Spatial Low Carbon Modelling for Urban Development: Japan Experience

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Contents

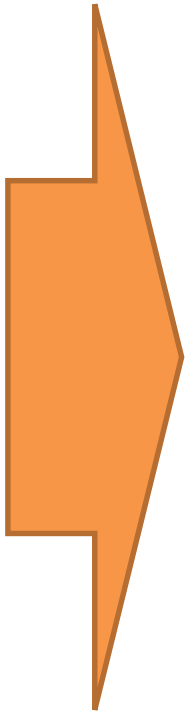
- Multiple sustainability challenges for the cities
- Spatial modeling method for assessment of feasibility of the low-carbon technologies
- Application in Koriyama City, Fukushima, Japan

Challenges for Cities in Japan

Environmental pressure

Population decrease & aging society

Economic recession “lost two decades”



Climate change Mitigation & Adaptation

Infrastructure maintenance

Welfare service

Ecosystem conservation

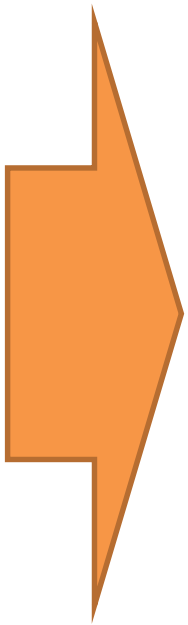
One of the Solutions

“Compact City” “Smart development”

Environmental pressure

Population decrease & aging society

Economic recession “lost two decades”



Climate change Mitigation & Adaptation

Infrastructure maintenance

Welfare service

Ecosystem conservation

Objective

- Developing an operational modeling methodology for analyzing future spatial distribution change in a city

- To assess the impacts of compact city form from the view point of low-carbon society.

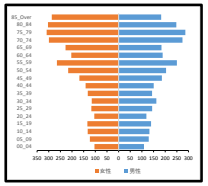
- Focus on two of low-carbon systems;
  - Combined heat and power supply system (CHP)
  - Car-sharing service (CS)

Developing Modeling Methodology

Modeling Framework

1. Socio-economic Macro Model

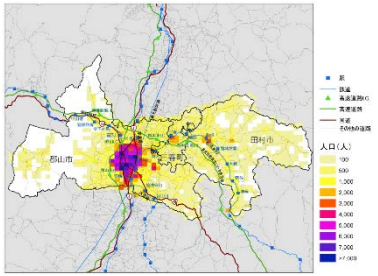
Population
GDP by industry
Employment
(City)



2. Spatial Distribution Model

Business condition of providing the low-carbon systems

Population
Employment
Floor area
(500x500m)



Spatial distribution model: Rules on intensification

1. Estimate average age of residential buildings in each cell

2. When the end of lifetime of the buildings (30yrs) come, the population in the cell can move to the other cells

3. Set the rate of migration of those population for each cell (stay or emigrate)

4. The migrating population move to pre-determined cells in “city core center”

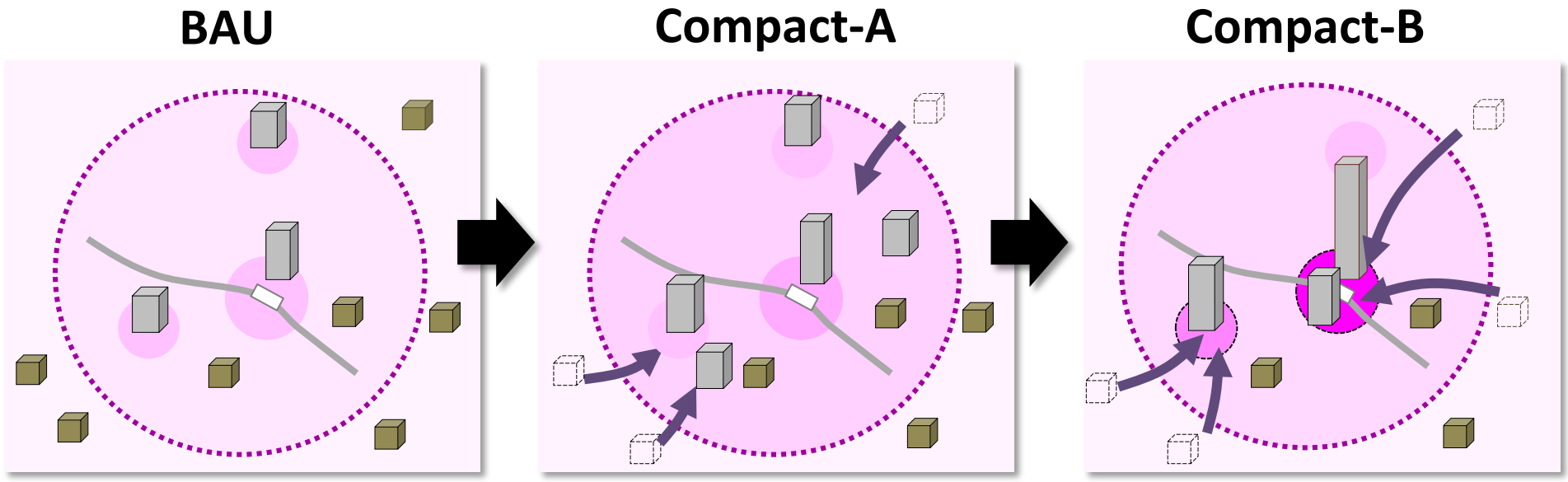
Target Low-carbon systems

Systems	Approximate conditions
Car sharing service	Max(x,y) >6000
District CHP (combined heat and power)	3x + y > 30000

x: living population (km^{-2})

y: working population(km^{-2})

Spatial distribution scenarios



BAU	Current spatial pattern continues throughout the simulation period
Compact-A	Move activities from suburban to “urbanization area”
Compact-B1	Move activities from suburban area to “city core centers” determined in the official urban plans.
Compact-B2	Move activities from suburban area to fewer number of “city core centers”.

Application

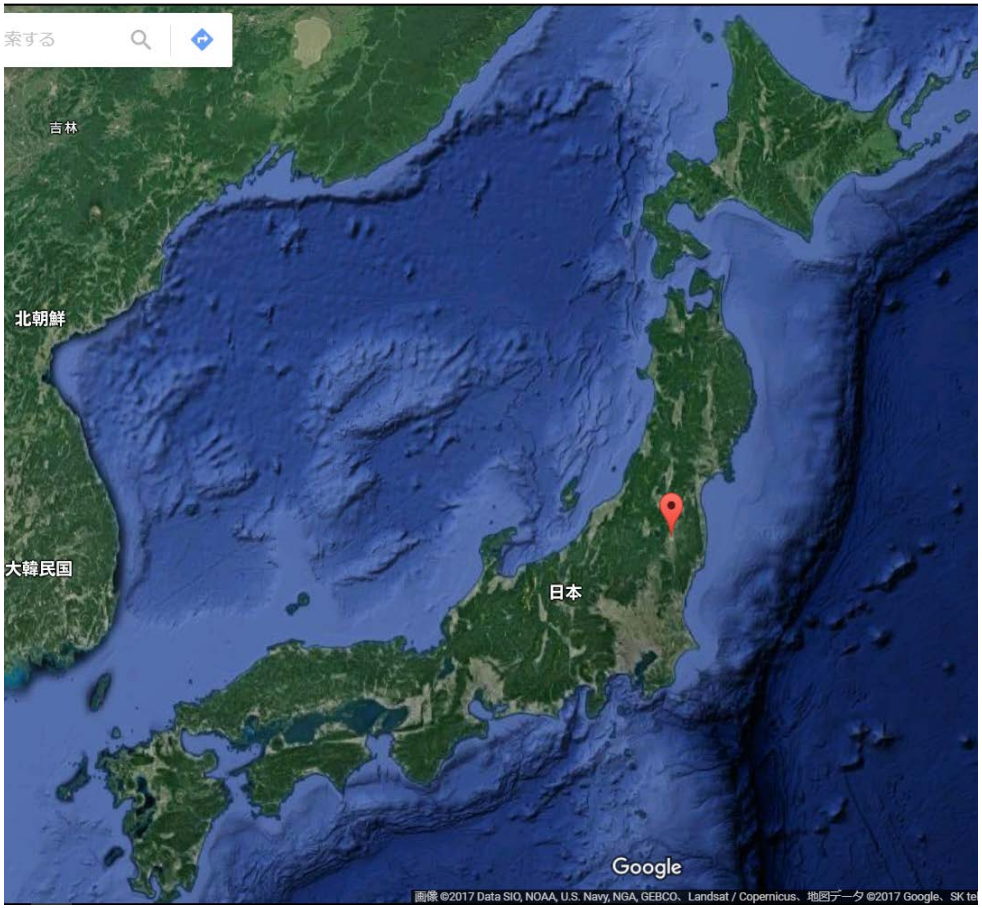
Koriyama city

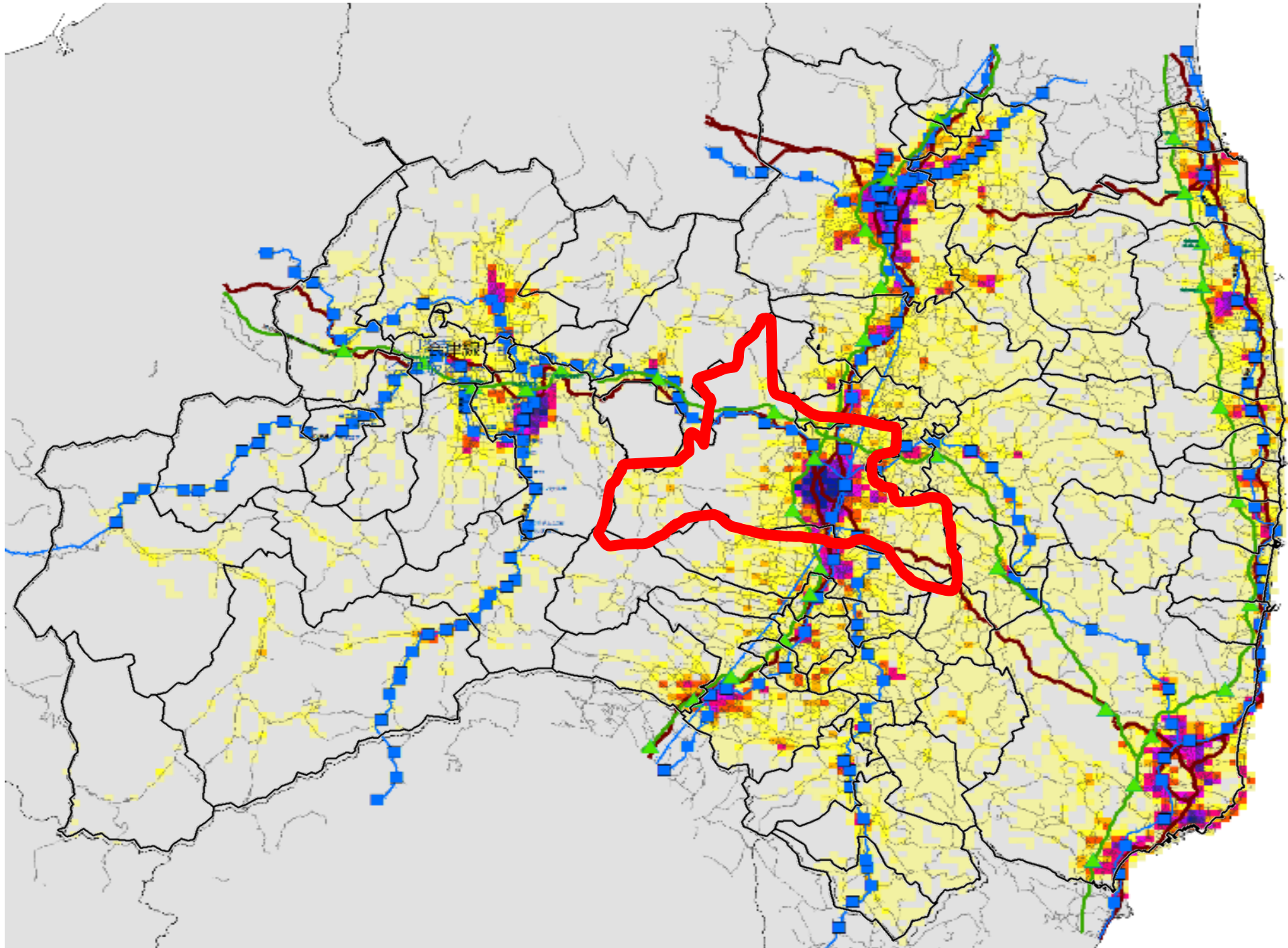
Population : 335,400

Area: 757km^2

- Center of Fukushima pref.
- 50km from Fukushima Daiichi Powerplant
- 3rd largest city in North-east Japan

Main industry: Manufacturing, services





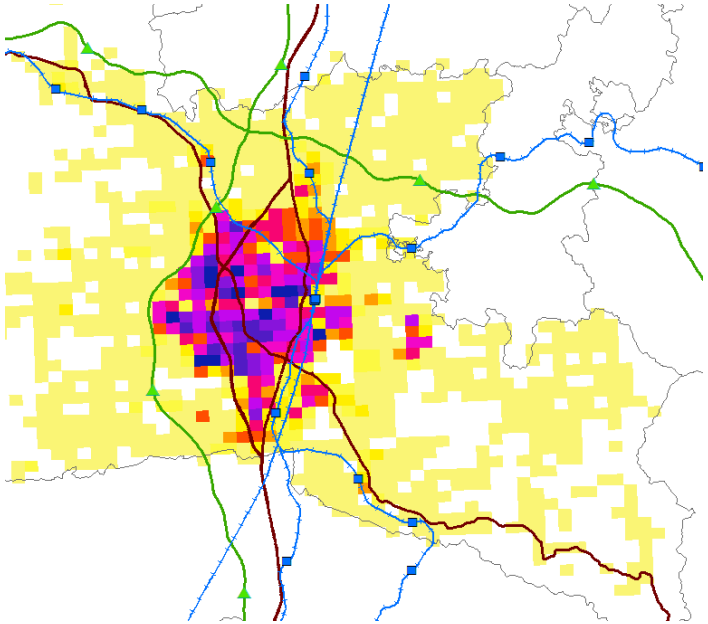
Frame of the scenarios

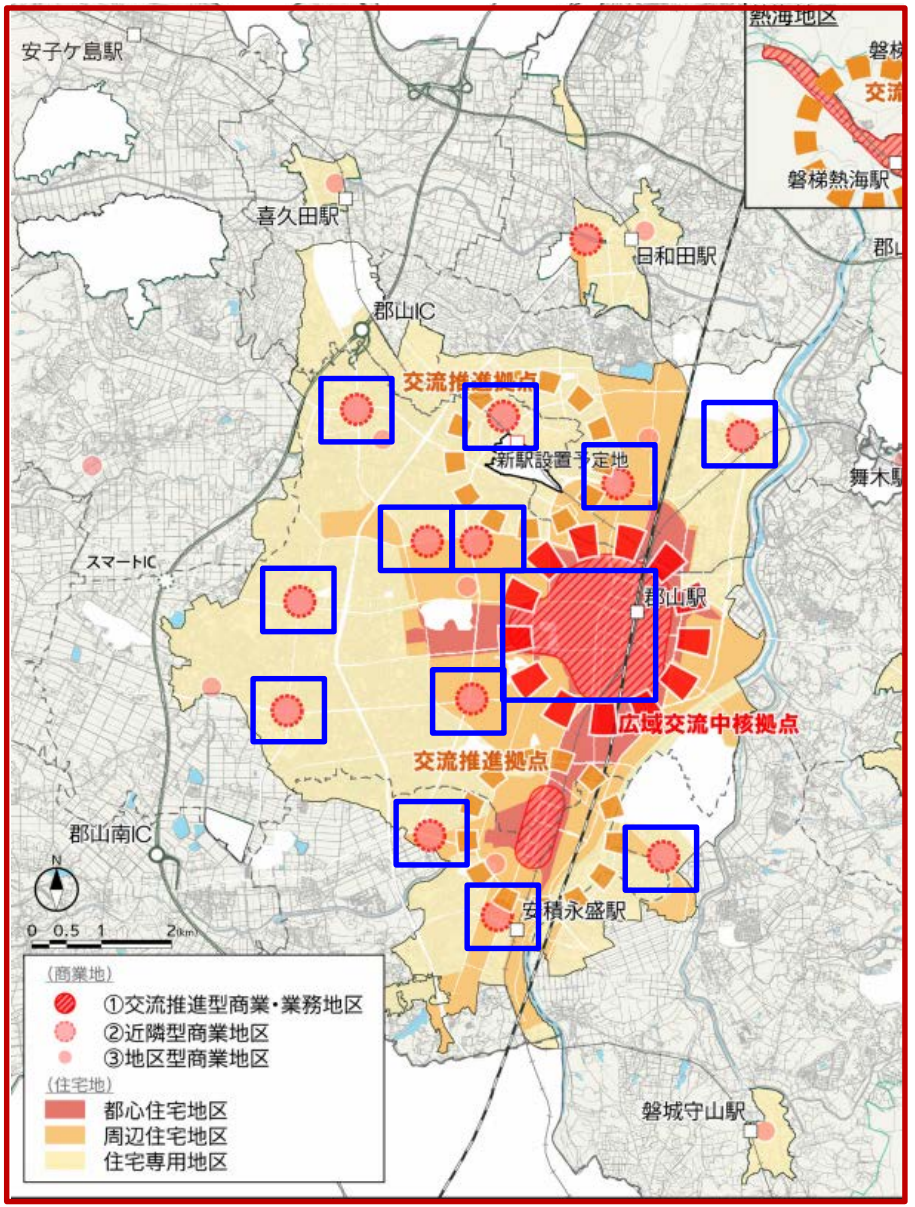
- Base year: 2010
- Target year: 2050

- Macro-economic projection
  - Local ExSS was applied
  - Population growth rate: -0.5%/year
  - Economic growth rate: 2%/year (PCGDP)

Current spatial distribution and urban plan

2010



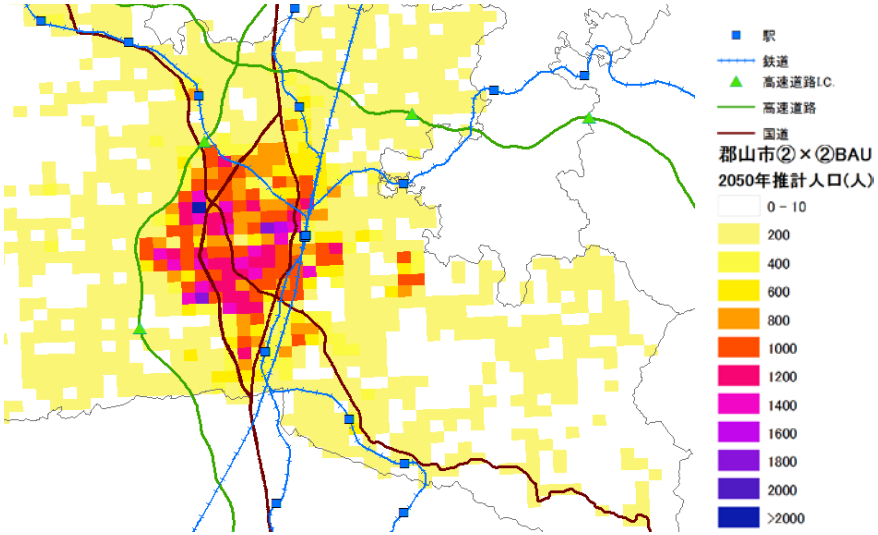


Spatial scenarios

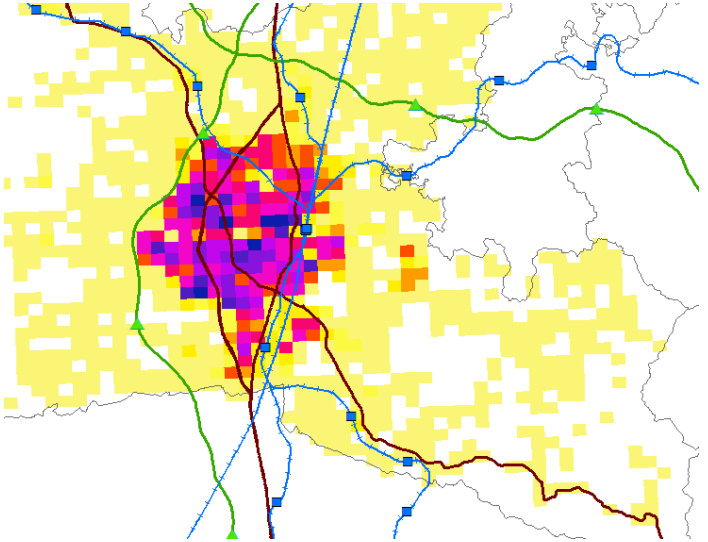
Scenarios	Spatial structure & policies	Building renewal rate (average lifetime)	Share of people migrating from suburb to urban core areas
BAU	Same as base year	2.3%/yr (30 years)	0%
A	Move activities from suburban to "urbanization area"		40%
B1	Move activities from suburban area to "city core centers" determined in the official urban plans.	4.5%/yr (15 years)	60%
B2	Move activities from suburban area to fewer number of "city core centers".		80%

Results: Population distribution 2050

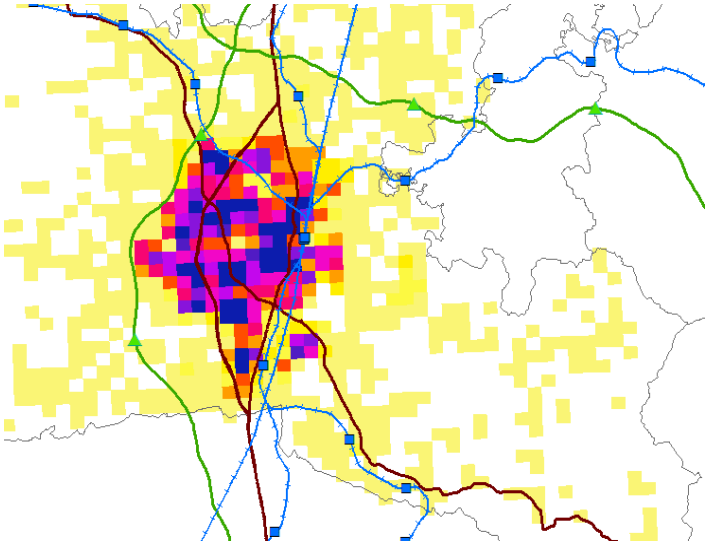
BAU



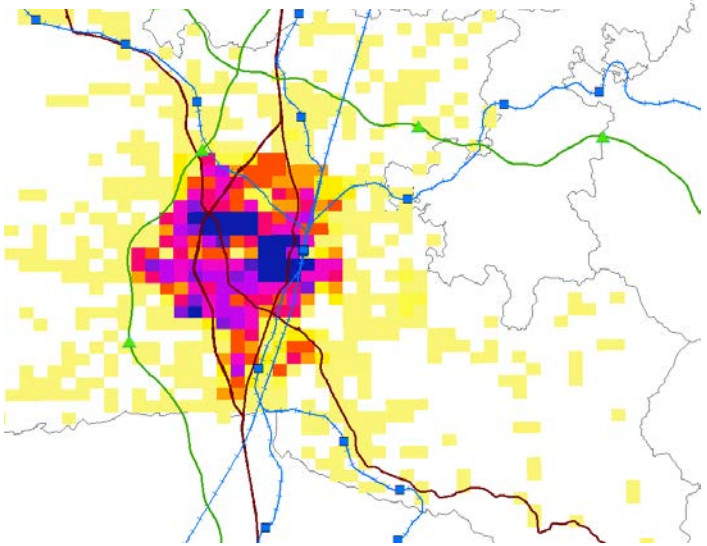
Compact-A



Compact-B1

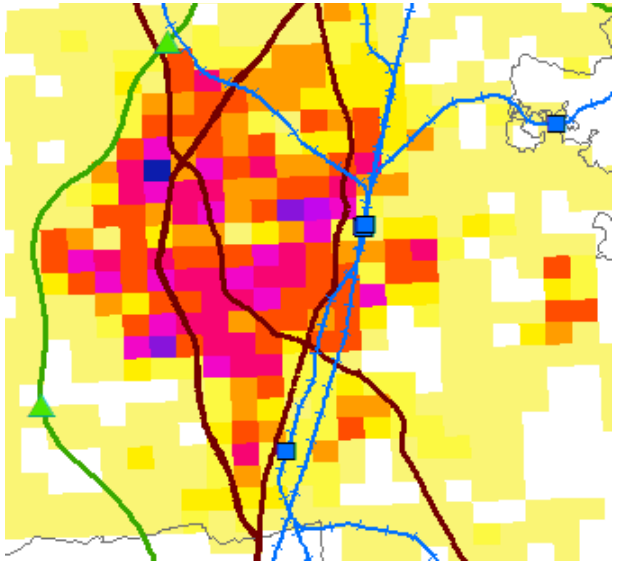


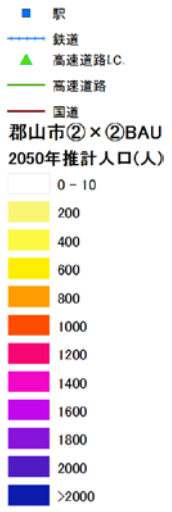
Compact-B2



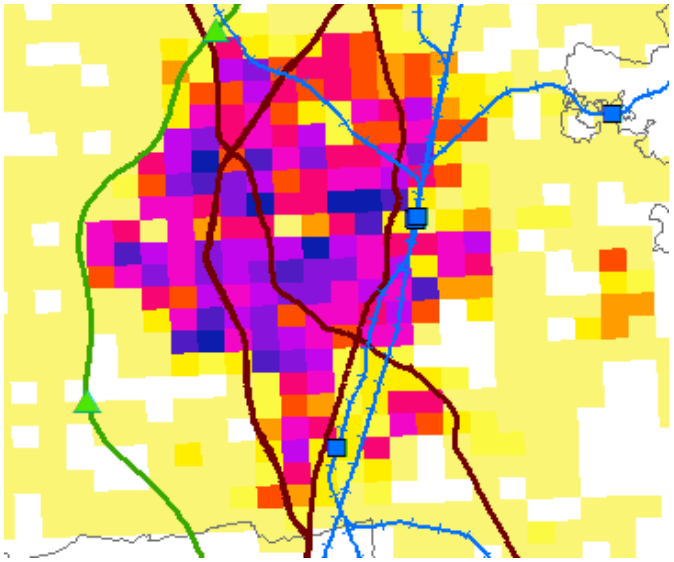
Results: Population distribution 2050

BAU

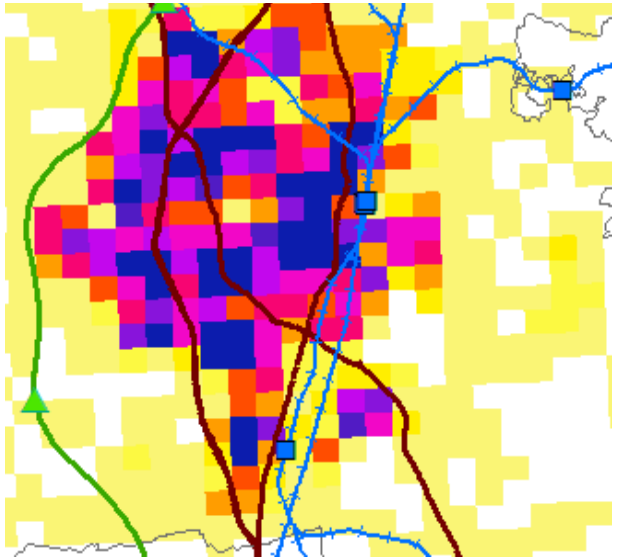




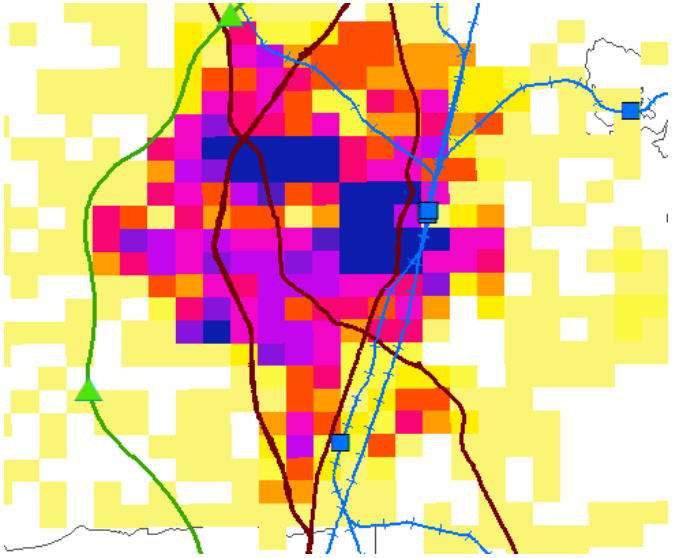
Compact-A



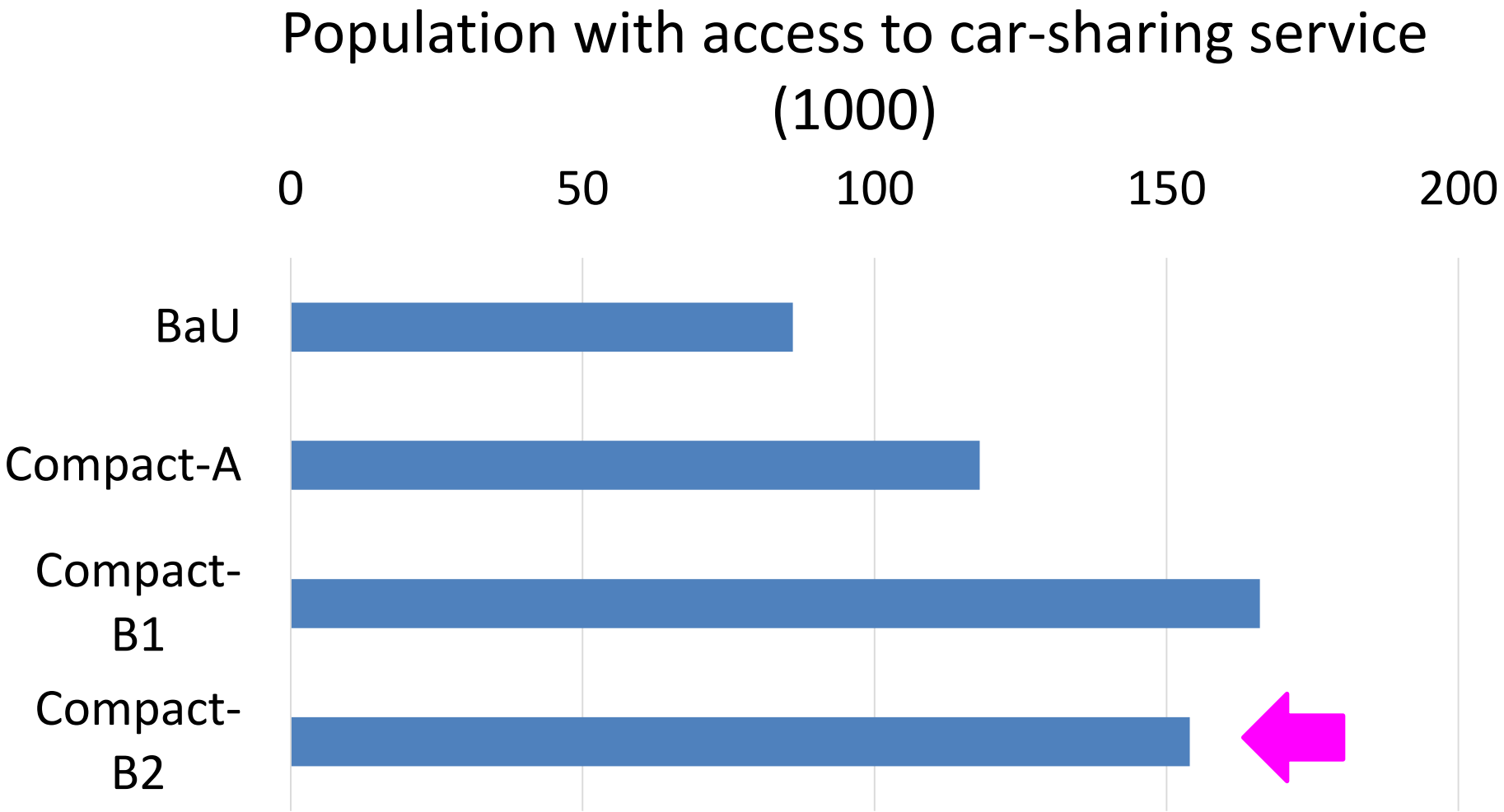
Compact-B1



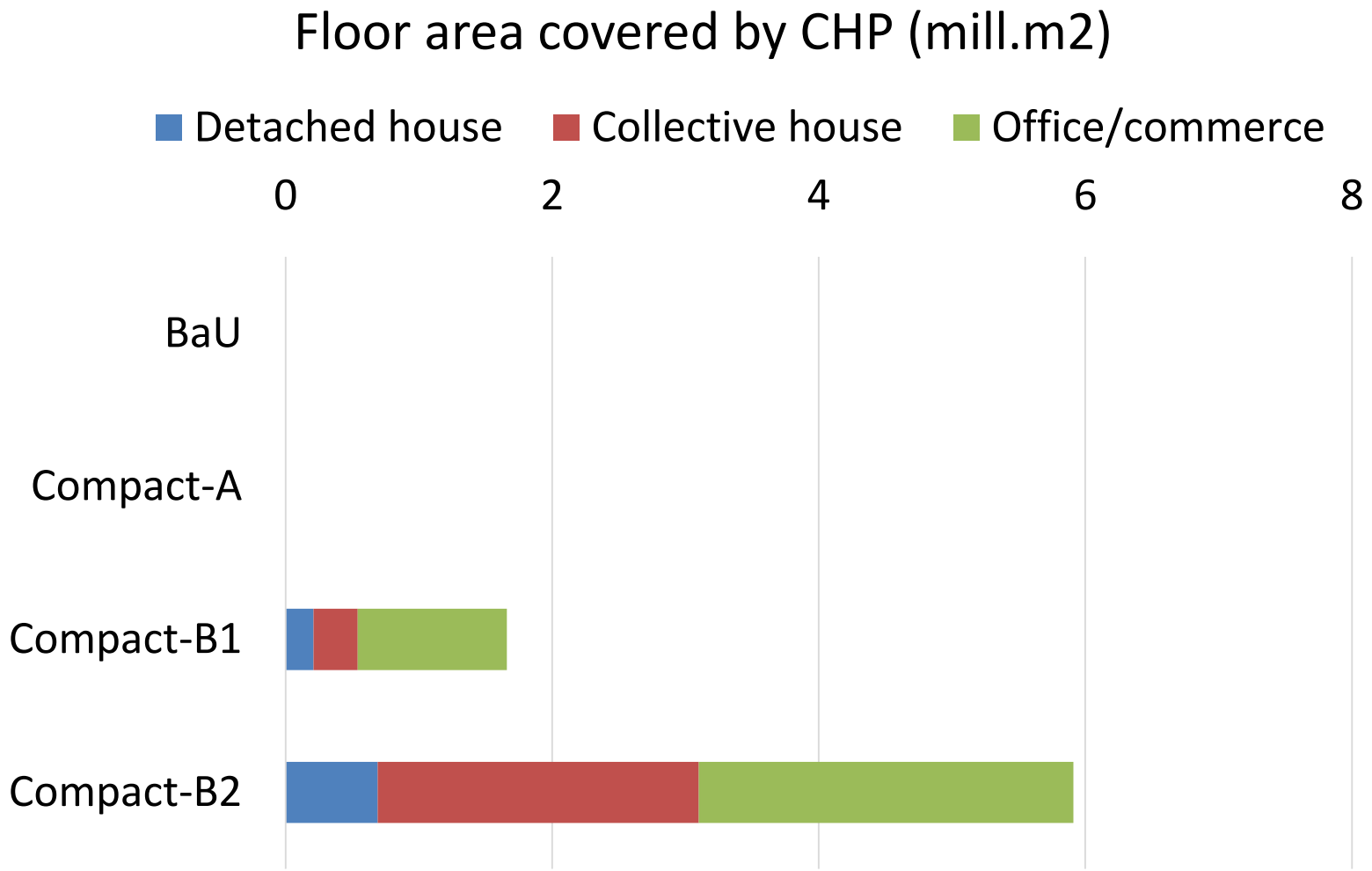
Compact-B2



Results: Car sharing services



Results: CHP potential



Summary

- Effect of “Compact city” concept on two low-carbon systems were assessed.
- Stronger intensification, in general, increase the potential of installation of the systems.
- Too high intensification may reduce coverage of population by car-sharing services because outside of city core is left from the service.
- The methodology can be used for planning of recovery from huge disaster