The role of electric vehicle penetration in urban decarbonization scenarios

-An integrated land use-transport-energy model-

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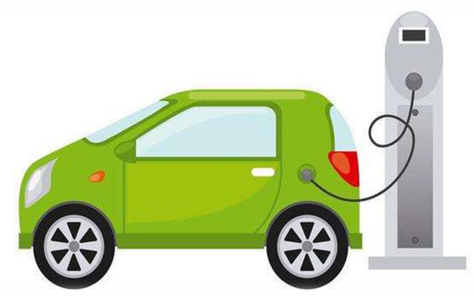

Background

- Many countries around the world intend to build **low-carbon cities** in hopes of achieving energy-efficient and livable communities.
- **Rapidly growing mobility demand** and **private vehicle ownership** counteract the efforts to reduce the CO_2 emissions and air pollutants in the regions of large human population such as urban areas.
- **Electric vehicle** (EV), which is often considered as a promising solution towards a green future, offers an alternative to conventional internal combustion engine vehicle (ICEV).

Method

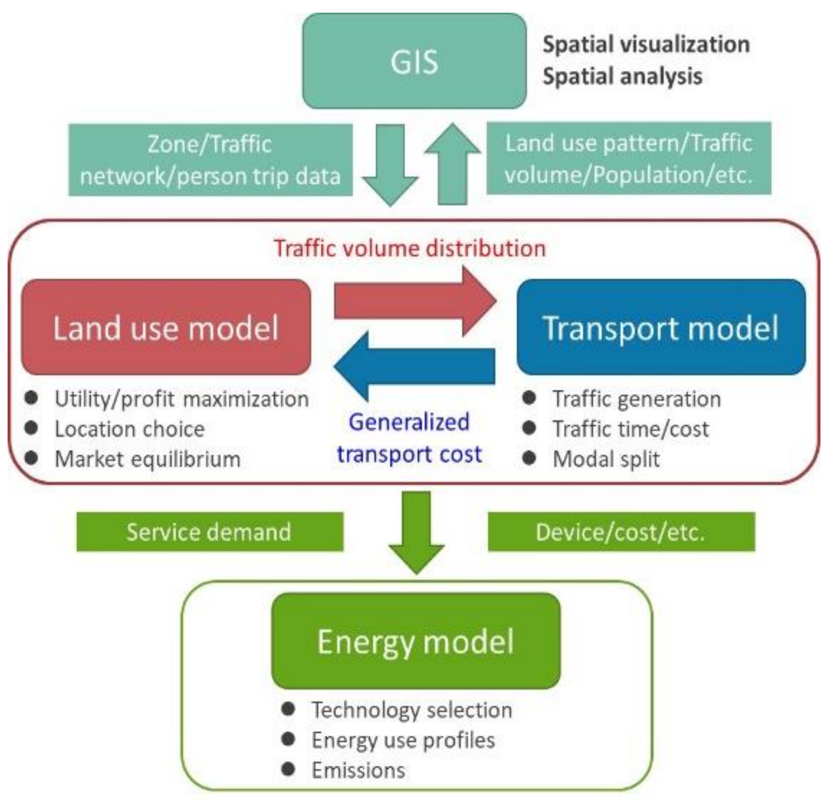

Figure 1. Model structure.

- First, we propose a land use-transport interaction model in the tradition of urban partial equilibrium mode that explicitly formulates the location choice decisions and travel behaviors.
- Second, the land use-transport interaction model is extended to incorporate the energy system for depicting the energy use and emissions profiles due to urban polices.
- **Scenarios**
  - Reference scenario (**REF**): without stringent penetration of EVs
  - EV scenario (**EV**): subsidies will cover around 50% of capital cost of EVs

Study area

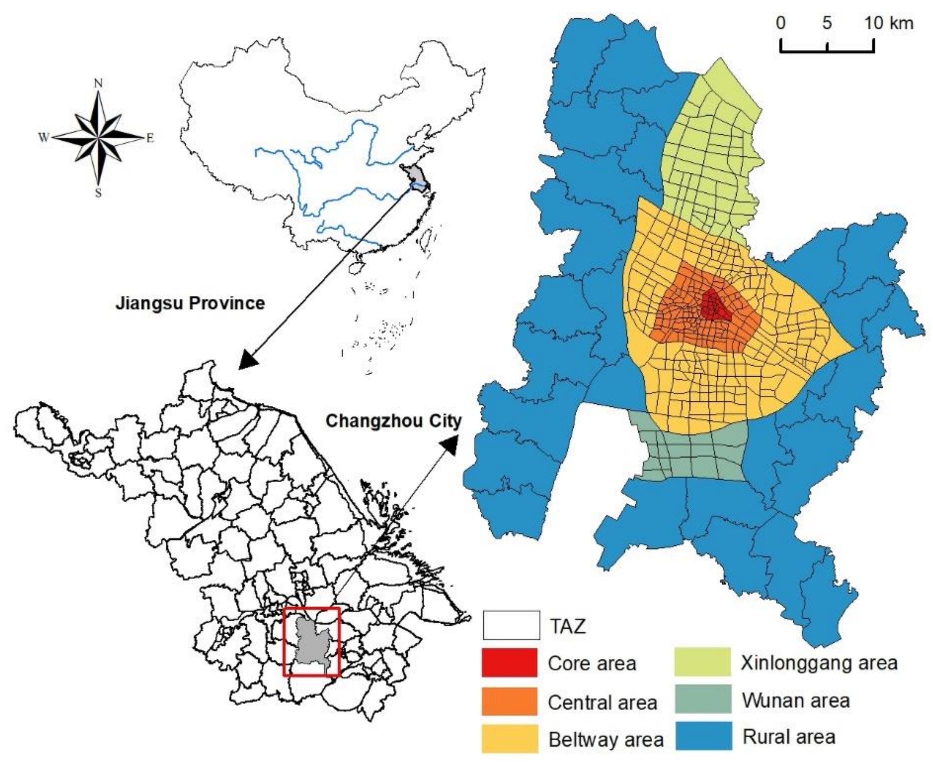

Figure 2. Study area.

Results

Impacts of EV penetration on transport demand, energy, emissions, and social welfare

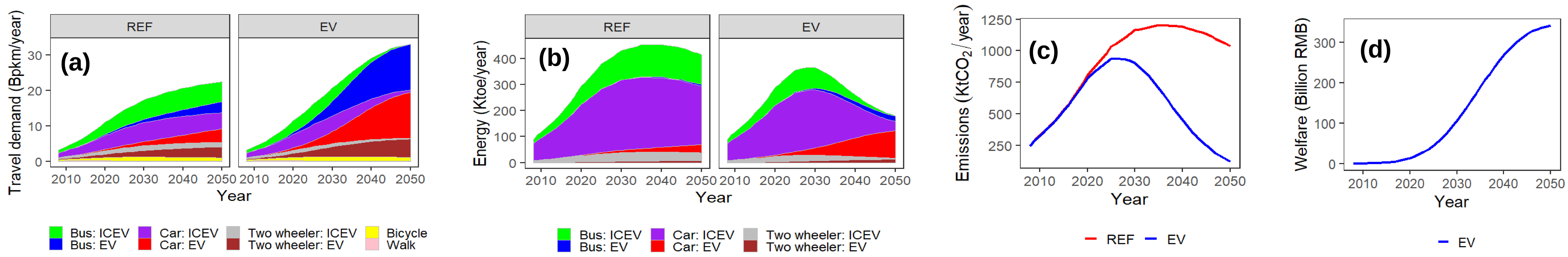

Figure 3. Impacts of EV penetration on transport demand (a), energy use (b), emissions (c), and social welfare (d).

Spatial differentiation on policy effectiveness

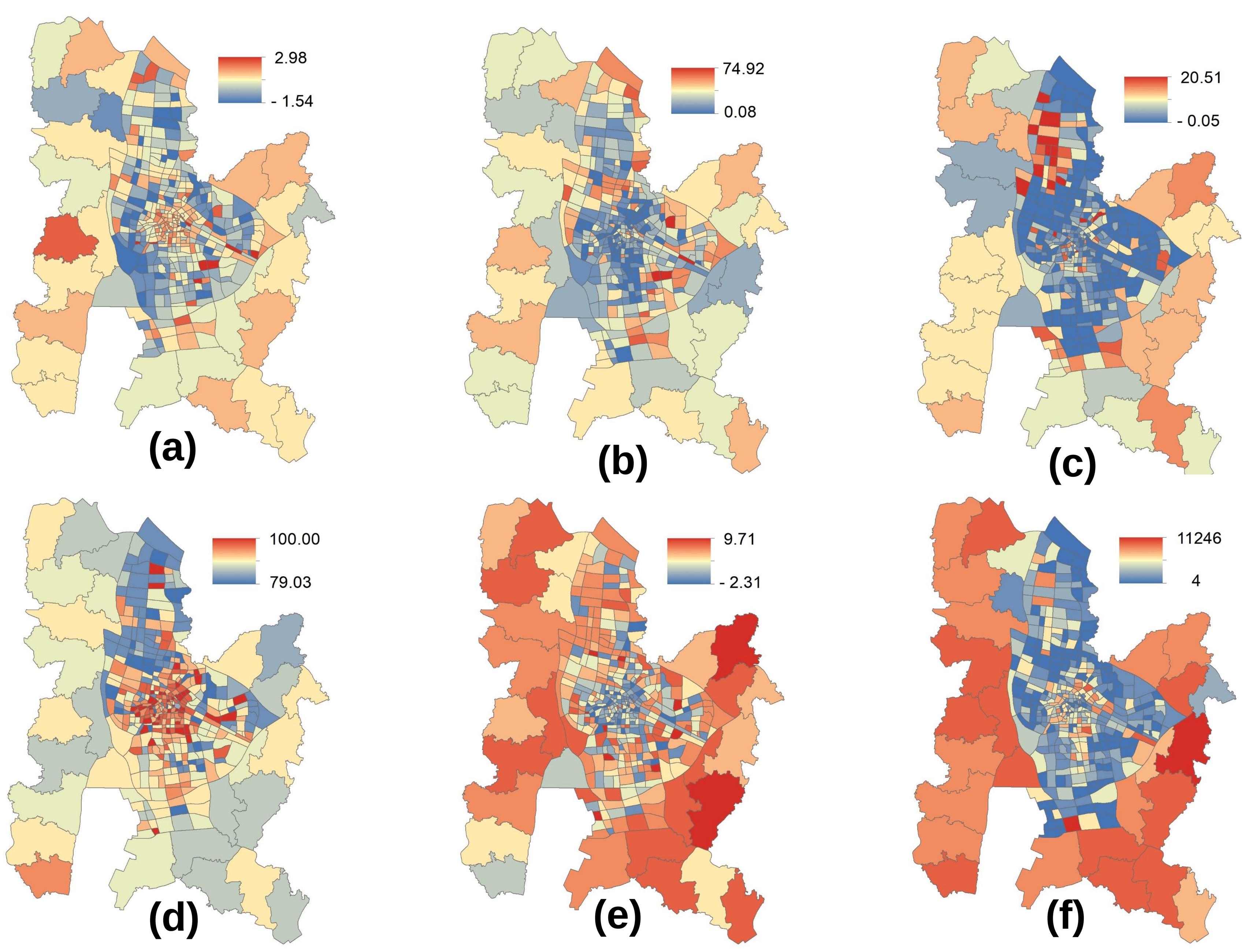

Figure 4. Changes in population (a), land for residence (b), land for production (c), emission intensity (d), car usage (e) and welfare (f) in 2050.

Cluster and hotspot analysis

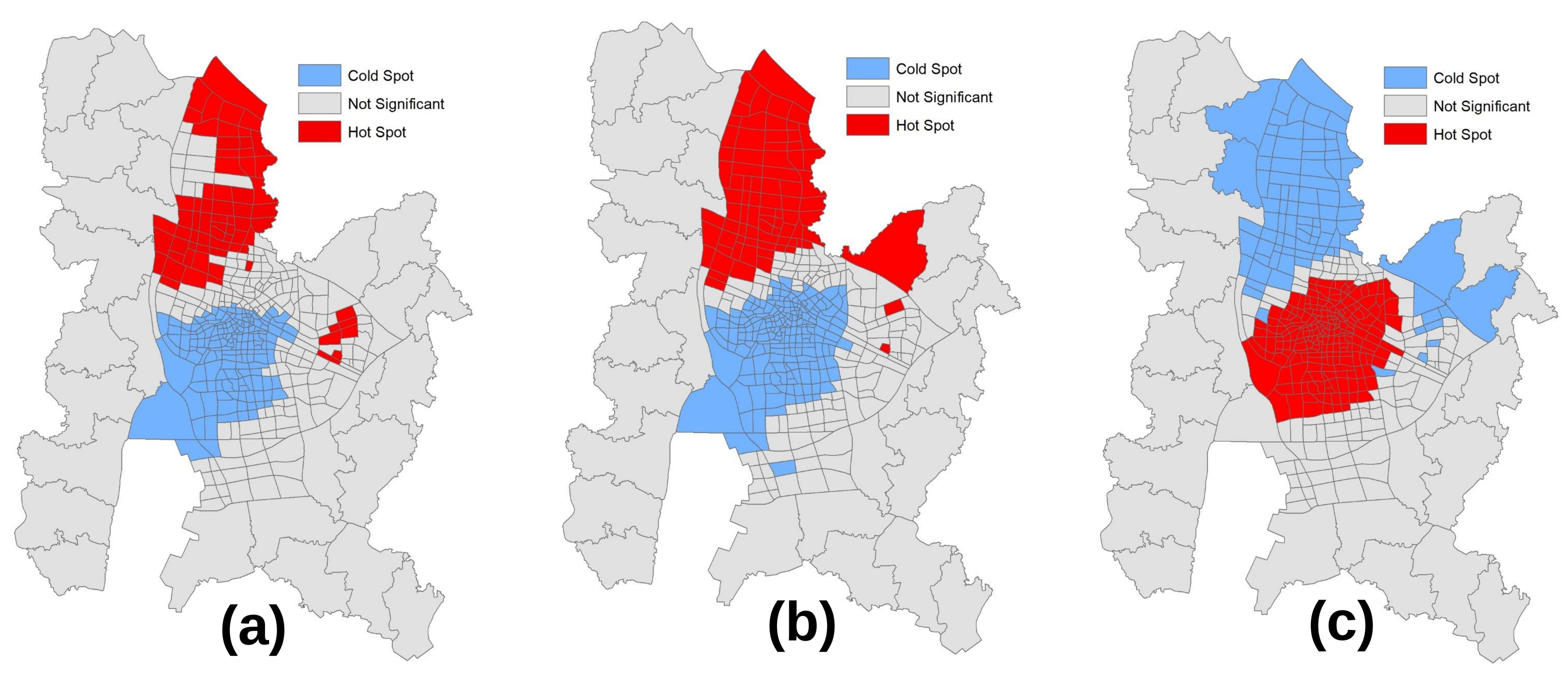

Figure 5. Cluster and hotspot analysis on emission intensity. REF (a), EV (b) , and changes between two scenarios (c).

- With the penetration of EVs, **population** would migrate from mediate areas to central and suburban areas, while **land for residence and production** decrease mainly in the central and mediate areas.
- A considerable **social welfare** would be generated due to the penetration of EVs, which are mainly distributed in the suburban areas.
- Hotspots of emission intensity are located in north suburban areas, and high values of **reduced emission intensities** for transport are clustered in central areas.

Conclusions

- The **Integrated Land Use-Transport-Energy Model (ILUTEM)** can capture the interaction between location choice, land market, urban mobility, energy system, and economy as well.
- The penetration of EVs has significant positive effects on emission reduction and social welfare, and **spatial differentiation and clustering on policy effectiveness** deserves more attention.
- Since the disaggregated spatial interactions can be handled by this model, ILUTEM offers a useful tool for **climate change oriented urban planning** and infrastructure policy making.
- In addition to the EV policy, future studies are needed to detect how **land use and transport planning** would contribute to the **deep urban decarbonization**.