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Urban Form, Jobs/Housing Relation, Commuting Efficiency of Chinese Cities

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Big questions

- What
- Why
- How
- Where
- Who
- When
- So what...

Urban form

- Urban form: Hard to define, but still an important area/topic of concern for many disciplines

Urban form: Lynch(1981)

- Purposeful human actions, imagination and perception
- Form and quality of human settlement
- Universal value system and lasting characteristics of the above form
- Actions that can change the above

Urban form: Lynch(1981)

- Multiple and conflicting interests
- Decision-making mechanisms: underlying multi-culture and responses to changes
- Theories for rapid and incomplete decisions and answers to questions from the public
- Theories for examining different forms and proposing new feasible forms

Jobs/Housing relation

- A dimension of urban form
- Quantitative/qualitative/spatial relations
- Implications for commuting and congestion
- Reflection of, or de facto social relations and ways of production and social organization/control (e.g., *Danwei*, racial segregation)

Commuting efficiency

- There exists theoretically minimum/maximum average commutes for given jobs/housing relation and/or urban form

- Existing commuting patterns can be improved or optimized via urban form and jobs/housing relation

A two-stage model

- *Jobs-housing relation=f(urban form and other factors)*
- *Commuting efficiency=f(jobs-housing relation and other factors)*

Modifiable unit of analysis

- Where should be the boundary of "urban" in urban form? (or how to define it)

- J/h balance is achieved at the regional level

- Commuting efficiency=f(j/h or urban form): subject to the above

- Who's j/h balance or commuting efficiency and when(temporal issues)?

- How to improve c.e.?

Not just data issues

- Existing studies: survey data, 5-year duration
- Proposed studies: big data, monthly and even daily! Field trips, interviews, etc.
- Urban form and j/h balance: Artifacts of the value system and social relations
- So is commuting efficiency (at least partially)

Prototypes/Theories for j/h, c.e. u.f.

- Theories/Principles: TOD-4D; New Urbanism; Transit Metropolis; Chicago School; LA School…

- Practices: ?

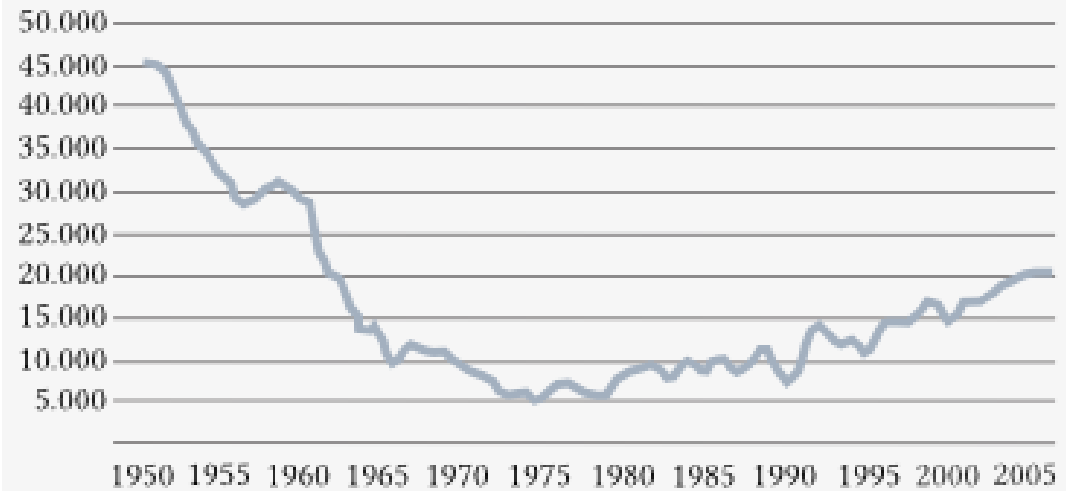- International cases: Copenhagen, Stockholm, Portland, Curitiba
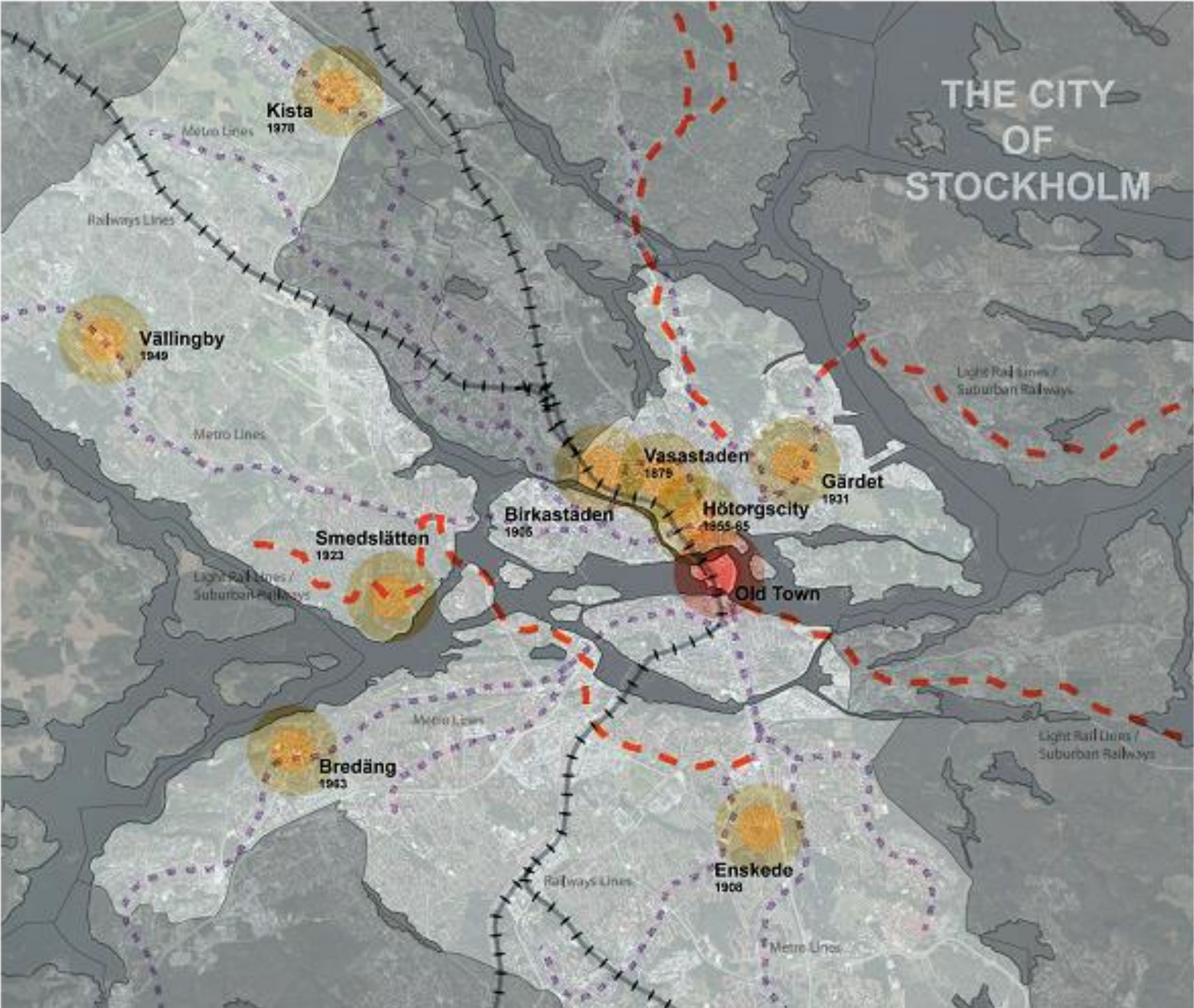
- Chinese cases?
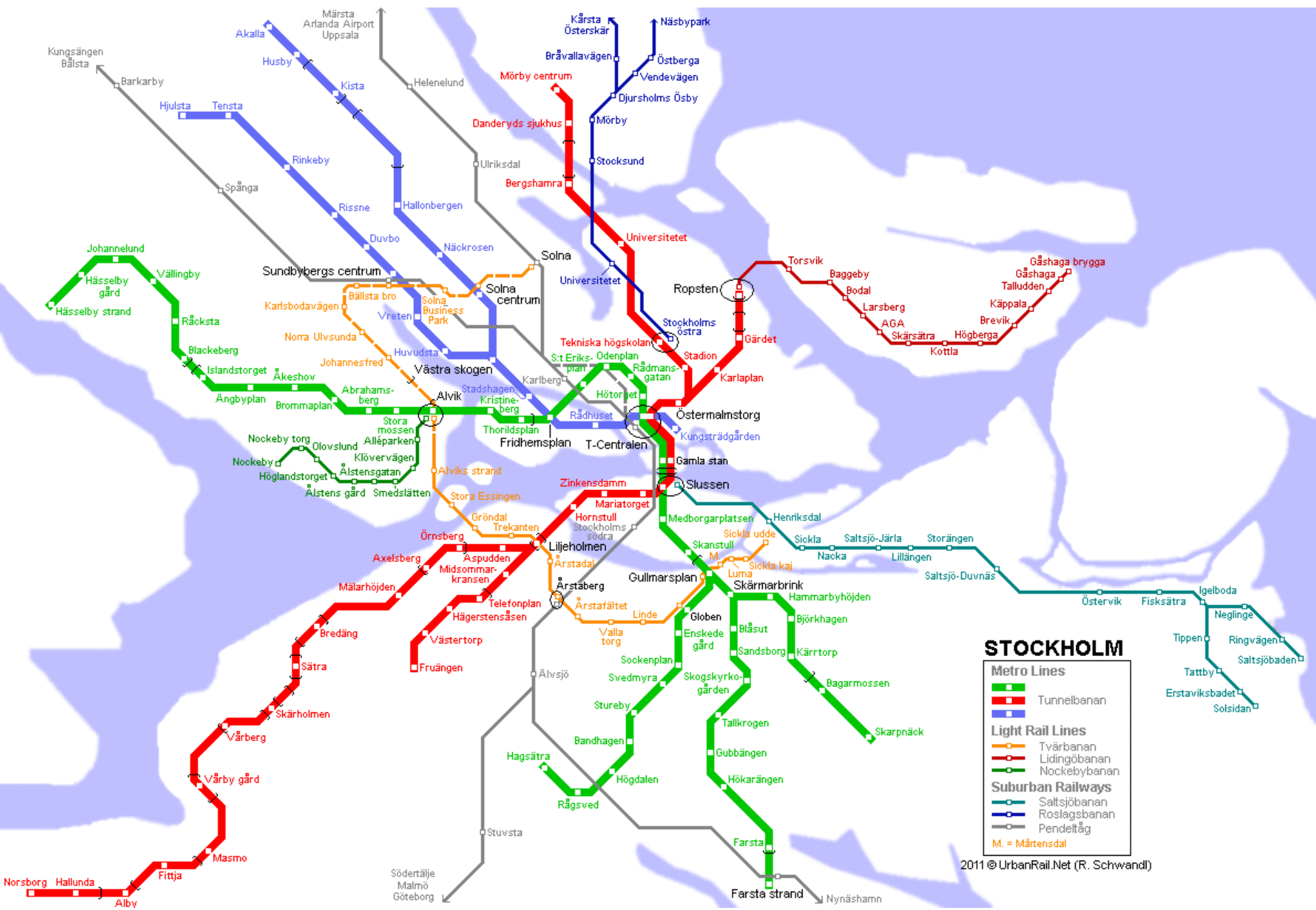
Copenhagen
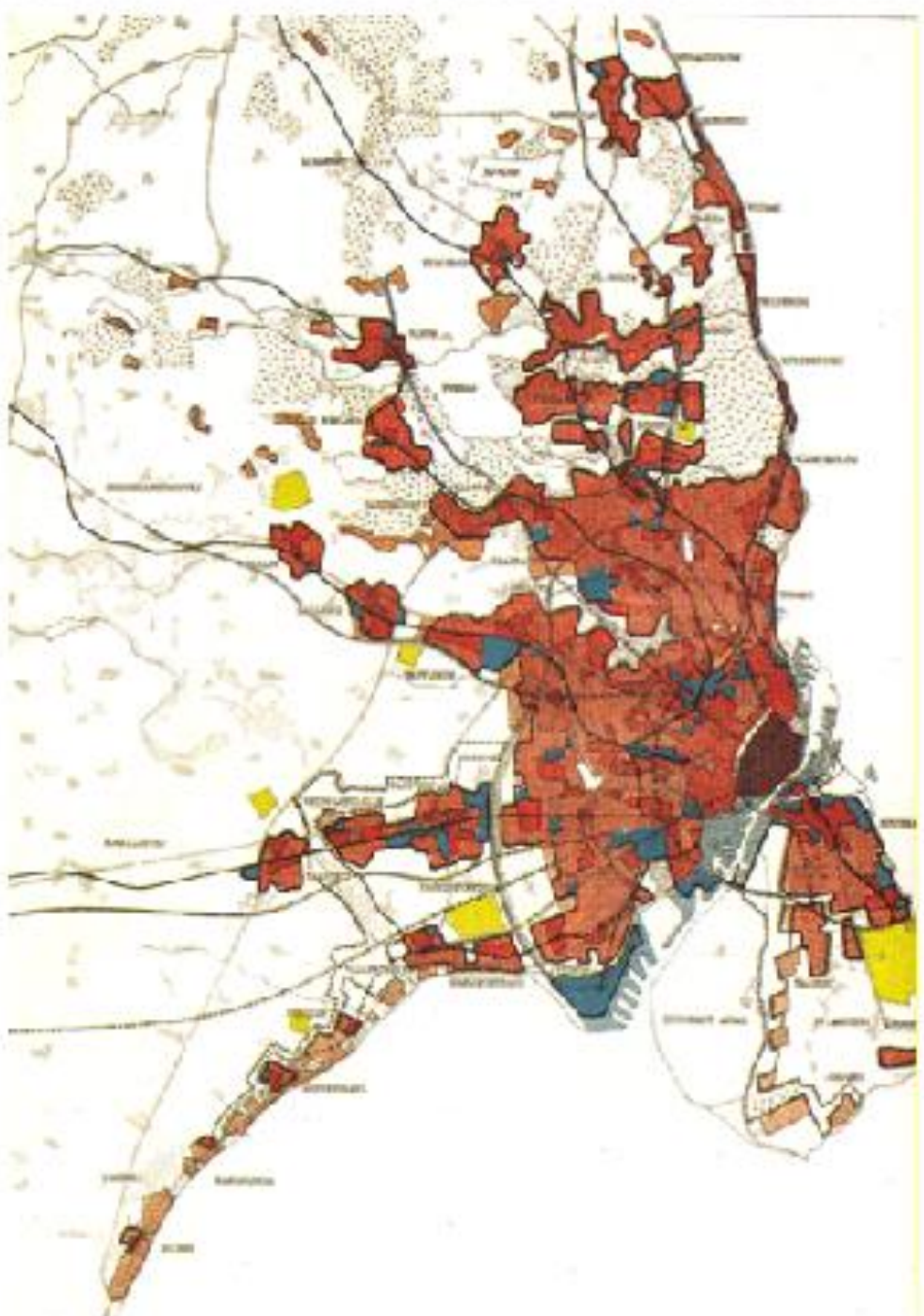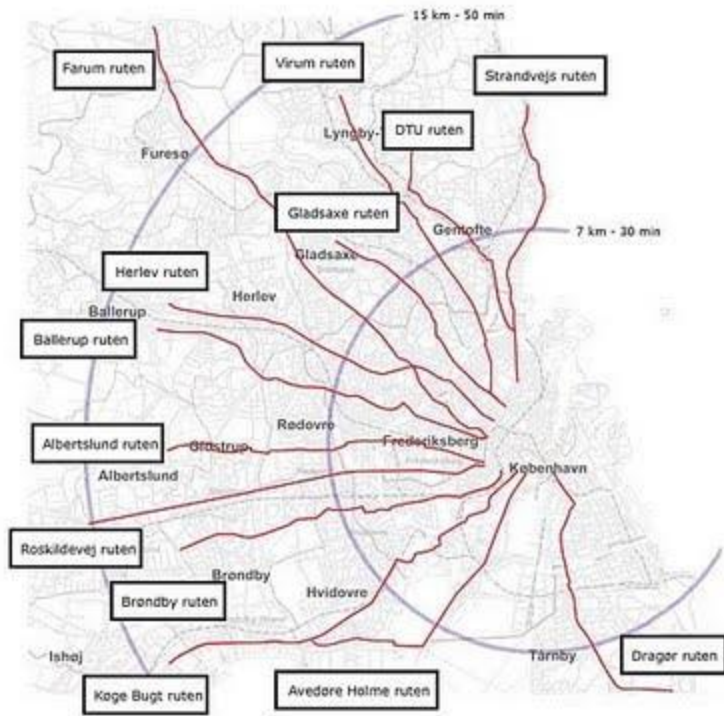
CYCLING IN COPENHAGEN

Cyclists entering the inner city (søsnittet) at peak hour 1950-2005

Stockholm

THE CITY
OF
STOCKHOLM

Kista
1978

Metro Lines

Railways Lines

Vällingby
1949

Metro Lines

Light Rail Lines /
Suburban Railways

Vasastaden
1875

Gärdet
1931

Birkastaden
1906

Hötorgscity
1955-65

Smedslätten
1923

Light Rail Lines /
Suburban Railways

Old Town

Bredäng
1963

Metro Lines

Light Rail Lines /
Suburban Railways

Enskede
1908

Railways Lines

Metro Lines

16

STOCKHOLM

Metro Lines
- Tunnelbanan

Light Rail Lines
- Tvärbanan
- Lidingöbanan
- Nockebybanan

Suburban Railways
- Saltsjöbanan
- Roslagsbanan
- Pendeltåg

M. = Mårtensdal

2011 © UrbanRail.Net (R. Schwandl)

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Station

Portland, OR

Reservations about urban and rural reserves

The L

N.W. Springville Rd.

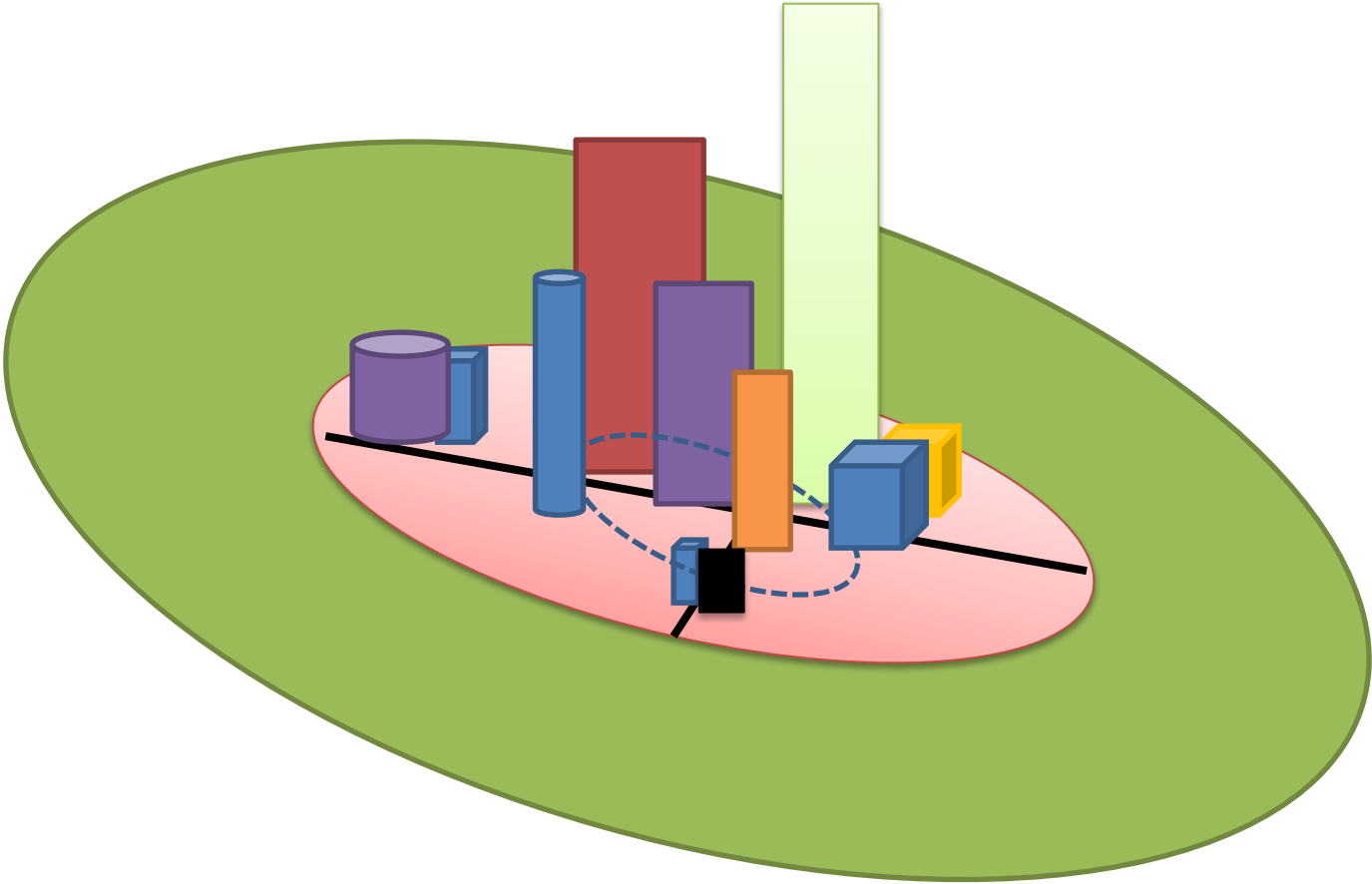N.W. Kaiser Rd.

0   1/2
MILES

1 In a decision that illustrates the complexity of long-range planning, a section of East Bethany known as "the L" was designated as rural reserves by Metro and Clackamas, Multnomah and Washington counties. The four governments designated 28,615 acres for urban development over the next 50 years and about 267,000 acres to remain farms or forests.

0   5
MILES

Vancouver

Camas

Bethany

Forest Grove

2

Hillsboro

Portland

Cornelius

Gresham

Beaverton

Farmland north of Cornelius was designated as urban reserves. Environmental groups and farmers fiercely oppose the decision.

Tigard

Lake Oswego

Milwaukie

Damascus

King City

West Linn

Oregon City

Sherwood

Wilsonville

3

— **Current urban growth boundary**

■ **Proposed urban reserve areas**

■ **Proposed rural reserve areas**

■ **Undesignated areas**

The Maletis property in French Prairie, long eyed for development, was left a rural reserve.

23

TRI●MET
Rail System

24

Curitiba

Chinese cases?

PRC->People's Republic of Cars?

Many Chinese cities have a significant # of overpasses and elevated expressways (for cars) and new towns

Few Chinese cities have public transit-land use patterns shown in, or even transcend the prototypes

Urban expansion rate is greater than urban population density growth rate*

*http://wenku.baidu.com/link?url=Dp-hSxeVKECC3bASVL6voy8mnyct2OdVTsJCmgY6ZQDwixobVcCSkJU4btkUEl9qs8T6wN2jkhl9H-Svsn4jKqauRR-rIQpWqKy4ly61PN3
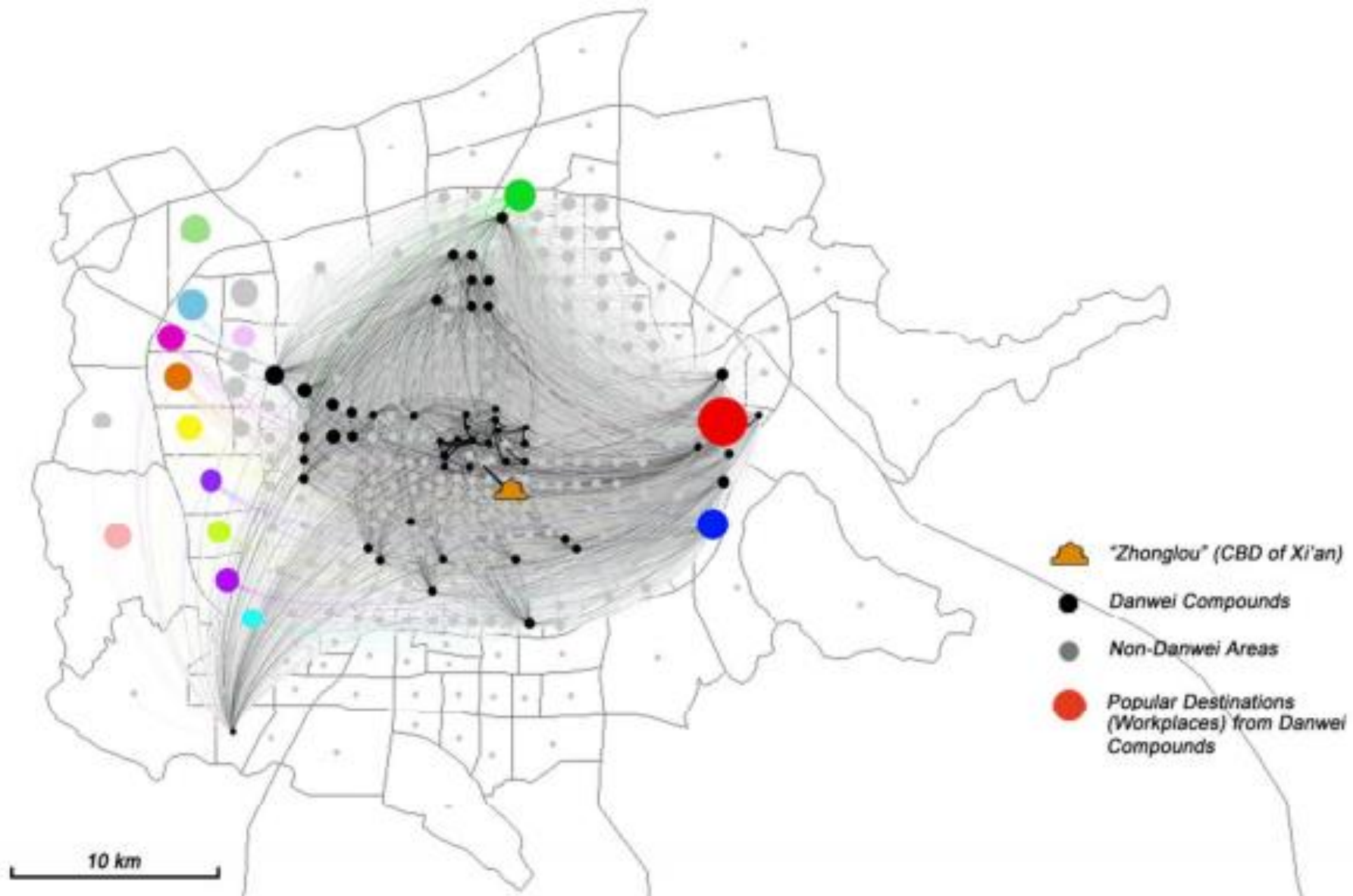
Binhai

Why the above happened? And how do they affect commuting efficiency? What can we do about them?

Case studies conducted

- Beijing: A metropolis facing various and rapid transformations

- Xi'an: A developing inland city where legacy of *Danwei* may still persists

- Suzhou Industrial Park: Can we plan for good urban form, j/h balance and commuting efficiency?

- ……

Xi'an

# Journeys to Work from Danwei Compounds in Xi'an, China

"Zhonglou" (CBD of Xi'an)

Danwei Compounds

Non-Danwei Areas

Popular Destinations (Workplaces) from Danwei Compounds

10 km

Journeys to Work from Non-Danwei Areas around
Danwei Compounds in Xi'an, China

"Zhonglou" (CBD of Xi'an)

Non-Danwei Areas around
Danwei Compounds

Danwei Compounds

Popular Destinations
(Workplaces) from Non-
Danwei Areas around
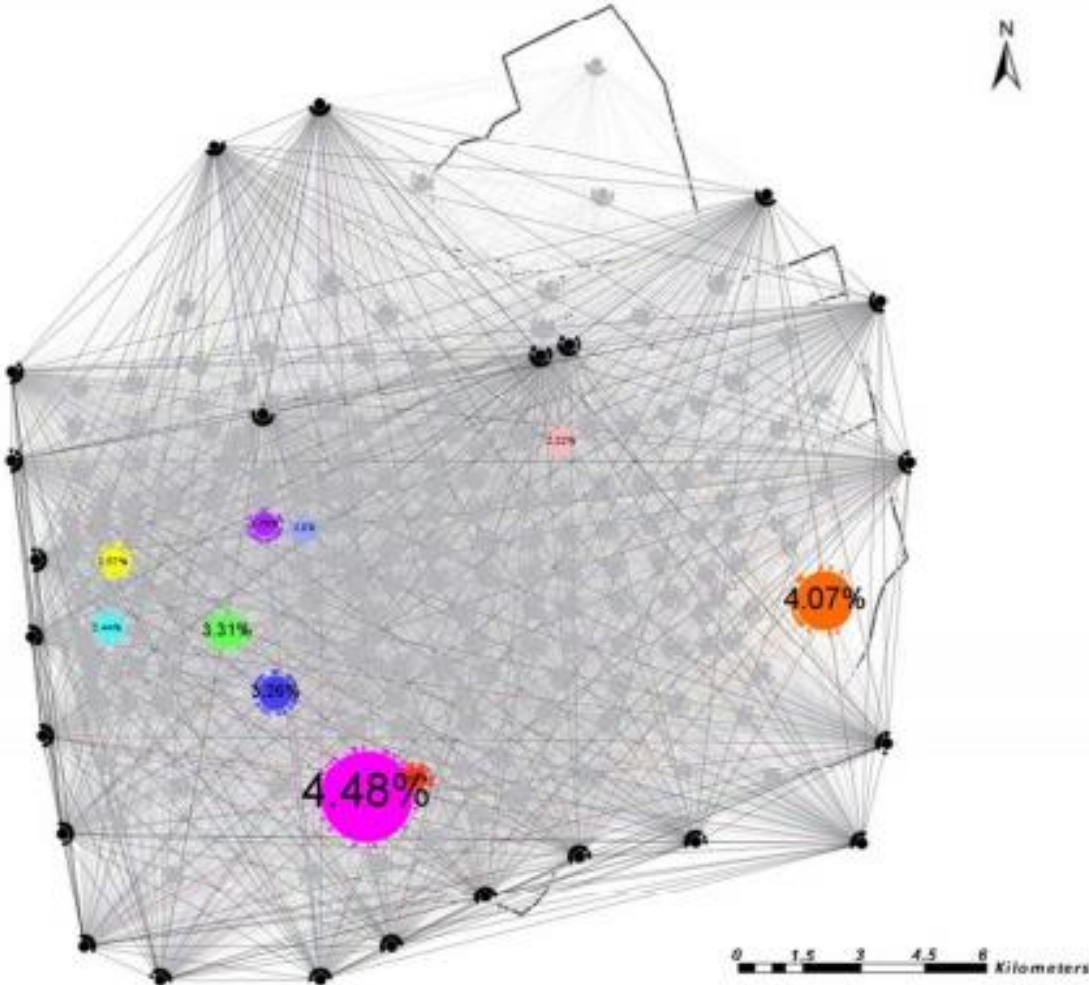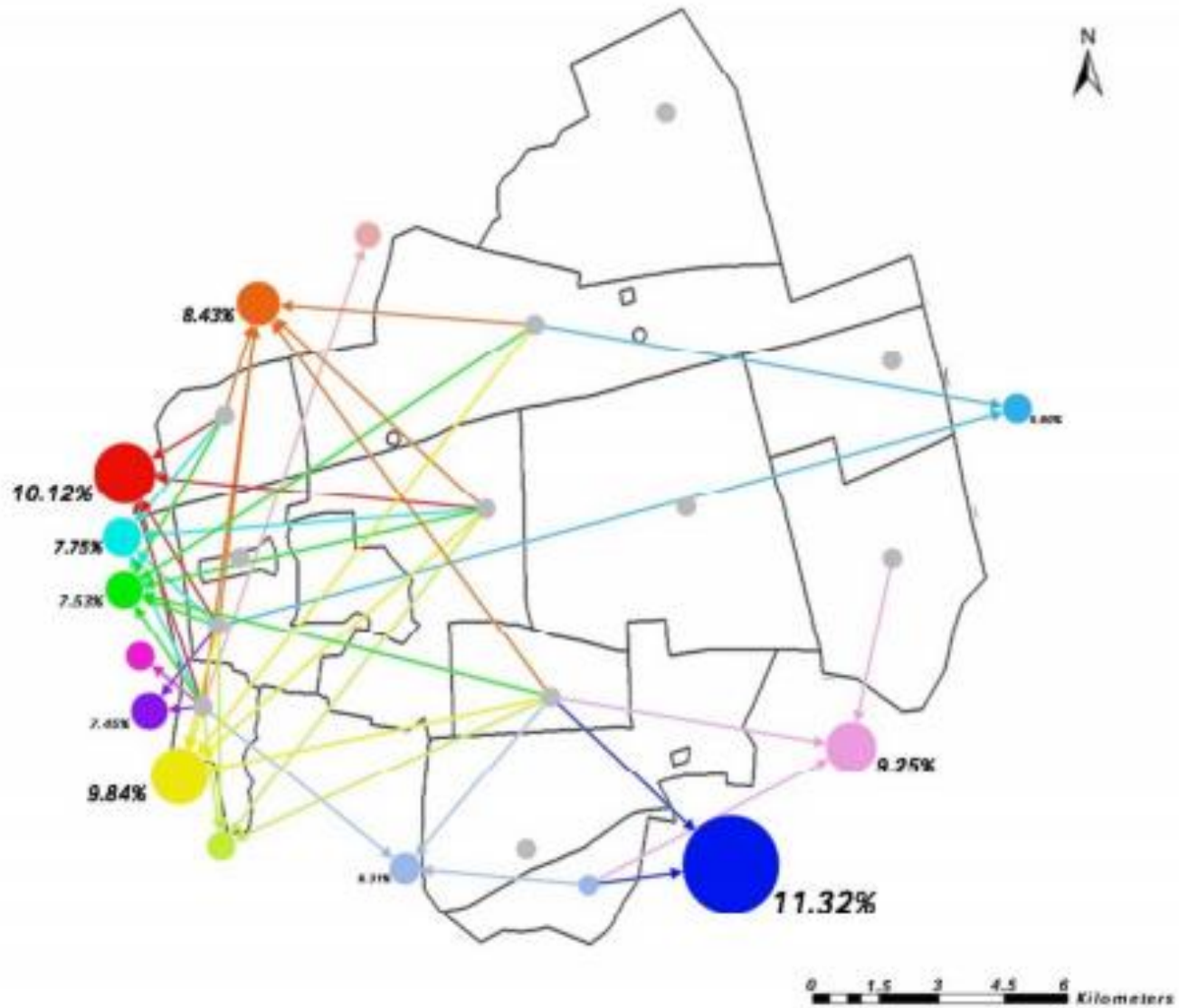Danwei Compounds

10 km

45
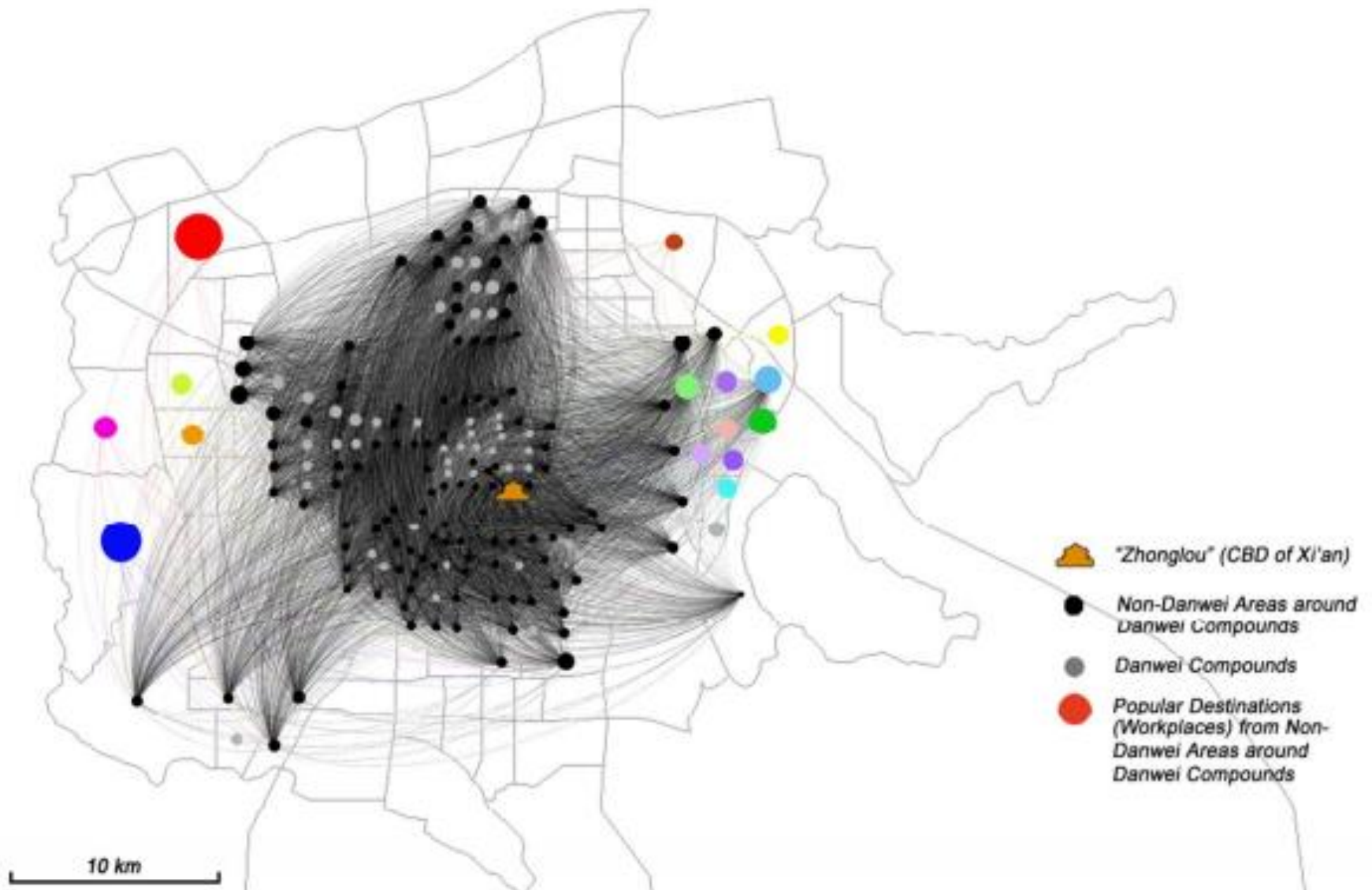
Suzhou Industrial Park

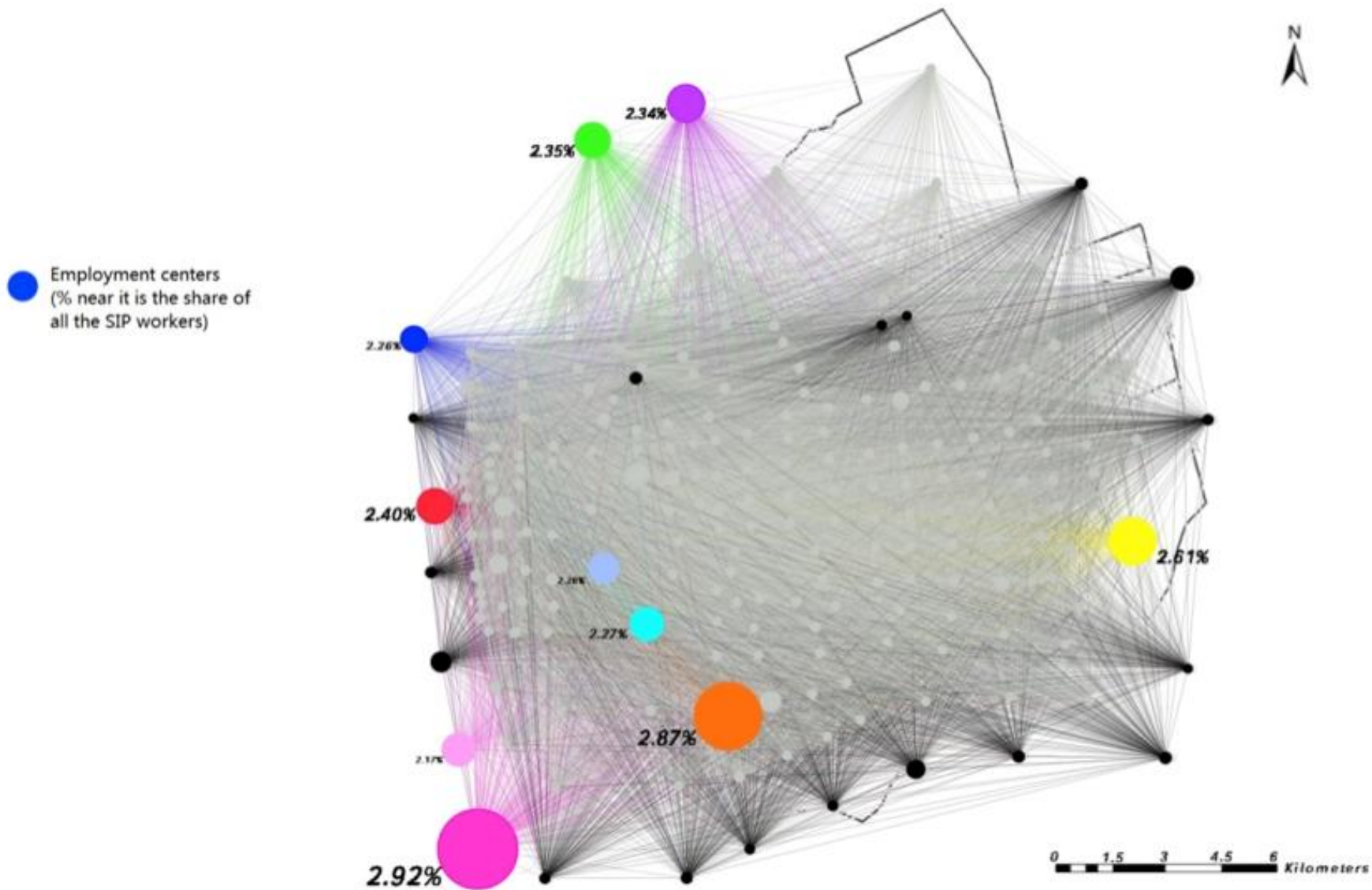# Journeys to work visualization:
Both workplace and home inside SIP
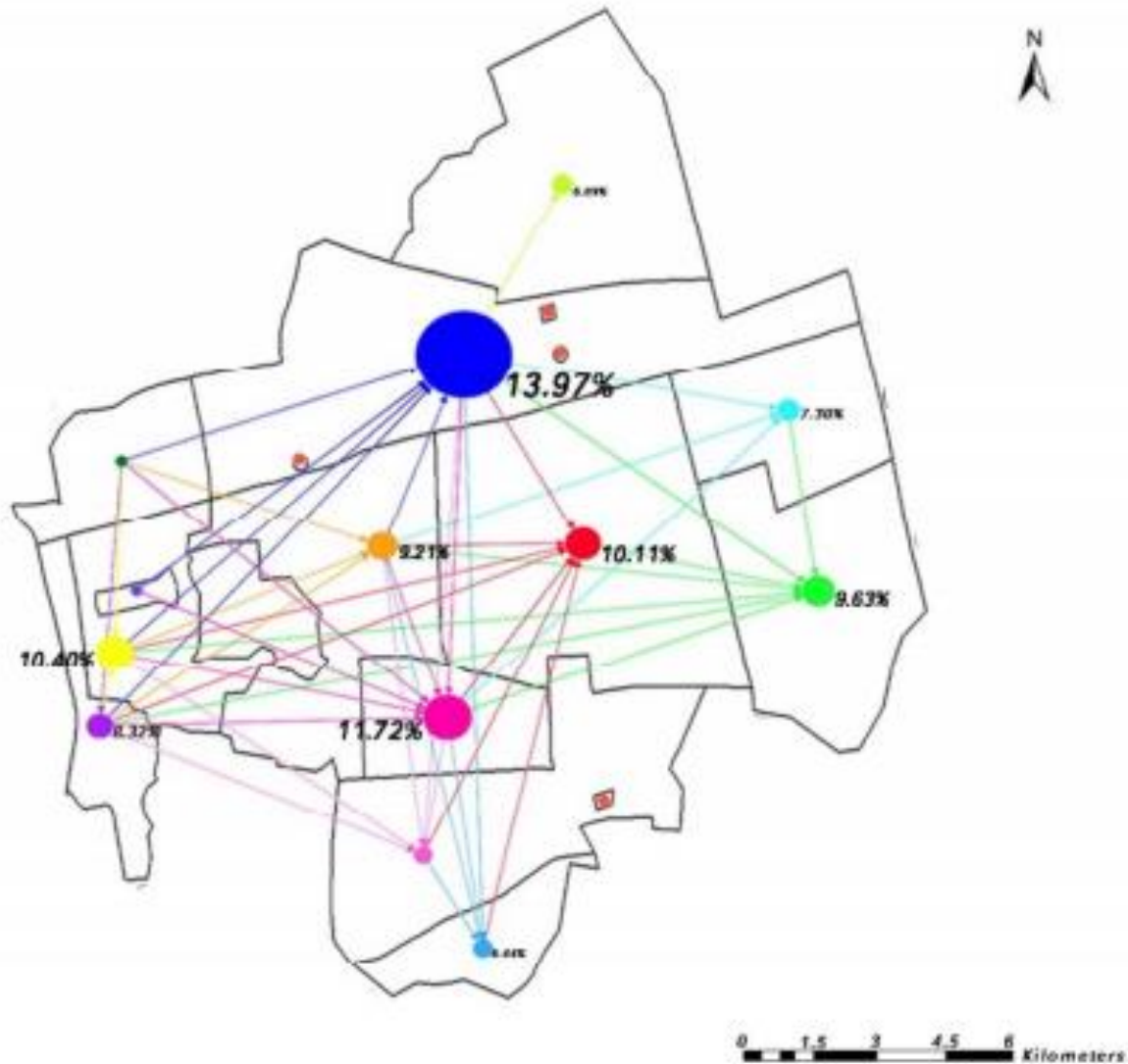
Journeys to work visualization:
Home outside SIP and Workplace inside SIP

Journeys to work visualization:
Workplace outside SIP and home inside SIP

The Top Ten Employment Centers in and around Suzhou Industrial Park

Employment centers
(% near it is the share of all the SIP workers)

2.34%

2.35%

2.26%

2.40%

2.61%

2.20%

2.27%

2.87%

2.17%

2.92%

The Top Ten Employment Centers in and around Suzhou Industrial Park:
When Commuting Flows Optimized
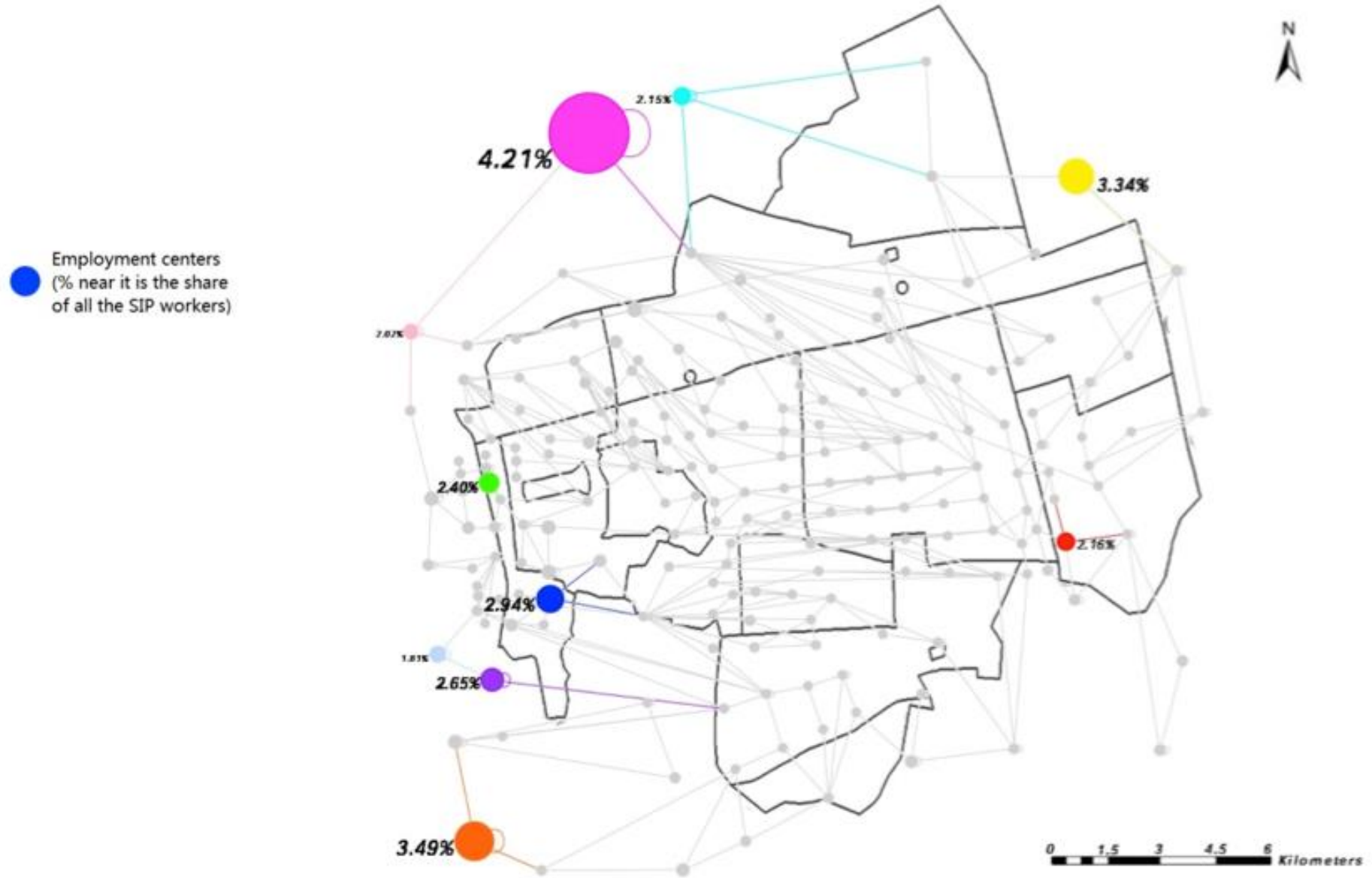
Beijing case study

- Beijing: **28%** of the residents commuting by bus*

- Using smart card data rather than survey data(n=216,844)

- Considering policy scenarios

- Supplementing the above with secondary housing data, expert opinions and field trips

- Establishing land use "prototypes" of jobs/housing separation/imbalance

*Our data were from April 2008 bus smart card swipes. Beijing's subway had only two lines and was 184 km in length then.

Case study site

- Over 20 million residents
- 16, 410 KM^2
- 28, 343 buses and 948 bus routes
- 187, 500 KM bus route length
- Total annual passengers: 4.9 billion

Beijing
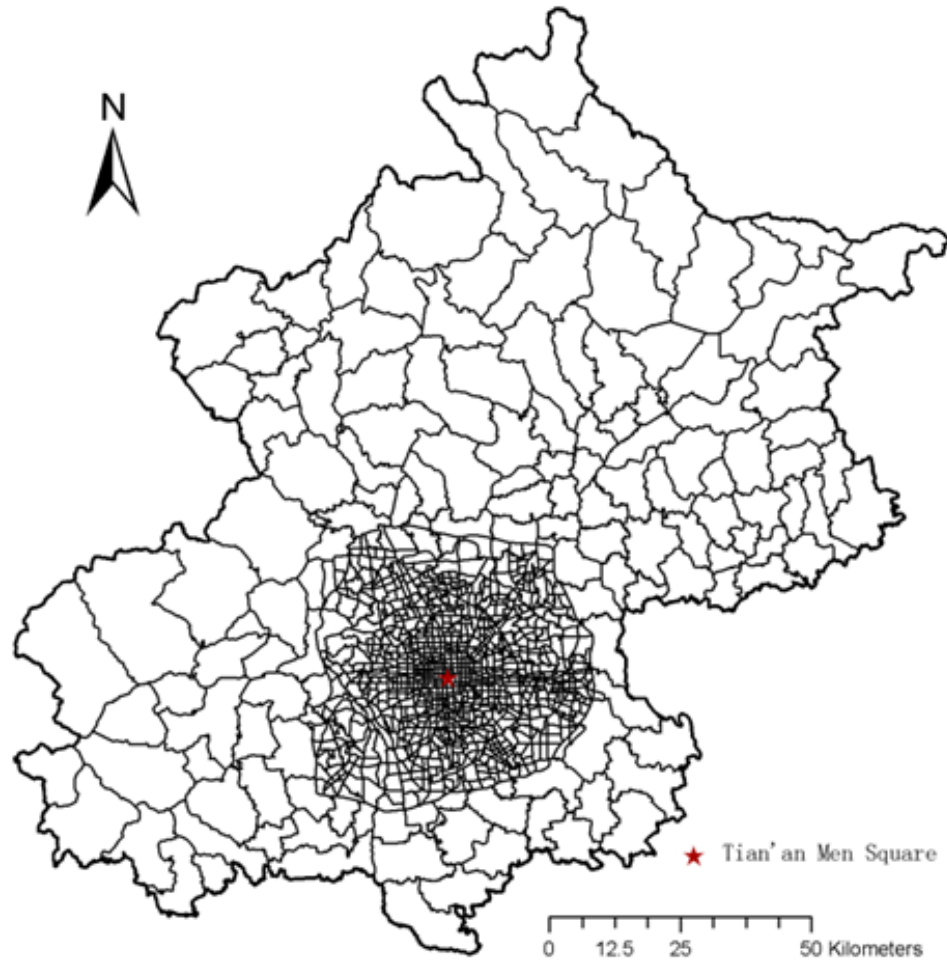
北京市公交线路和站点可视化（数据来源：BCL）

The 1543 bus lines and 42,161 stops of Beijing were crawled by the BCL research fellow Dr
Jianghao Wang in 2013. The data format is Shapefile

2003

1994   2001

1990

0   3km

5th Ring Road

56

Method(1)

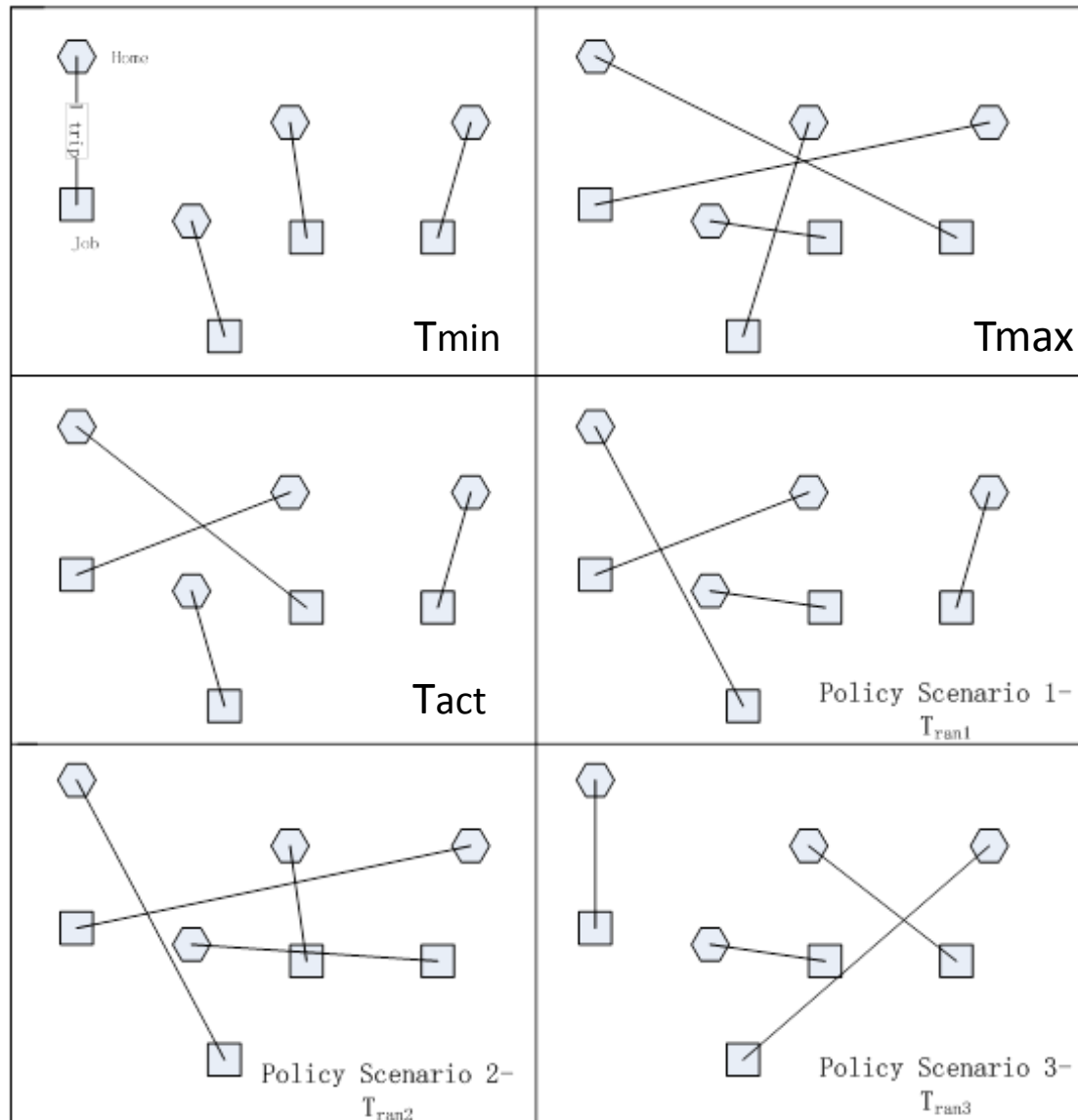- Commuting efficiency: Excess commuting framework

- Assumptions:

Homogeneous jobs and workplaces

Numerical and distributions of jobs and workplaces are fixed (fixed urban form)

Commuters can be enticed or forced to swap jobs and/or workplaces

T_{ran} and policy relevance

$T_{ran4}\cdots, T_{ran13},$ which are of less policy relevance

Method(2)

- Transportation problem: Linear programming

$$\text{Min: } Z = \frac{1}{N} \sum_{i=1}^{m} \sum_{j=1}^{n} c_{ij} X_{ij}$$

$$\text{s.t.} \quad \sum_{i=1}^{n} X_{ij} = D_j \qquad \forall j = 1, \ldots, m$$

$$\sum_{j=1}^{m} X_{ij} = O_i \qquad \forall i = 1, \ldots, n$$

$$X_{ij} \geq 0 \qquad \forall i, j$$

where, m = number of origins; n = number of destinations; O_i = trips beginning at zone i; D_j = trips destined for zone j; c_{ij} = travel cost from zone i to zone j; X_{ij} = number of trips from zone i to zone j, and N = total number of trips. The objective function minimizes average transport costs.

T_{min}, T_{act}, T_{ran} and T_{max}

Mean of T_{ran}

Distribution of T_{ran}'s
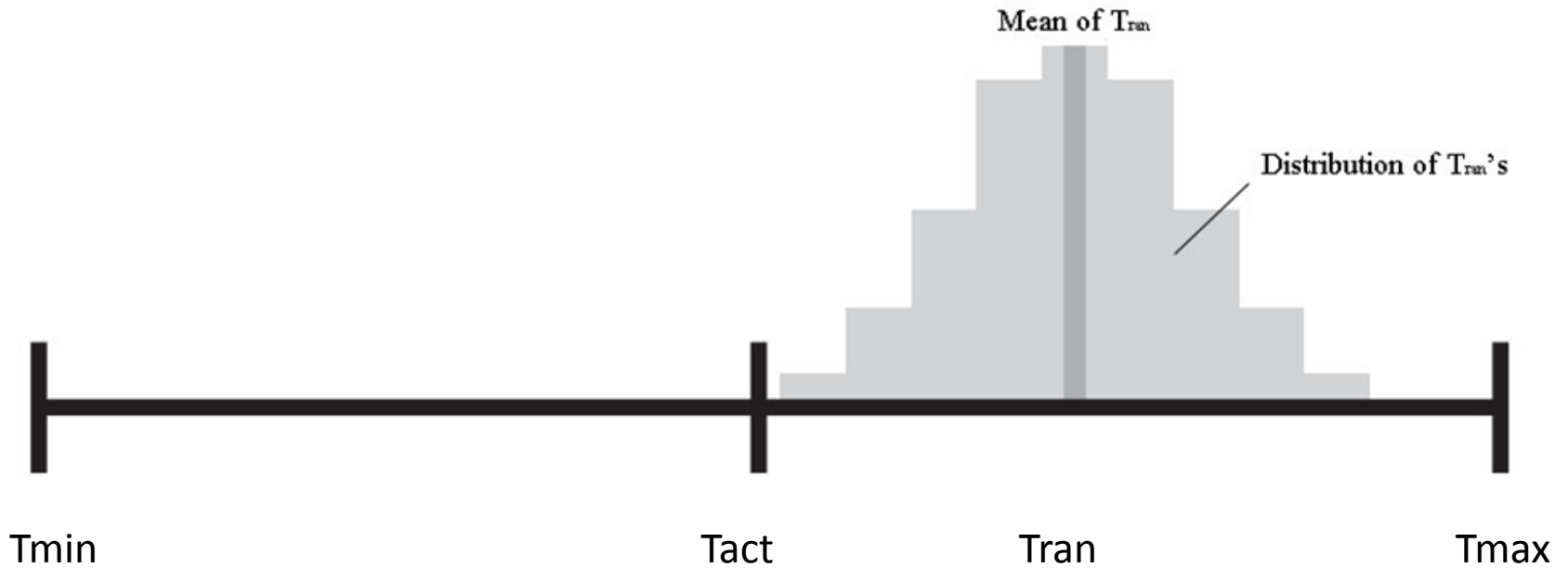
Tmin   Tact   Tran   Tmax

Excess Commuting(EC) and Commuting Efficiency(Cu)

$$EC = \left(\frac{T_{act} - T_{min}}{T_{act}} \right) * 100$$

$$Cu = \left(\frac{T_{act} - T_{min}}{T_{max} - T_{min}} \right) * 100$$

T_{ran} Calculation

Method 1:

$$T_{ran} = \frac{1}{W^2} \sum_i \sum_j O_i D_j C_{ij}$$

(9)

Method 2: The Mote Carlo simulation

Method 3: Tran' in light of policy relevance (value systems)

Excess commuting & policy relevance

- Policies (Value systems + purposeful actions) can change supply and demand (numerical and distributional) of jobs and housing, travel cost, trip production/attraction, mode choice and trip distribution

- It is difficult to compare impacts of different policies on excess commuting if all the above changes simultaneously

To single out the policy's impacts

- We can assume only transportation cost and trip distribution change, which would allow us to quantify/compare the impacts of policies on excess commuting and commuting efficiency

How to quantify travel cost and trip distribution relationship?

- Gravity model:

Trips between two nodes=f(costs between them and weighs of two nodes)

Policy scenarios for Beijing

- Base scenario: Commuting efficiency and j/h balance of bus commuters in 2008

Policy scenarios for Beijing

- Policy Scenario 1: Beijing does not restrict car usage based on the car's plate number on weekdays and sees 0-20% increase in traffic and travel cost between TAZs. In reality, Beijing has enforced such restriction since 2008 and about 20% of all the cars are not allowed to run on weekdays in the city.
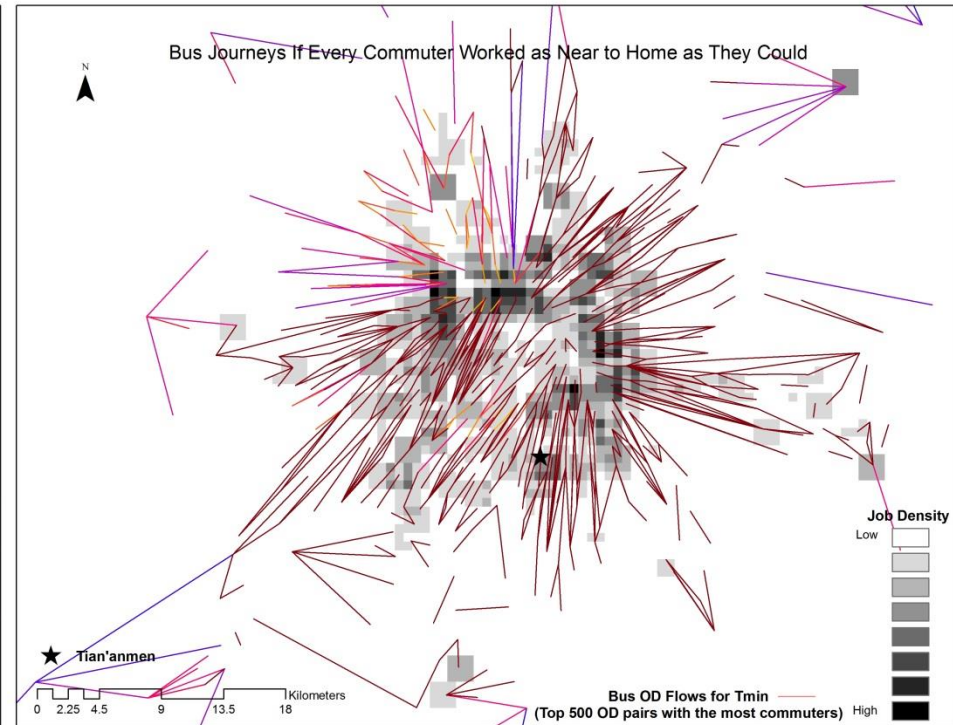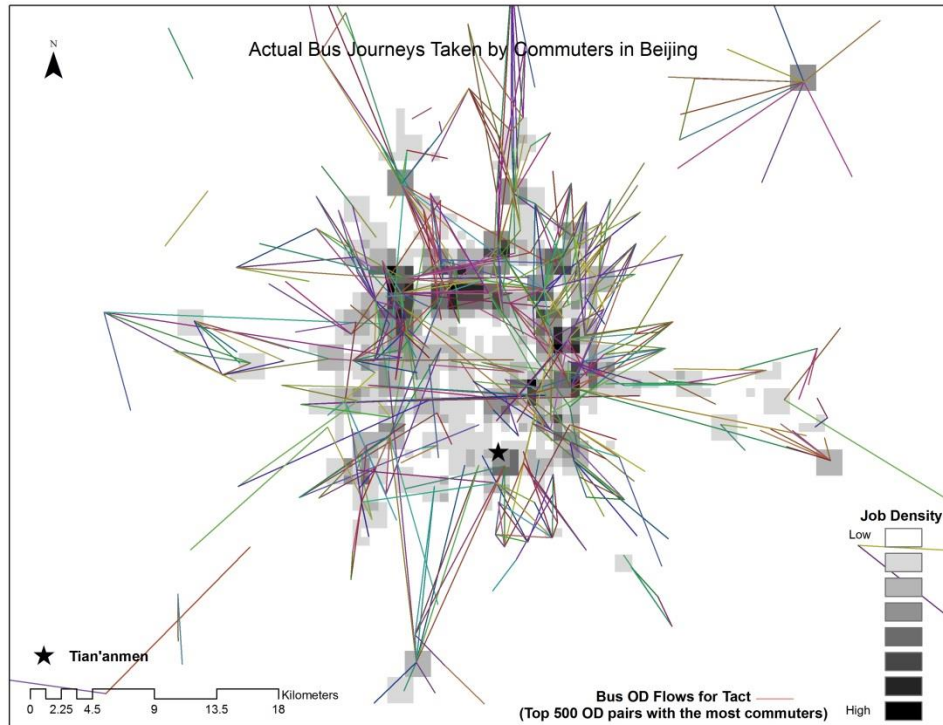
Policy scenarios for Beijing(2)

- Policy Scenario 2: In light of large volumes of bus riders to several employment centers (TAZs 97, 216, 284, 651 and 694) where there are more than 2,000 bus commuters per day, Beijing now operates bus rapid transit (BRT) from these centers and consolidating services of certain existing bus routes, as a result, all bus trips to and from these employment centers see a reduction of travel cost between 0-20%. This can be seen as a partial implementation of the measures mentioned in Policy Scenario 2.
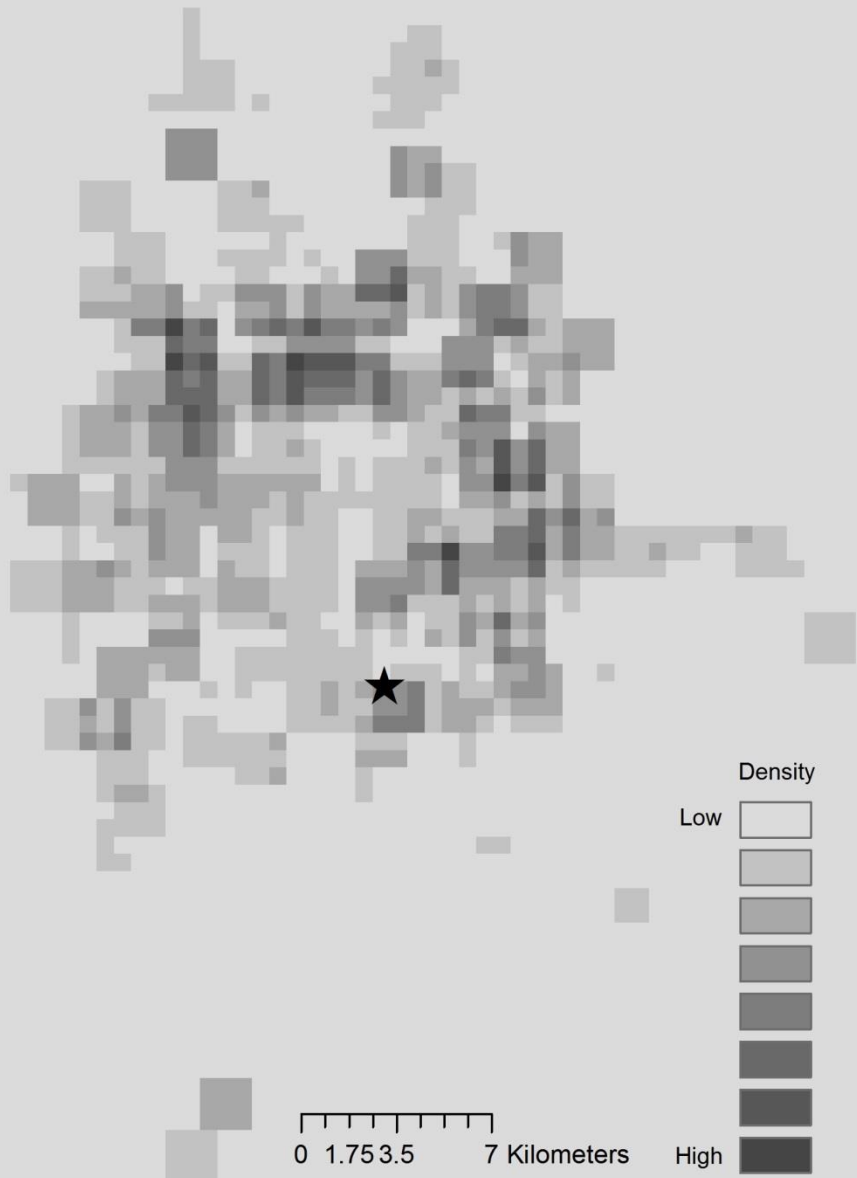
Findings

Study/Survey	Mode, year	Sample size (City, if not Beijing)	T_a (km)	T_{ran} (km)	T_a (min.)	T_r (km)	T_m (km)	E	C_u	C_e	NC_e
This study	Bus, 2008	216,844(Commuting, 767 TAZs)	8.2	10.5-11.6	36.0****	2.5	24.7	69	25	22-30	29-37
BICP, 2006	Bus, 2005	n/a (All purpose, door-to-door)	16.3	-	-	-	-	-	-	-	-
	Subway, 2005		23.2	-	-	-	-	-	-	-	-
	All, 2005		5.5	-	-	-	-	-	-	-	-
The 2009 Survey*	Bus, 2008	n/a (AM peak-hour trips, door-to-door)	-	-	62.7	-	-	-	-	-	-
	Car, 2008		-	-	39.5	-	-	-	-	-	-
	Subway, 2008		-	-	77.3	-	-	-	-	-	-
	Bike,2008		-	-	20.8	-	-	-	-	-	-
The 2010 Survey*	Bus, 2009	9,778(All purposes, door-to-door)	-	-	60.3	-	-	-	-	-	-
	Car, 2009	9,292(All purposes, door-to-door)	-	-	38	-	-	-	-	-	-
	Subway, 2009	4,593(All purposes, door-to-door)	-	-	69.5	-	-	-	-	-	-
	Bike, 2009	8,932(All purposes, door-to-door)	-	-	22						
	E-bike, 2009	2,091(All purposes, door-to-door)	-	-	25.4						
Liu and Wang (2011)	Bus, 2007	307(All purpose, door-to-door)	-		46.3	-	-	-	-	-	-
Wang and Chai (2009)	Bus, 2001	227(Commuting, door-to-door)	-		55.1	-	-	-	-	-	-

Findings(1)

Actual Bus Journeys Taken by Commuters in Beijing

Bus Journeys If Every Commuter Worked as Near to Home as They Could

Bus Commuters' workplaces and residences

Jobs

Residences

Density

Low

High

0   1.75 3.5   7 Kilometers

N

★ Tian'anmen

71

Findings(2)

Legend:
- ★ Tian'an Men Square

Commuting Distance (km)
- <=8.1
- 8.2 - 16.2
- 16.3 - 24.3
- 24.4 - 32.4
- > 32.4

0   2.5   5   10 Kilometers

N
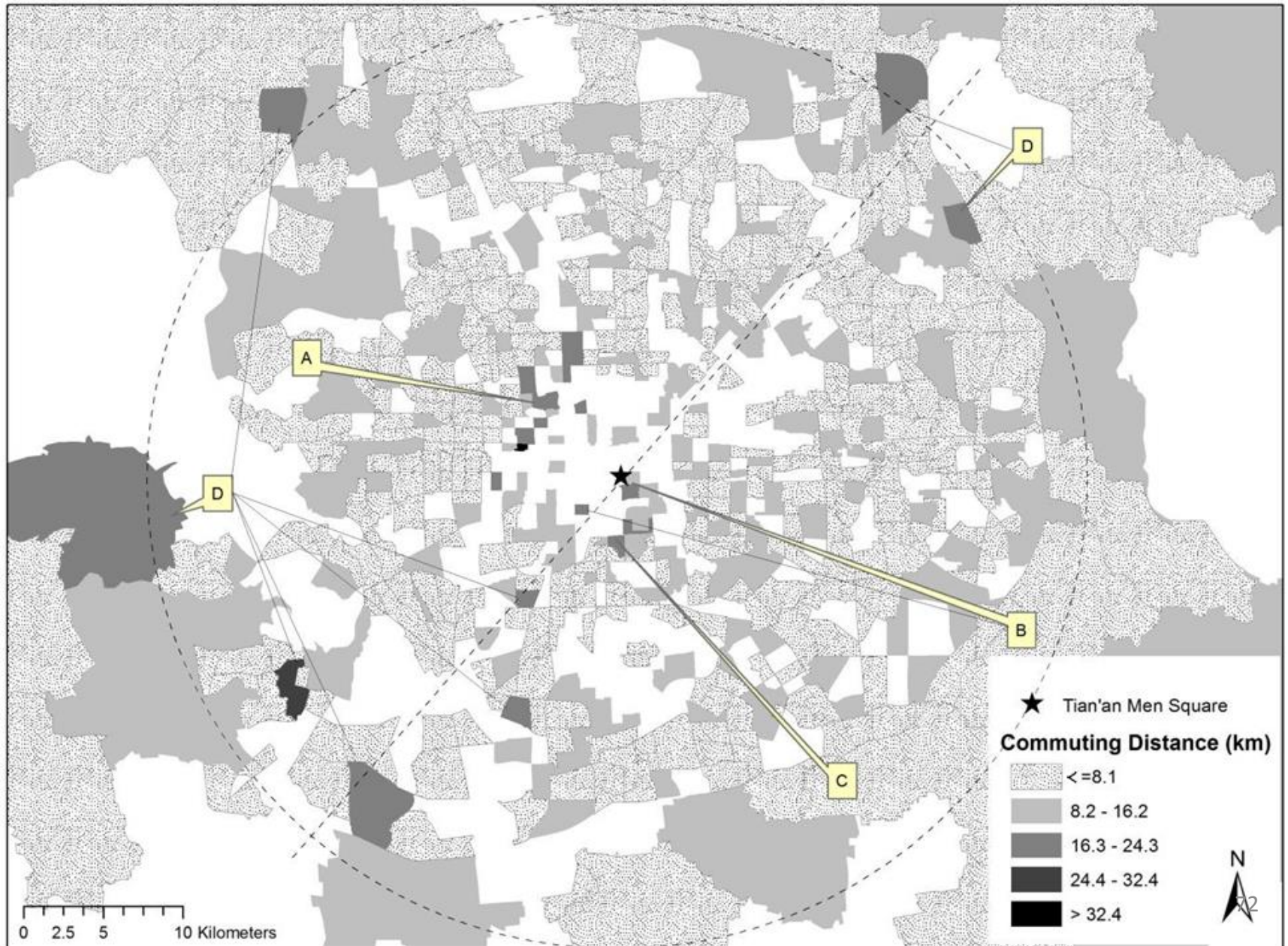
Findings(3)

Prototype	Characteristics	Landmarks and Directions	Spatial Index in Figure 2
1	University campuses, hotels and old Danwei compounds left with mostly apartment buildings	Minzu and Jiaotong Universities and areas in between; Beijing Technology and Business University and Capital Normal University (east campus) and areas adjacent to them; Beijing University of Aeronautics and Astronautics and Beijing University of Science and Technology and adjacent areas	A (Areas around and areas to its northeast)
2	Parks with luxury hotels, high-end apartments, specialized research institutes, hospitals and some mixed-use residential areas	Areas north to Yu Yuan Tan Park; Area adjacent to Tian Tan Park in the east	A (South to A, the darkest area); The U-shaped area south to the star
3	Traditional Hu'tong with old, cheap, small, shared and underserviced rental housing units	Areas in between Qian Men Da Jie and Zhu Shi Kou Da Jie	B
4	Residential areas with mixed-age housing units adjacent to freeway interchanges or arterials, railways within the fifth ring road	Areas near Yong Ding Men and Nan Sha Wo Bridges	C
5	Low density, developing areas with relatively cheap housing units in the suburb	Areas adjacent to the sixth ring road and Jingshi Freeway interchange; Areas adjacent to Yan Chun Railway Station	D

Findings(4)

Policy implications and discussions (1)

- Comparisons within Beijing, between Beijing and other Chinese cities and between Beijing and foreign cities:

Good quantitative balance of jobs and homes (T_{min}=2.5 km)

Excess commuting of Beijing's bus commuters, already worst in identified studies (69%), but can be even worse (C_u=25%)

Policy implications and discussions (2)

- BRT to and from employment centers can have comparable impacts as car restrictions on commuting efficiency of bus commuters (+13% vs +12%)

Policy implications and discussions (3)

- To other researchers who want to use smart card data to conduct more studies, this study provides a generic roadmap regarding how to enhance the value of smart card data with complementary data

Future research

- Subway swipes only; bus + subway swipes
- Stakeholder surveys (Value system + Social relations!)
- Planning/policy implications

Future research(2)

- Life-cycle of jobs/housing relation
- Land use/urban form and non-commuting trip efficiency/quality of life
- More big's: big Qs, theories, data, group…!

Still have questions?

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