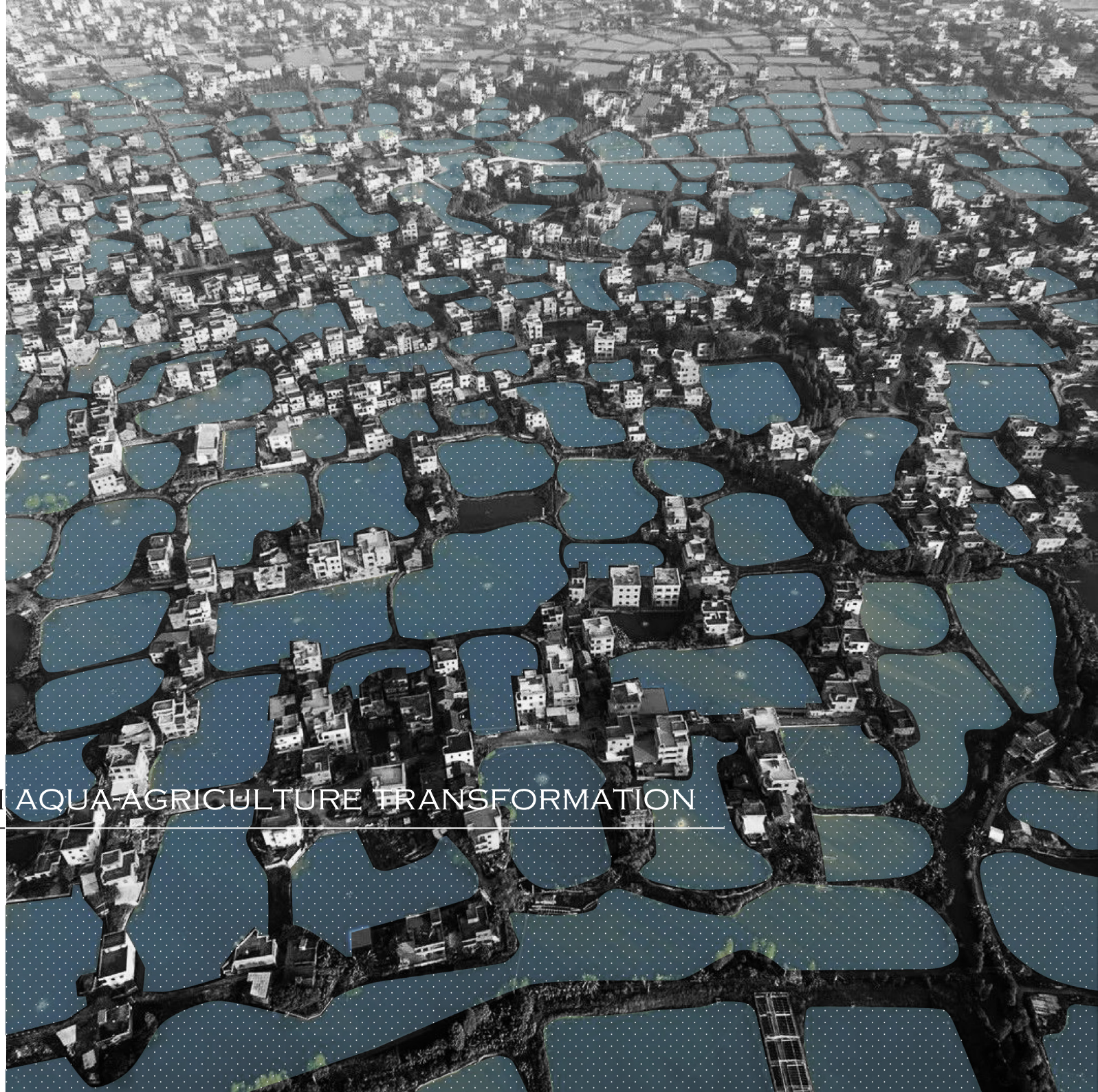


RESILIENCE THROUGH AQUA-AGRICULTURE TRANSFORMATION

TOWARDS A MULTISCALE APPROACH FOR ADAPTIVE LANDSCAPE DEVELOPMENT IN PEARL RIVER DELTA

Chuanzhi Sun
Mentor:
Steffen Nijhuis
Gregory Bracken



A typical rural landscape under transformation in Shunde, Pearl River Delta

CONTENT

01.INTRODUCTION
The problem and research question

02.ANALYSIS AND PRINCIPLES
Understand the landscape of PRD

03.DESIGN EXPLORATION AT REGIONAL SCALE
Strategic plan and intervention

04.ELABORATION AT LOCAL SCALE IN RURAL CONTEXT
Elaboration and phasing

05.CONCLUSION AND REFLECTION
Generic and specific lessons



A typical rural landscape under transformation in Shunde, Pearl River Delta

01. INTRODUCTION

I. FASCINATION
II. PROBLEM STATEMENT
III. RESEARCH OBJECTIVE &QUESTION
IV. METHODOLOGY
V. RESEARCH SCOPE





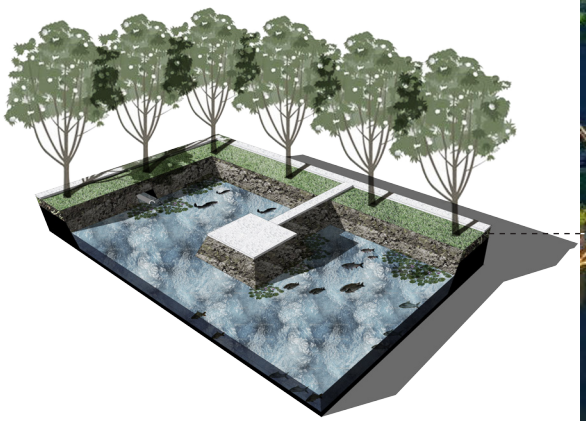
FASCINATION

-An integrated system of agriculture, aquaculture and water dwelling

-An adaptive and productive landscape

-An unique solution especially for the flood prone region, Shunde district of Pearl River Delta.





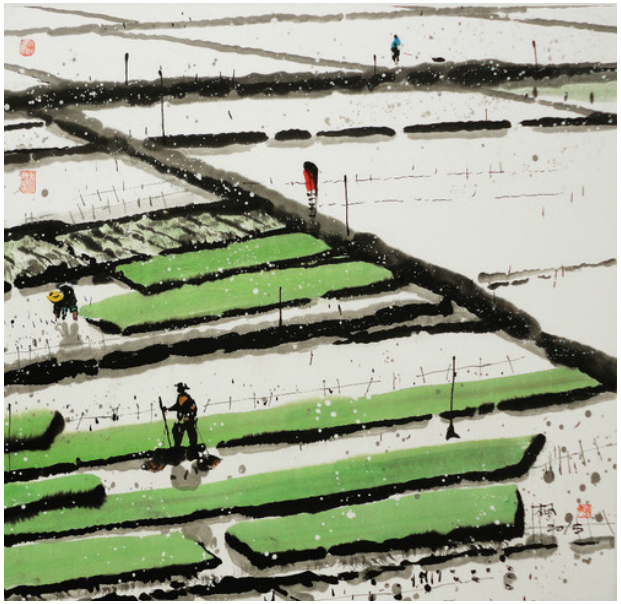
HOUSING

FISHPOND

BANANA DYKE

MULBERRY DYKE

TRADITIONAL LIFE IN PRD: CLOSE RELATIONSHIP WITH WATER



AGRICULTURE OVER THOUSANDS OF YEARS



FISHING ACTIVITY IN LOWLAND OF PRD



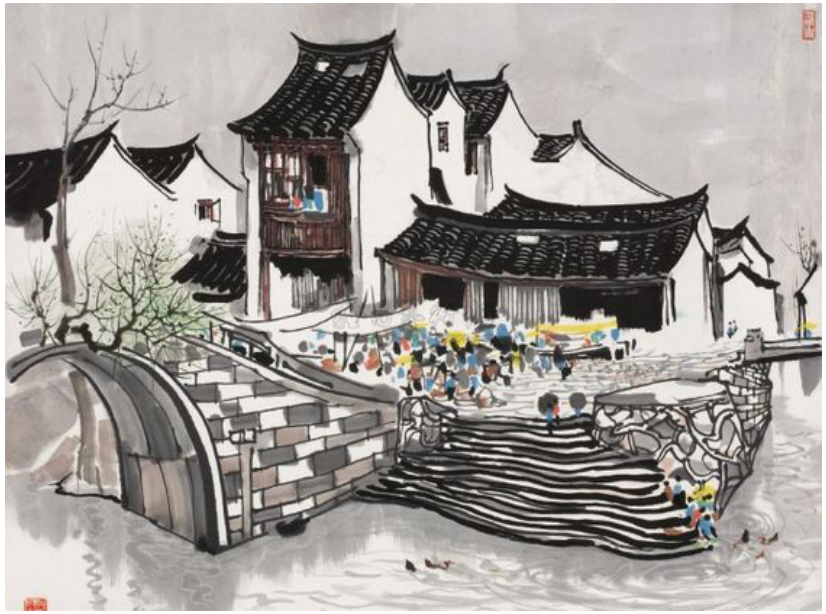
INTEGRATION OF AGRICULTURE AND AQUACULTURE UPON WATER



TRANSPORTATION TROUGH WATER



WATER DWELLINGS



PUBLIC LIFE BESIDES WATER

CURRENT PRD: WATER AS A THREAT

MAIN THREAT I: RIVER FLOOD

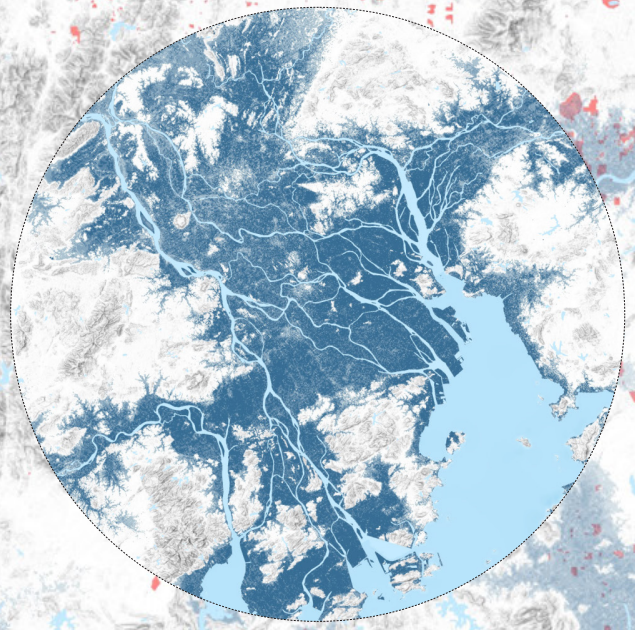
-River dominated delta
-Subtropical monsoon season climate

MAIN THREAT II: RAIN

-Heavy rain fall increases discharge and danger of internal flood in city region

THREAT III: SEA LEVEL RISING

-Sea level rising and urbanization in flood prone zone



LOWLANDS IN FLOOD PRONE AREAS(+10M) OF PRD

MAP: STEFFEN NIJHUIS


INTENSIFIED FLOOD BY
-Dramtic urbanization in alluvial plain
-Long-term of dyke construction and channelization
DEMOLISH CONSTRUCTION
1990
2017
DRMATIC URBANIZATION
1979
2003
DYKE & CHANNELIZATION
1000
1600
1900
2015

CONCLUSION

THE DELTA IS IN GREAT DANGER FROM WATER.

CAN WE MAKE THE URBAN DELTA IN PEARL RIVER MORE RESILIENT AGAINST FLOOD BY APPROACH OF AQUA-AGRICULTURE TRANSFORMATION?



RAIN STORM IN GUANGZHOU CAUSED BY TYPHOON IN 2005



RIVER FLOOD OF WEST RIVER IN 1998 (FLOOD IN 100



RIVER FLOOD OF WEST RIVER AND NORTH RIVER IN 1994 (FLOOD IN 50 YEARS)

RESEARCH OBJECTIVE

EXPLORE STRATEGIES/DESIGN PRINCIPLES FOR WATER RESILIENT URBAN LANDSCAPE DEVELOPMENT BASED ON DYKE-POND SYSTEM, WATER MANAGEMENT METHODS IN THE FLOODPLAINS OF THE WESTRIVER THROUGH MULTI-SCALE

RESEARCH QUESTION

-What are the traditional dyke-fish pond system and ecological water management and its social structure through different scales ?

-What are the principles about living with water including water management(Storage, Drainage and Purification), ecology(Biodiversity), agriculture and social structure(Water culture, Activities)?

-How to apply principles to resilient design explorations in relation to water management, ecology, urbanization(Water dwelling, Circularity) and social structure(Water recreation)?

-What are the lessons (principles&strategies) learned of connecting agri-aquaculture, water management, urbanization to make a new type of delta urban landscape?

-What is the possibility of its application in other region?



RESEARCH SCOPE

L. REGIONAL SCALE (Shunde district)

NORTH RIVER

WEST RIVER

XINGTAN COUNTY

SHUNDE DISTRICT, FOSHAN CITY



S. VILLAGE AND BUILDING SCALE(multiple site)

MADONG VILLAGE

M. COUNTY SCALE(Xingtan county)

02. UNDERSTAND THE LANDSCAPE

I. DYKE-FISHPOND AS A SPECIAL AGRICULTURE

II. MULTISCALAR WATER MANAGEMENT

III. MODERN INTERVENTION



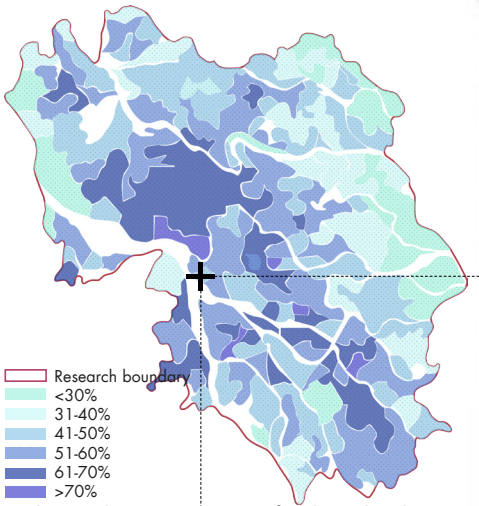
A banana-fishpond in Xingtan county, Shunde district, Foshan city

DYKE-FISHPOND AS A SPECIAL AGRICULTURE

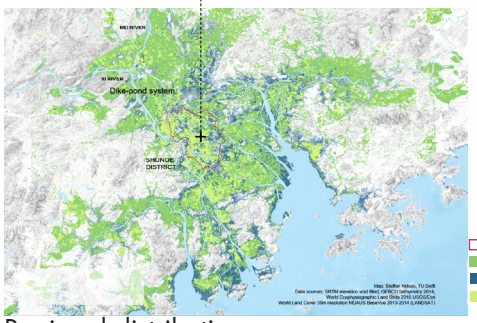
-CONCENTRATION IN FLOOD PRONE ZONE
in Shunde district between West River and North River

-CIRCULAR SYSTEM
Energy & material circulation and reuse

-INTEGRATED SYSTEM
Agriculture production, ecological benefit and flood protection



Fishpond percentage of Shunde district



Regional distribution

MATERIAL FLOW

SILKWORM

FILATURE

MULBERRY LEAF

COCOON WASTE &EXCREMENT

MICROORGANISM

DIKE

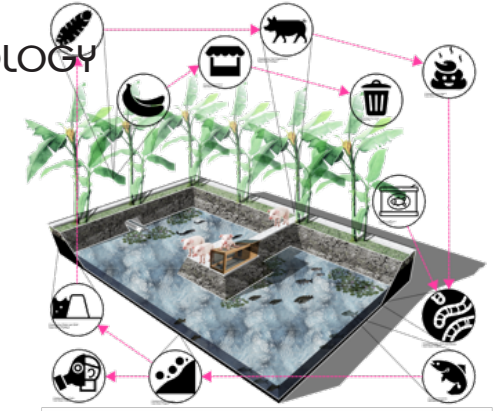
POND MUD

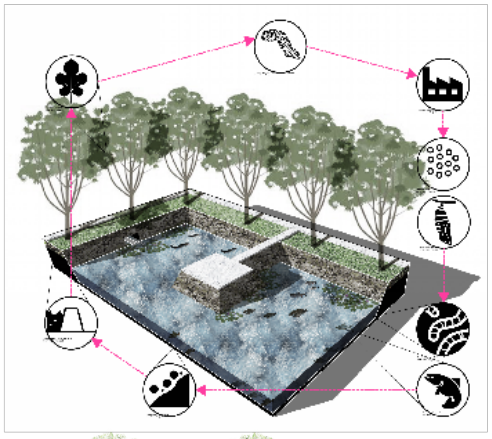
FISH

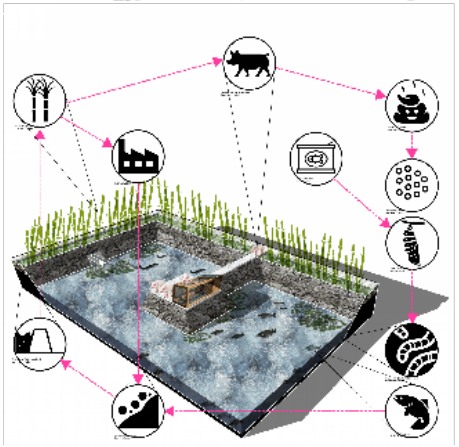
TRANSFORMATION AND TYPOLOGY

INTEGRATED SYSTEM

Circulation and
Low environmental impact

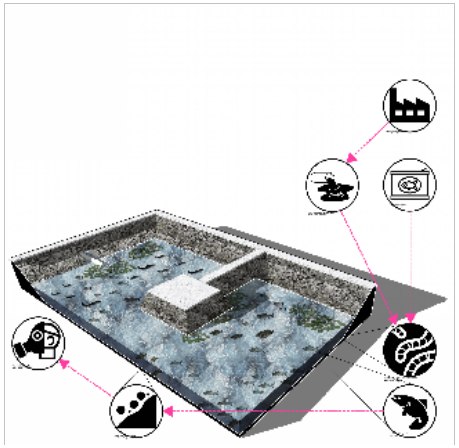




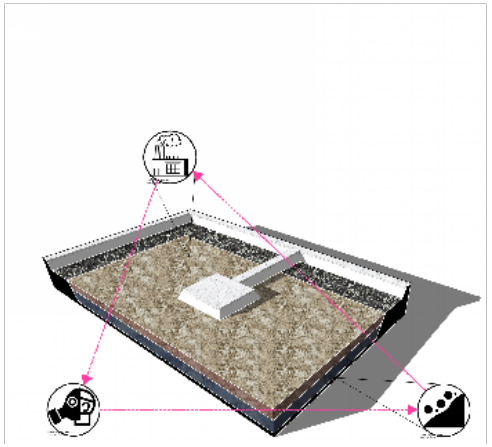


MONO SYSTEM

Massive production



Industrialization









1018	1350	1650	1750	1866	1926	1929	1936	1945	1949	Now
Capture/ Collection	Fishery/ Cultivation	Mulberry-fishpond	Paddy transformation	Revolution promotion	Peak period	Great depression	Sugarcane transformation	Japanese aggression	Industrialization	Urbanization

PROBLEMS


Channelization


Demolishment

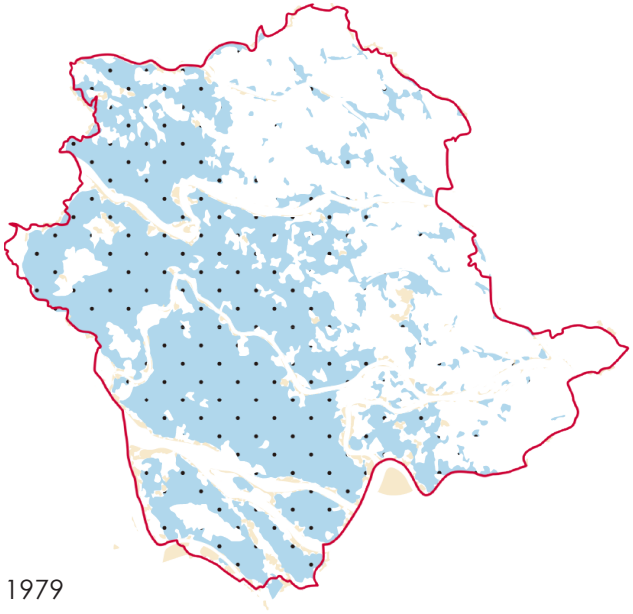

Deplanting

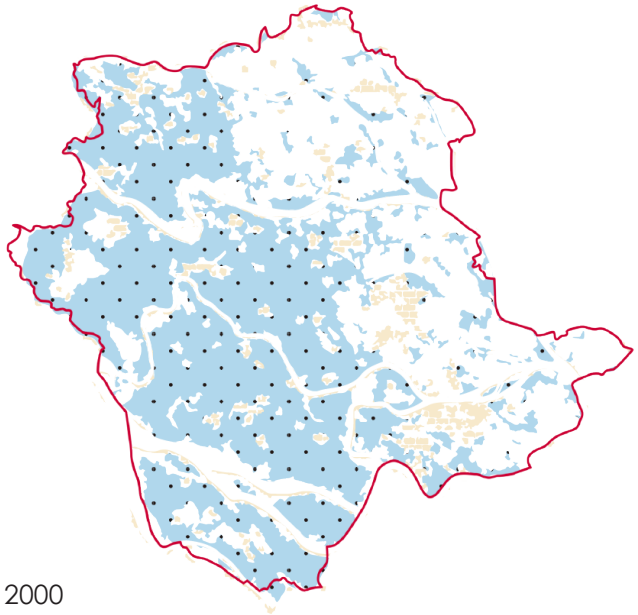

Eutrophication

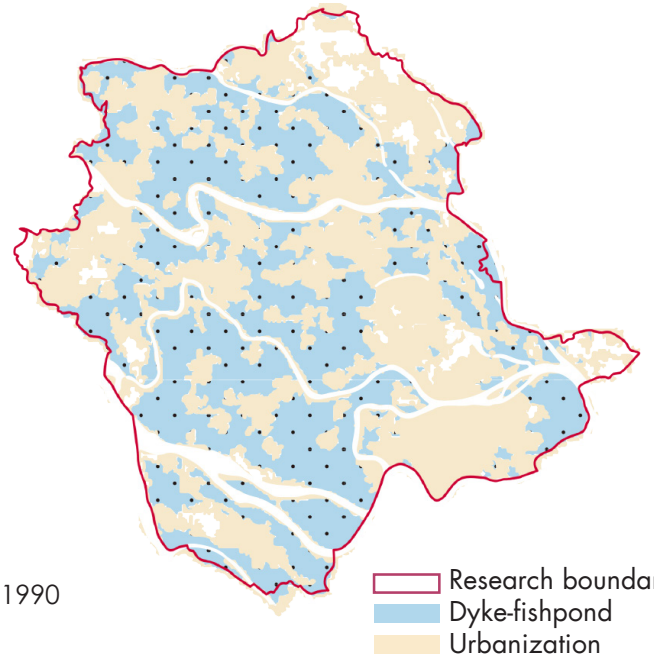

Pollution


Rationalization

DECLINE OF DYKE-FISHPOND IN SHUNDE DISTRICT


1979


2000



1990

CONCLUSION

-PRINCIPLES TOWARDS WATER-SENSITIVE DESIGN
Flood resilience
Reuse and circulation

-MODERN PROBLEMS
From integrated system to mono-system
From circulation to pollution

HISTORICAL WATER MANAGEMENT

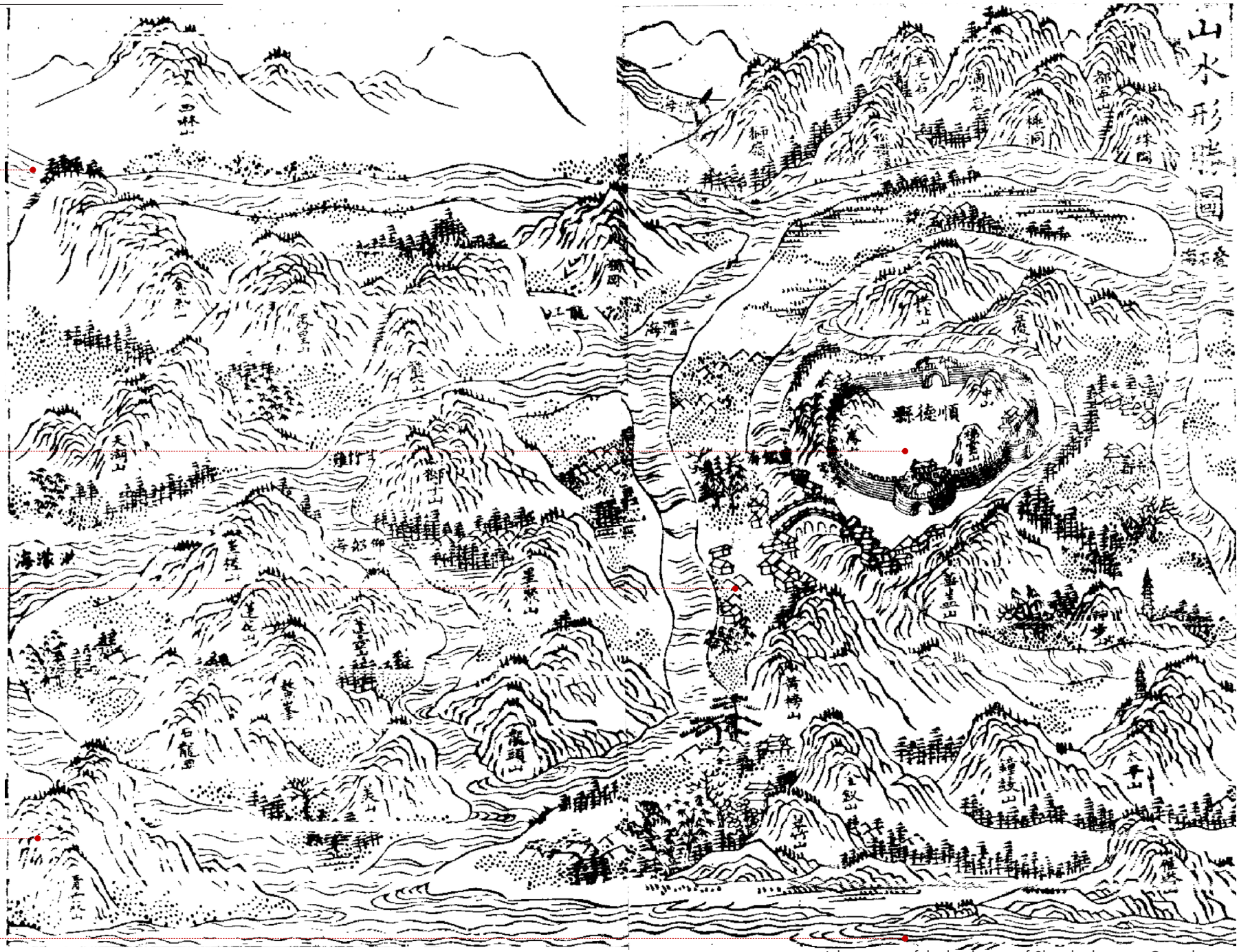
North river

Regional center

Villages &
Dyke-fishponds

Mountains

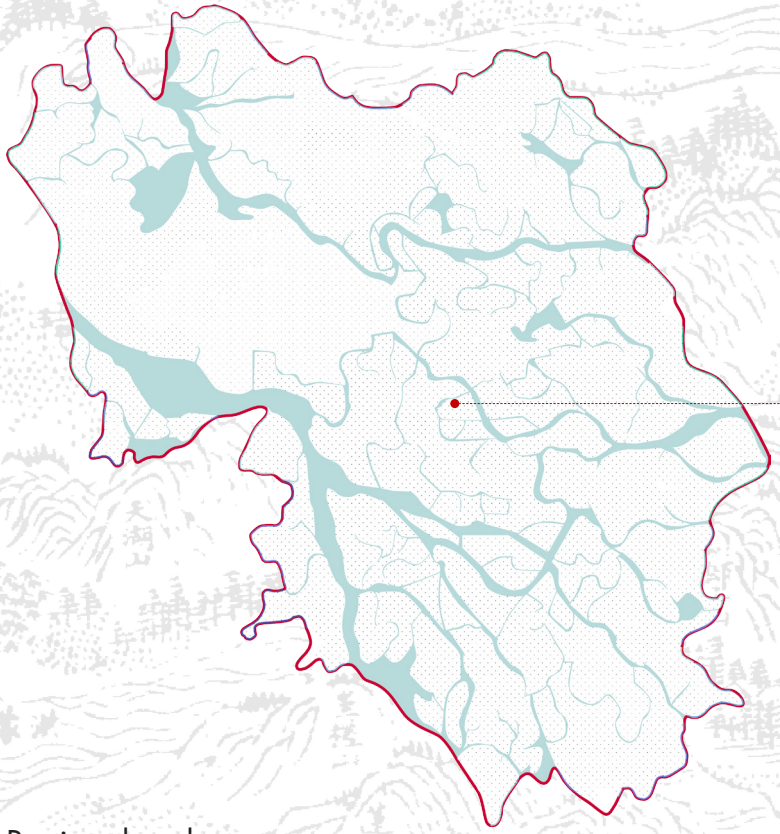
West River



Ink painting of the landscape of Shunde district in Qing dynasty

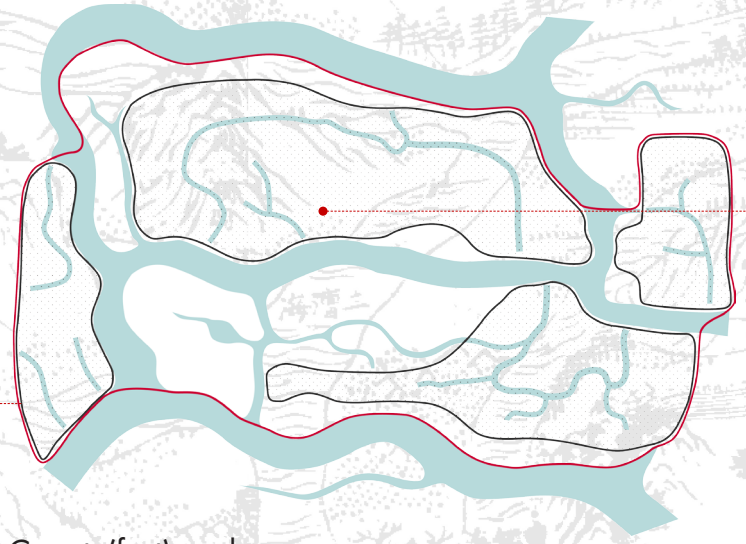
source: Annals of Shunde County (順德县志)

MULTISCALAR WATER MANAGEMENT



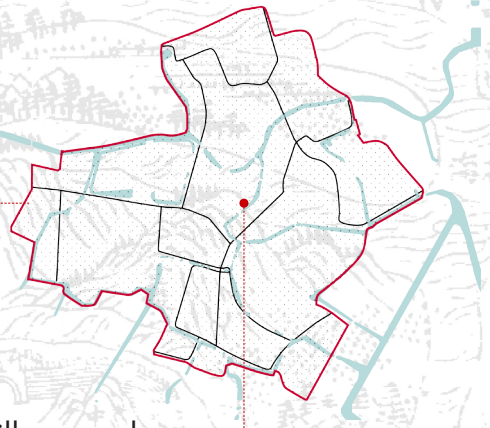
Regional scale

40,000 m



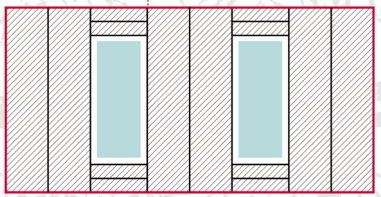
County(fort) scale

4,000 m



Village scale

1,000 m



Building scale

40 m

Research boundary
Hydrology
Dyke

REGIONAL SCALE WATER MANAGEMENT

LONG PROCESS & COLLABORATION

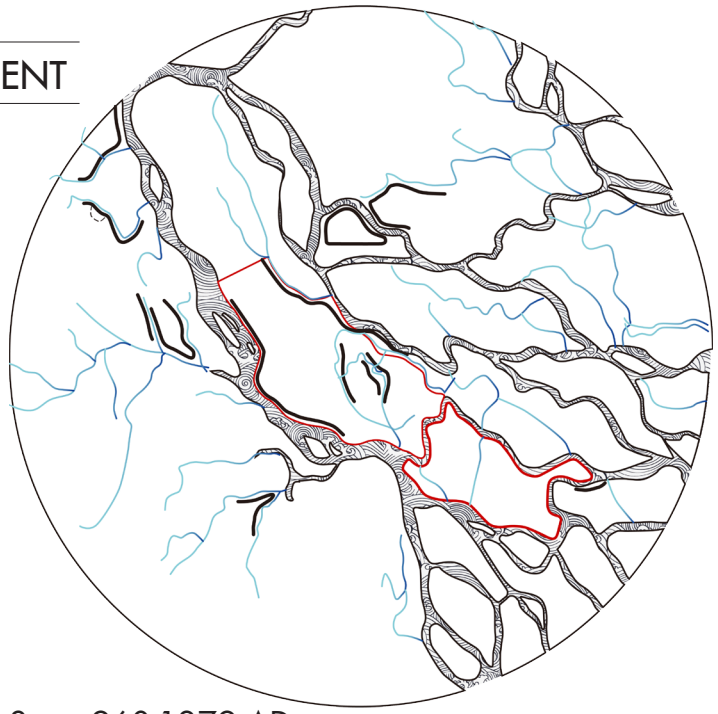
Song dynasty
-Linear dyke with proper distance from river

Yuan dynasty
-Half open dyke ring to protect flood from two main rivers

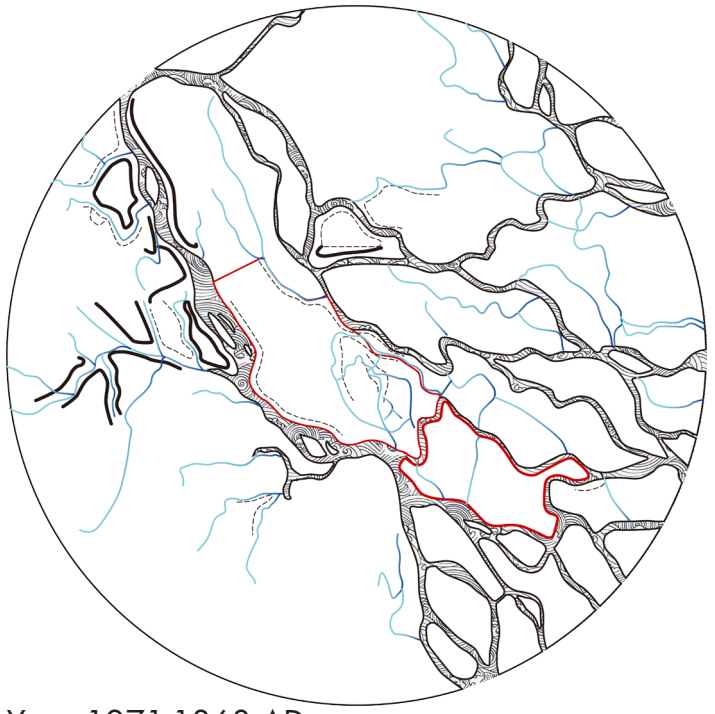
Ming dynasty
-Closed dyke ring construction to protect flood from rivers and sea tide

Qing dynasty
-Coalescence of smaller dykes into large ones and dyke-fishponds towards internal flood.

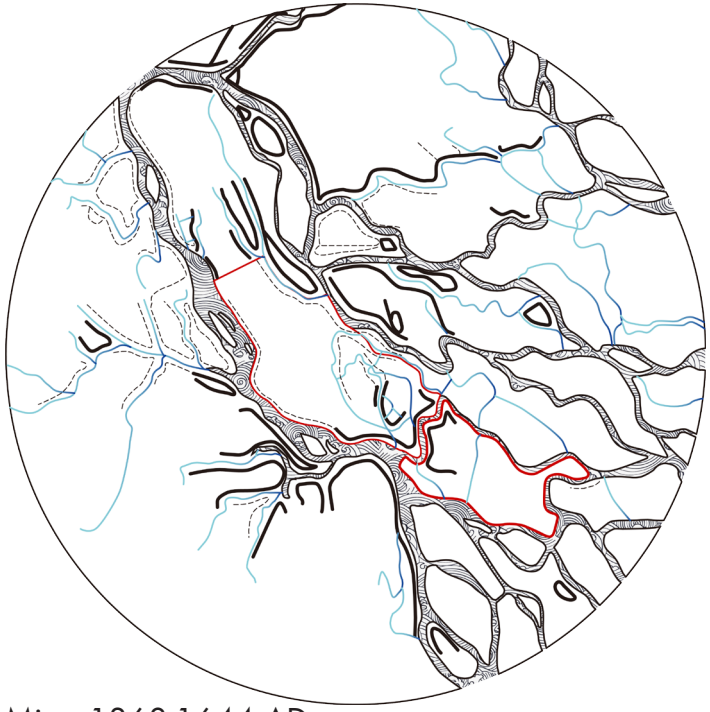
Research boundary
Internal river
Dyke construction
Historical dyke
County border
External river



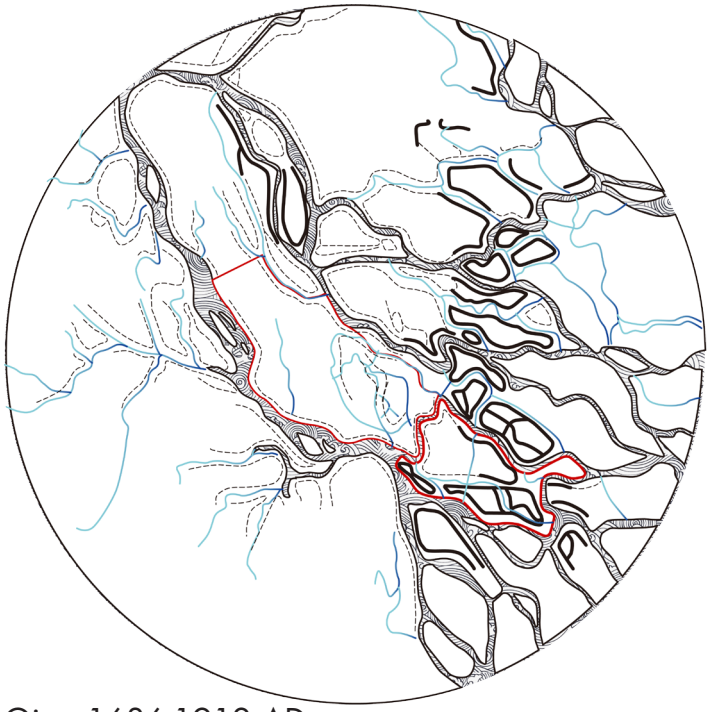
Song 960-1279 AD



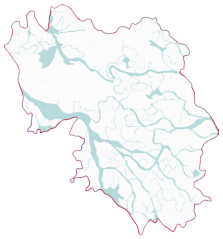
Yuan 1271-1368 AD



Ming 1368-1644 AD



Qing 1636-1912 AD



COUNTY SCALE WATER MANAGEMENT

Collection

基塘
Dike fish pond

河涌
Internal River

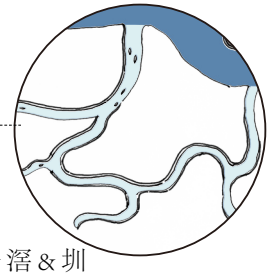
堤围
Dike

海
External

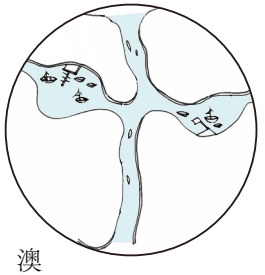
Drainage

勒流堡图
Leliu Fort Map

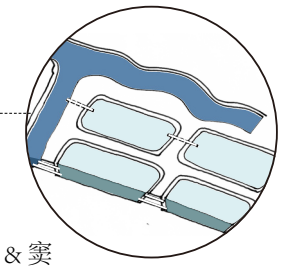




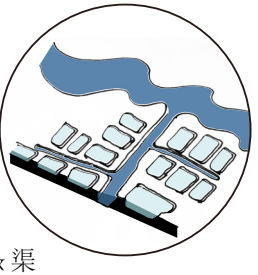
涌 & 滘 & 圳
Internal River & Creek & rivulet



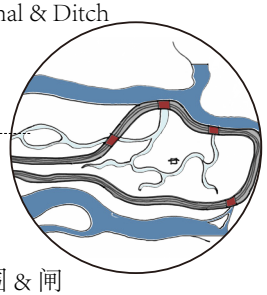
澳
Bay



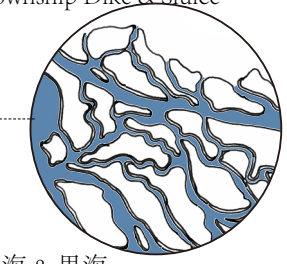
塘 & 窦
Pond & Drainage hole



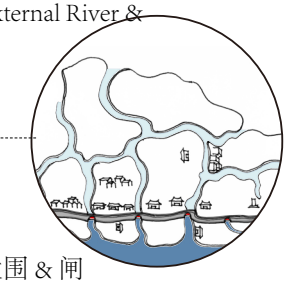
堑 & 渠
Canal & Ditch



子围 & 闸
Township Dike & Sluice

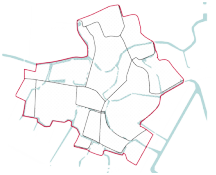


大海 & 里海
External River &

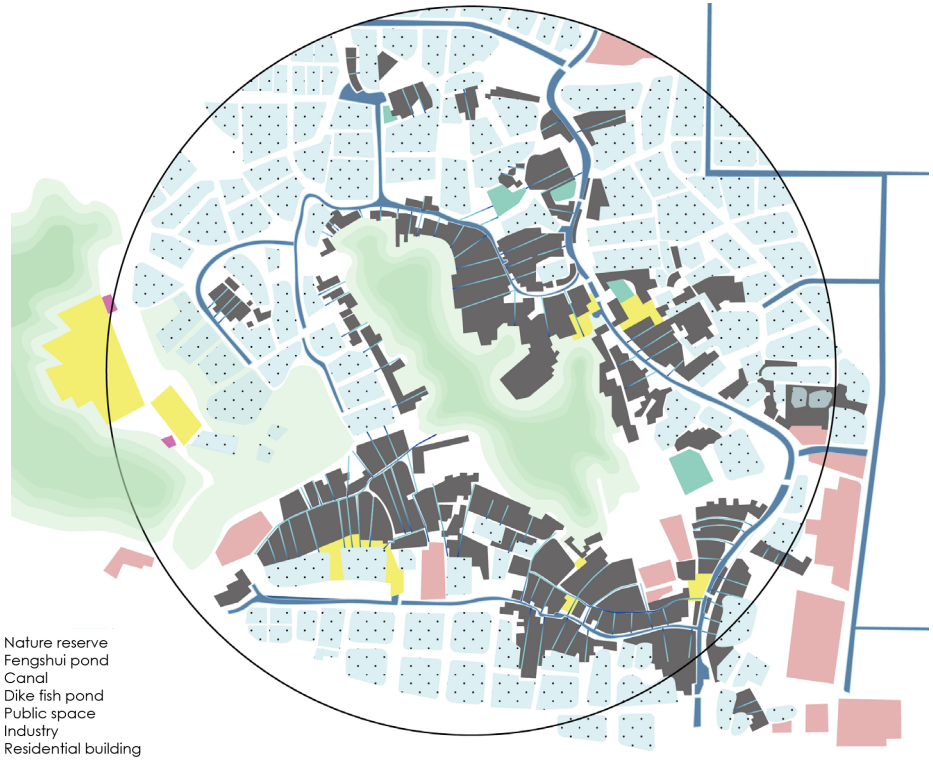


大围 & 闸
Regional Dike & Sluice

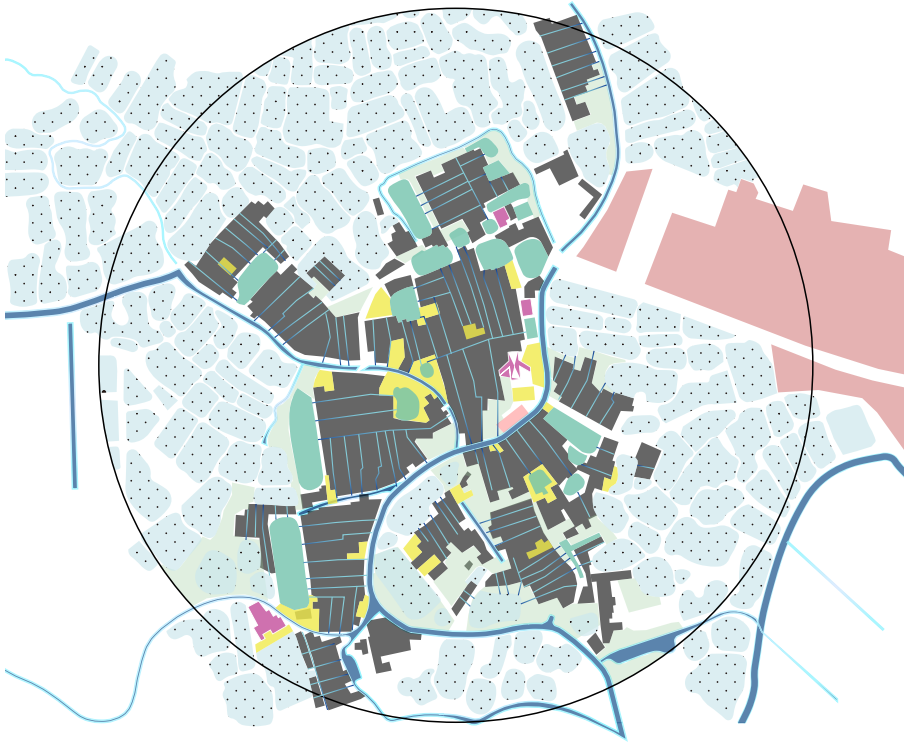
VILLAGE SCALE WATER MANAGEMENT



MOUNTAIN VILLAGE

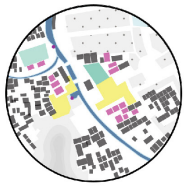


PLAIN VILLAGE





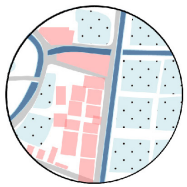
Layout&Drainage



Public space& Cultural building



Agriculture



Industry&Infrastructure



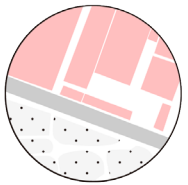
Layout&Drainage



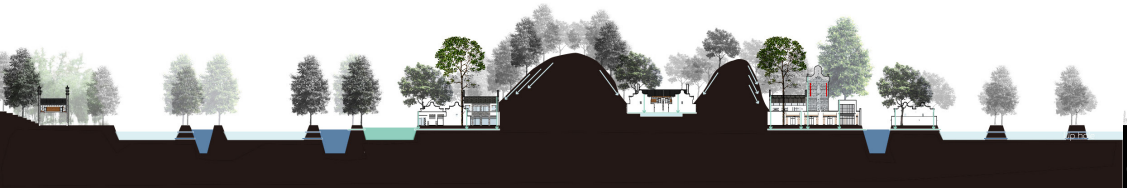
Public space& Cultural building

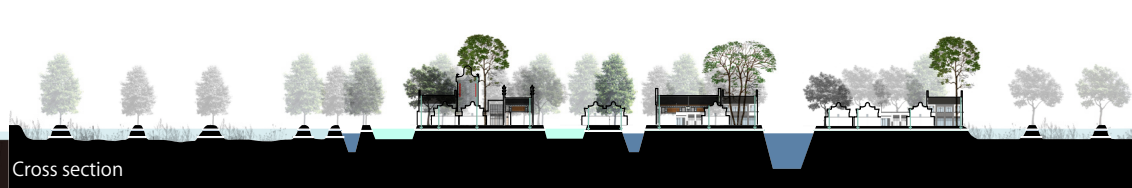


Agriculture



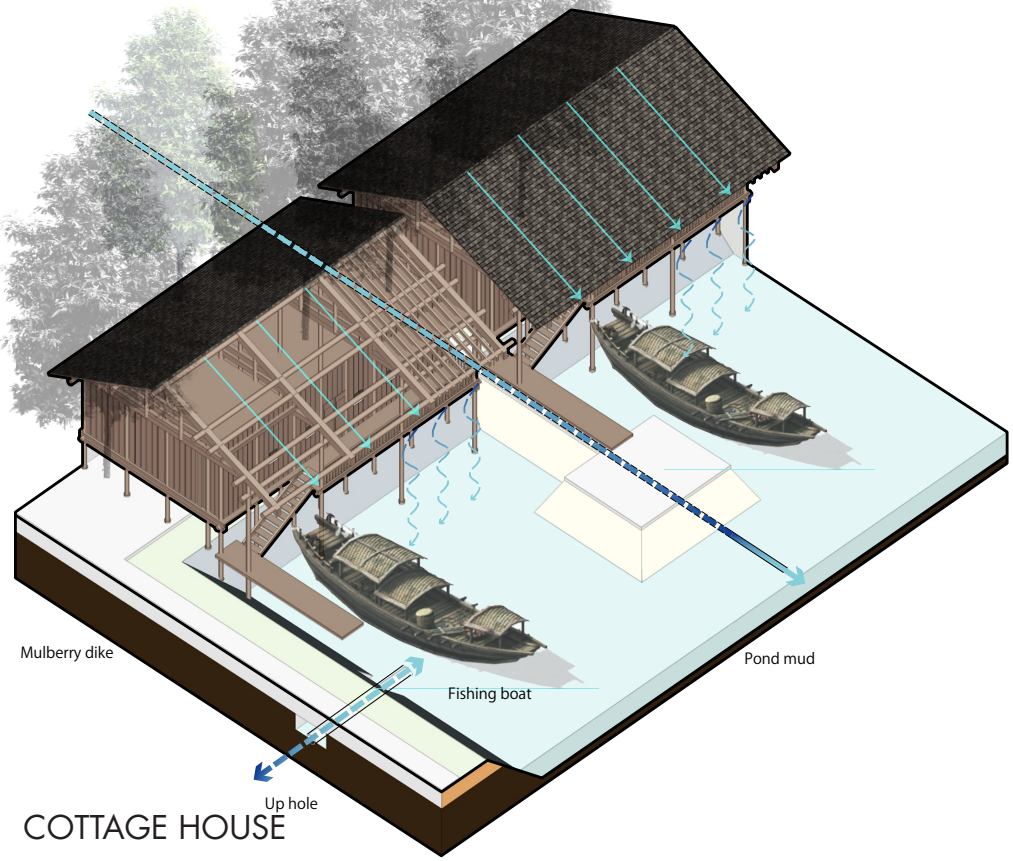
Industry&Infrastructure



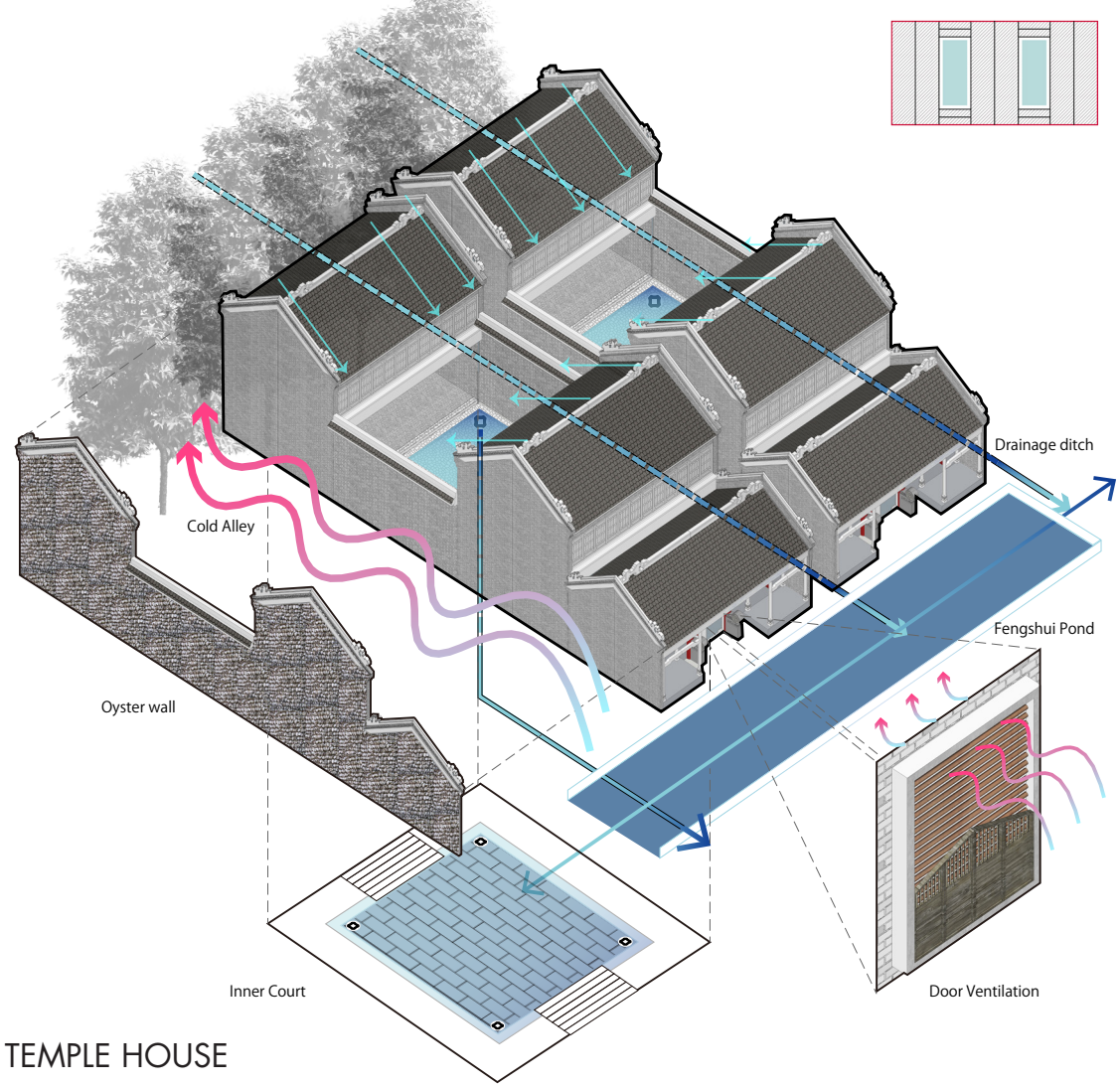


Cross section

BUILDING SCALE WATER MANAGEMENT



COTTAGE HOUSE



TEMPLE HOUSE


Chinese fir


Rice husk


Mulberry tree branch

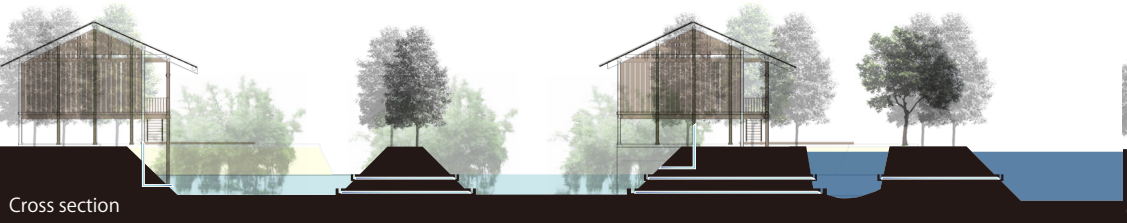

Pine bark

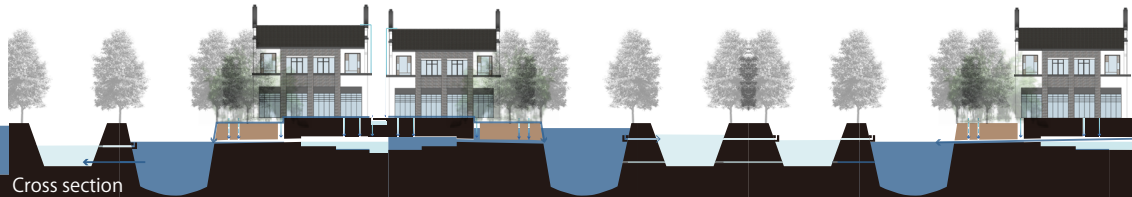

Oyster shell


Blue Brick


Pebble


Glazed brick


Cross section


Cross section

PRINCIPLES THROUGH MULTISCALE

-LONG-TERM DEVELOPMENT PROCESS

-COLLABORATIVE EFFORT

-MULTISCALE APPROACH

-UNDERSTANDING TERRAIN CONDITIONS

-WORKING WITH NATURE

-SPACE FOR WATER

-MULTIFUNCTIONAL WATER MANAGEMENT

-RE-USE AND CIRCULARITY

Building scale

Village scale

County scale

Regional scale

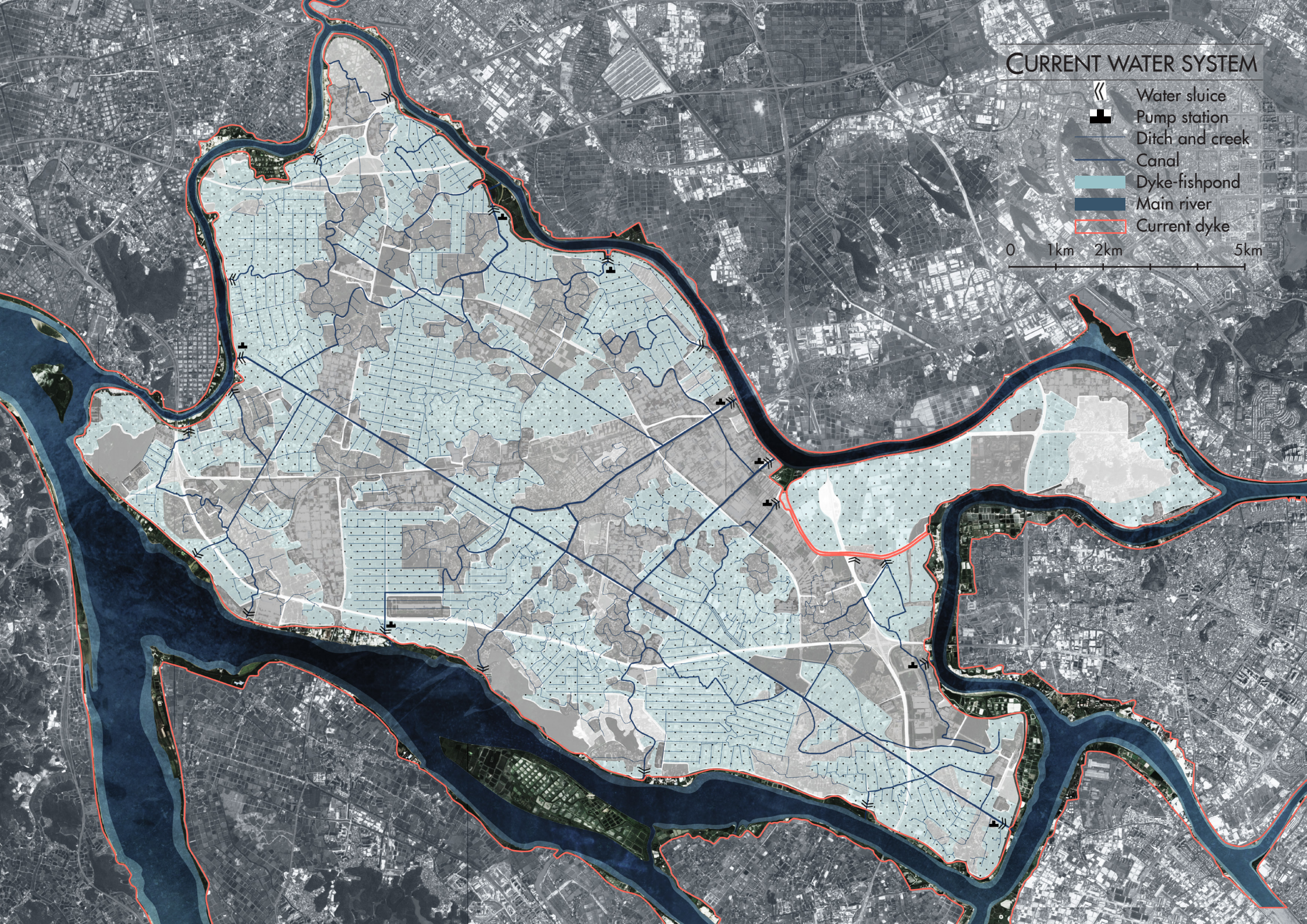




03. DESIGN EXPLORATION AT REGIONAL SCALE

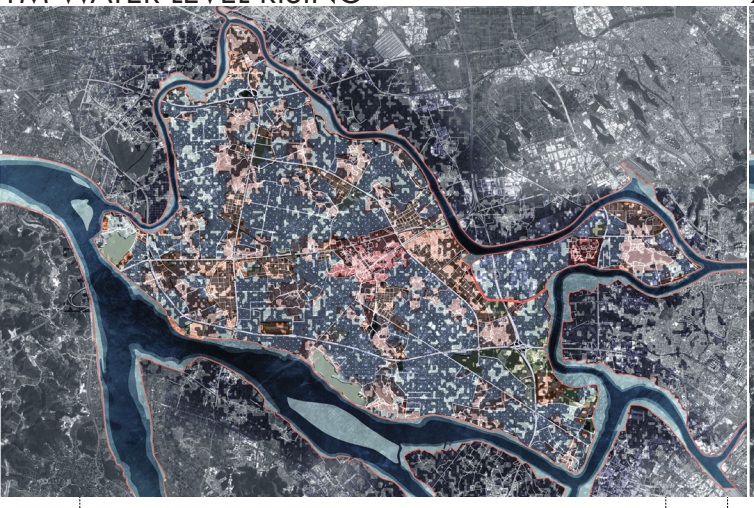
I.BACKGROUND ANALYSIS
II.PRINCIPLE AND STRATEGY
III.REGIONAL PLAN AND STRATEGY
IV.THEMATIC PLAN AND INTERVENTION
V.VISION


CURRENT LAND USE
Modern urbanization
Industry
Transformed agriculture
Dyke-fishpond
Historical village
Main river
Current dyke
0
1km
2km
5km

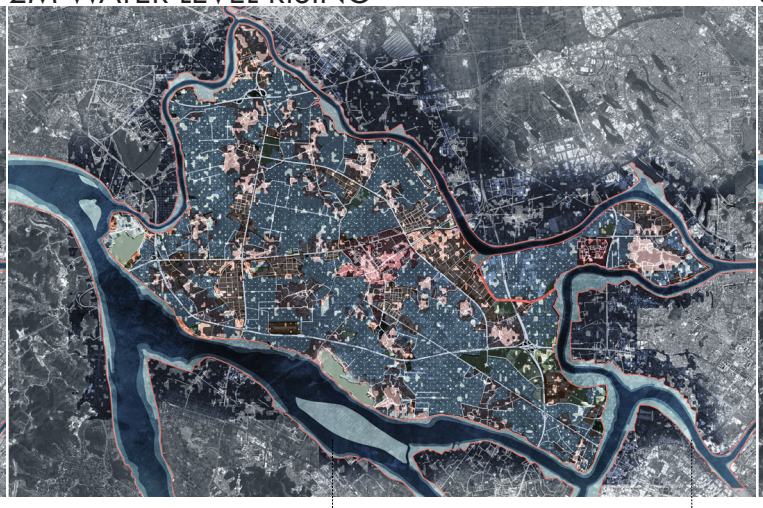

CURRENT WATER SYSTEM
Water sluice
Pump station
Ditch and creek
Canal
Dyke-fishpond
Main river
Current dyke
0
1km
2km
5km

FLOOD SEQUENCE

1M WATER LEVEL RISING



2M WATER LEVEL RISING



3M WATER LEVEL RISING



October November December January February March April May

"四月八" FLOOD

June July August September

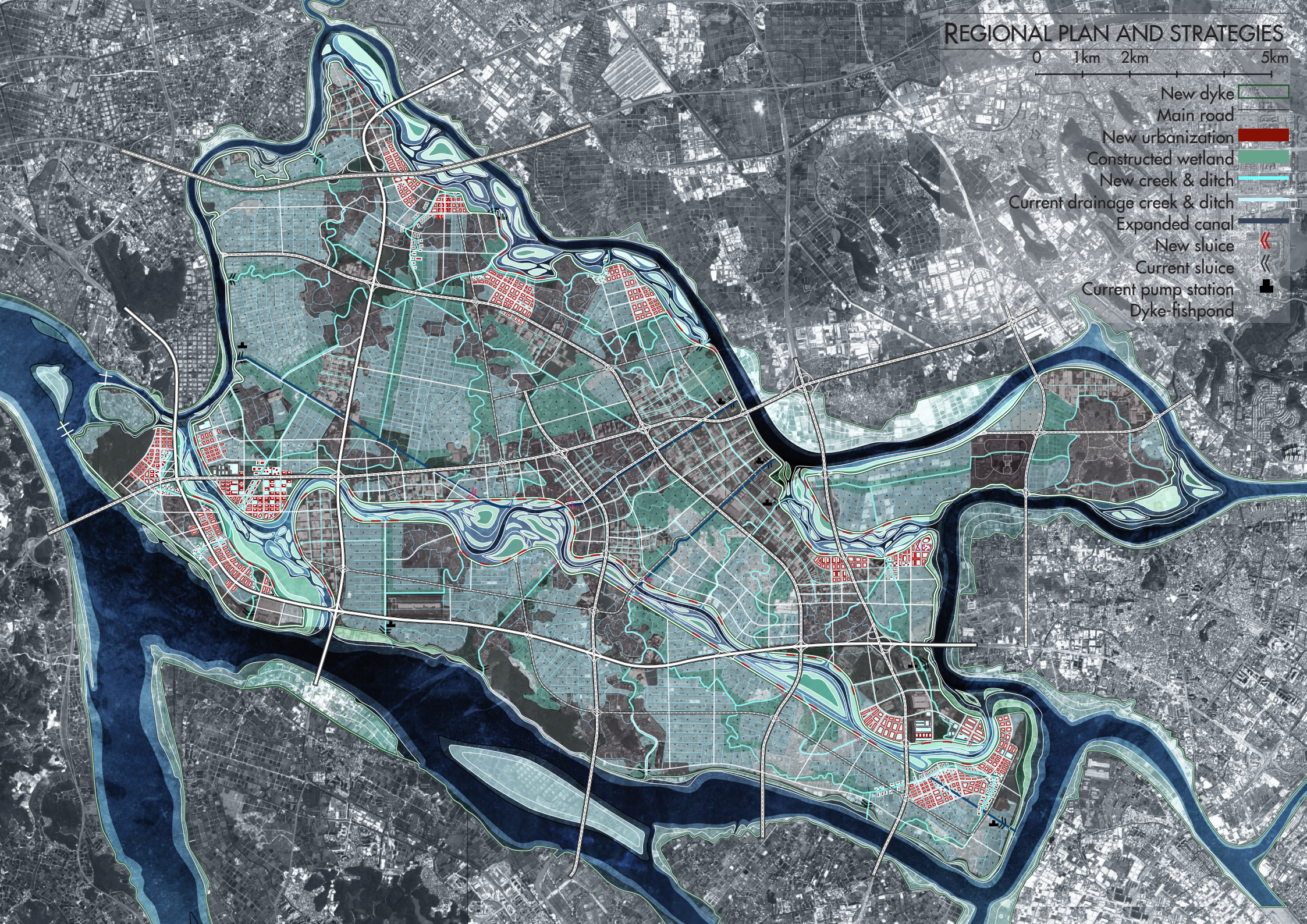
FIRST"头造" FLOOD

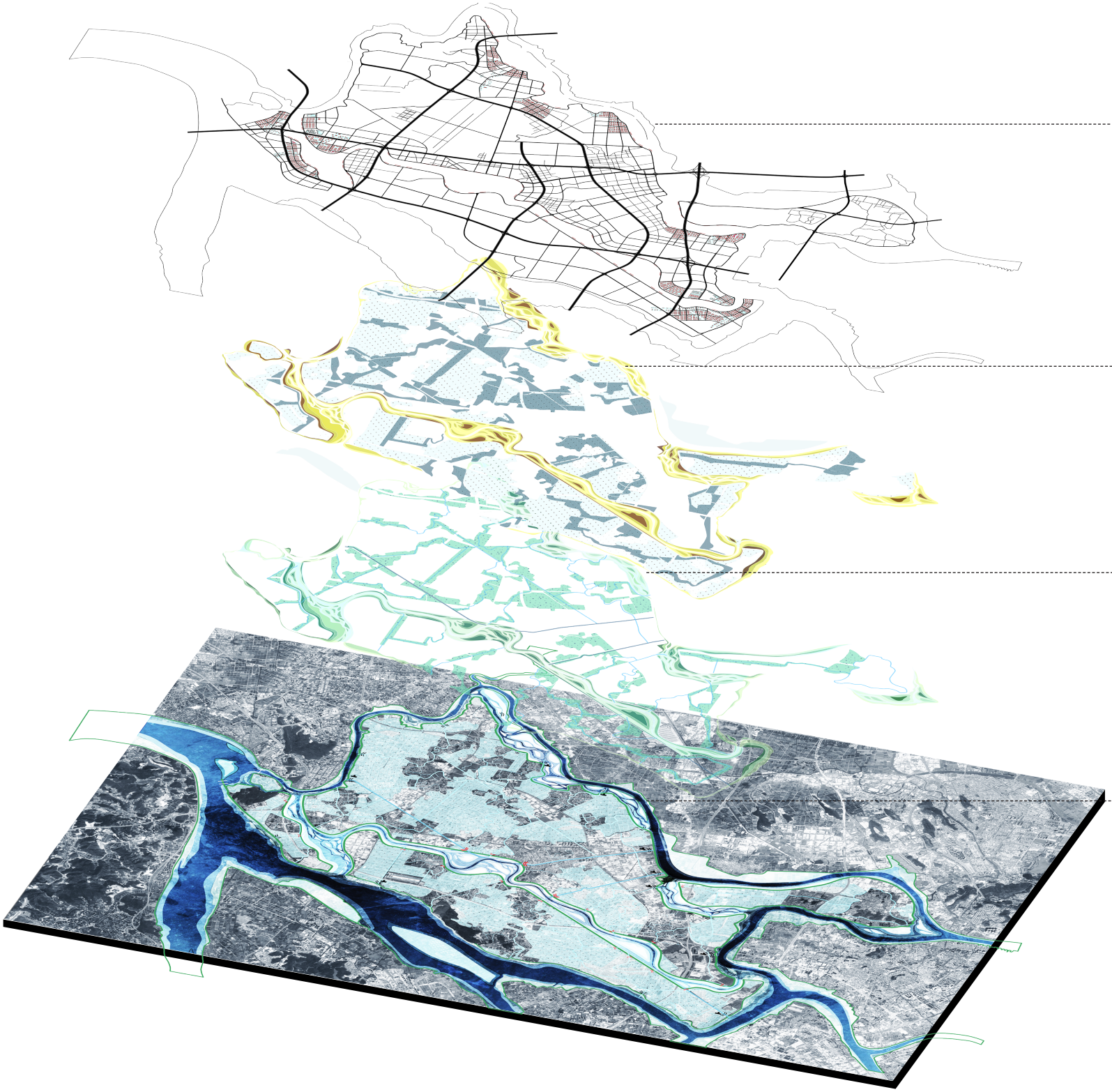
DRAGON BOAT FLOOD

"慕仙" FLOOD

MID AUTUMN FLOOD




REGIONAL PLAN AND STRATEGIES
0
1km
2km
5km
New dyke
Main road
New urbanization
Constructed wetland
New creek & ditch
Current drainage creek & ditch
Expanded canal
New sluice
Current sluice
Current pump station
Dyke-fishpond



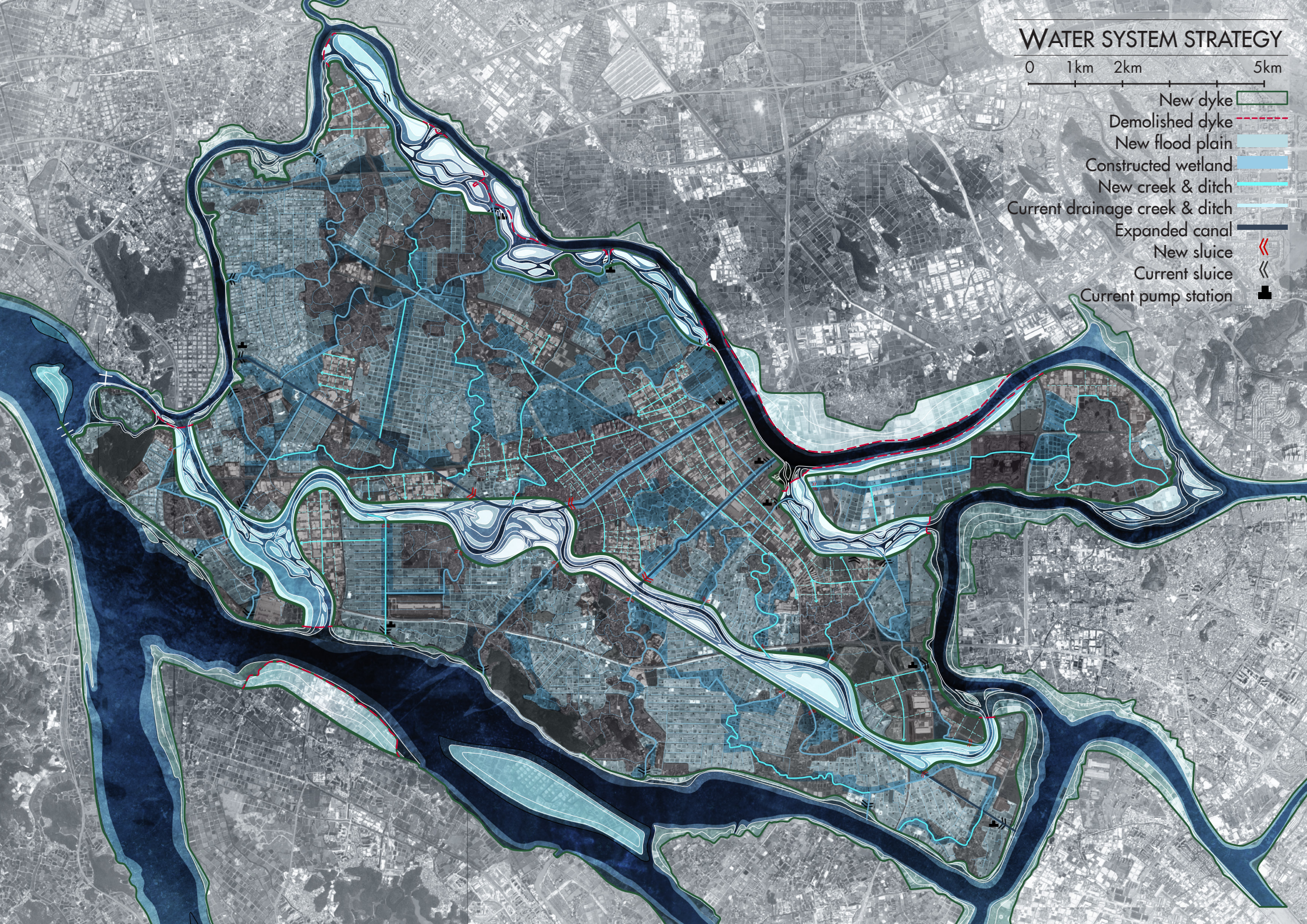
SYSTEMATIC LAYERS OF PLAN

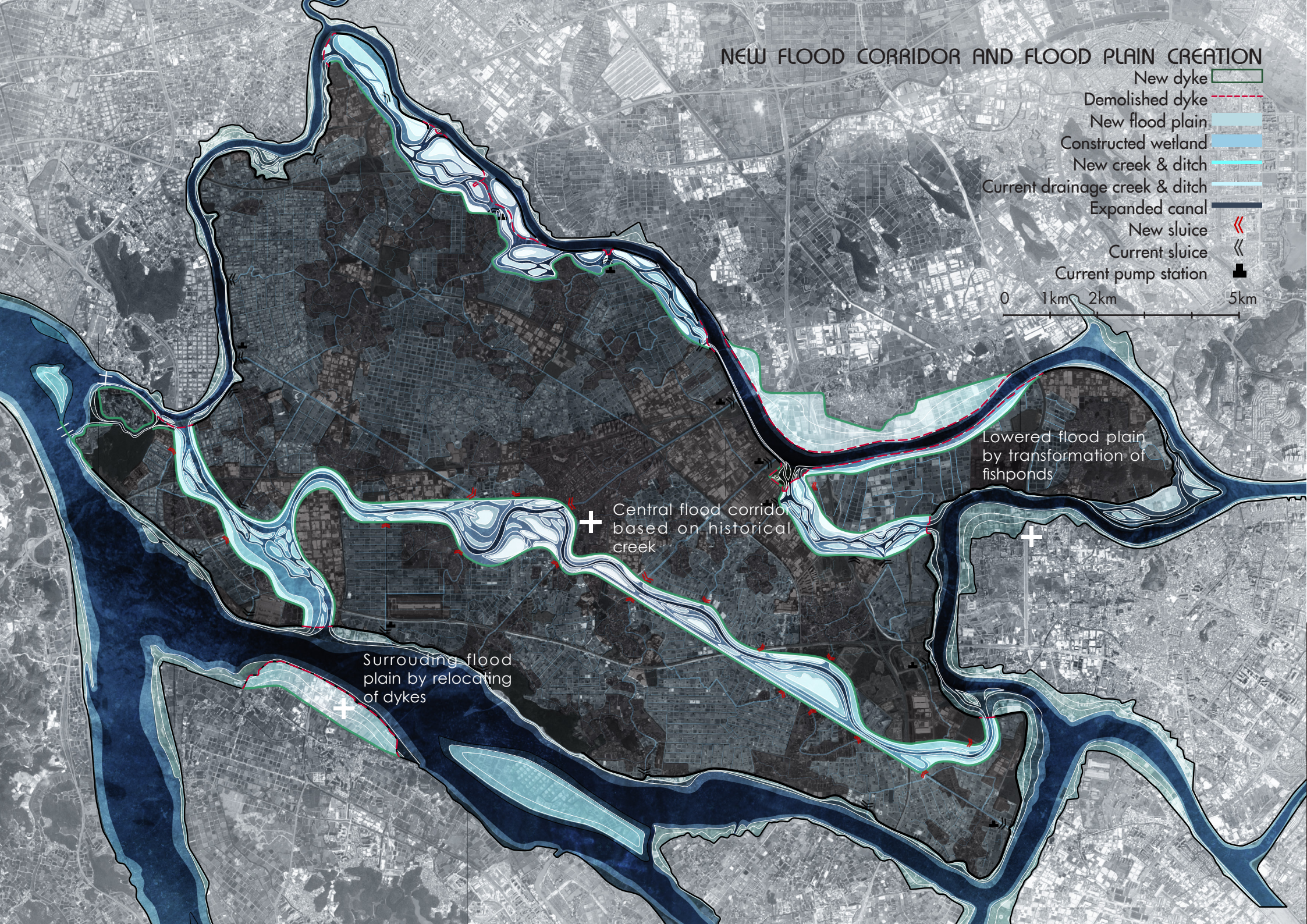
Infrastructure &
Urbanization system

Sedimentation &
aqua-agriculture system

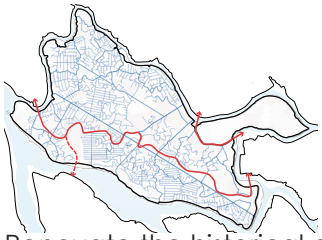
Eco-system

Water system

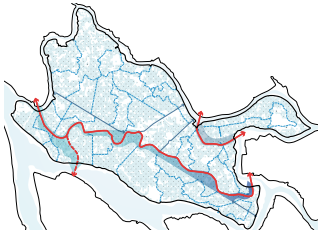

WATER SYSTEM STRATEGY
0
1km
2km
5km
New dyke
Demolished dyke
New flood plain
Constructed wetland
New creek & ditch
Current drainage creek & ditch
Expanded canal
New sluice
Current sluice
Current pump station


NEW FLOOD CORRIDOR AND FLOOD PLAIN CREATION
New dyke
Demolished dyke
New flood plain
Constructed wetland
New creek & ditch
Current drainage creek & ditch
Expanded canal
New sluice
Current sluice
Current pump station
0
1km
2km
5km
Lowered flood plain by transformation of fishponds
Central flood corridor based on historical creek
Surrouding flood plain by relocating of dykes

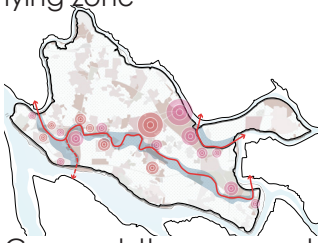
CREATE A NEW FLOOD PLAIN BASED ON HISTORICAL CREEK



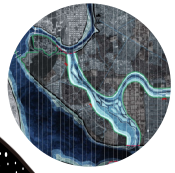
Renovate the historical creek



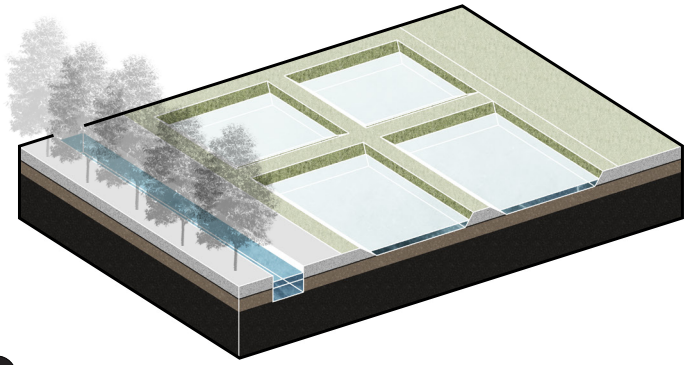
Define a new flood corridor in low lying zone



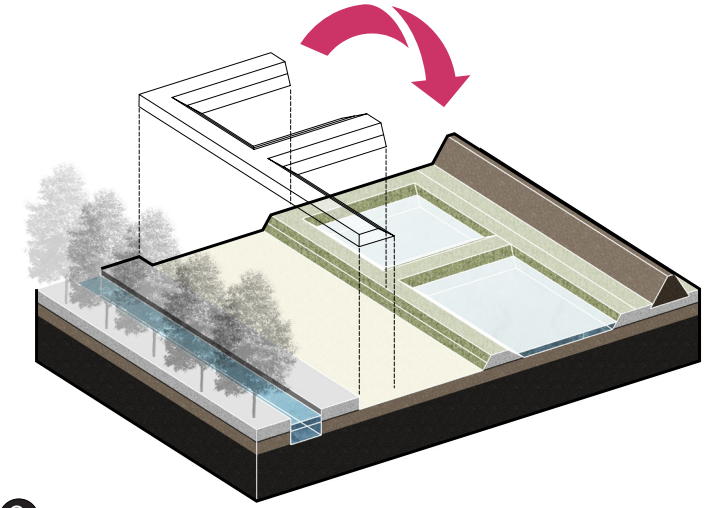
Connect the new water system with current land use



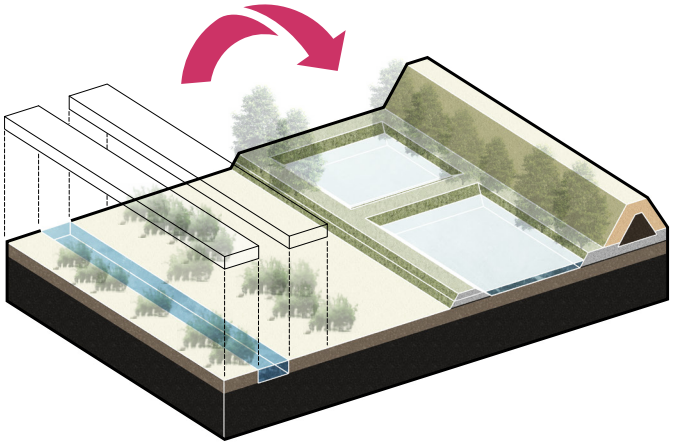
Sedimentation(sand & clay)
Concrete
Subsoil
Bottom soil



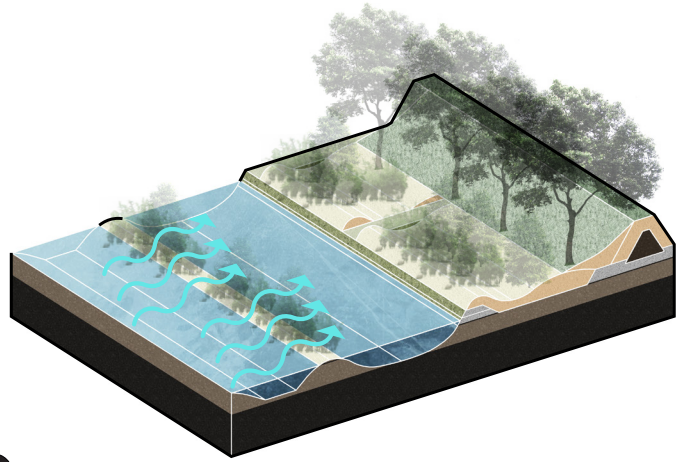
1 Current state (0 year)



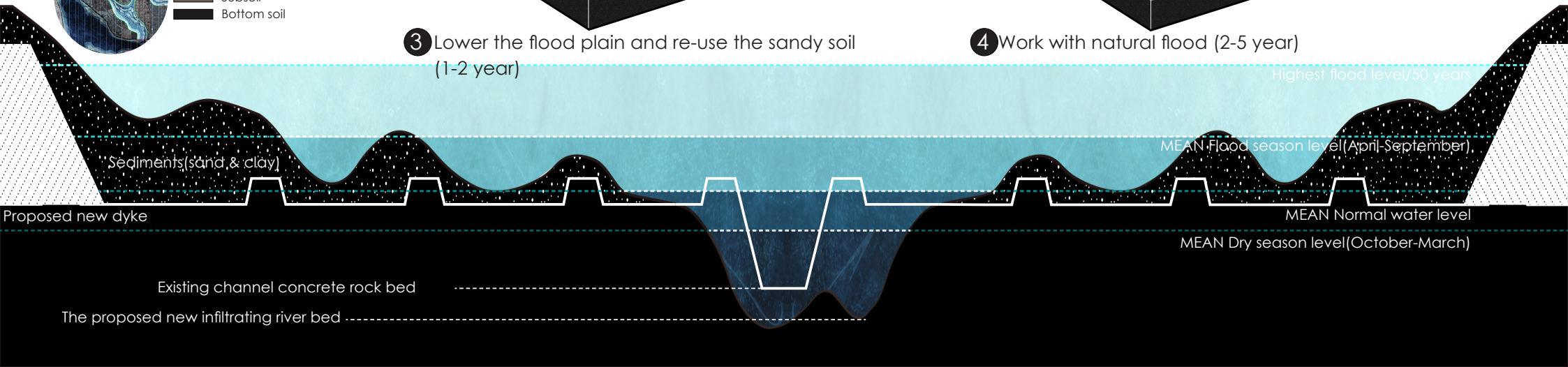
2 Relocate the small dykes (0-1 year)



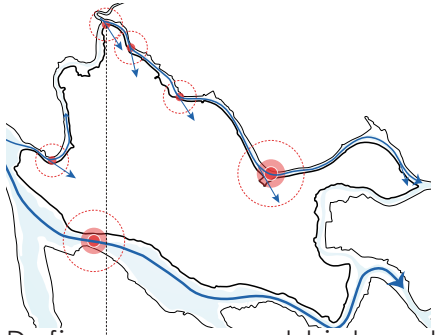
3 Lower the flood plain and re-use the sandy soil (1-2 year)



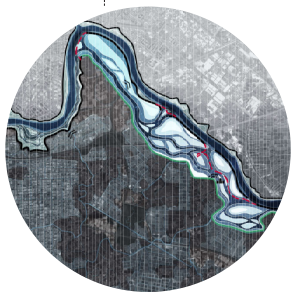
4 Work with natural flood (2-5 year)



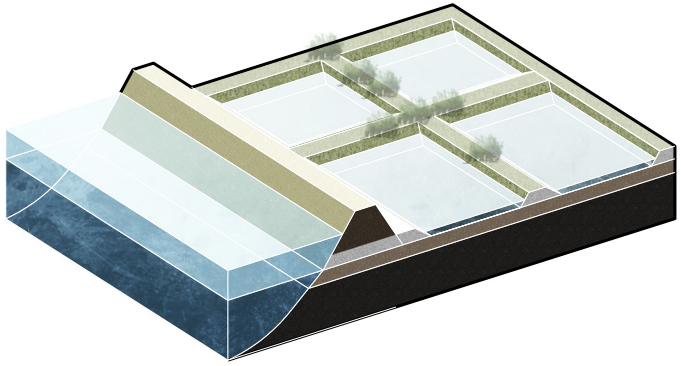
EXPAND FLOOD PLAIN BY RELOCATING DYKE



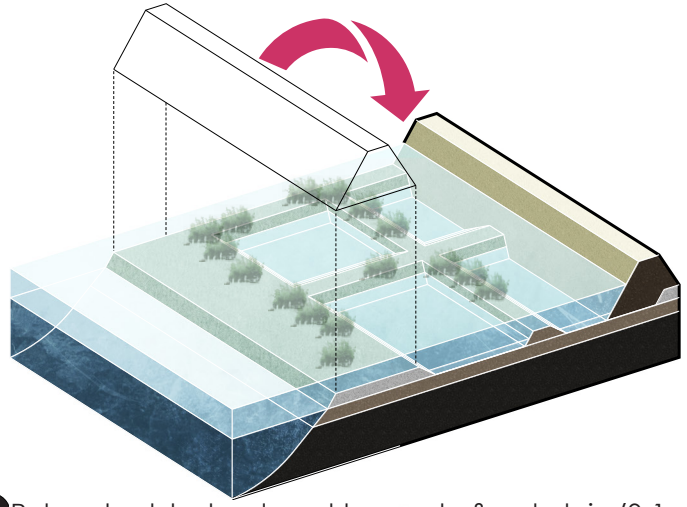
Define narrow and high water impact point





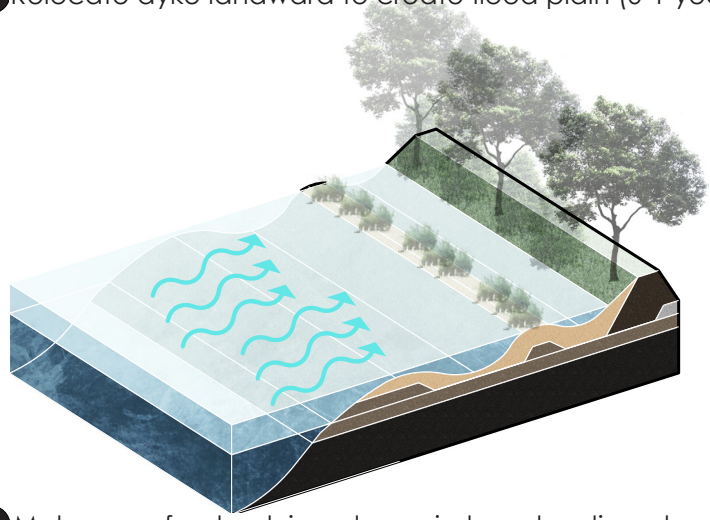


1 Current state (0 year)

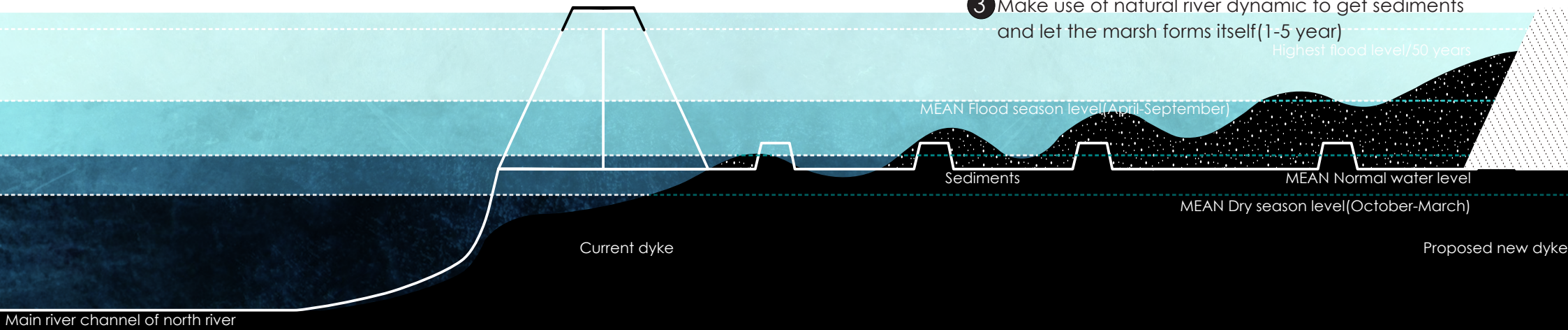


2 Relocate dyke landward to create flood plain (0-1 year)

Sedimentation(sand & clay)
Concrete
Subsoil
Bottom soil



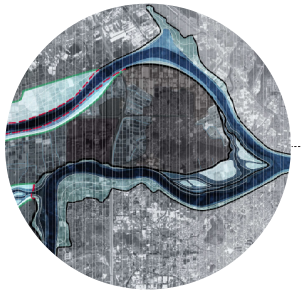
3 Make use of natural river dynamic to get sediments and let the marsh forms itself(1-5 year)

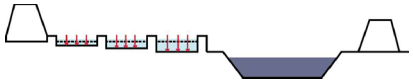


ENLARGE THE WATER CAPACITY WITH LOWER FISHPOND

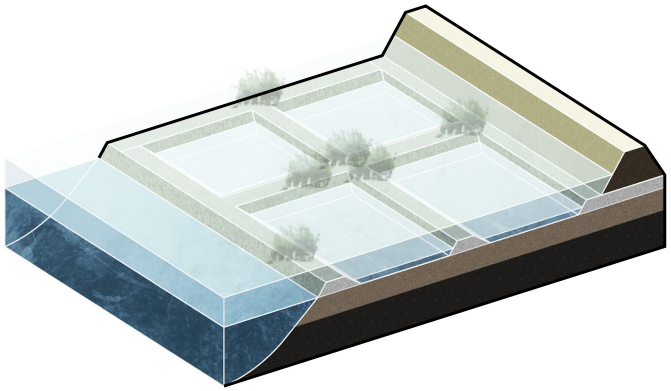


Lower the zone between dyke and river

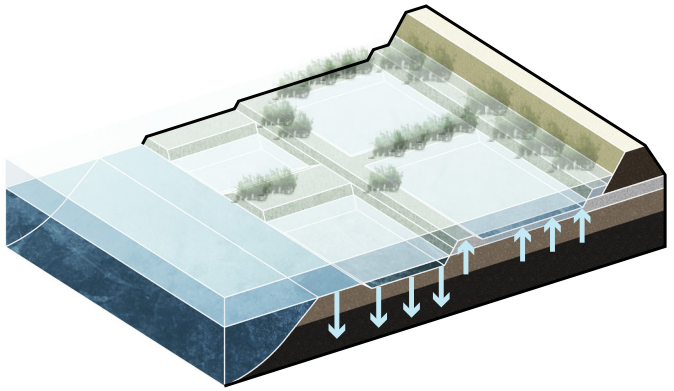




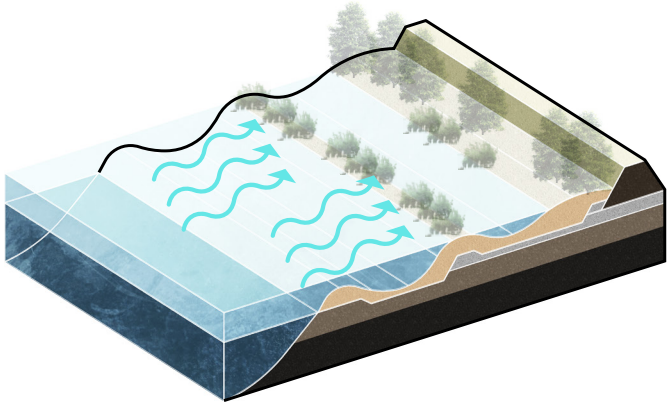
Sedimentation(sand & clay)
Concrete
Subsoil
Bottom soil



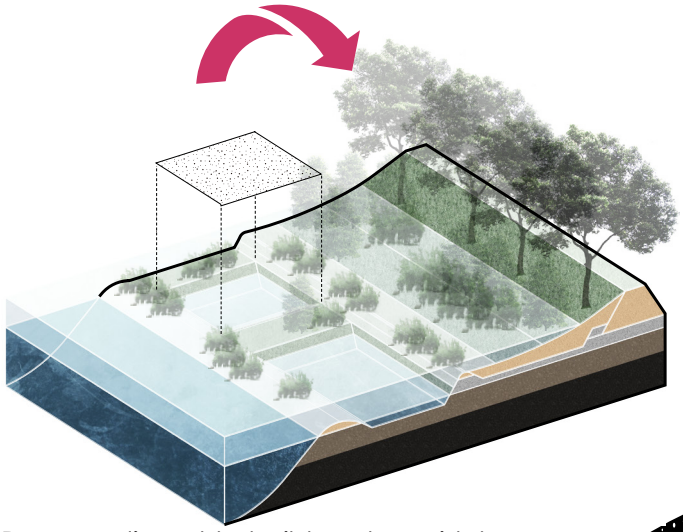
1 Current state (0 year)



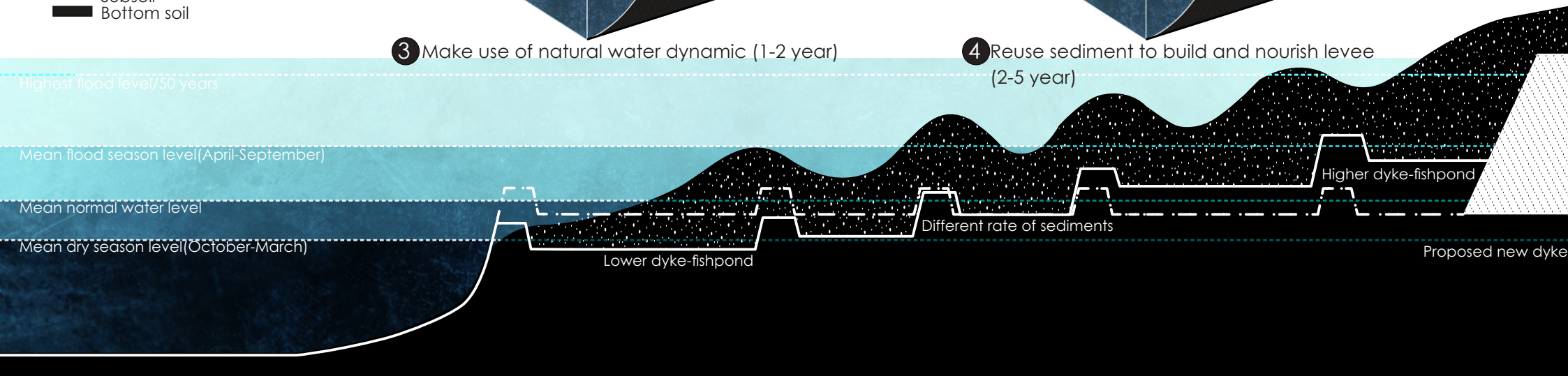
2 Lower the fishpond to different height(0-1 year)



3 Make use of natural water dynamic (1-2 year)



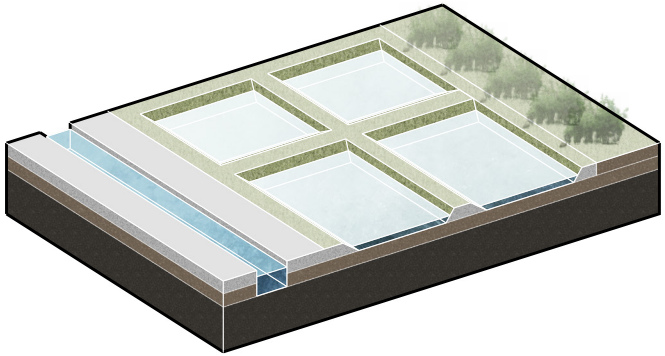
4 Reuse sediment to build and nourish levee (2-5 year)



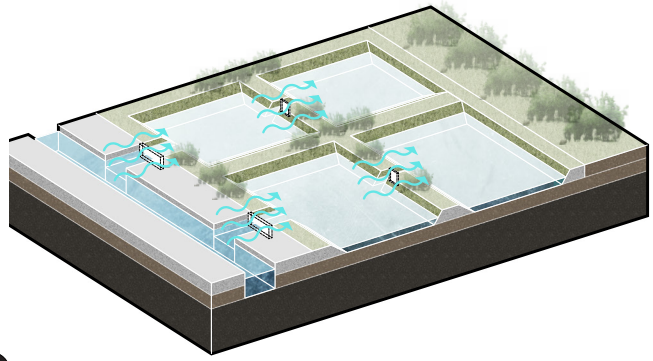

RESTORATION OF DITCH AND CANAL EXPANDING
New dyke
New urban drainage ditch & creek
New urban drainage ditch
Expanded urban canal
Current drainage creek & ditch
New sluice
Current sluice
Current pump station
0
1km
2km
5km

EXPAND THE CURRENT DITCH SYSTEM

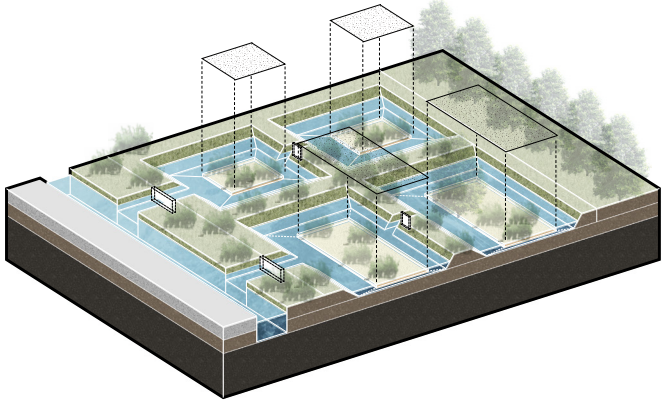




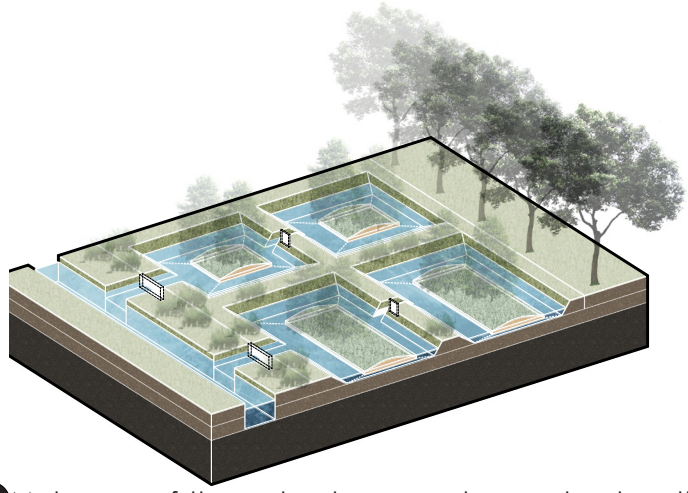
1 Current state (0 year)



2 Connect the fishponds with ditches via water sluice (0-1 year)

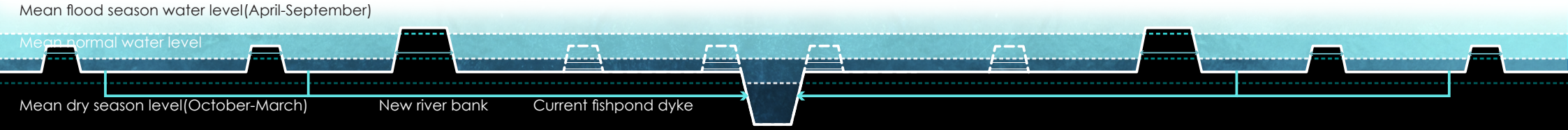


3 Construct floating frame to trap nutrient and soil for wetland vegetation(1-2 year)

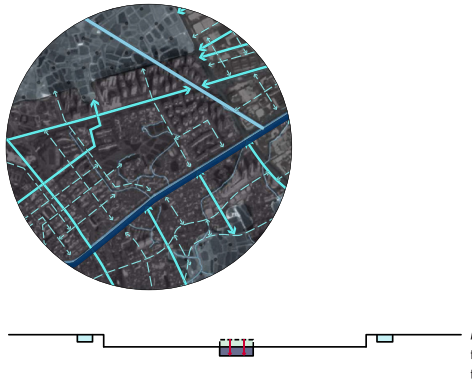


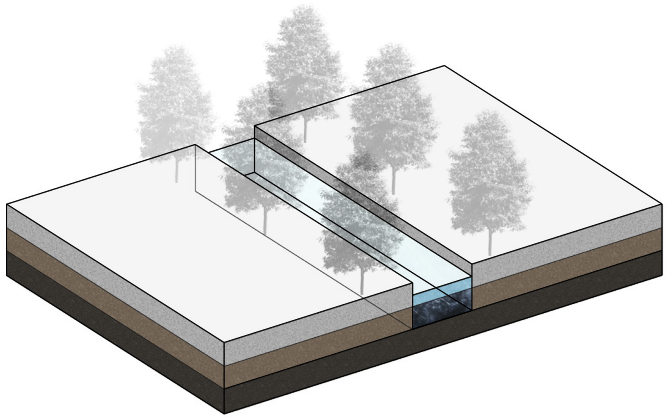
4 Make use of the natural process to construct wetland (2-5 year)

Sedimentation(sand & clay)
Concrete
Subsoil
Bottom soil

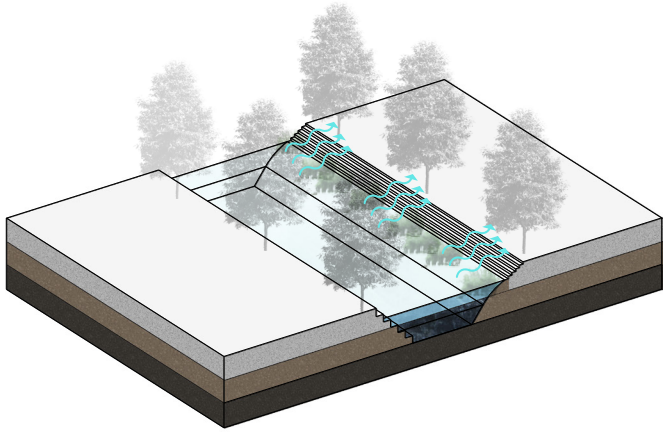


ENLARGE THE WATER CAPACITY IN URBAN REGION

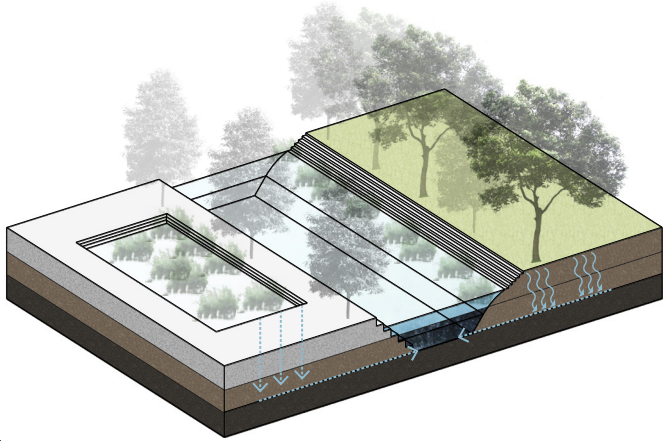




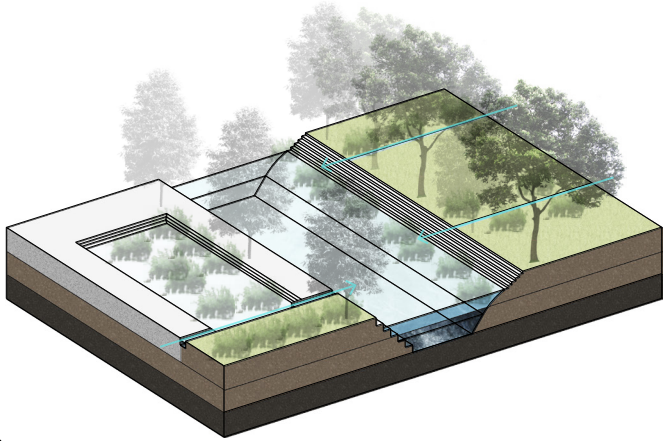
1 Current state (0 year)



2 Expand the canal and create terrace (0-1 year)

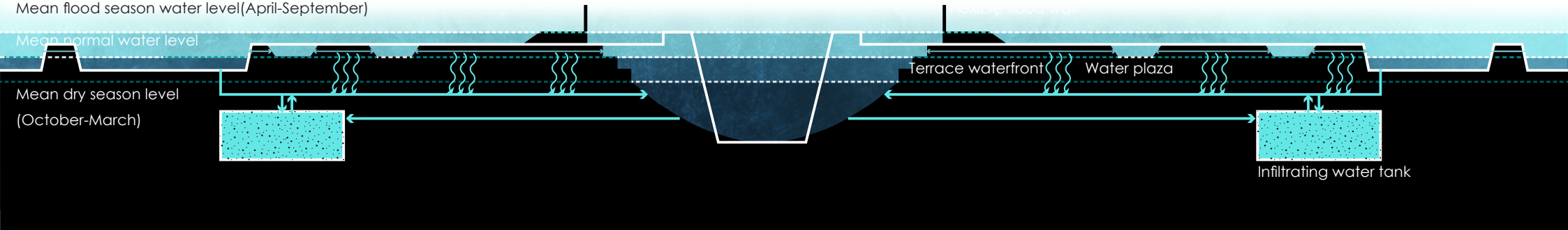


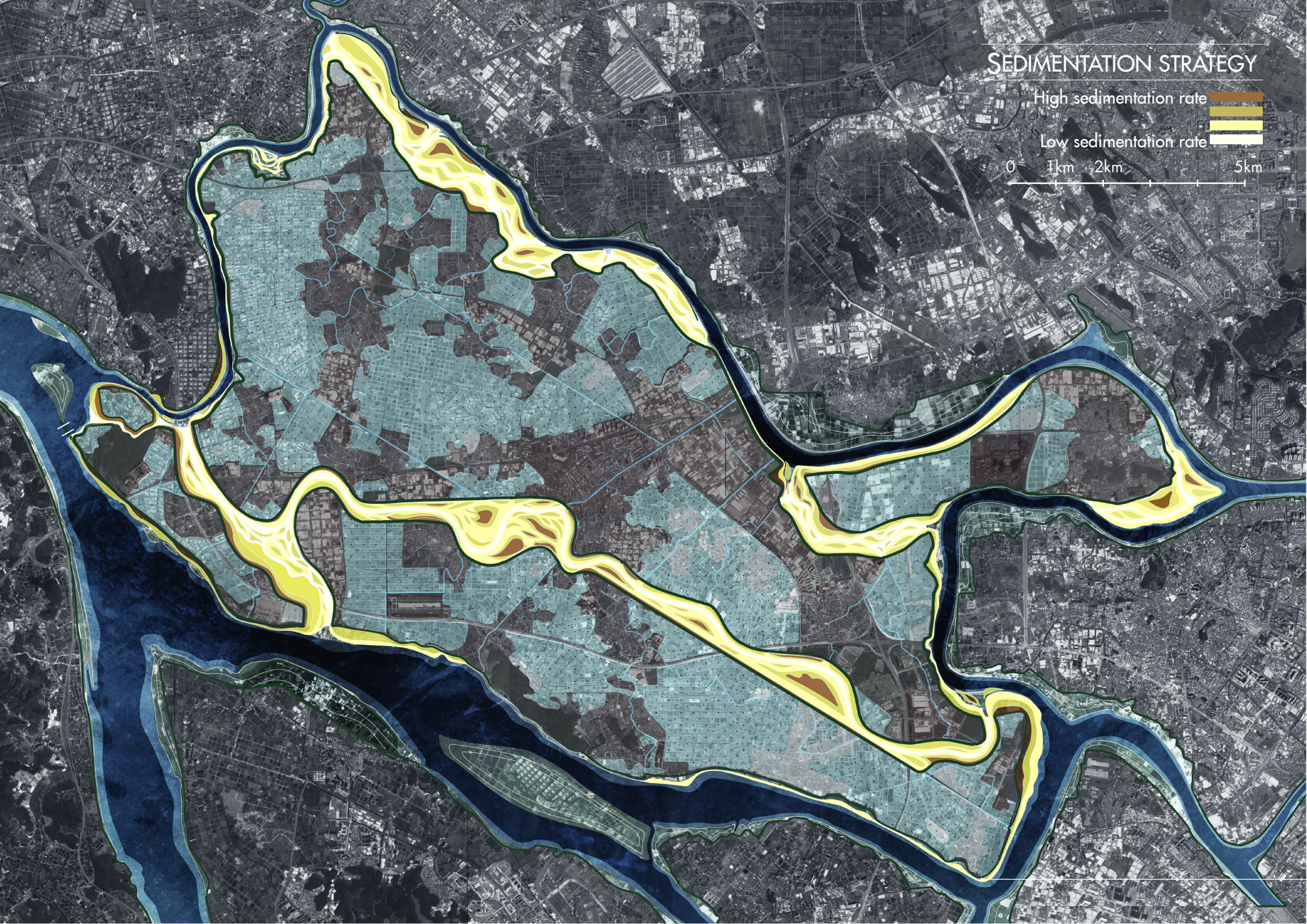
3 Dechannelize the bank into soft edge and build water plaza (0-1 year)



4 Connecting the city drainage to canal and restore the water dynamics(2-5 year)

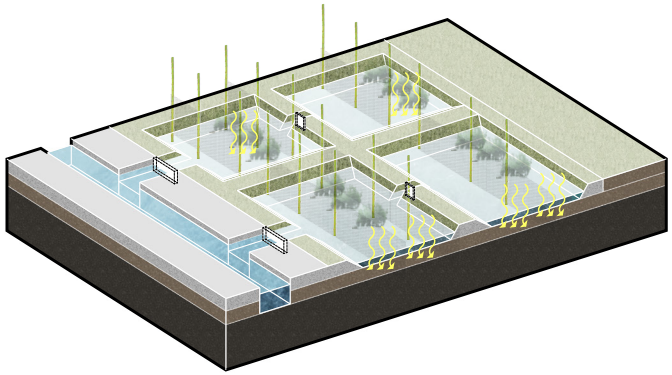
Sedimentation(sand & clay)
Concrete
Subsoil
Bottom soil




SEDIMENTATION STRATEGY
High sedimentation rate
Low sedimentation rate
0
1km
2km
5km

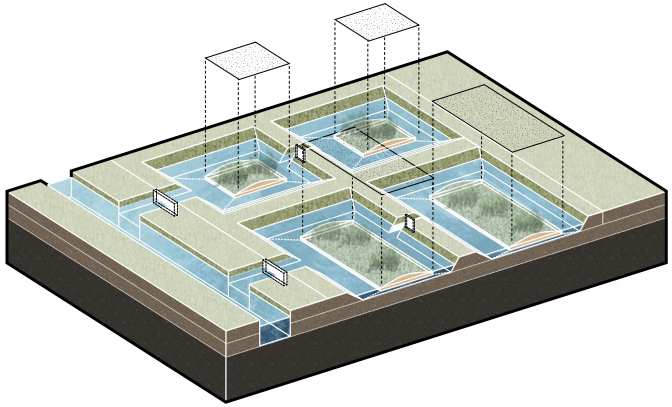
ACCELERATE SEDIMENTATION PROCESS

FISHPOND SEDIMENTATION





Use the fisnnet to trap the nutrient-rich soil in fishpond for agriculture

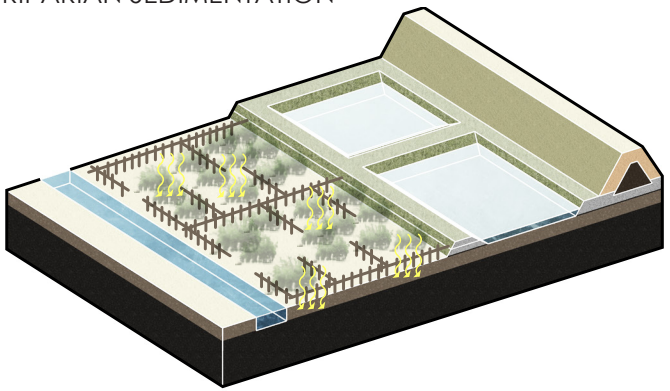




Construct floating wooden frame as base for traping sediments and wetland construction

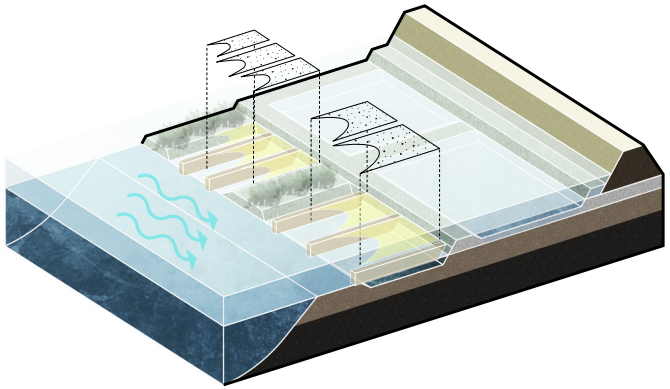
Sedimentation(sand & clay)
Concrete
Subsoil
Bottom soil

RIPARIAN SEDIMENTATION



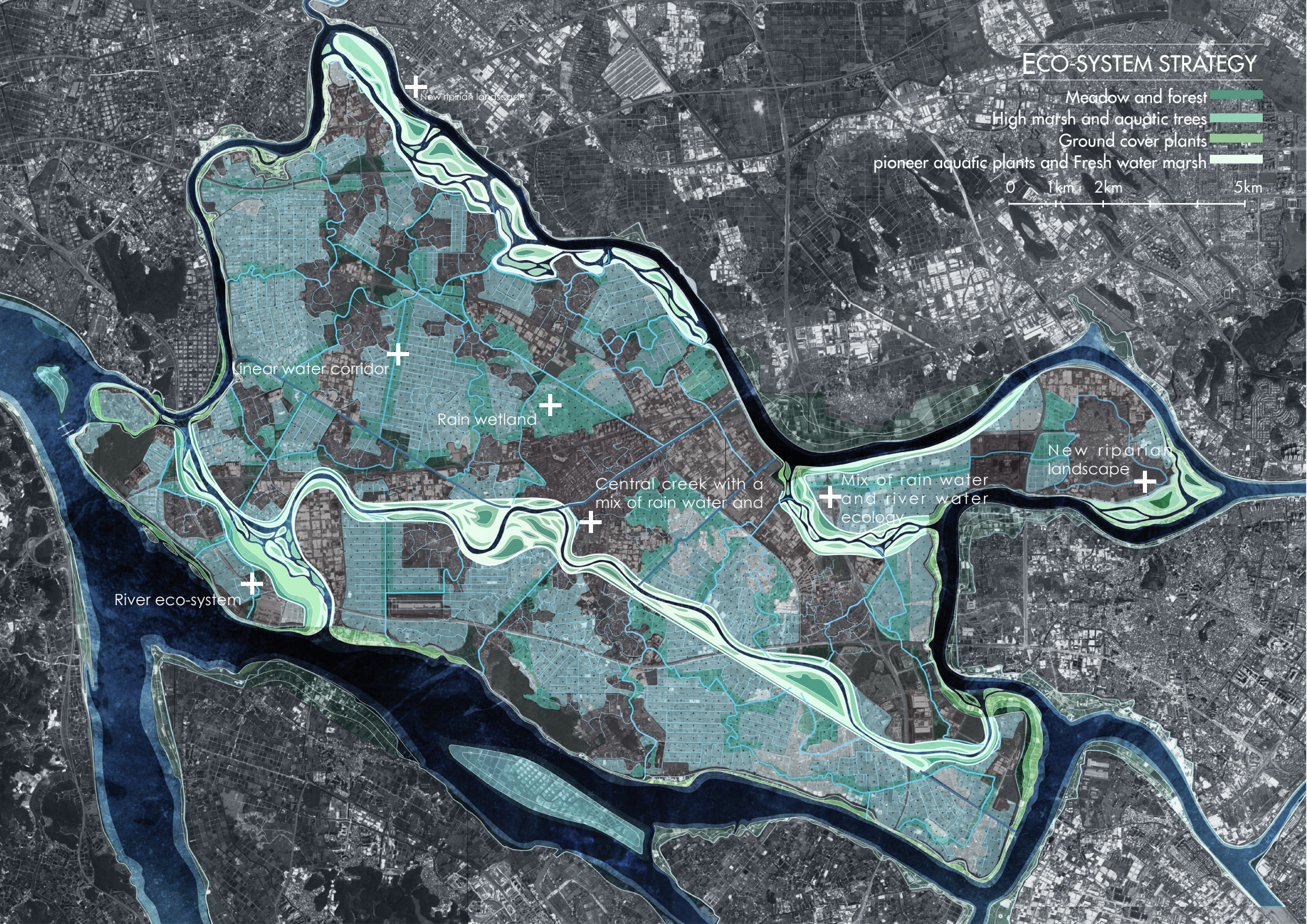


Construct permeable dam to intensify sedimentation for nature restoration





Build groyne along the river to protect the shore and intensify sedimentation for river ecology restoration


ECO-SYSTEM STRATEGY
Meadow and forest
High marsh and aquatic trees
Ground cover plants
pioneer aquatic plants and Fresh water marsh
0
1km
2km
5km
New ripirian landscape
Linear water corridor
Rain wetland
Central creek with a mix of rain water and
Mix of rain water and river water ecology
New riparian landscape
River eco-system

RESTORE THE ECO-SYSTEM

Fauna



Flora



0. Current dyke-fishpond

1. Pioneer aquatic and low marsh plants

Ceratopteris thalictroides
BraseniaschreberiJ.F.Gmel
Nymphaea tetragona
Glennia littoralis Fr. Schmidt ex Miq

2. Ground cover plants and high marsh plants

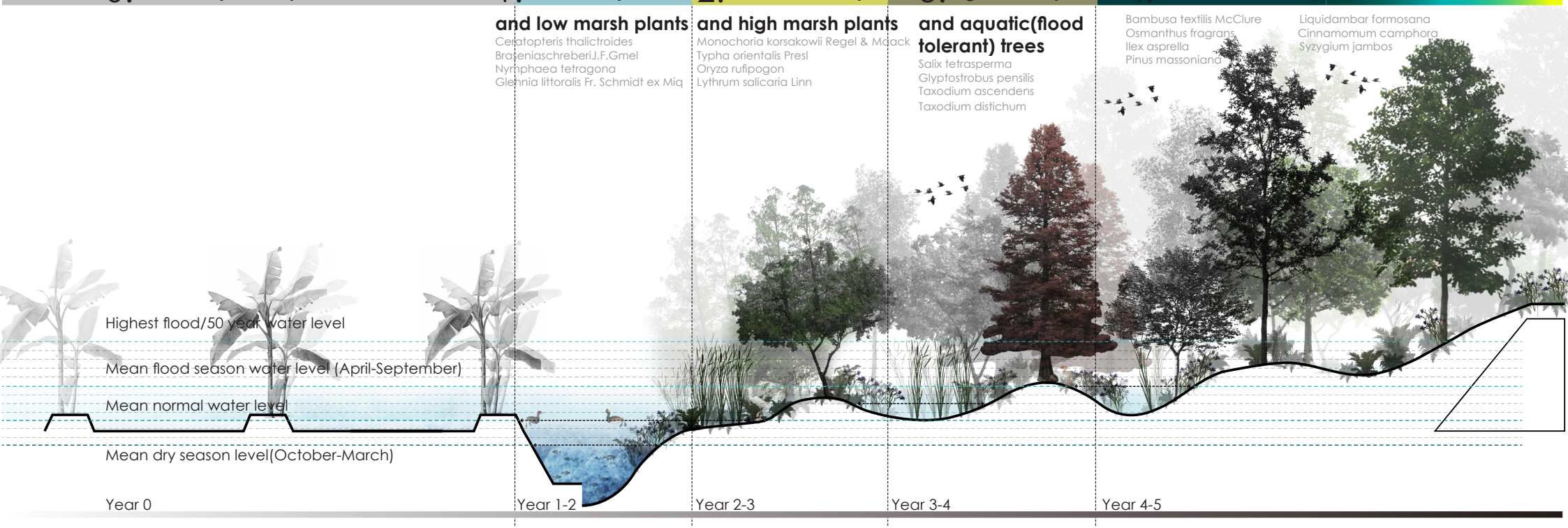
Monochoria korsakowii Regel & Maack
Typha orientalis Presl
Oryza rufipogon
Lythrum salicaria Linn

3. High marsh plants and aquatic(flood tolerant) trees

Salix tetrasperma
Glyptostrobus pensilis
Taxodium ascendens
Taxodium distichum

4. climax community

Bambusa textilis McClure
Osmanthus fragrans
Ilex asprella
Pinus massoniana
Liquidambar formosana
Cinnamomum camphora
Syzygium jambos




INFRASTRUCTURE STRATEGY
Demolished road
Main road
Secondary road
0
1km
2km
5km

INTEGRATE ROAD & WATER TRANSPORTATION



Demolish roads for new flood plain.



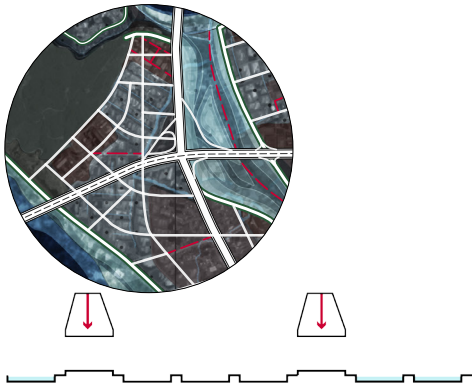
Create new road infrastructurebased on the new dyke



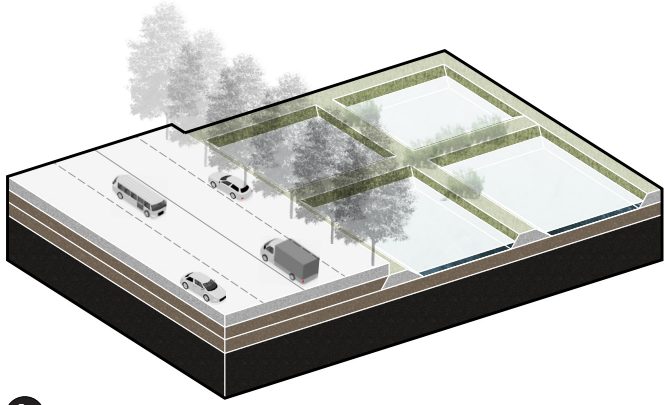
Connect the main road to the new central infrastructure



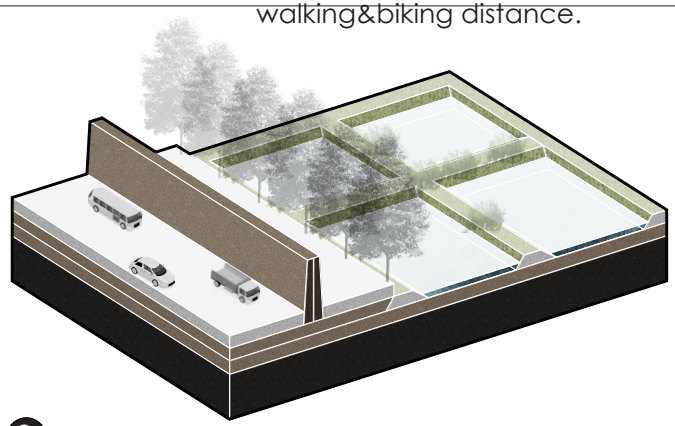
a new secondary road system based on dyke-fishpond pattern and walking&biking distance.



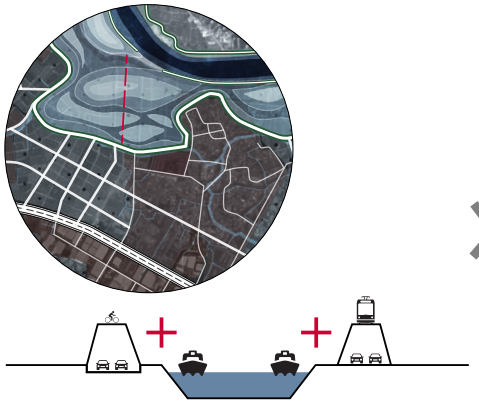
Integrate the current road infrastructure into water management



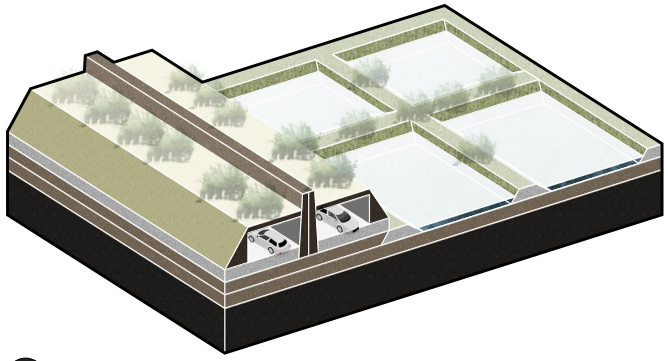
1 Current state



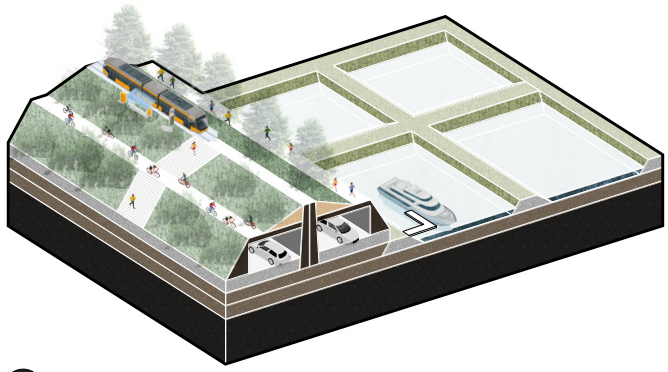
2 Build up the dyke core (0-2 year)



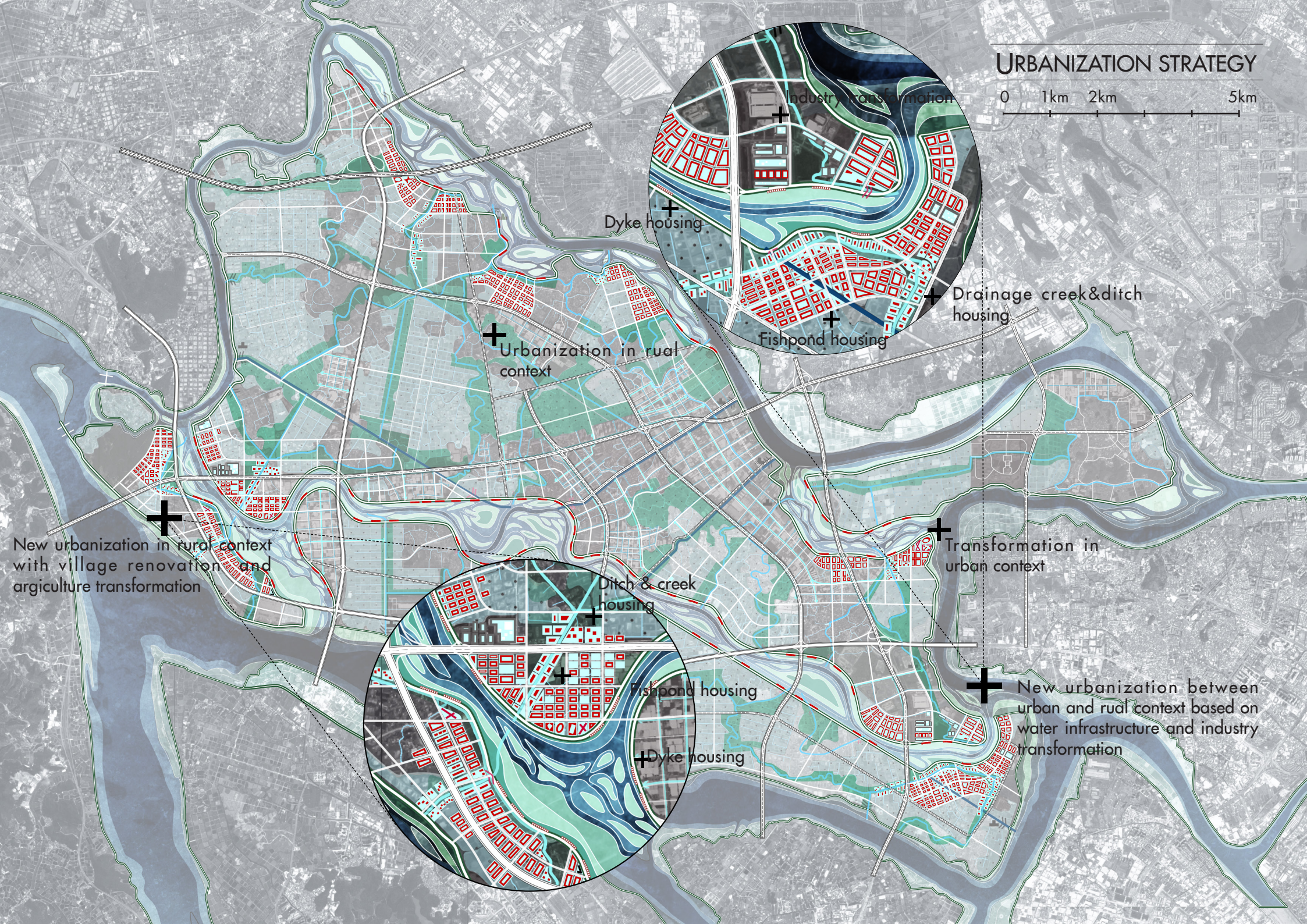
Renovate water transportation and integrate it with new public transport



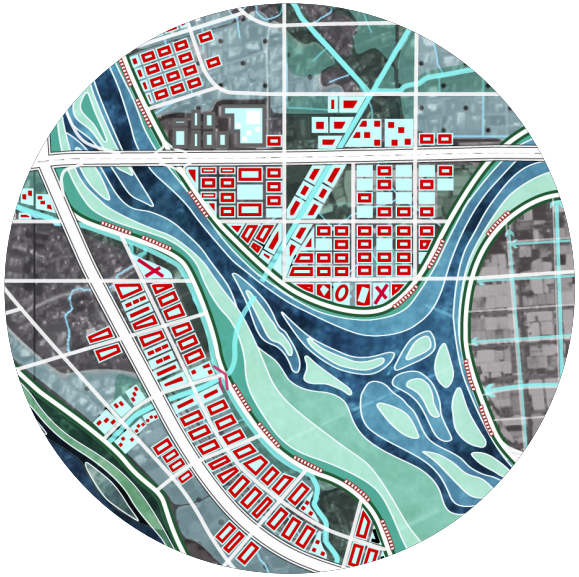
3 Cover the existing road with the dyke (2-3 year)

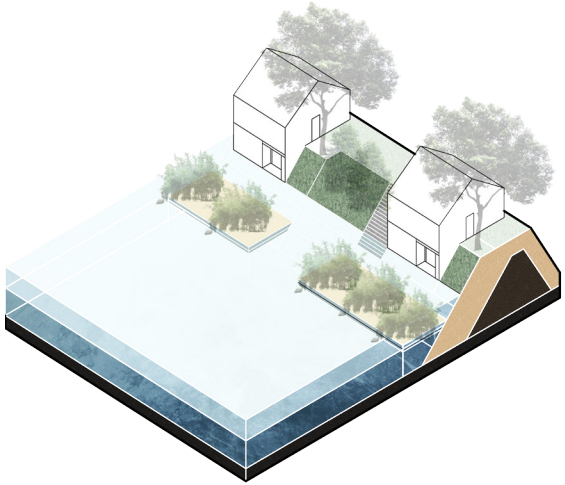


4 Integrate tram, biking path, pedestrian path and new pier to the dyke (3-5 year)

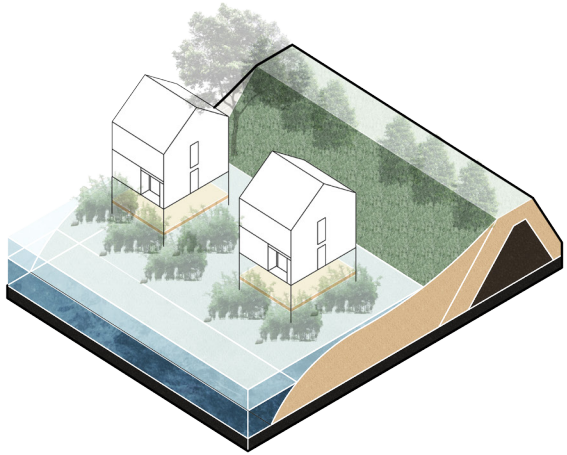

URBANIZATION STRATEGY
0 1km 2km 5km
Industry transformation
Dyke housing
Drainage creek&ditch housing
Fishpond housing
Urbanization in rual context
New urbanization in rural context with village renovation and argiculture transformation
Transformation in urban context
Ditch & creek housing
Fishpond housing
Dyke housing
New urbanization between urban and rual context based on water infrastructure and industry transformation

WATER-SENSITIVE HOUSING TYPOLOGY

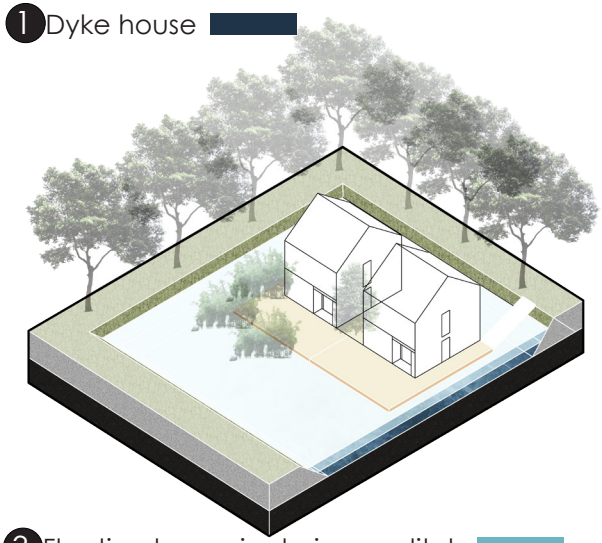




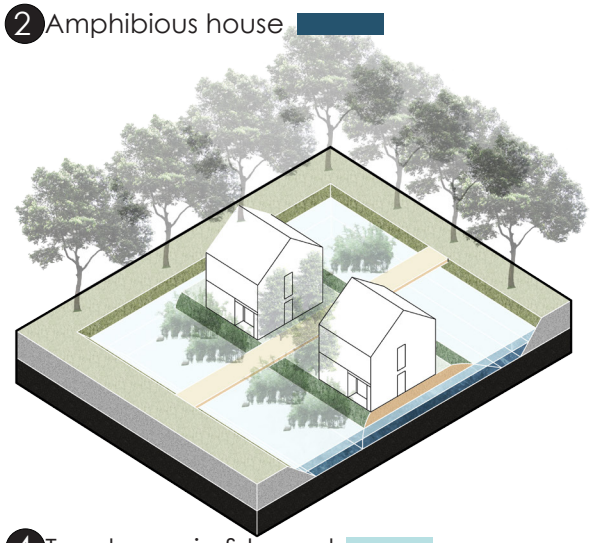
1 Dyke house



2 Amphibious house

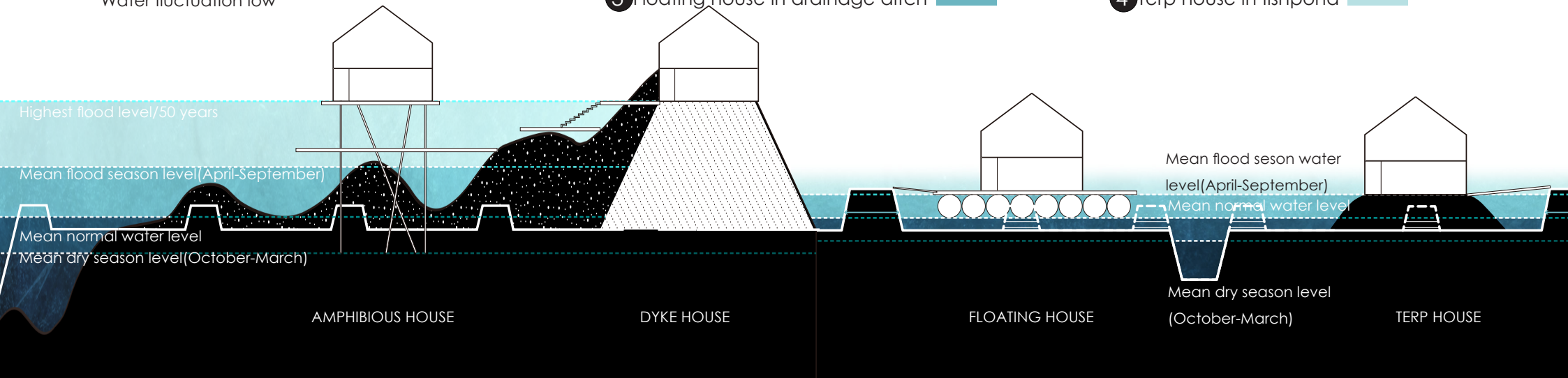


3 Floating house in drainage ditch



4 Terp house in fishpond

Sedimentation(sand & clay)
Concrete
Subsoil
Bottom soil
Water fluctuation high
Water fluctuation low



VISION IN DRY SEASON


JOGGING


BIRD WATCHING


FISHERMAN MARKET

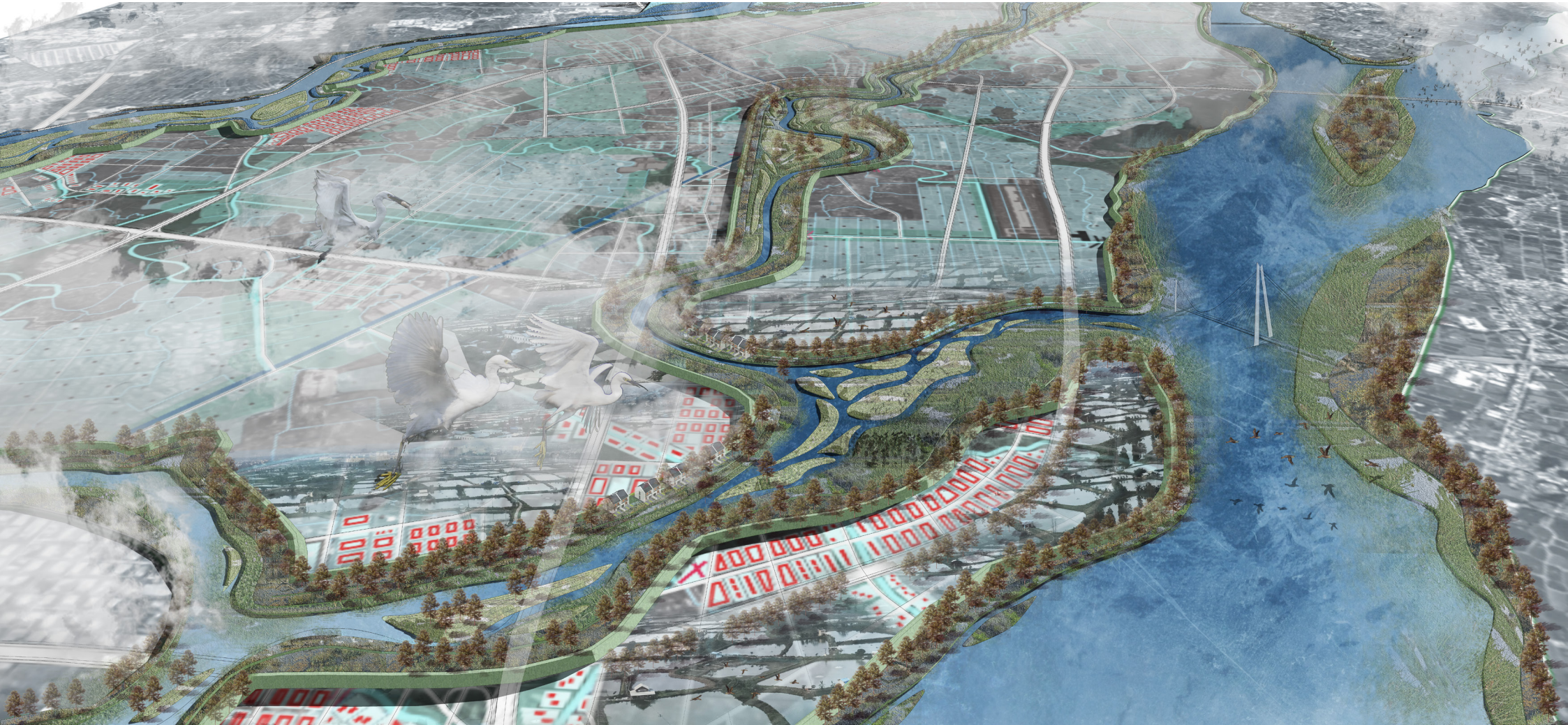

BIKING


CAMPING


OUTDOOR SPORT


RIPARIAN


AQUACULTURE



VISION IN RAIN SEASON

DRAGON BOAT

SWIMMING

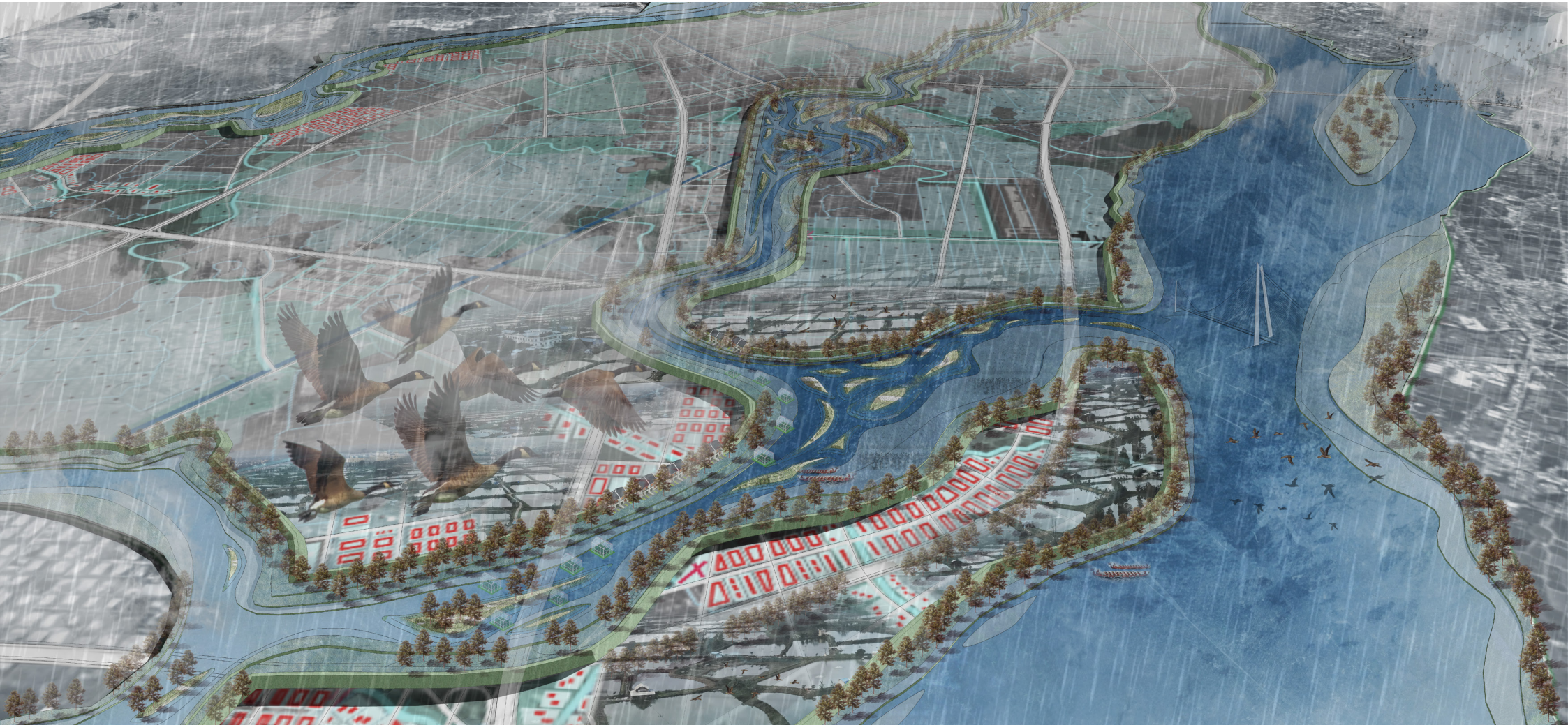
AQUACULTURE

FISHING

COLLECTION AND PURIFICATION

WATER EDUCATION

SEDIMENT HARVEST



VISION IN DRY SEASON

JOGGING

BIRD WATCHING

FISHERMAN MARKET

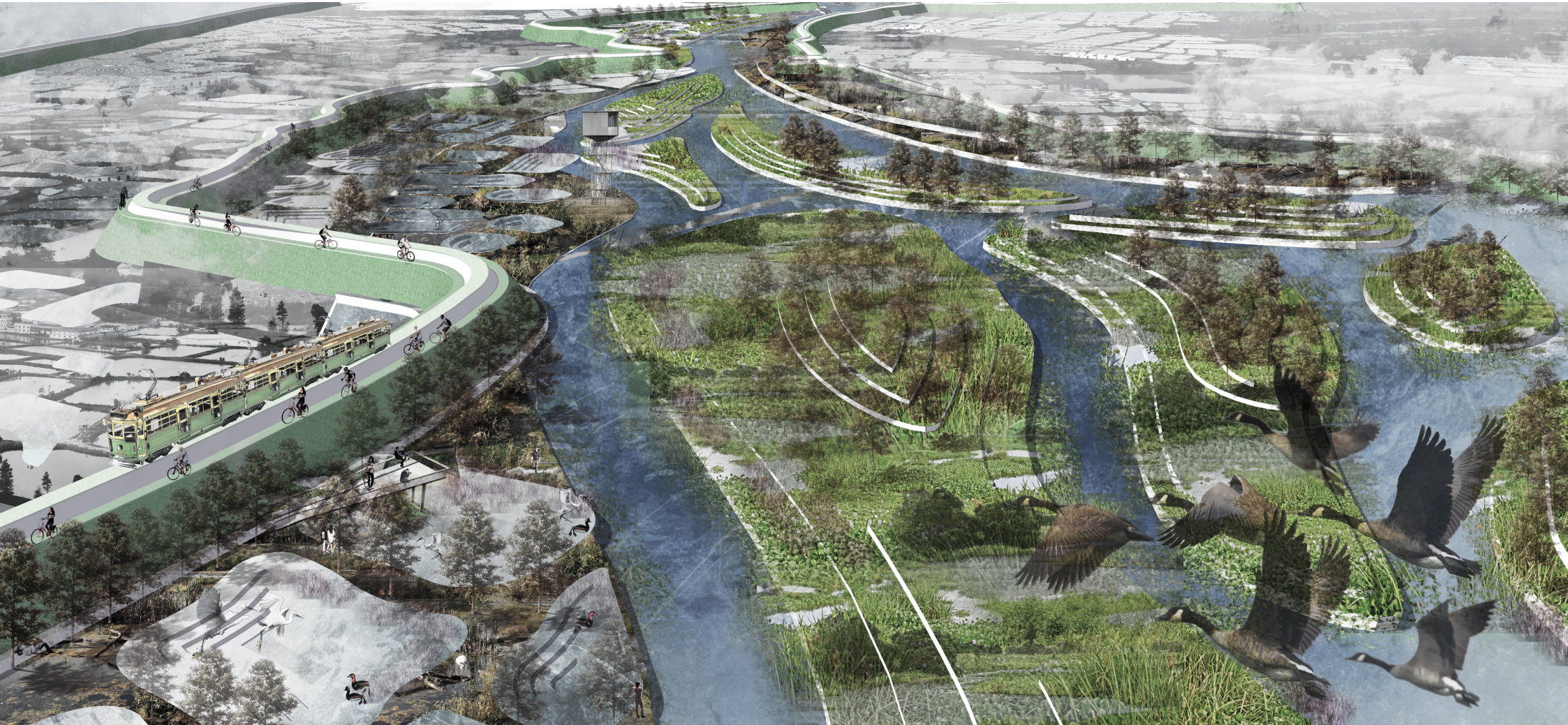
BIKING

CAMPING

OUTDOOR SPORT

RIPARIAN

AQUACULTURE



VISION IN RAIN SEASON

DRAGON BOAT

SWIMMING

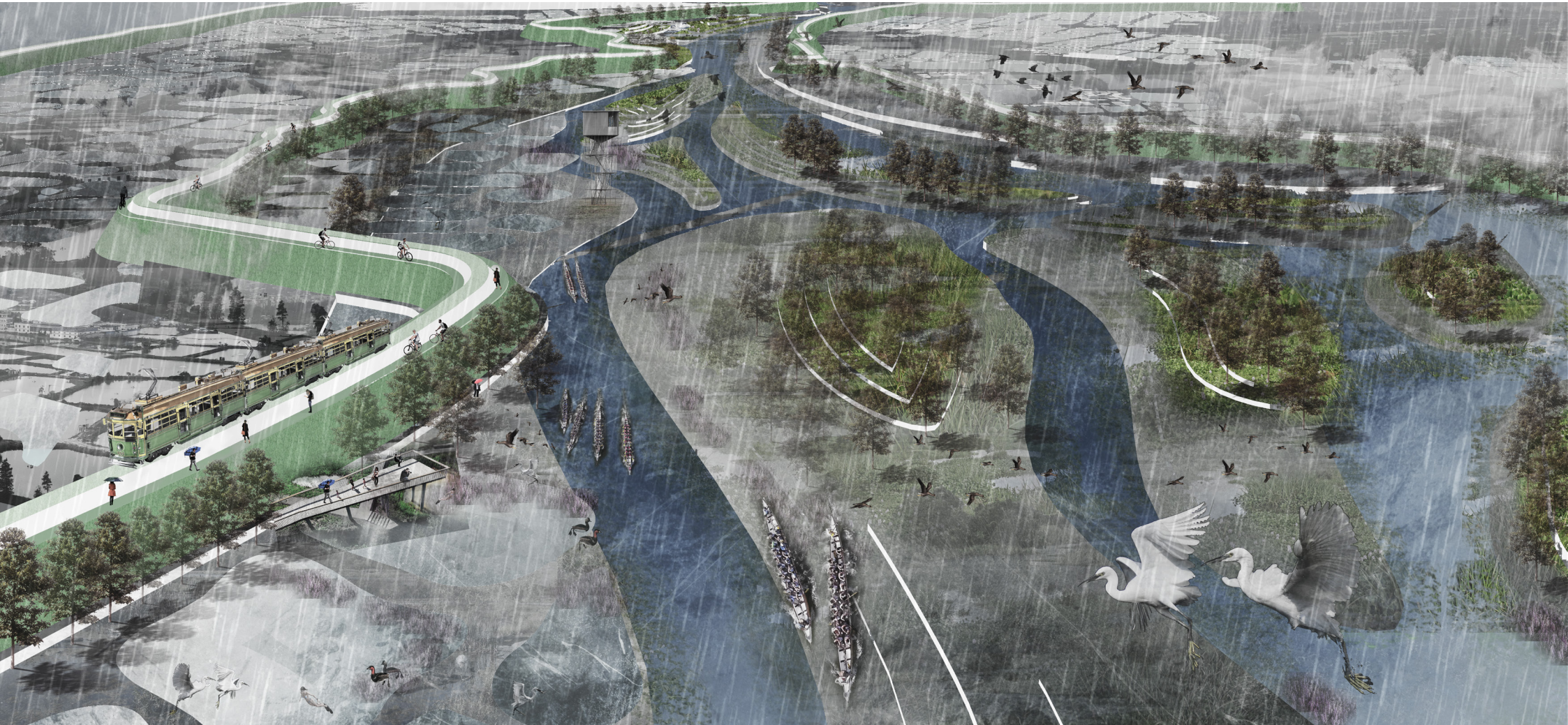
AQUACULTURE

FISHING

COLLECTION AND PURIFICATION

WATER EDUCATION

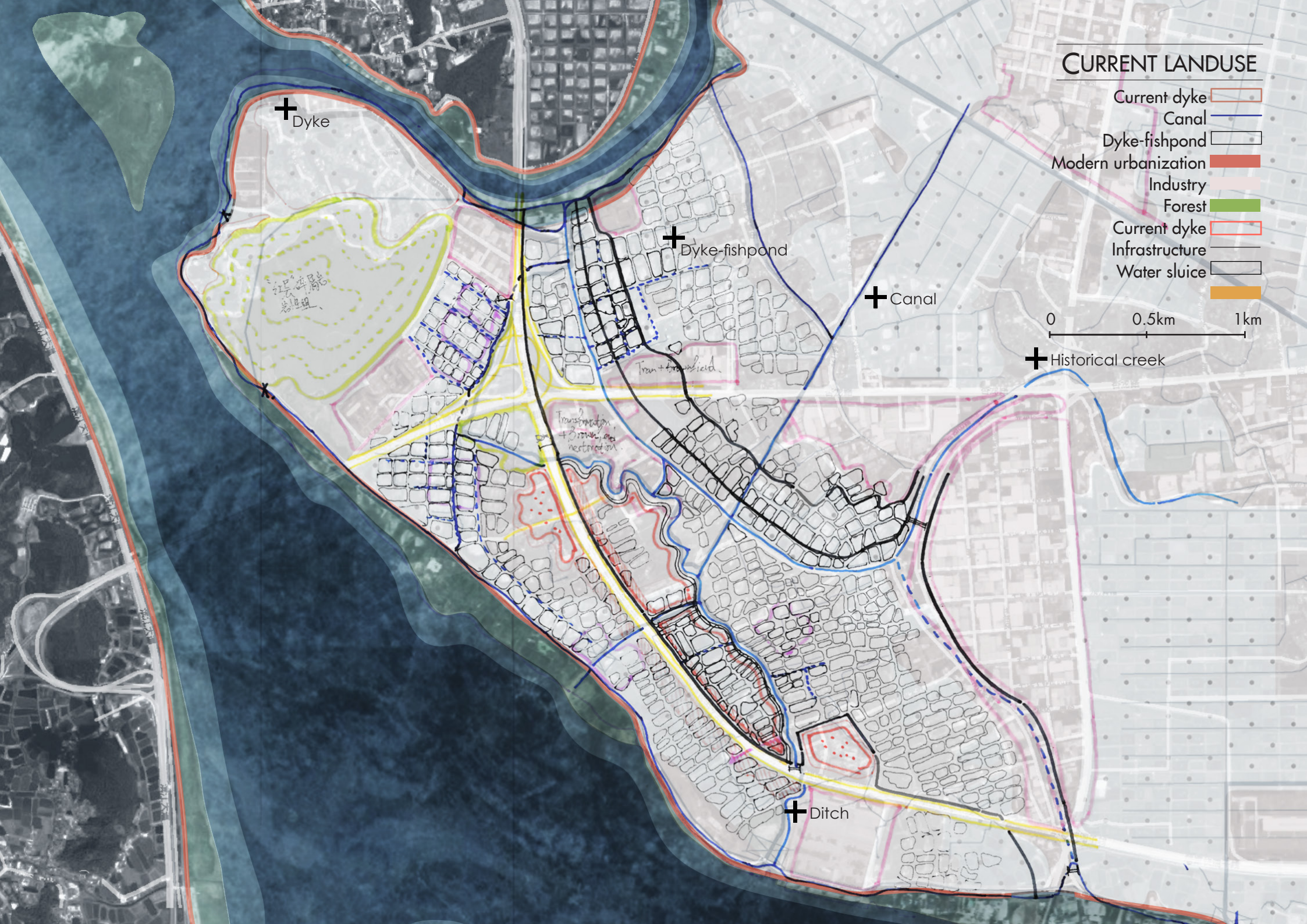
SEDIMENT HARVEST



04. DESIGN EXPLORATION AT LOCAL SCALE IN RURAL CONTEXT

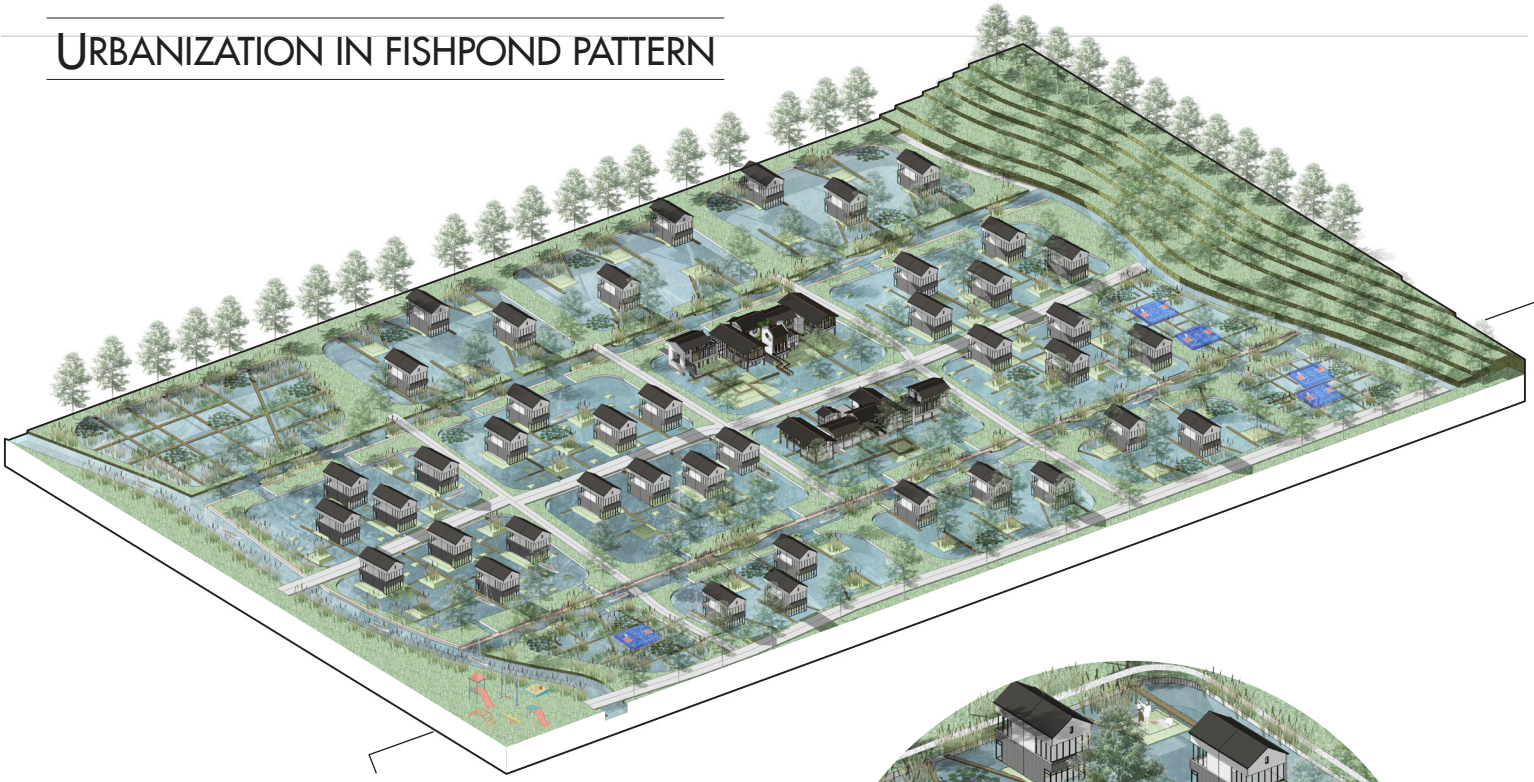
I.PLAN FOR LOCAL SCALE
II.SPATIAL ELABORATION
III.DETAIL DESIGN
IV.PHASING

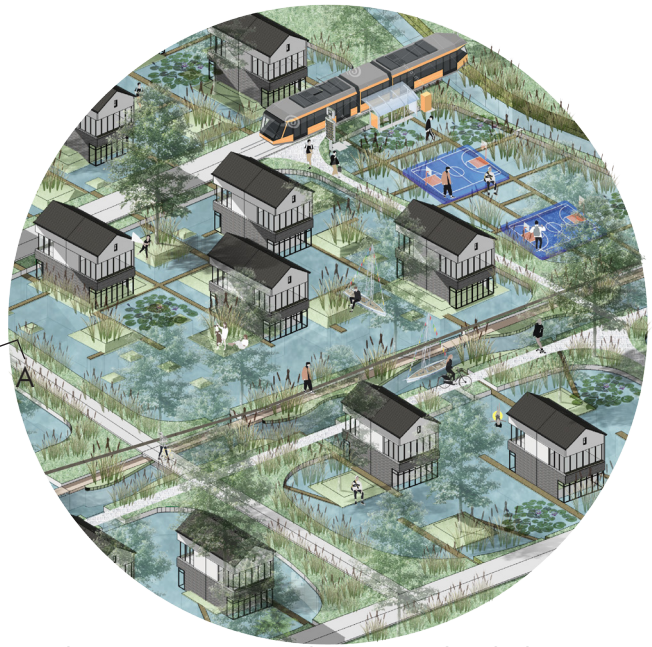



Dyke
Dyke-fishpond
Canal
Historical creek
Ditch
CURRENT LANDUSE
Current dyke
Canal
Dyke-fishpond
Modern urbanization
Industry
Forest
Current dyke
Infrastructure
Water sluice
0
0.5km
1km

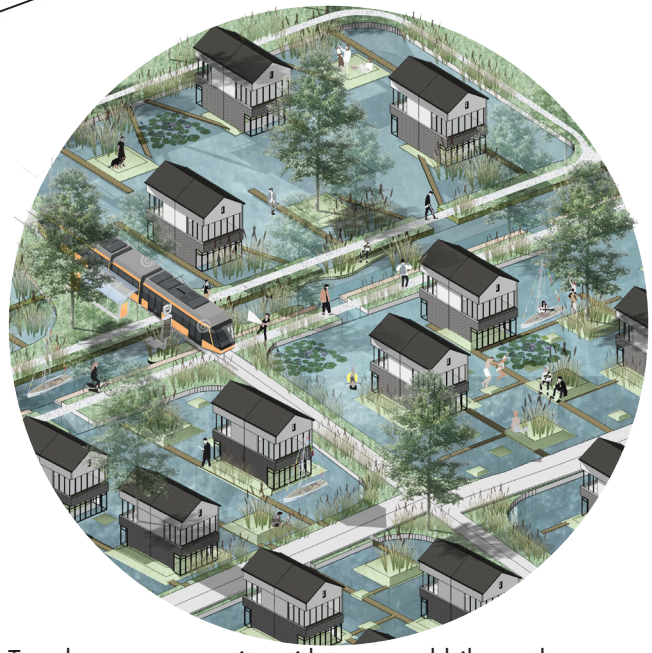

PLAN FOR LOCAL SCALE
0
0.5km
1km
Floating house and terp house in fishpond
Dyke house and wetland

URBANIZATION IN FISHPOND PATTERN

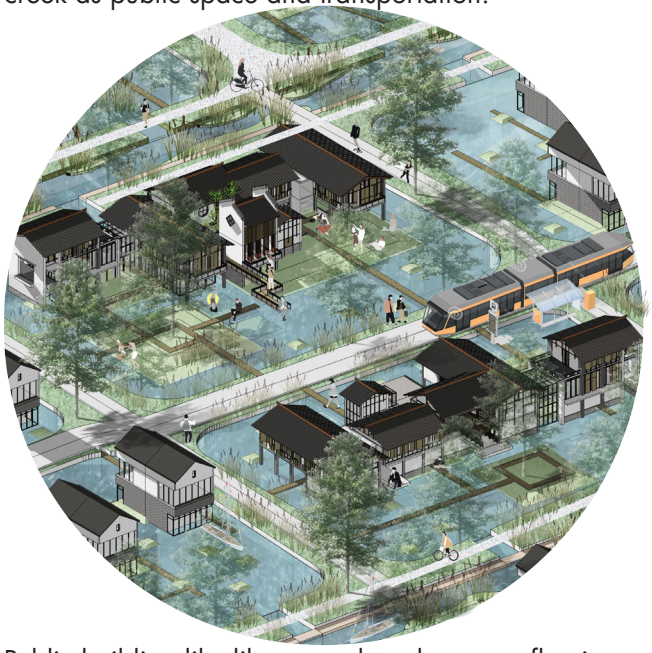




Terp house community with connected with drainage creek as public space and transportation.



Terp house community with tram and bike path

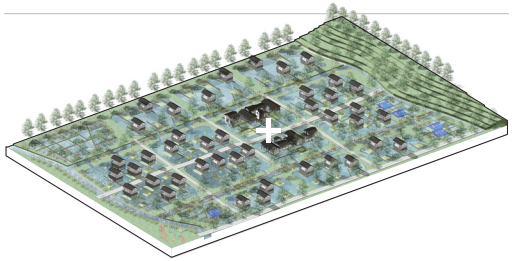


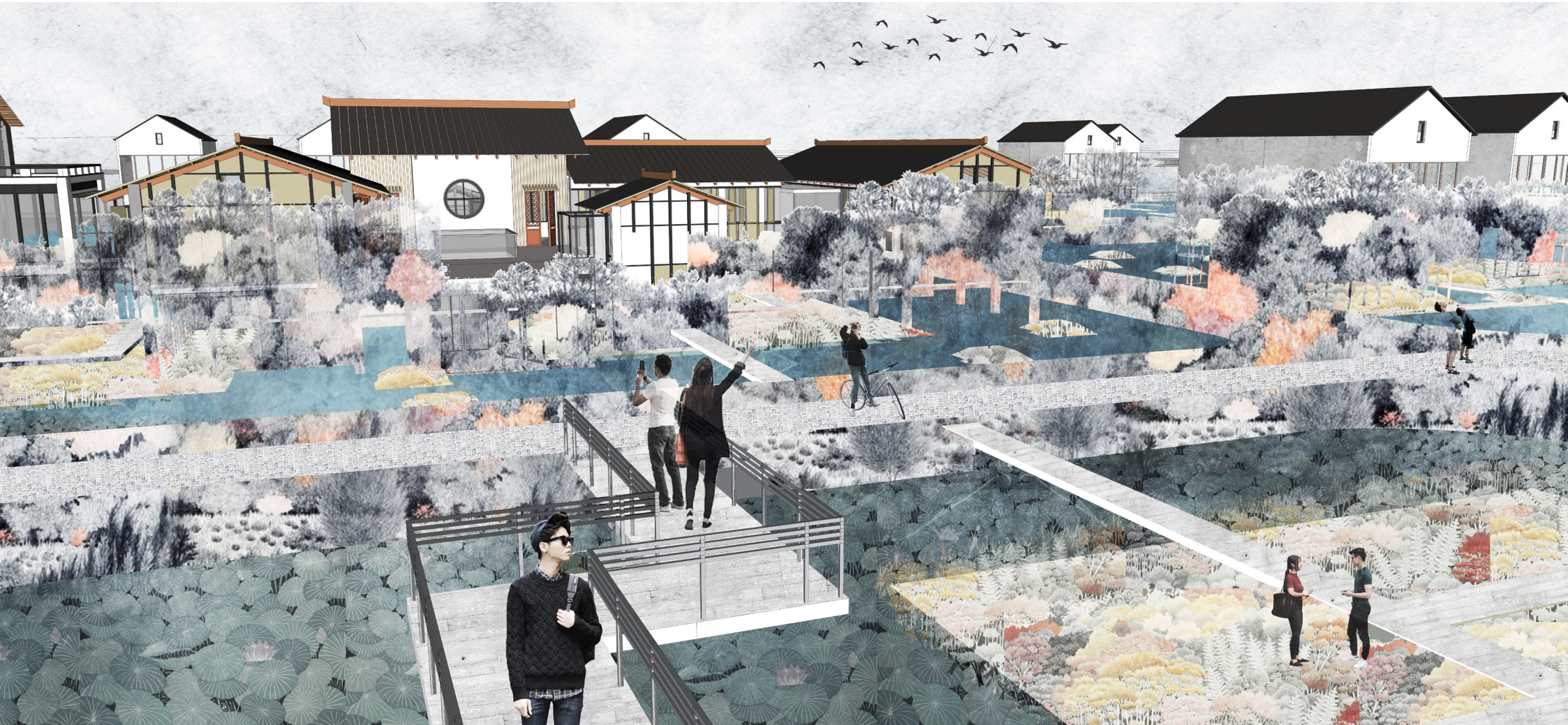
Public building like library and tea house on floating



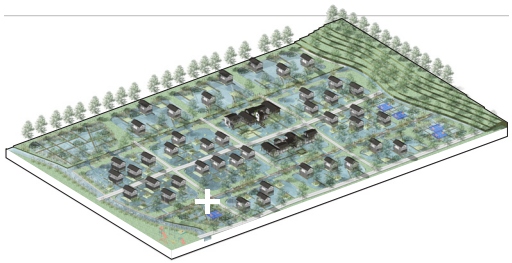
Section A-A
1:2000

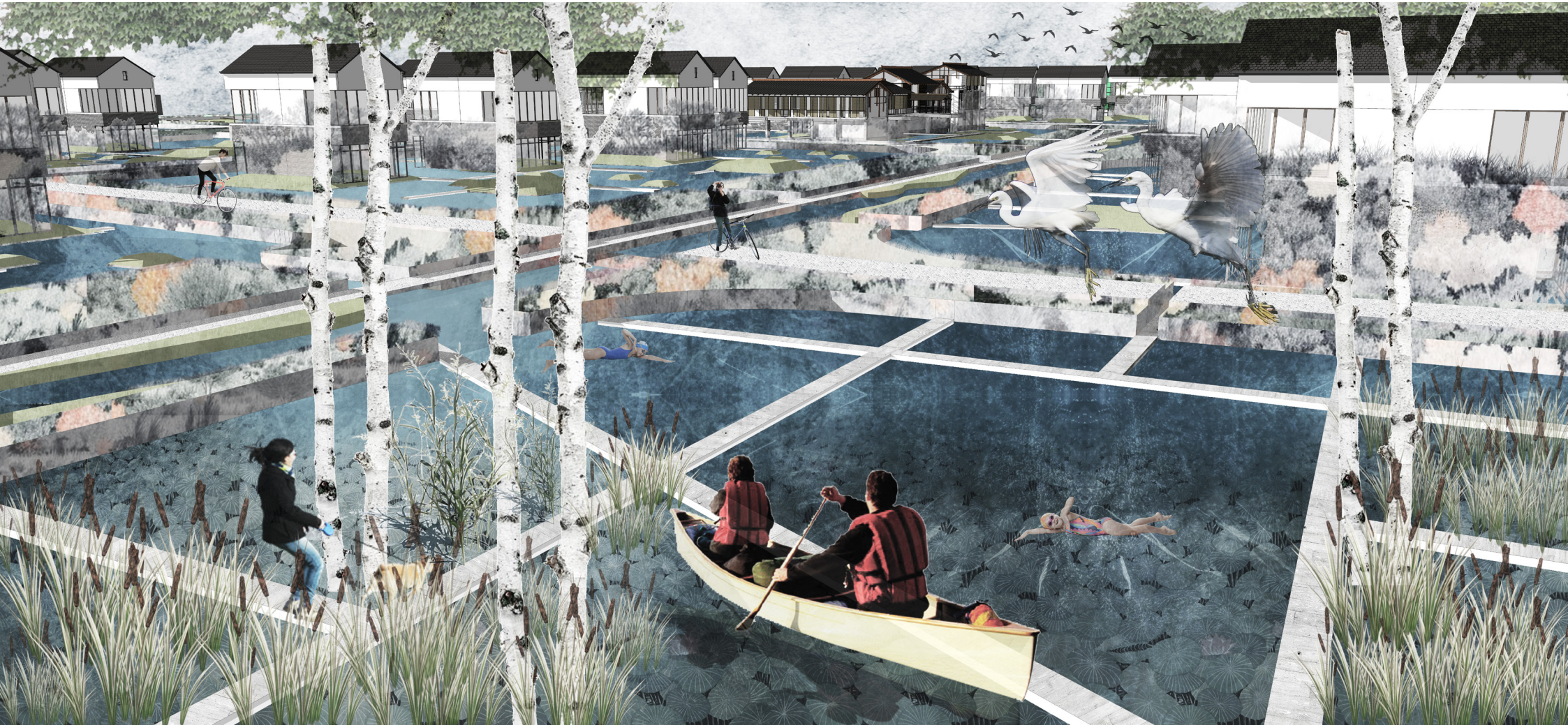
PUBLIC BUILDING IN COMMUNITY CENTER



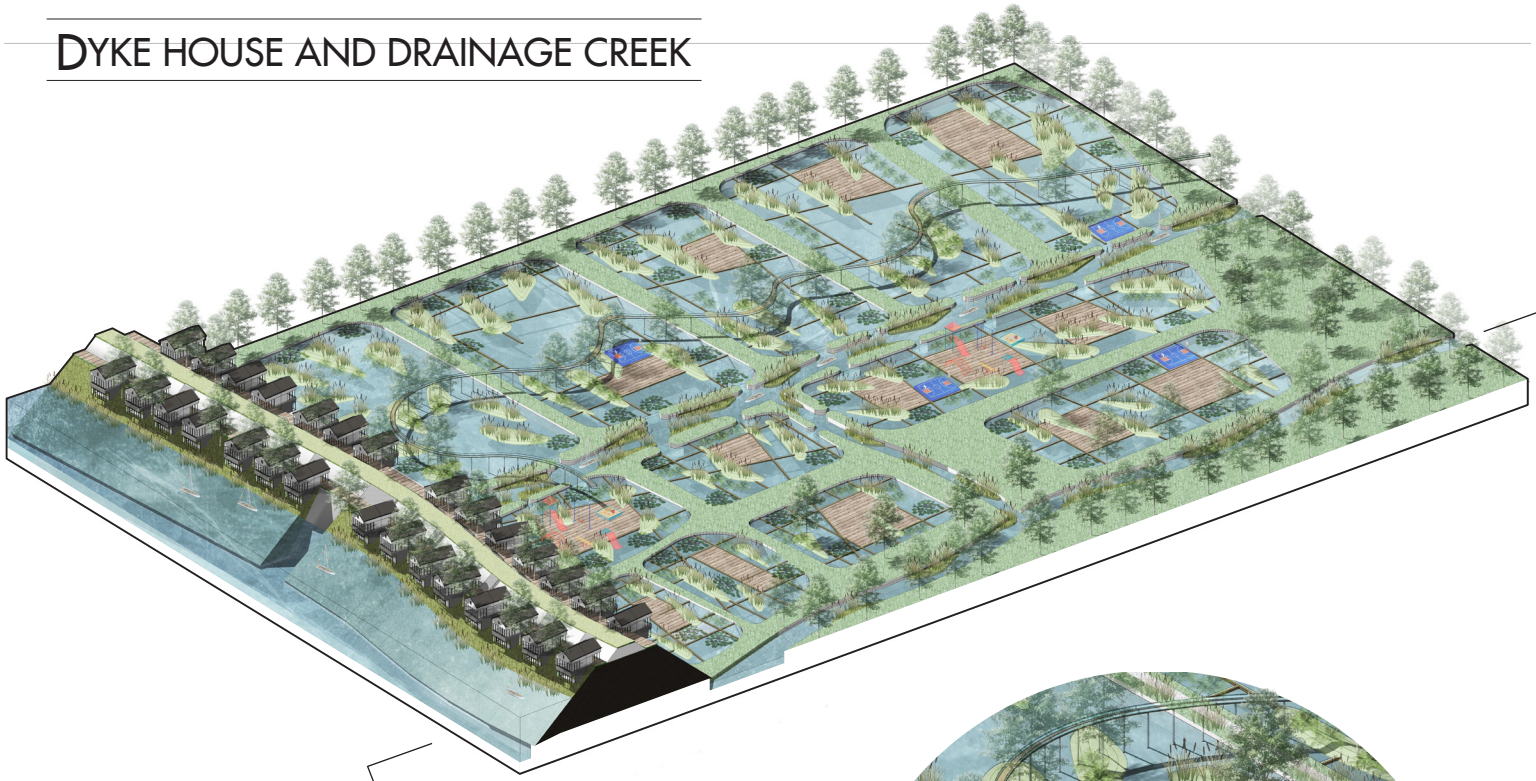


CONSTRUCTED WETLAND AND WATER COMMUNITY





DYKE HOUSE AND DRAINAGE CREEK

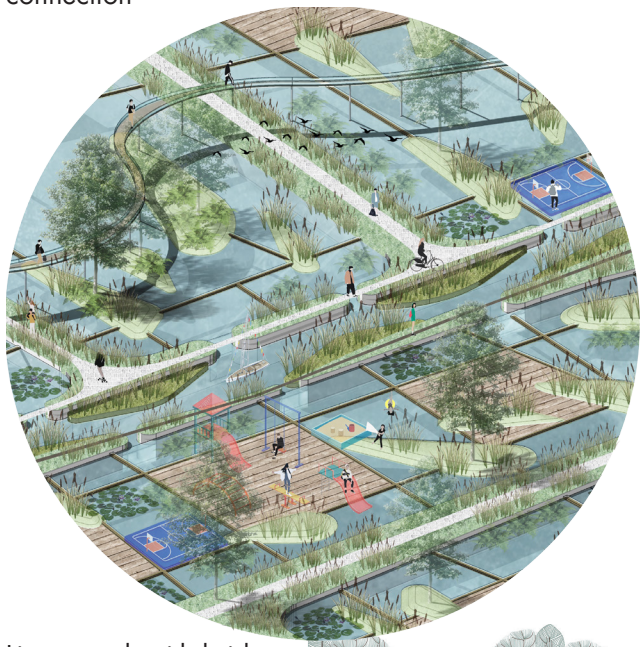




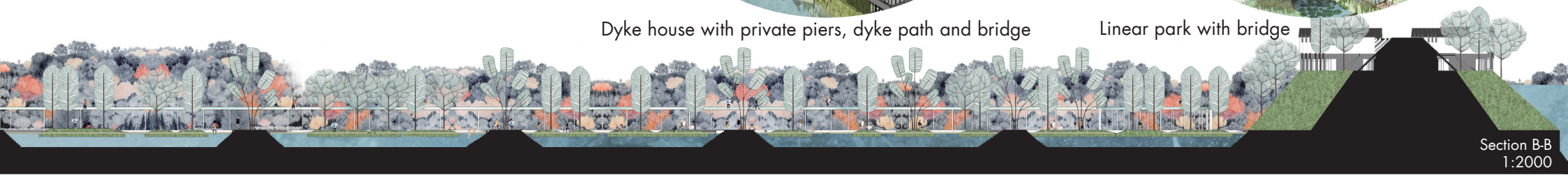
Drainage creek with transformed fishponds via open connection



Dyke house with private piers, dyke path and bridge



Linear park with bridge



Section B-B
1:2000

VIEW FROM THE DYKE HOUSE



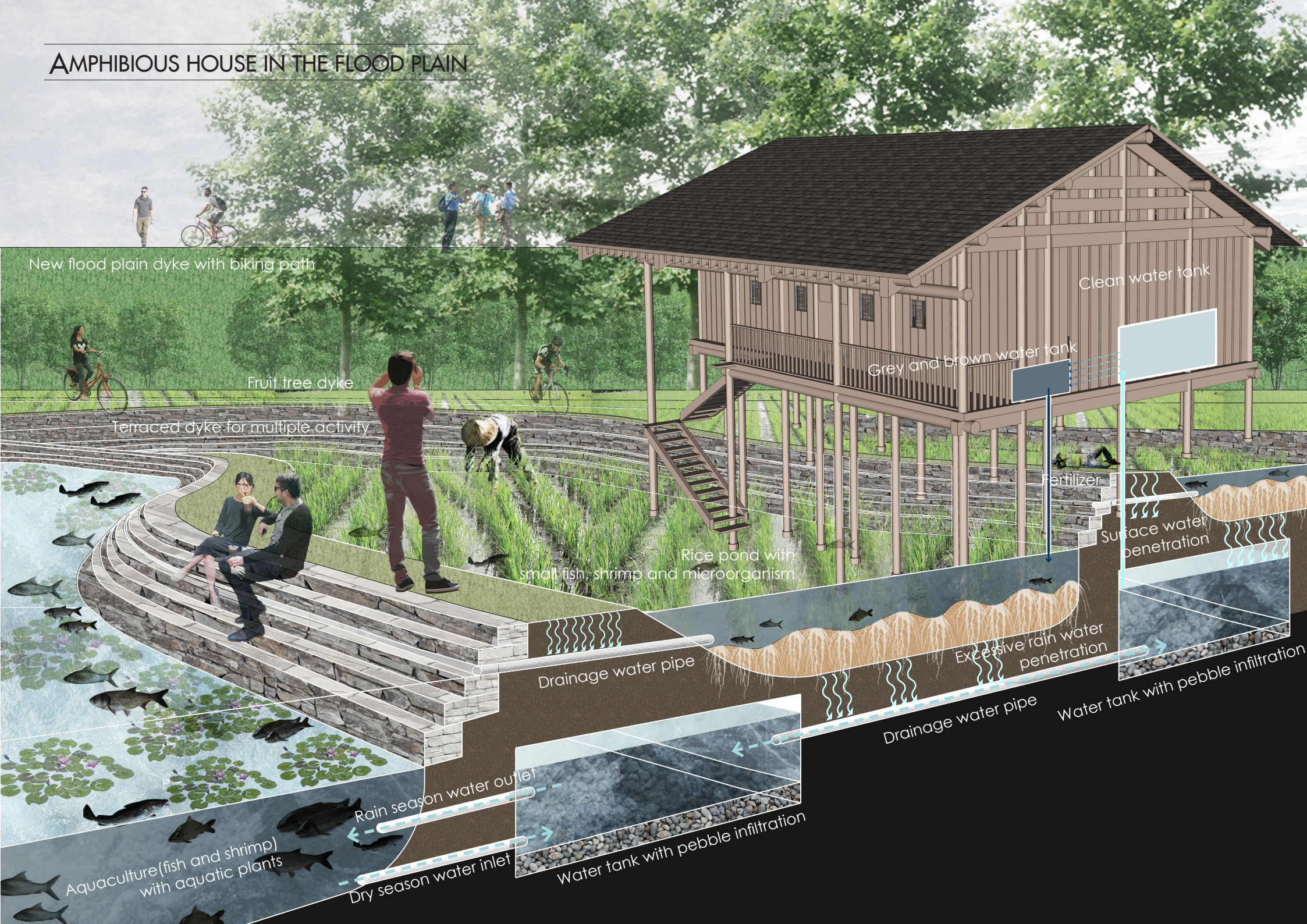


VIEW ALONG THE DYKE PATH





AMPHIBIOUS HOUSE IN THE FLOOD PLAIN

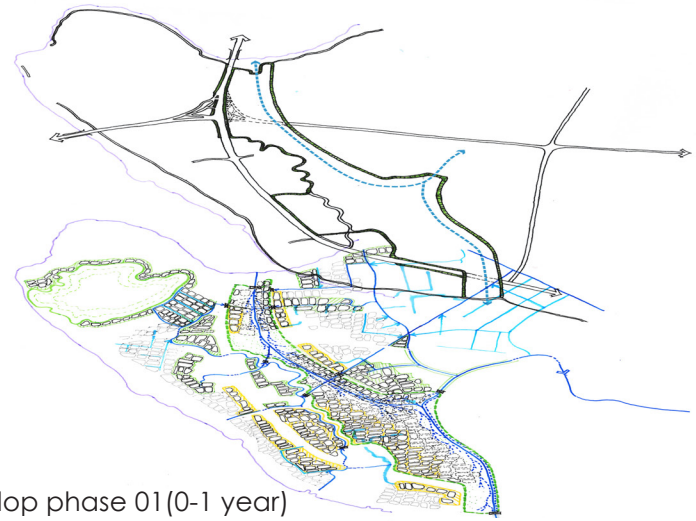


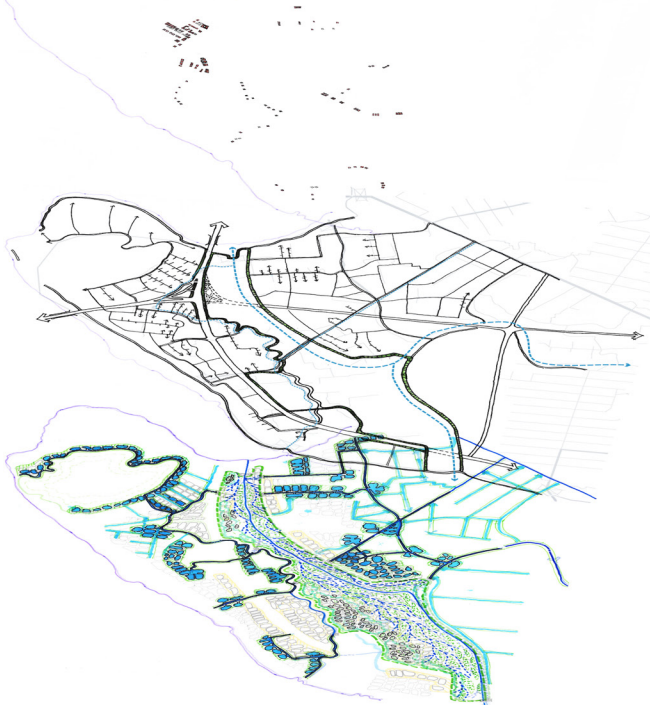
PHASING

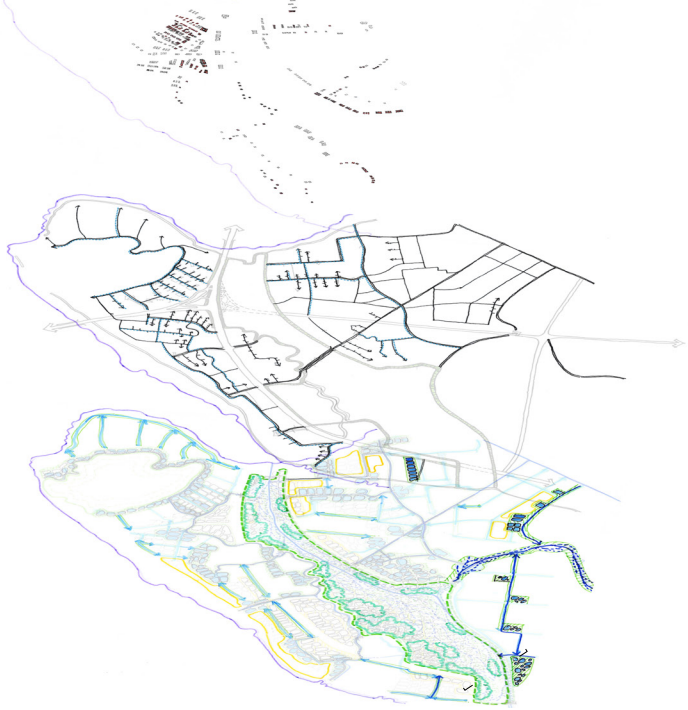
1 Develop phase 01(0-1 year)
Water infrastructure construction

2 Develop phase 02 (1-3 year)
Water dynamic restoration,
infrastructure construction
Housing

3 Develop phase 03 (3-5 year)
Eco-system restoration
Infrastructure and water system complete
Housing



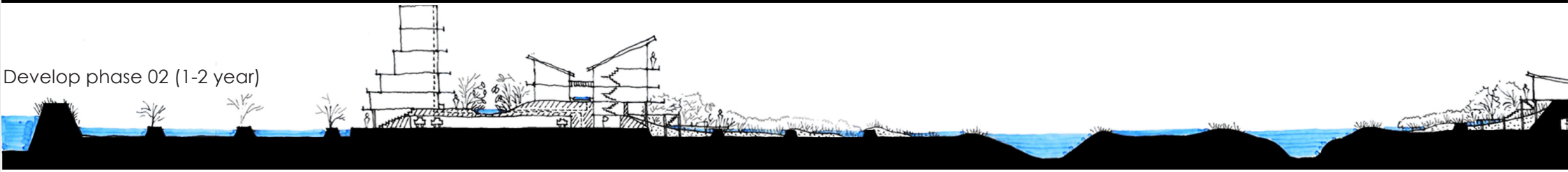




Develop phase 01(0-1 year)



Develop phase 02 (1-2 year)

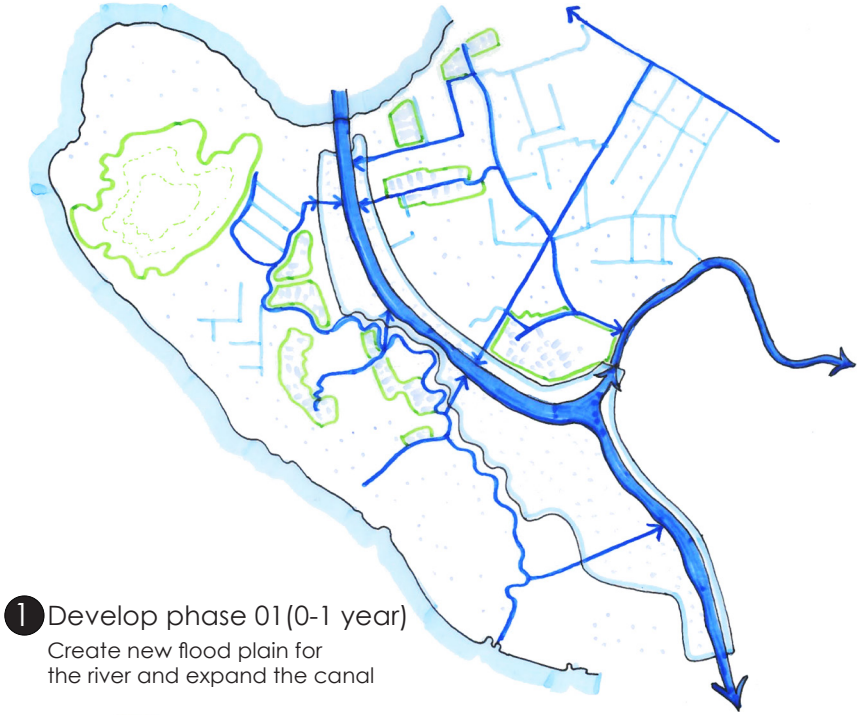


Develop phase 03 (2-5 year)



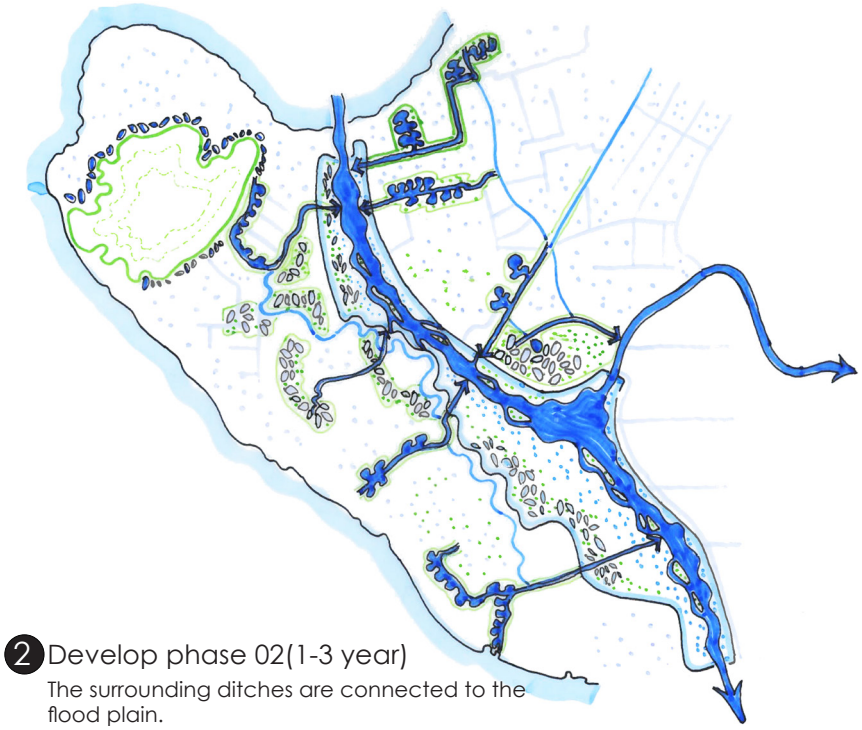

WATER SYSTEM STRATEGY
New dyke
Expanded canal&creek
Drainage ditch
Restored historical creek
Current drainage creek & ditch
New sluice
0
0.5km
1km

PHASING OF WATER MANAGEMENT



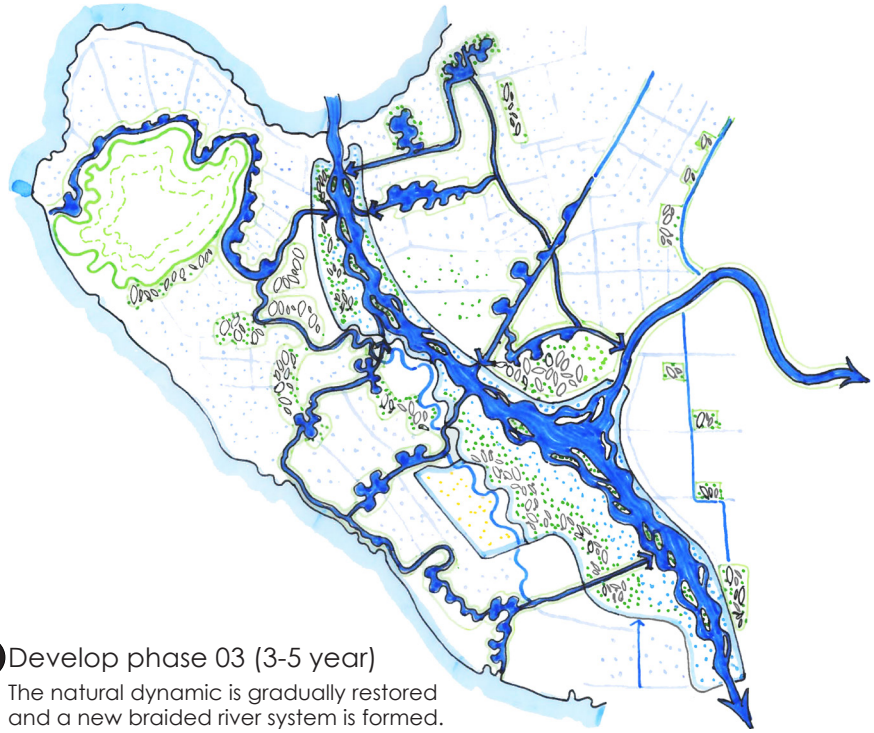
1 Develop phase 01(0-1 year)

Create new flood plain for
the river and expand the canal



2 Develop phase 02(1-3 year)

The surrounding ditches are connected to the
flood plain.



3 Develop phase 03 (3-5 year)

The natural dynamic is gradually restored
and a new braided river system is formed.


ECO-SYSTEM STRATEGY
New dyke
Restored historical creek
River development
Fishponds with floating
wetland
New agriculture using
0
0.5km
1km

SEDIMENTATION EXPERIMENT

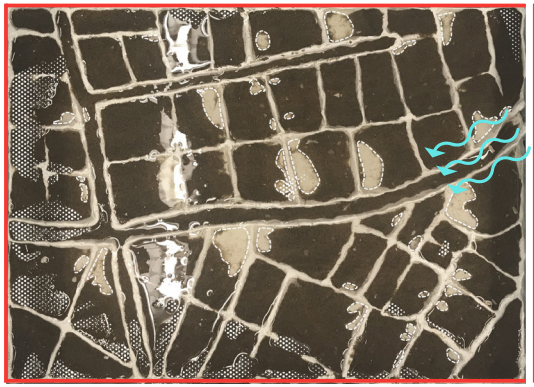
01(concrete dyke)



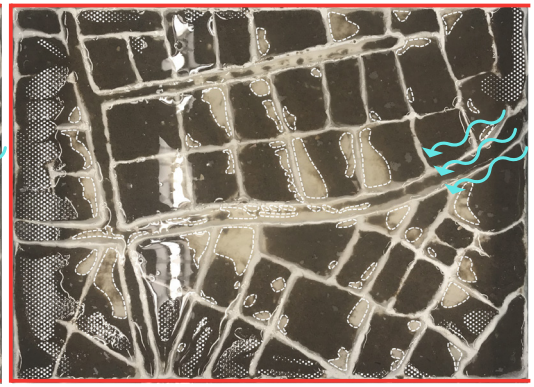
0 Current state



1 River comes into the flood plain again and sedimentation

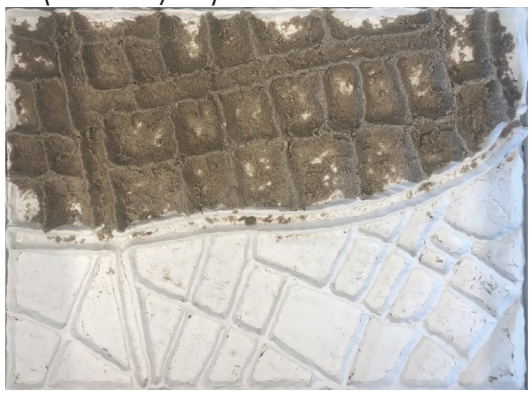


2 More sediments in the ponds around dyke



3 The final sedimentation pattern

02(mud dyke)



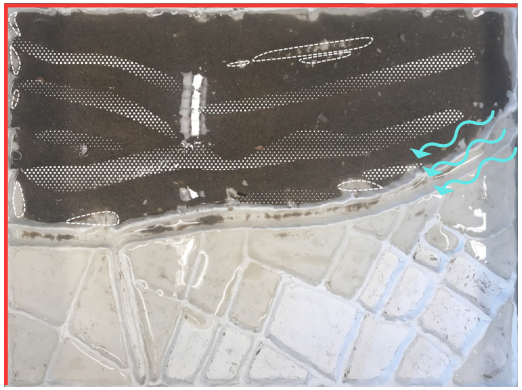
0 Current state with demolished concrete dyke surface.



1 The main erosion happens around the linear dykes while the conjunction part remains.



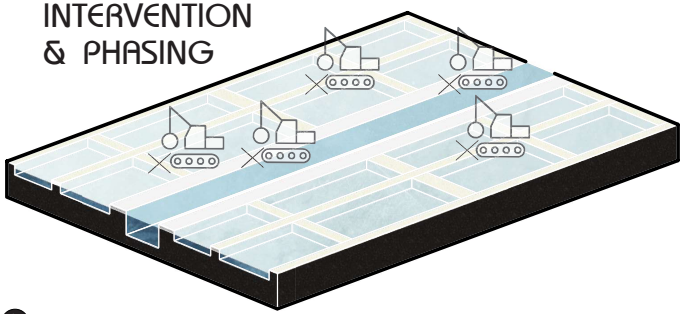
2 A natural river morphology starts to take place.

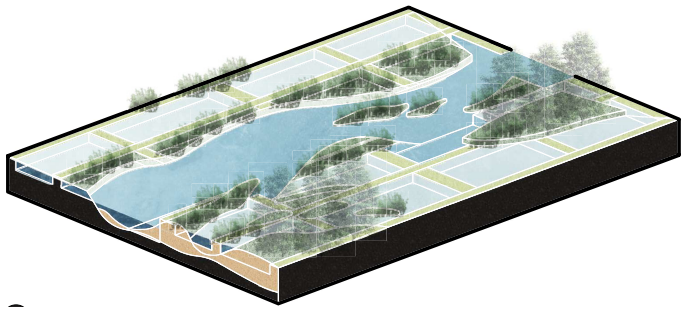


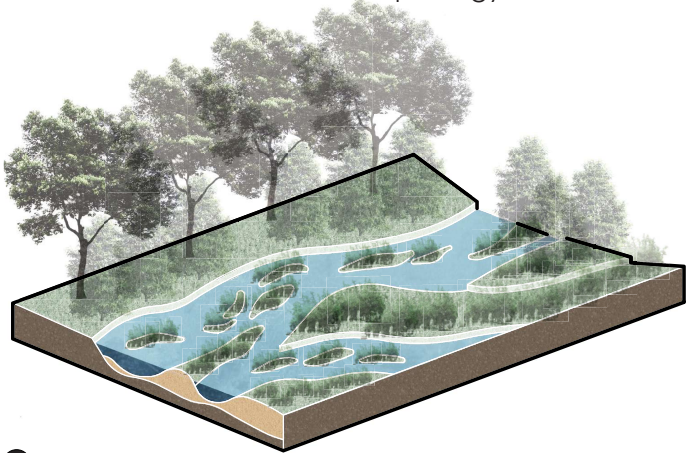
3 The sedimentation & erosion follow braided river morphology.

Sedimentation
Erosion
Subsoil
Flow direction
New dyke

INTERVENTION & PHASING

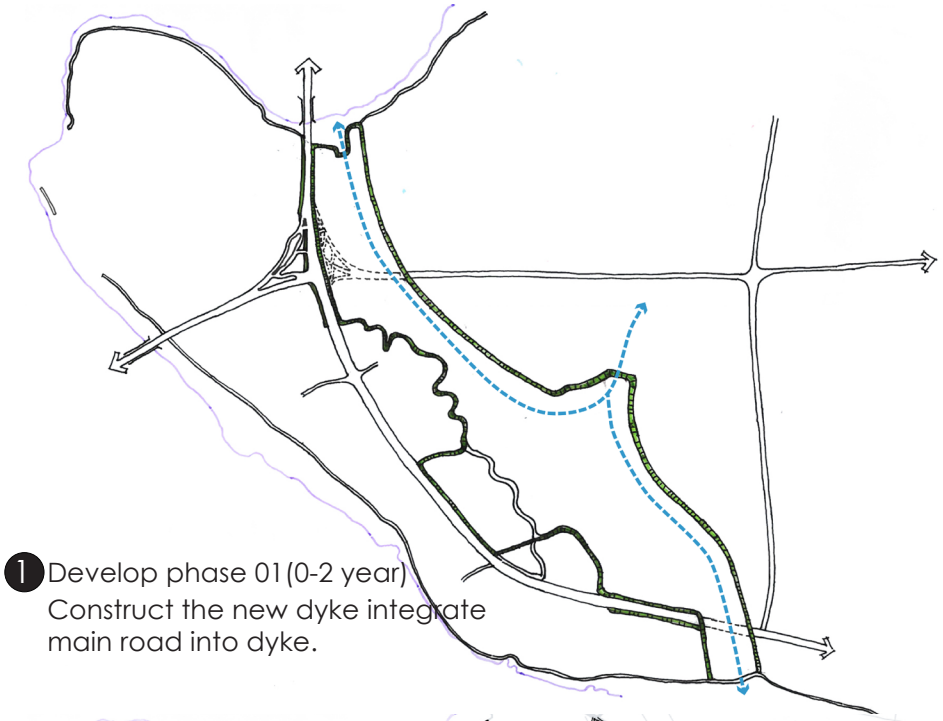




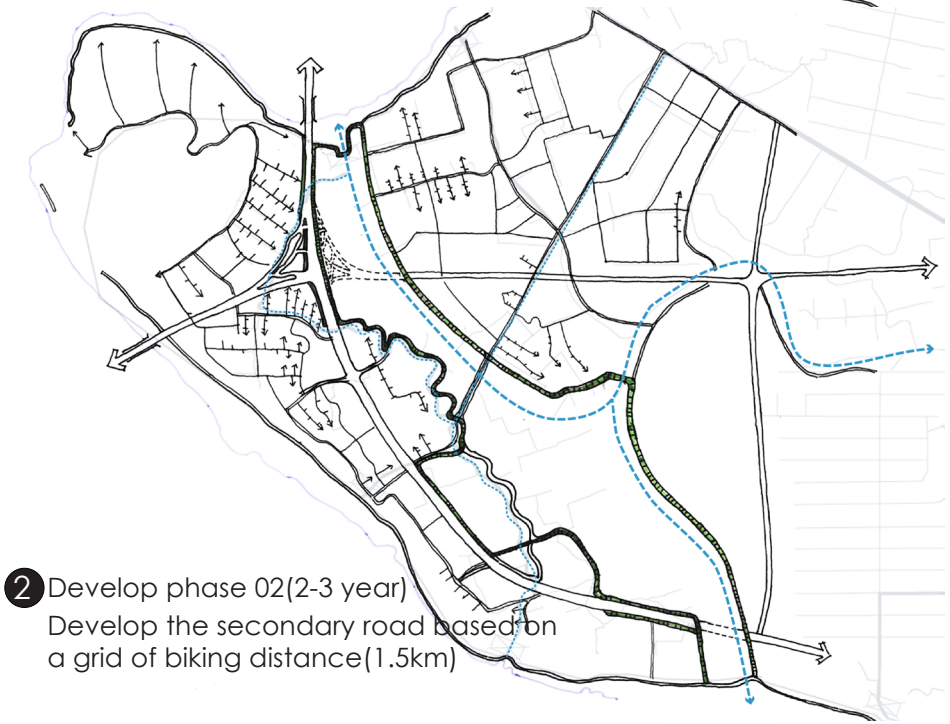



INFRASTRUCTURE SYSTEM STRATEGY
New dyke
Main road
Secondary road
Water transportation
0
0.5km
1km

PHASING OF INFRASTRUCTURE



1 Develop phase 01(0-2 year)
Construct the new dyke integrate main road into dyke.



2 Develop phase 02(2-3 year)
Develop the secondary road based on a grid of biking distance(1.5km)



3 Develop phase 03 (3-5 year)
A "Rhizome" model based on water system and other development

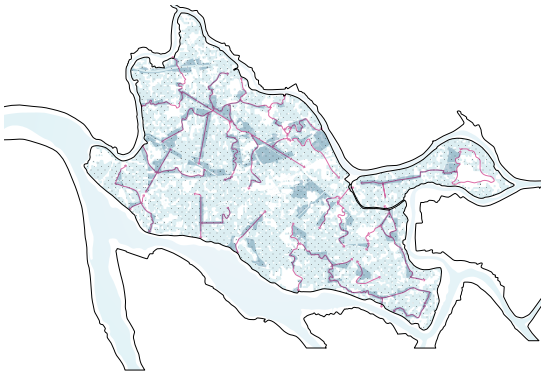
05. CONCLUSION AND REFLECTION

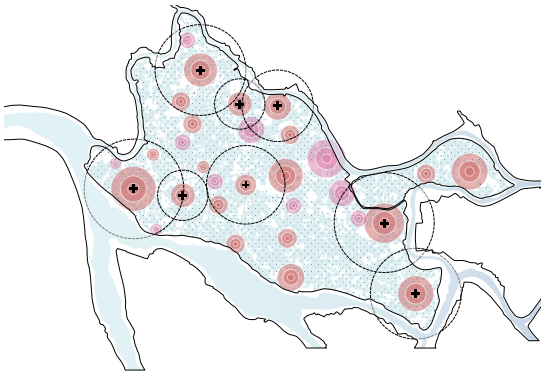
I. WATER-SENSITIVE STRATEGIES FOR SHUNDE

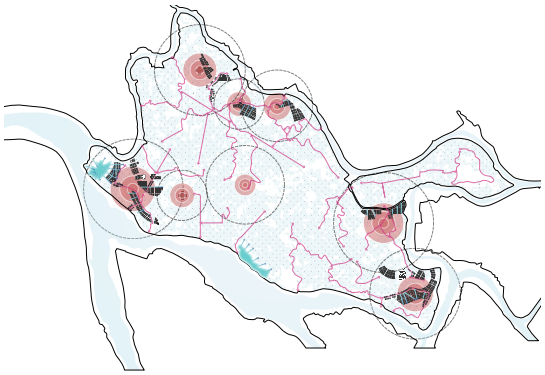
II. LESSONS FOR WATER-SENSITIVE DESIGN

III. RESEARCH THROUGH DESIGN

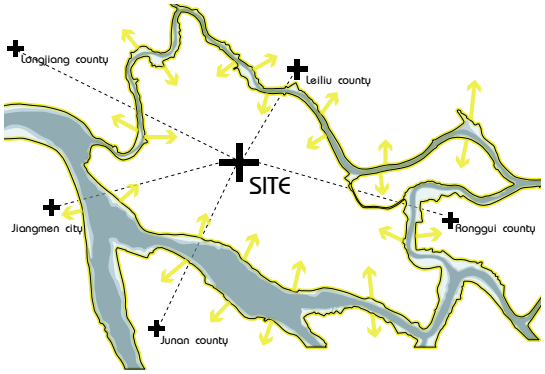
UNDERSTANDING TERRAIN



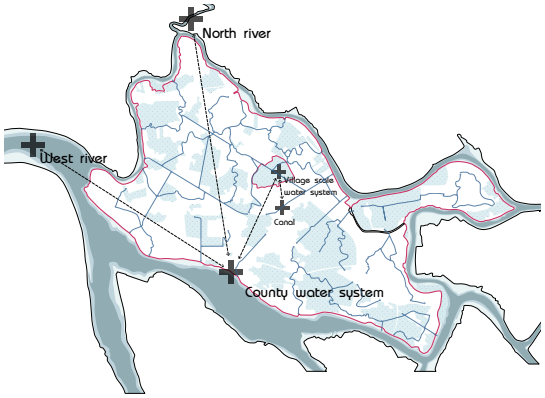




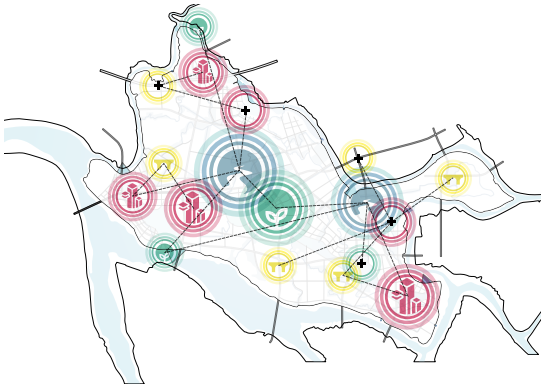
COLLABORATIVE PRINCIPLE



MULTISCALE WATER MANAGEMENT



PROCESS PRINCIPLE



WATER-SENSITIVE STRATEGIES FOR SHUNDE

MORE SPACE FOR WATER



WORK WITH NATURE

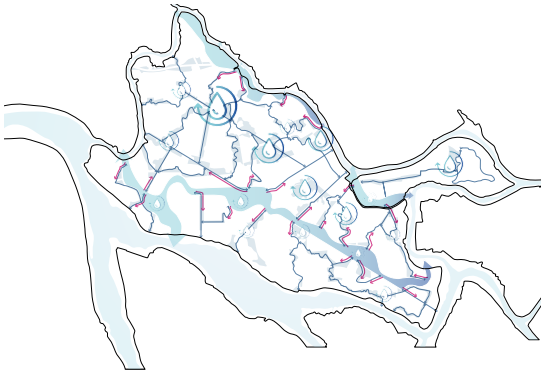


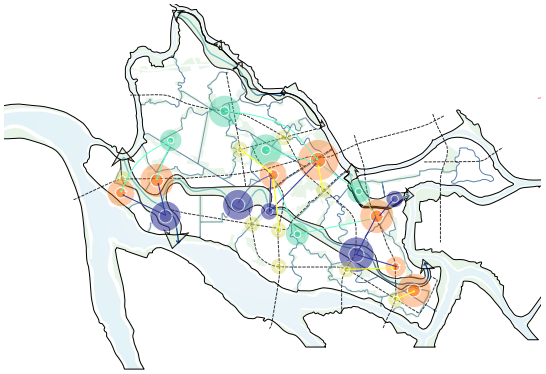
MULTIFUNCTIONAL WATER MANAGEMENT



RE-USE AND CIRCULATION

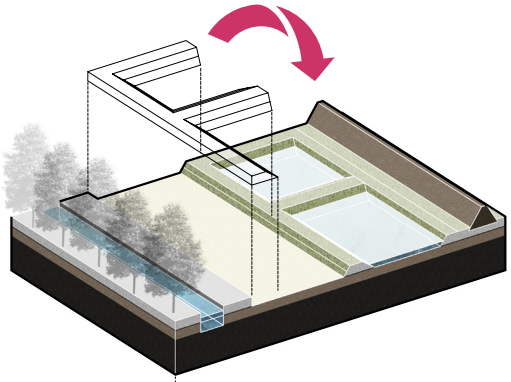




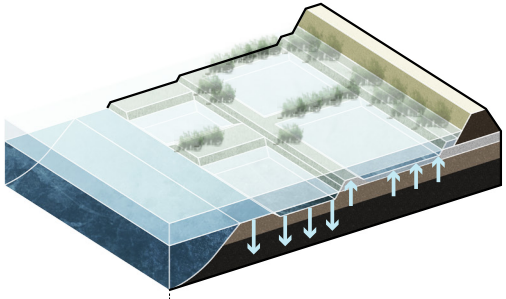


UNDERSTAND THE TERRAIN AND MORE SPACE FOR WATER

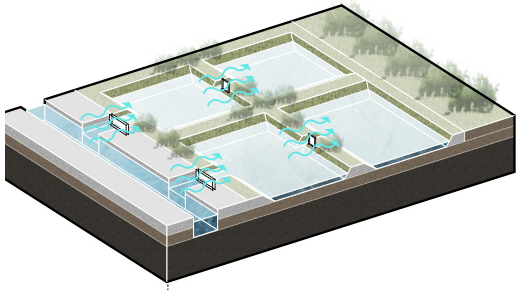
BASED ON HISTORICAL CREEK



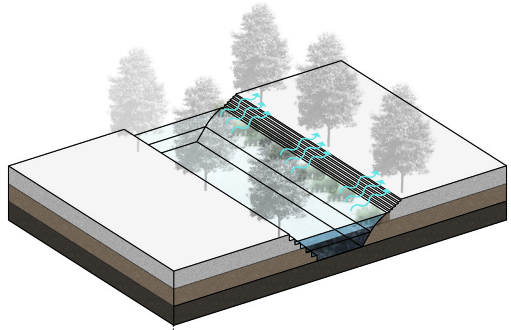
OUTSIDE THE DYKE



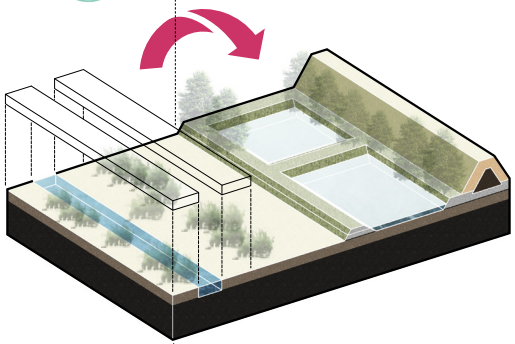
ALONG THE DITCH

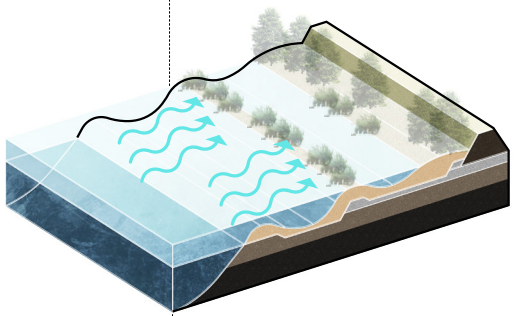


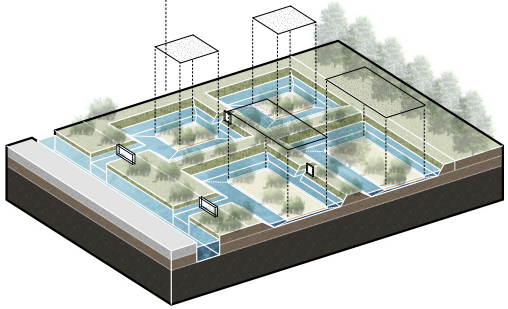
CITY CANAL

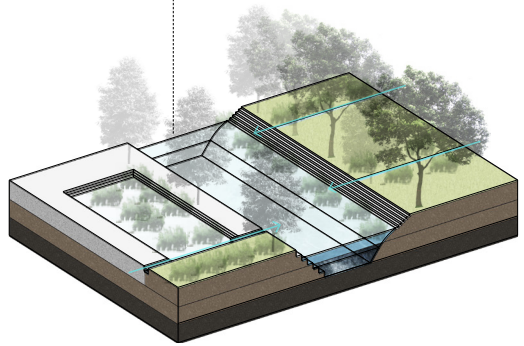


REUSE AND CREATE CONDITION FOR NATURE

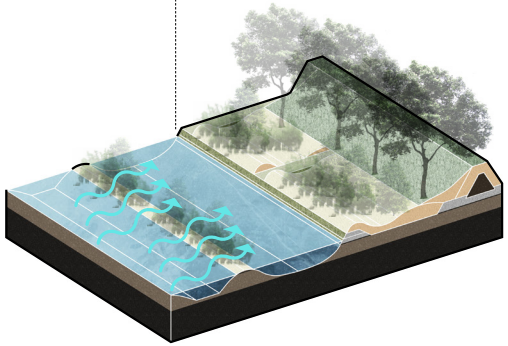


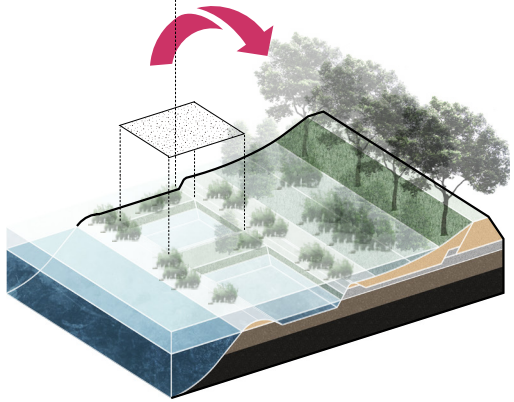


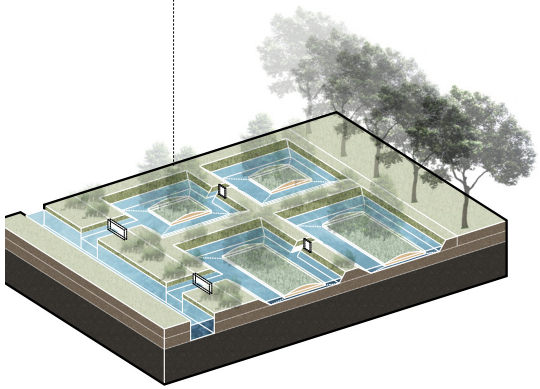


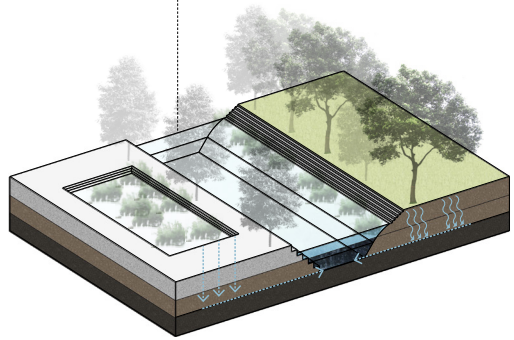


WORK WITH NATURE AND MULTIFUNCTIONAL WATER MANAGEMENT



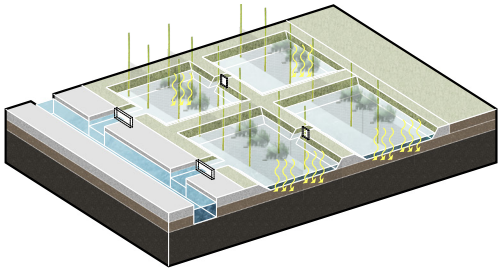




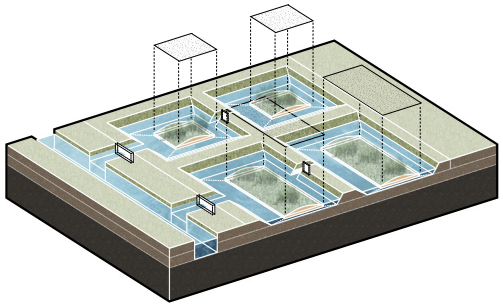


WORK WITH NATURE AND ENHANCE DIFFERENT ECO-SYSTEM

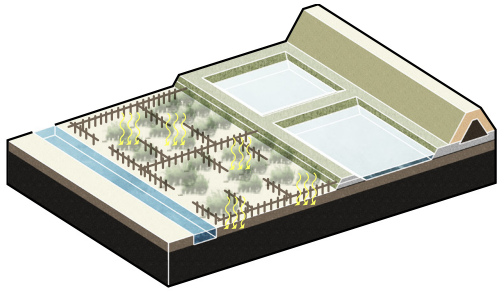
FISHPOND ECO-SYSTEM



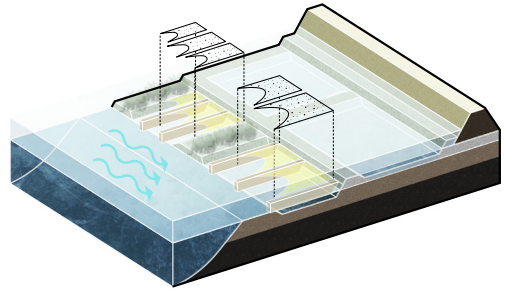
FISHPOND ECO-SYSTEM



RIPARIAN ECO-SYSTEM

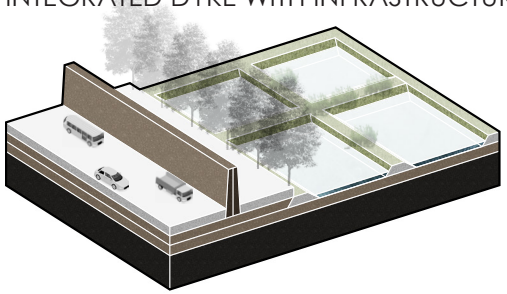


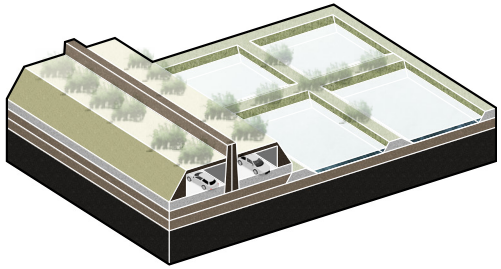
RIPARIAN ECO-SYSTEM

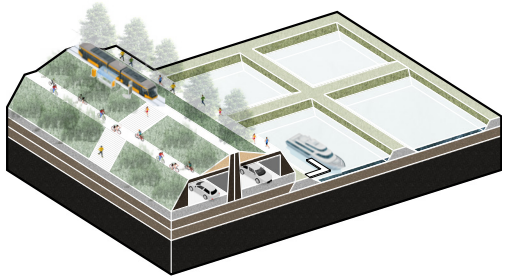


MULTIFUNCTIONAL WATER MANAGEMENT

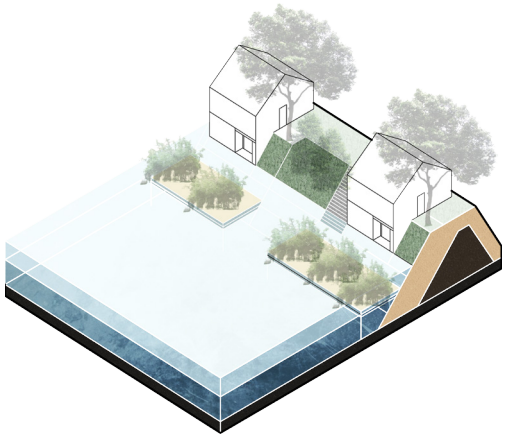
INTEGRATED DYKE WITH INFRASTRUCTURE

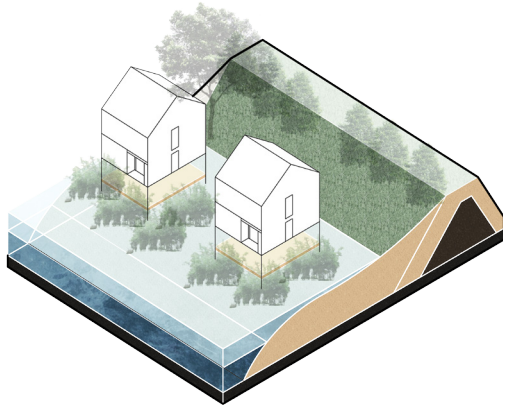


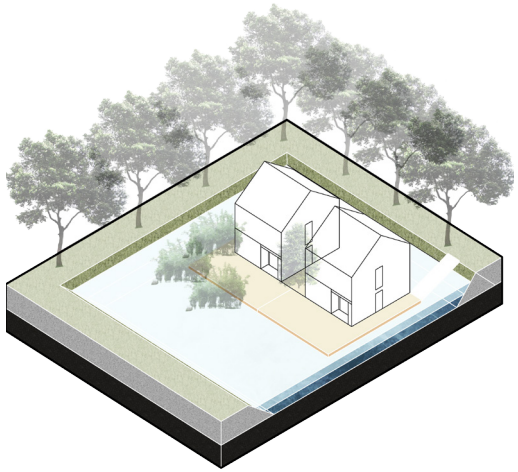


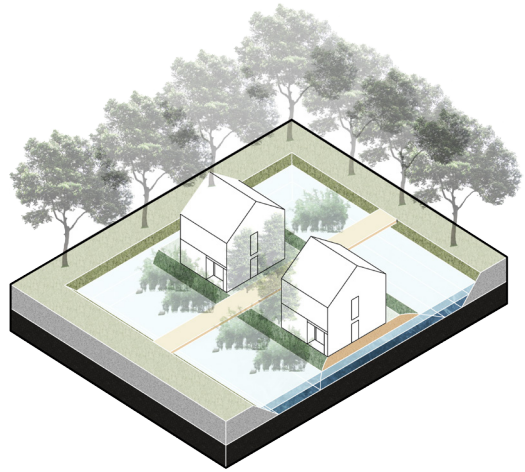


INTEGRATED HOUSING TYPOLOGY









LESSONS FOR WATER-SENSITIVE DESIGN

SPECIFIC LESSONS FOR SHUNDE

-Transformative perspective towards Shunde, PRD with a long-term of dealing with water.

-Special development based on understanding of terrain and dyke-fishpond system

COMMON LESSONS

-Work through multiscale

-Collaboration of different local governments

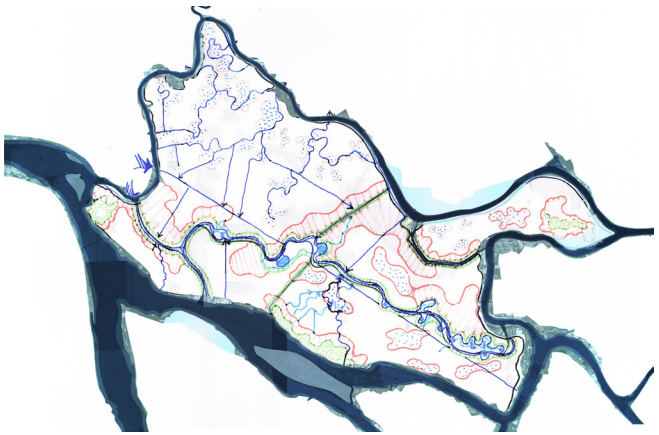
-Landscape as a process of multiple layers with different dynamic

-Work with the nature and circular development as a more sustainable method

-Water management as catalyst for multifunctional development



RESEARCH THROUGH DESIGN



Process of plan:Version 01



Process of plan:Version 02



Process of plan:Version 03

-DESIGN SETS THE FOCUS FOR RESEARCH

-DESIGN AS USEFUL TOOL TO TEST RESEARCH

THANKS FOR LISTENING

An article called "Learning from Agri-Aquaculture for Multiscale Water-Sensitive Design in the Pearl River Delta" written by the Chuanzhi Sun, Steffen Nijhuis and Gregory Bracken

