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Rail Transportation Lead to Urban Form Changes: Case Study of Beijing-Tianjin-Hebei Region

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BEIJING JIAOTONG UNIVERSITY - SCHOOL OF ARCHITECTURE AND DESIGN

UC-BJTU FUTURE CITY CO-LAB

Outline

1. **National Level:** HSR in China
2. **Regional Level:** JJJ Region on the Rail
3. **City Level:** Synergy Development— Integration between Urban Space and Rail Transportation

Problems

China：Nation on the Rail

Urbanization and Railway Construction Railway is a critical transportation infrastructure that impact regional and economic development.

Railway is firmly associated with urbanization and the development metropolitan areas.

The Development History between Rail Construction and Urbanization

- “First Five Year Plan”, begin construction era
- Cultural revolution period: stopped and stagnated
- After economic Reform and Open-Up: Adjustment and Development
- 21st century: Golden time for High-speed Railway

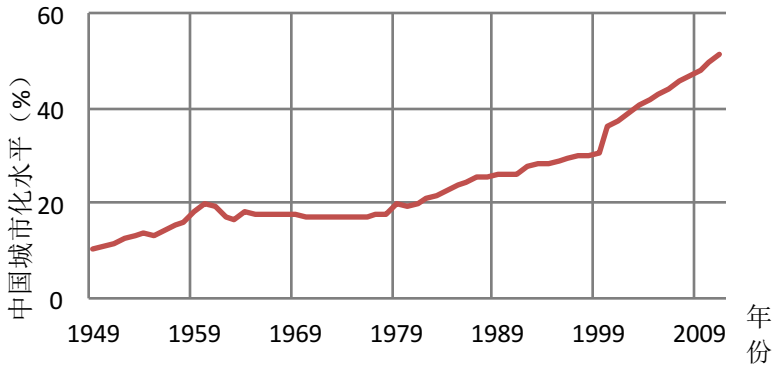


Figure. Urbanization in China after 1949

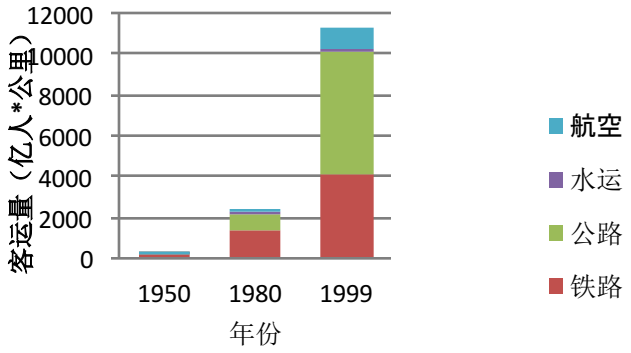


Figure Percentage of Railway Ridership Change

Before 2000：Miles issues
After 2000：Speed issues

Rail Development

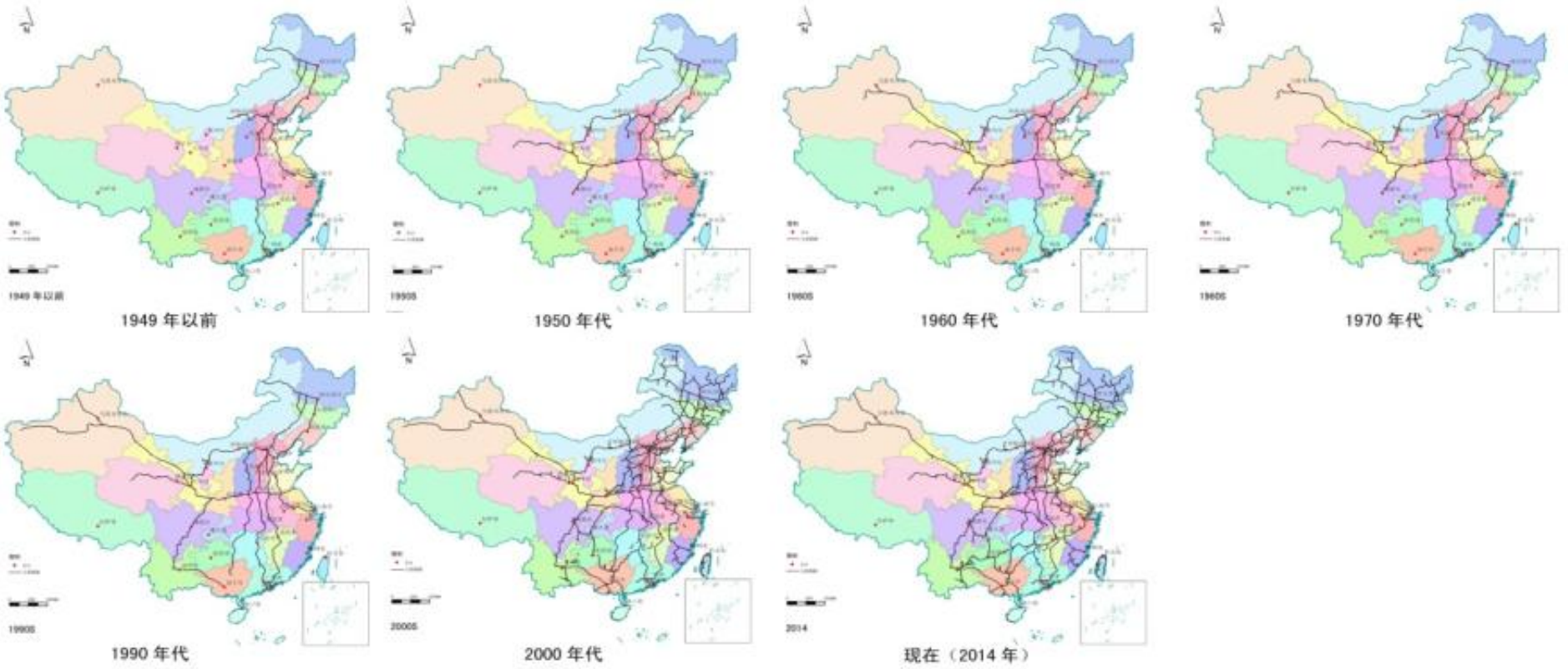


Figure. Railway development in China

China high-speed railway has achieved several **No.1** in the world.

1、The longest operating length--20 ,000 km

2、The highest operating speed-- 486.1km/h

3、The world's highest level —Beijing-Shanghai HSR

4、The world's first newly built in alpine region—Harbin-Dalian HSR

5、The longest operating length— Beijing - Guangzhou HSR 2298km

6、The world's first one-time completed high speed railway with the longest operating length— Lanzhou-Xinjiang HSR 1776

HSR in China

Operating length in China： 20000km

HSR and Mega-region

On national level, HSR promotes mega-region development

- **Population Density**

  Improve Mobility： connection intra mega-regions

  500,000 people per day on Jing-Hu line

  Lan-Xin line on the silk road as 2rd Euro Asia Land Bridge

- **Improve Accessibility： connection inter mega-regions**

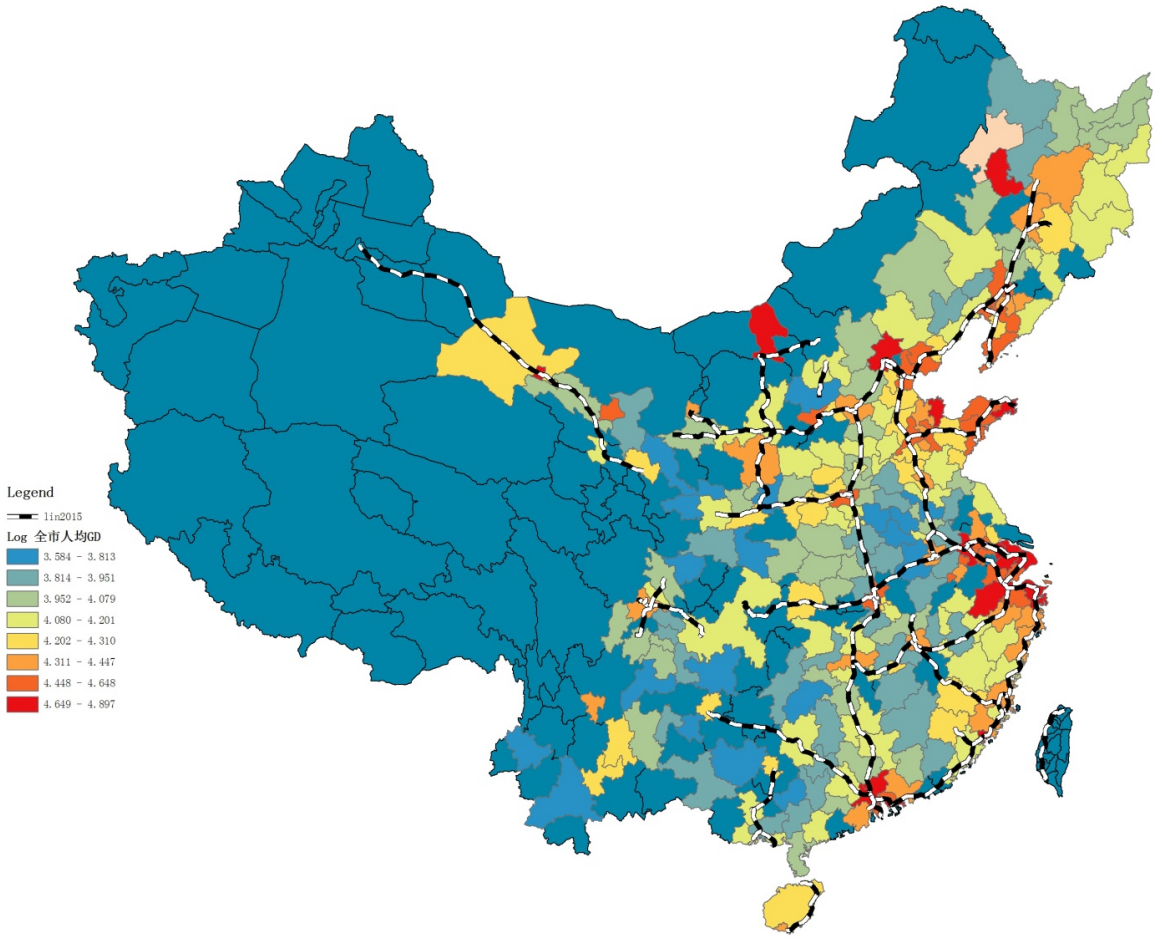
- Current Character:
  Fragmentation High-density region oriented

Figure High Speed Railway in China and Metropolitan Areas

HSR Planning in 2020 – What will happen next ?

HSR and Mega-region

On national level, HSR promotes mega-region development



- **Per Capita GDP Perspective**
- **Connectivity of the rich cities and regions**

  Cities along Jing-Hu line accounts for 32.8% of the total national gross income, connecting the richest regions in China.
- **Regional gap might be larger due to un-balanced spatial distribution of HSR**

Developed areas become better, while undeveloped areas enjoy little benefit

Brief summary

On national level, HSR promote the regional un-equilibrium:

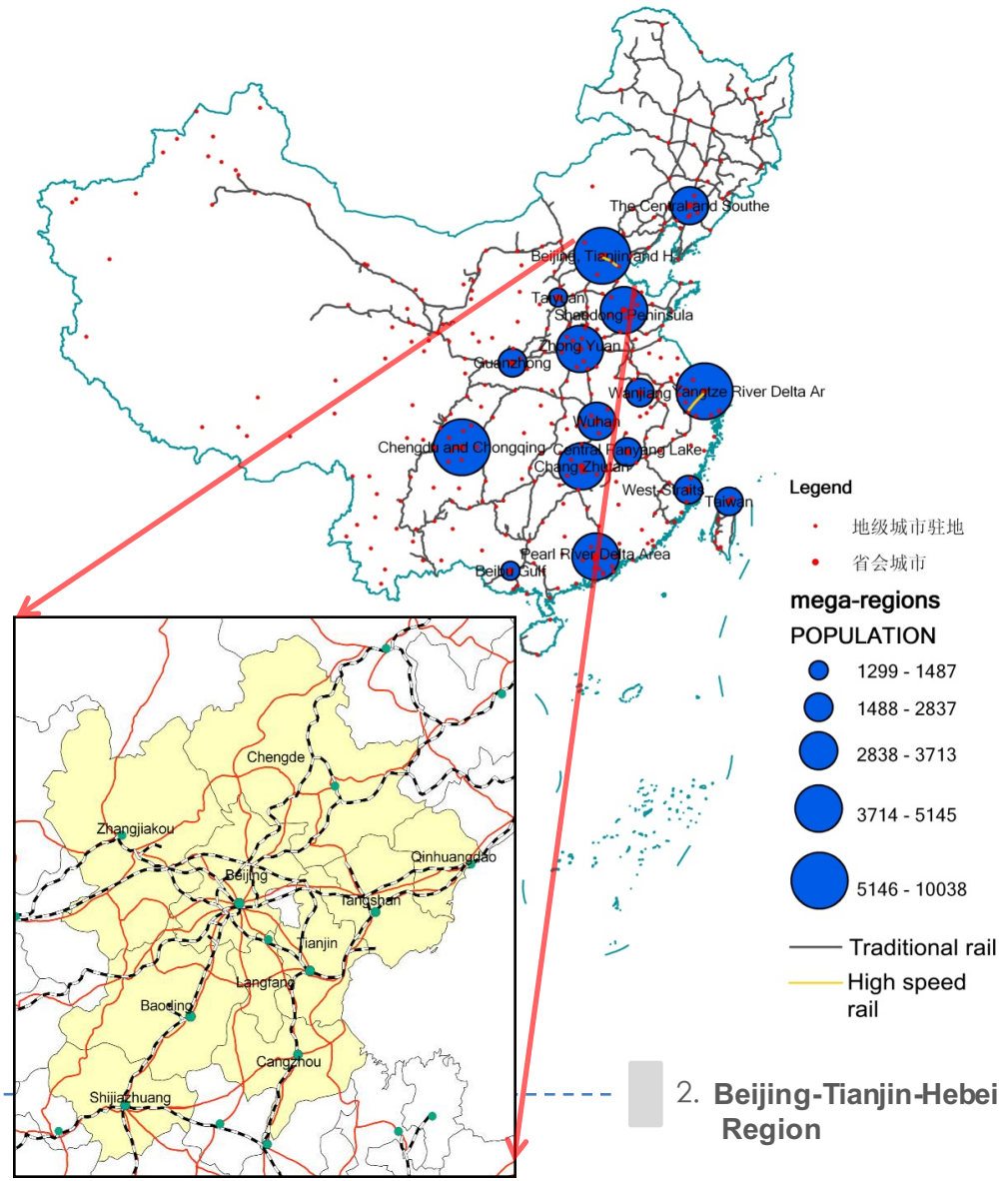
1）Double effect on national and regional development. It changes from equilibrium to uneven. The agglomeration for big cities and mega-regions are more obvious due to time-spatial compression effect.

2） Change of city-region relationship—benefits from pass-by to nodes. Conventionally, the allocation of railway stations benefits city development. However, in high-speed railway era, the benefits requires good connection of high-speed railway stations and urban space.

2 JJJ Region on the Rail

Location of Beijing-Tianjin-Hebei

Mega-Regions	Population In 2009 (10 Thousand)	Land Area(km2)	Built-up Area (km2)	GDP (100 million Yuan)	Central City	Secondary Central City	Other Cities	Total No. of cities
Yangtze River Delta	7837	100704	3324	51991	Shanghai	Nanjing, Hangzhou	Suzhou,Changzhou,Yangzhou,Wuxi, Zhenjiang,Taizhou,Nantong,Jiaxing, Huzhou, Shaoxing, Ningbo, Zhoushan	15
Pearl River Delta	5145	74187	2577	30492	Guangzhou	Shenzhen	Zhuhai, Zhongshan, Foshan, Dongguan, Huizhou, Jiangmen, Qingyuan, Zhaoxing	10
Beijing, Tianjin and Hebei	7340	182501	2836	29835	Beijing	Shijiazhuang	Tangshan, Baoding, Langfang, Qinhuangdao, Chengde, Zhangjiakou, Cangzhou	10
Shandong Peninsula	3713	117241	1488	14794	Jinan	Qingdao	Yantai, Weihai, Weifang, Zibo, Dongying, Rizhao	12
West-Straits	4021	73855	1437	20302	Fuzhou	Xiamen	Zhangzhou, Quanzhou, Putian, Ningde	8
Central and Southern Liaoning Province	2606	55875	580	8704	Shenyang	Dalian	Anshan, Benxi, Fushun, Liaoyang, Yingkou, Panjin, Jinzhou, Huludao, Tieling, Dandong	6
Central Panyang Lake	2358	76646	377	4002	Nanchang	Jiujiang	Fuzhou, Yingtan,Shangrao, Jingdezhen	6
Wanjiang	2837	71992	731	5684	Hefei	Wuhu	Ma'anshan,Tongling,Anqing,Chaohu,Yicheng, Chizhou,Chuzhou	9
Zhong Yuan	4291	58719	973	10562	Zhengzhou	Luoyang, Kaifeng	Xinxiang, Jiaozuo, Xuchang, Pingdingshan, Luohe, Jiyuan	9
Wuhan	3112	58052	773	6972	Wuhan	Wuhan	Huangshi,Ezhou,Xiaogan,Huanggang,Xianning, Xiantao, Qianjiang, Tianmen	9
Chang Zhutan	4110	96951	758	8761	Changsha	Zhuzhou, Xiangtan	Yueyang,Changde, Yiyang, Loudi, Hengyang	8
Beibu Gulf	1299	42473	320	2220	Nanning		Beihai, Fangchenggang, Qinzhou	4
Chengdu and Chongqing	10038	224132	1723	15601	Chongqing,Chengdu		Zigong,Luzhou, Deyang, Mianyang, Suining, Neijiang, Leshan, Nanchong, Meishan, Yibin, Guangan, Yaan, Ziyang	15
Guanzhong	2314	55498	547	4319	Xian		Xianyang,Baoji,Weinan,Tongchuan, Yangling	6
Taiyuan	1487	74321	363	3287	Taiyuan		Jinzhong, Yangquan, Xinzhou, Lvliang	5
Taiwan	2304	35990	-----	26301	Tai Bei		Taibei,Jilong,Gaoxiong,Taizhong,Tainan	9

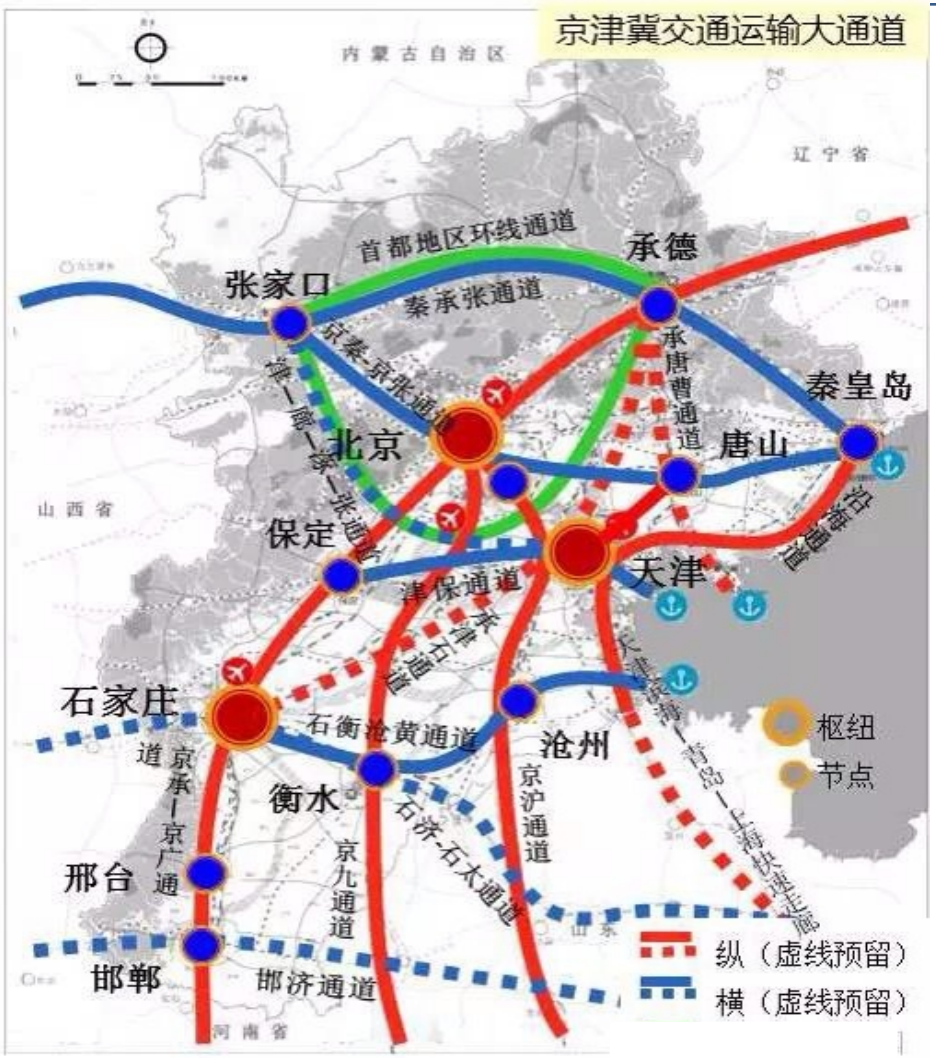


2. **Beijing-Tianjin-Hebei Region**

Regional Transportation Planning of Beijing-Tianjin-Hebei:

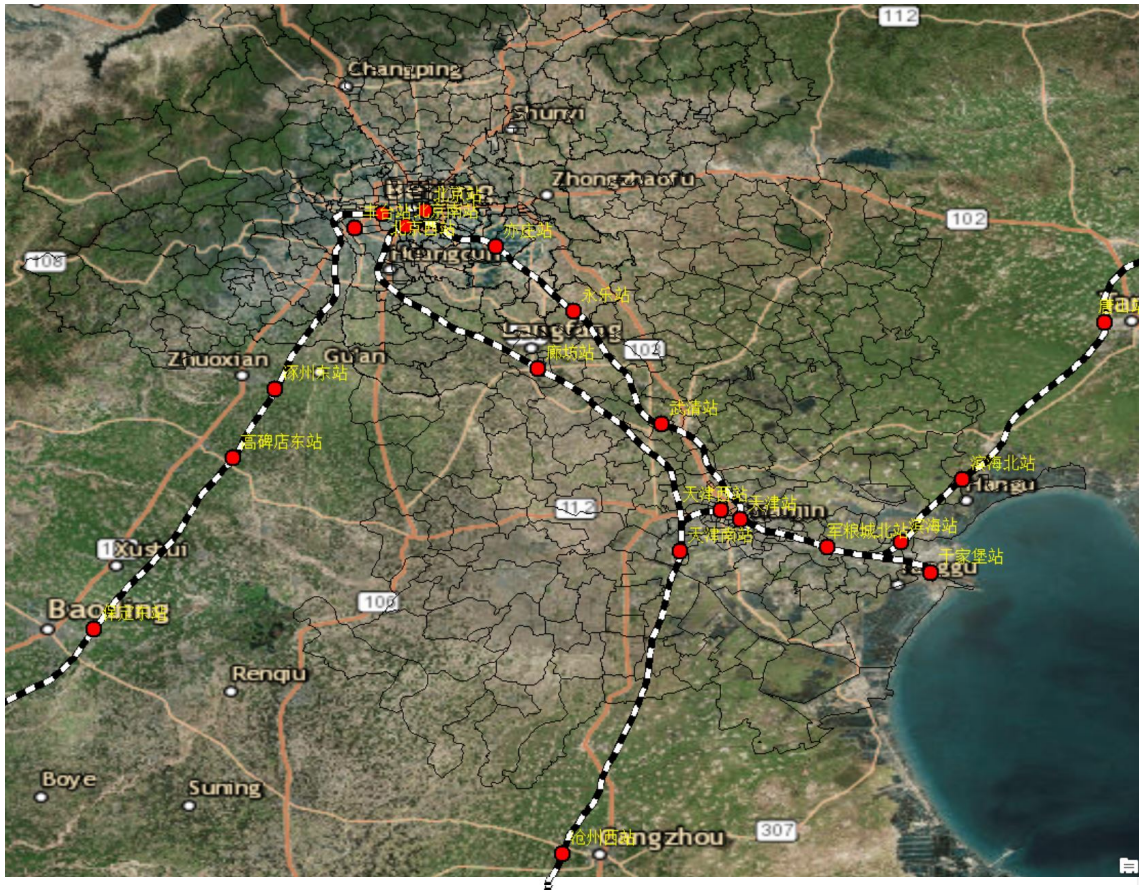
Three center: Beijing, Tianjin, and Shijiazhuang
Travel Mode: Rail transportation and urban metro, forming 1 hour commuting zones

Rail transportation plays an important role on regional development



2 JJJ Region on the Rail

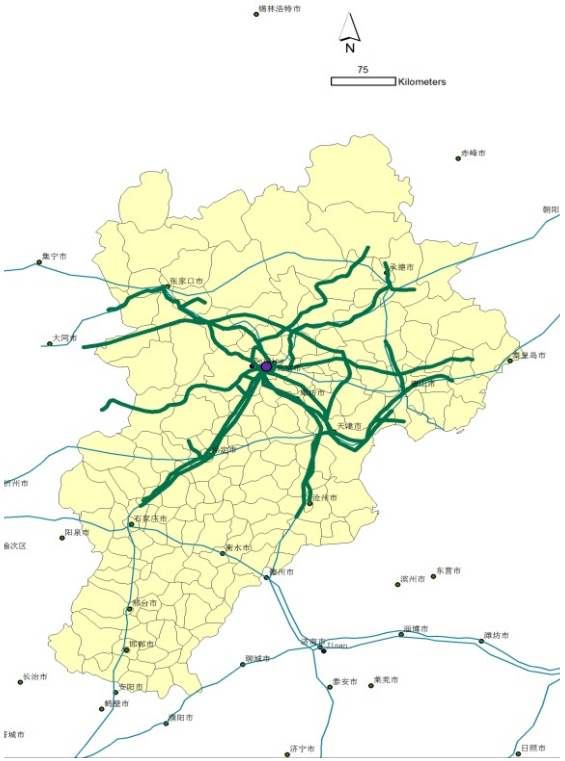
- Two issues with the development of HSR
- Connectivity between HSR and Urban Metro network
- Synergy and integration of HSR and surrounding region area



2 JJJ Region on the Rail

Accessibility of county level cities

Using GIS network analysis, calculate average commute time from county-level cities to 13 regional-level cities.



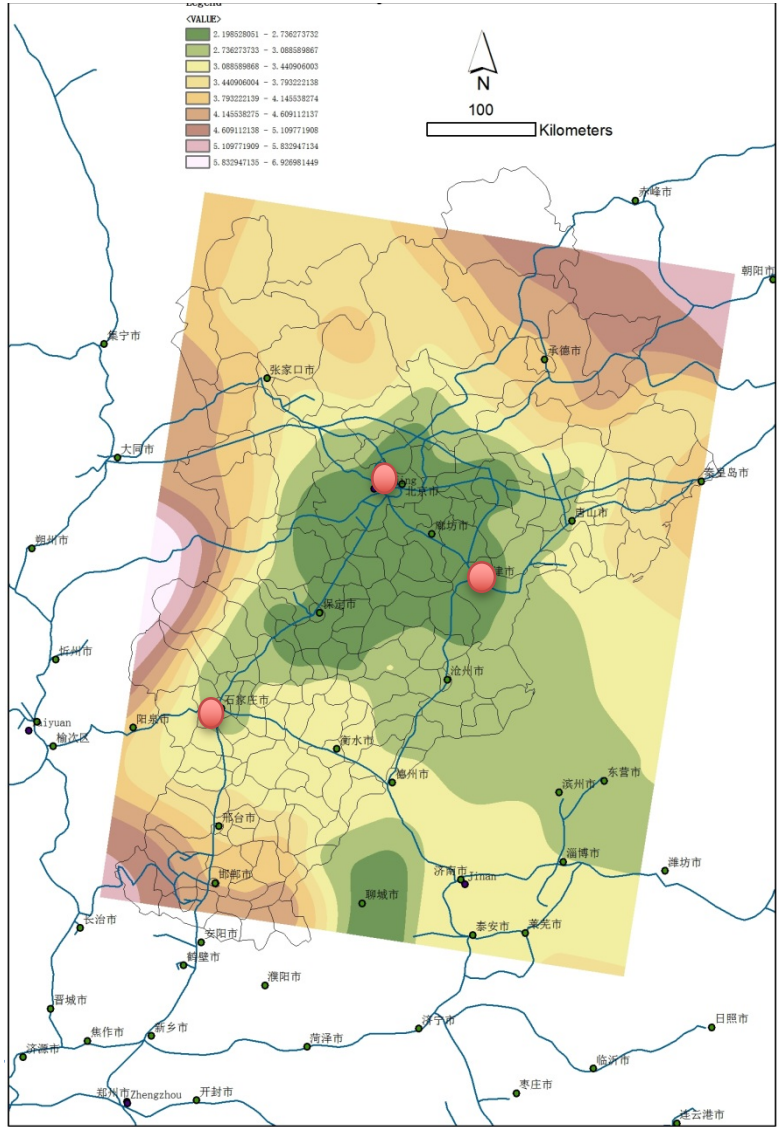


图 京津冀地区的普通铁路支持的可达性计算（作者自绘）

Characteristics of accessibility

accessibility is high when county level cities are along the major rail lines

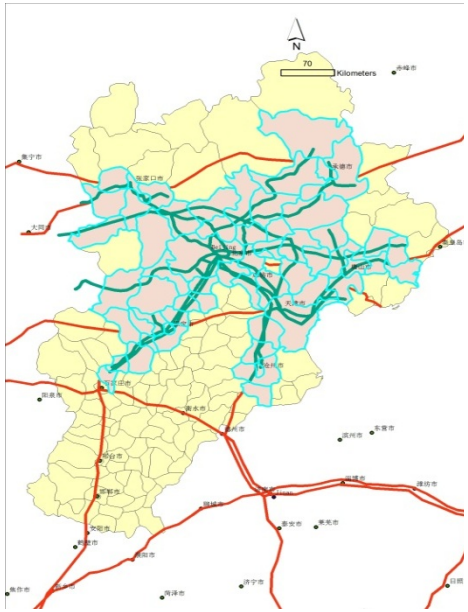
There will be benefits as soon as railway goes through.

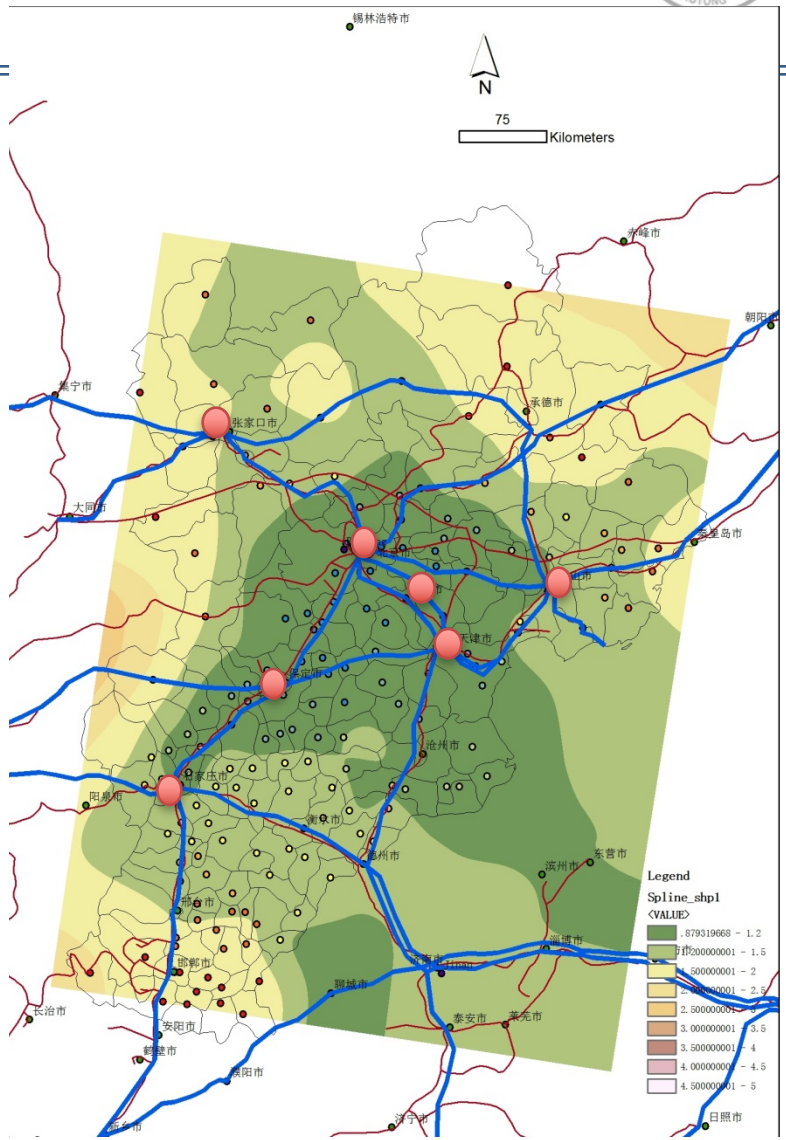
2 JJJ Region on the HSR

Synergy Development

One-hour commuting circle under high-speed rail system scenario

One-hour commute circle expands 5 times, which covers Beijing, Tianjin, Shijiazhuang, and most 9 cities





The difference of Accessibility in regional Space

County level unit with stations will have better accessibility

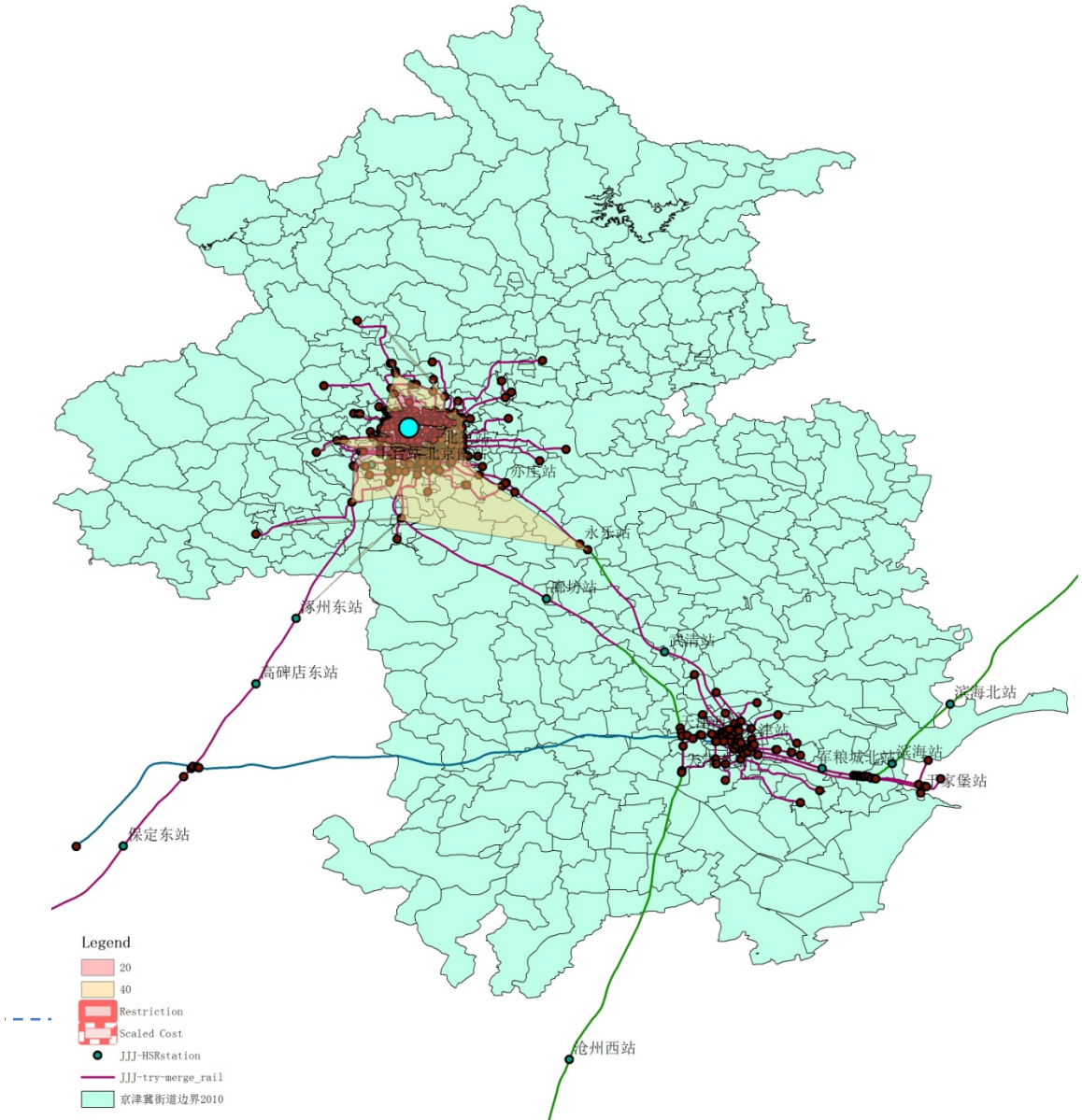
node effect bring benefits, which should be the major consideration on allocation of stations.

图 京津冀地区的高速铁路支持的可达性计算

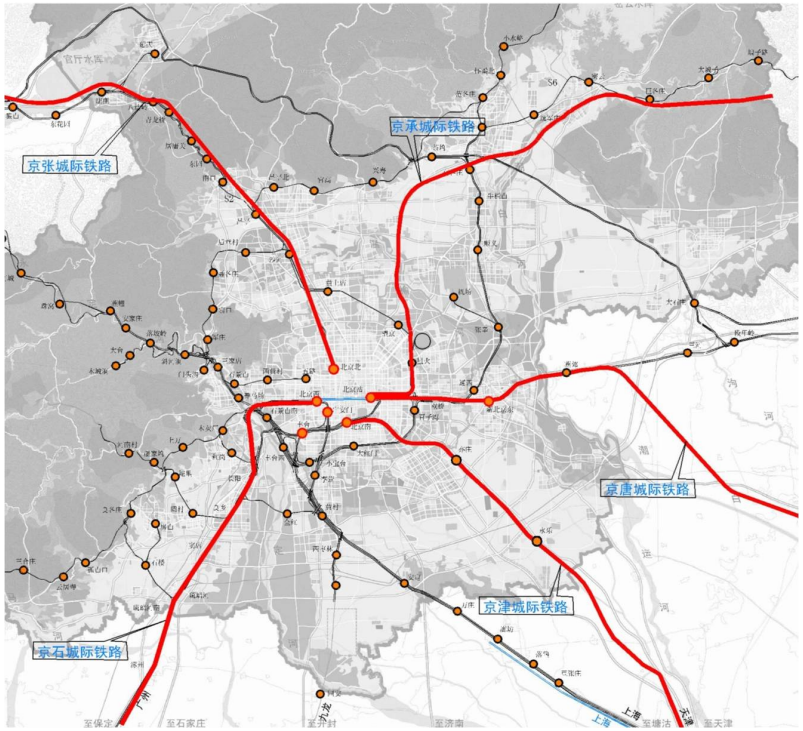
2 JJJ Region on the Rail

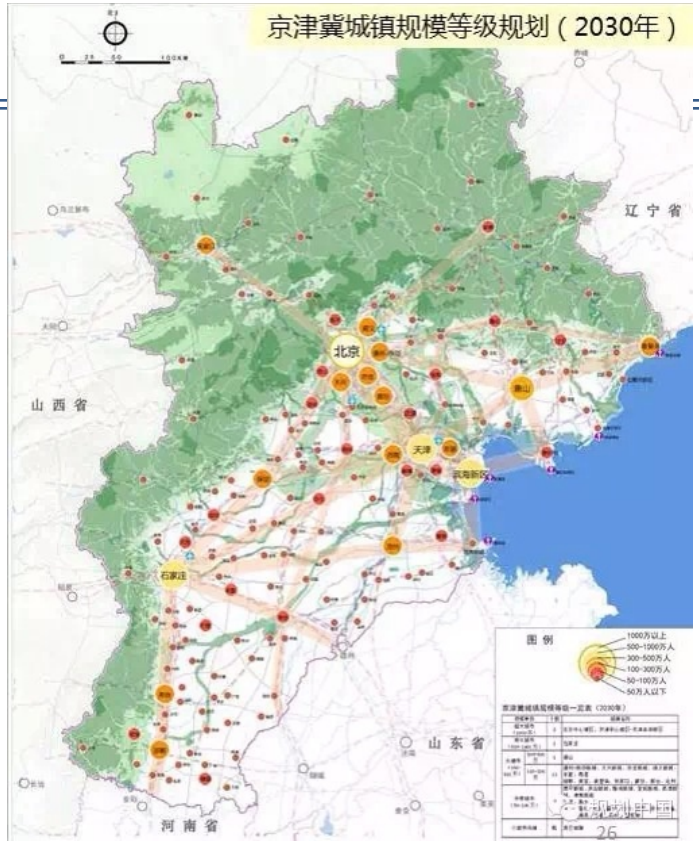
Connectivity between networks：

- Service Area within 30 min and 60 min, from Beijing South Station, Beijing North Station and Changping Station
- Travel times are longer intra-city and inter-city
- Transfer efficiency among different travel mode becomes critical issued to improve connectivity



3 Synergy Development





The impact of high-speed railway stations on city space is not only at individual points, but a connection joint to network to the whole region. In Beijing- Tianjin-Hebei Region, the connection of high-speed railway network and city space supports the idea of regional integration.

3 Synergy Development

Comparison of population change before / after high-speed railway construction

- Although the accessibility of fringe of metropolitan increases, connectivity is strengthened, however, Population is moving out of the remote cities

Better transportation draws more population concentration, especially in Beijing and Tianjin areas

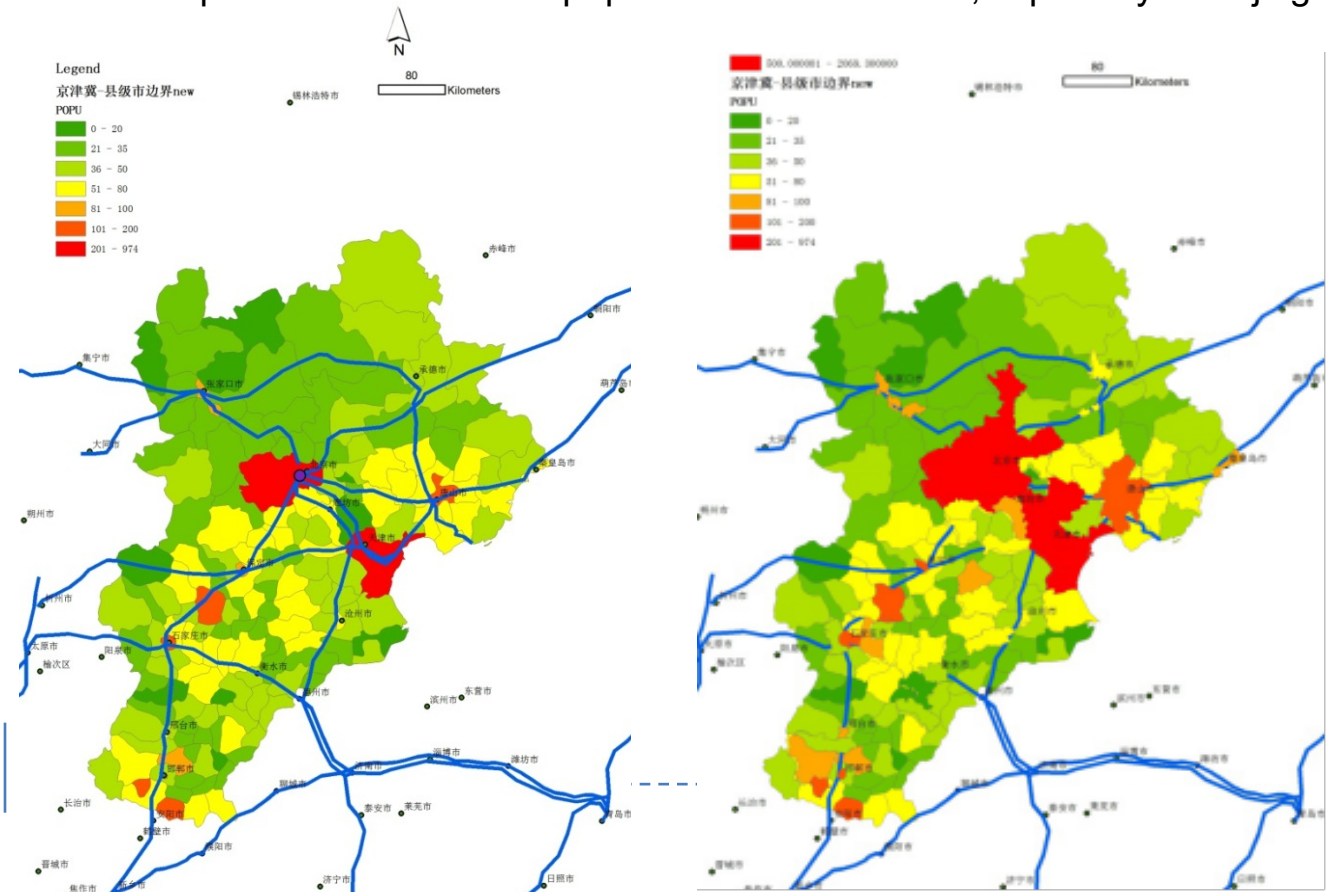


Figure Comparison of population change after high-speed railway is completed

Beijing-Tianjin-Hebei region -- HSR and commuting across cities

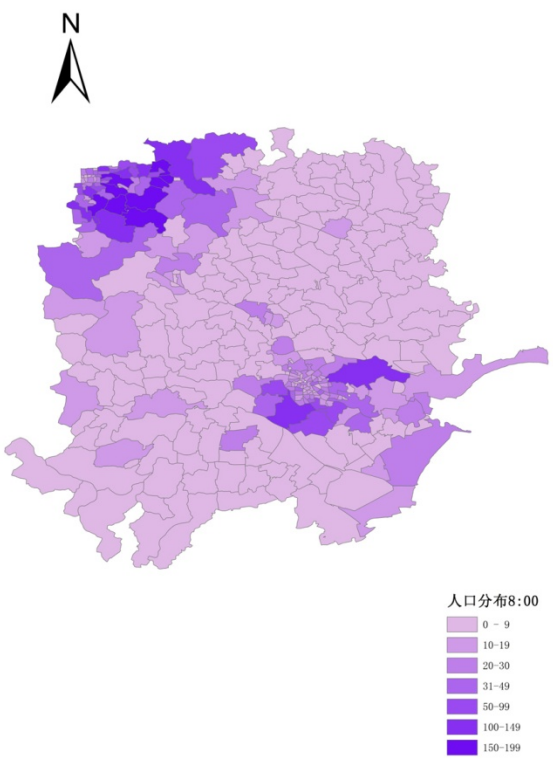
京津高铁 Along Jing-Jin Line

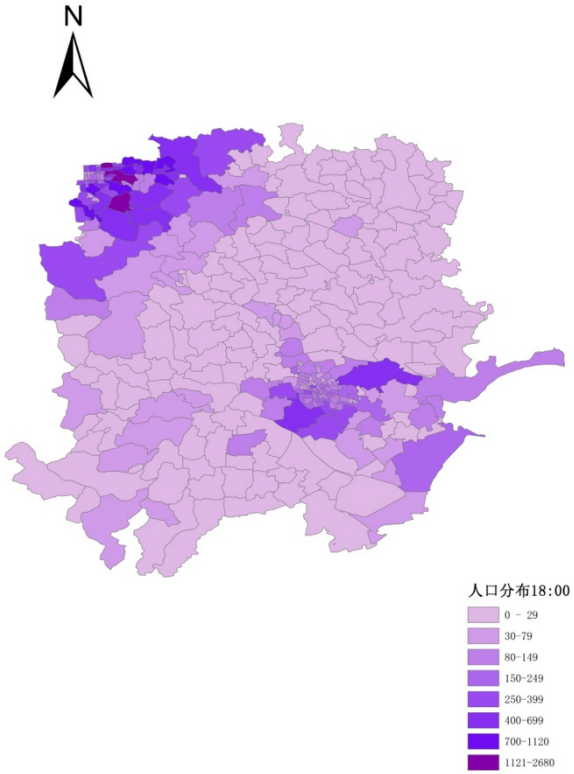
- **Population Mobility**

  90 pair HSR trains carry 50,000 commuters

- **Spatial Mismatch across cities**

  Daily Commuting across the administrative boundary





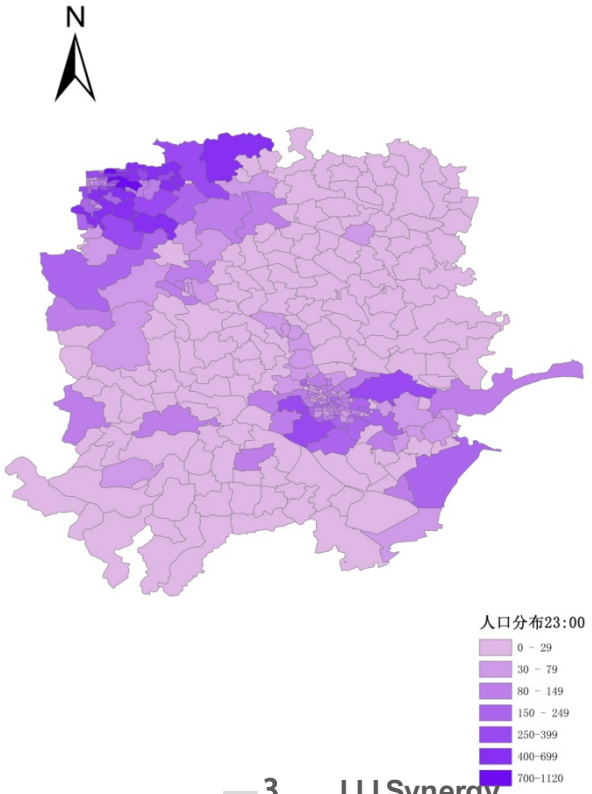


图 京津冀地区的普通铁路支持的可达性计算（作者自绘）

3 Synergy Development

1） City rail transit and city inner population space change

Simultaneously, Suburbanization and concentration happens

Trend of Scattering: suburbanization happened because rail transit system connected center and suburb areas. (Typical regions: Tongzhou Guanzhuang, Changping Huilongguan, Tiantongyuan, Daxing)

Trend of Concentration: Population density increased at rail transit system nodes, especially at the areas where rail transit system is with high density

Simultaneously, Scattering and clustering happens

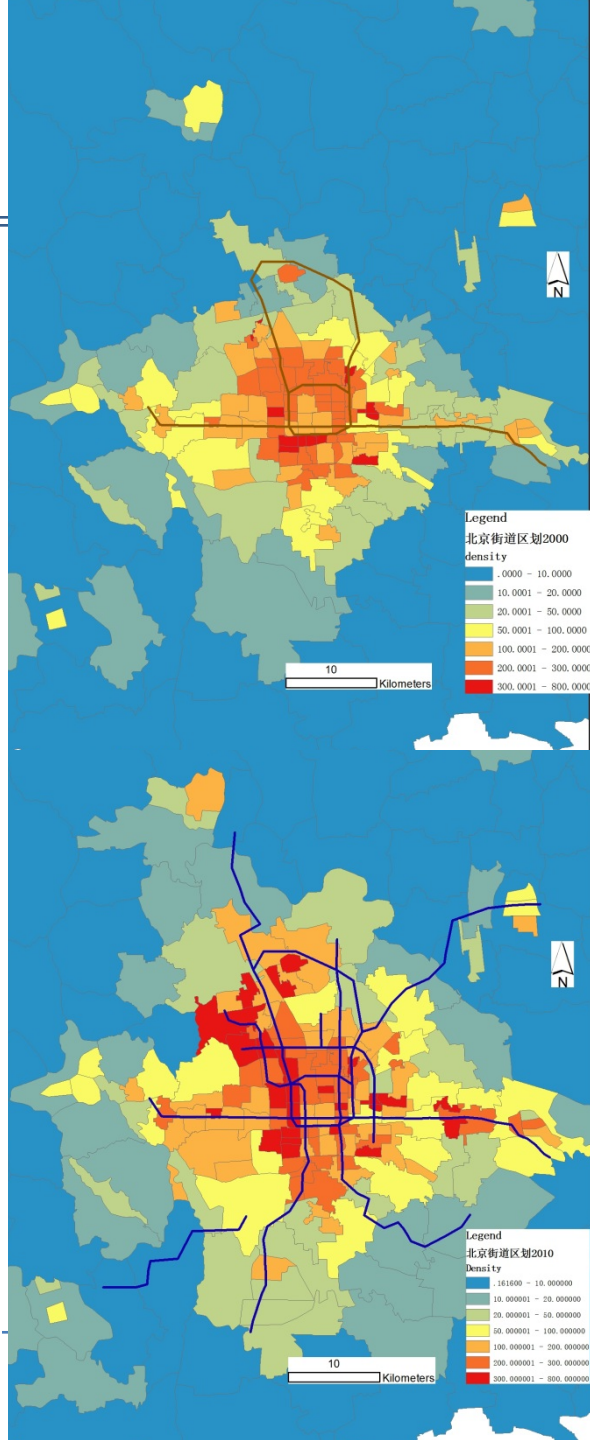
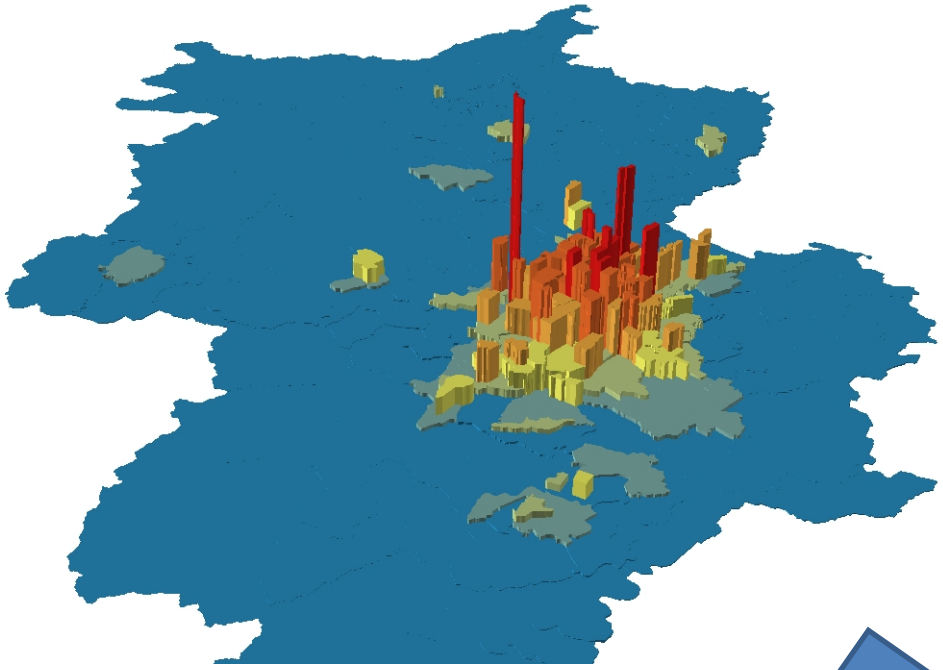


Figure. Evolution of Beijing job population distribution 2000(up) and 2010 (bottom).

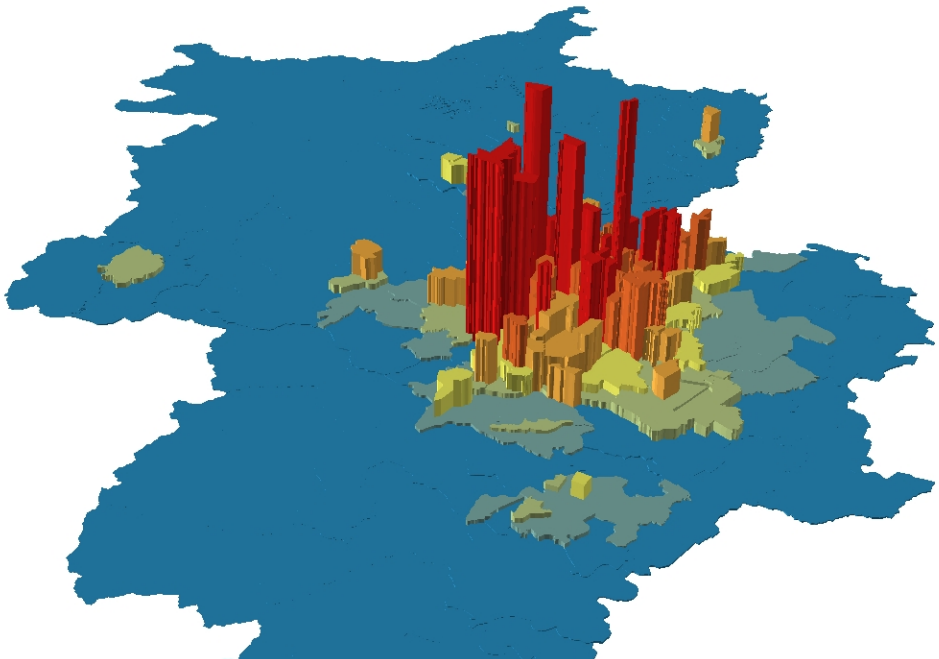


population distribution: Polarization plays a dominant role than Homogenization

•Homogenization and Polarization

Homogenization: since using rail transit system saves time, population distribute along subway lines, which embodies the homogenization of city rail transit system (Line 4 and Line Tongzhou)

Polarization: some nodes have evident advantages, bigger differences in population distribution



2）Job Density Change

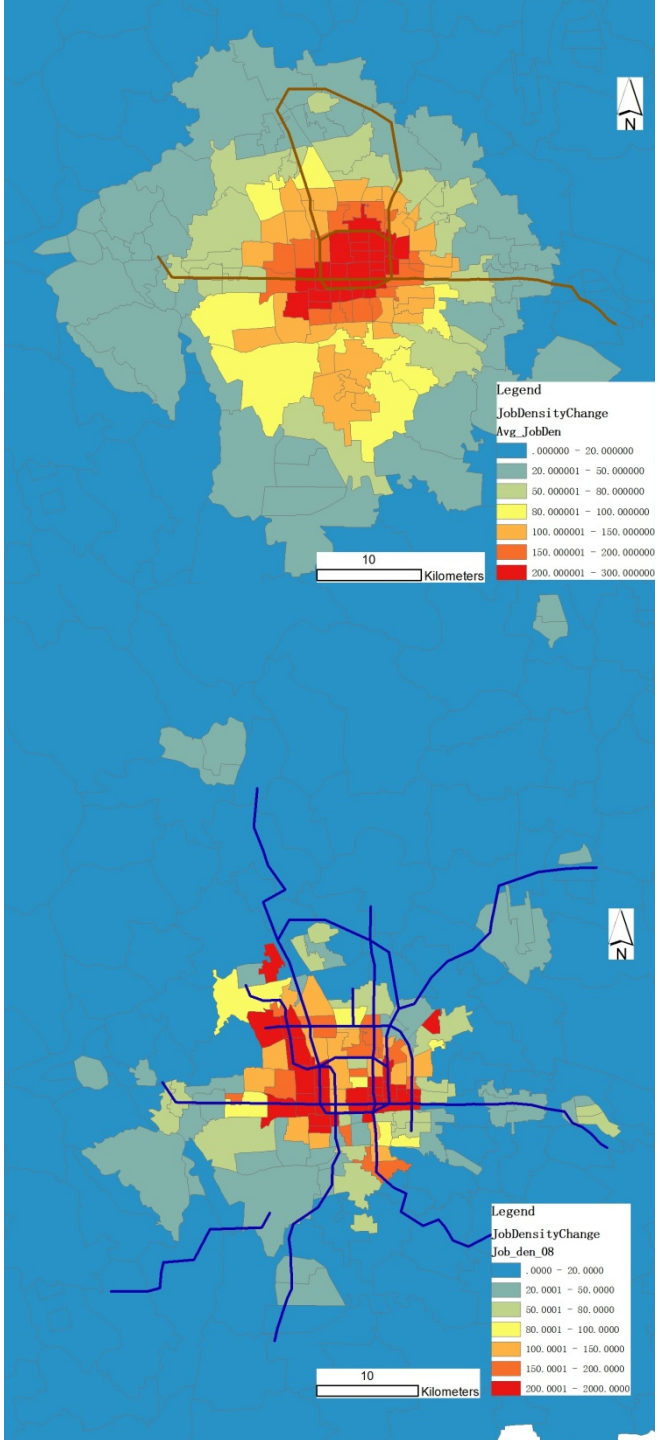
Urban transit system construction and city job space change

• Scattering and concentration

A very strong trend of concentration. Compared with population distribution, the construction of city transit system enhanced the accessibility and concentrated the economic elements. CBD is at the nodes of rail transit system

A weak trend of scattering. While rail transit system provides better transportation, very few job space appears in suburb areas. Two expectations are Shangdi and Dashanzi areas.

——The effect of concentration is bigger than that of scattering.



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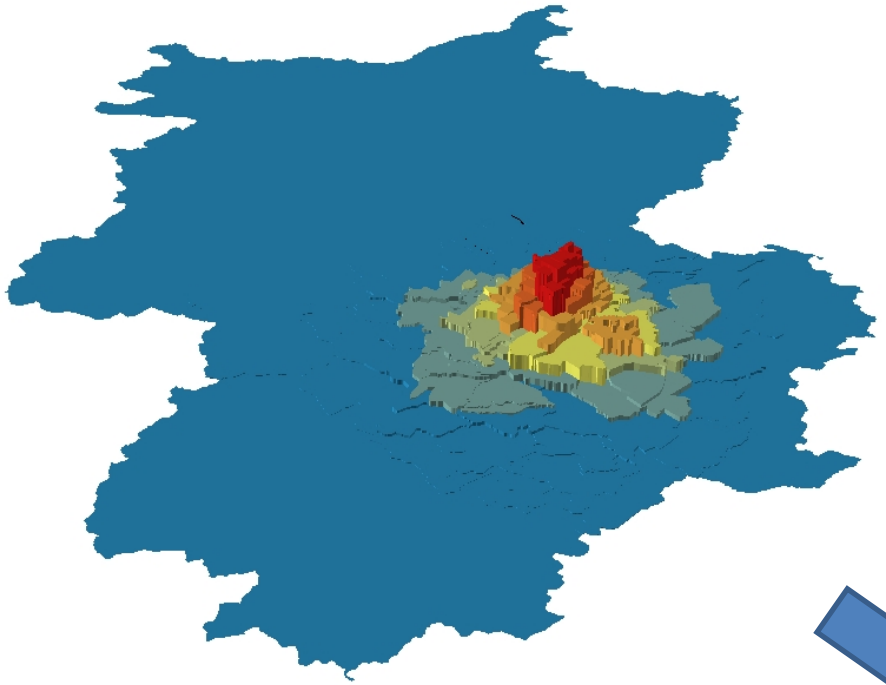
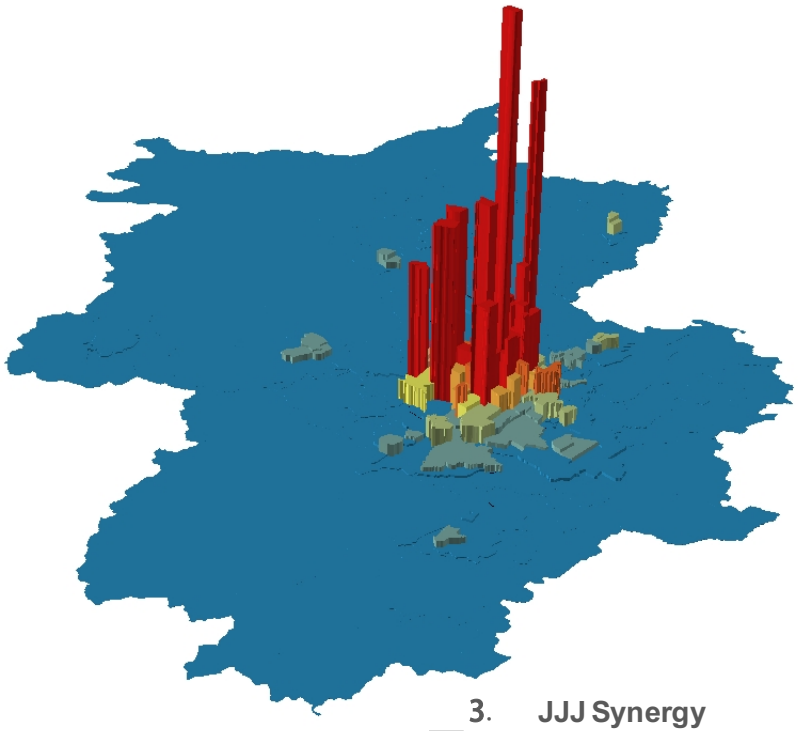


Job density: Polarization plays a dominant role.



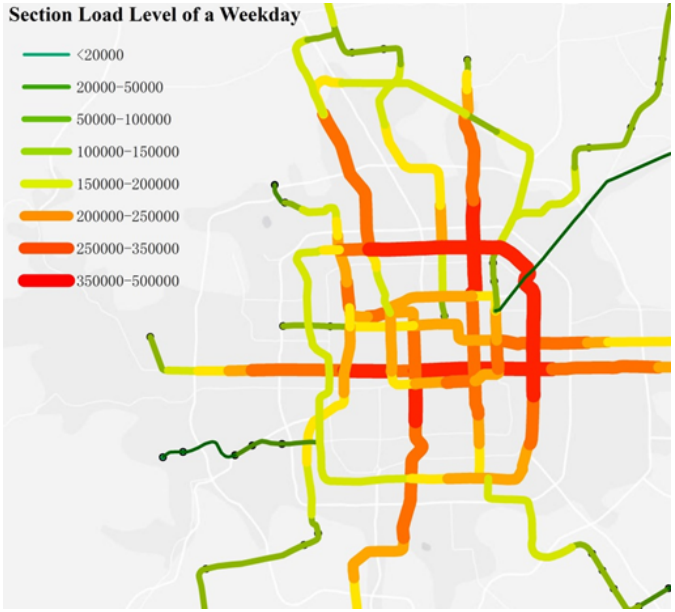
•Homogenization and Polarization

-Compared with population change, polarization is more dominant in job distribution

-Regional differences are more evident. City job space is not Homogenized.

3 Synergy Development

- From perspective of Job/ Housing Ratio, High-speed railway stations have good connectivity with city rail transit system, which brings more regional economic impact.
- City rail transit Passenger traffic shows the volume on the commute oriented city



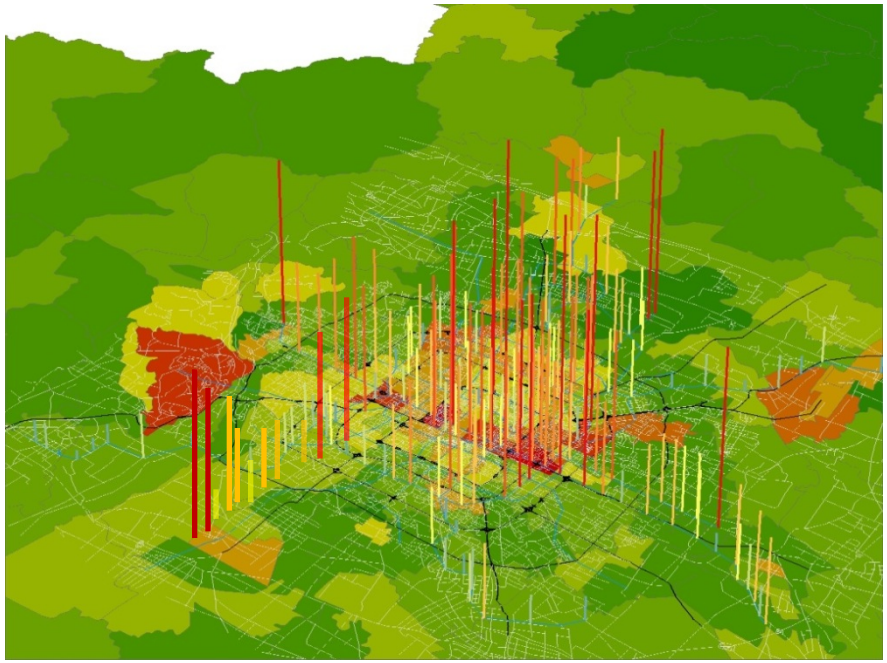


Figure. Beijing Subway system passenger traffic and their work and living locations (2014)

4 Conclusion

1) On metropolitan scale , HSR provides more than transportation infrastructure. Accessibility brings double effects, inducing population and economic elements polarization. Connectivity between and within rail network both matter.
2) On urban scale, urban metro increase urban mobility, while restructuring job/housing spatial distribution. Function adjustment and coordination becomes important.

Suggestions

（1）Strengthen the connection between High Speed Rail and Urban Metro system

Suggestion: to further development of Suburban Railway

（2）Land use should be integrated with surrounding urban metro station

（3）Synergy of rail transportation with urban functions

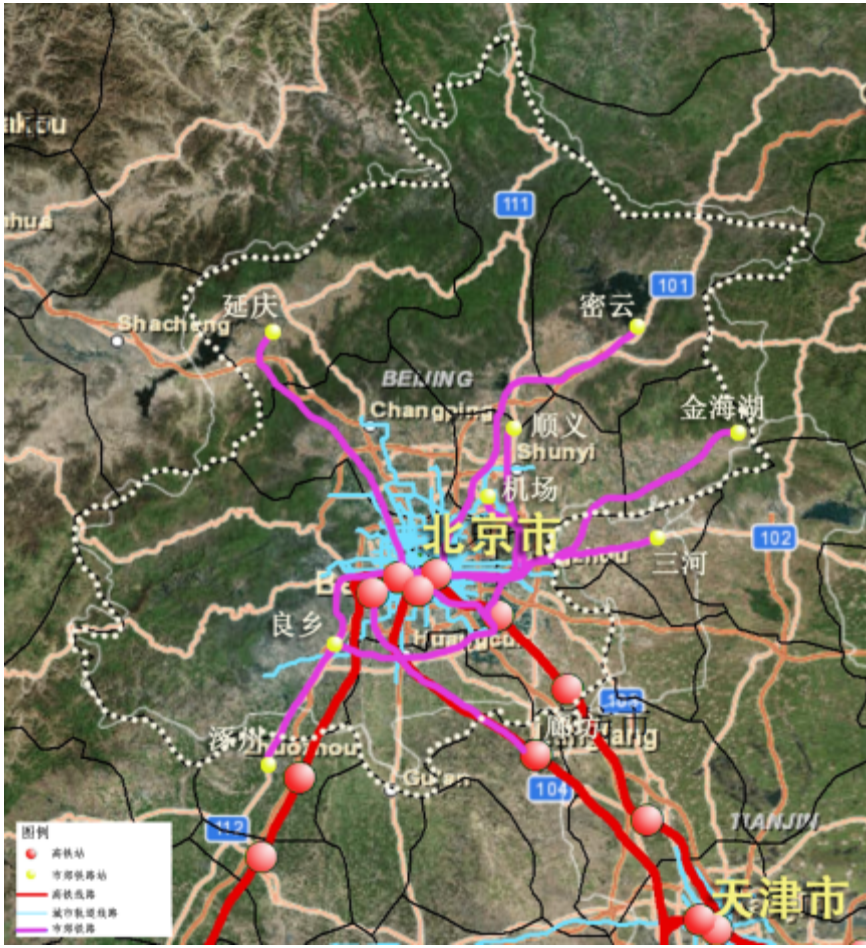


图 北京高铁、市郊铁路、城市轨道交通网络关系示意图

Thanks

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