High-speed rail development and access equity: the case of Guangdong province, China

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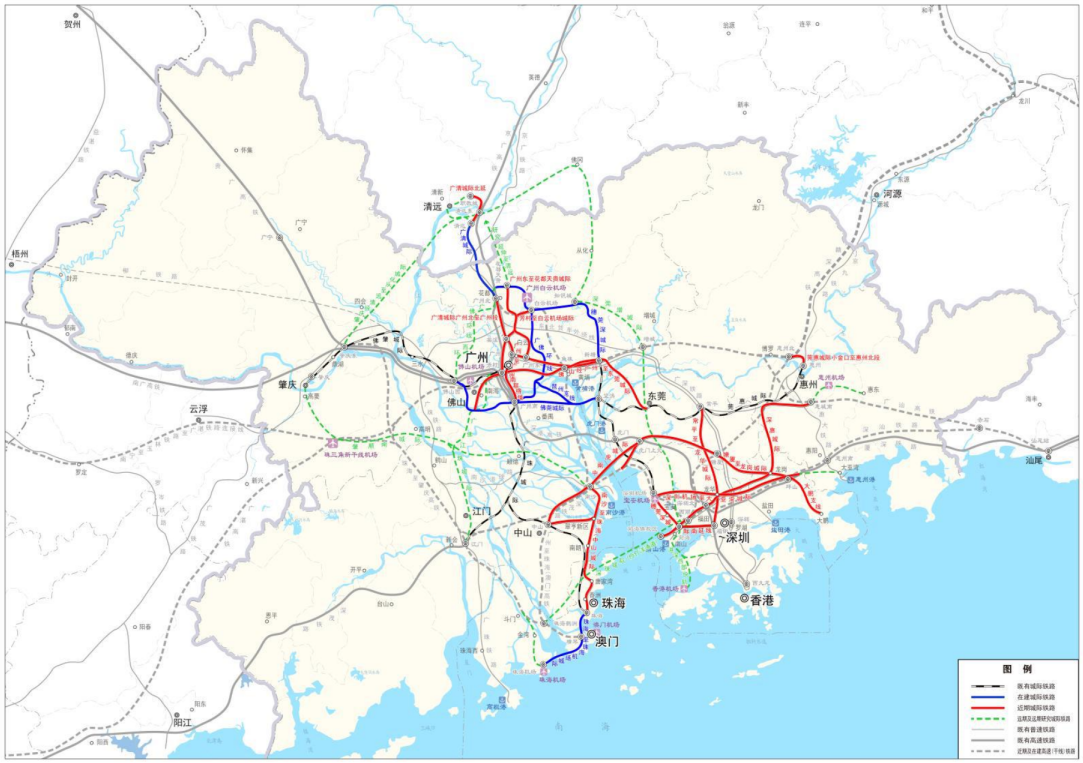
High speed rail development in China

Very rapid development of a new HSR network in China since 2008 (8+8 plan at the national scale) [Zhou et al., 2018]



Inter-city Railway plan for the Greater Bay Area (Source: China Mid-term and Long-term Railway Network Planning, 2016)

HSR and access equity

Concerns over negative impact of HSR development on access equity:

- Moderate economic impact on smaller cities [Liu and Zhang, 2021]
- Increase in national accessibility inequality [Jiao et al., 2017]
- Major cities negotiate station location more easily [Zhu et al., 2015]
- Mitigation of travel time improvements due to remote stations [Wang et al., 2013]

Transport access equity

No unique definition of access equity [Kim and Sultana, 2015]:

- geographical equity [Welch, 2013]
- socio-economic equity [Litman, 2002]

Methods to quantify access equity:

- Travel time improvements [Wang et al., 2013]
- Generalised accessibility (opportunities) [Vickerman, 1997]

Quantifying access equity in GBA

Previous work on access equity in the GBA:

- Access impacts in 2020 of ICR [Hou and Li, 2011]
- Socio-economic disparities in Guangzhou [Chen and Yeh, 2021]
- HSR and industrial movement [Chang et al., 2021]

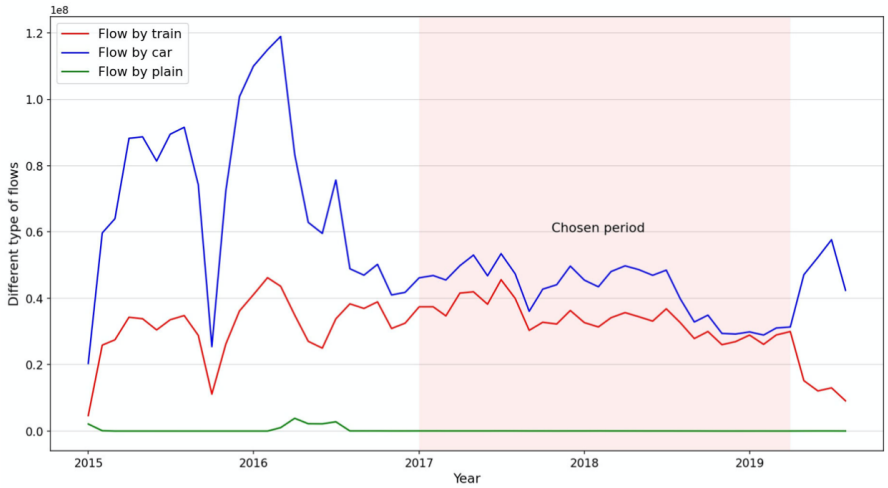
Research question

What is the impact of HSR construction on accessibility and its equity; What will be the impact of mid-term and long-term planned lines?

Data

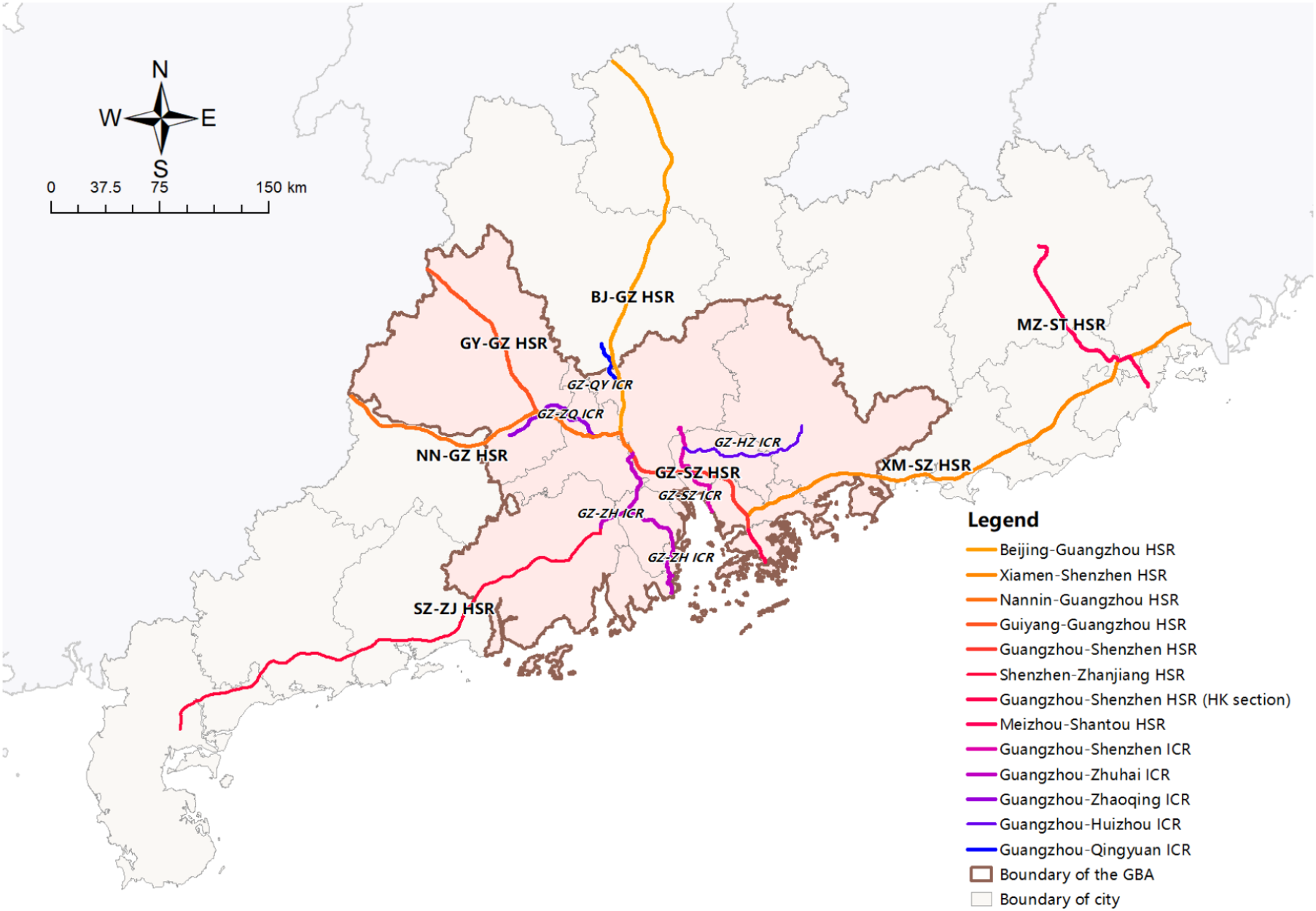
- Road travel times scrapped from Gaode maps; train timetables gathered manually from China Railway website
- Tencent flow data between cities (driving, railway, plane)
- Socio-economic data from Guangdong statistical yearbook 2020 and HK and Macao statistics; housing prices from Anjuke website
- Network data (expressway and railway) from OpenStreetMap

Aspects	Indicators	Description	Unit	Label
Population	**Population**	Registered population at the end of 2019	10000 persons	Pop
	Labour force	Number of Employed Persons at the end of 2019	10000 persons	Lab
Economy	**Per capita GDP**	Per capita gross domestic product of 2019	10000 yuan /1 person	Gdp
	Investment in fixed assets	Investment in fixed assets of 2019	100 million yuan	Ifa
	Foreign trade	Total exports and imports of 2019	100 million yuan	Ft
	R&D investment	Research and development expenditure of 2019	10000 yuan	Rdi
Life	**Number of primary schools**	Number of primary schools owned by unit population in 2019	unit/10000 persons	Edu
	Housing price	Average housing price per unit area in 2019	10000 yuan /m^2	Hp
Travel	**Car ownership**	Possession of civil vehicles by unit population in 2019	unit/10000 persons	Co
	Highway length	Length of highways in 2019	km	Hwl
	Railway length	Length of railways in 2019	km	Rwl

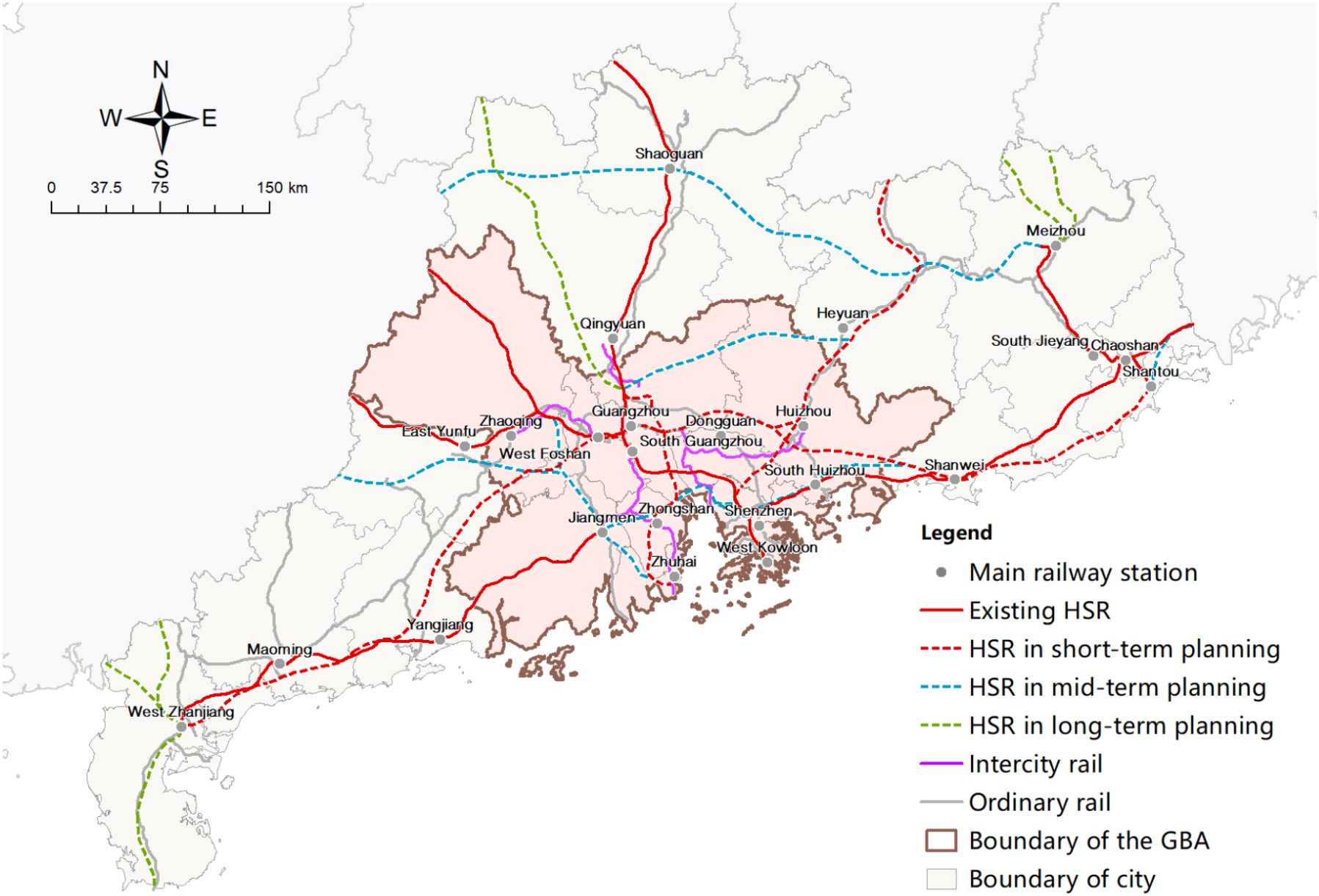


(Left) Socio-economic data for spatial interaction models; (Right) Tencent flows

Current HSR lines in the GBA



Planned HSR lines in the GBA



Methods

→ Accessibility indicators computed:

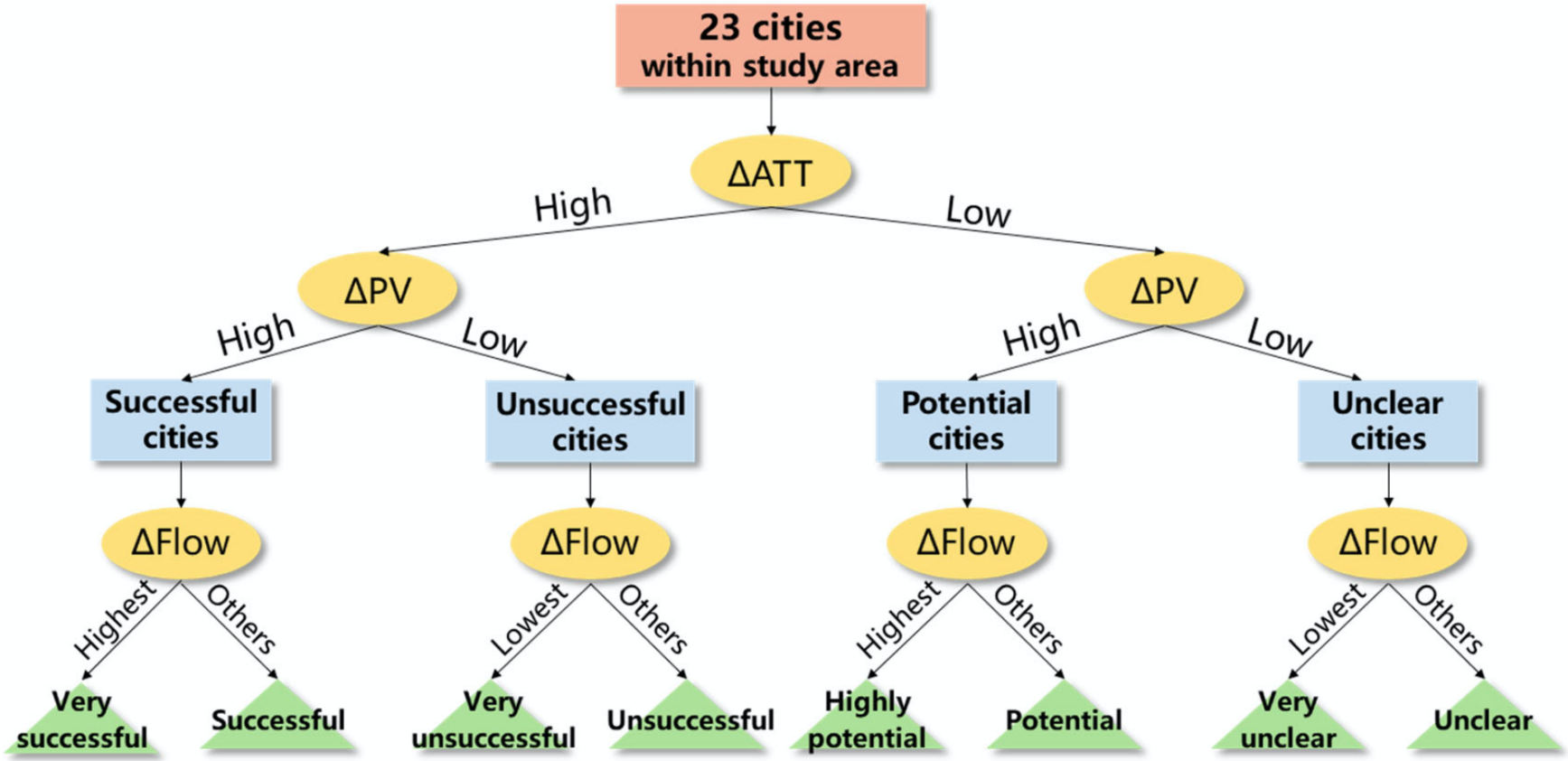
- Average travel time
- Economic potential [Gutiérrez, 2001]
- Gravity travel flow (observed and simulated) [Liu and Zhang, 2021]

→ Inequality quantified using changes in coefficient of variation

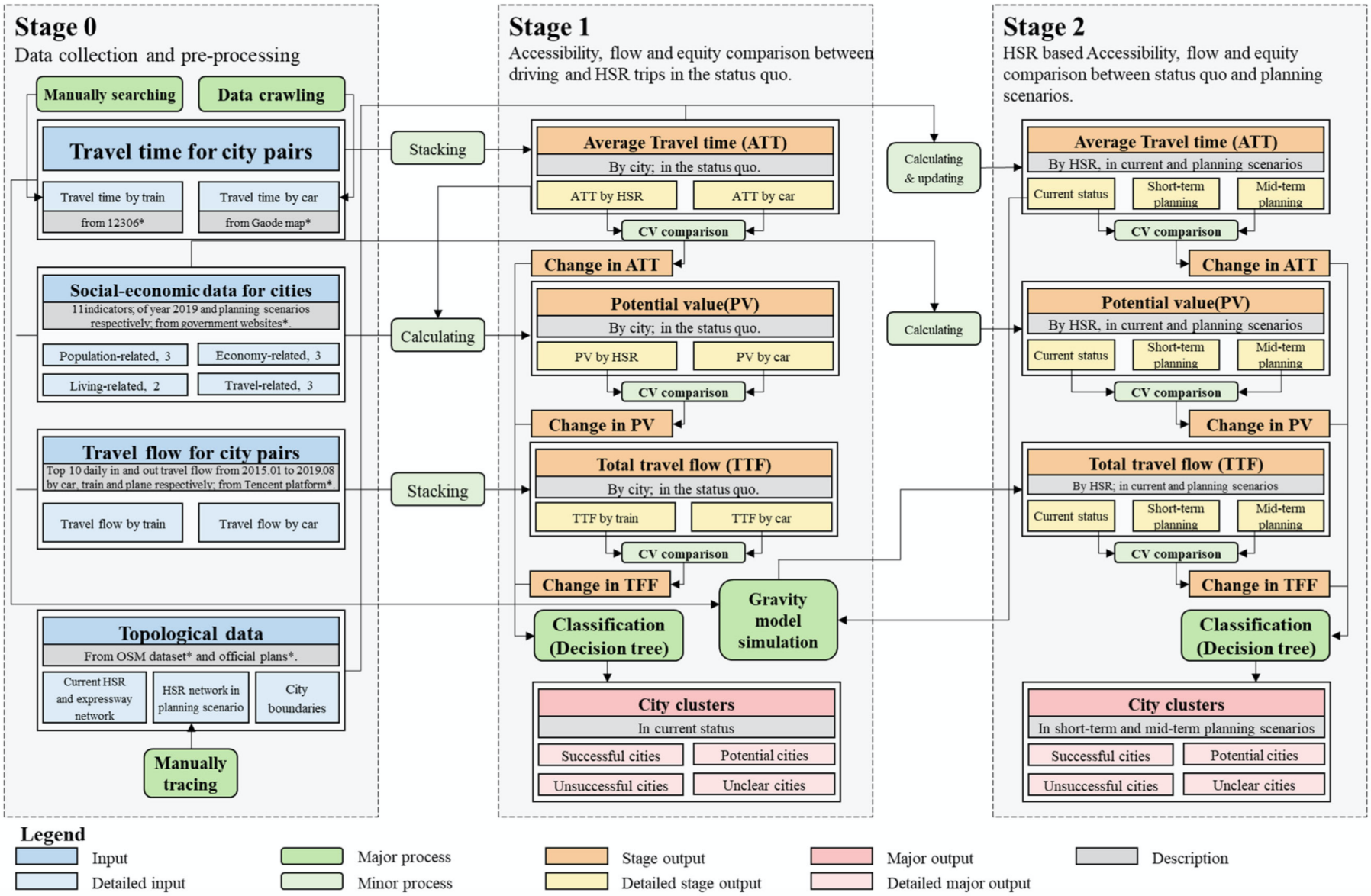
→ Spatial interaction models estimated on flow and socio-economic data (variable selection using bidirectional elimination approach)

→ Cities classified with a binary tree based on travel time, potential and flow differences

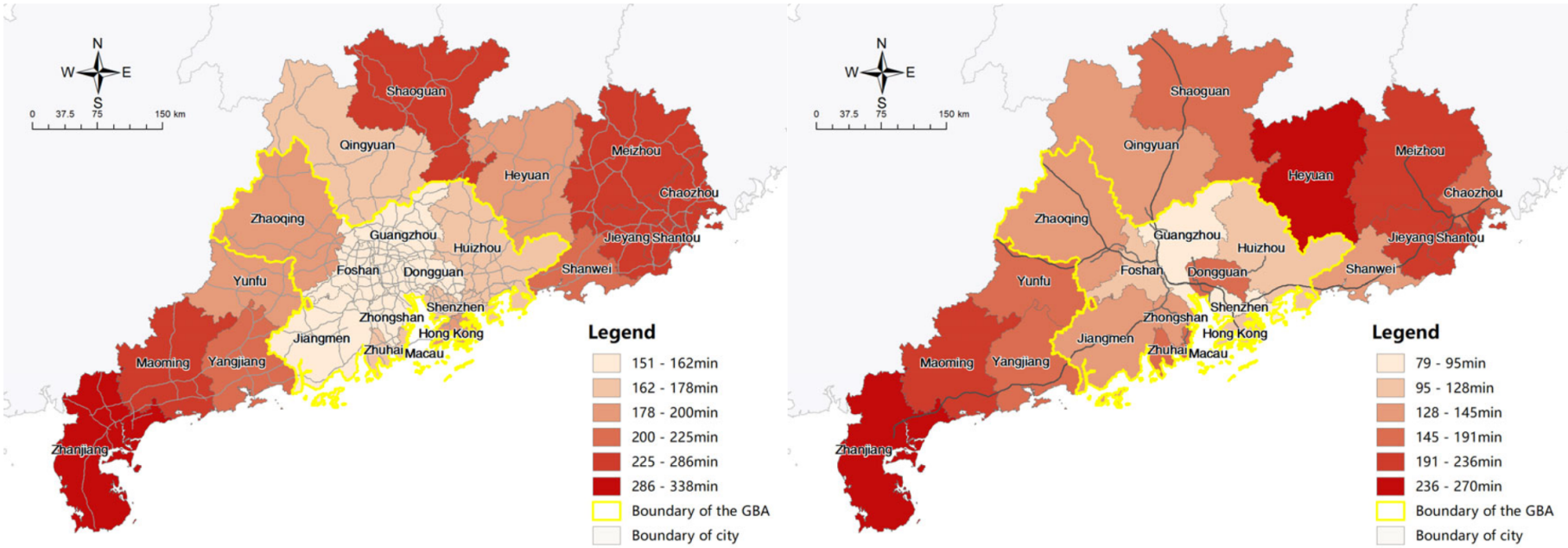
Binary tree classification



Detailed research workflow

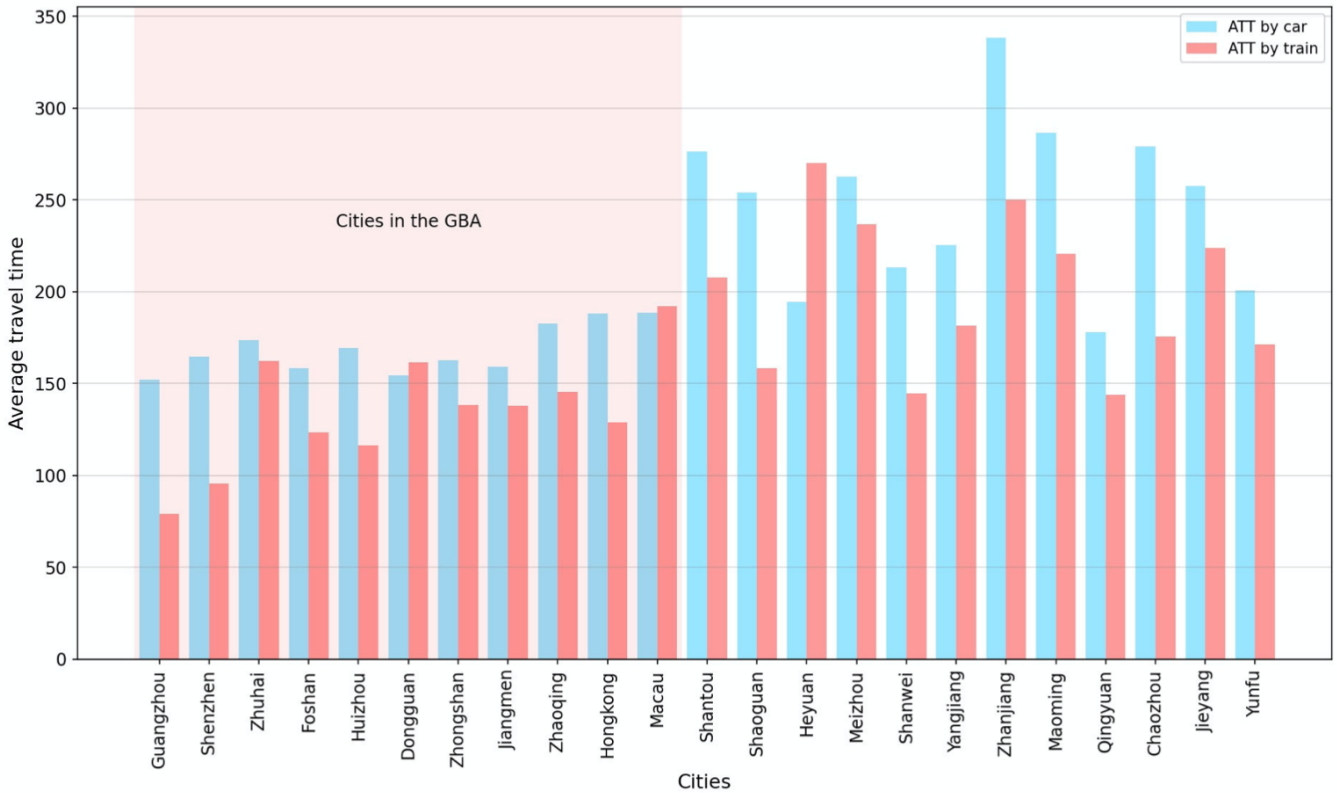


Travel time improvements



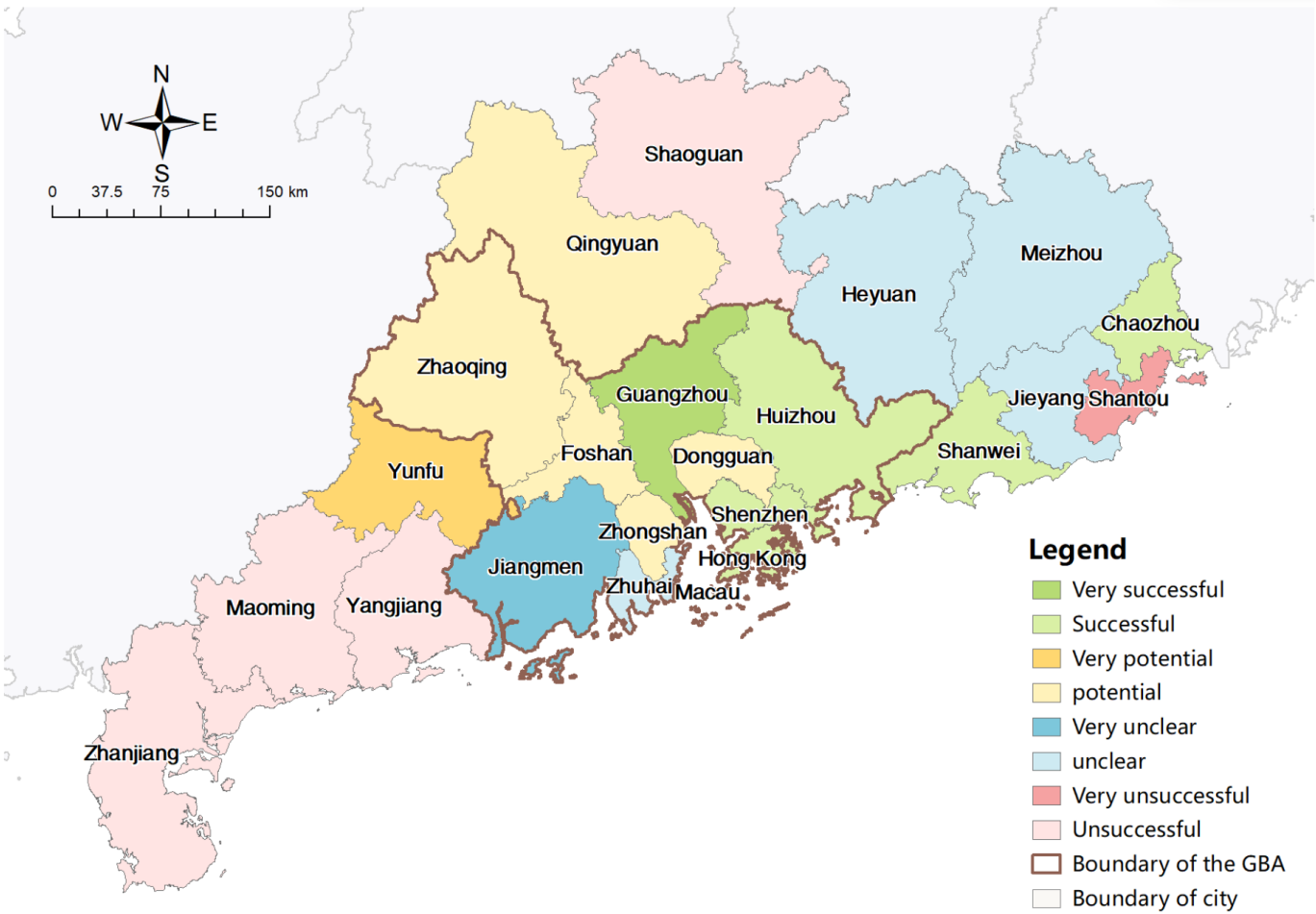
ATT by car (left) and HSR (right)

Increased access inequalities



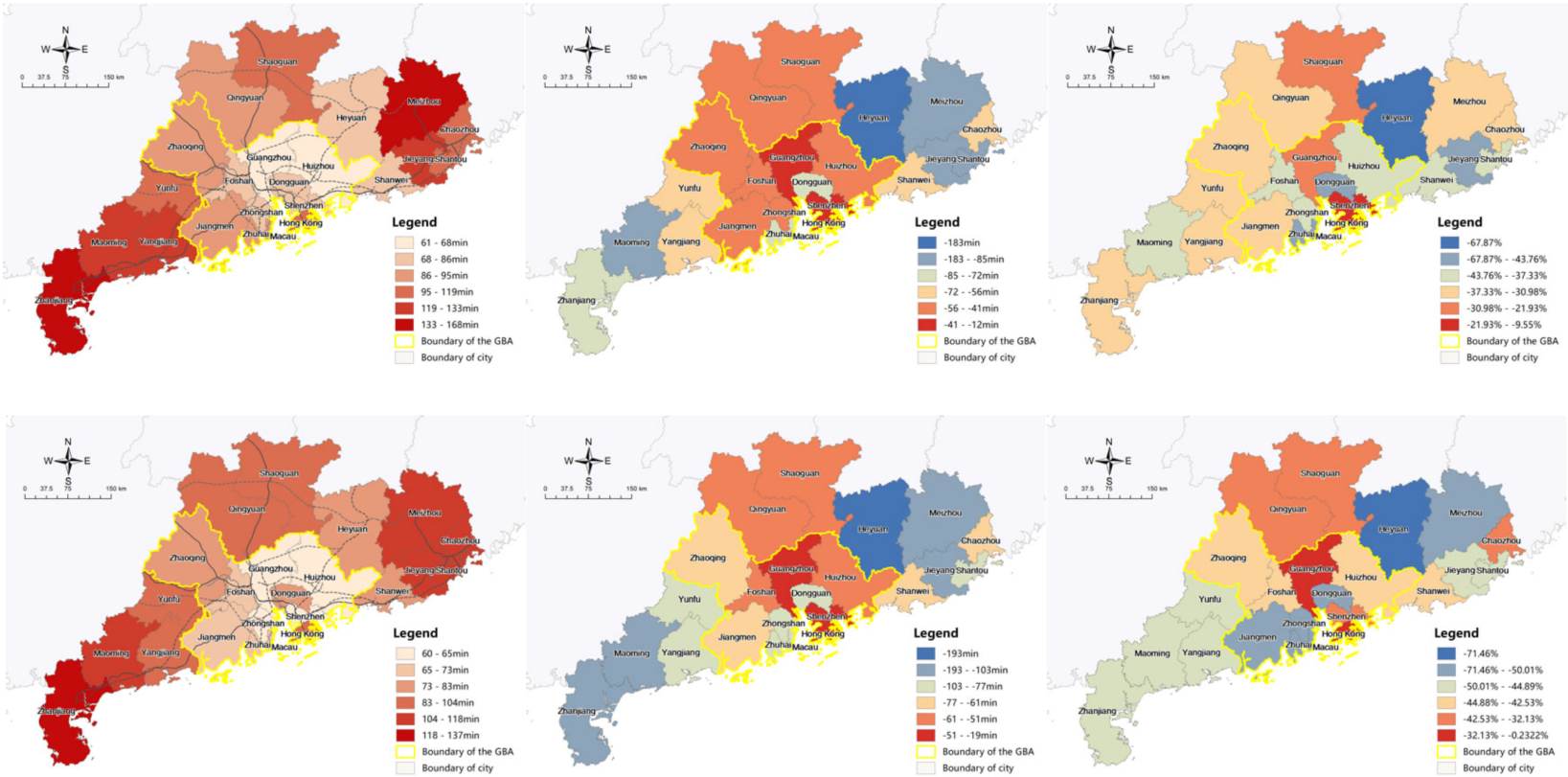
- Increase in CV in GBA from 7.81% to 23.50%; 25.08% to 29.26% in Guangdong: increased access inequality
- Similar results with potential and travel flows

City classification



Synthesis: consequent improvements in accessibility, but increase in access inequity; centre-periphery pattern

Impact of new lines



ATT improvements for short term (top) and middle term (bottom) scenarios

Rebalancing and decrease in inequality; similar results for potential and simulated flows

Discussion

Possible extensions

→ spatial resolution: new mobility data

→ multi-modal accessibility

→ accessibility and socio-economic categories

Planning and theoretical implications

→ issue of differentiated network development - compromise between spatial and temporal scales and levels of the urban hierarchy

→ role of incentives and policies to foster the impact of access improvement on land-use: co-evolution [Raimbault, 2021]

→ simulation models to better understand the interplay between governance and the land-use transport interaction system across scales, in particular within MCRs [Raimbault and Le Néchet, 2021]

Conclusion

$\rightarrow$ A study of HSR and transport equity in the GBA, using detailed train timetables

$\rightarrow$ Immediate impacts of HSR increase access inequalities, which are decreased by future plans

$\rightarrow$ Implication for planning and policies: compromise between short and long term effects and between scales, interactions between transportation and land-use

Open repository

`https://github.com/lizhiyuan913/Traffic_Equity_in_the_GBA`

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