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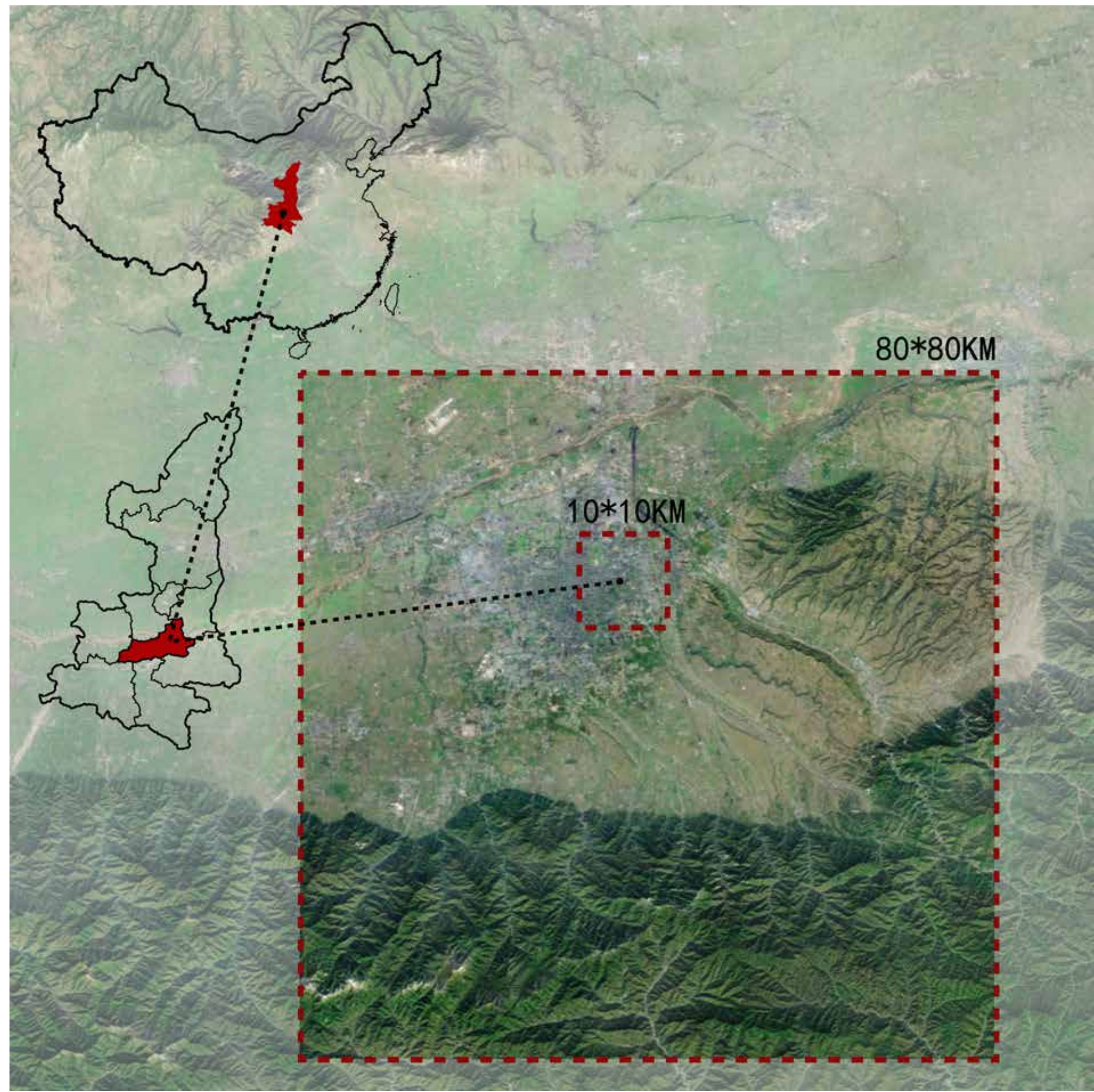**IGC**

Project area: 80*80km

Geodesign of Historic City Xi'an, China

Xi'an, the ancient capital of 13 dynasties, is one of the centers of economic in the western China and the balance point of China's economic regional development strategy. In 2010, it was proposed to build the Great Xi'an as international metropolis, which can raise the development of Xi'an from a local level to a national level, and develop a diverse urban vision for the future of Great Xi'an region.

As our research subject of geodesign, it includes scales of 80*80km and 10*10km. The 80km area is selected based on historical and cultural heritages, ecosystem background and existing administrative divisions, including the entire administrative scope of Xi'an, as well as some administrative divisions of Xianyang City. The 10km area in Xi'an extends west to Daming Palace and east to the Chan River, spreading from the downtown area to the suburbs.

The College of Architecture and Landscape Architecture, Peking Univ. organized the workshop within the guidelines of the Internetional Geodesign Collaboration. It was conducted in a 3 day workshop in Dec. 2018 using GIS and Geodesignhub.

Based on the remote sensing interpretation map, the area of construction land has increased by about 463 square kilometers, and the area of forest land has increased by nearly 3,000 square kilometers. The area with cultivated land was heavily encroached, and it decreased by nearly 3,500 square kilometers from 2010 to 2016, which directly led to serious landscape fragmentation, destruction of biodiversity, and greatly weakened ecosystem service functions, giving regional ecological security and urban sustainability.
- Water pollution.Organic pollutants, metal pollution and fluorine pollution are serious.
- Landscape fragmentation and biodiversity, continuous erosion and destruction of river wetlands and farmland ecosystems. Divided and fragmented existing ecosystems.
- Historical sites destroyed or disappeared, resulting in the loss of important urban cultural and historical memory.

WI AGR GRN Energy Gray IND/COM RES Mixed INS Historical

Major Requirements by 2050
- Great Xi'an and neighboring cities develop coordinated as a national first-class city group. The construction of a distinctive urban framework, the four-level urban system of "main city-sub-center - group - small town".
- The resident population of study area is about 16.7 million.The floating population is about 1.71 million.
- Maintaining the scope and standard of ecological protection in the Qinling Mountains.
- Restoration of historical sites in Xi'an (waterways, city walls, palace ruins), and improve related protection policies combined

with urban GI and WI systems construction.

Major assumptions and innovations
- **GRN 2035/2050 4** Resilent landscape infrastructure
- **WI 2035/2050 2** Water retention
- **Gray 2035/2050 6** Smart cars for a smart future
- **Energy 2050 1** Renewable energy sources
- **AGR 2035/2050 3** Rewilding, letting nature take its course
- **IND/COM 2035 11** Artificial Intelligence
- **Res 2035/2050 11** Adaptable housing will increase
- **Mixed 2035/2050 1** Mixed use development
- **Insit 2035/2050 9** Larger traditional insititution
- **Historic 2035** Heritage parks
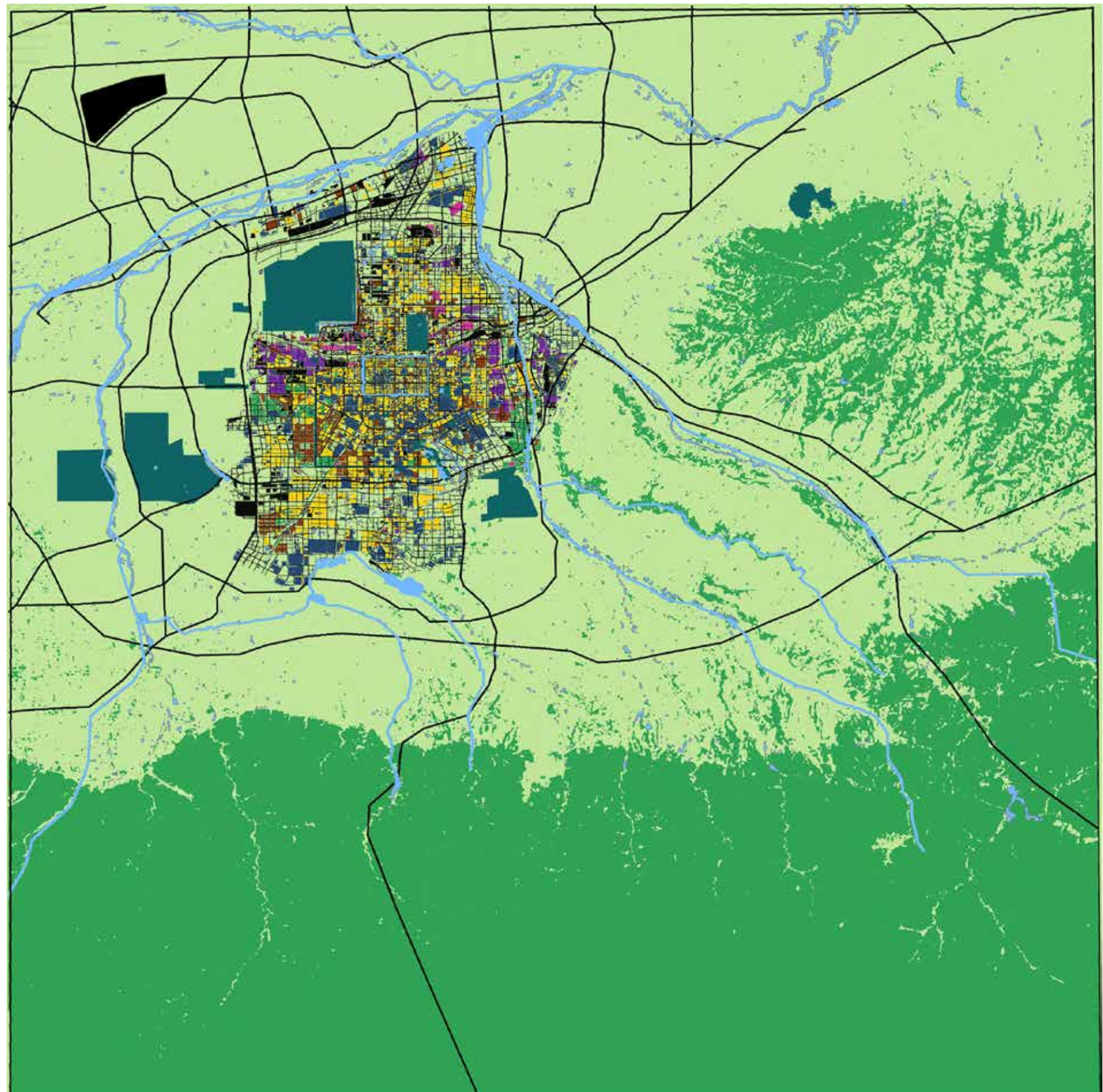
Existing situation: 2020

Workflow
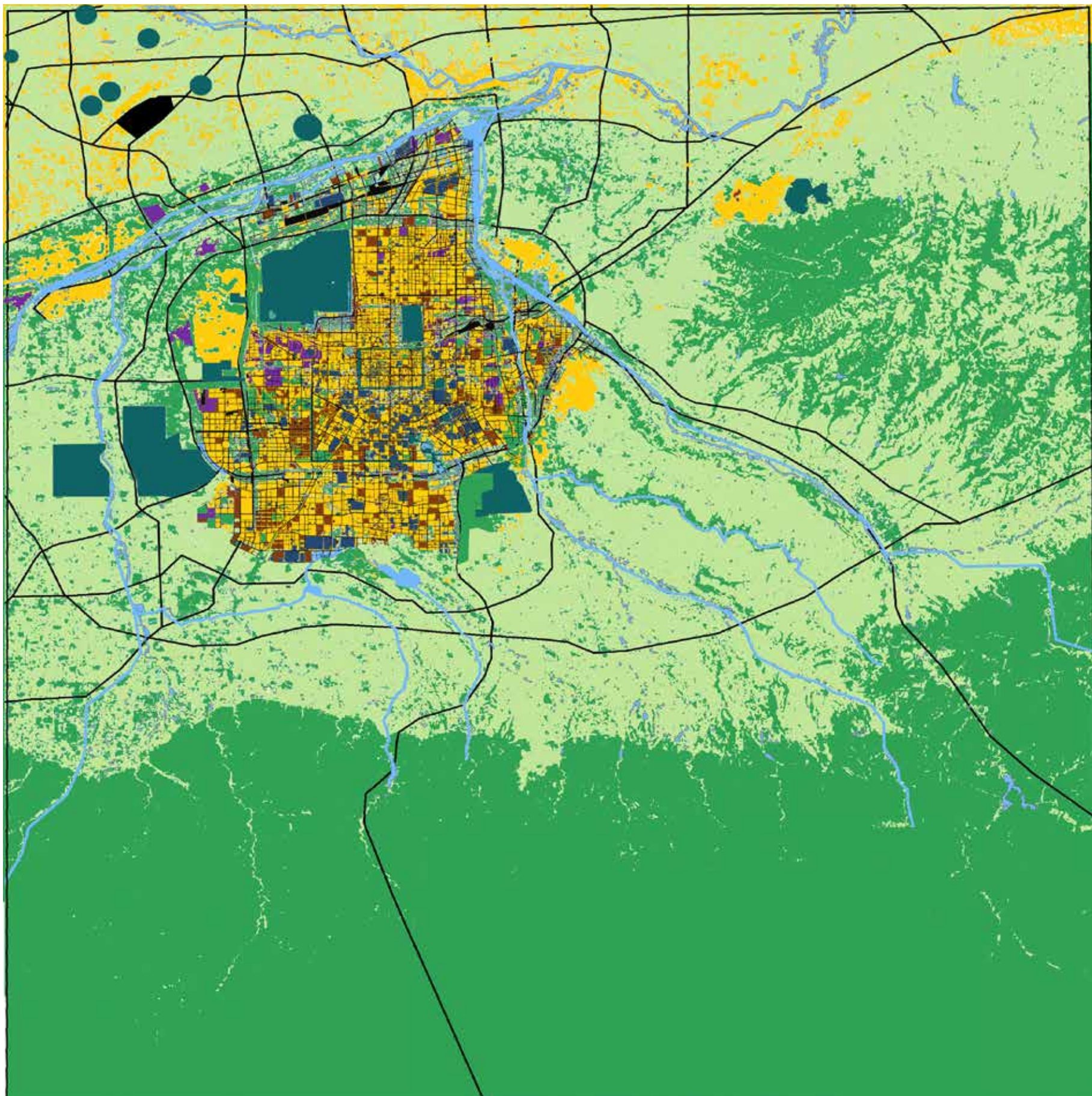
Early adopter: 2035
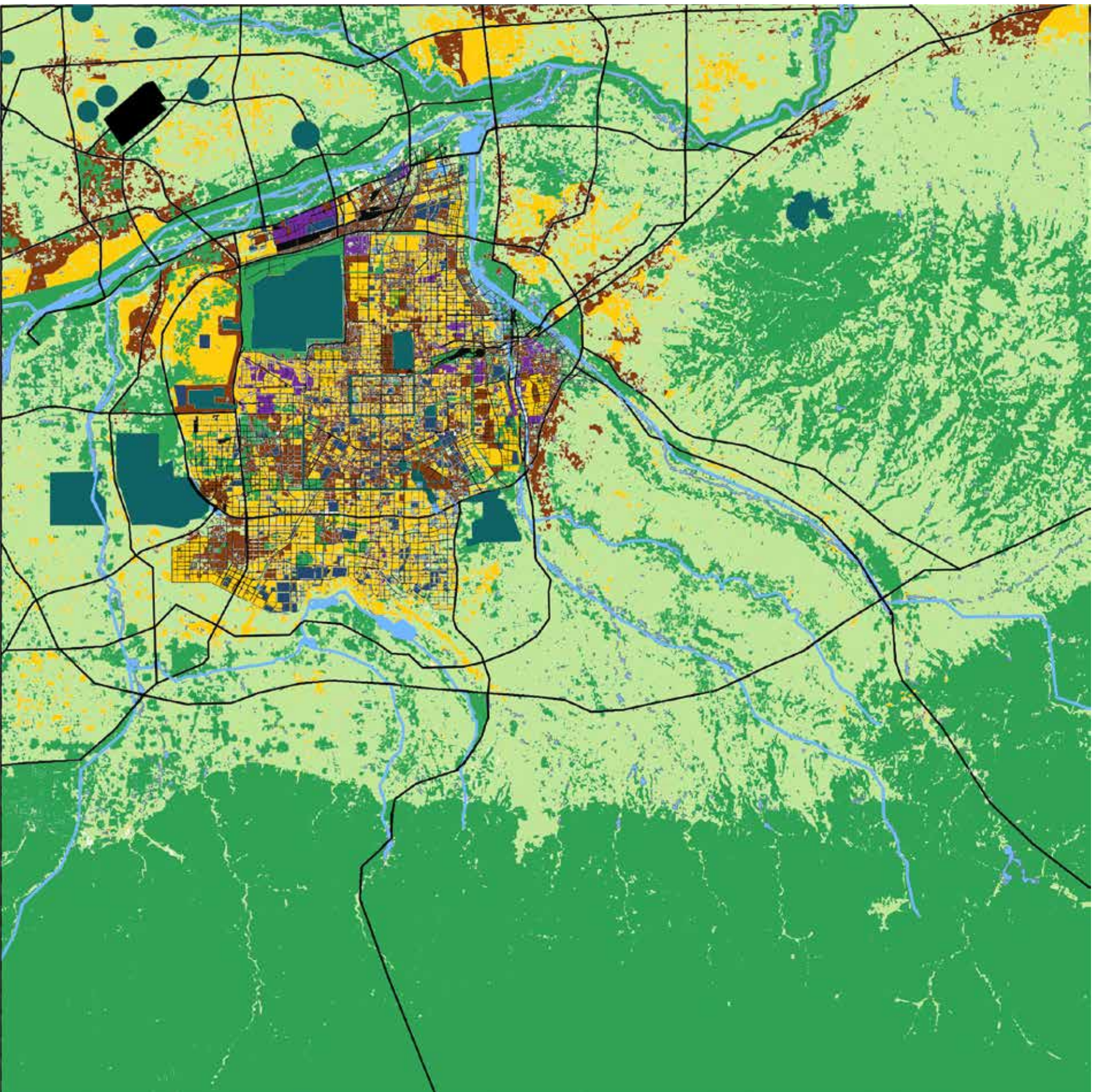
Early adopter: 2050

Early adopter scenario
impact table, round 2

A (early adaptor)	GOV	DEV	RES	EXP
GOV	x	+	0	+
DEV	+	x	-	--
RES	0	0	x	0
EXP	++	+	+	x
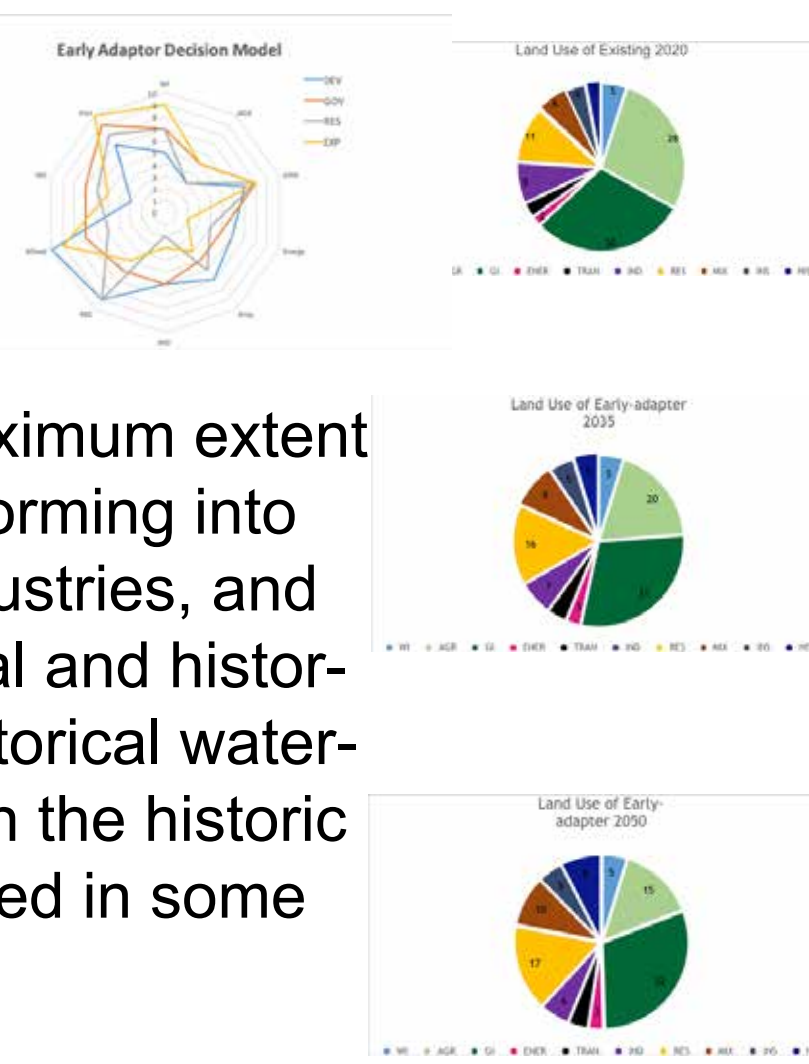
2035:
The city is still expanding to the maximum extent reducing pollution industries, transforming into high-tech industries and tertiary industries, and developing residential areas.Cultural and historical areas, historical waterways, historical watersheds repaired.Vehicles restricted in the historic city, and motor vehicles are prohibited in some areas.

2050:
Population pressure will be eased. High-pollution industries transforme into high-tech industries and begin to restore polluted lands.Maximum strength of preservation of farmland and green space environment.Xi'an historical heritages restoration will be completed also combined with GI and WI systems in the city.
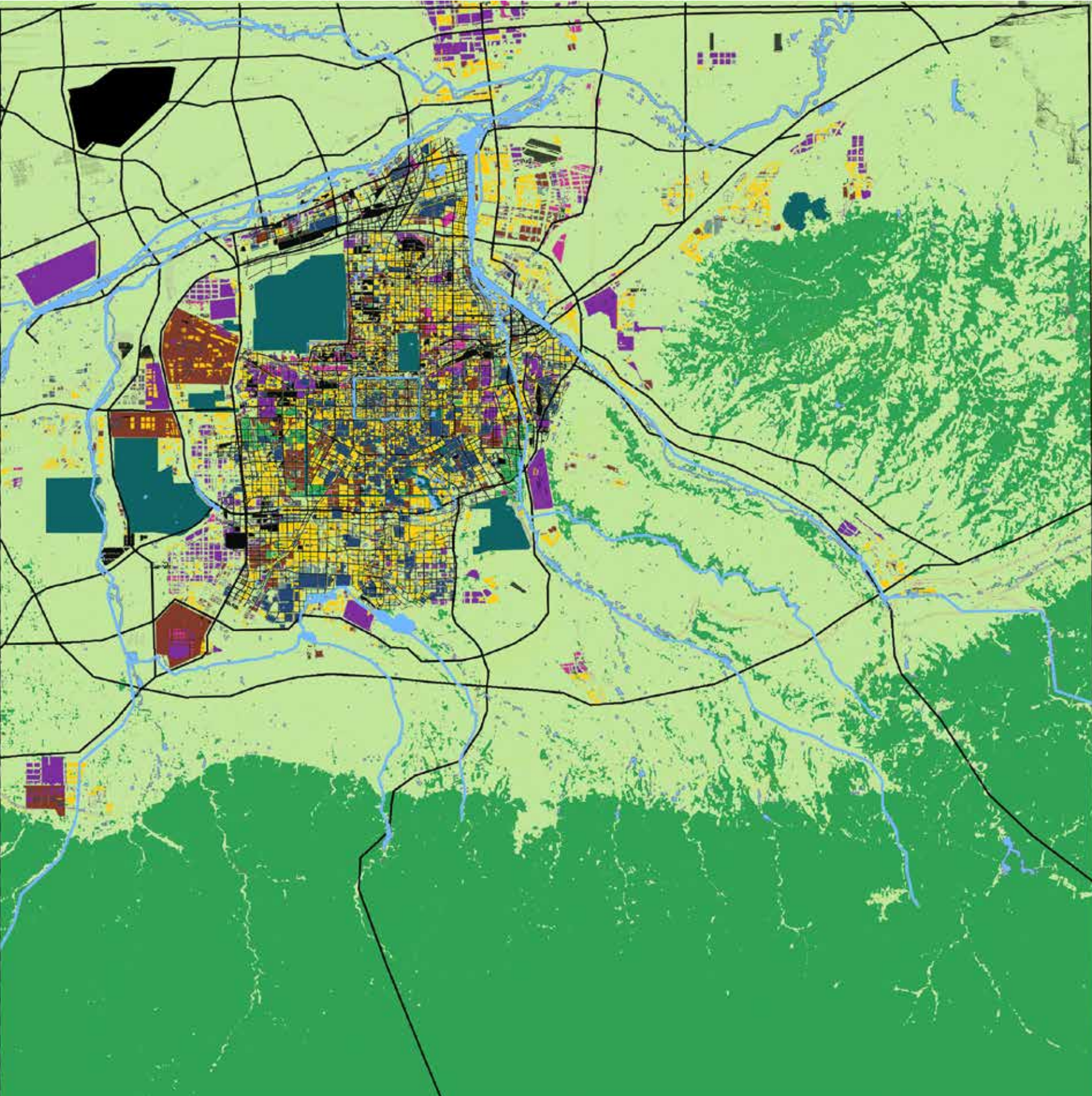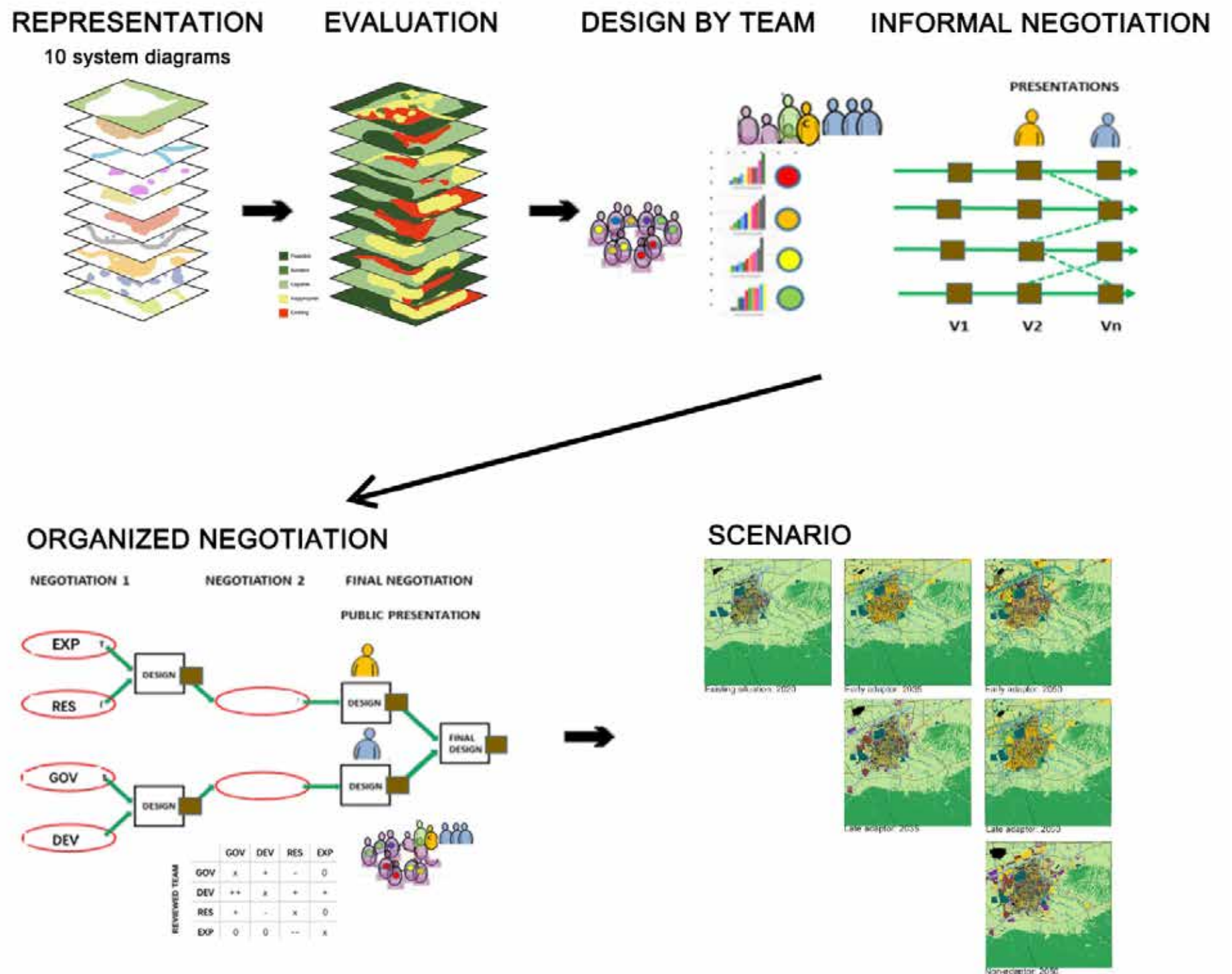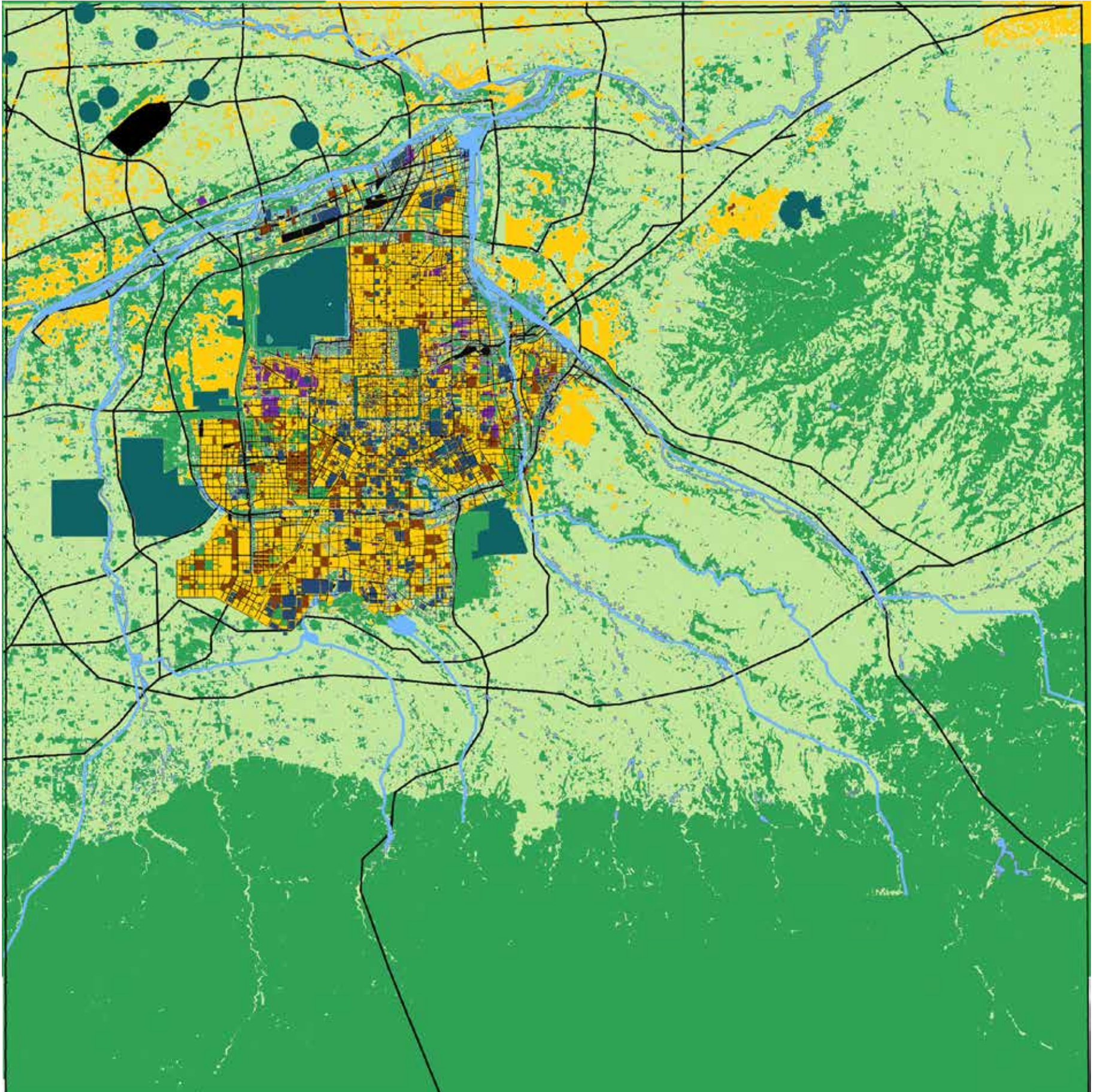
Late adopter: 2035

Late adopter: 2050

Late adopter scenario
impact table, round 2

B (late adaptor)	GOV	DEV	RES	EXP
GOV	x	+	+	+
DEV	0	x	--	0
RES	++	0	x	+
EXP	0	-	0	x

2035:
The urban population increases and the city naturally expands around.Mixed function-based expansion (residence + office + business), forming a large community around the city. High-pollution industries moved out.

2050:
New mixed-function groups are founded during city expansion, where normal needs of life can be satisfied. Heavy industrial reduced, and the renovation of small industrial areas upgraded to green spaces and parks. The restoration of large historical sites has been completed, and Xi'an has consolidated its position in the international historic city. Developed Public transportation, private fuel vehicles completely banned.

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Impact Assessment, Round 1

Early adaptor	GI	WI	Gray Energy	Agri	Indu	Res	Mixed	Insit	Hist	Total
GOV plan	2	1	1	-1	0	1	-1	2	1	1	7
DEV plan	0	1	1	1	-2	1	1	2	0	1	6
RES plan	-1	-1	2	-1	-1	0	2	2	0	1	3
EXP plan	2	1	-1	-1	2	1	1	1	-1	1	6

The impact assessments are consisted of each process-evaluation team evaluating each of the four stakeholder change proposals with a 5-level scale (-2,-1,0,+1,+2).

Impact Assessment, Round 2

- Decision models
- Land use areas
- 4 impact models (Economic impact model, Ecological imapct model, Water carrying population ability model, Historical Conservation impact model)
- Assessment table between stakeholder teams

Index	Index Description	Full Mark (100)
Area	Historical Conservation Area	30
Heritage Amount	Historical Conservation Building	20
	Intangible Cultural Ceritage	15
	Historical Conservation Tree	5
Ecology	Water and Green Infrastructure Level	10
Development	Commercial Development Level Based on Historical Conservation	10
Protection Distance	Minimum Distance to Heavy Industry & Energy	5
Policy	Special Policy within Workshop	5

Historic Conservation Impact Model Based on Xi'an

Assessment and Comparison

Scenarios		Early adaptor			Late adaptor			Non-adaptor
		2020	2035	2050	2035	2050	2050	2050
Population(million p.)		14.4	15.9	16.5	16	16.7		17.5
Land Use	Built-up Areas(%) (RES+MIX+GRAY+ENER+IND+INS)	34	39	42	42	47		54
	Historical Areas(%)(HIS)	3	5	6	3	5		3
	Ecological Areas(%)(WAT+GRN)	35	36	37	35	33		28
	Crop Areas(%)(AGR)	28	20	15	20	15		15
Impact Model	Water Carrying Population(million p.)	17.5	21.9	24.6	18.8	21.9		19.4
	Historical Conservation Index	71	86	91	73	88		74

Non-adopter scenario

impact table, round 2

C (non-adaptor)	GOV	DEV	RES	EXP
GOV	x	+	-	0
DEV	+	x	+	+
RES	+	-	x	0
EXP	0	0	--	x

2050:
The construction area reaches the most, and expand across the Wei River to the north (to achieve industrial automation due to AI). Large area of industry and residential are developed in suburban.

The urban population has passed the climax and turn to a negative growth, while the urban land continues to expand.

The economy performance of this scenario turns out to be the best one, and Xi'an has been a developed international city.

The urban ecological environment is deteriorated seriously, and the whole society is working hard to change.

Non-adopter: 2050

Basic Analysis

Hydro
Integrated water ecological security pattern

Biology
Integrated biological security pattern

Cultural
Cultural heritage security pattern

Intergrated ecological
Intergrated ecological security pattern

Transportation
Traffic accessibility

Commercial
Commercial development intensity

Water Resources Model

Water resources carrying population

Unit : 10,000 person

Water corridors

13km
4.5km
6.1km
6km

- Water area
- Green land
- Corridor planed
- Underground channel planed
- River heritage

Green strategy

Lack of green space service   Greenland service range

Mode A   Mode B   Mode C   Mode D

1) As for same patch area, the effect of multiple patches is greater than one patch: mode B is better than mode A.
2) As for the same patch area, the ecological effect of patch with high boundary density is better than that of regular patch: mode C is better than mode A.
3) Connectivity between patches can significantly increase ecological effects: Mode D is better than Mode B.

Early adaptor 2035 (10*10km)

IMPACT SUMMARY
DECISION MODEL
TOTAL COST EUR 82.36B
SCORE 3512.32
FUNDING

- Decision model shows the hign identity of green infrastructure, water infrastructure, and historical.
- Less constructions and cost but higher score.
- More restricted and eco-friendly policies, such as low-impact development, fuel vehicel prohibition in ancient districts.
- Linear green belt with Chan river, which is restored to natural form.
- Heritage conservation is systematic promoted, especially waterway heritages and ancient city heritages.

Late/non adaptor 2035 (10*10km)

IMPACT SUMMARY
DECISION MODEL
TOTAL COST EUR 91.83B
SCORE 2906.10
FUNDING

- Decision model of green infrastructure, water infrastructure, and historical is less than early adaptor obviously.
- More constructions, especially housing area but lower score.
- More economic-oriented policies.
- Linear water heritages are appreciated because of potential commerce value.
- Focus on transportation development to ease the transportation pressure of ancient districts.

Participant team credits:

Faculty director
Xu Liyan

Credits
Project coordinator

Participants

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