Seminar for International Human Resource Development about Sustainable Infrastructure Policy

Integrated Land Use-Transportation-Environment Planning & Modeling in China

Runsen ZHANG

26th April 2013

BACKGROUND

- Urbanization and city disease
- Urban sprawl, Traffic congestion, Carbon emission

- As results of urban sprawl disorder, spatial function mismatching, traffic congestion, economic efficiency loss and environment emissions are becoming damaging factors of high quality of urban life

CURRENT SITUATION

- **Planning & governance separation:** planning, policy making, governance and management of urban, land, transport, and environment are separated.
- **Research separation:** land use and urban eco-environment have been given attention by environmental scientist and geographer, while transport planning is consider as civil engineers and economists' business.

Urban/infrastructure/housing/construction	⇒	Ministry of Housing and Urban-rural Development 住房与城郷建設部
Land use/natural resources management	⇒	Ministry of Land and Resources 国土資源部
Transport planning & management	⇒	Ministry of Transport 交通運輸部
Environmental governance	⇒	Ministry of Environmental Protection 環境保護部

QUESTIONS?

- How to sustain the high quality of urban life in the trend of population growth and urban land expansion?

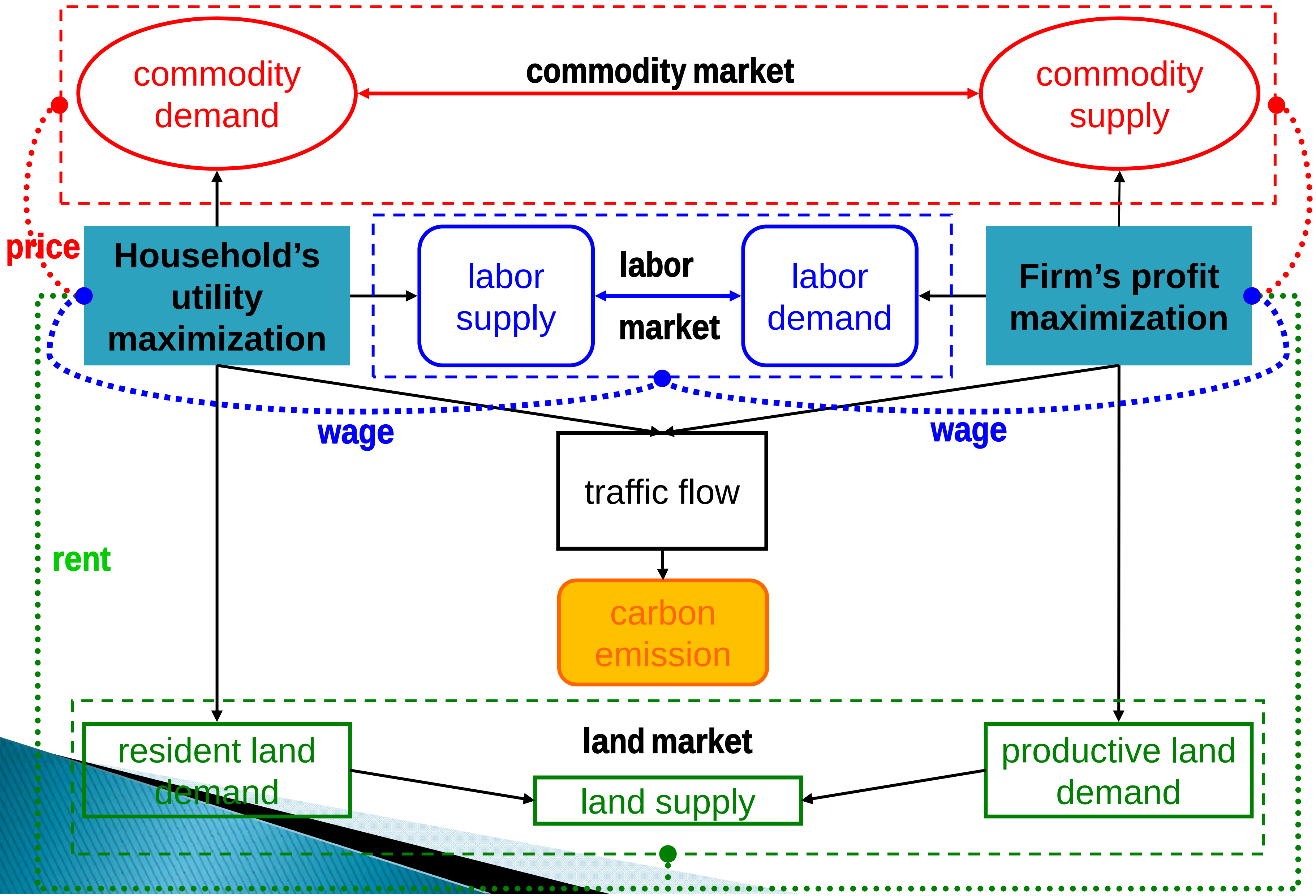
- What urban spatial structure, land use pattern and infrastructure policy have the lowest environment emission?

- How to investigate the interaction mechanism among land use, transport and environment emission?

MODELING: Equilibrium Model

- Integrated modeling combines including household, firm, transport and environment sub-models in one framework.
-
- Bidding process of Households and firms results in spatial equilibrium with exogenous locations that are determined by agglomeration economies and traffic cost.
-
- Integration of sub-models can reflect relevance and coupling of urban subsystems which are interacted by each other, avoiding being isolated, static and one sided.

MODELING：framework



MODELING: structure

- Location choice of household: location choice decision-making based on utility maximization considering land rent, wage rate and traffic cost.

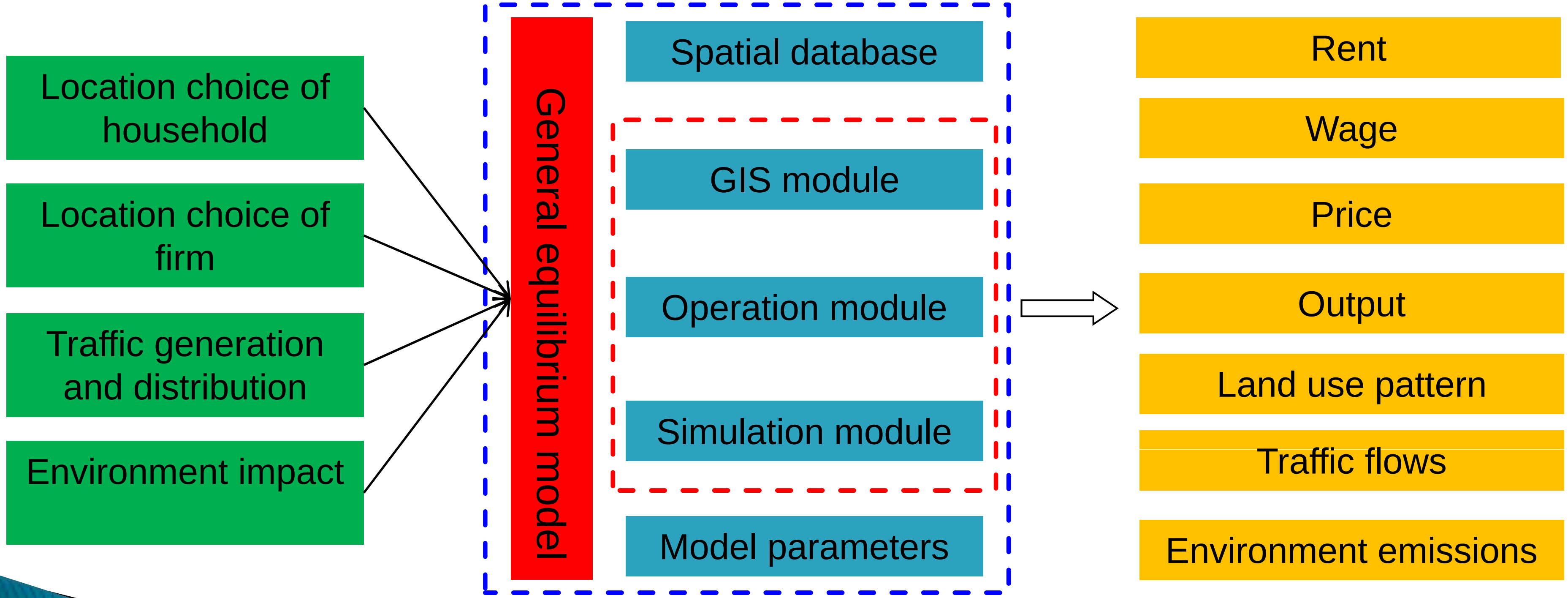
- Location choice of firm: location choice decision-making based on profit maximization considering land rent, labor cost and agglomeration economies.

- Traffic generation and distribution: choice of travel mode, frequency and times based on residential, employment location and traffic accessibly.

- Environment impacts: environment emission induced by life, production and traffic trips.

MODELING： implementation

- Spatial data collection and storage
- Remote sensing and GIS technology
- Computer numerical simulation technology



MODELING：application

- Scenario simulation and prediction

  Spatial urban structure, land use pattern, land price, population distribution, traffic volume, carbon emissions, etc.

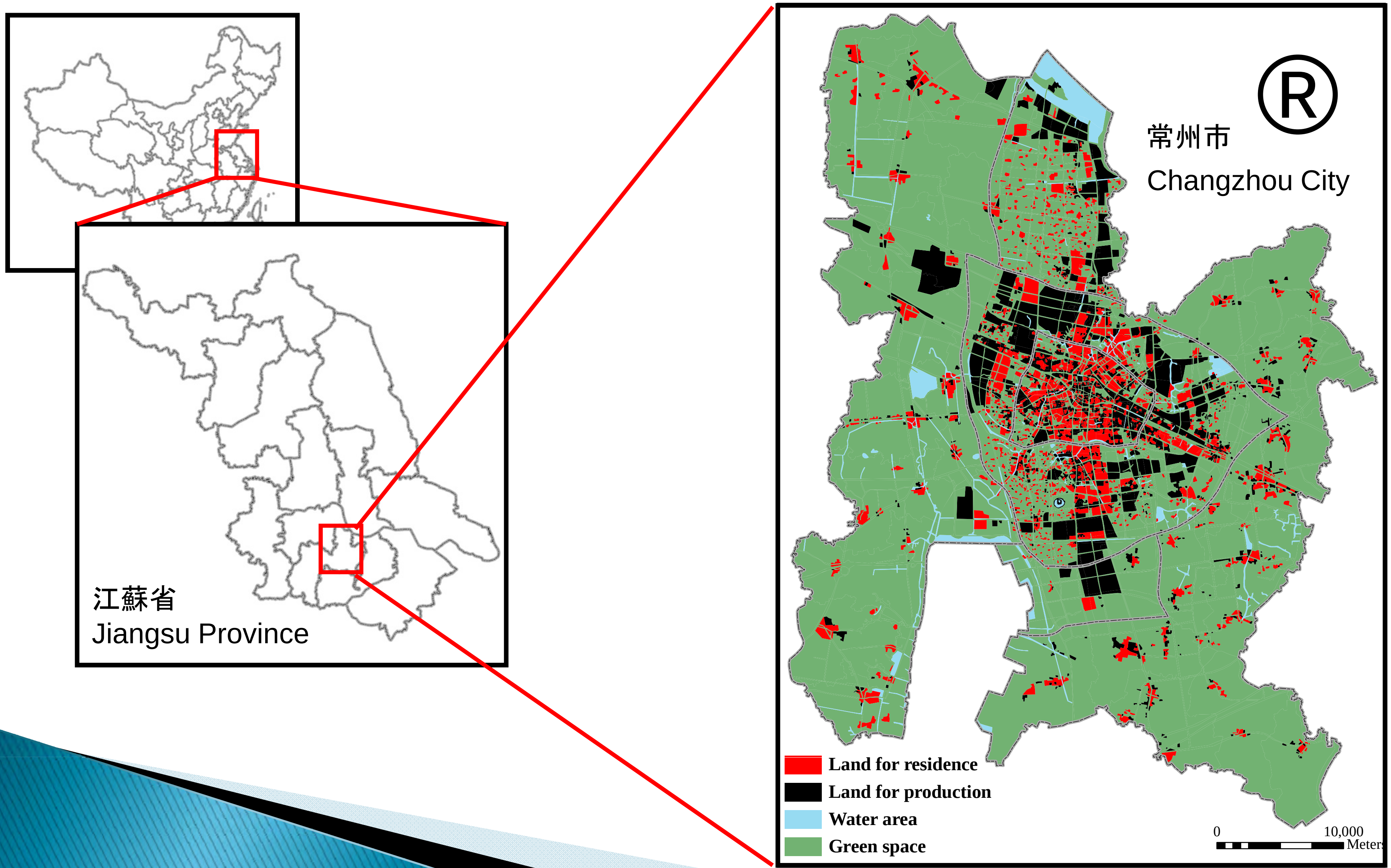
- Infrastructure policy evaluation

  Transport infrastructure planning, new town planning, housing policy, land use control, congestion charges, carbon tax, etc.

- Industrialization

  Real estate development, transport fares system, population agglomeration and market potential, etc.

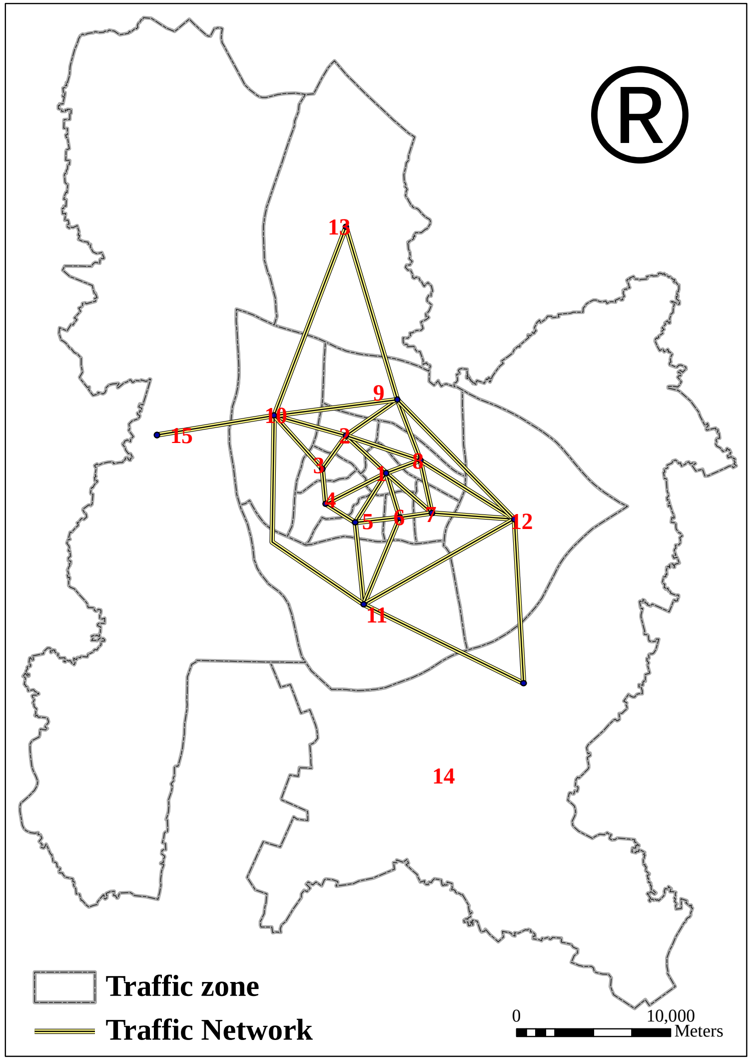
CASE: study area



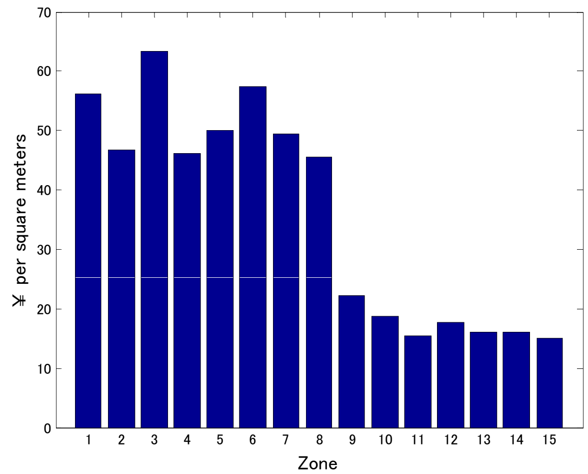
CASE: benchmark simulation

- Traffic zones of Changzhou City were merged into 15 zones (8 central zones, 5 suburban zones, 2 peripheral zones), with simplified traffic network.

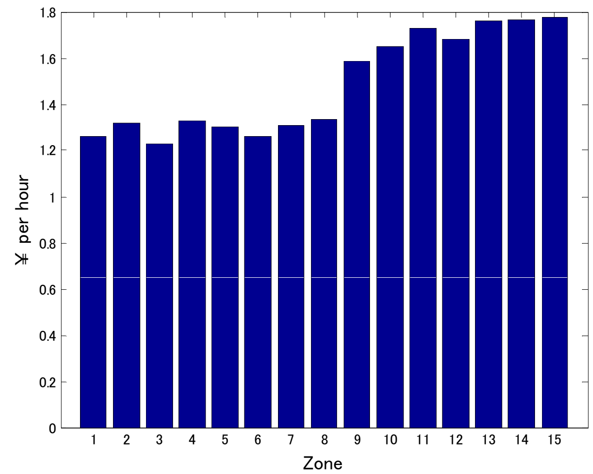
- This zoning captures the feature that in real cities the supply of land increases with the distance from the urban geometric center.



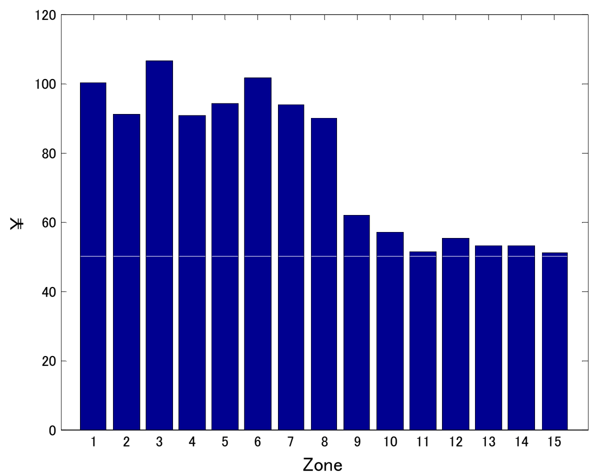
CASE: results (1) spatial economic data



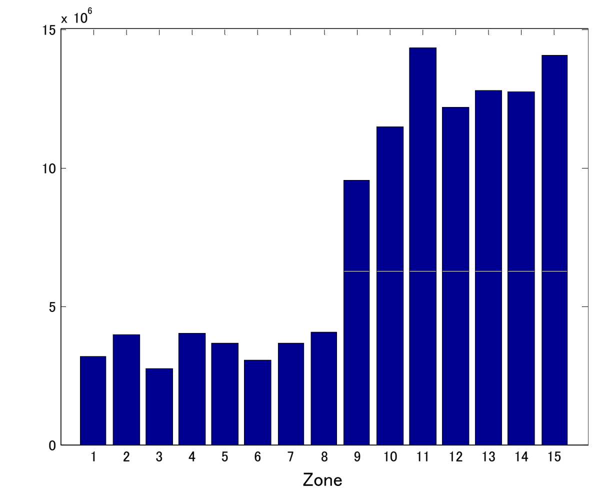
(a) rent



(b) wage

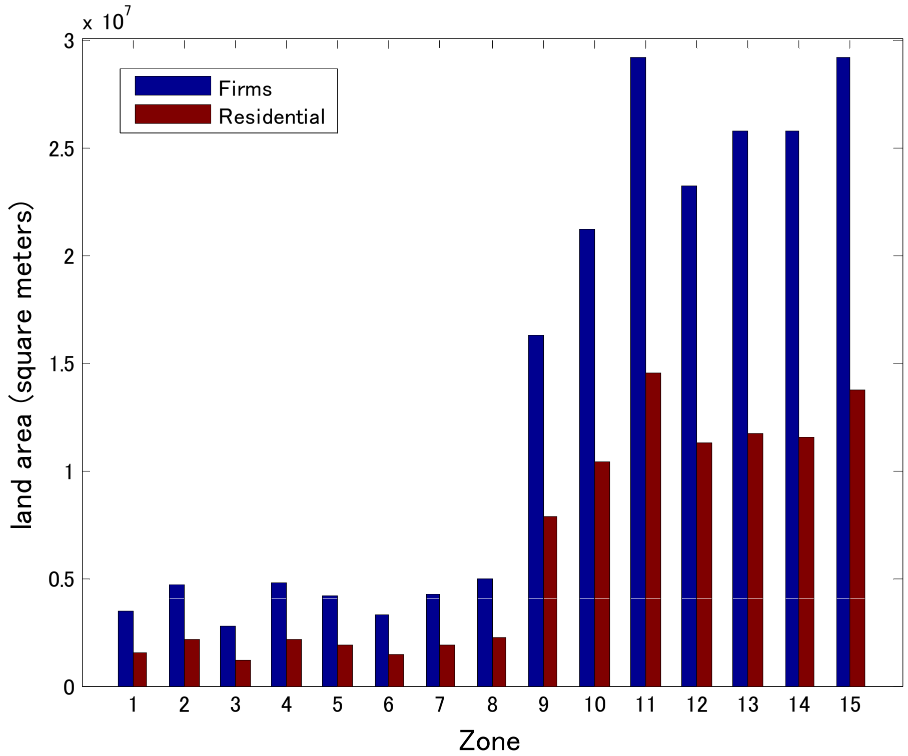


(c) price



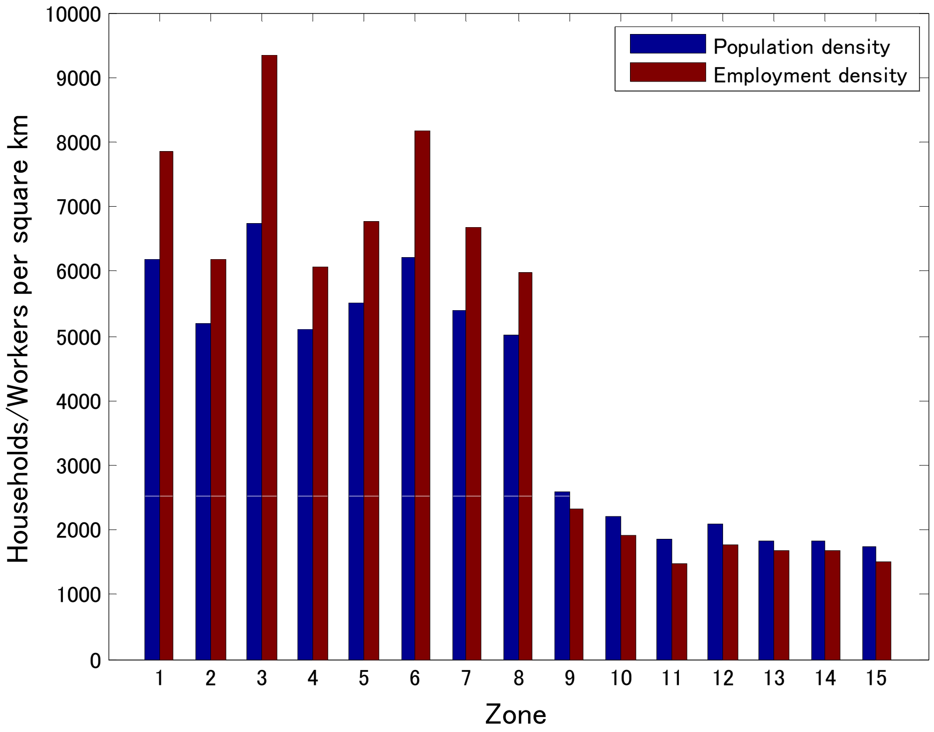
(d) output

CASE: results (2) land use pattern



- In the city, 42.78% of the land is used by residence, and 57.22% is taken up by firms.

CASE: results (3) population distribution



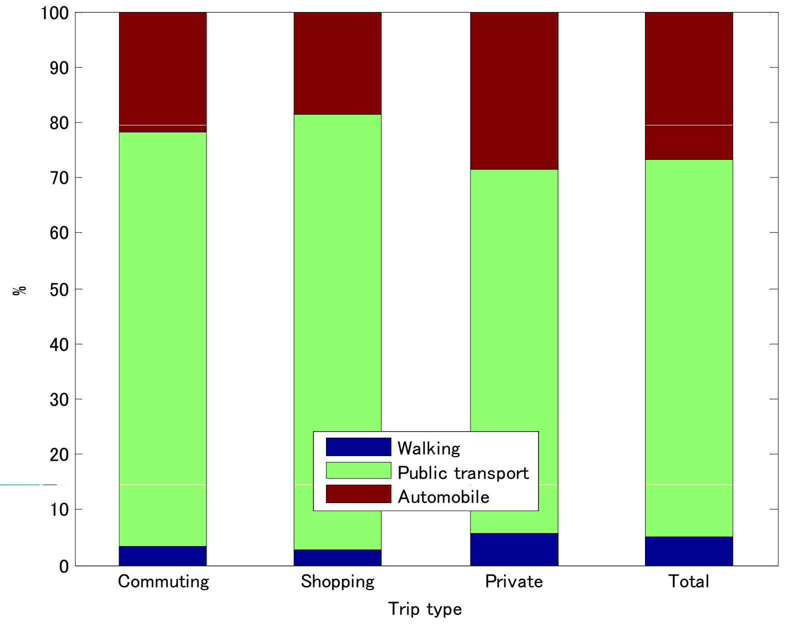
- Residential and employment densities in central zones (zone 1–8) are far more than them in suburban and peripheral zones (zone 9–15).

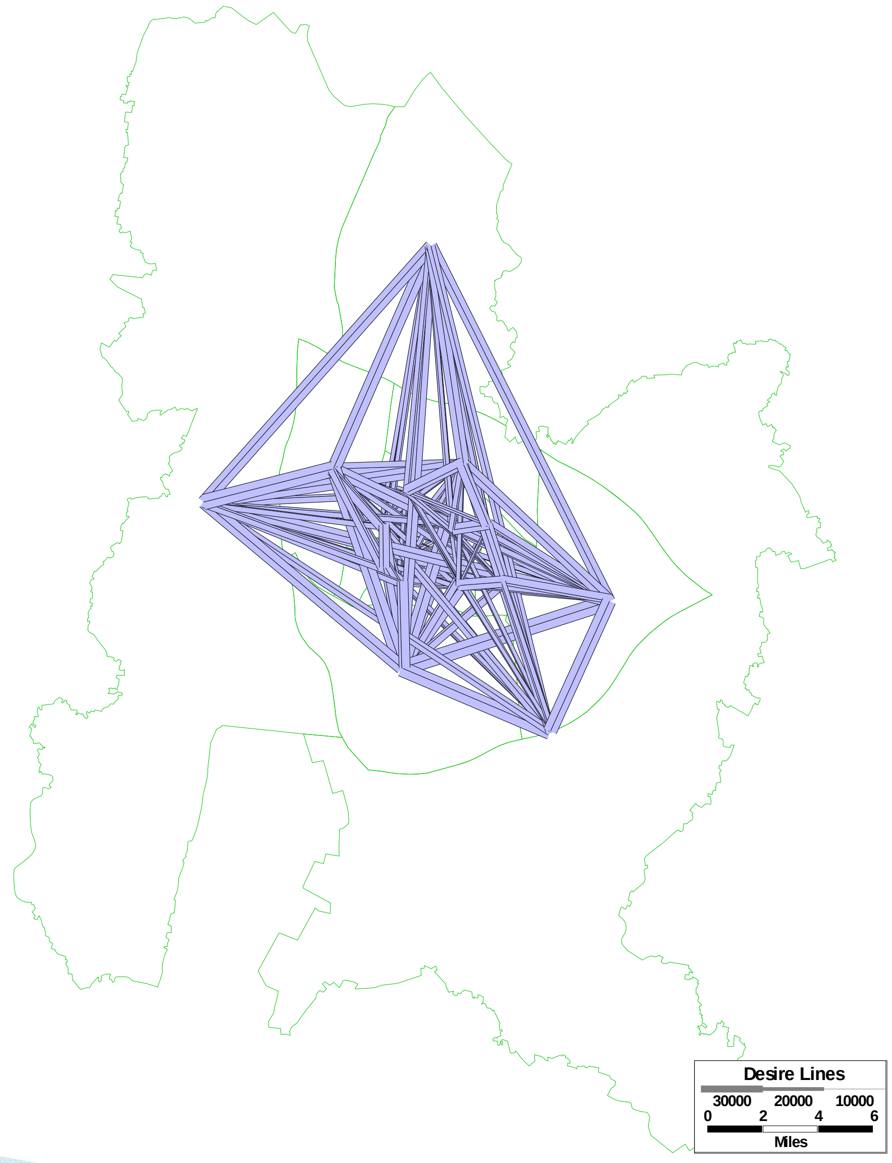
- Employment densities in central zones (zone 1–8) are more than residential densities but less in suburban and peripheral zones (zone 9–15).

CASE: results (4) traffic flow

Table 3 Trips of simulation

Trip type	Gross	per household
Commuting	757, 277	1.00
Shopping	461, 632	0.61
Private	3, 885, 765	5.13
Total	5, 104, 674	6.74





CASE: results (5) carbon emission

Table 4 Carbon emission of different trips and travel modes (10^3 tons/day)

Trip type	Public transport	Automobile	Total
Commuting	2.95	9.44	12.39
Shopping	2.13	5.50	7.63
Private	11.04	49.72	60.76
Total	16.12	$\boxed{64.66}$	80.78

- Automobile plays a predominant role in carbon emission

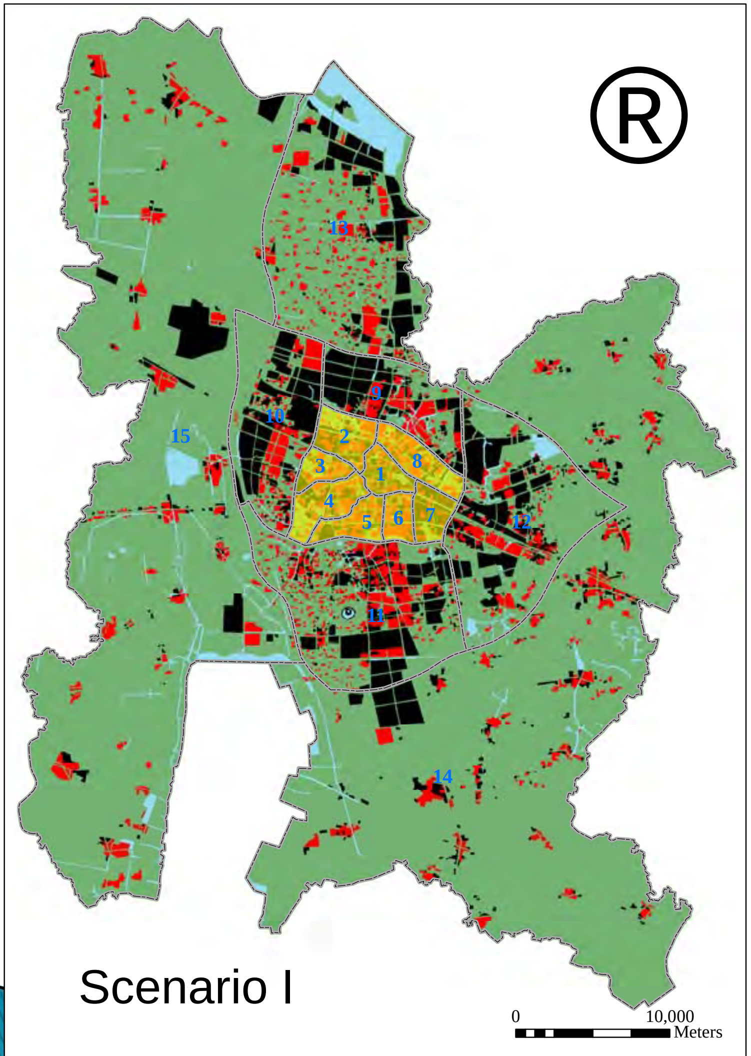
CASE: Infrastructure policy simulation (1)

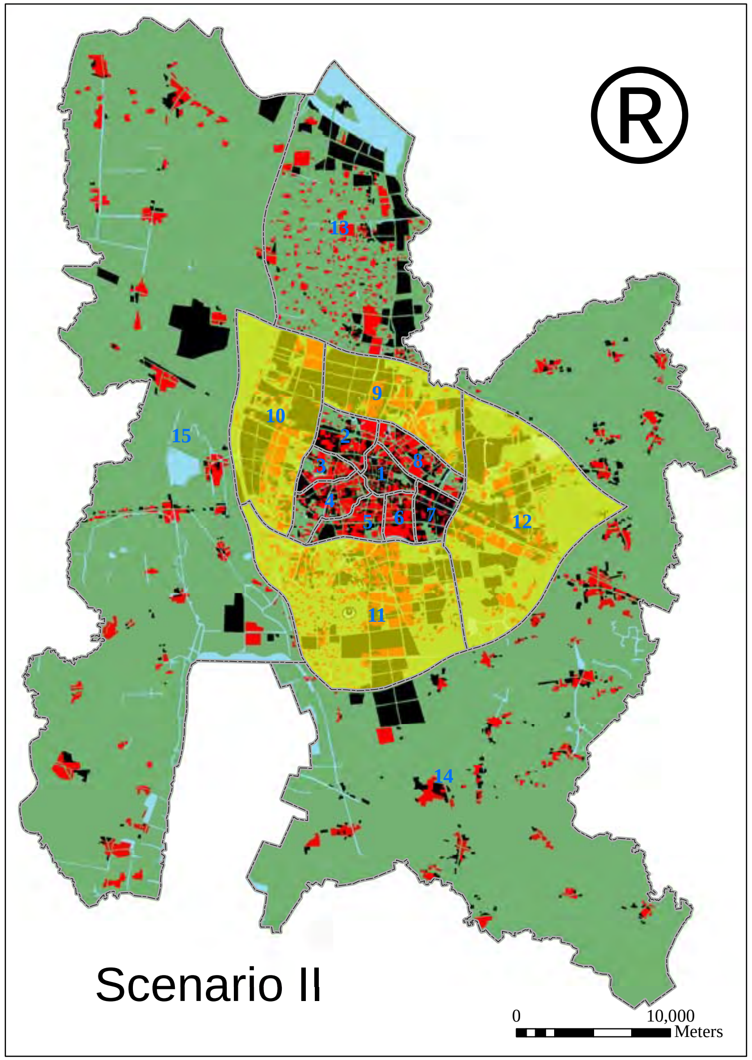
Simulation for land use policy

- Scenario I: available land area in central zone (zone 1-8) will increase by 500,000 square meters respectively owing to the policy for improving the land use efficiency and quantity in city center.

- Scenario II: available land areas in suburbs (zone 9-12) will increase by 1,000,000 square meters respectively due to the land use policy encouraging urban expansion and agricultural land conversion.

CASE: Infrastructure policy simulation (1)





CASE: Infrastructure policy simulation (1)

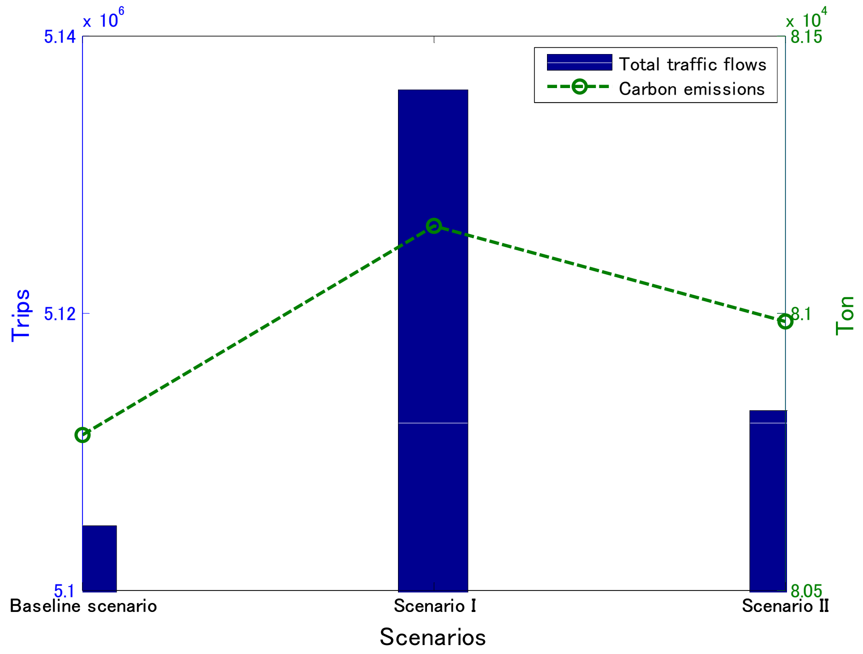


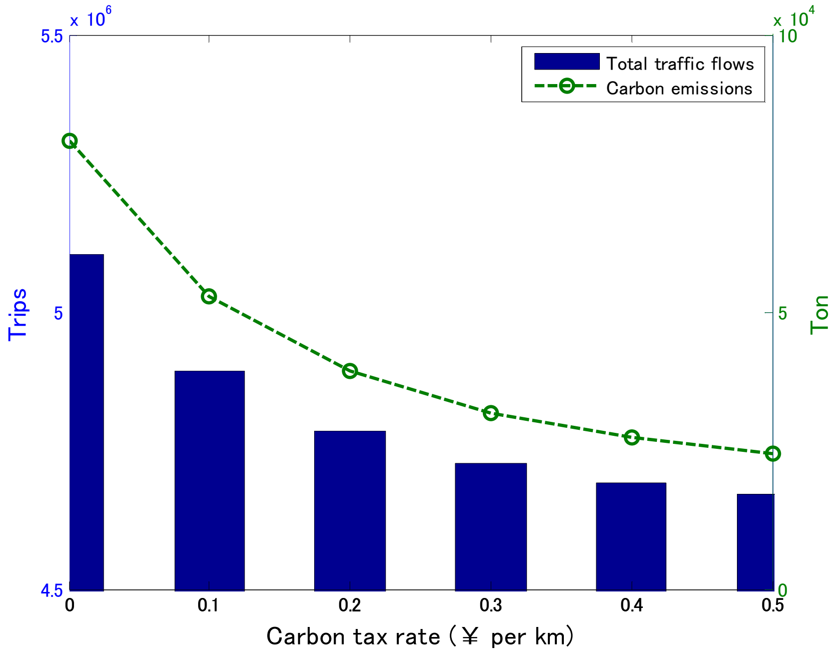
Table 4 Carbon emissions (10^3 tons/day)

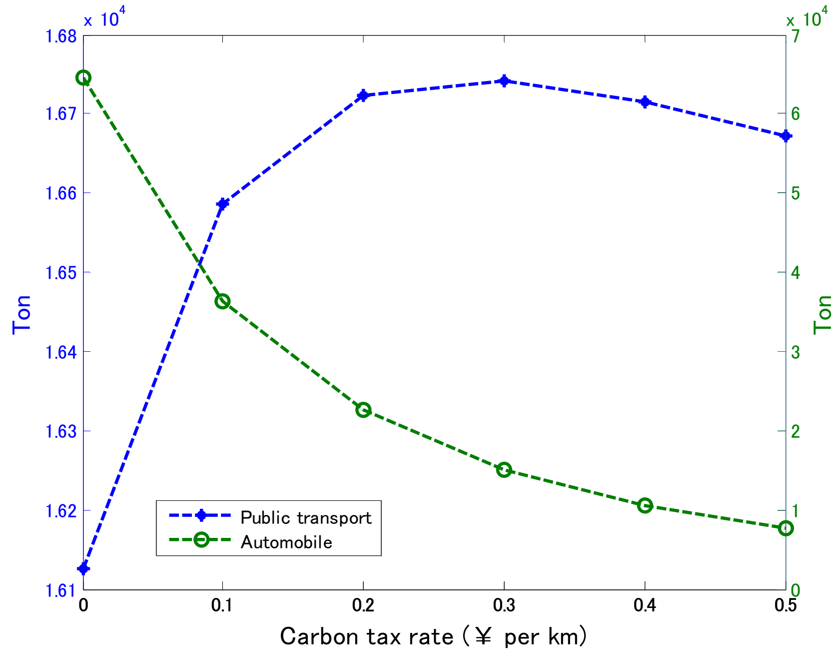
Trip type	Public transport	Automobile	Total
Baseline scenario	16.12	64.66	80.78
Scenario I	16.03	$\boxed{65.12}$	81.15
Scenario II	16.12	64.86	80.98

- Increasing available land area in central zones results in growth of traffic flows and carbon emissions, while it in suburban zones generates lower traffic flows and carbon emissions.
- carbon emissions induced by automobile in scenario I are higher than them in Scenario II

CASE: Infrastructure policy simulation (2)

Simulation for carbon tax





- Traffic flows and total carbon emissions display descending trend.
- Carbon tax can make more households to choose public transport due to increasing traffic cost of automobile.

CONCLUSION

- Spatial equilibrium model integrates each sector in urban space, by which planner and policy maker can evaluate impacts of infrastructure policies on every urban sub-systems.
-
- This behavior-based model is on basis of behavioral theories of urban economics, transport planning and environment evaluation, which can be understood, accepted and used by infrastructure policy designer, decision maker and the public.
-
- Integrated planning and modeling will be conducive to infrastructure policy coordination and systematic decision making, offering technical supports to the participatory planning and policy debate.

Discussion

- In theory

  Incomplete markets, institutional transformation, etc.

- In method

  Endogeneity, dynamics, etc.

- In dataset

  Historical data, calibration, etc.

THANK YOU FOR YOUR ATTENTION!