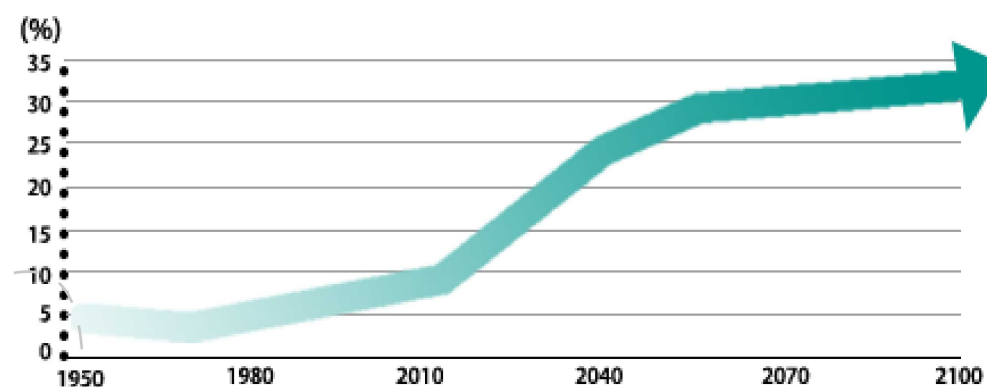

Senior citizen
Lack of rest and relaxation facilities

Road setting
The per capita length of greenway is less than 1.25 tenthousand/kilometer

The disabled
Accessibility facilities are less than or equal to 70%

Water affinity facilities
The disappearance of the river wharf has reduced the residents' water affinity experience and social spaces

Education facilities
There are few natural education venues

Service facilities
less than one location per hundred meters

Plant cultivation
The water mouth forest has low canopy closure

Eligible   Current

Psychiatric Patient

1 in every 15 people

Disabled People

1 in every 16.5 people

(%)
35
30
25
20
15
10
5

1950   1980   2010   2040   2070   2100

The proportion of people over 65 years old in China

2020 year nationwide
80-90
70-80
60-70
50-60
40-50
30-40
20-30
10-20
0-10
100000

2020 year WU YUAN
80-90
70-80
60-70
50-60
40-50
30-40
20-30
10-20
0-10
100000

Our vision for river restoration was to stimulate related processes and reboost river vitality. The Le'an River, the mother river of Wuyuan and the birthplace of Huizhou culture, is recognized as a national wetland park, bearing significant ecological responsibility and cultural value. This project adopts a One Health perspective, emphasizing the interconnected health of the river, the food chain, and human populations throughout their lifecycles.
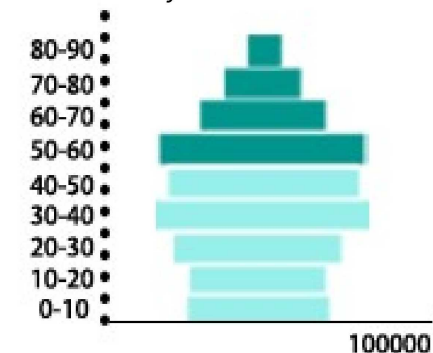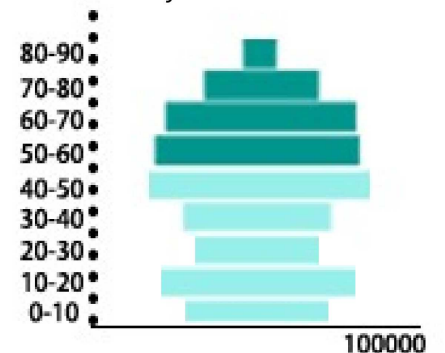
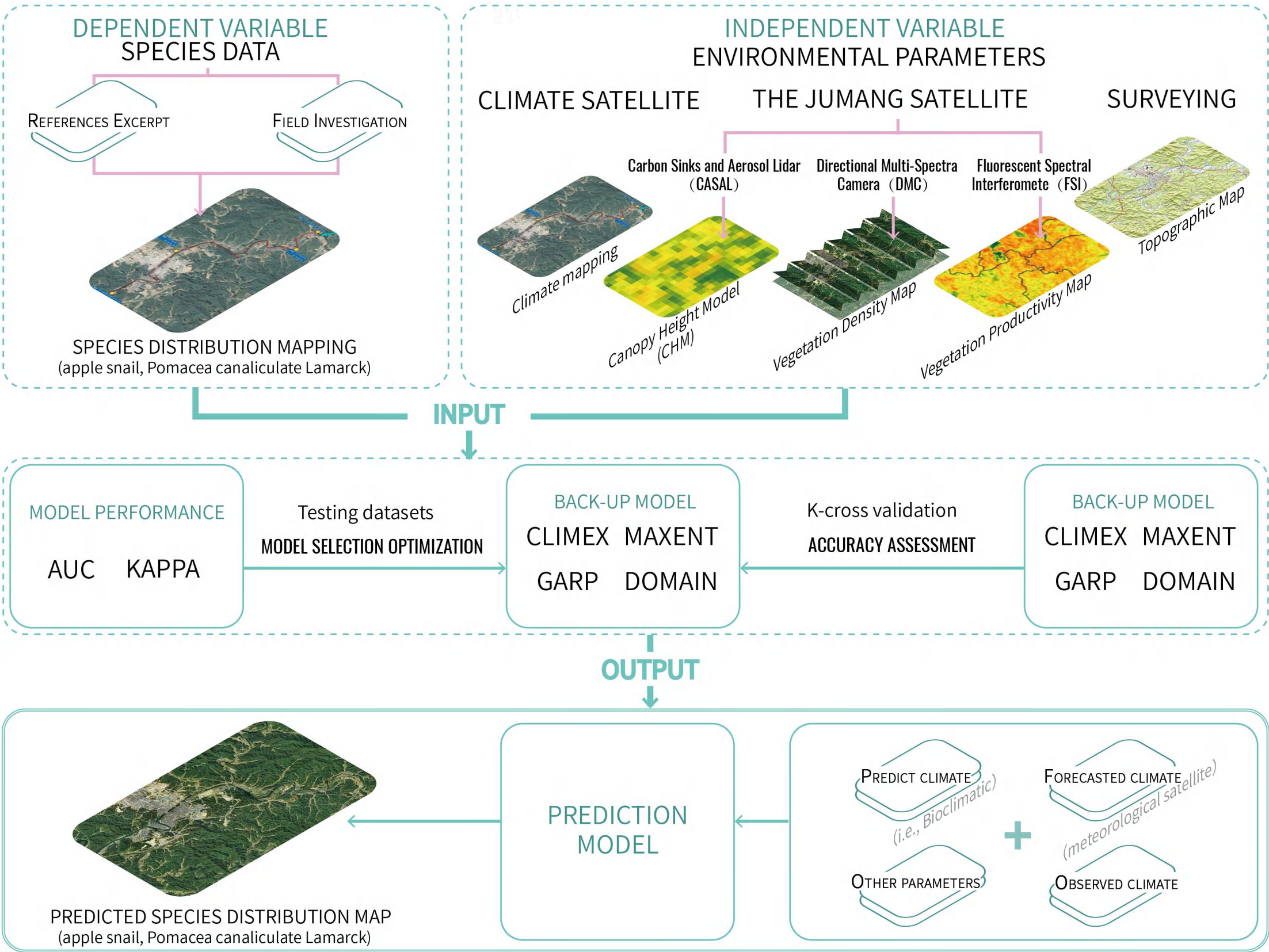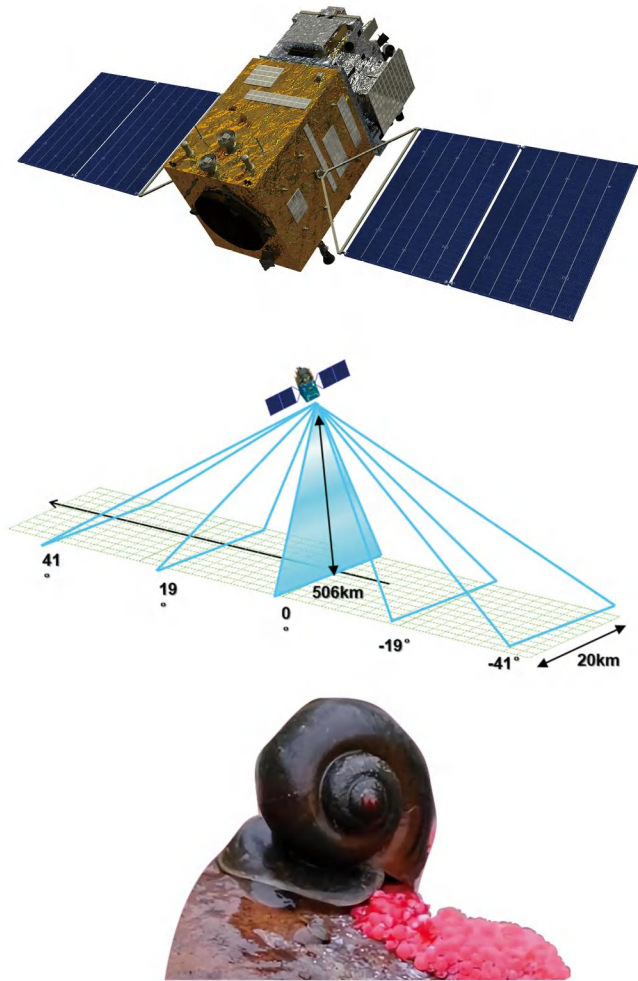# SATELITE ASSISTED INVASIVE SPECIES MONITORING

Our project is the first to conduct a research on using China's first dedicated land ecosystem carbon MONITORING SATELLITE —— THE JUMANG satellite for the forestry system. This satellite has observation methods such as hyperspectral data, stereo observation large-scale modeling, and plant fluorescence data, which are not available on ordinary GIS data-base, and is used for multi-dimensional ecosystem monitoring.

STAGE 1

DEPENDENT VARIABLE
SPECIES DATA

REFERENCES EXCERPT   FIELD INVESTIGATION

SPECIES DISTRIBUTION MAPPING
(apple snail, Pomacea canaliculate Lamarck)

INDEPENDENT VARIABLE
ENVIRONMENTAL PARAMETERS

CLIMATE SATELLITE   THE JUMANG SATELLITE   SURVEYING

Carbon Sinks and Aerosol Lidar (CASAL)   Directional Multi-Spectra Camera (DMC)   Fluorescent Spectral Interferomete (FSI)

Climate mapping

Canopy Height Model (CHM)

Vegetation Density Map

Vegetation Productivity Map

Topographic Map

INPUT

STAGE 2

MODEL PERFORMANCE

AUC   KAPPA

Testing datasets
MODEL SELECTION OPTIMIZATION

BACK-UP MODEL
CLIMEX   MAXENT
GARP   DOMAIN

K-cross validation
ACCURACY ASSESSMENT

BACK-UP MODEL
CLIMEX   MAXENT
GARP   DOMAIN

OUTPUT

STAGE 3

41°   19°   0°   506km   -19°   -41°   20km

PREDICTION MODEL

PREDICTED SPECIES DISTRIBUTION MAP
(apple snail, Pomacea canaliculate Lamarck)

PREDICT CLIMATE   FORECASTED CLIMATE
(i.e., Bioclimatic)   (meteorological satellite)

+

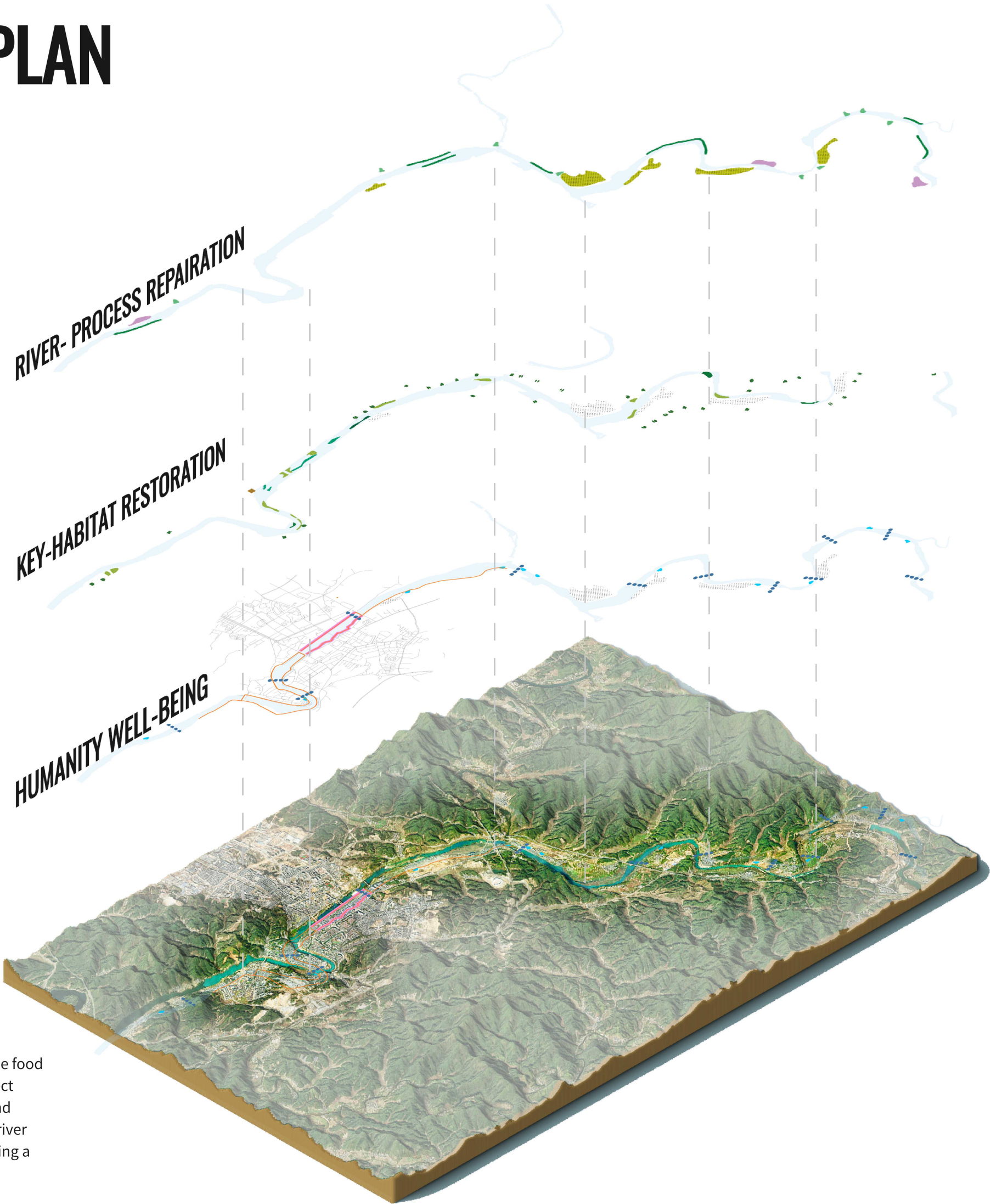OTHER PARAMETERS   OBSERVED CLIMATE

Based on the field survey data of the snail in Wuyuan, we reconstructed the quantitative relationship between the distribution of the snail and multiple sources of satellite remote sensing data such as land use and vegetation coverage, and then realized the inversion of the potential distribution of the snail. This study is the first to quantitatively analyze the spatiotemporal changes in the distribution of the snail in the Wuyuan area based on the remote sensing observation of the "Gumang" satellite. It provides technical support for predicting the potential distribution of snails under future climate change. It is expected to improve the risk-based monitoring system to cope with zoonoses and other health threats, and to help promote the development of a healthy society that is harmonious between people and nature.
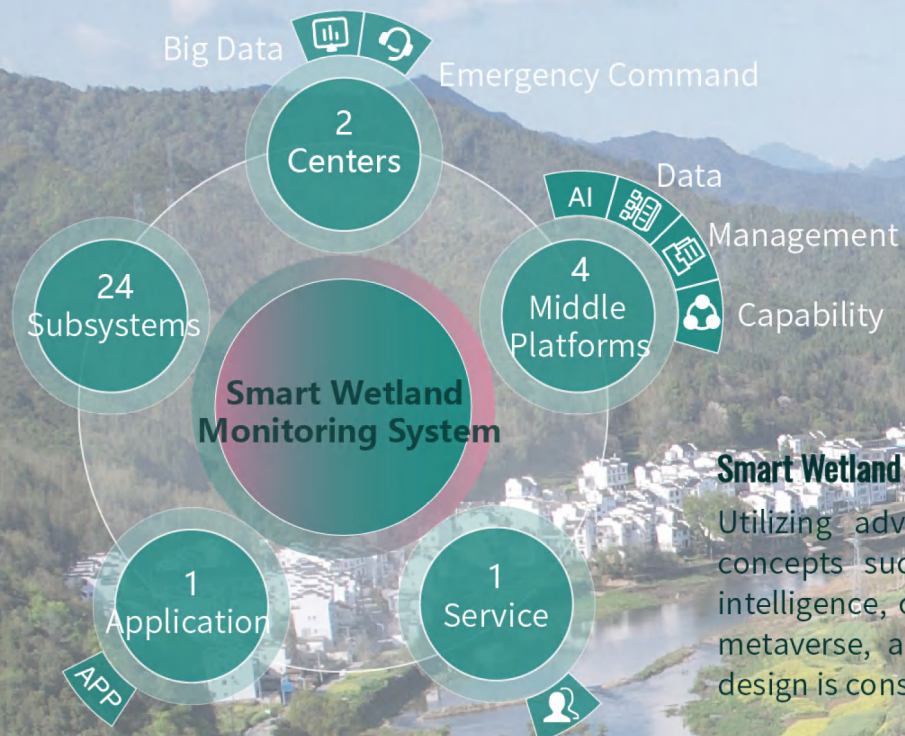
COMPREHENSIVE MASTERPLAN

LEGEND		
RIVER BASE REPAIRATION		Pollution-purification constructed wetland
		Rewilden wetland and tidal flats
		Restore natural shorelines
		Sand mining site restoration
		Add new wetland forests
		Supplement with aquatic plants
HABITAT INTERVENTION		Restored habitat for *Sarcocheilichthys nigripinnis*
		Firefly conservation research center
		Wildlife corridors
HUMAN HEALTH FACILITIES		Reconstructed river docks
		Wetland cultural corridor
		Health and wellness slow-traffic roads
		Accessibility facilities
		Restore cascading stones and water falls

RIVER- PROCESS REPAIRATION

KEY-HABITAT RESTORATION

HUMANITY WELL-BEING

This project adopts a One Health perspective, emphasizing the interconnected health of the river, the food chain, and human populations throughout their lifecycles.From a One Health perspective, this project aims to restore key fish populations, enhance food chain integrity, share waterfront living spaces, and establish a monitoring system. In the near future, the Le'an River is expected to become a beautiful river with ecological health, stable food chains, and improved residents' physical and mental health, setting a model for ecological civilization construction in Wuyuan and across China.

SMART WETLAND MONITORING SYSTEM

Big Data

Emergency Command

2 Centers

24 Subsystems

AI

Data Management

4 Middle Platforms

Capability

Smart Wetland Monitoring System

1 Application

1 Service

APP

Smart Wetland Monitoring System
Utilizing advanced technologies and concepts such as big data, artificial intelligence, cloud computing, and the metaverse, a smart wetland top-level design is constructed.
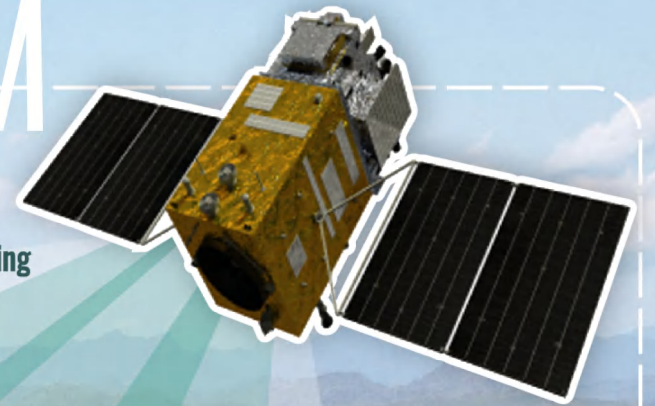
Satellite Remote Sensing

CCTV Surveillance

Infrared Camera

Unmanned Aerial Vehicle

Monitoring Robot

Unmanned Surface Vehicle

01 Sensor Layer

02 Platform Layer

Two centers collect various types of wetland monitoring data (including biodiversity data, spatial geographic data, patrol data, human activity data, etc.), comprehensively displayed in the form of a 'wetland map,' providing support for intelligent analysis and decision-making assistance.

Emergency Command Center

Big Data Center
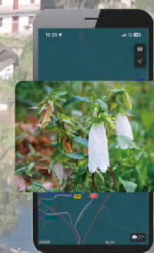
Smart Wetland Cloud Platform
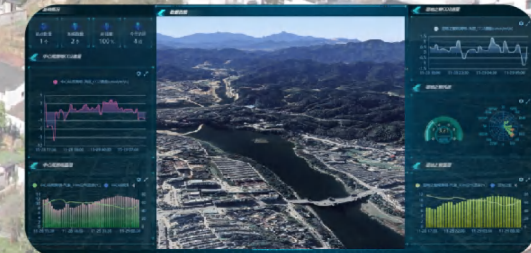
03 Presentation Layer

Wetland Patrol
The subsystem can combine personnel patrols to record patrol tracks and collect information.

The environmental monitoring subsystem can perform real-time monitoring of water quality, hydrology, meteorology, air quality.

Environmental Monitoring

The subsystem can identify birds through image and sound recognition.

Bird Identification

Human Activities
The subsystem can monitor and analyze human activities and vehicle movements within the park.

Fire and Smoke Detection
Monitoring can assist in providing early warnings for fire hazards.

04 Application Layer

RIVER HEALTH IMAPCT

A total of 30.52 hectares of tidal flats were added for mallard ducks, black water chickens and egrets.

The natural shoreline was restored 12 kilometers, and the water quality was stabilized in the whole section from class IV to class III.

3.15 hectares of wetland forest were added, and colorful trees were planted to enhance the landscape of Shuikou forest.

Adjust the upstream sluice to reduce the water temperature from 14.7-27.6 degrees to 11.8-23.2 degrees during the spawning season in April to July

UPSTREAM DAM INTERVENTION

4 discharge holes at different elevations, selected based on the migratory timing, spawning, and incubation requirements of various fish species to control or improve the water temperature of discharged water according to local conditions and timing.

REWILDEN WETLAND AND TIDAL FLATS

RESTORED WETLAND FORREST
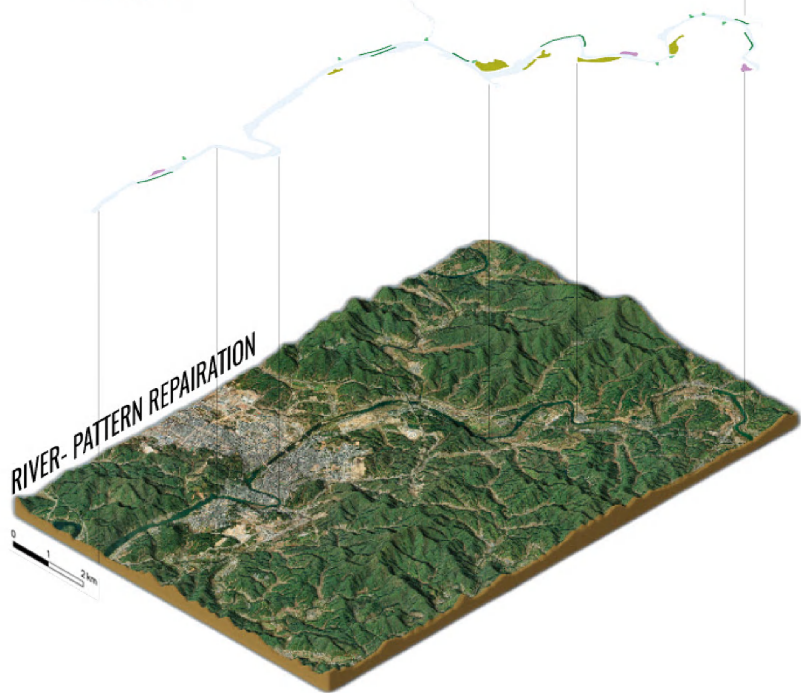
RIVER- PATTERN REPAIRATION

12 KM NATURAL SHORELINE

THE NATURAL SHORELINE WAS RESTORED 12 KILOMETERS, AND THE WATER QUALITY WAS STABILIZED IN THE WHOLE SECTION FROM CLASS IV TO CLASS III.

3.15 HA WETLAND FOREST

3.15 HECTARES OF WETLAND FOREST WERE ADDED, AND COLORFUL TREES WERE PLANTED TO ENHANCE THE FOREST LANDSCAPE OF THE ESTUARY.

14.7~27.6°C ↑ 11.8~23.2°C

ADJUST THE UPSTREAM SLUICE TO REDUCE THE WATER TEMPERATURE FROM 14.7-27.6 DEGREES TO 11.8-23.2 DEGREES DURING THE SPAWNING SEASON IN APRIL TO JULY

30.52 HA NEW TIDAL FLATS

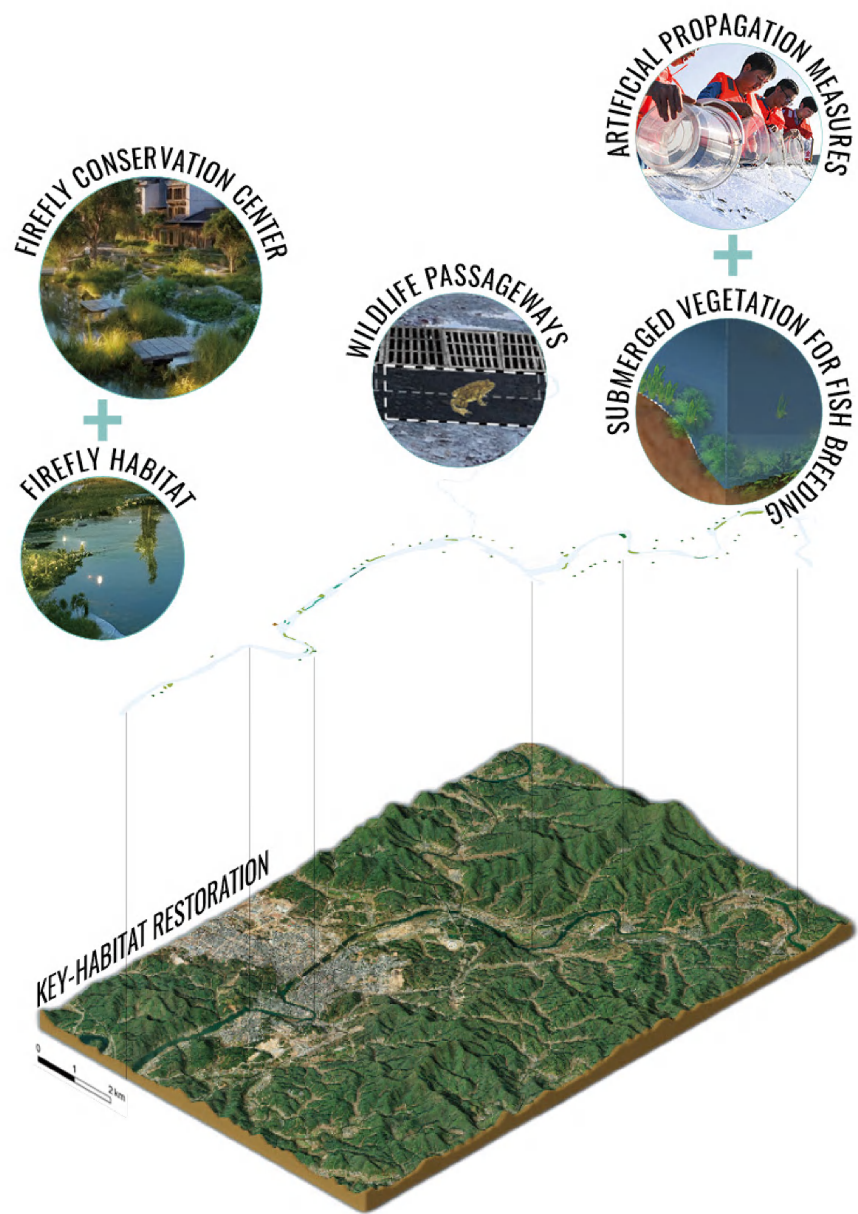ADD 30.52 HECTARES OF TIDAL FLATS WHERE MALLARDS, COMMON MOORHENS, EGRETS AND OTHER SPECIES INHABIT.

HEALTHIER ECO-CHAIN

Increase the number of birds that prey onlarge fish, with a 60% increase in mallard populations and an 80% increase inegrets. The population of spinibarbus and ophiocephala decreased by 30%,restoring the balance of the food chain.

The submerged vegetationarea was increasedby about 13.5 ha, and the evenness of the key species rhodeusnigrodorsalis wasincreased by 70%.

Establish a fireflyconservation center,increase the number of fireflies by 1 million through the"fireflyco-cultivation" system, and control the harm offushun snail on 200hectares.

Fifteen new wildlife passageways have been added to provide "green Bridges" for animals such as black-browed snake and tiger frog.

FIREFLY CONSERVATION CENTER
+
FIREFLY HABITAT
WILDLIFE PASSAGEWAYS
ARTIFICIAL PROPAGATION MEASURES
+
SUBMERGED VEGETATION FOR FISH BREEDING

KEY-HABITAT RESTORATION

1 🏠 | 1,000,000
ESTABLISH A FIREFLY CONSERVATION CENTER,INCREASE THE NUMBER OF FIREFLIES BY 1 MILLION THROUGH THE "FIREFLYCO-CULTIVATION" SYSTEM, AND CONTROL THE HARM OF FUSHUN SNAIL ON 200HECTARES.

13.5HA 70% ↑
THE SUBMERGED VEGETATION AREA WAS INCREASEDBY ABOUT 13.5 HA, AND THE EVENNESS OF THE KEY SPECIES RHODEUS NIGRODORSALIS WASINCREASED BY 70%.

60% 80% ↑ 30% ↓
INCREASE THE NUMBER OF BIRDS THAT PREY ONLARGE FISH, WITH A 60% INCREASE IN MALLARD POPULATIONS AND AN 80% INCREASE INEGRETS. THE POPULATION OF SPINIBARBUS AND OPHIOCEPHALA DECREASED BY 30%,RESTORING THE BALANCE OF THE FOOD CHAIN.

15
FIFTEEN NEW WILDLIFE PASSAGEWAYS HAVE BEENADDED TO PROVIDE "GREEN BRIDGES" FOR ANIMALS SUCH AS BLACK-BROWEDSNAKE AND TIGER FROG.

HEALTHIER LIFE-STYLE

We will build a 21-kilometer cultural corridor and a health and leisure travel system to improve residents' physical and mental health.

Barrier-free facilities are 100% complete, helping the elderly and disabled people to enjoy waterfront recreation.

Popular science education activities reached 50,000 people per year, raising public awareness of environmental protection.

The number of days with air average negative ions higher than or equal to 3000 /cm^3 increased from 185 days to 232 days in the repair of 12 landslide rocks.

HUMANITY FACILITIES

21km SLOW-MOVING SYSTEM

WE WILL BUILD A 21-KILOMETER CULTURALCORRIDOR AND A SLOW-MOVING SYSTEM FOR HEALTH AND WELLNESS, AND ENHANCE THEPHYSICAL AND MENTAL HEALTH OF RESIDENTS.

50,000 PEOPLE PER YEAR

POPULAR SCIENCE EDUCATION ACTIVITIESREACHED 50,000 PEOPLE PER YEAR, RAISING PUBLIC AWARENESS OF ENVIRONMENTALPROTECTION.

3000 /CM^3

THE NUMBER OF DAYS WITH AVERAGE NEGATIVEIONS ABOVE 3000 /CM^3 INCREASED FROM 185 TO 232 DAYS.

100% BARRIER-FREE FACILITIES

BARRIER-FREE FACILITIES ARE 100% COMPLETE, HELPING THE ELDERLY AND DISABLED PEOPLE TO ENJOYWATERFRONT RECREATION.

12 RIVER WATERFALL