Water Resilient Mosaic

[Envisioning a co-evolutionary transformation of territories-in-between in the BTH metropolitan region]

Yuzhou Jin

P5 Presentation

06/24/24

Content

Introduction

Haihe flood 2023 | Problematization | Research Question

Unrepaired junction near Zhuozhou, eight months after the flood.

Over 13 billion euros property loss
5.2 million people suffered from floods

North Juma River bank, heavily damaged road, Zhuozhou

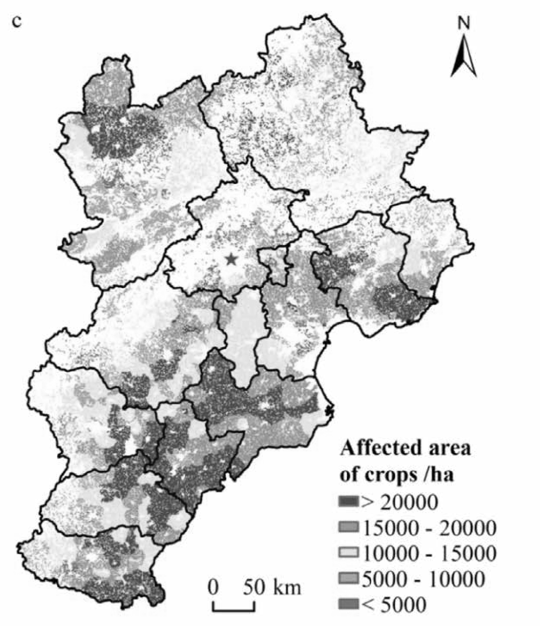
Tree roots hanging on electric wires, Jinghai district, Tianjin

Villagers rebuilding homes, Suqiao down, Bazhou

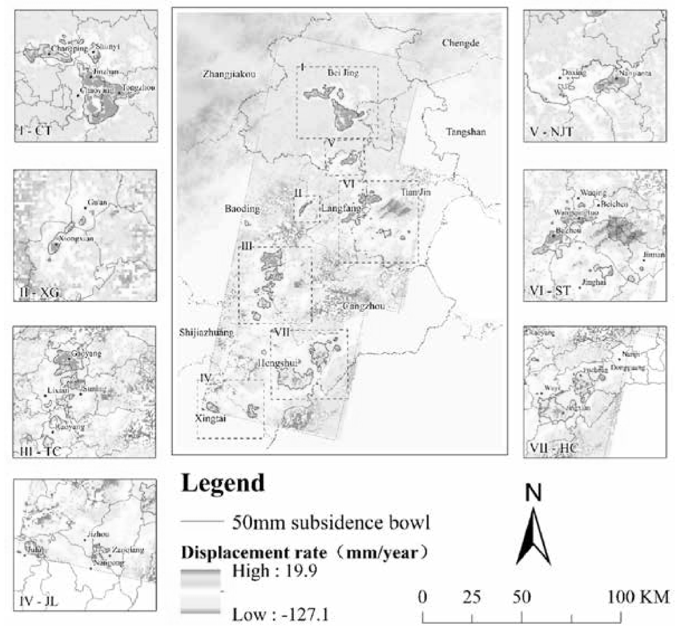
Introduction
Problematization

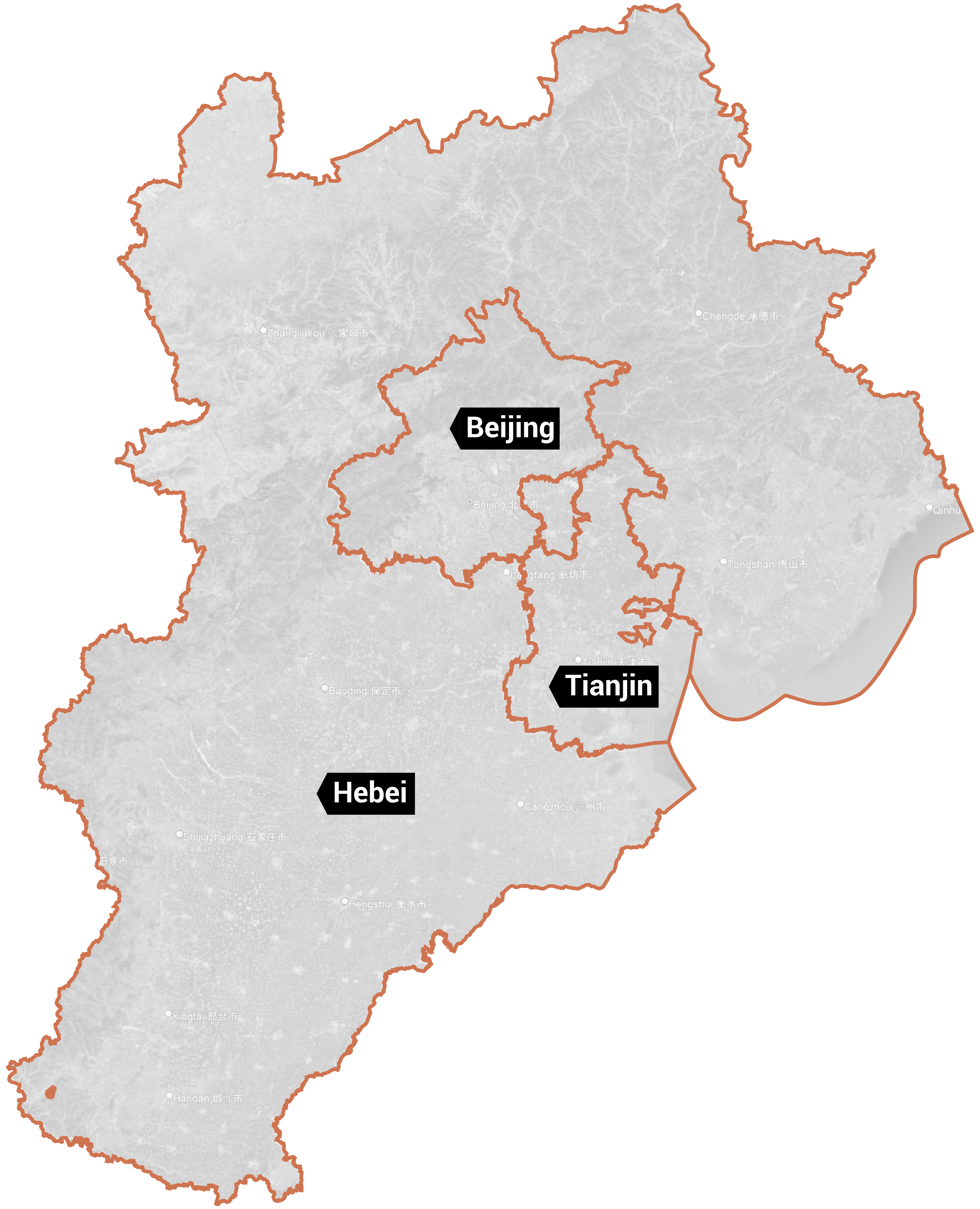
Flood

Drought & Heat



Subsidence

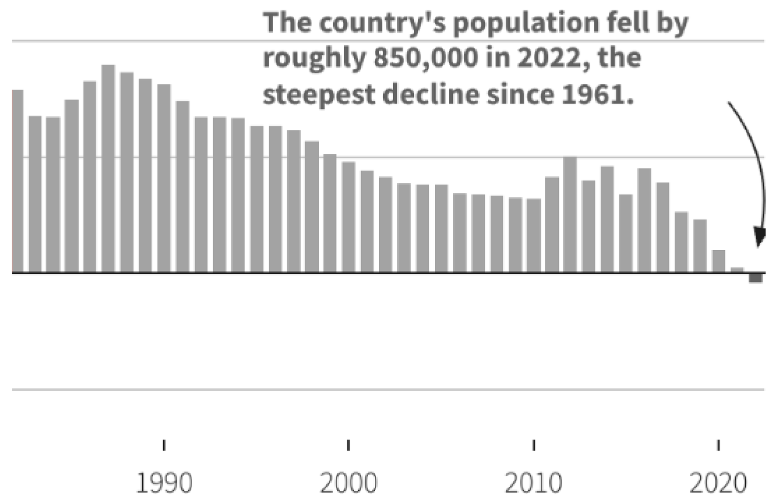




Air Pollution

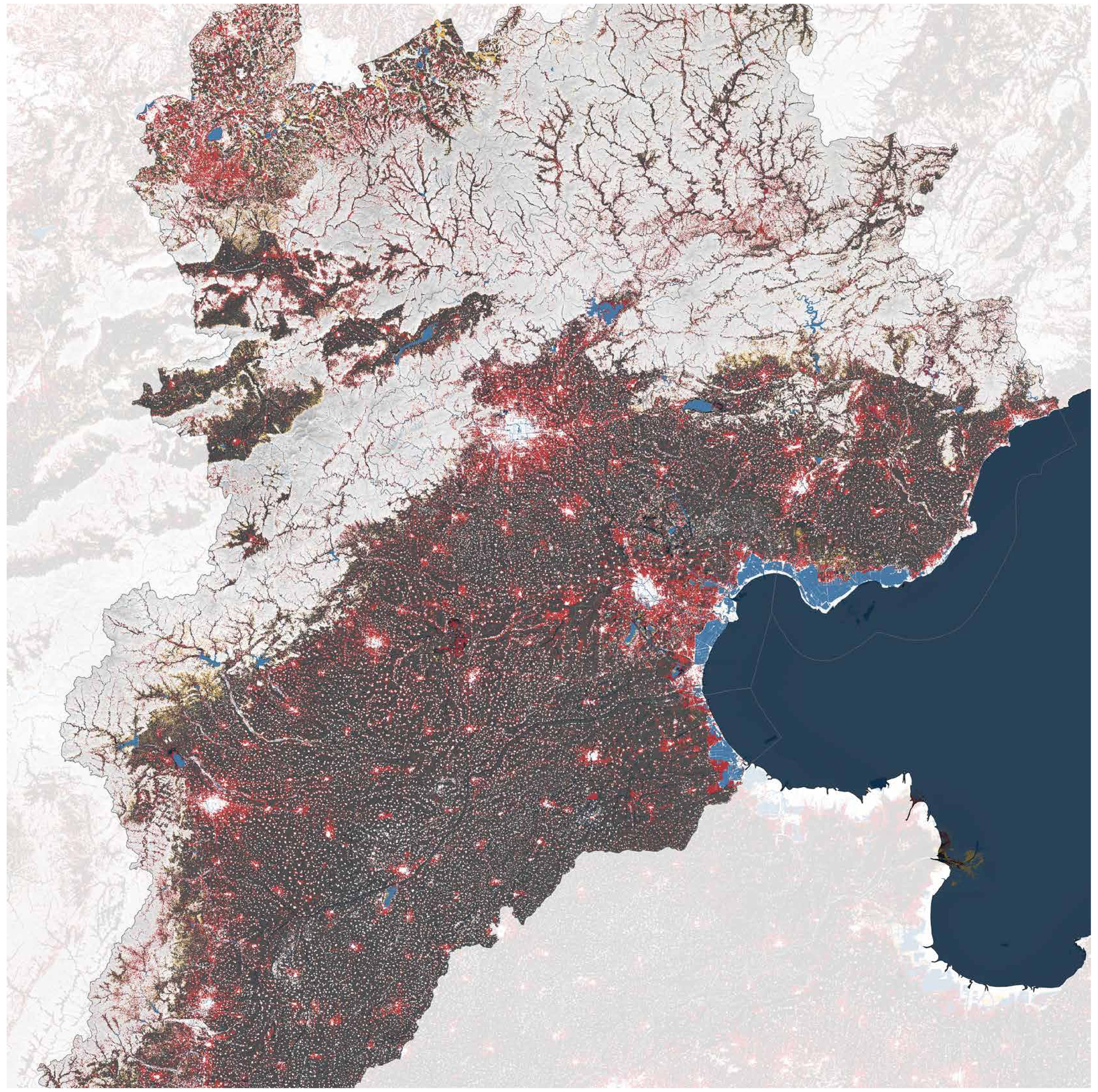
Polarized Development

Aging Population



Landscape fragmentation | ecosystem degradation

The ongoing construction in Xiong'an New Area exemplifies the rapid urban expansion in the Beijing-Tianjin-Hebei (BTH) metropolitan region, driven by China's strategic initiatives to decentralize Beijing, promote regional integration, and develop new economic hubs.



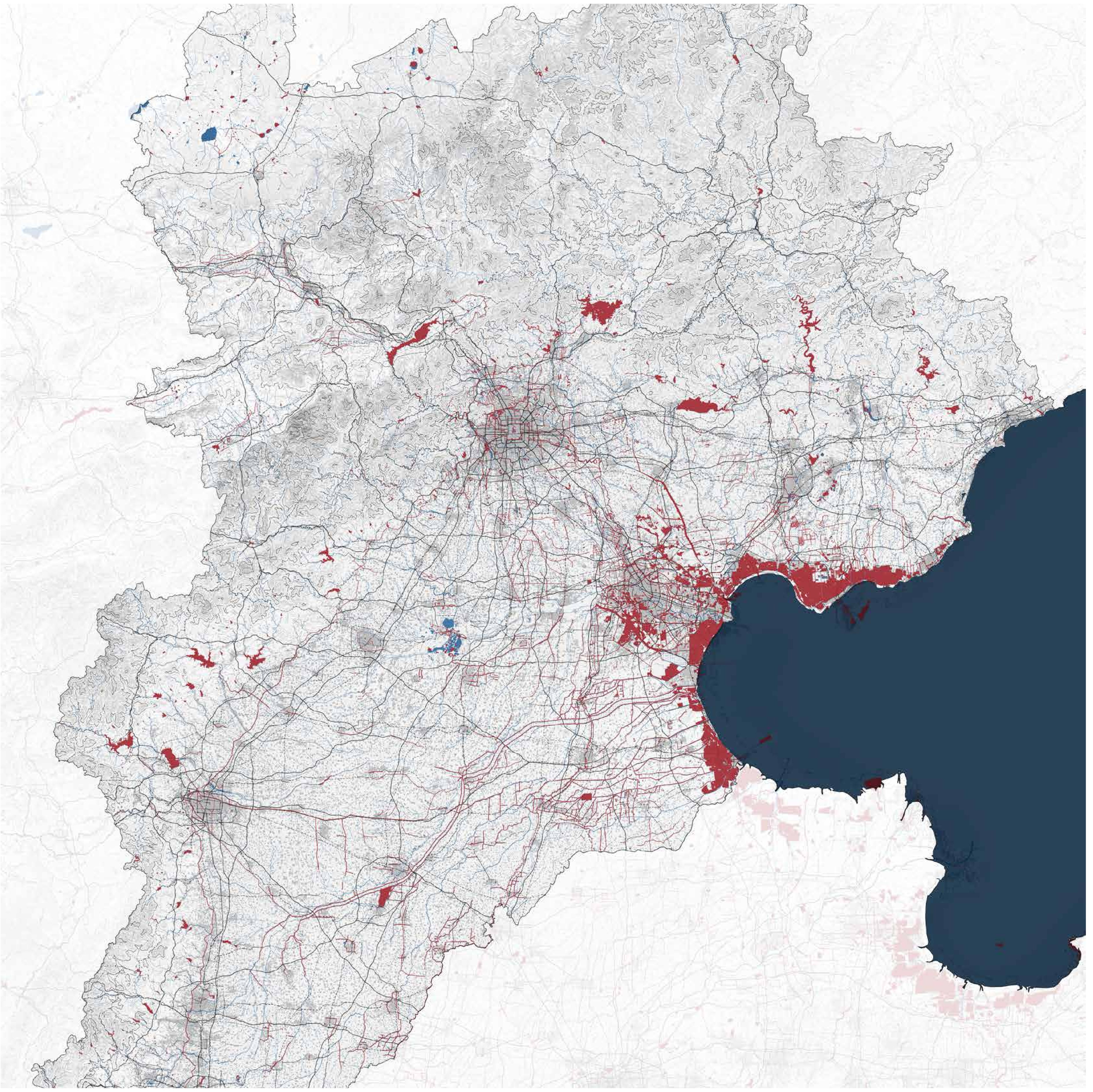
Cropland change 1985-2022 (Data: OSM, Jie Yang et al. (2023). 10.5281/zenodo.8176941)

- *Persistent*
- *Increasement*
- *Decreasement*
- *Waterbody*
- *Waterway*
- *Administrative boundary*

0 10 200 km

Hydrological fragmentation | water hazard exposure

The South–North Water Transfer Project, a major engineering endeavor diverting water from the Yangtze River Basin to alleviate northern water shortages and support urban growth, significantly alters the hydrological system and causes ecological disruptions and reduced water availability in source regions.



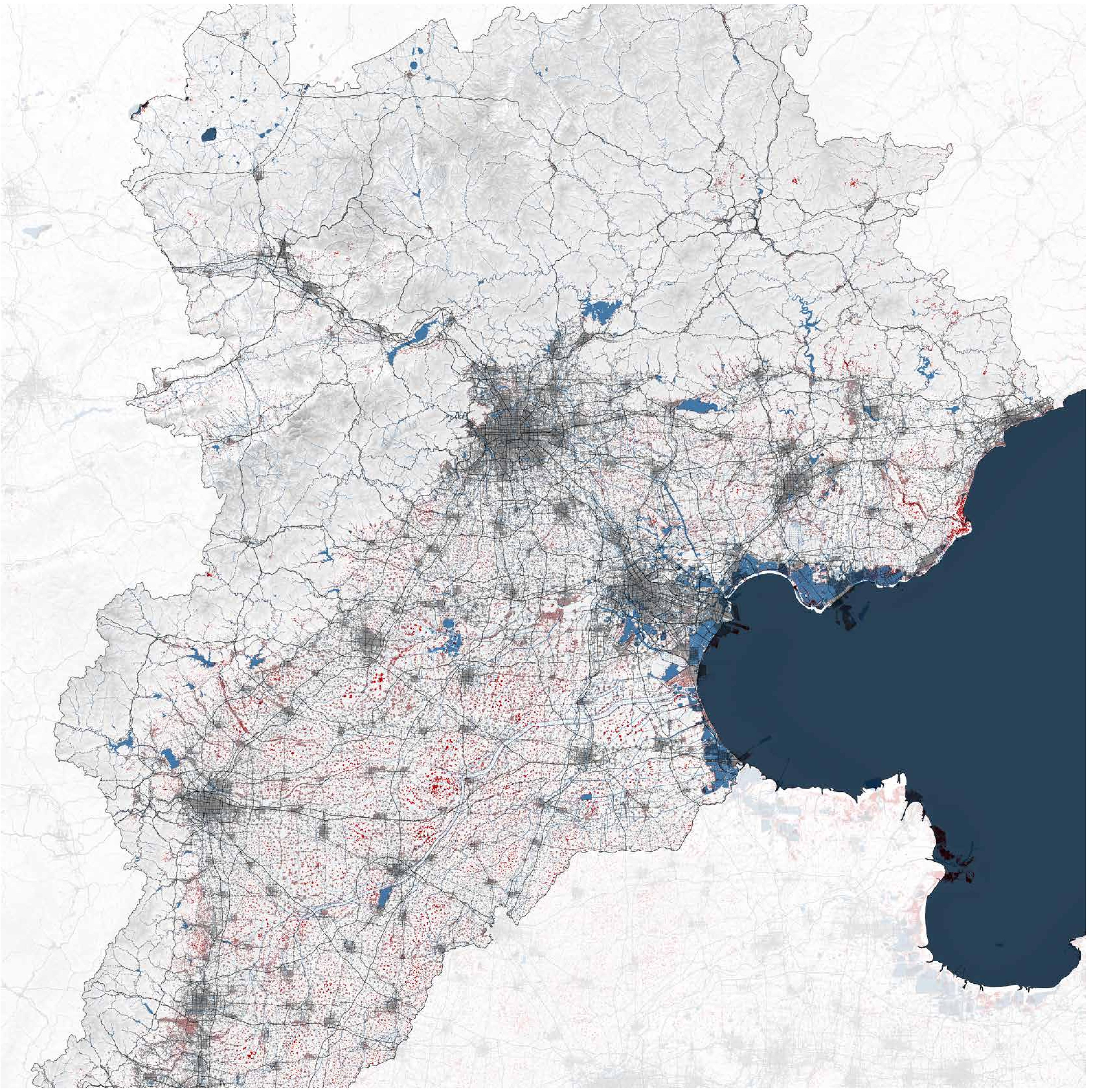
The altered and fragment hydrological system of the BTH region (Data: ASTER Global Digital Elevation Model, GHS built-up surface, OSM)

- *Engineered waterbody (canal, reservior, salt pond, etc.)*
- *Built-up surface*
- *Waterbody*
- *Transportation network*
- *Waterway*
- *Contour line 200/600m*

0 10 200 km

Morphological fragmentation | social segregation

A typical village (left) compared to Xiong'an (right) highlights the stark development imbalance in the BTH metropolitan region. This imbalance can lead to social segregation by exacerbating economic disparities, limiting access to urban amenities for rural residents, and concentrating wealth and opportunities in urban areas.



Disconnected and fragment morphology (Data: ASTER Global Digital Elevation Model, GHS built-up surface, OSM)

Well-connected area
Poorly-connected area
Built-up surface
Waterbody
Transportation network
Waterway

0 10 200 km

Problem Statement

Fragmentation ->
Incapable of effectively addressing water-related socio-environmental challenges ->
Biophysical and social vulnerabilities

How can a paradigm shift towards **water resilience** in the development of **territories-in-between** help alleviate the **spatial and temporal disequilibrium of water resources** in the Beijing-Tianjin-Hebei (BTH) region, while simultaneously sustaining **environmental justice** for its inhabitants?

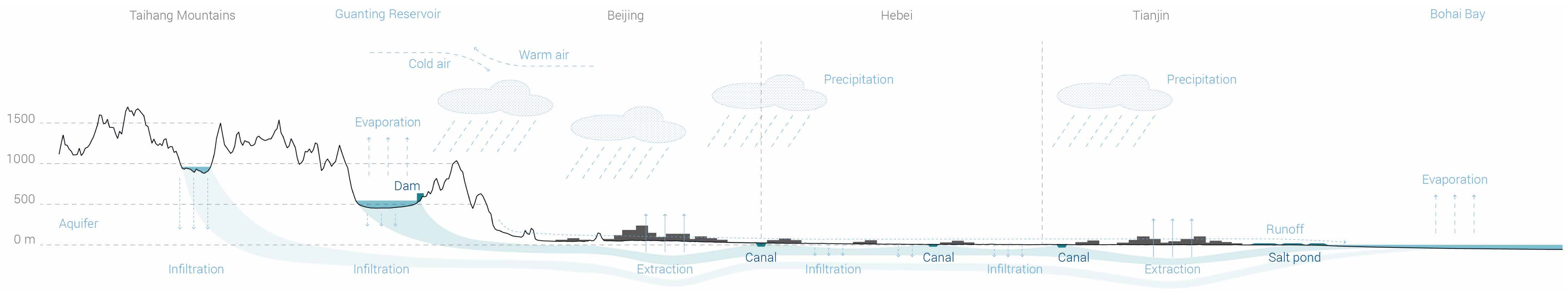
Analysis

From drought to flood | Unequal distribution | Paradigm shift

Tree underwater. Yesterday's land became today's river.

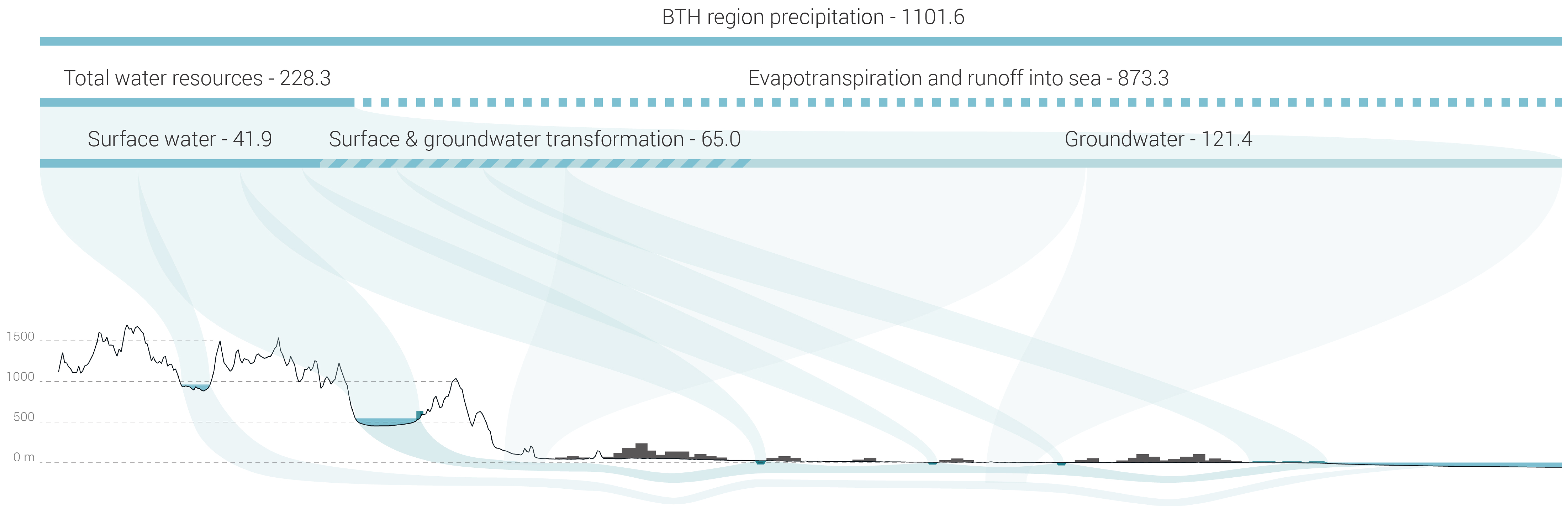
Analysis
From drought to flood

Water cycle in the Haihe basin

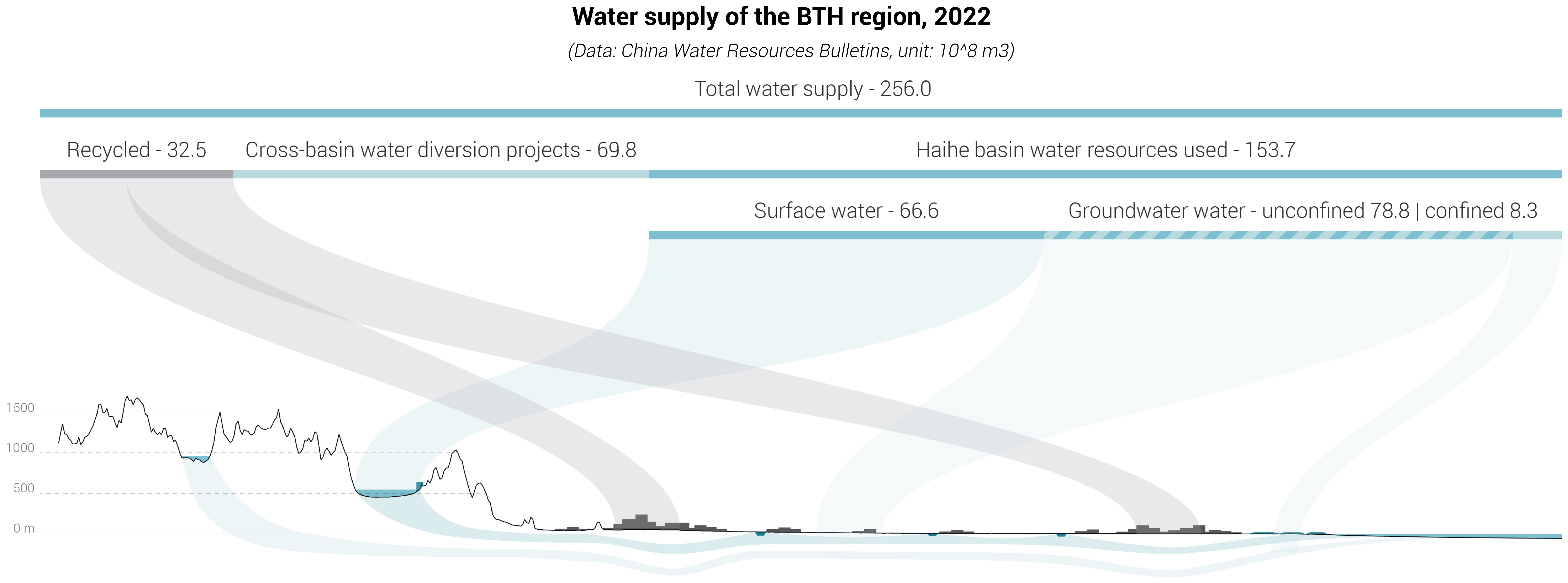


Natural water resource of the BTH region, 2022

(Data: China Water Resources Bulletins, unit: 10^8 m3)



Average annual precipitation - 539 mm - below the national average
80% of this precipitation is lost to evapotranspiration or flows into the Bohai Bay

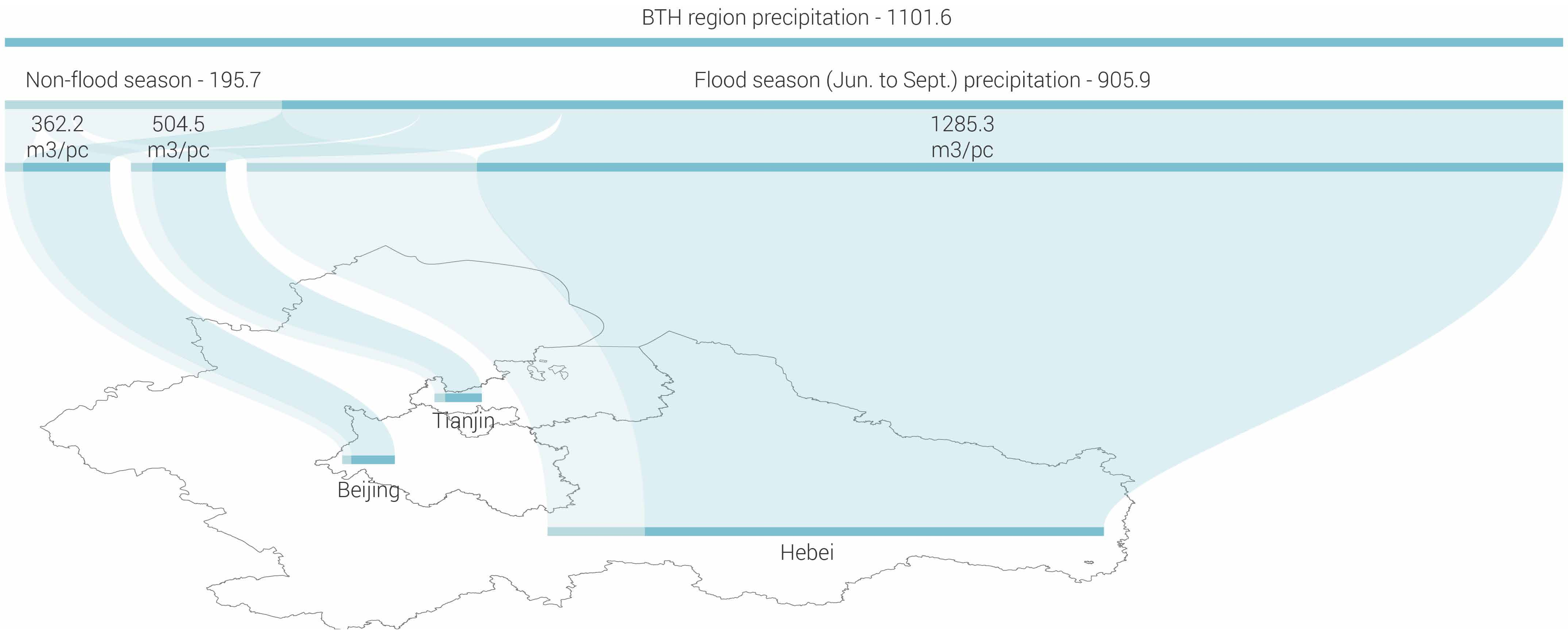


Over half of the water is sourced from groundwater extraction
Rely on cross-basin water diversion from other basins

Analysis
From drought to flood

Temporal distribution of water resource

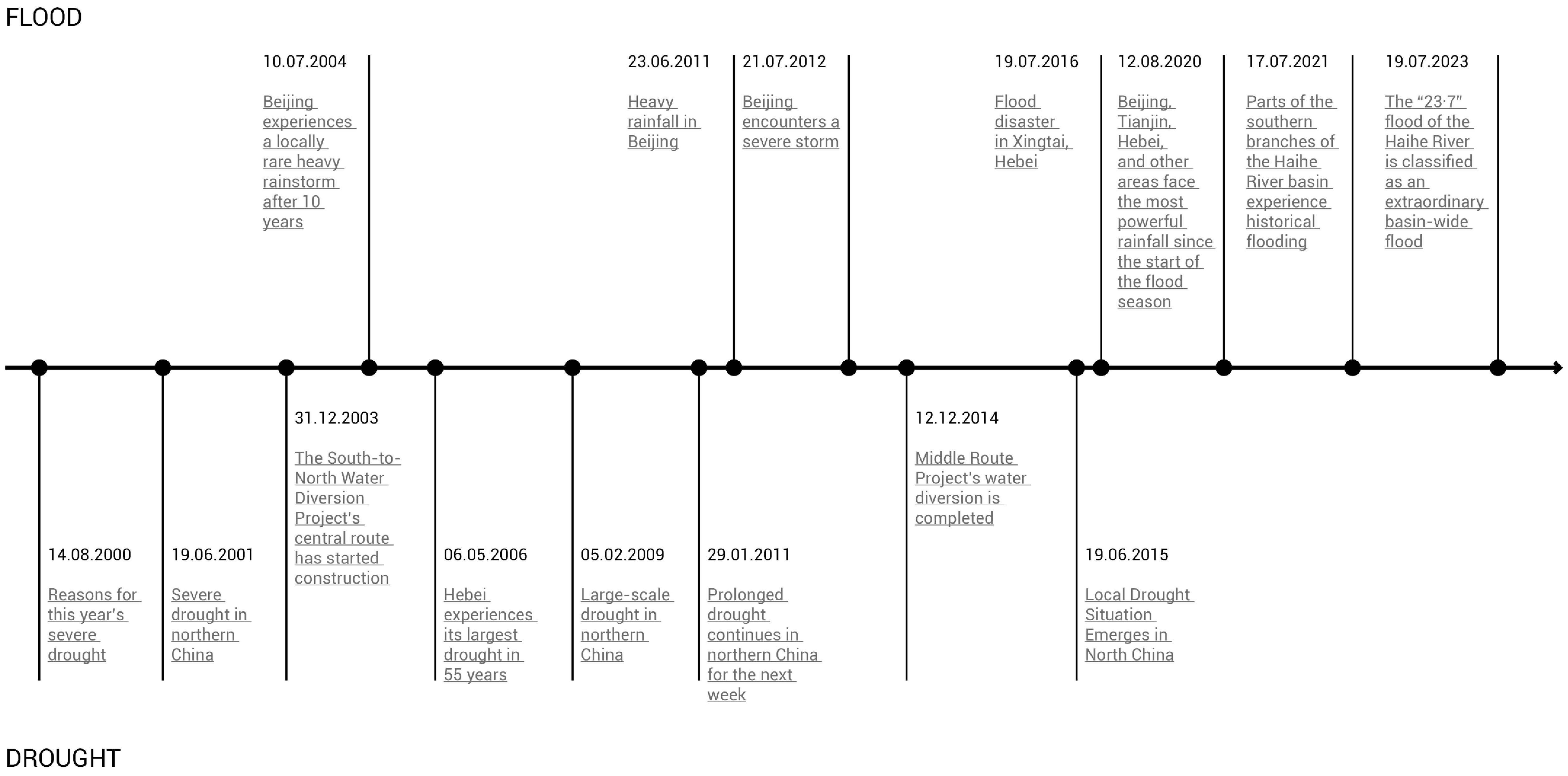
(Data: China Water Resources Bulletins, unit: 10^8 m3)



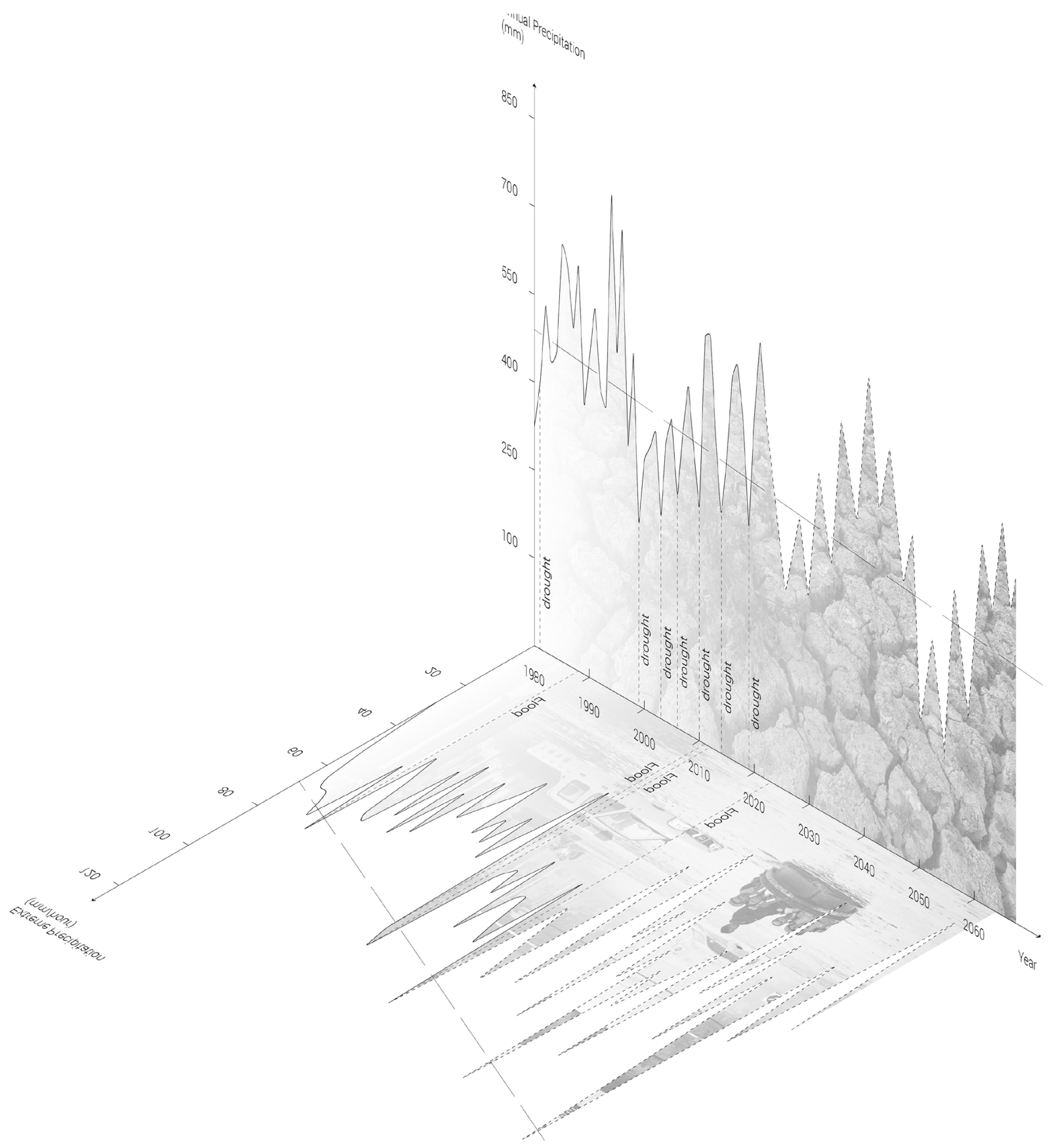
The temporal distribution of water resources is also extremely imbalanced
80%of the annual precipitation occurs during the flood season, leading to an increase in flood events

Analysis
From drought to flood

Historical flood and drought events in the Haihe basin



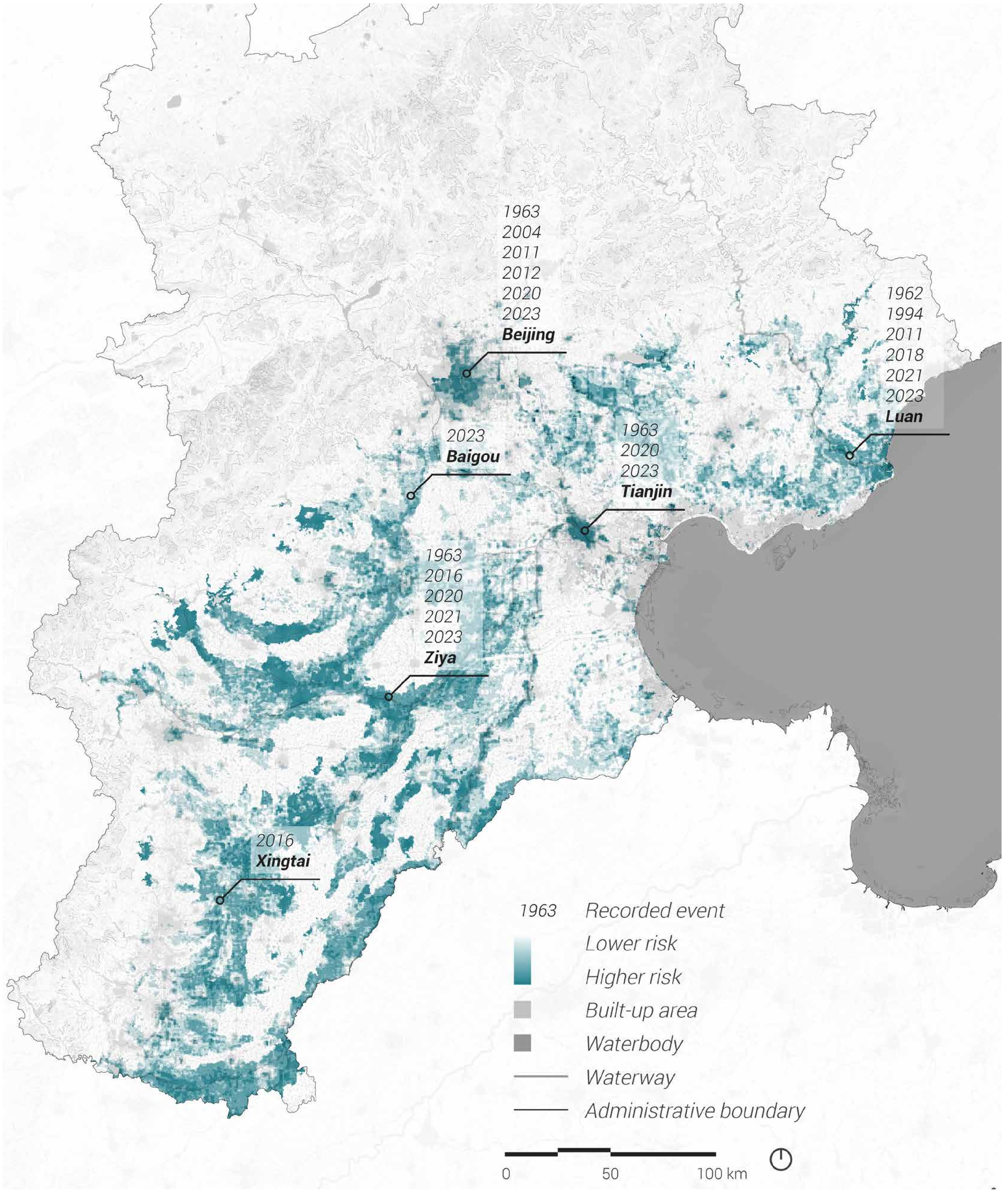
Flood-drought duality



Data:Annual Report of Beijing Meteorological Bureau

Exacerbated by climate change
Validated by event records since 2000

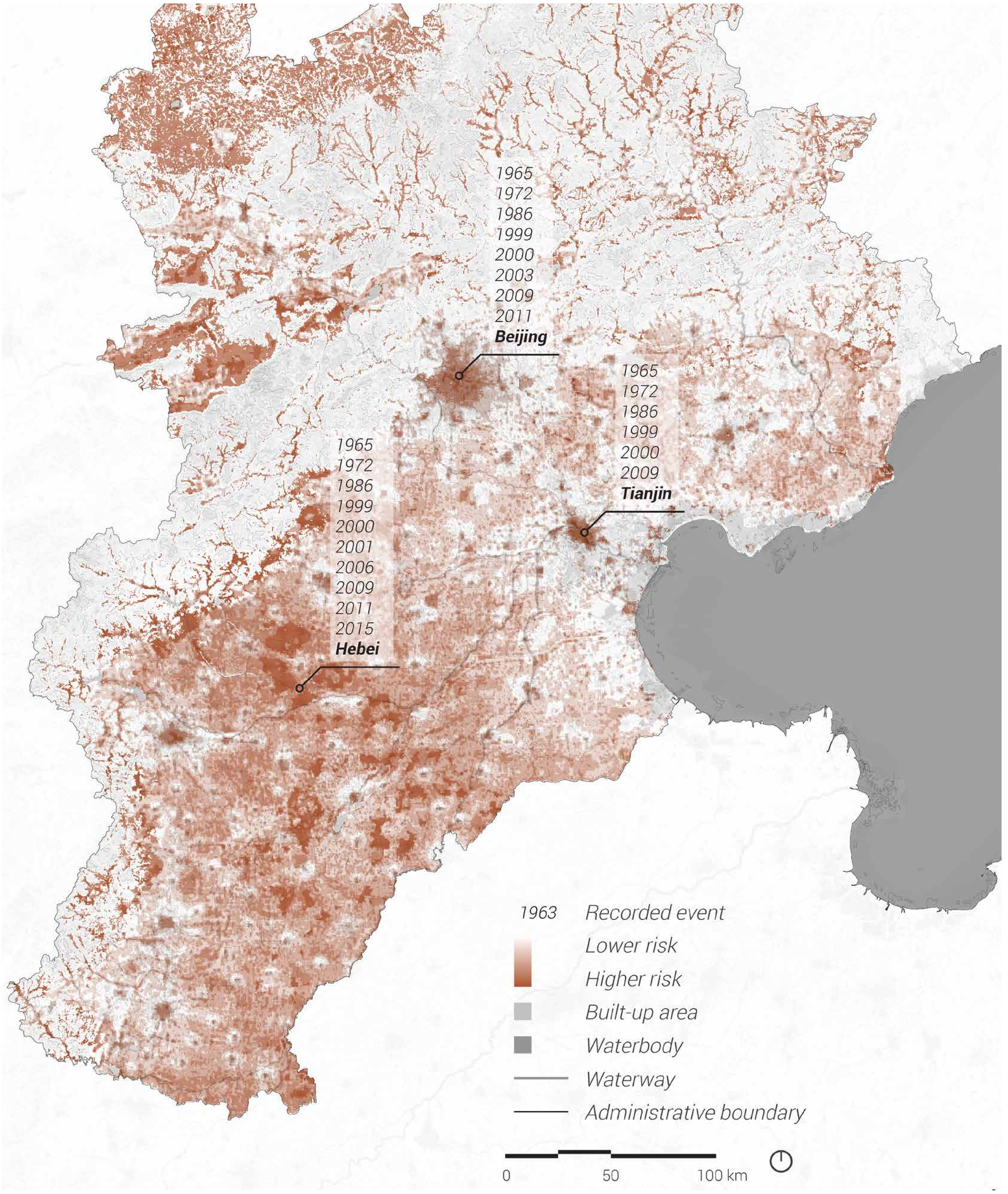
Flood risk



Synthesis of inundation potential, development inequality (utilizing night-time light data as a proxy), and population density to provide an initial understanding of flood risk in the BTH region.

Data: GIEMS-D15, DMSP Nighttime Lights, GPWv4

Drought risk

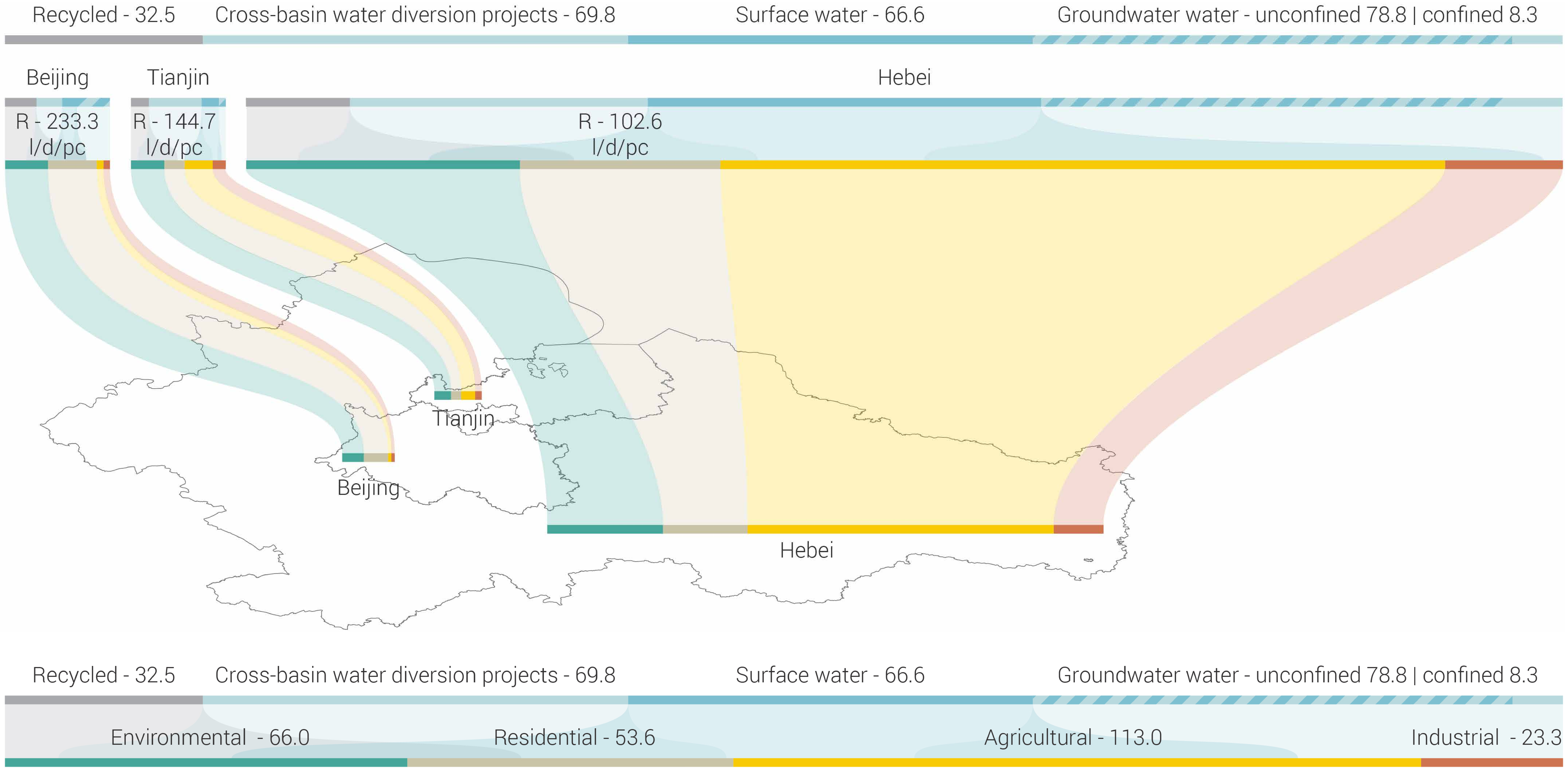


Synthesis of annual precipitation, evapotranspiration, population density, and average water consumption per landcover type to provide an initial understanding of water scarcity in the BTH region.

Data: WorldClim, Global-AET, GPWv4, Jie Yang et al. (2023). 10.5281/zenodo.8176941

Spatial distribution of water consumption, 2022

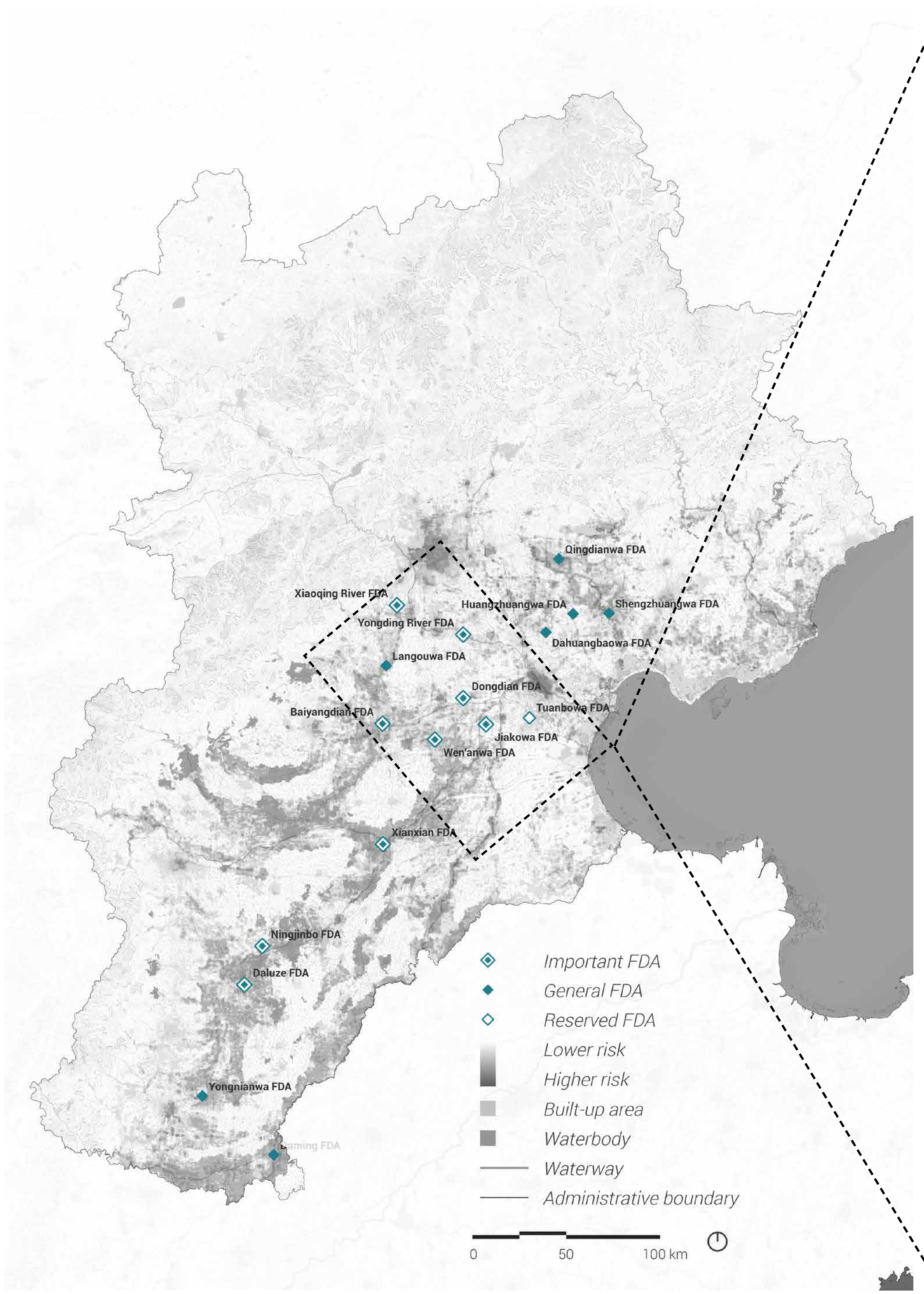
(Data: China Water Resources Bulletins, unit: 10^8 m3)



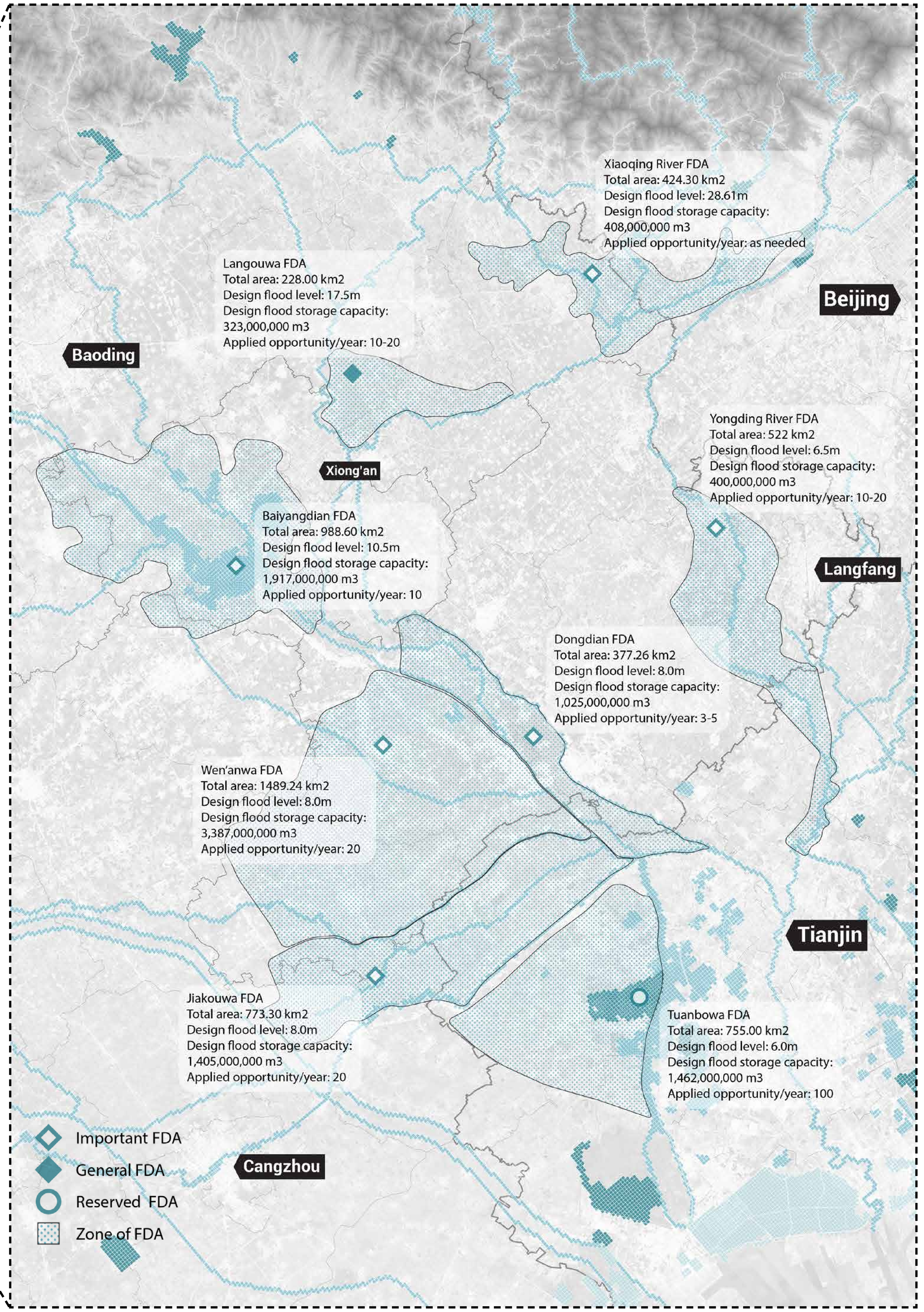
Beijing consumes twice as much water per capita for residential use as Hebei does

Analysis
Unequal distribution

Flood Detention Areas at macro scale



Flood Detention Areas at meso scale



Designated Flood Detention Areas will be flooded during heavy rain events to protect large cities, with all the local resident temporarily relocated to elsewhere for refuge
Directly contributes to the unequal distribution of flood risk

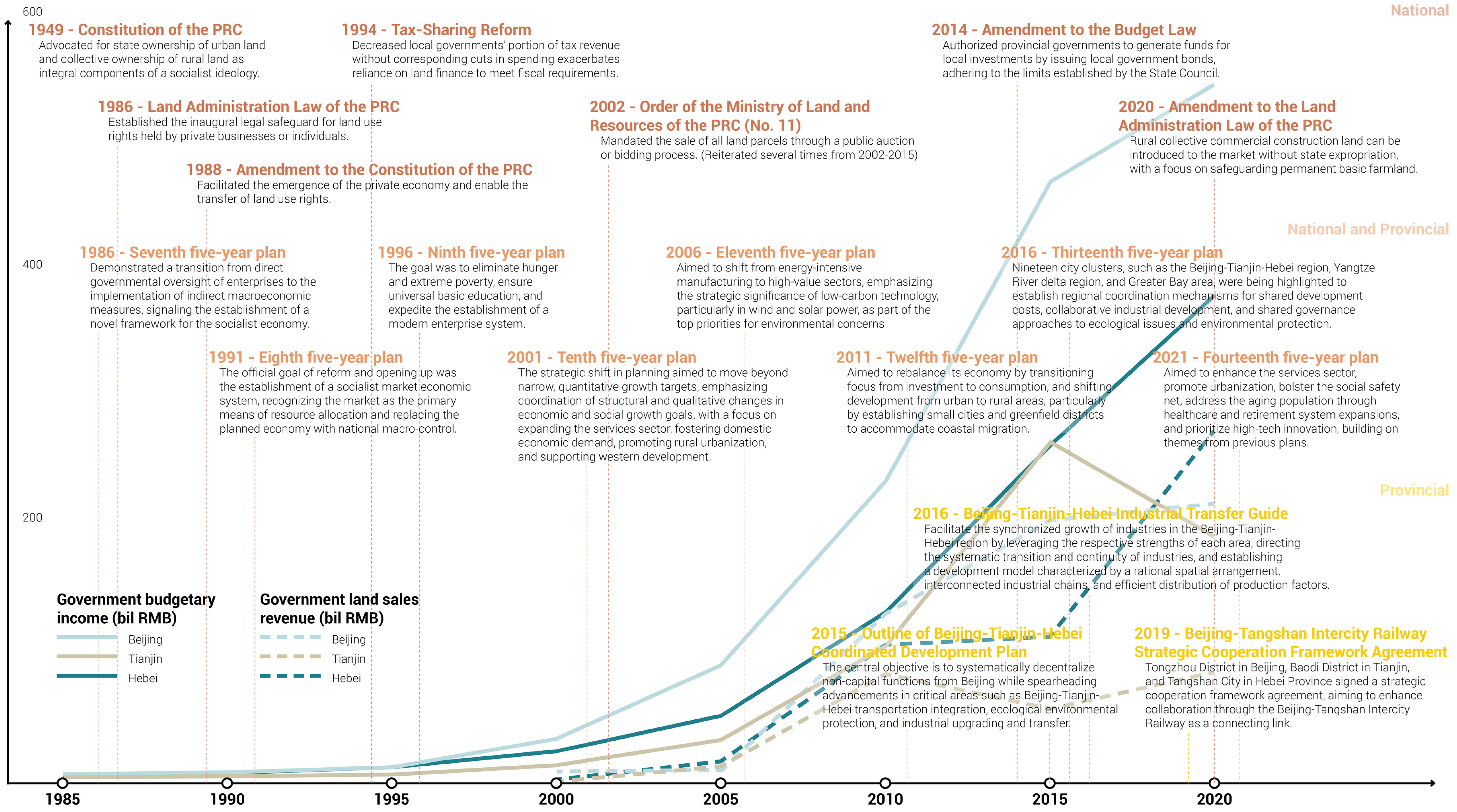
Urbanization process of 13 cities in the region

(Data: CLCD Land Cover, Jie Yang et al., 2023)

Unequal distribution of water resources and risks correlates with the imbalanced development priorities across the entire metropolitan region

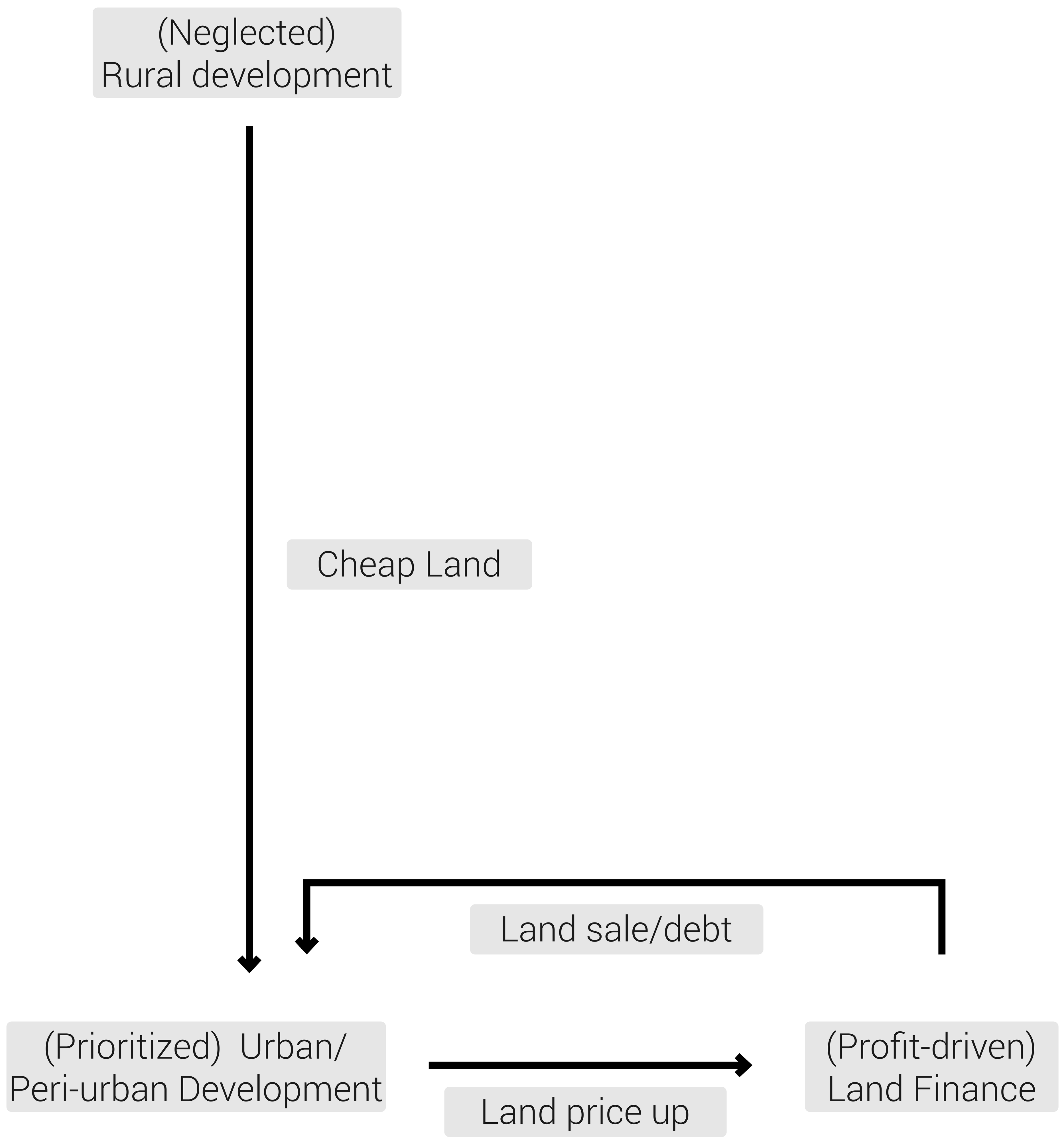
Major law & policy evolution which shaped the urbanization of the BTH region

(Data: Gyourko et al., 2022)

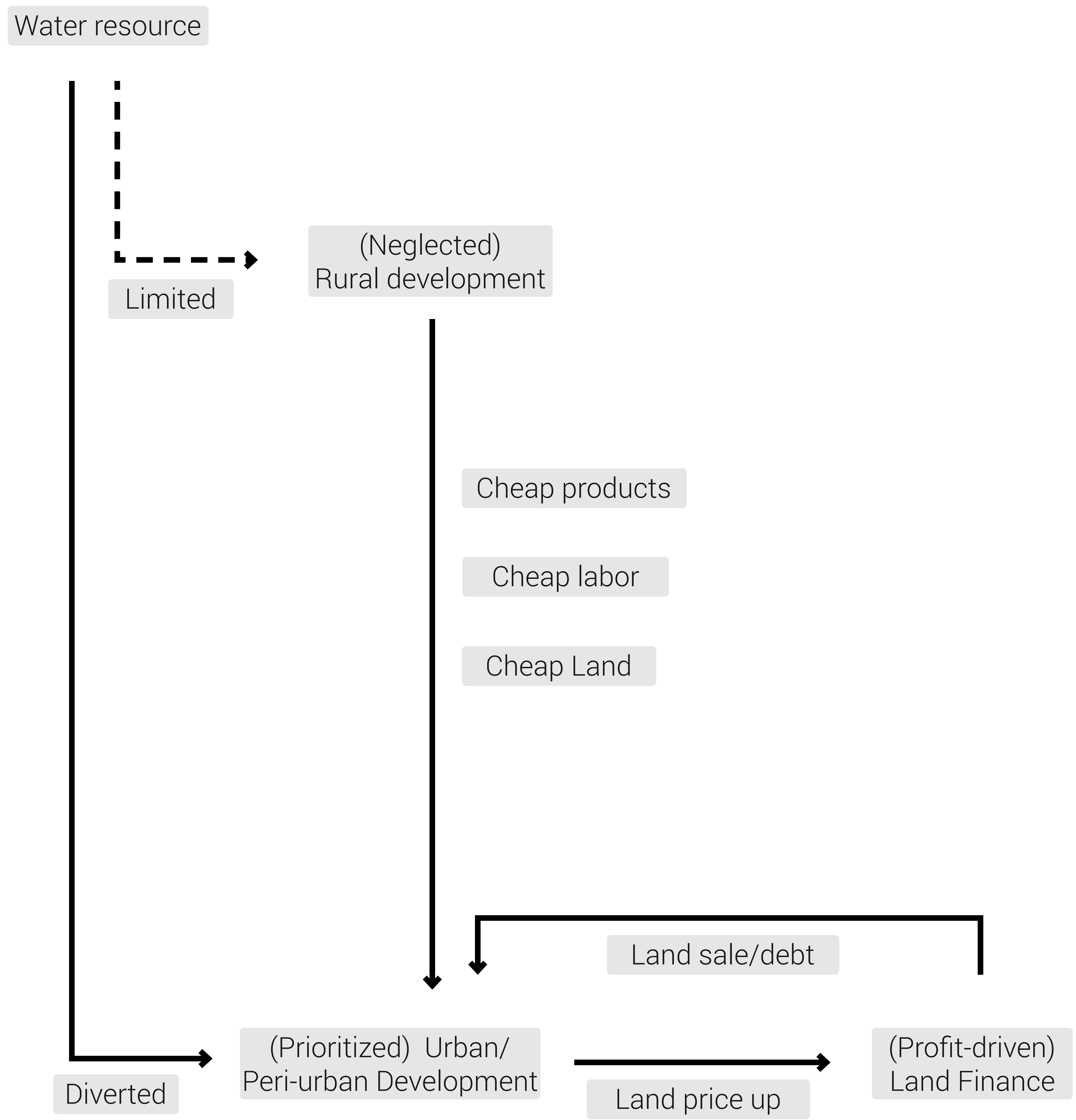


... and shaped by the land finance model and its policies.

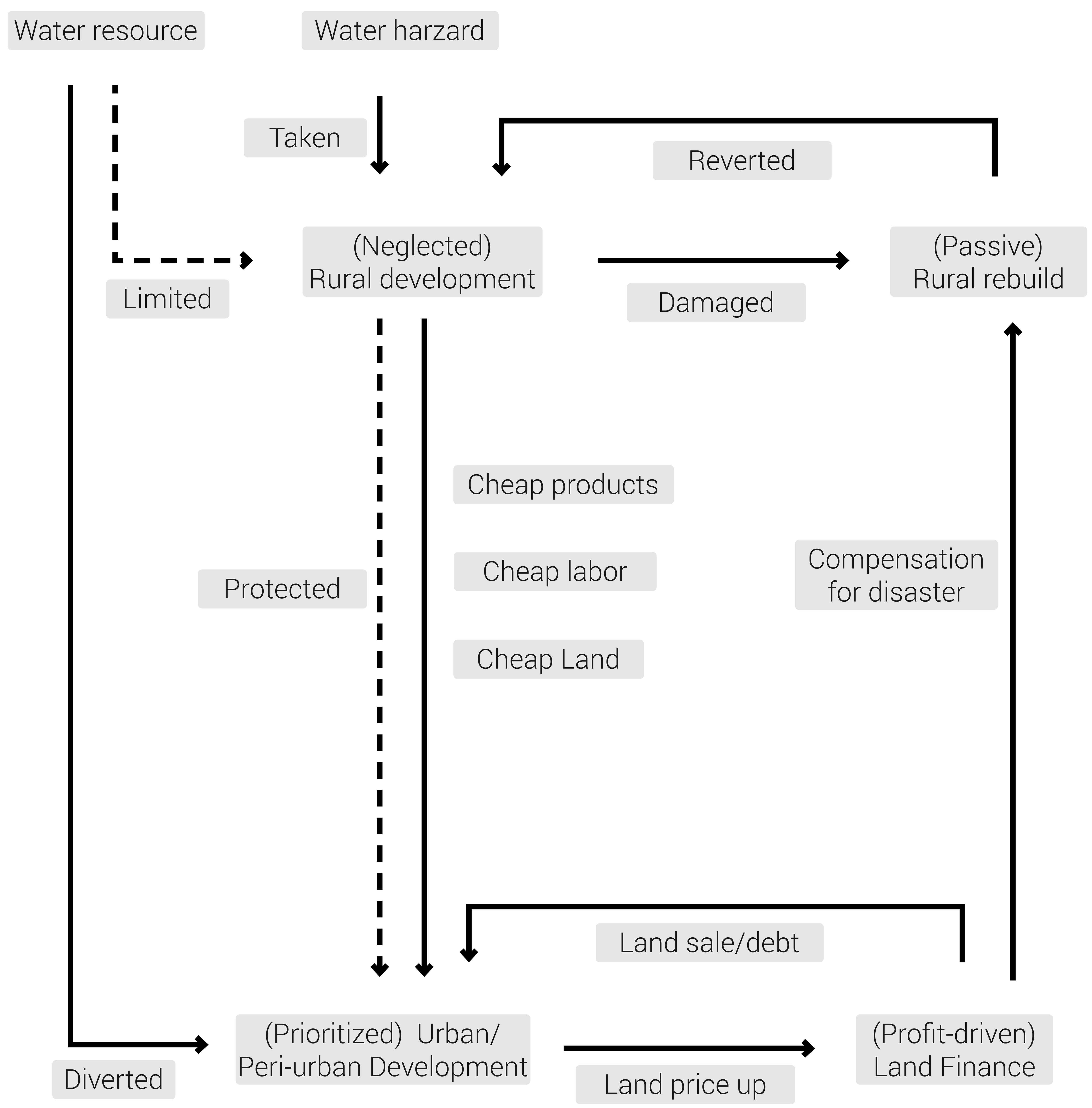
Profit-driven development paradigm



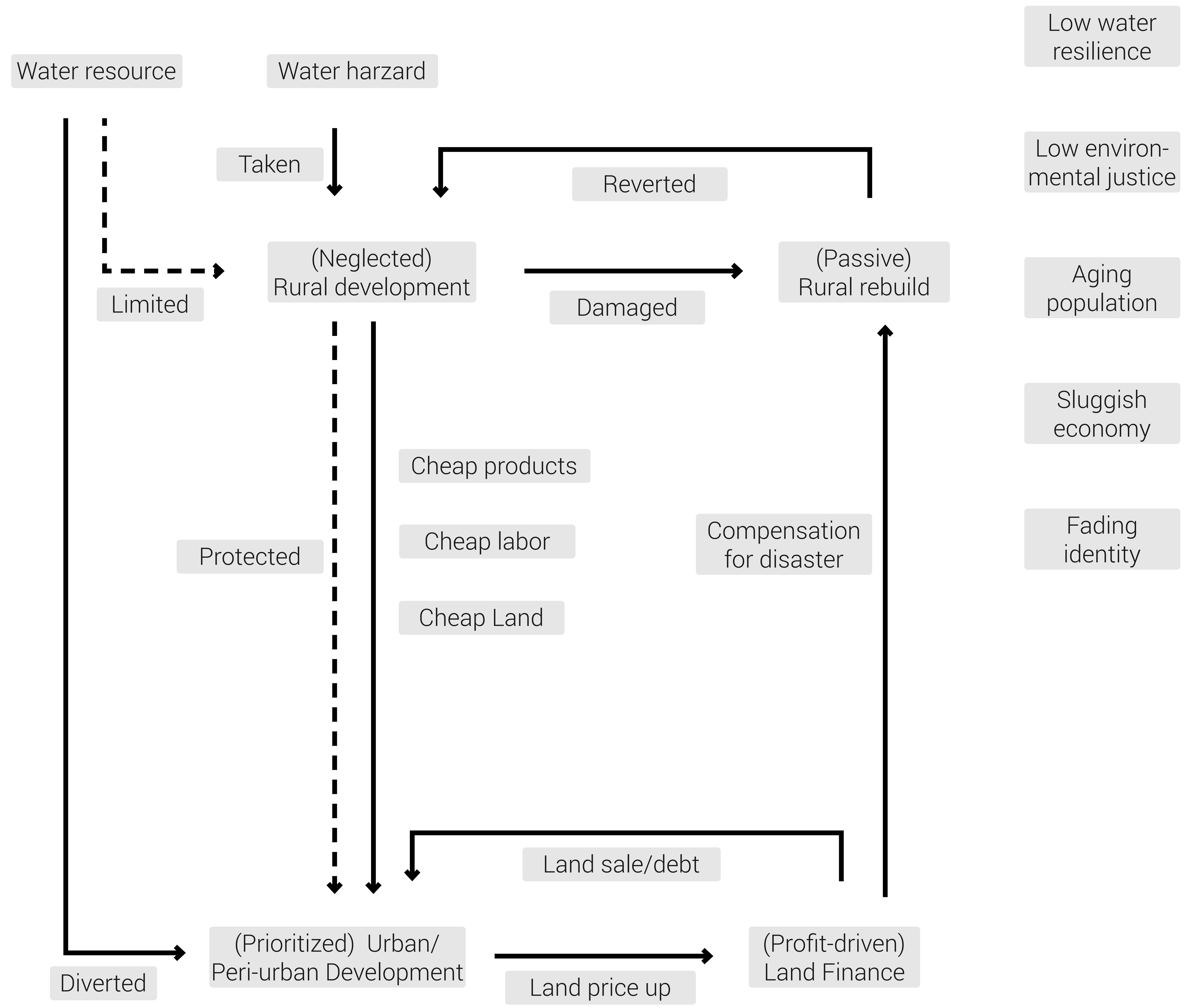
Profit-driven development paradigm



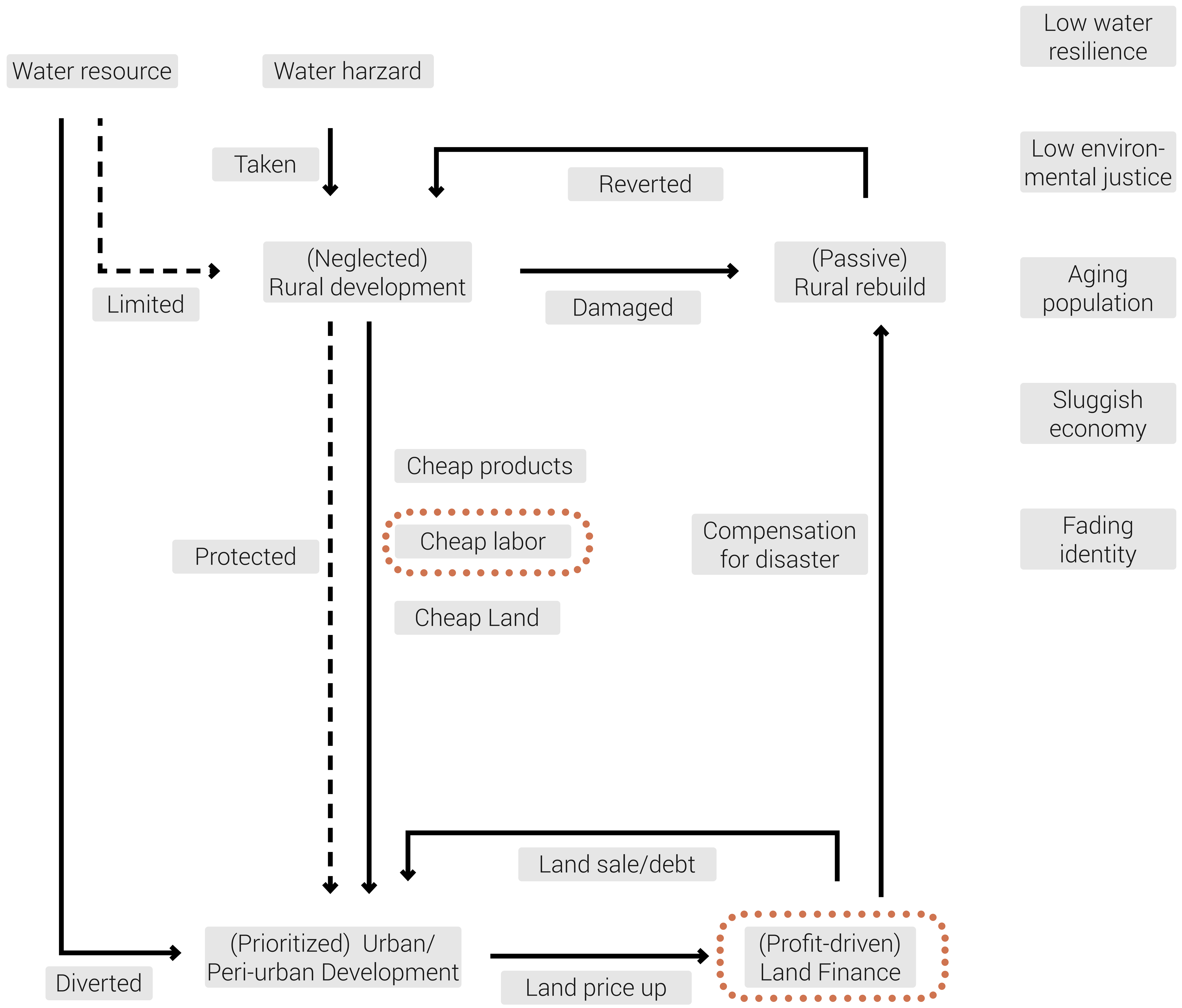
Profit-driven development paradigm



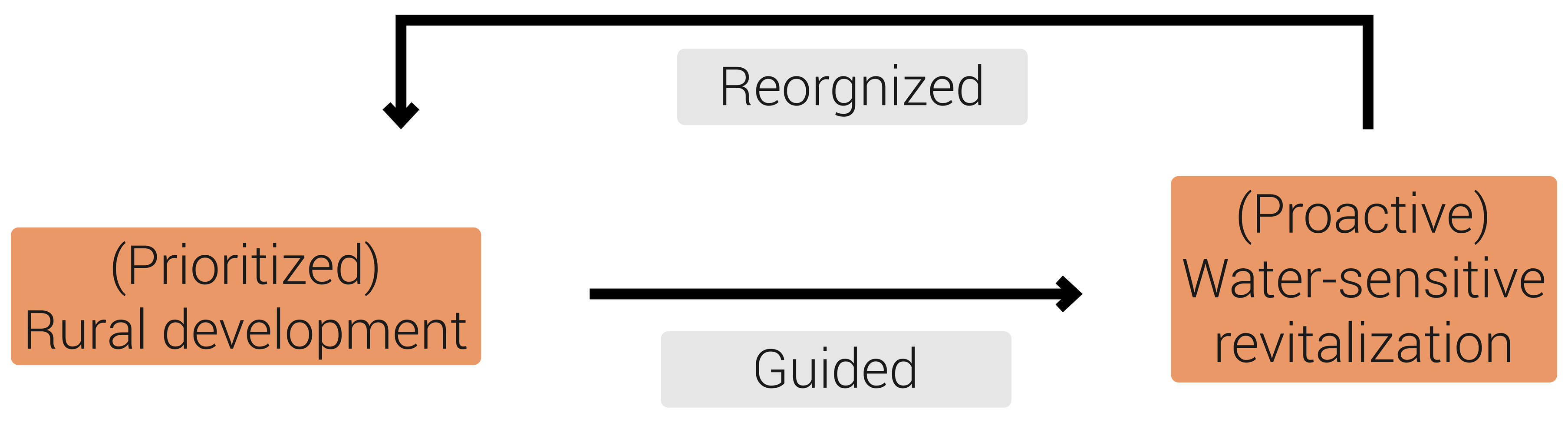
Profit-driven development paradigm



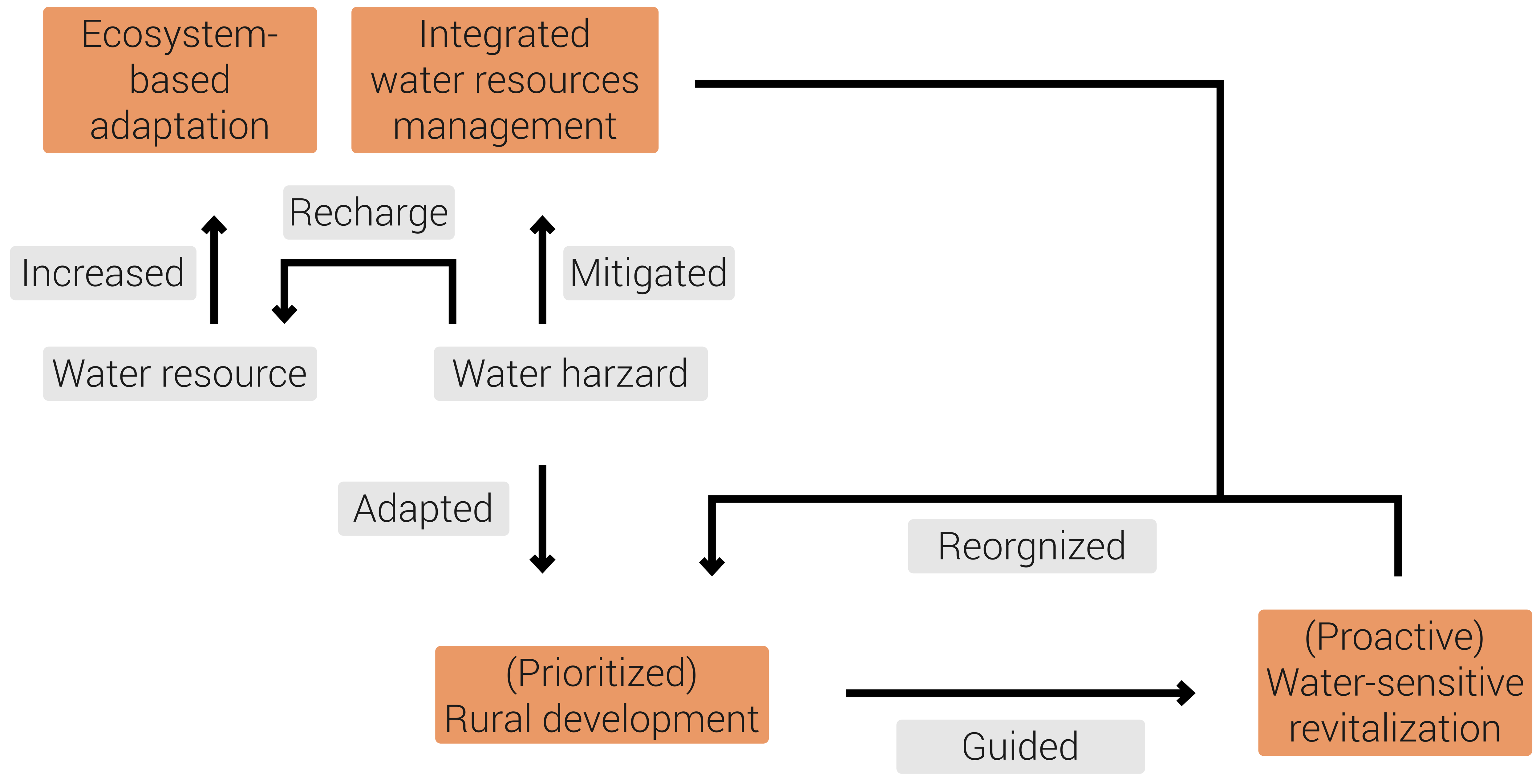
Profit-driven development paradigm



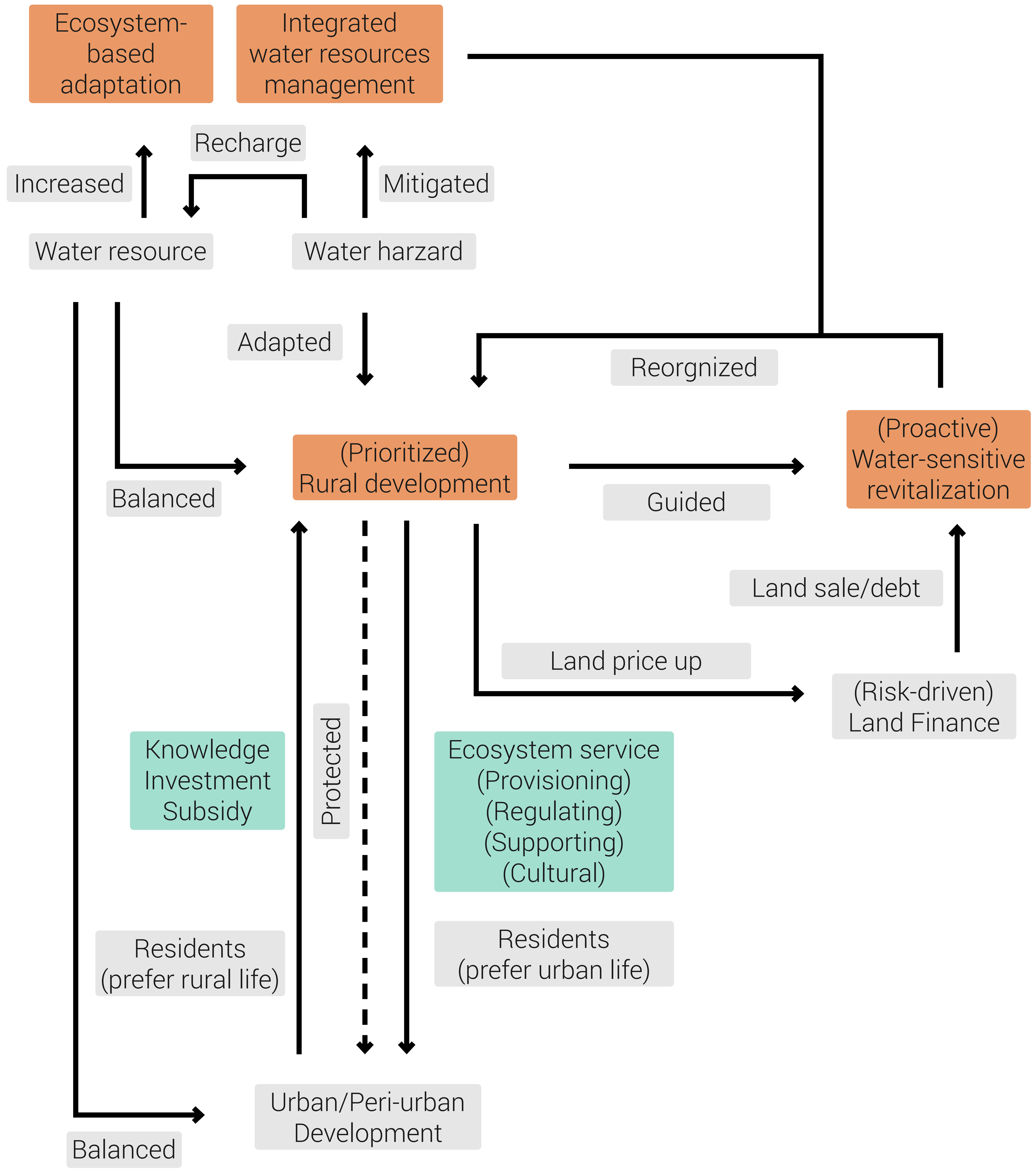
Risk-driven development paradigm



Risk-driven development paradigm

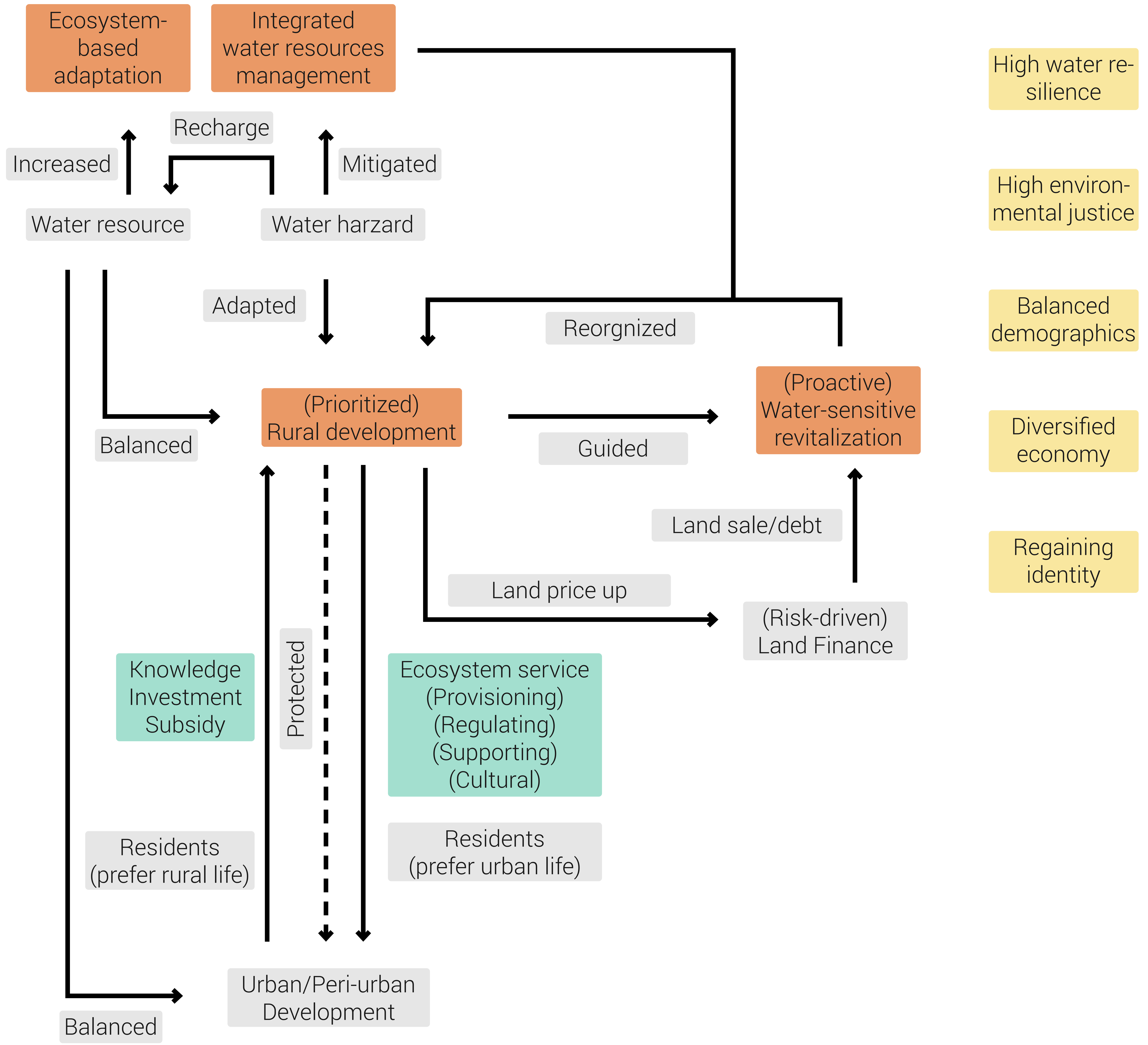


Risk-driven development paradigm



Analysis
Paradigm shift

Risk-driven development paradigm



Intervention

Framework | Measure as pattern | Scenario making | Dynamic adaptive pathway | Design exploration

An abandoned house in Baiyangdian: a symbol of extensive urbanization.

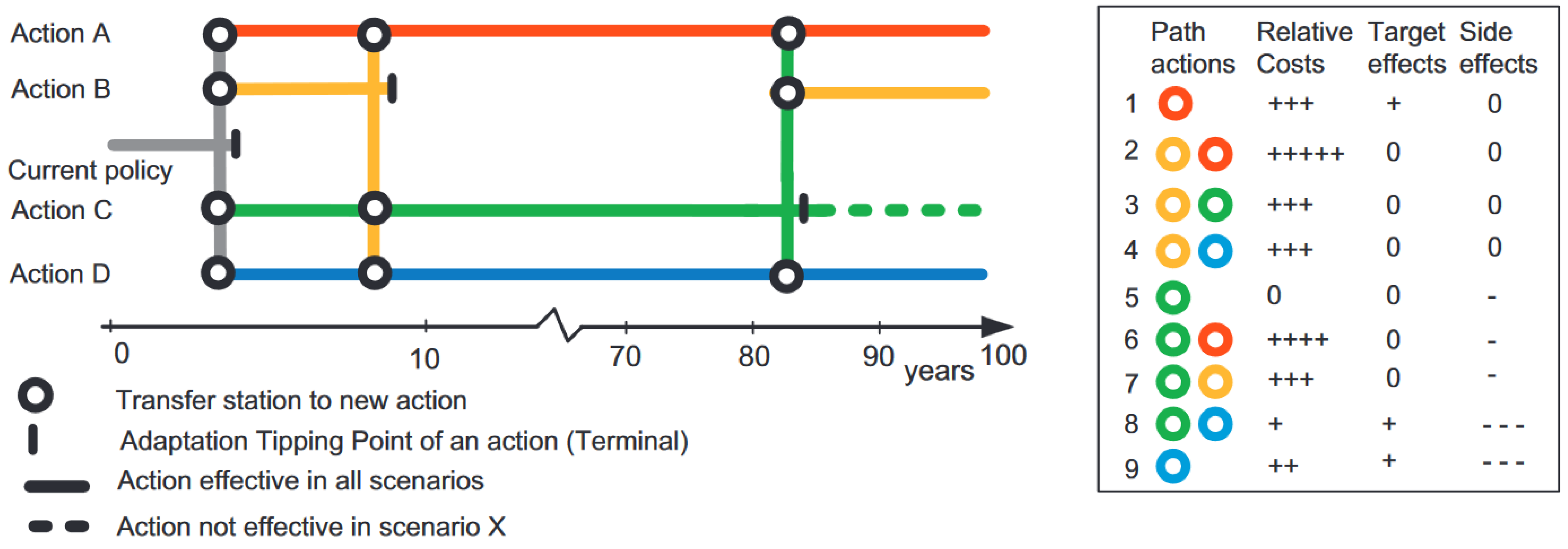
Intervention
Framework

Patterns:
1. Design action
2. Relative cost
3. Target effect
4. Side effect
5. Sell-by date
6. Stakeholder

Scenarios:
1. Socio-economic condition
2. Climate change speed
3. Risk composition

Input

→ Dynamic adaptive pathways



Adaptation Pathways Map

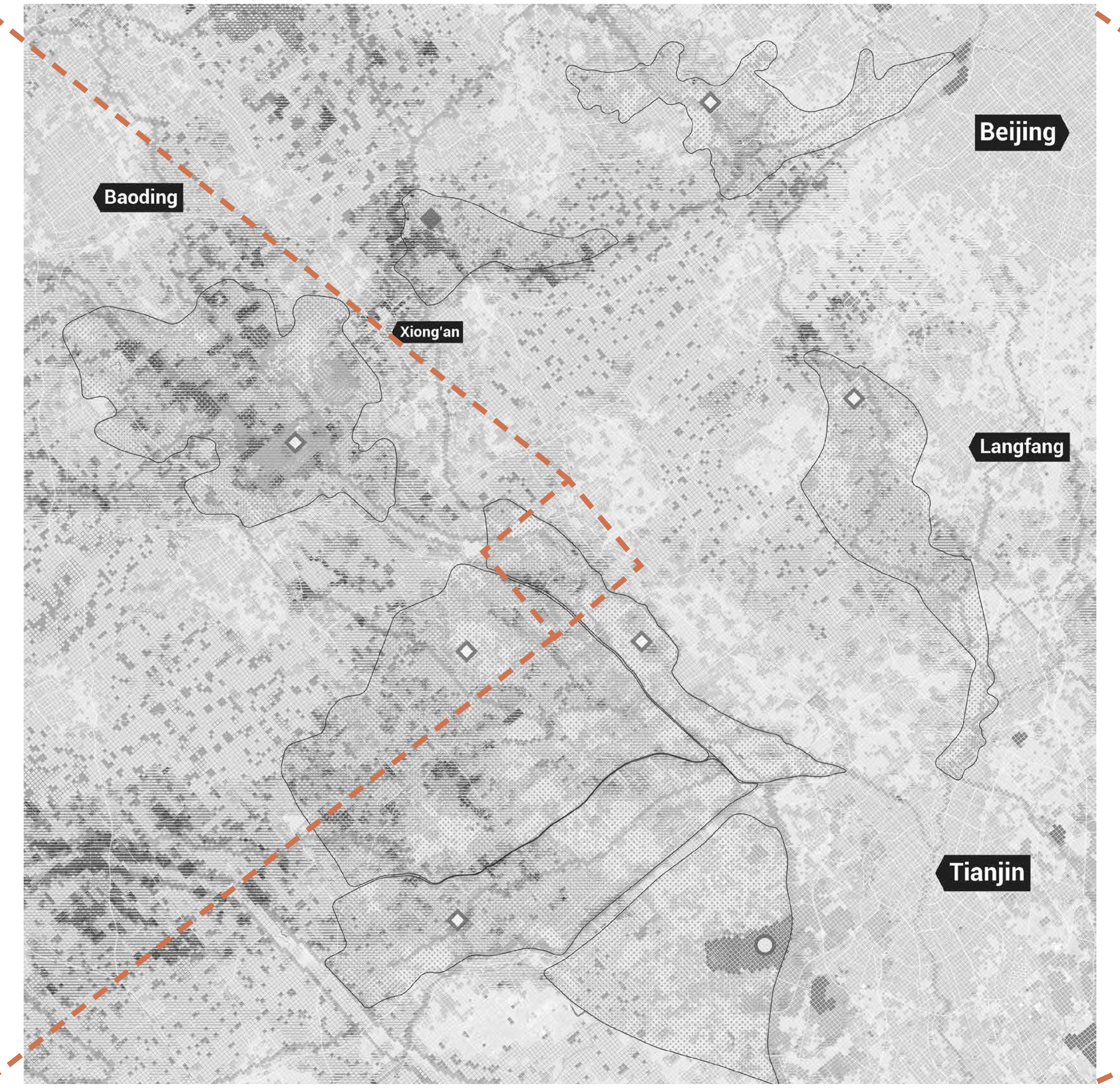
(Haasnoot et al., 2013)

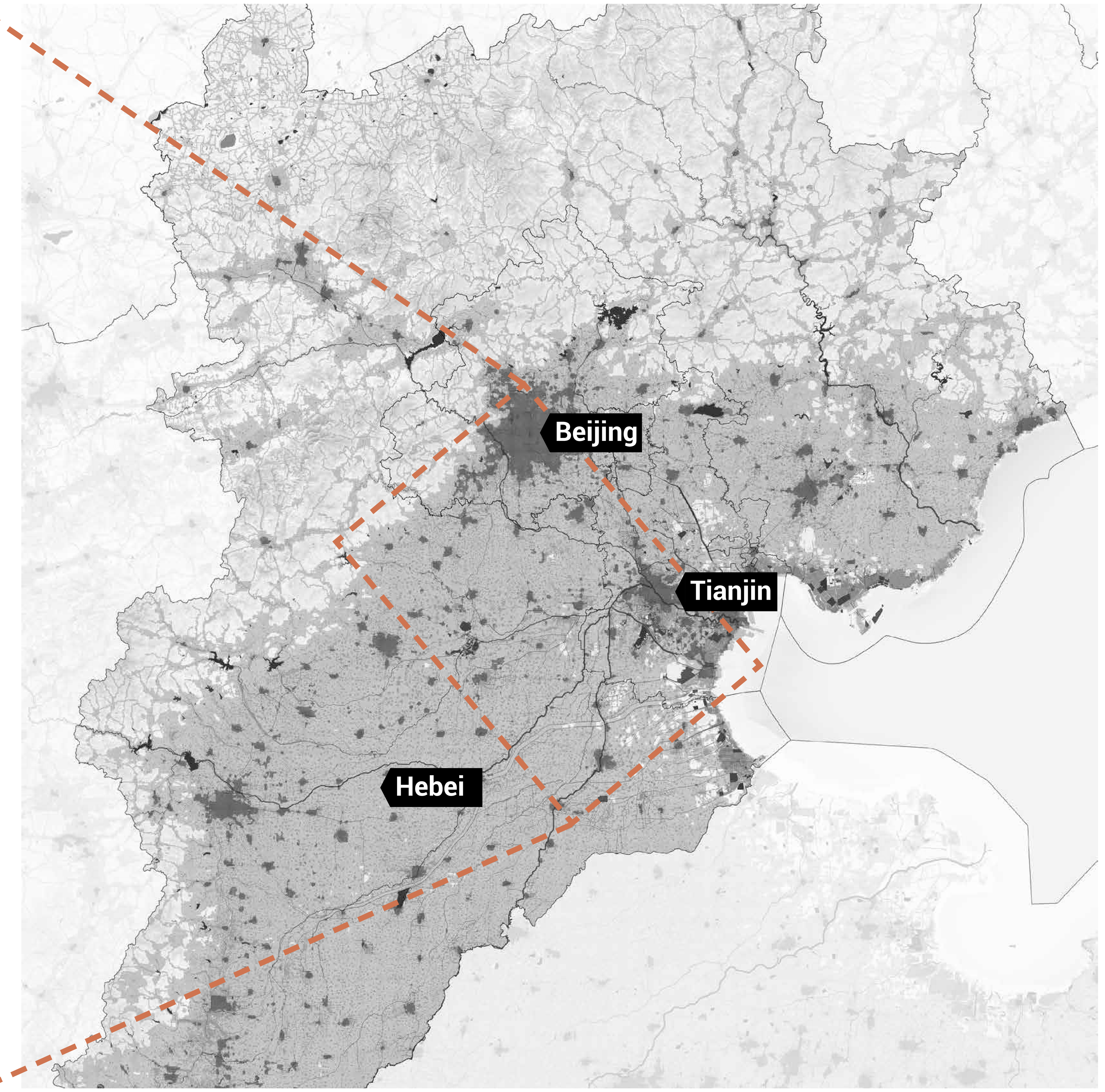
↓ Local adaptation → Tributary reorganization → Territory transformation

Output

Intervention
Framework

Multi-scale validation and assessment





Local adaptation
(Synthetic scenarios)

Tributary reorganization
(Ecosystem service)

Territory transformation
(Stakeholder status)

Pattern languages | action & measure

Ecosystem-based adaptation

A1 Waterway restoration
- E10 Riverbank softening
- E11 Streambed re-naturalization
- E12 Restoration of seasonal streams
- E13 Dam removal

A2 Floodplain restoration
- E1 Meadows and pastures
- E2 Buffer strips
- E3 Green cover
- E5 Forest riparian buffers
- E8 Detention basins
- E9 Wetland restoration

A3 Water source protection
- E4 Agri-managed aquifer recharge
- E6 Afforestation in headwater areas
- E7 Afforestation of reservoir catchments

Integrated water resources management

A4 Efficient water use
- I3 Precision irrigation
- I10 Use of adapted varieties

A5 Hybrid infrastructure system
- I2 Channel as distributor
- I4 Decentralized water storage
- I7 Dikes as flood-proof road network
- I8 Reuse of sediment

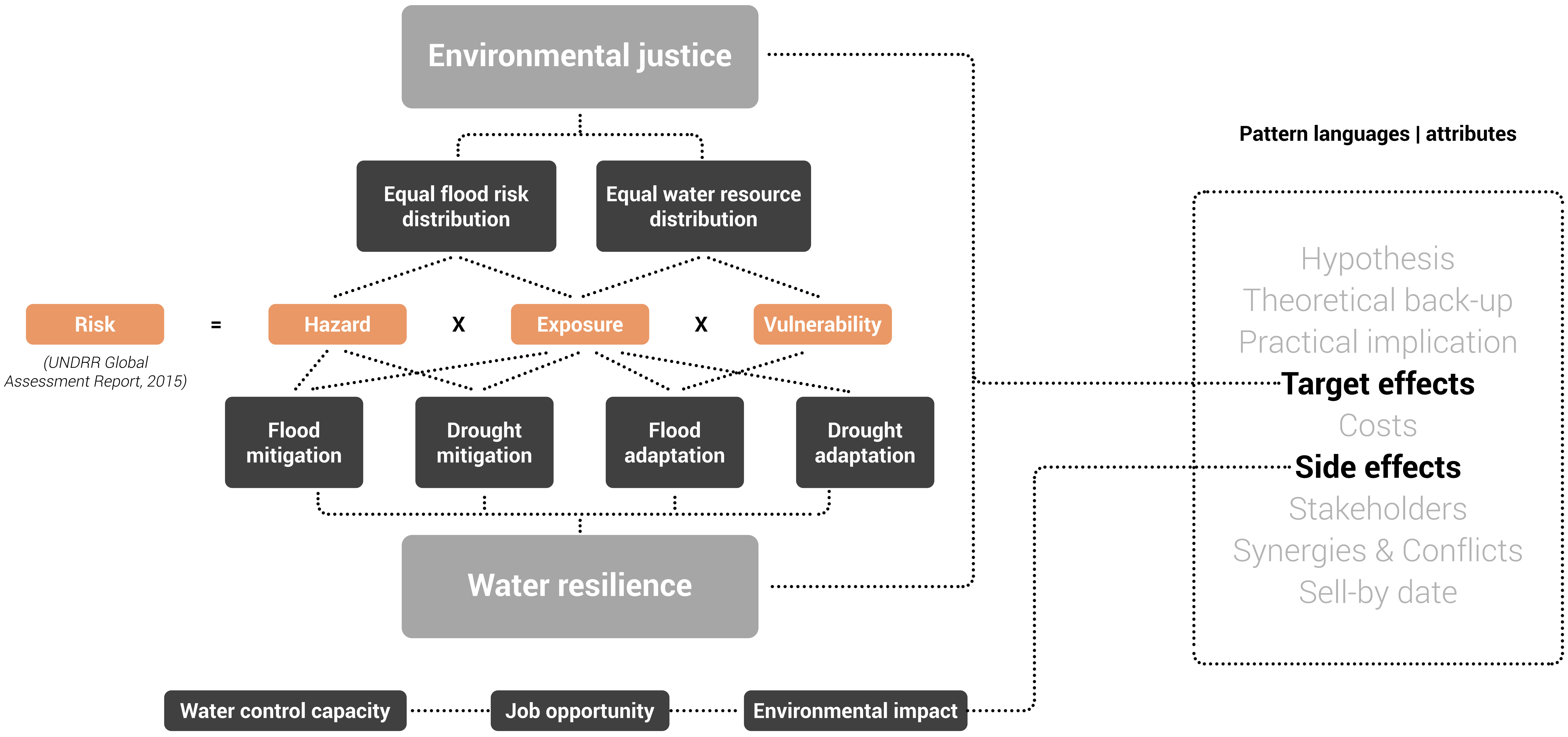
A6 Non-conventional water resources
- I1 Seawater desalination
- I5 Greywater Recycling
- I6 Agro-industrial wastewater reuse
- I9 Rainwater harvesting

Water-sensitive revitalization

A7 Water sensitive land consolidation
- W1 Village relocation
- W2 Farmland consolidation
- W7 Economy diversification
- W8 Climate-proofing structure

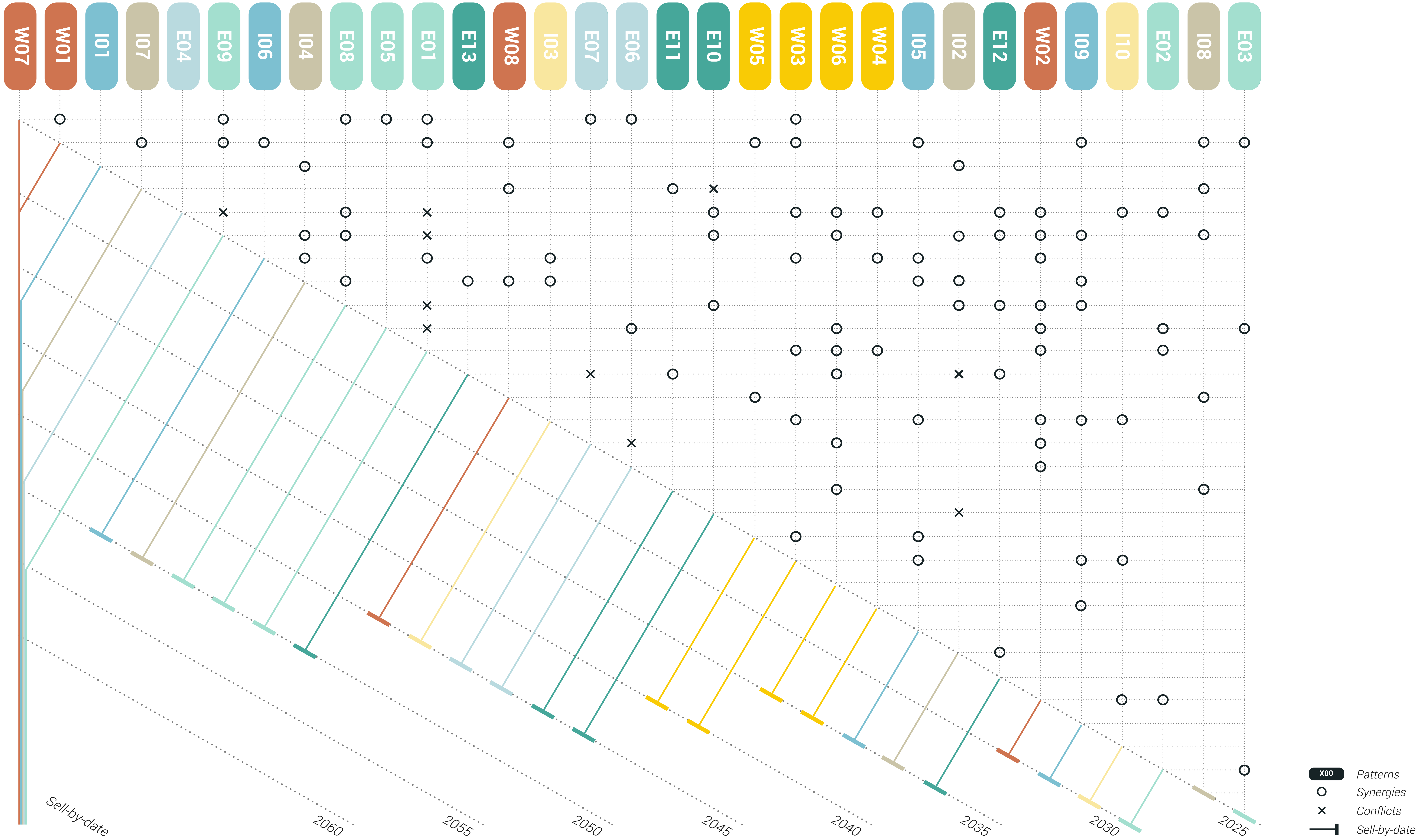
A8 Water-resilient communities
- W3 Water resilience knowledge hub
- W4 Increasing public risk awareness
- W5 Establishment of early warning systems
- W6 Monitoring and evaluation

Intervention
Measure as pattern



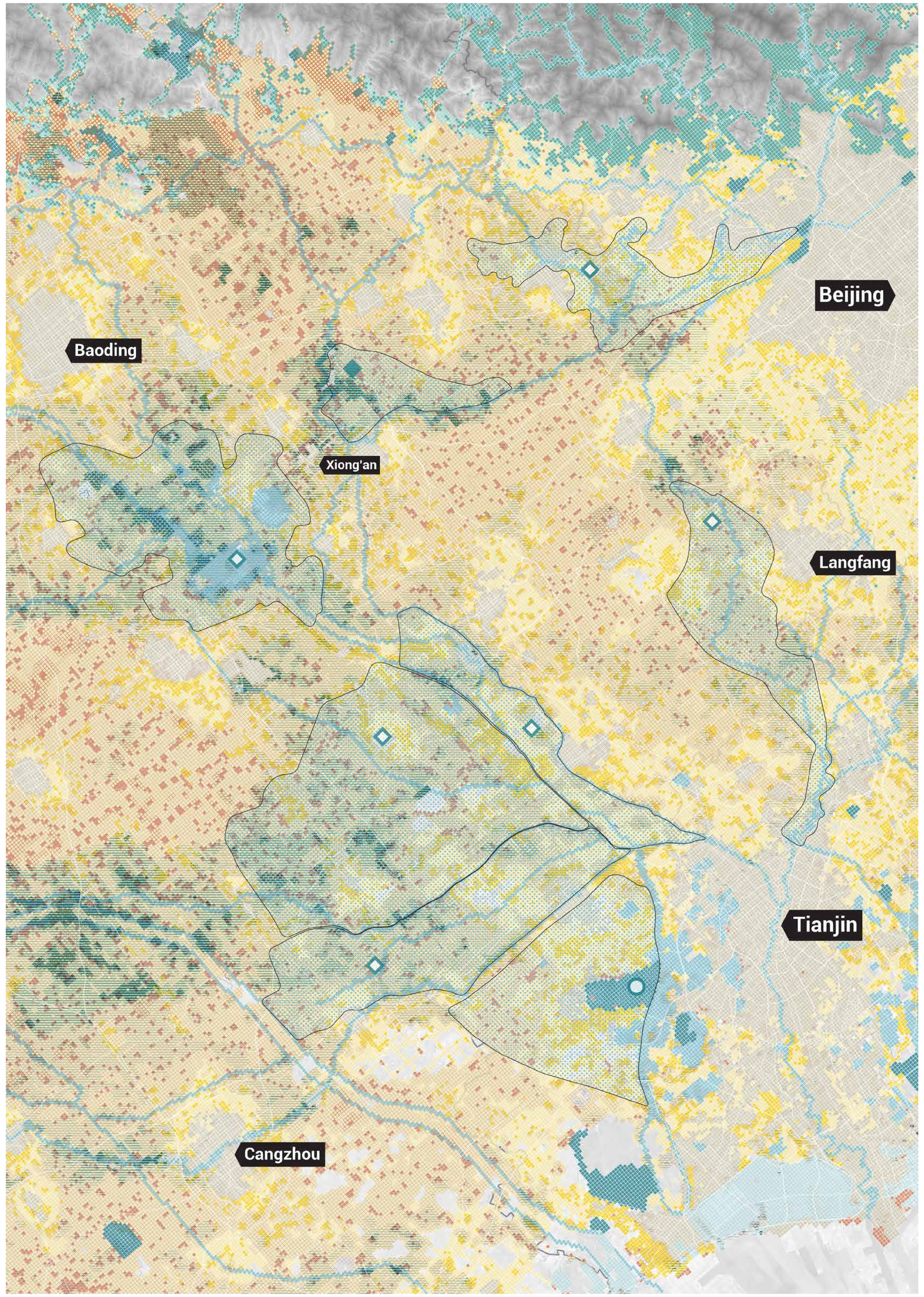
Intervention
Measure as pattern

Pattern fields | Synergies, conflicts and sell-by date (deadline for implementation)



Intervention
Measure as pattern

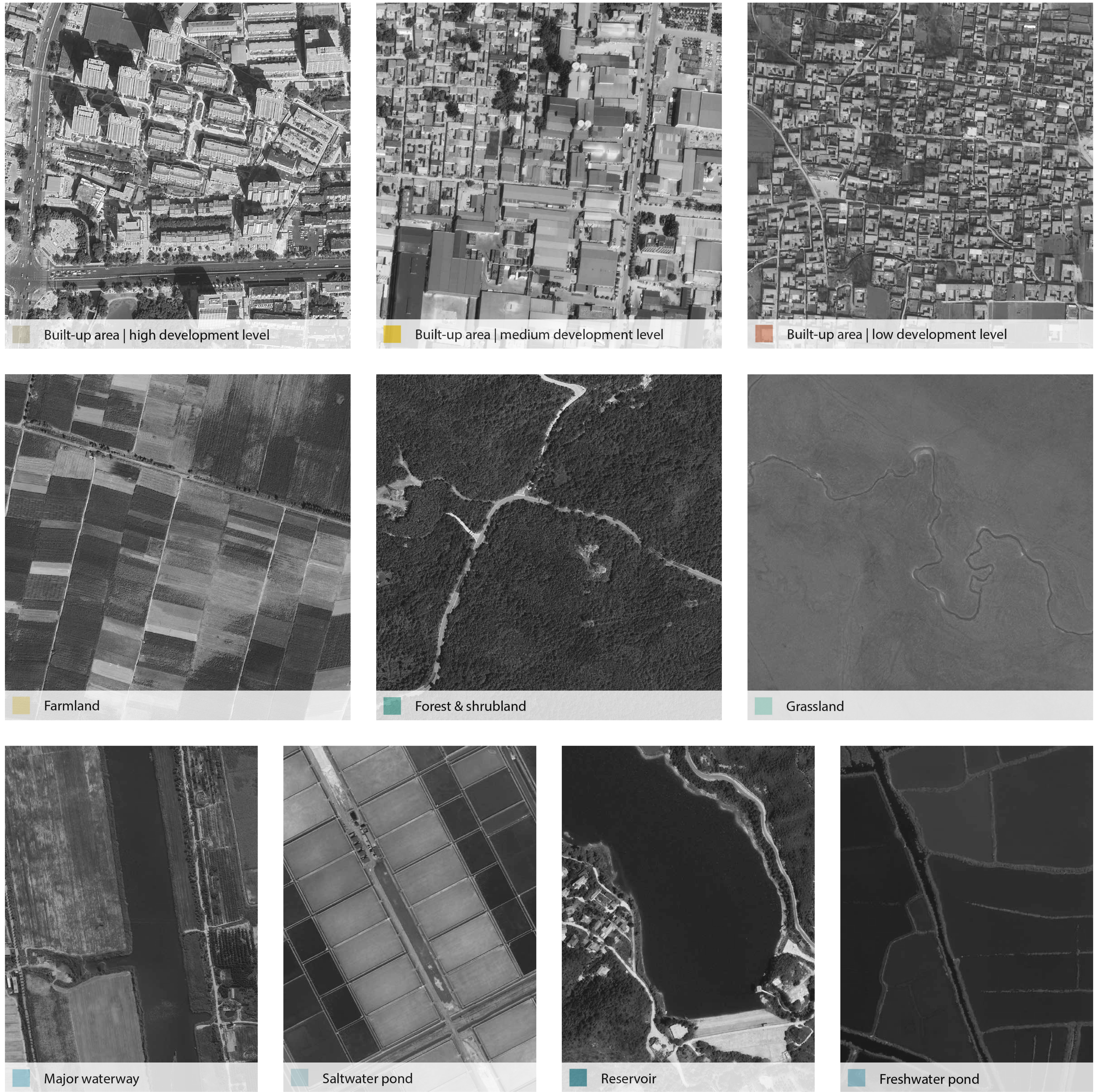
Index map | spatial anchoring



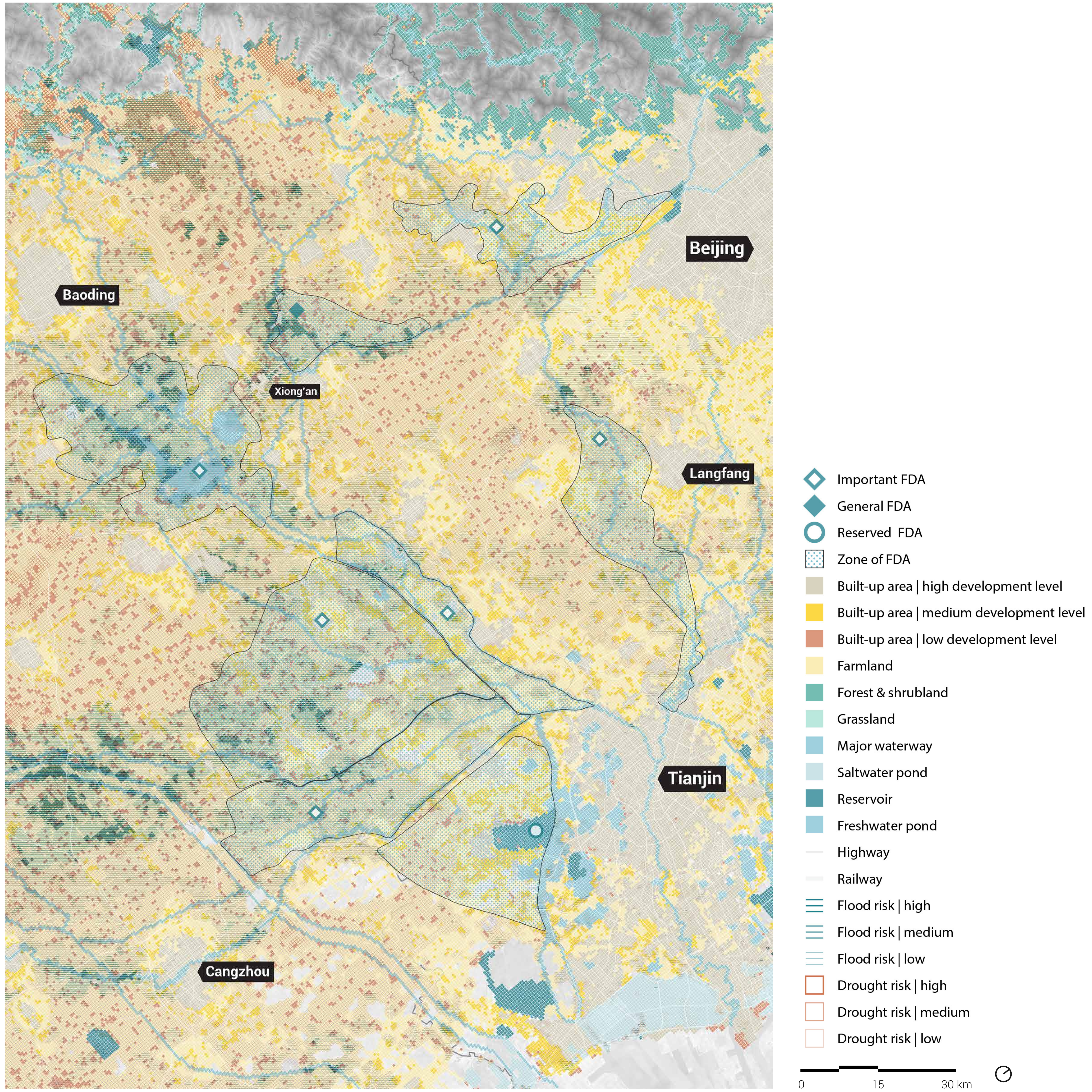
- Important FDA
- General FDA
- Reserved FDA
- Zone of FDA
- Built-up area | high development level
- Built-up area | medium development level
- Built-up area | low development level
- Farmland
- Forest & shrubland
- Grassland
- Major waterway
- Saltwater pond
- Reservoir
- Freshwater pond
- Highway
- Railway
- Flood risk | high
- Flood risk | medium
- Flood risk | low
- Drought risk | high
- Drought risk | medium
- Drought risk | low

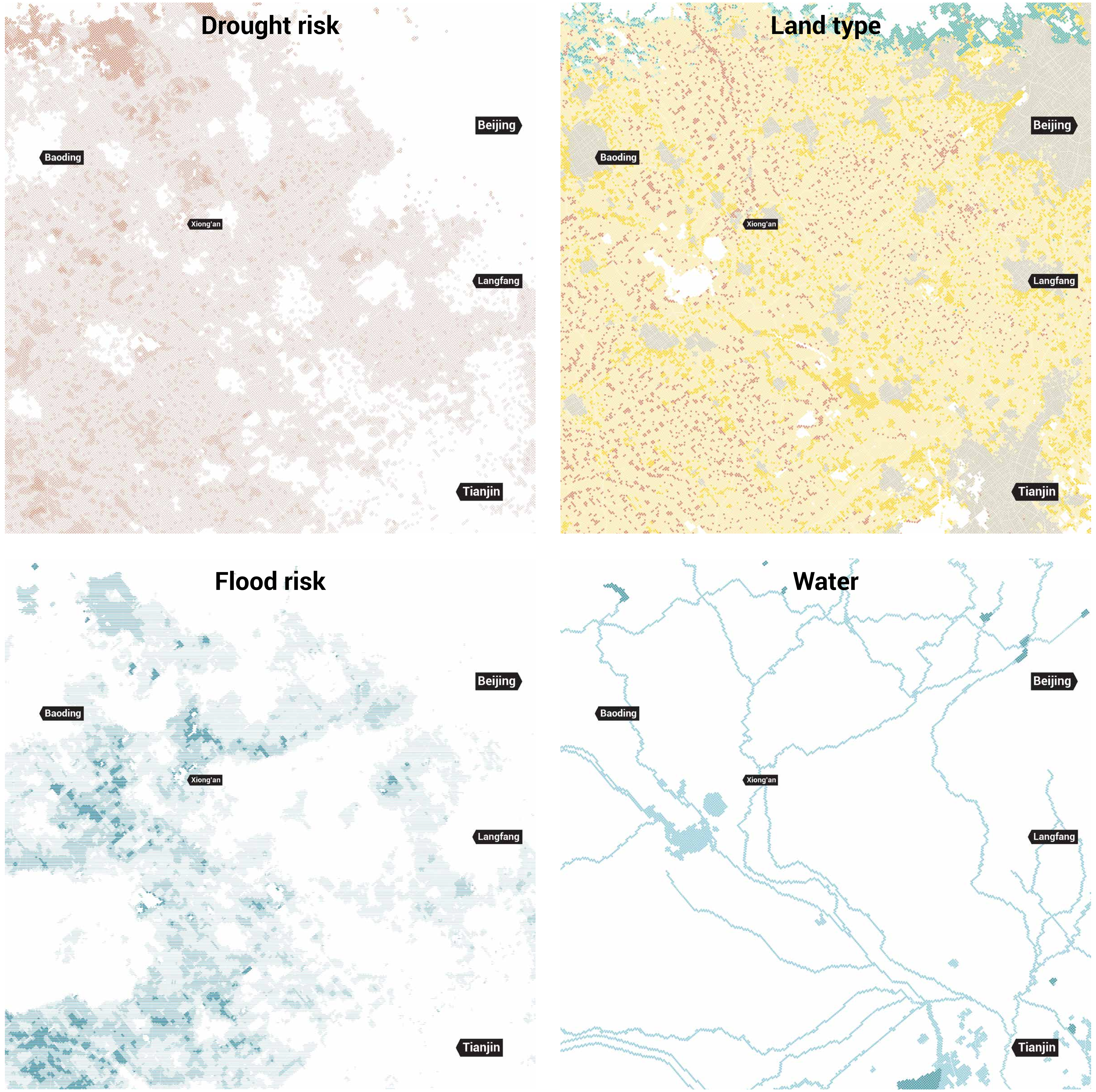
0 15 30 km

Typical land types | 500m blocks



Index map | spatial anchoring



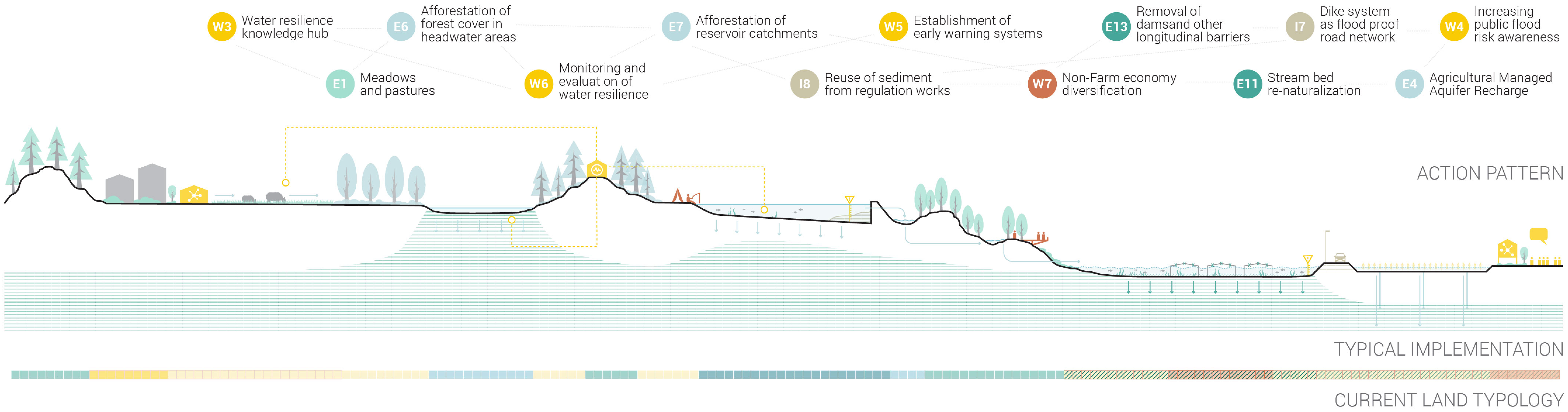


Intervention
Measure as pattern

Land typology

- Built-up area | high development level
- Built-up area | medium development level
- Built-up area | low development level
- Farmland
- Forest & shrubland
- Grassland
- Major waterway
- Saltwater pond
- Reservoir
- Freshwater pond
- Flood risk | medium
- Flood risk | low
- Drought risk | high
- Drought risk | medium
- Drought risk | low

Schematic sections for patterns | upstream



Land typology

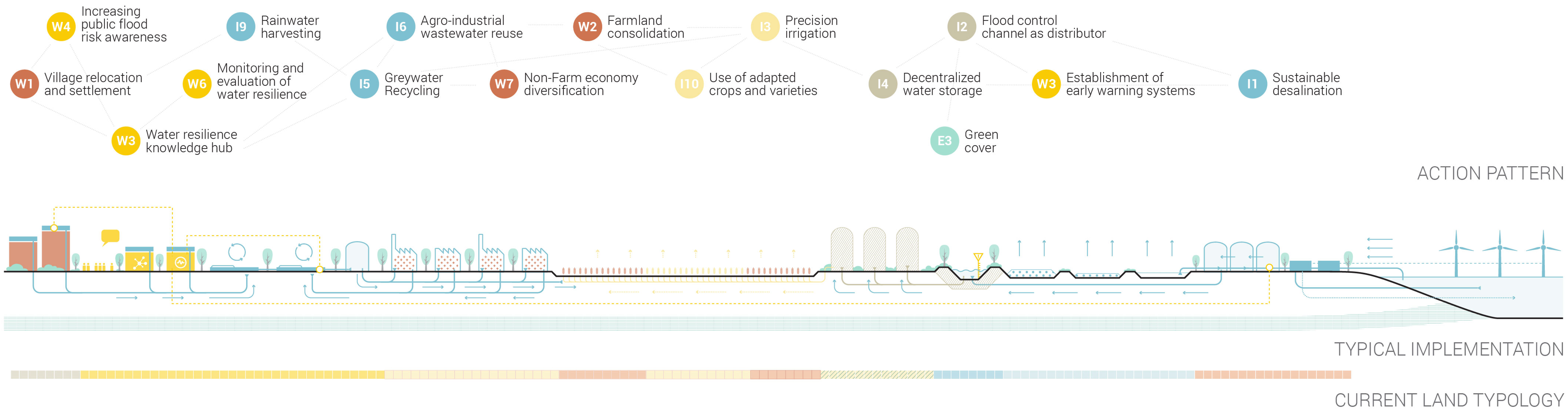
- Built-up area | high development level
- Built-up area | medium development level
- Built-up area | low development level
- Farmland
- Forest & shrubland
- Grassland
- Major waterway
- Saltwater pond
- Reservoir
- Freshwater pond
- Flood risk | medium
- Flood risk | low
- Drought risk | high
- Drought risk | medium
- Drought risk | low

Schematic sections for patterns | midstream

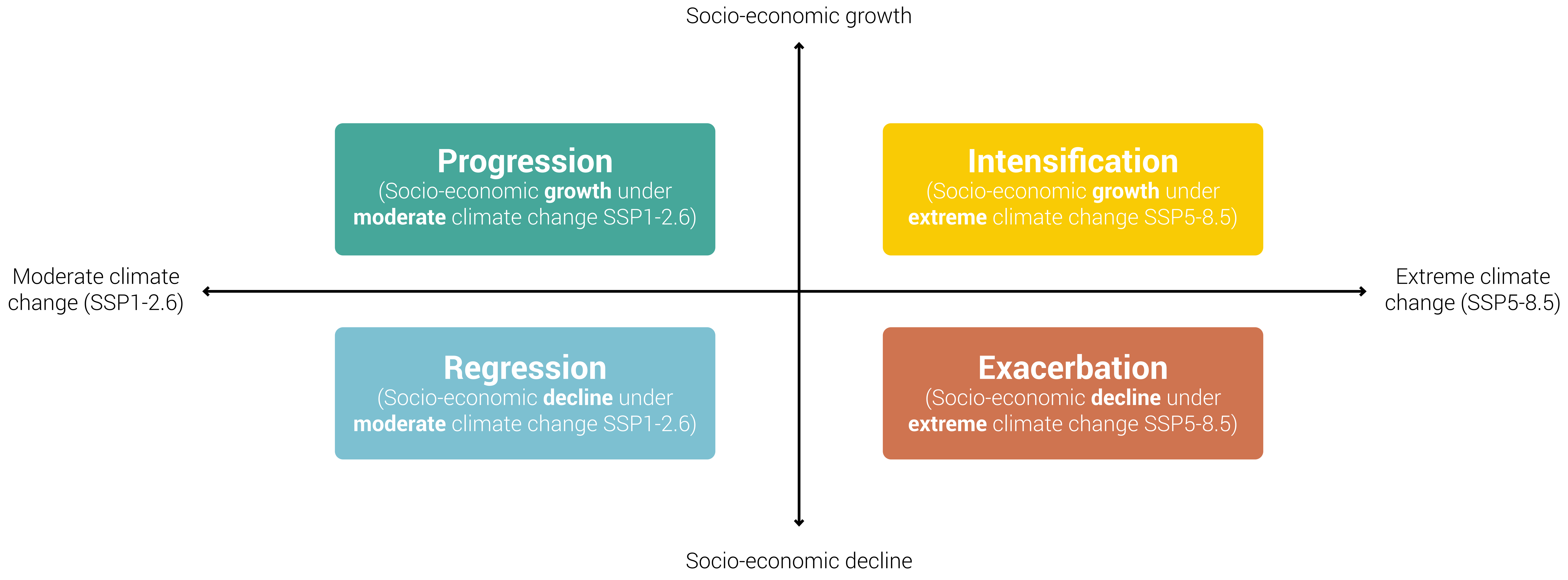
Land typology

- Built-up area | high development level
- Built-up area | medium development level
- Built-up area | low development level
- Farmland
- Forest & shrubland
- Grassland
- Major waterway
- Saltwater pond
- Reservoir
- Freshwater pond
- Flood risk | medium
- Flood risk | low
- Drought risk | high
- Drought risk | medium
- Drought risk | low

Schematic sections for patterns | downstream



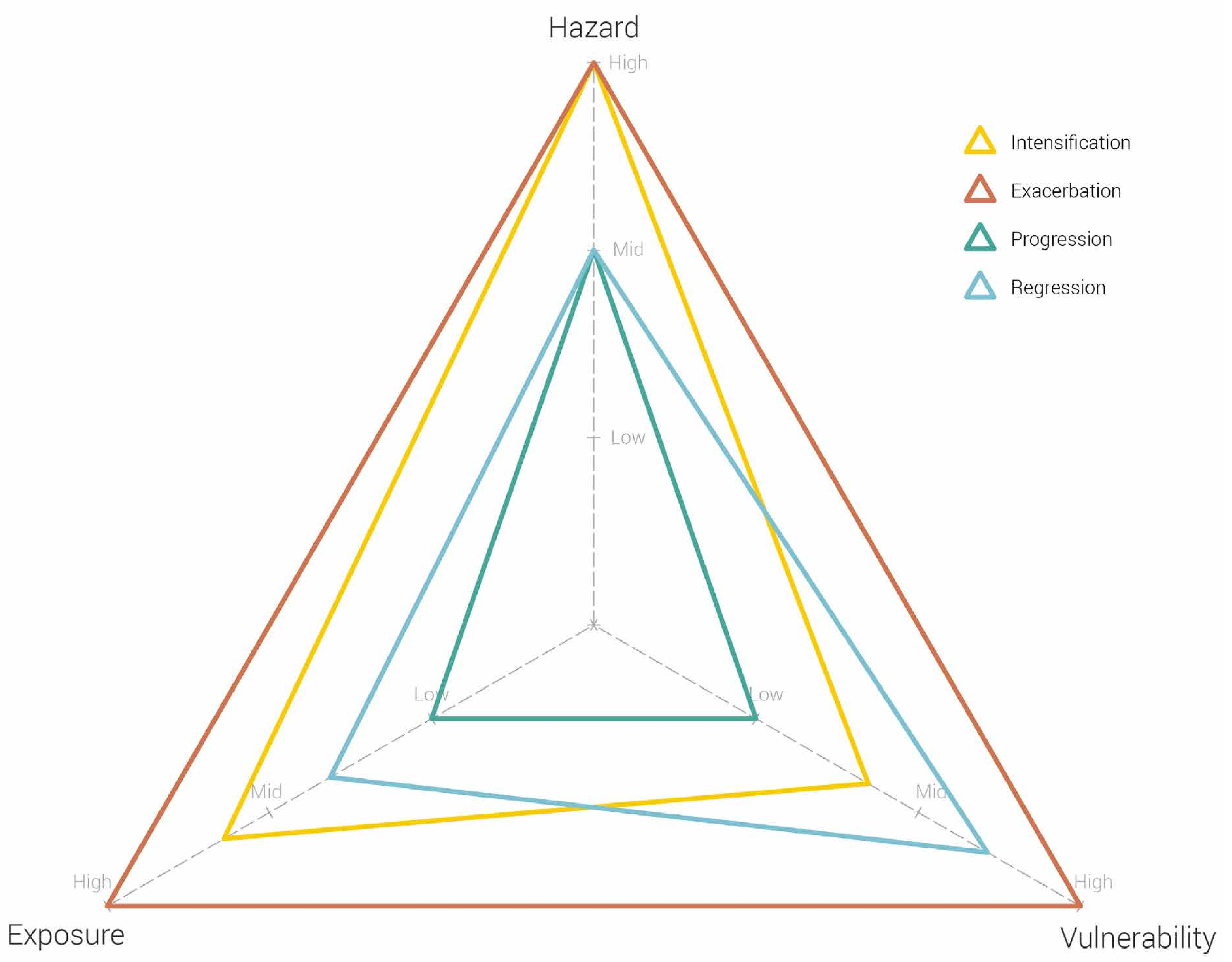
Dynamic adaptive policy pathways | scenarios



Socio-environmental parameters

(by 2060)	Intensification (Socio-economic growth under extreme climate change SSP5-8.5)	Exacerbation (Socio-economic decline under extreme climate change SSP5-8.5)	Progression (Socio-economic growth under moderate climate change SSP1-2.6)	Regression (Socio-economic decline under moderate climate change SSP1-2.6)	Ref.
Mean temperature (deg C)	+2.3	+2.3	+1.5	+1.5	(Calvin et al., 2023)
Days with TX above 35ºC	+9.2	+9.2	+6.0	+6.0	(Calvin et al., 2023)
Frost days	-25.7	-25.7	-12.5	-12.5	(Calvin et al., 2023)
Total precipitation during flood season (6-9)	+7.1%	+7.1%	+6.6%	+6.6%	(Calvin et al., 2023)
Total precipitation during non-flood season	+7.3%	+7.3%	+7.8%	+7.8%	(Calvin et al., 2023)
Maximum 1-day precipitation during flood season	+21.1%	+21.1%	+17.8%	+17.8%	(Calvin et al., 2023)
Population of BTH region (million people)	-9	-26	-9	-26	(Zhang et al., 2023)
GDP	+225%	+94%	+225%	+94%	(Jiang et al., 2018)
GDP growth rate	+2% per year	+0% per year	+2% per year	+0% per year	(Jiang et al., 2018)
Builtup area	7%	5%	7%	5%	(Fan, 2022)
Nature and recreation	40%	38%	40%	38%	(Fan, 2022)
Agriculture	53%	57%	53%	57%	(Fan, 2022)

Risk compositions



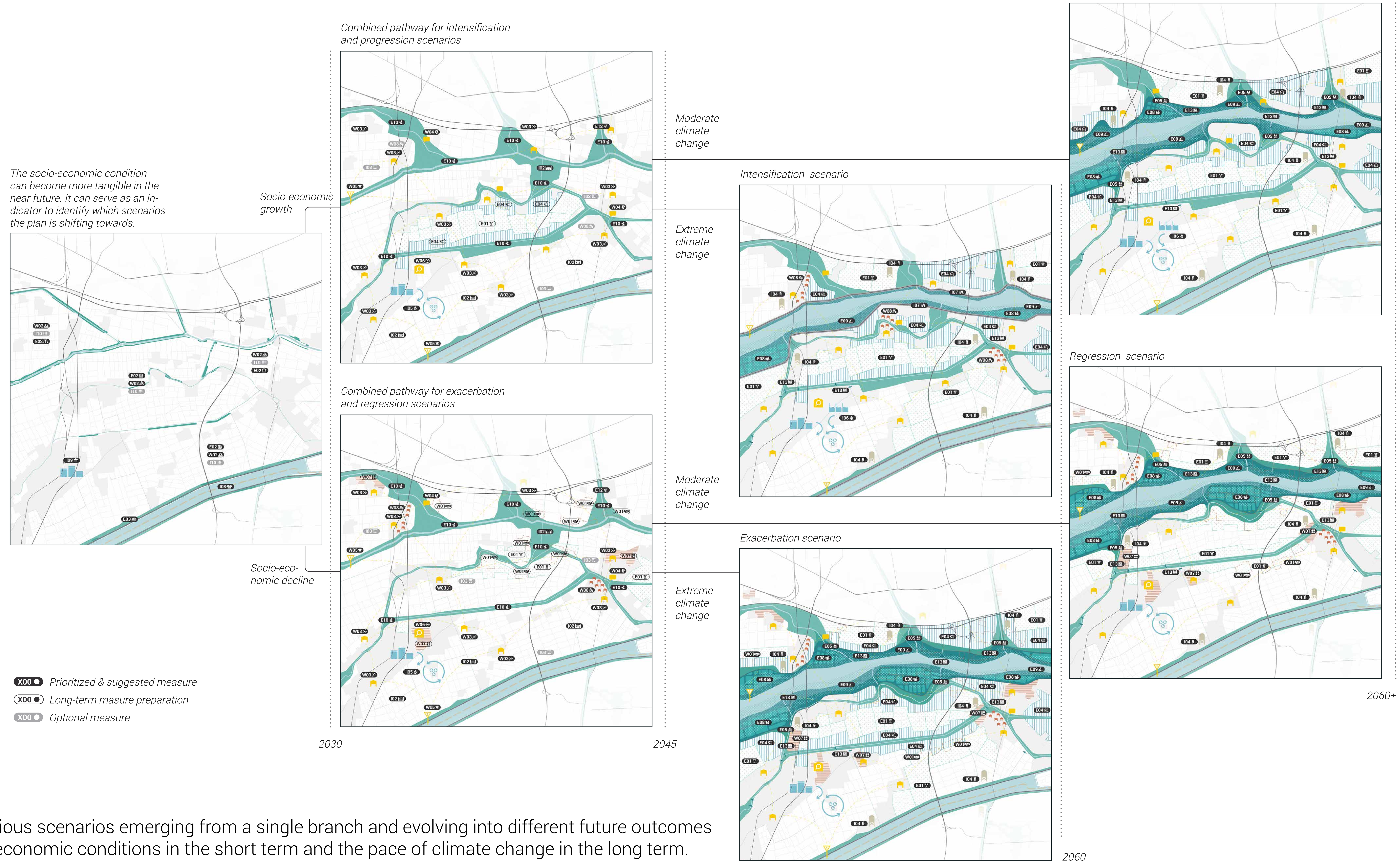
Intervention
Scenario making

Intervention
Scenario making

Preferred pathway

Design exploration

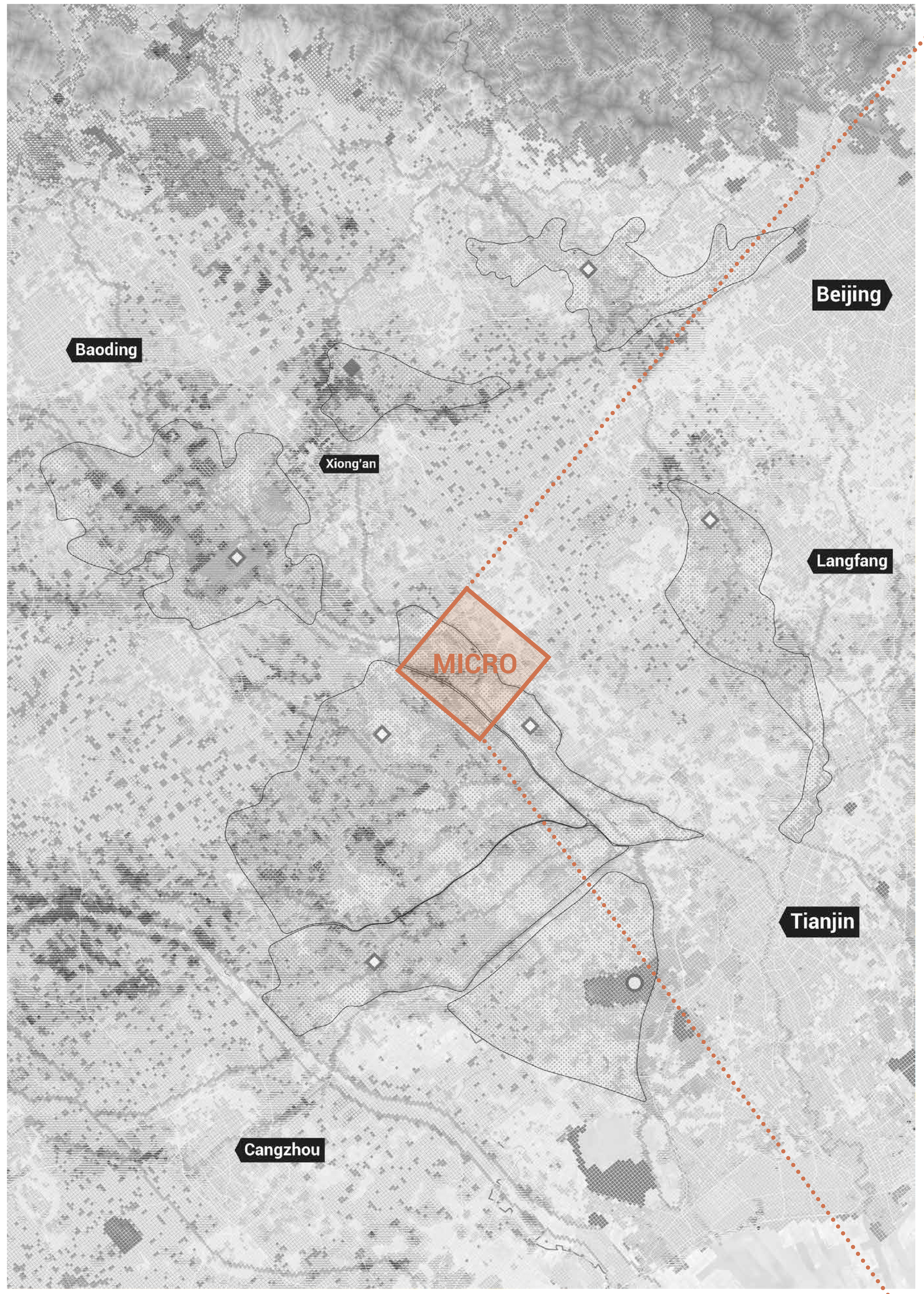
Synthetic scenarios | steering in a temporal sequence

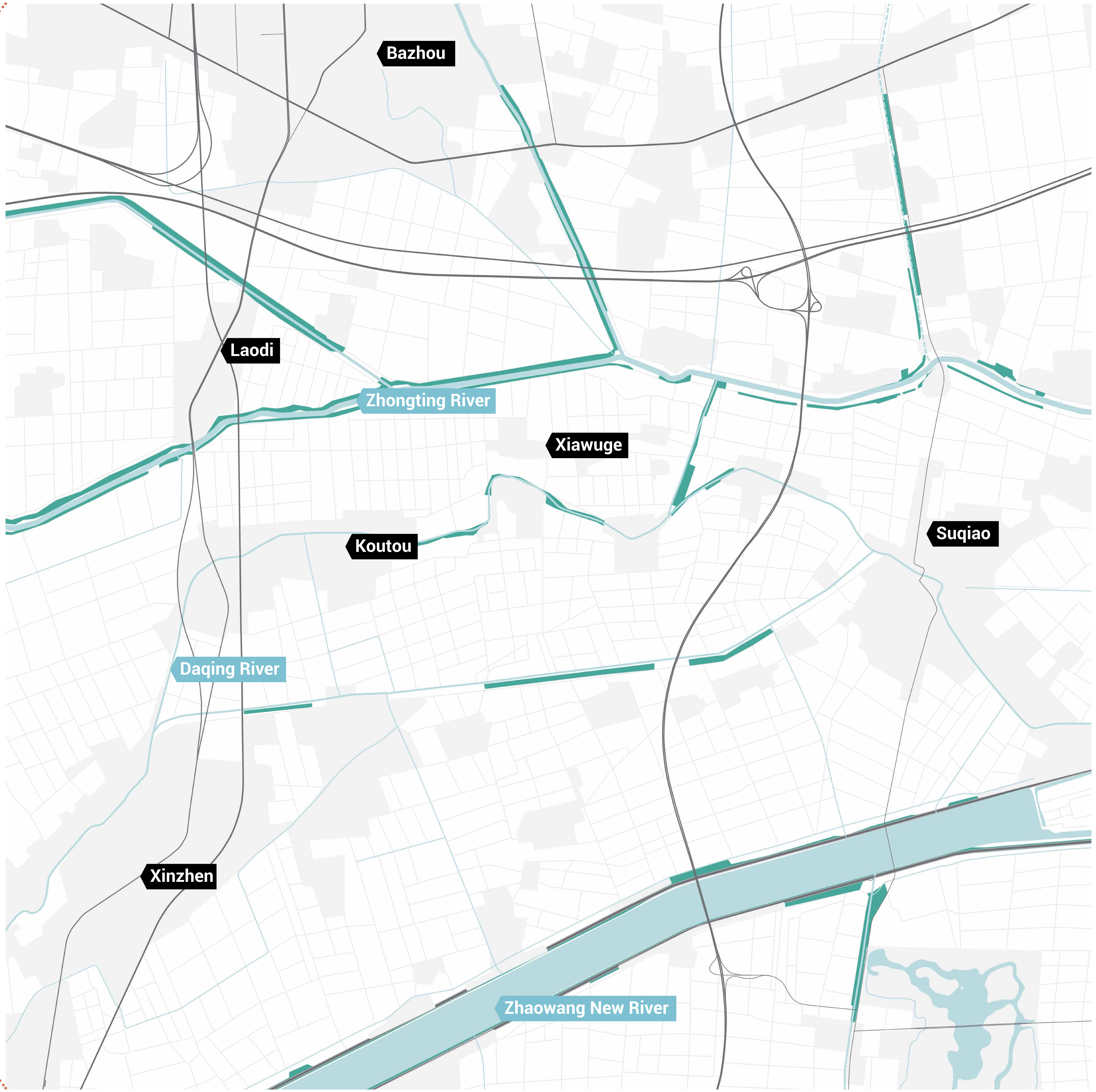


Possibility of various scenarios emerging from a single branch and evolving into different future outcomes based on socio-economic conditions in the short term and the pace of climate change in the long term.

Local adaptation | current

Local zoom-in location





Farmland in poor condition

Erosion along waterway

Villages under risk

Built-up area
Dike
Tree buffer
Road
Waterway

0 600 1200 m

Local adaptation | By 2030

Key measures

E2 Buffer strips

E3 Green cover

I9 Rainwater harvesting

I8 Reuse of sediment

I10 Use of adapt-ed varieties

W2 Farmland consolidation

Leading to

- **Intensification**
- **Exacerbation**
- **Progression**
- **Regression**

Growth

Decline

Low cost
Foundation for future measures

Farmland consolidation
Buffer strips
Reuse of sediment
X00 *Long-term masure preparation*
X00 *Optional measure*
X00 *Prioritized & suggested measure*
Built-up area
Dike
Tree buffer
Road
Waterway

0 600 1200 m

Intervention
Design exploration

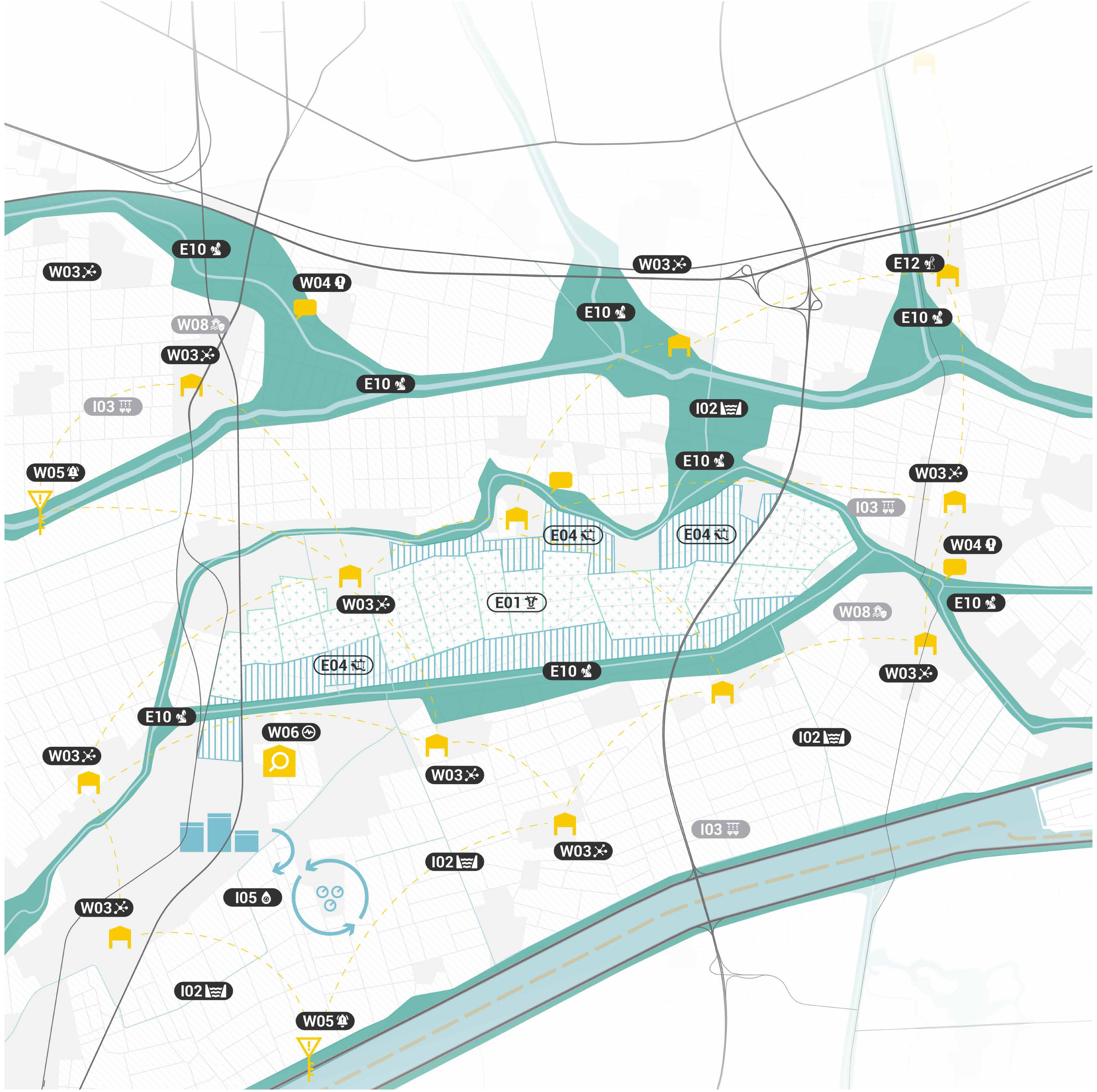
Local adaptation | Socio-economic growth | By 2045

Key measures

E10 Riverbank softening
- E1 Meadows and pastures
- E4 Agri-managed aquifer recharge
- E12 Restoration of intermittent streams

I5 Greywater recycling
- I2 Channels as distributor
- I3 Precision irrigation

W3 Water resilience knowledge hub
- W4 Increasing public risk awareness
- W5 Early warning systems
- W6 Monitoring and evaluation
- W8 Climate-proofing structure



Waterway restoration
Efficient water recycle and use
Water resilience network
Preperation for long term measures

Leading to

Intensification — Extreme
Exacerbation
Progression — Moderate
Regression

Agri-managed aquifer recharge
Meadows and pastures
Monitoring and evaluation
Water resilience knowledge hub
Monitoring and evaluation
Early warning system
Water recycling
Farmland consolidation
Buffer strips
Reuse of sediment
X00 Long-term masure preparation
X00 Optional measure
X00 Prioritized & suggested measure
Built-up area
Dike
Tree buffer
Road
Waterway

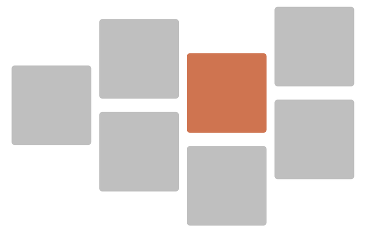
0 600 1200 m

Local adaptation | Socio-economic growth + Extreme climate change | By 2060

Key measures

- **E08 Detention basins**
- E1 Meadows and pastures
- E4 Agri-managed aquifer recharge
- E9 Wetland restoration
- E13 Dam removal
- **I7 Dikes as flood -proof road network**
- I4 Decentralized water storage
- I6 Agro-industrial wastewater reuse
- **W8 Climate-proofing structure**

High control



Leading to

Intensification
Exacerbation
Progression
Regression

Wetland restoration
Detention basins
Farmland consolidation
Agri-managed aquifer recharge
Meadows and pastures
Decentralized water storage
Climate-proofing structure
Monitoring and evaluation
Water resilience knowledge hub
Monitoring and evaluation
Early warning system
Water recycling
Dam removal
Buffer strips
Reuse of sediment
X00 *Long-term masure preparation*
X00 *Optional measure*
X00 *Prioritized & suggested measure*
Built-up area
Dike
Tree buffer
Road
Waterway

0 600 1200 m

Dynamic adaptive pathways | Intensification scenario

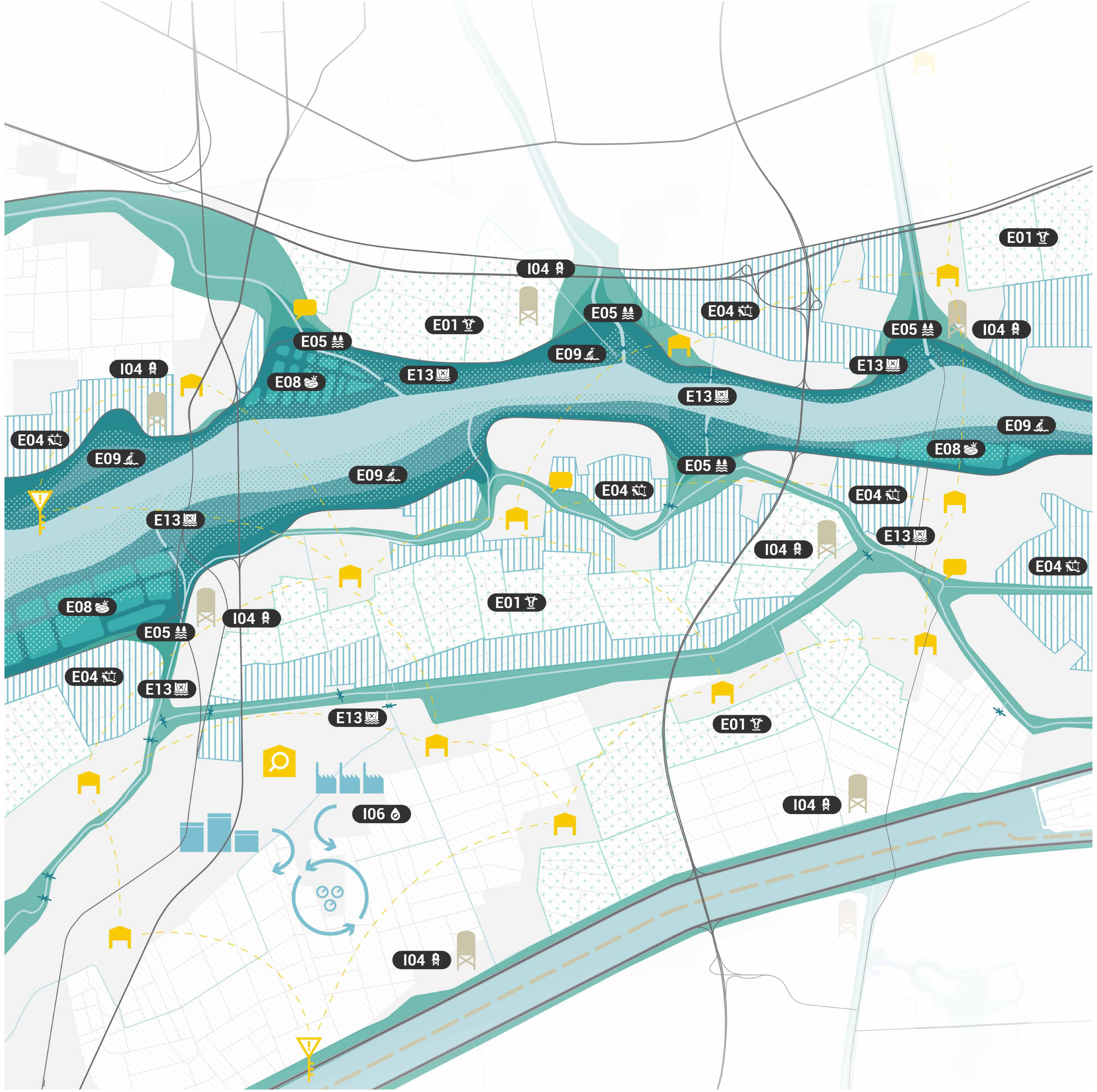
# Measure	Target effects (0,+,++,+++): water resilience: Flood mitigation	Drought mitigation	Flood adaptation	Drought adaptation	environmental justice: Equal flood risk distribution	Equal water resource distribution	Costs (0,+,++,+++): Initiate	Maintain	Side effects(---,--,-,0,+,++,+++): Water control capacity	Job opportunity	Environmental impact
now-2030											
Prioritized pathway	2	2	3	0	3	3	2	1	2	1	3
Preferred pathway	3	2	3	1	4	5	3	3	2	5	6
2030-2045											
Prioritized pathway	6	7	5	4	7	8	7	5	-1	4	8
Preferred pathway	8	10	17	15	15	16	17	17	3	12	17
2045-2060											
Prioritized pathway	11	11	11	5	13	11	15	10	5	8	6
Preferred pathway	13	16	11	5	16	17	22	13	5	10	8
By 2060	Flood mitigation	Drought mitigation	Flood adaptation	Drought adaptation	Equal flood risk distribution	Equal water resource distribution	Initiate	Maintain	Water control capacity	Job opportunity	Environmental impact
Prioritized pathway	19	20	19	9	23	22	24	16	6	13	17
Preferred pathway	24	28	31	21	35	38	42	33	10	27	31

Local adaptation | Socio-economic growth + Moderate climate change | By 2060+

Key measures

- E9 Wetland restoration
- E1 Meadows and pastures
- E4 Agri-managed aquifer recharge
- E5 Forest riparian buffers
- E8 Detention basins
- E13 Dam removal
- I4 Decentralized water storage
- I6 Agro-industrial wastewater reuse

Low control



Leading to

- Intensification
- Exacerbation
- **Progression**
- Regression

Forest riparian buffers
Wetland restoration
Detention basins
Farmland consolidation
Agri-managed aquifer recharge
Meadows and pastures
Decentralized water storage
Monitoring and evaluation
Water resilience knowledge hub
Monitoring and evaluation
Early warning system
Water recycling
Dam removal
Buffer strips
Reuse of sediment
X00 *Long-term masure preparation*
X00 *Optional measure*
X00 *Prioritized & suggested measure*
Built-up area
Dike
Tree buffer
Road
Waterway

Dynamic adaptive pathways | Progression scenario

#	Measure	Target effects (0,+,++,+++): water resilience: Flood mitigation	Drought mitigation	Flood adaptation	Drought adaptation	environmental justice: Equal flood risk distribution	Equal water resource distribution	Costs (0,+,++,+++): Initiate	Maintain	Side effects(---,--,-,0,+,++,+++): Water control capacity	Job opportunity	Environmental impact
now-2030												
	Prioritized pathway	2	2	1	0	2	3	1	2	1	3	4
	Preferred pathway	3	2	4	3	5	5	4	4	2	6	6
2030-2045												
	Prioritized pathway	8	10	3	1	7	10	10	3	-2	4	14
	Preferred pathway	8	10	15	16	15	17	17	17	2	12	19
2045-2060												
	Prioritized pathway	9	8	6	2	10	10	10	5	-2	3	10
	Preferred pathway	12	14	11	5	16	16	18	10	1	8	16
By 2060		Flood mitigation	Drought mitigation	Flood adaptation	Drought adaptation	Equal flood risk distribution	Equal water resource distribution	Initiate	Maintain	Water control capacity	Job opportunity	Environmental impact
	Prioritized pathway	19	20	10	3	19	23	21	10	-3	10	28
	Preferred pathway	23	26	30	24	36	38	39	31	5	26	41

Intervention
Design exploration

Local adaptation | Socio-economic decline | By 2045

Key measures

E10 Riverbank softening

E1 Meadows and pastures

E12 Restoration of intermittent streams

I5 Greywater recycling

I2 Channels as distributor

I3 Precision irrigation

W3 Water resilience knowledge hub

W4 Increasing public risk awareness

W5 Early warning systems

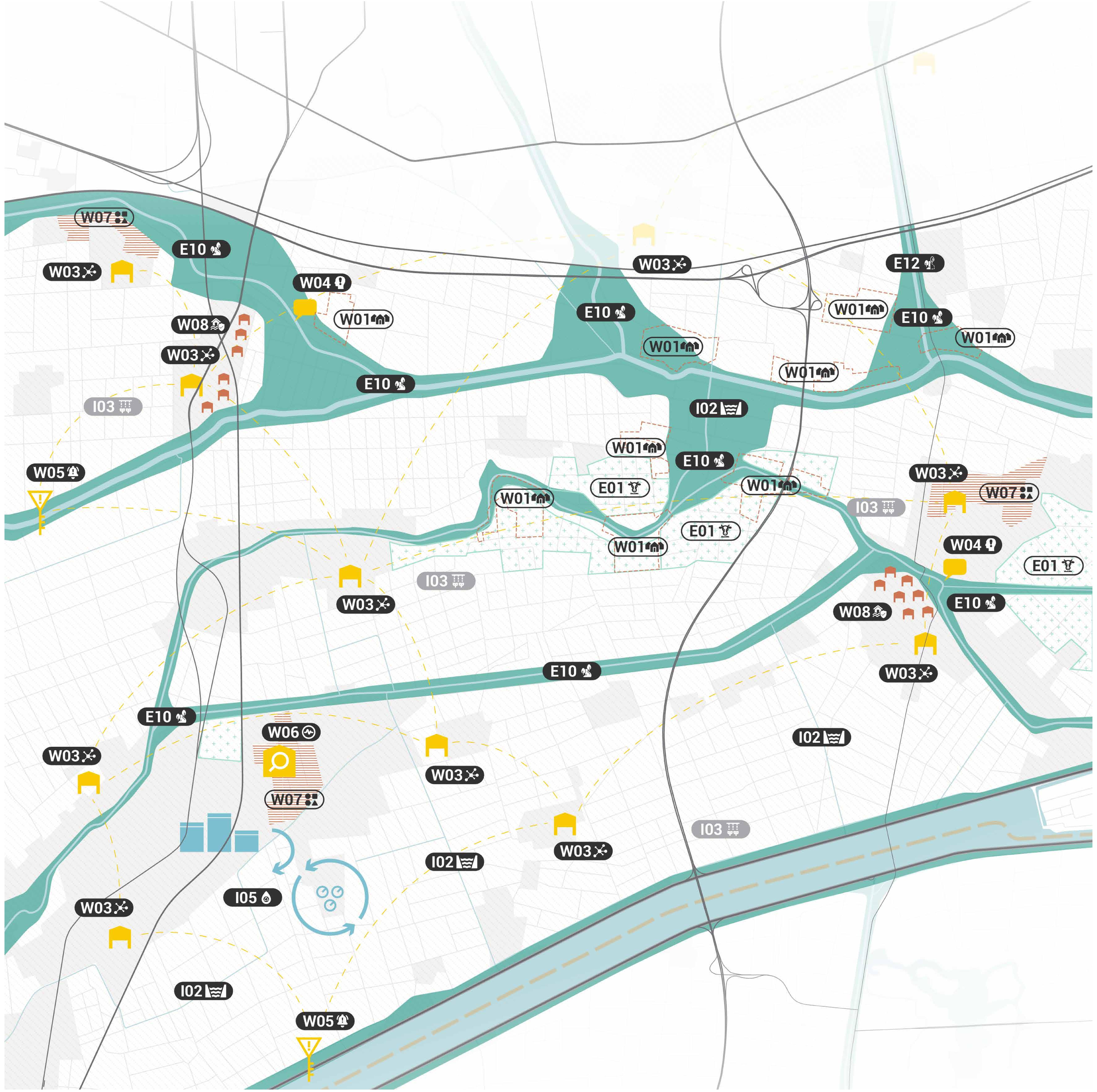
W6 Monitoring and evaluation

W1 Village relocation

W7 Economy diversification

W8 Climate-proofing structure

Waterway restoration
Efficient water recycle and use
Water resilience network
Preperation for long term measures
(Village relocation)



Leading to

Intensification

Exacerbation — Extreme

Progression

Regression — Moderate

Economy diversification
Meadows and pastures
Village relocation
Climate-proofing structure
Monitoring and evaluation
Water resilience knowledge hub
Monitoring and evaluation
Early warning system
Water recycling
Farmland consolidation
Buffer strips
Reuse of sediment
X00 Long-term masure preparation
X00 Optional measure
X00 Prioritized & suggested measure
Built-up area
Dike
Tree buffer
Road
Waterway

0 600 1200 m

Local adaptation | Socio-economic decline + Extreme climate change | By 2060

Key measures

E9 Wetland restoration

E1 Meadows and pastures

E4 Agri-managed aquifer recharge

E5 Forest riparian buffers

E8 Detention basins

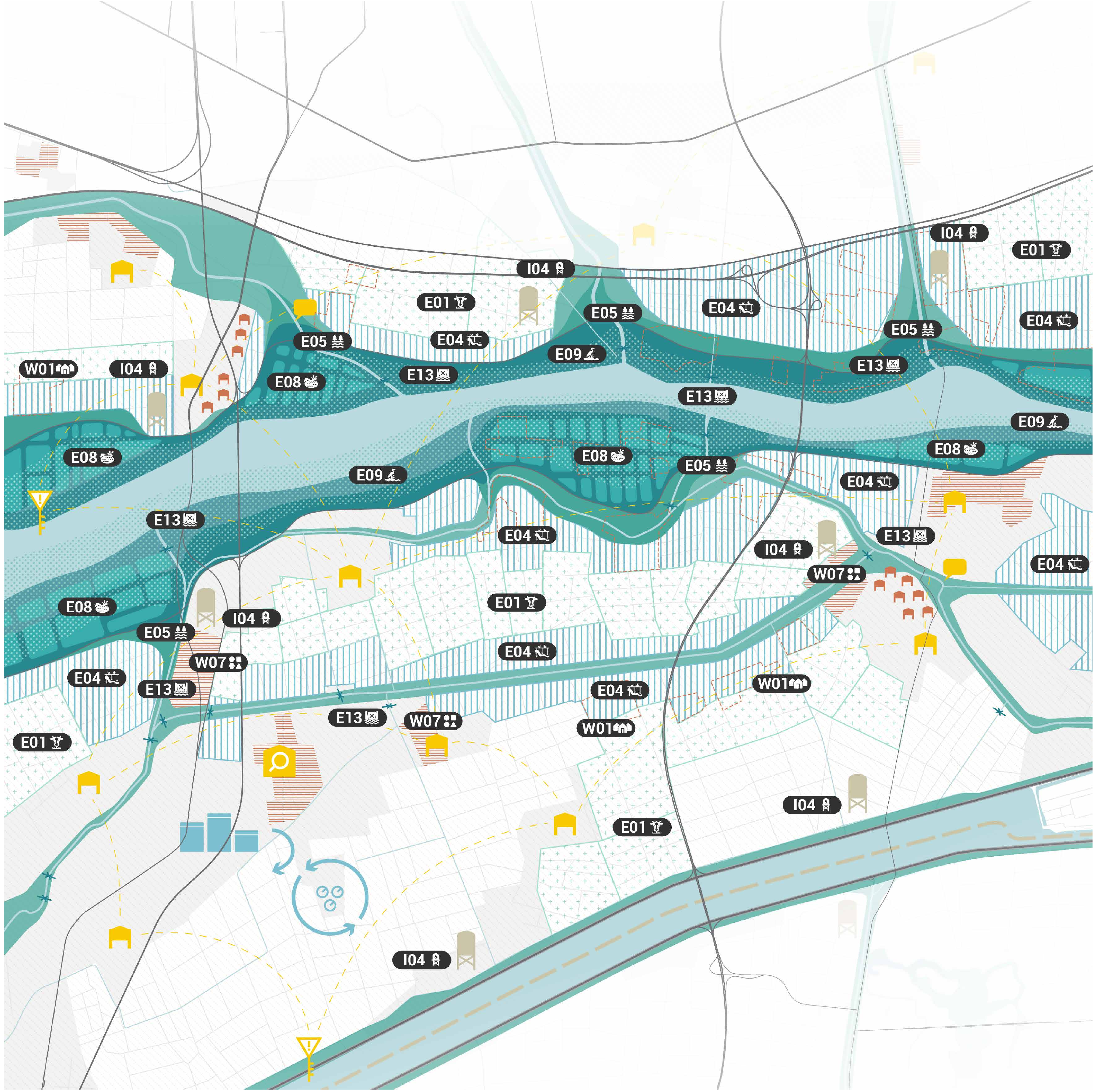
E13 Dam removal

I4 Decentralized water storage

W1 Village relocation

W7 Economy diversification

Cost-effective



Leading to

Intensification

Exacerbation

Progression

Regression

- Forest riparian buffers
- Wetland restoration
- Detention basins
- Economy diversification
- Agri-managed aquifer recharge
- Meadows and pastures
- Village relocation
- Decentralized water storage
- Climate-proofing structure
- Monitoring and evaluation
- Water resilience knowledge hub
- Monitoring and evaluation
- Early warning system
- Water recycling
- Dam removal
- Buffer strips
- Reuse of sediment
- X00 Long-term masure preparation
- X00 Optional measure
- X00 Prioritized & suggested measure
- Built-up area
- Dike
- Tree buffer
- Road
- Waterway

0 600 1200 m

Intervention

Dynamic adaptive pathways

Dynamic adaptive pathways | Exacerbation scenario

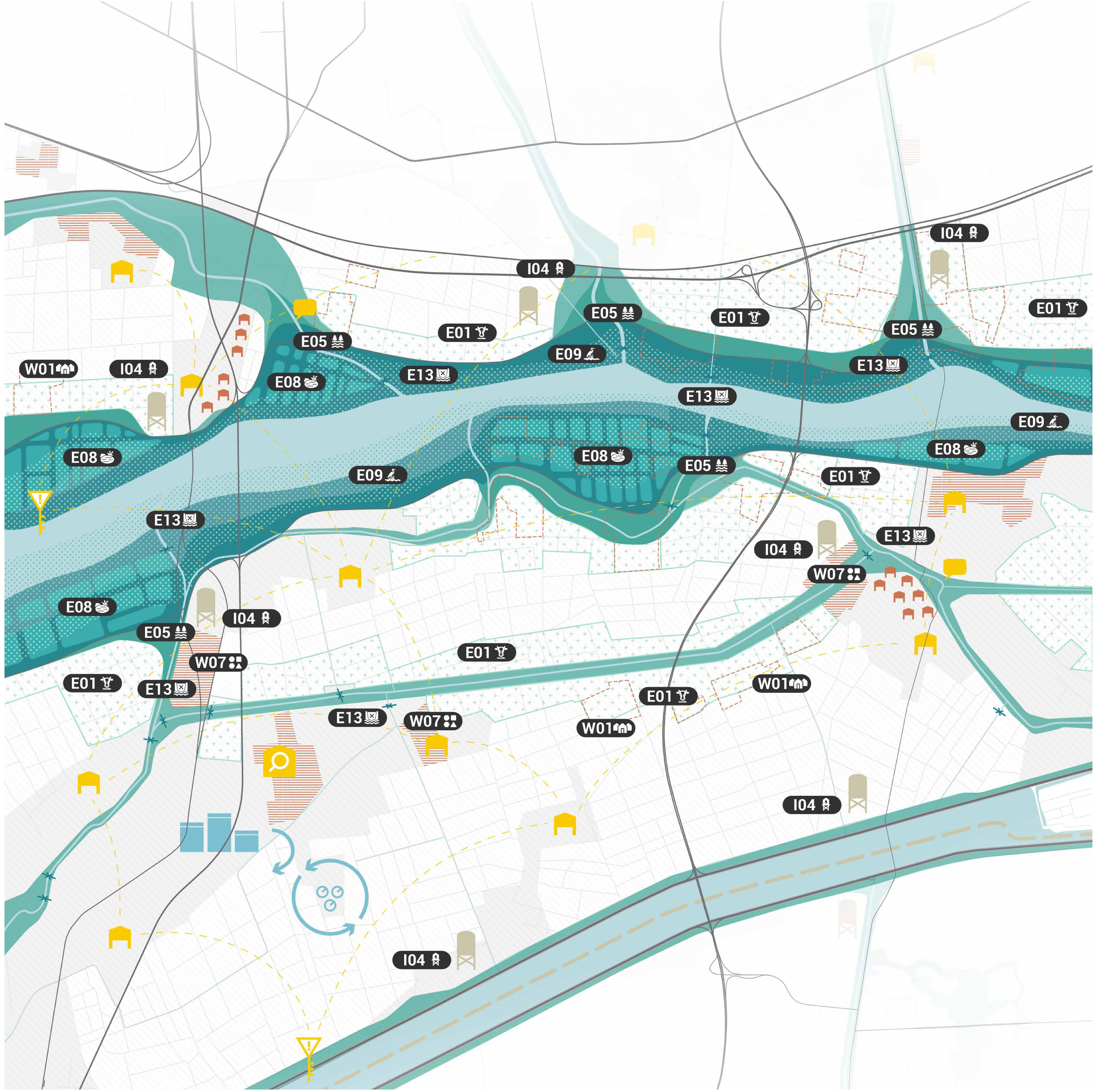
#	Measure	Target effects (0,+,++,+++): water resilience: Flood mitigation	Drought mitigation	Flood adaptation	Drought adaptation	environmental justice: Equal flood risk distribution	Equal water resource distribution	Costs (0,+,++,+++): Initiate	Maintain	Side effects(---,--,-,0,+,++,+++): Water control capacity	Job opportunity	Environmental impact
	now-2030											
	Prioritized pathway	1	2	3	2	3	3	2	2	2	2	1
	Preferred pathway	3	2	4	3	5	5	4	4	2	6	6
	2030-2045											
	Prioritized pathway	5	5	10	8	11	9	8	9	3	6	9
	Preferred pathway	7	9	17	15	16	15	15	17	4	12	14
	2045-2060											
	Prioritized pathway	7	8	6	5	8	8	9	6	2	6	6
	Preferred pathway	12	11	17	9	20	15	21	14	2	11	13
	By 2060	Flood mitigation	Drought mitigation	Flood adaptation	Drought adaptation	Equal flood risk distribution	Equal water resource distribution	Initiate	Maintain	Water control capacity	Job opportunity	Environmental impact
	Prioritized pathway	13	15	19	15	22	20	19	17	7	14	16
	Preferred pathway	22	22	38	27	41	35	40	35	6	29	33

Local adaptation | Socio-economic decline + Moderate climate change | By 2060+

Key measures

- E9 Wetland restoration
- E1 Meadows and pastures
- E5 Forest riparian buffers
- E8 Detention basins
- E13 Dam removal
- I4 Decentralized water storage
- W1 Village relocation
- W7 Economy diversification

Smaller footprint
Least intervention



Leading to

- Intensification
- Exacerbation
- Progression
- **Regression**

- Forest riparian buffers
- Wetland restoration
- Detention basins
- Economy diversification
- Meadows and pastures
- Village relocation
- Decentralized water storage
- Climate-proofing structure
- Monitoring and evaluation
- Water resilience knowledge hub
- Monitoring and evaluation
- Early warning system
- Water recycling
- Dam removal
- Buffer strips
- Reuse of sediment
- X00 Long-term masure preparation
- X00 Optional measure
- X00 Prioritized & suggested measure
- Built-up area
- Dike
- Tree buffer
- Road
- Waterway

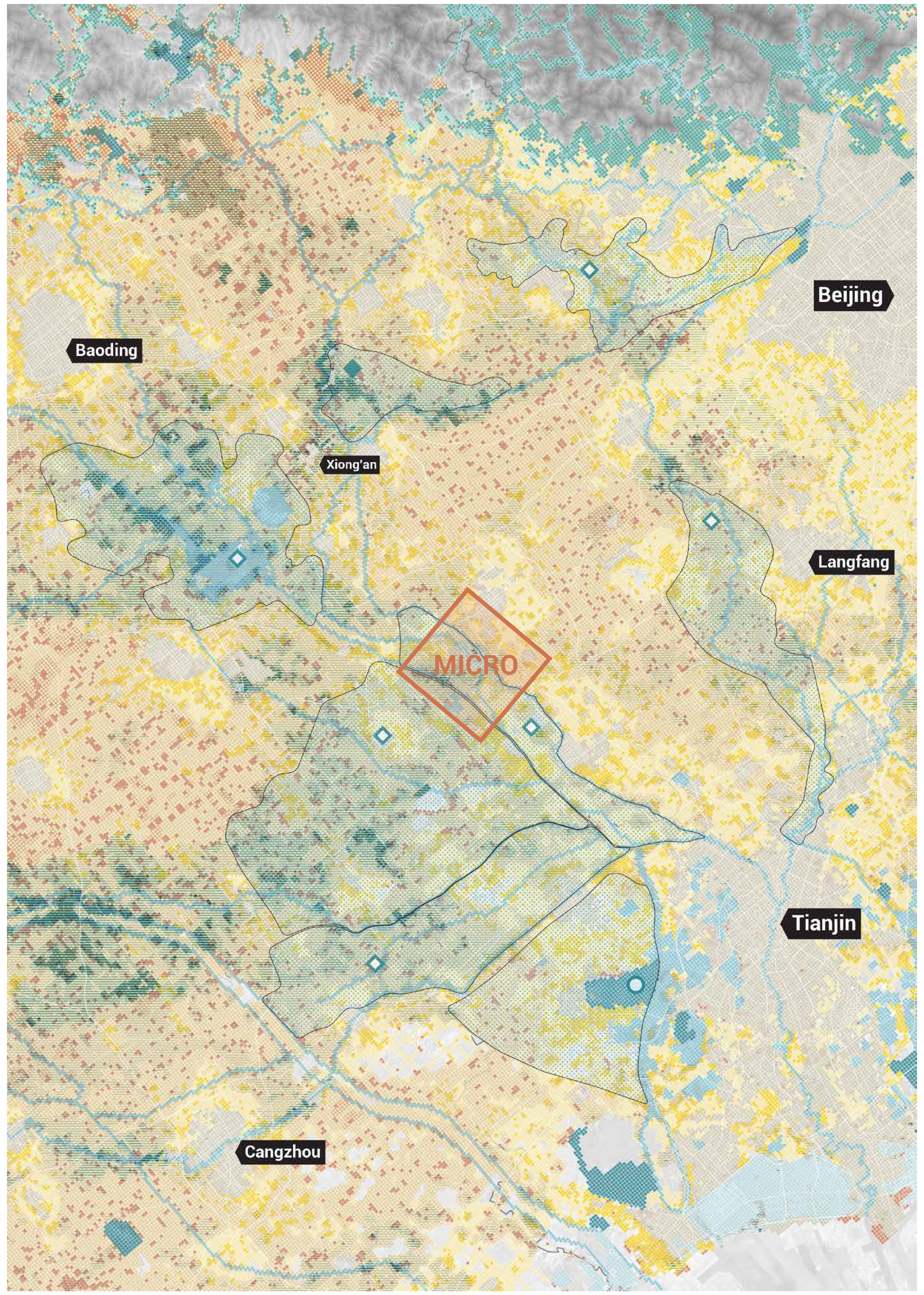
0 600 1200 m

Dynamic adaptive pathways | Regression scenario

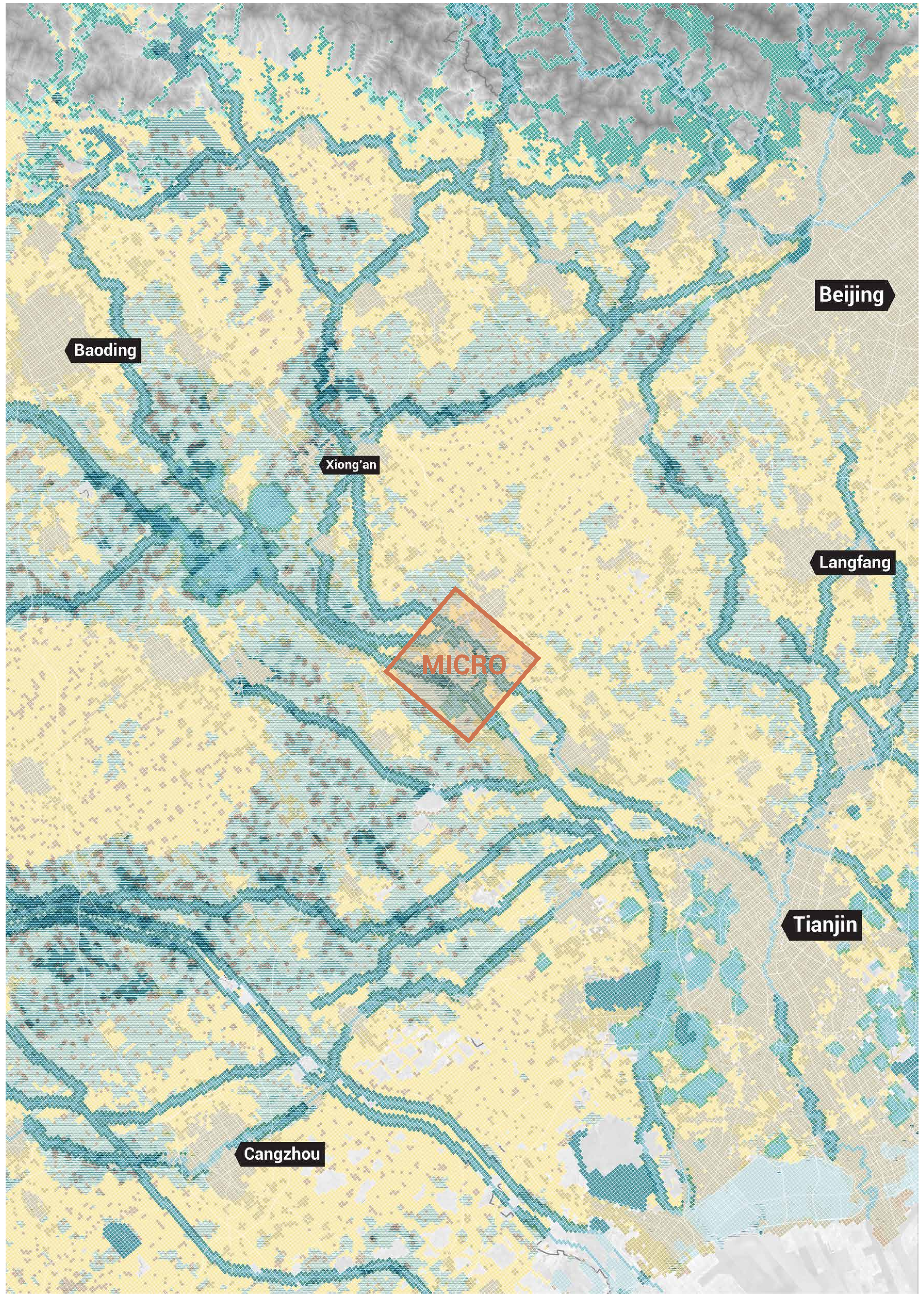
#	Measure	Target effects (0,+,++,+++) water resilience: Flood mitigation	Drought mitigation	Flood adaptation	Drought adaptation	environmental justice: Equal flood risk distribution	Equal water resource distribution	Costs (0,+,++,+++): Initiate	Maintain	Side effects(---,--,-,0,+,++,+++): Water control capacity	Job opportunity	Environmental impact
	now-2030											
	Prioritized pathway	1	2	3	2	3	3	2	2	2	2	1
	Preferred pathway	3	2	4	3	5	5	4	4	2	6	6
	2030-2045											
	Prioritized pathway	2	2	9	9	7	7	4	7	2	4	3
	Preferred pathway	4	6	15	18	11	14	13	16	5	11	11
	2045-2060											
	Prioritized pathway	3	4	8	7	7	5	8	6	2	5	5
	Preferred pathway	10	8	15	9	18	12	18	12	-1	11	13
	By 2060	Flood mitigation	Drought mitigation	Flood adaptation	Drought adaptation	Equal flood risk distribution	Equal water resource distribution	Initiate	Maintain	Water control capacity	Job opportunity	Environmental impact
	Prioritized pathway	6	8	20	18	17	15	14	15	6	11	9
	Preferred pathway	17	16	34	30	34	31	35	32	6	28	30

Tributary reorganization | Exacerbation scenario (most plausible) | 2060

Current



→



The main rivers widening
Villages resettled to safer locations
More space for water retention and infiltration

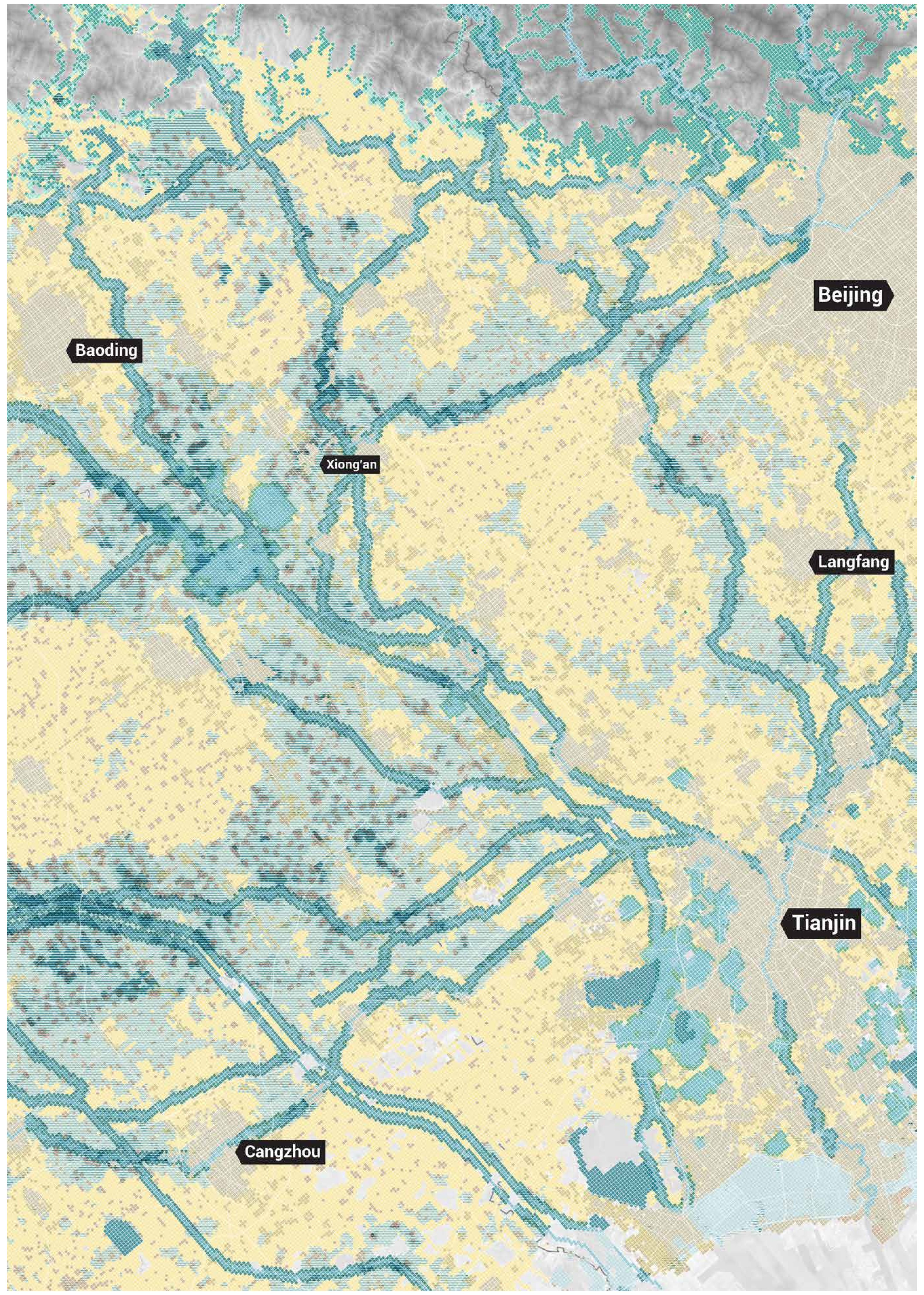
Decentralized water retention and buffering
More equitable distribution of water resources and risks

Relocated built-up area
Built-up area
Farmland
Forest & shrubland
Grassland
Pasture & Ag-MAR farmland
Freshwater
Highway
Railway

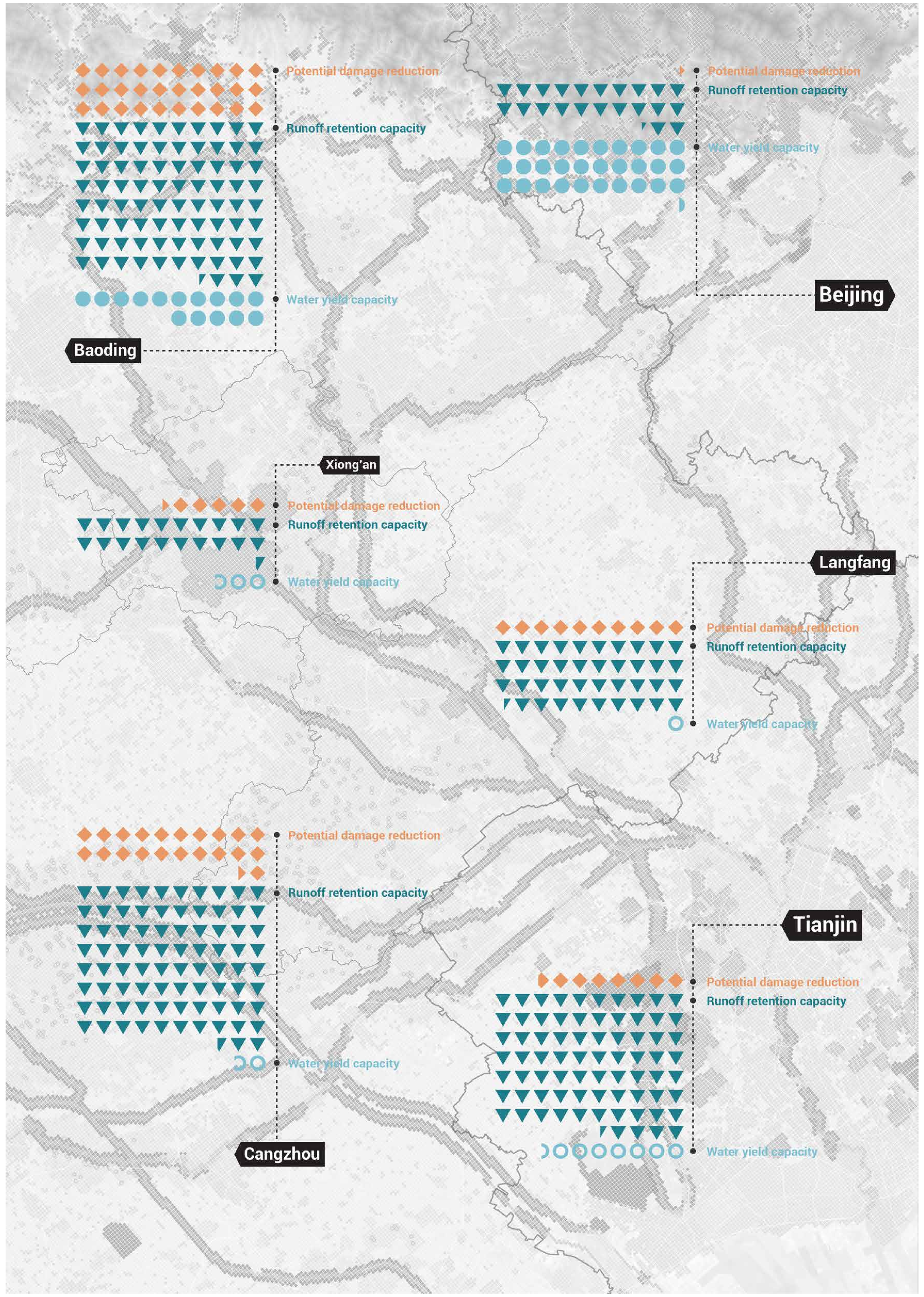
0 10 20 km

Ecosystem service assessment | Exacerbation scenario (most plausible) | 2060

Proposed



→



Nearly 750 million m² of built-up area protected from flood damage

Runoff retention capacity increases across all areas, ranging from 200 million m³ to 830 million m³

Higher water yield capacity as a whole.

City boundary

Potential damage reduction - builtup area (10 million m²/each)

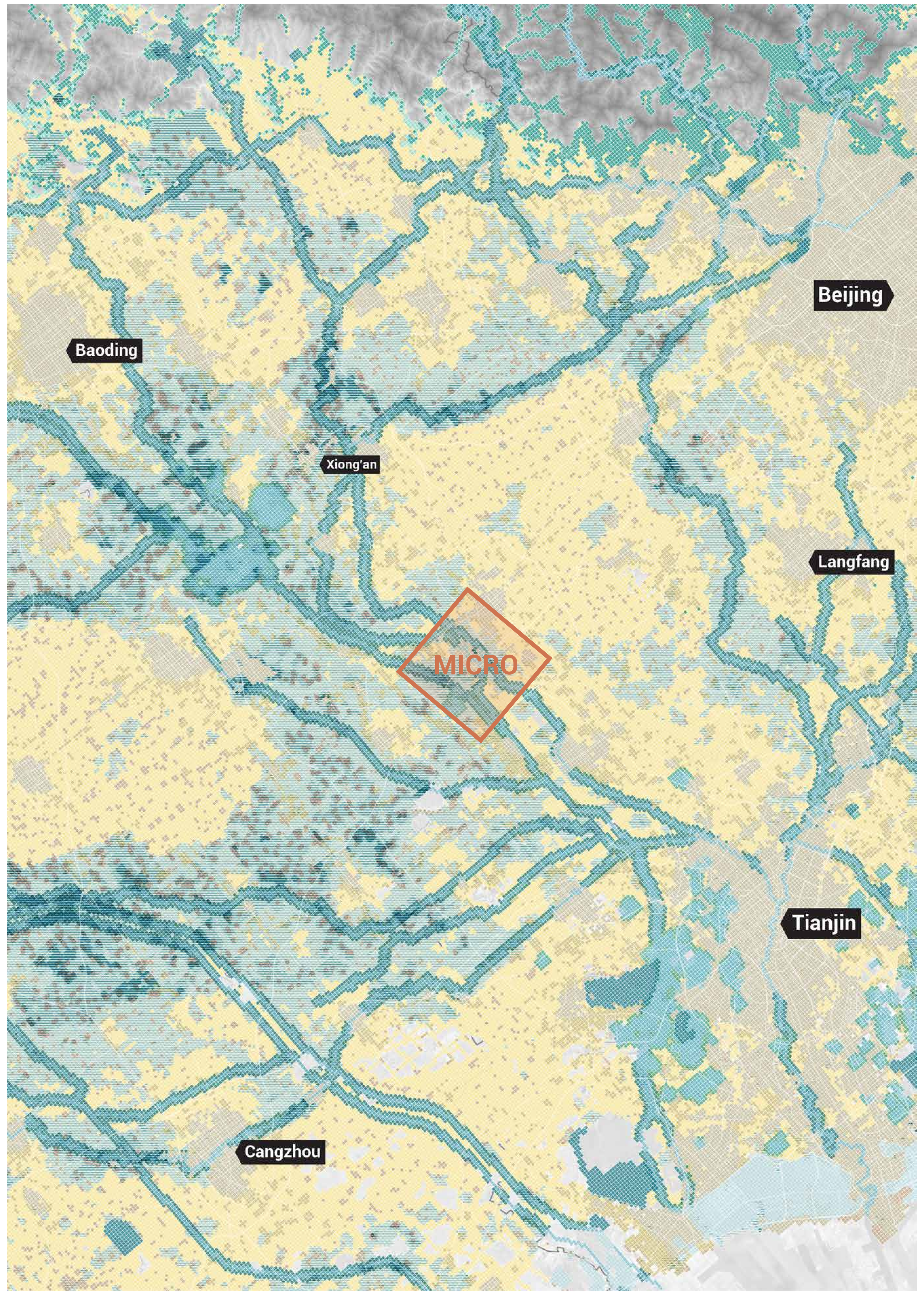
Runoff retention capacity increasement - 150 mm rainfall event (10 million m³/each)

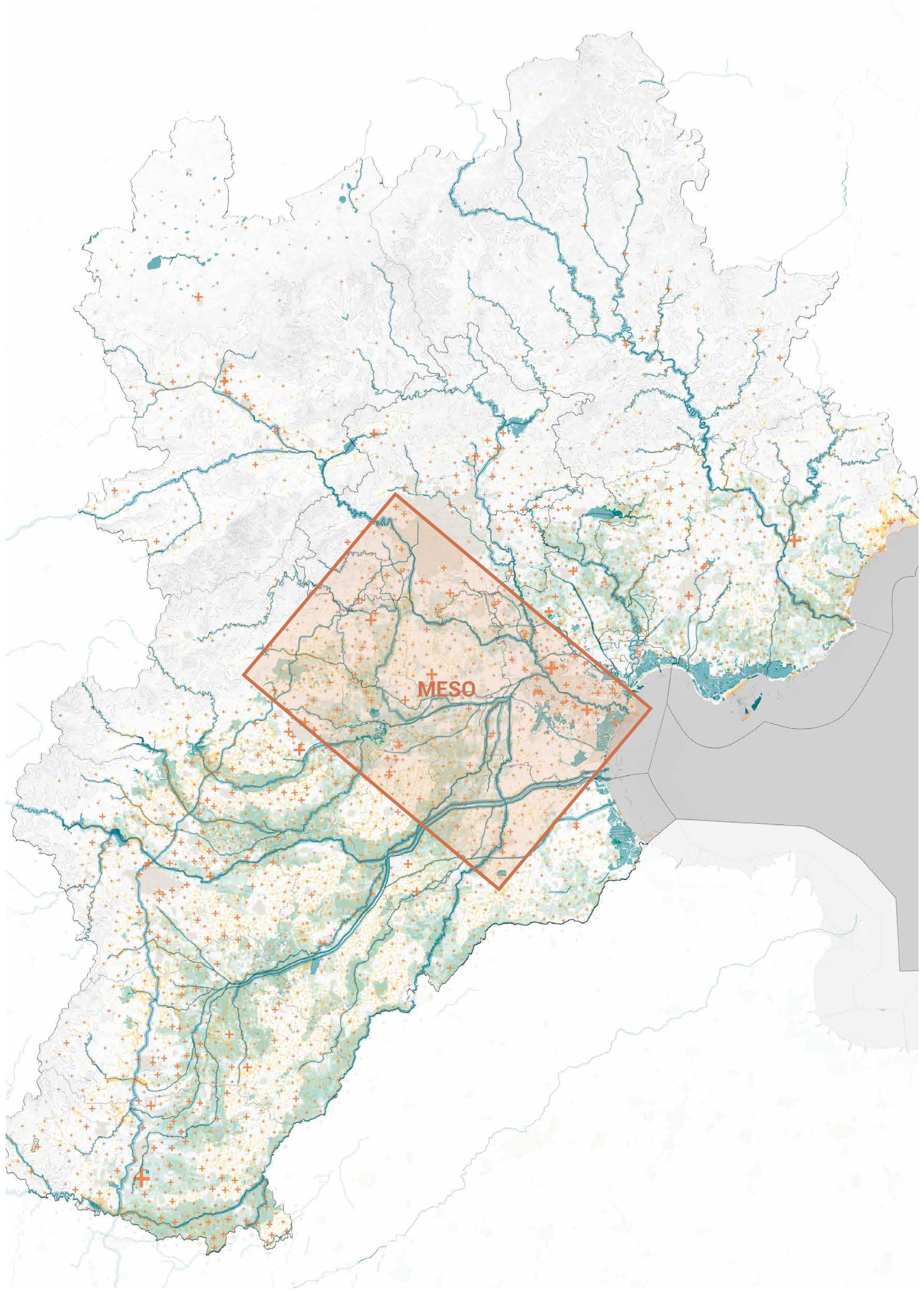
Water yield capacity change (+/- 10 million m³/year/each)

0 10 20 km

Territory transformation | Synthesis scenarios | 2060

Tributary reorganization



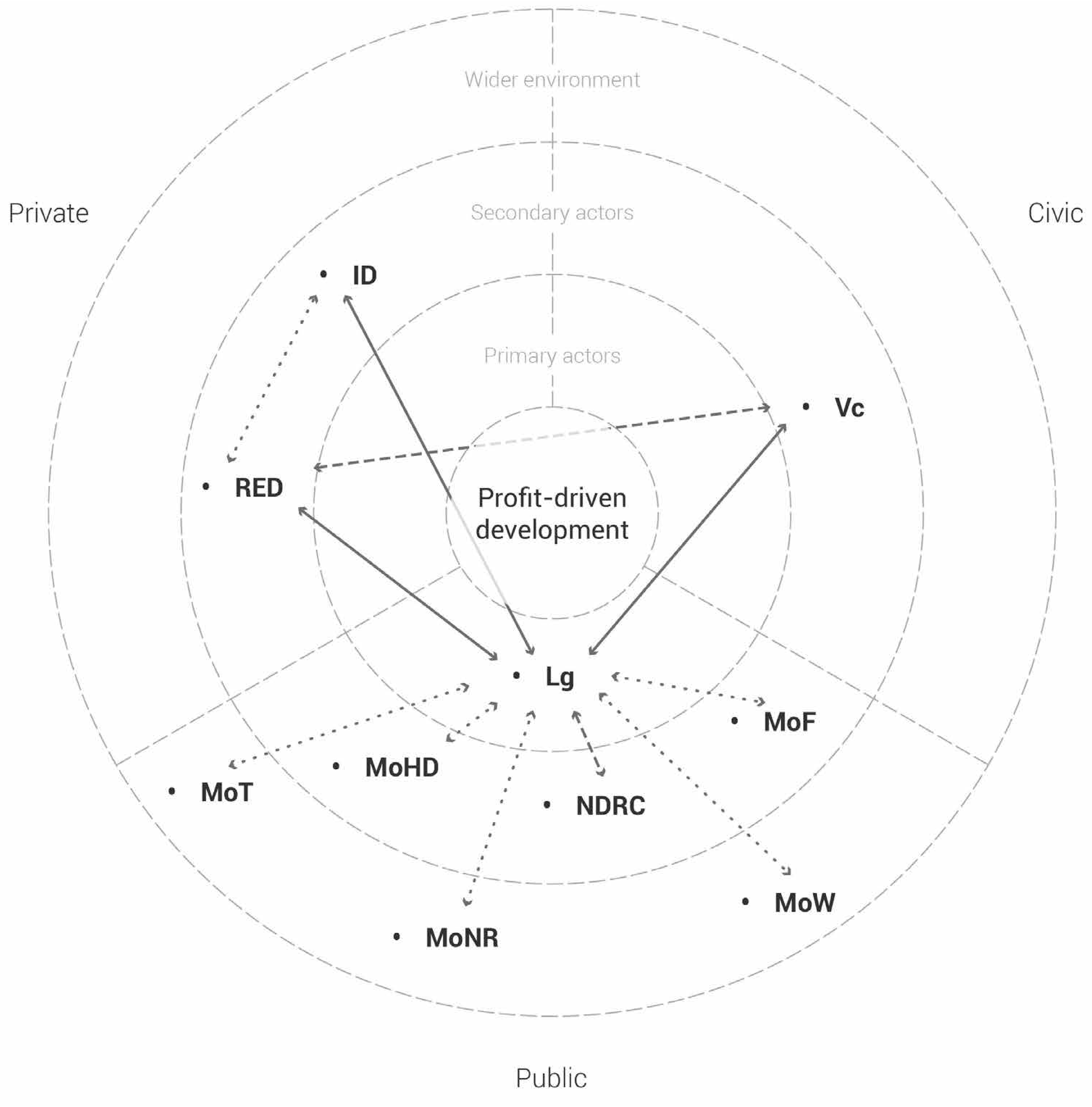


Restored tributaries and floodplains
Water knowledge and risk-sharing network
-> water-relisient mosaic

Urban area
Water-resilient communities
Water sensitive land consolidation
Water source protection
Floodplain restoration
Waterway restoration
Waterway
Administrative boundary

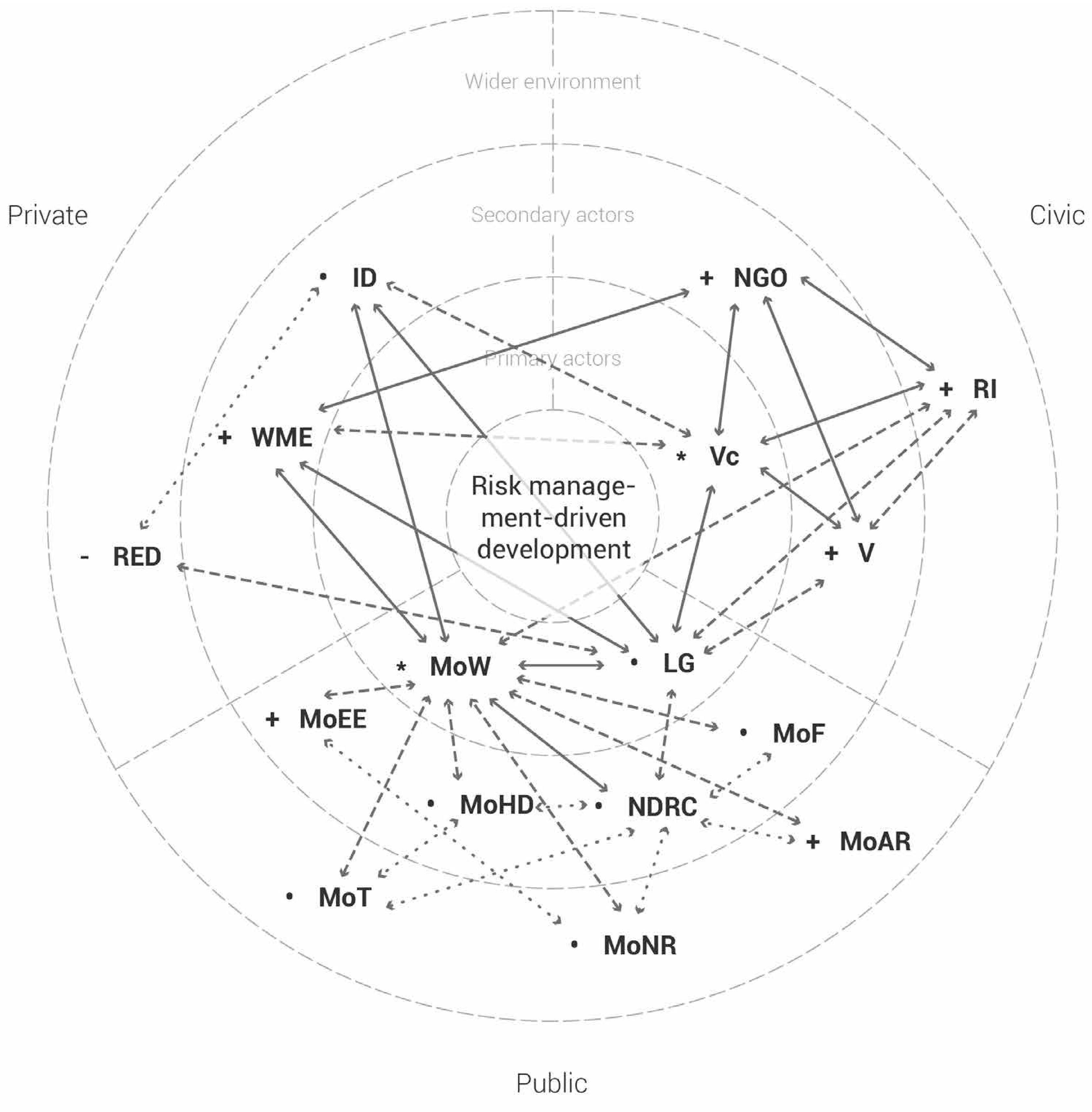
0 100 200 km

Stakeholder status | Current



Lack of civic agents
Monopoly of private agents
Sectoral public agencies

Stakeholder status | Proposed



Introduce new civic agents
Balance the role of private agents
Integrated public agency network

-> transparency and constant communication

MoF	*Ministry of Finance*
NDRC	*National Development and Reform Commission*
MoNR	*Ministry of Natural Resources*
MoEE	*Ministry of Ecology and Environment*
MoW	*Ministry of Water Resources*
V	*Villager*
Vc	*Villagers' committee*
MoAR	*Ministry of Agriculture and Rural Affairs*
MoT	*Ministry of Transport*
MoHD	*Ministry of Housing and Urban-Rural Development*
NGO	*Non-governmental organisation*
RED	*Real estate developer*
LG	*Local government*
ID	*Infrastructure developer*
RI	*Research institute*
WME	*Water management entrepreneur*

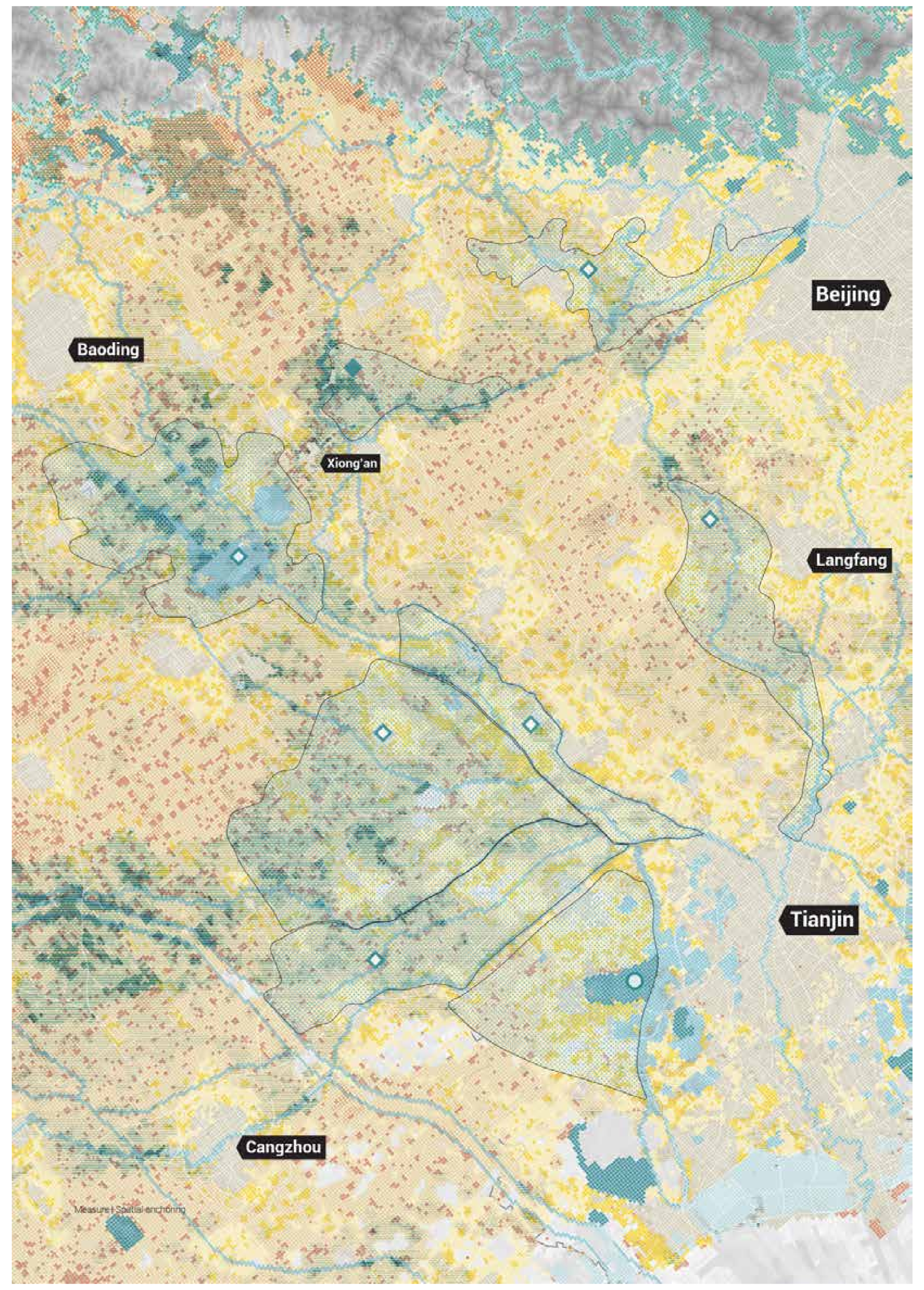
*	*Enhanced participation*
-	*Diminished participation*
+	*Introduced participation*
•	*No change*
⟷	*Strong collaboration*
⟷	*Task-specific collaboration*
⟷	*Indirect collaboration*

Conclusion and Reflection

A vision for discussion

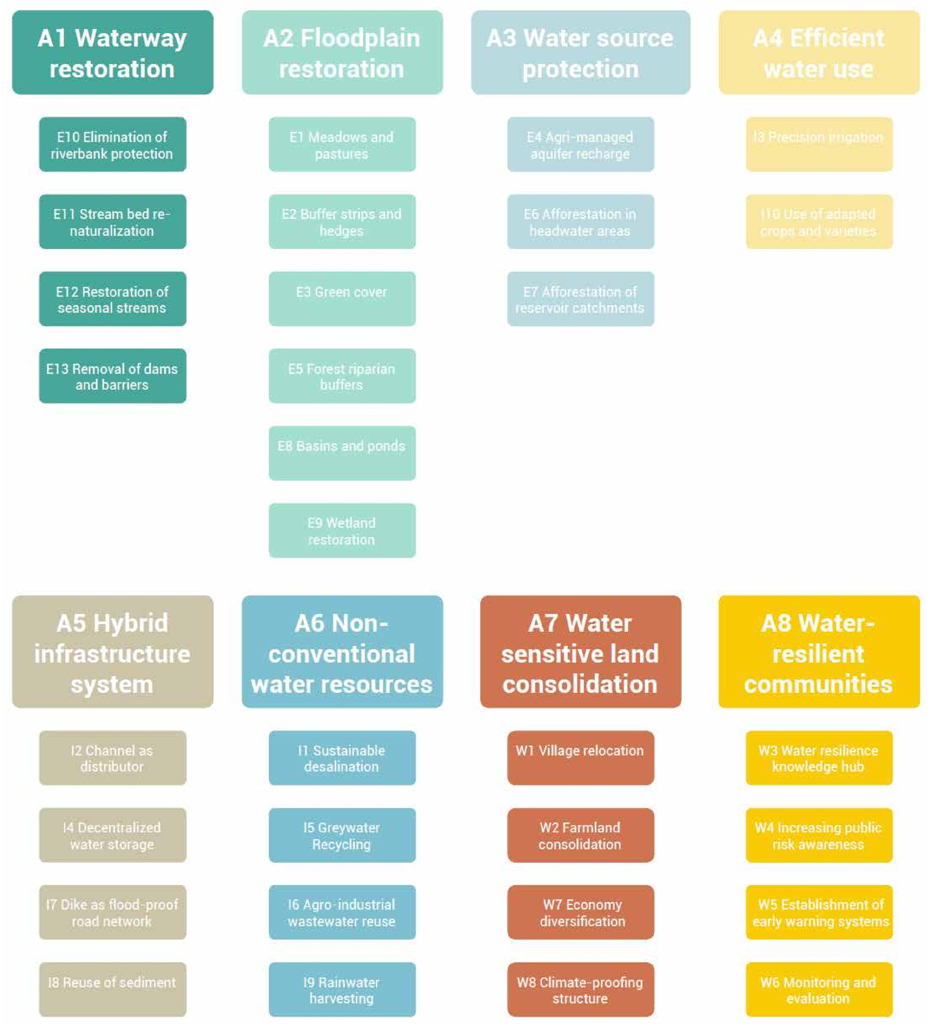
Unsustainable profit-driven paradigm
Unethical water management approach in often neglected regions
Possible alternatives - benefits and trade-offs
to become a shared vision

Analysis



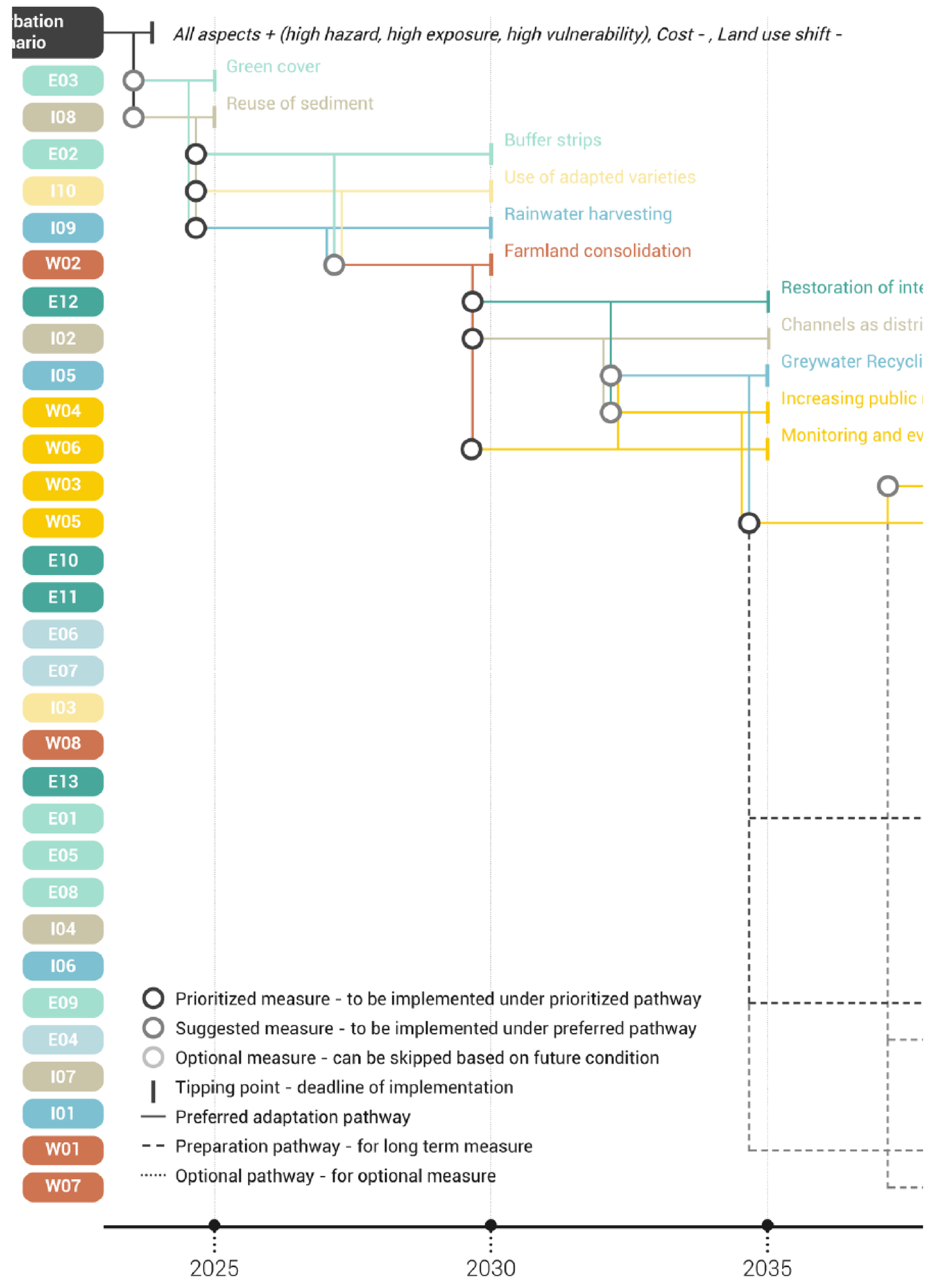
+ Socio-environmental factors behind the duality of long-standing droughts and escalating floods

Measure



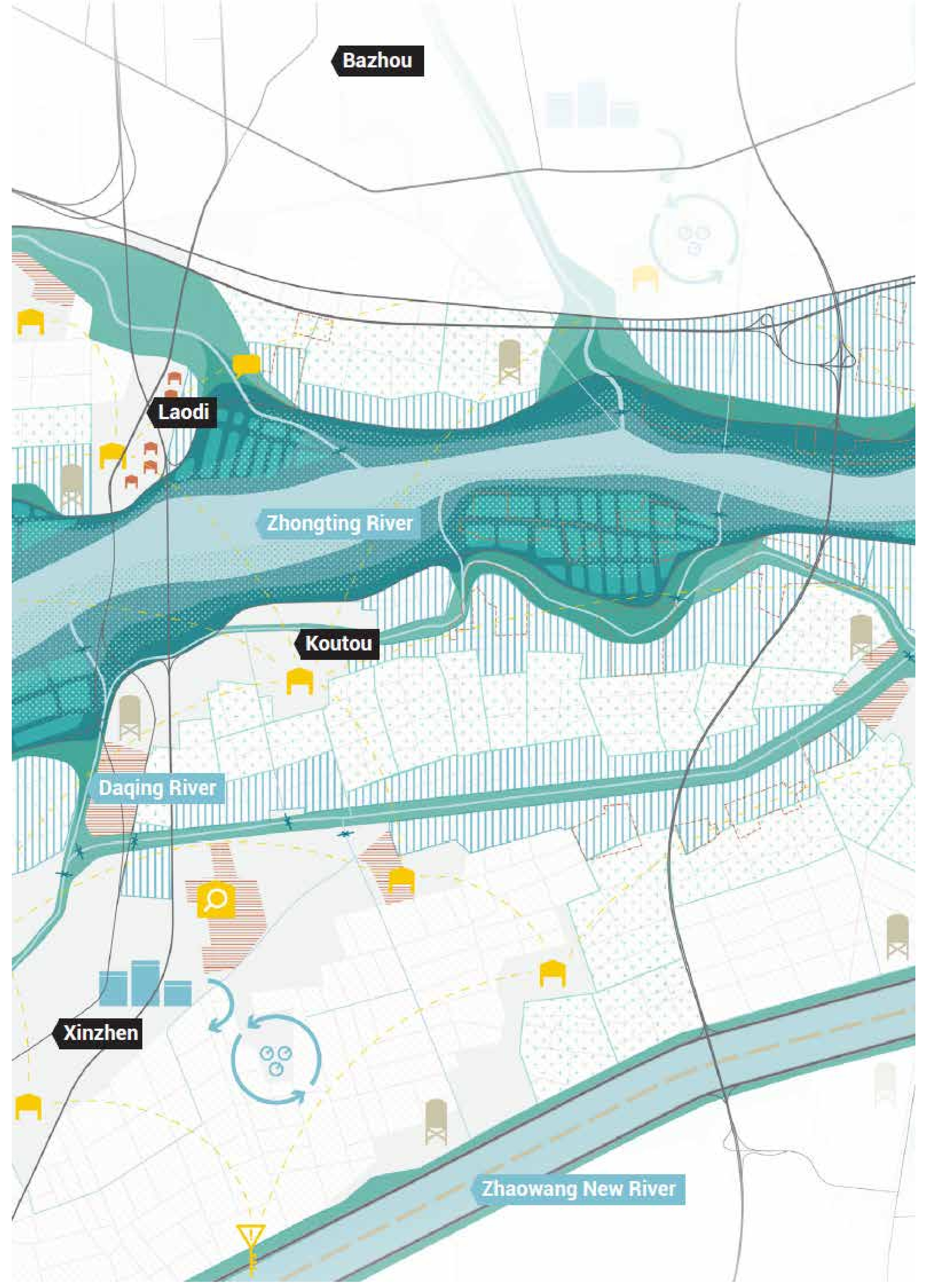
+ Potential measures enabling the paradigm shift from profit-driven to risk management-driven development

Strategy



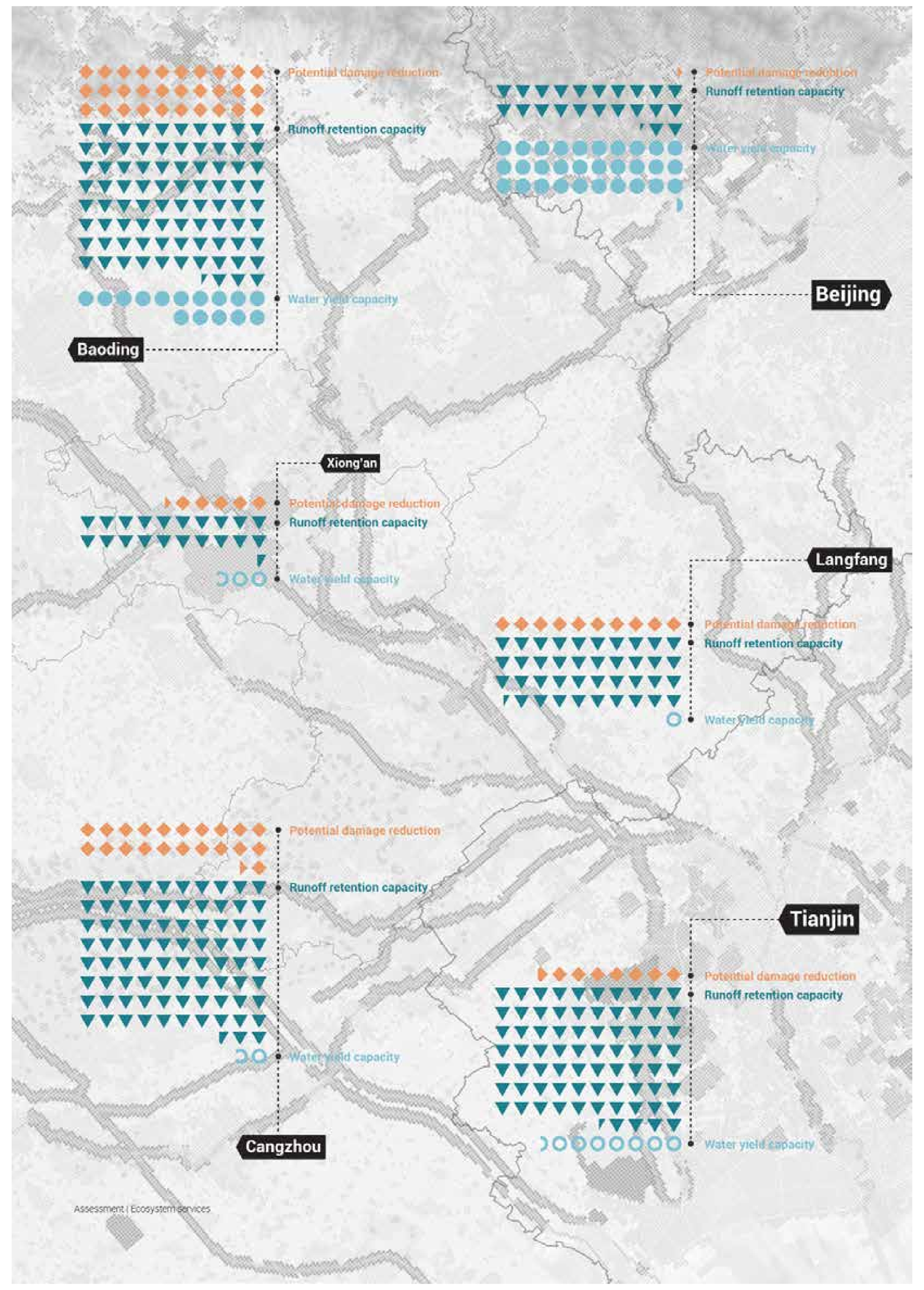
+ Dynamic adaptive pathway guiding the implementation of measures across various future scenarios

Design



+ Multiscale design exploration visualizing the spatial impacts of strategies

Assessment

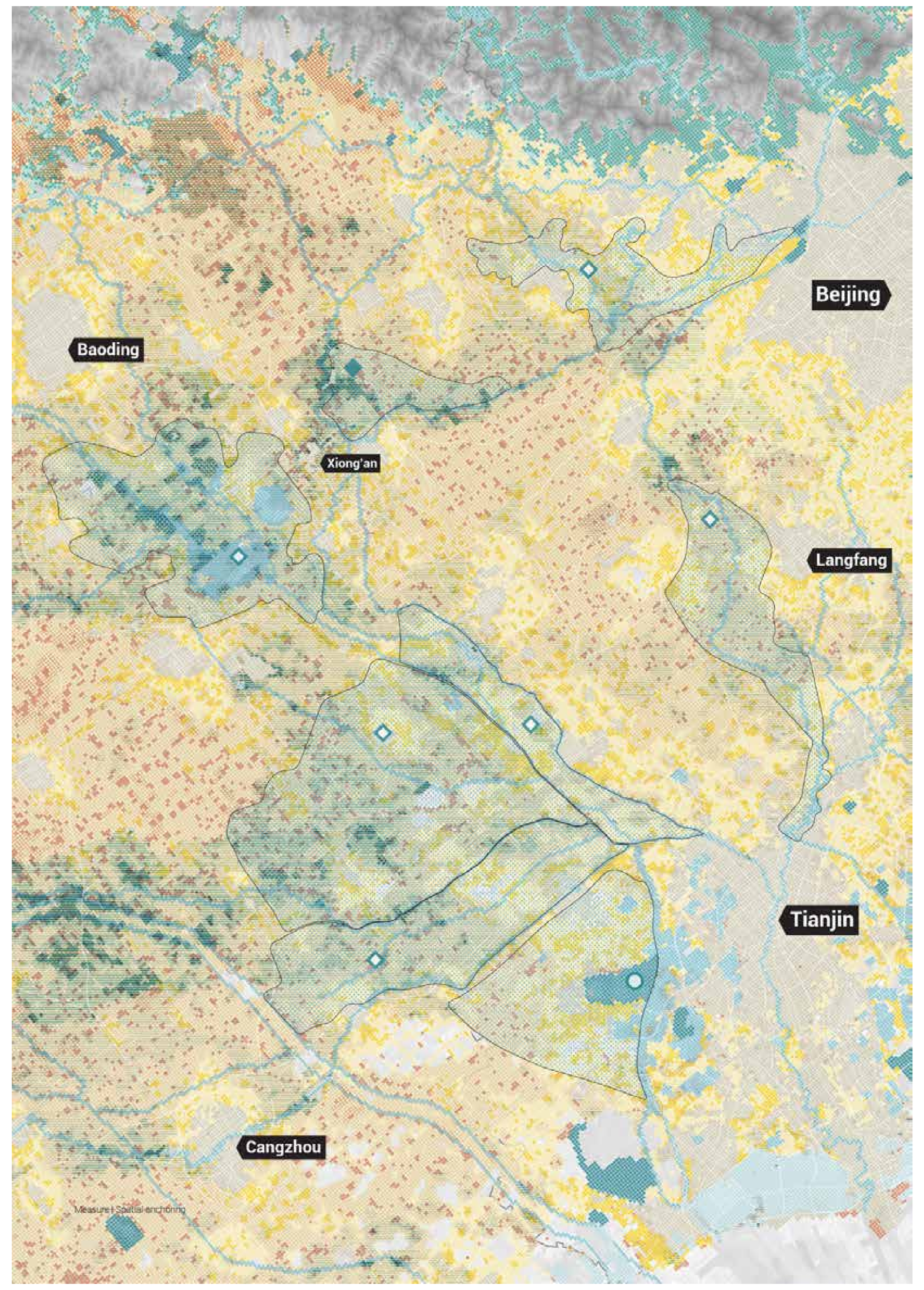


+ Multi-aspect assessment validating the proposal through both quantitative and qualitative methods.

A transferable methodological framework

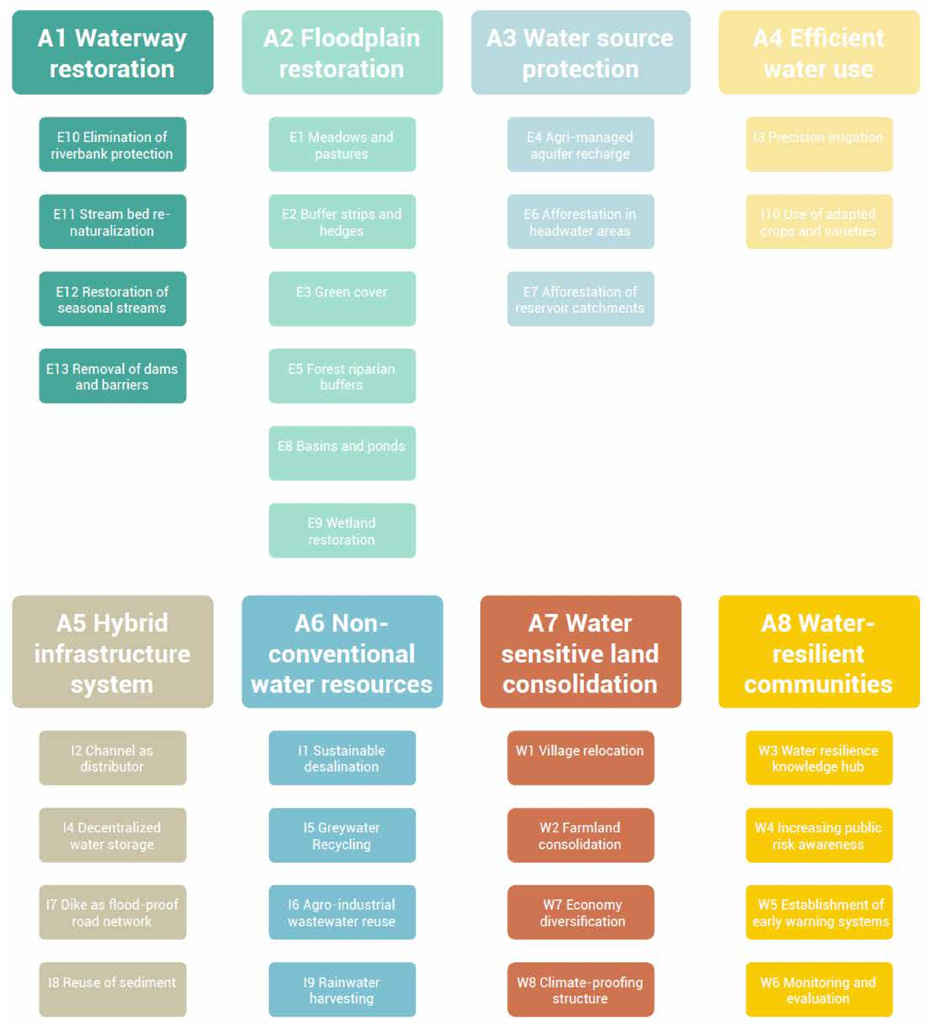
Adaptability beyond local context - localized patterns
Flexibility across temporal and spatial scales
to tackle future uncertainty - especially water crisis

Analysis



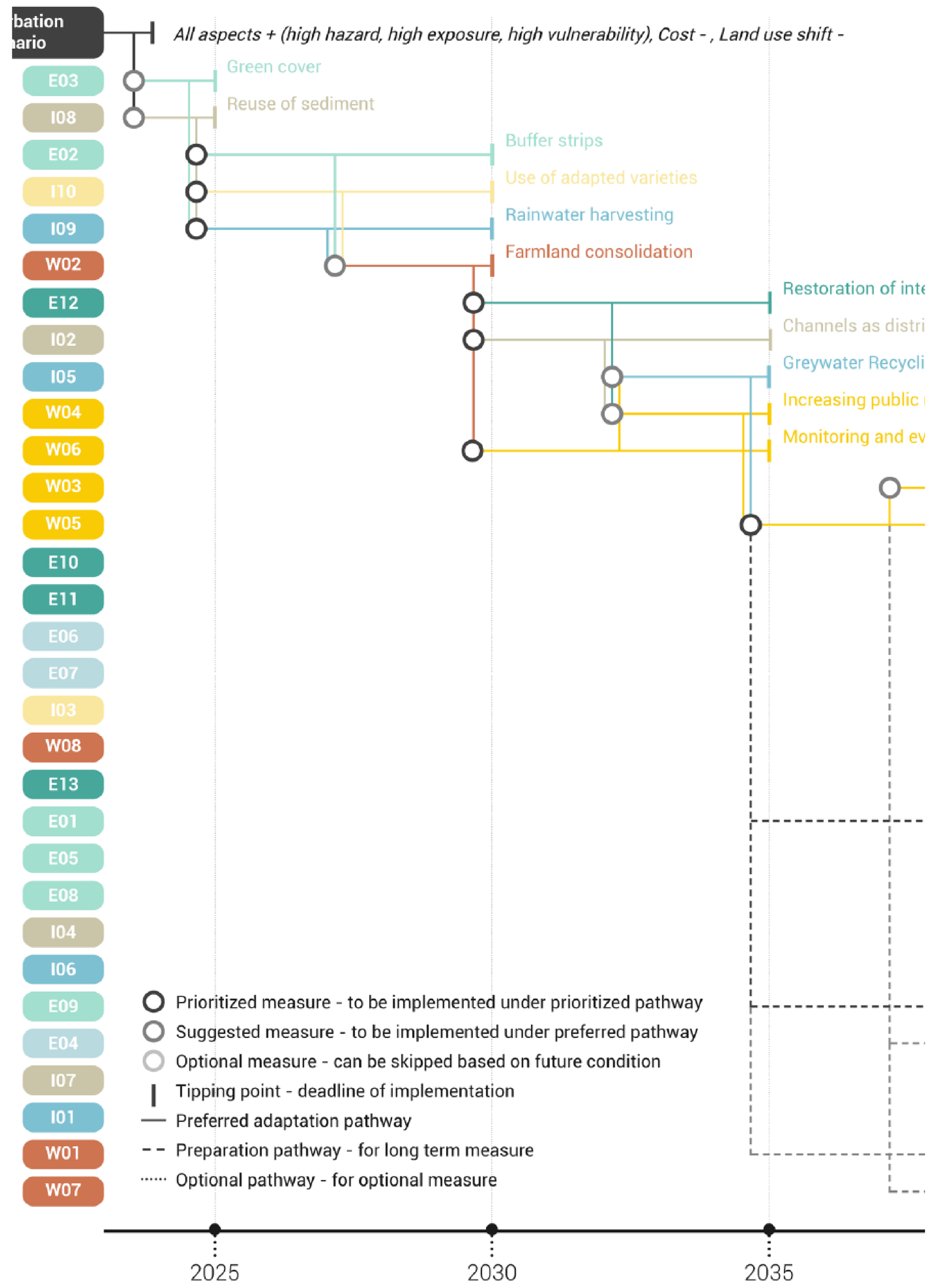
+ Socio-environmental factors behind the duality of long-standing droughts and escalating floods

Measure



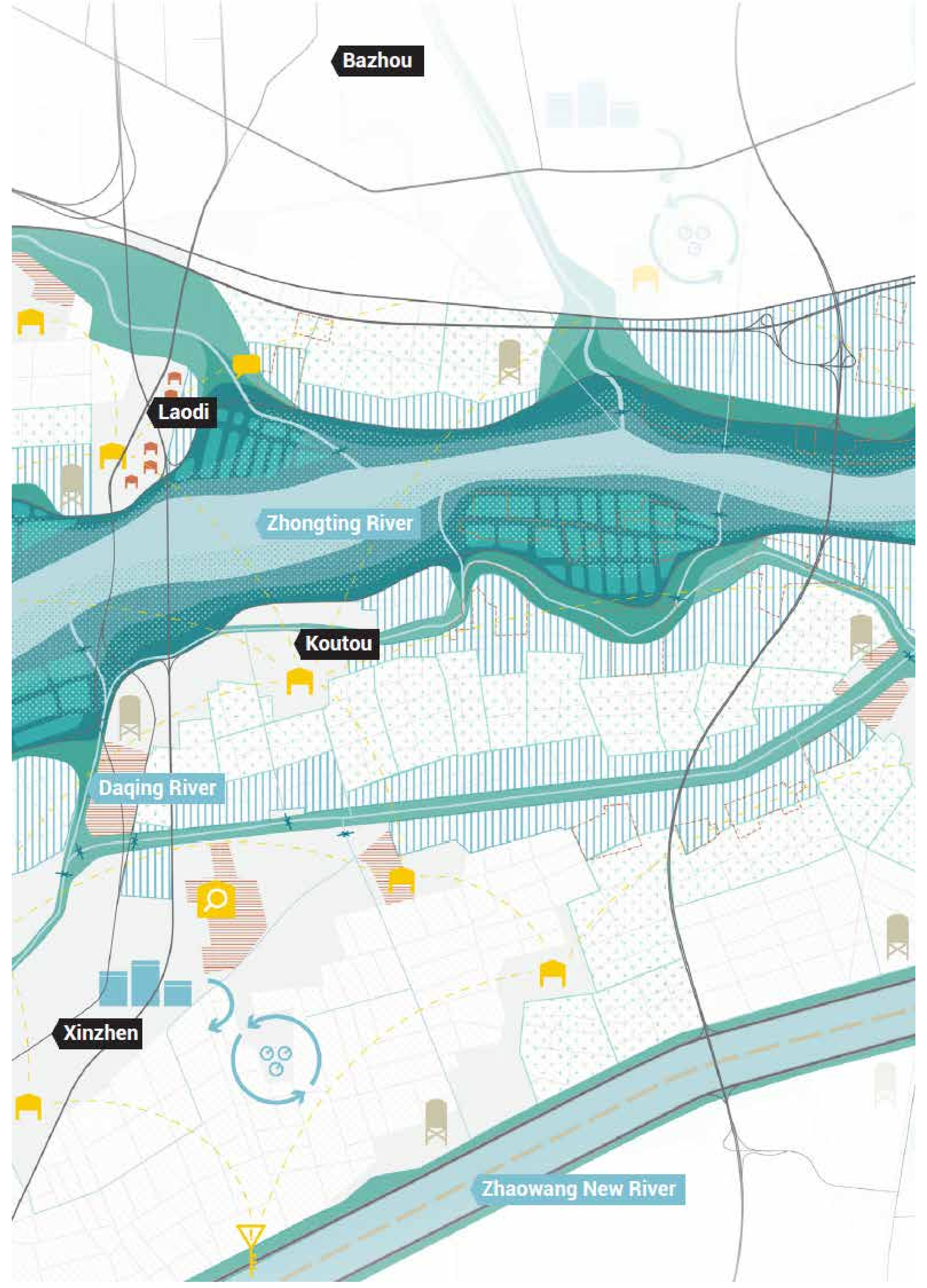
+ Potential measures enabling the paradigm shift from profit-driven to risk management-driven development

Strategy



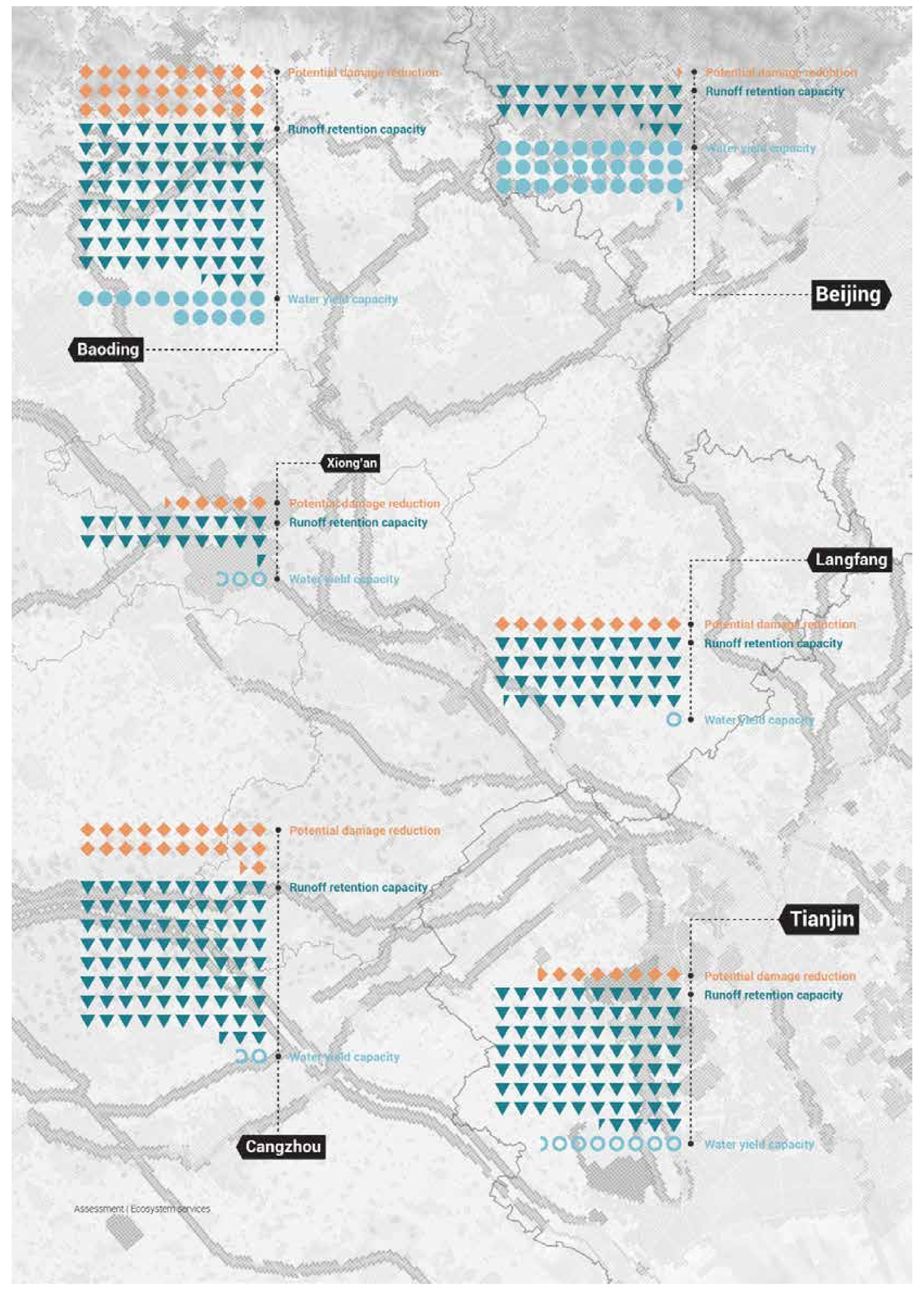
+ Dynamic adaptive pathway guiding the implementation of measures across various future scenarios

Design



+ Multiscale design exploration visualizing the spatial impacts of strategies

Assessment



+ Multi-aspect assessment validating the proposal through both quantitative and qualitative methods.

THANK YOU