城市模型及其规划设计响应

Applied Urban Models and Their Applications in Urban Planning & Design

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城市模型及其规划设计响应

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Applied Urban Models and Their Applications in Urban Planning & Design

1 Urban Models and Planning Support Systems

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1

Introduction

Urban growth boundaries (UGBs) in China

- UGBs, used for curbing urban sprawl
- Widely adopted in the U.S.A
- Planned urban area could be regarded as UGBs in China
  - According to the latest city planning act
- UGBs not implemented well
  - Beijing, Shenzhen and Shanghai, only half new developments within UGBs
  - Tian and Shen, Han, Long, etc.

UGBs evaluation: existing methods

- All focusing on physical development
  - Remote sensing images (Han et al 2011 ZJU; Long et al 2012 LUP)
  - Land use permits (Long et al. 2013 JAPA to submit)
- While admitting their merits, shortcomings lies in
  - How people use UGBs not discussed (human mobility and activities)
  - No connections between UGBs
  - Physical spaces are not homogenous (density not included)
- Few attention paid to estimating effectiveness of UGBs in terms of their densities and connections

People in and beyond UGBs

- They are citizens that are using the city
  - Within or beyond UGBs
- It would be more direct for taking citizens into account for evaluating UGBs
  - In terms of their activities and mobility
- More information on human mobility and urban activities available in the big data era
  - Check-in, smart card records
  - Provide new channel as a complement to existing methods

This study would

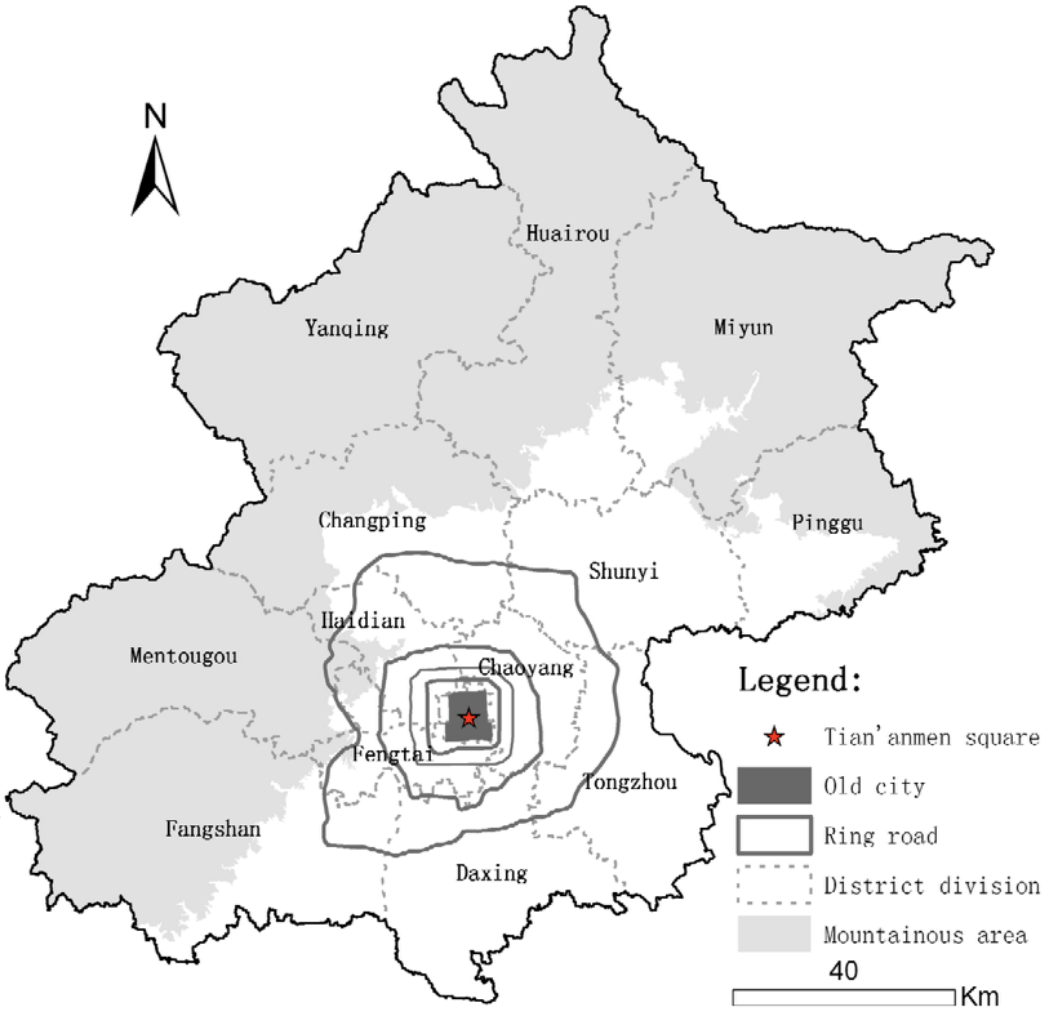
- Evaluate UPI using human mobility and urban activities from increasingly available “big data”
  - E.g. check-ins from social networking and smartcard records from public transportation system
- Take various levels of UGBs in the 2004 Beijing master plan for empirical analysis
  - The central cities, new cities and towns
- Estimate UGBs density to compare with aims specified in the master plan
- Identify legal and illegal/informal inter-UGBs flows for evaluating the effectiveness of UGBs
- Reveal links between UGBs using intra-UGBs flows

2

Data

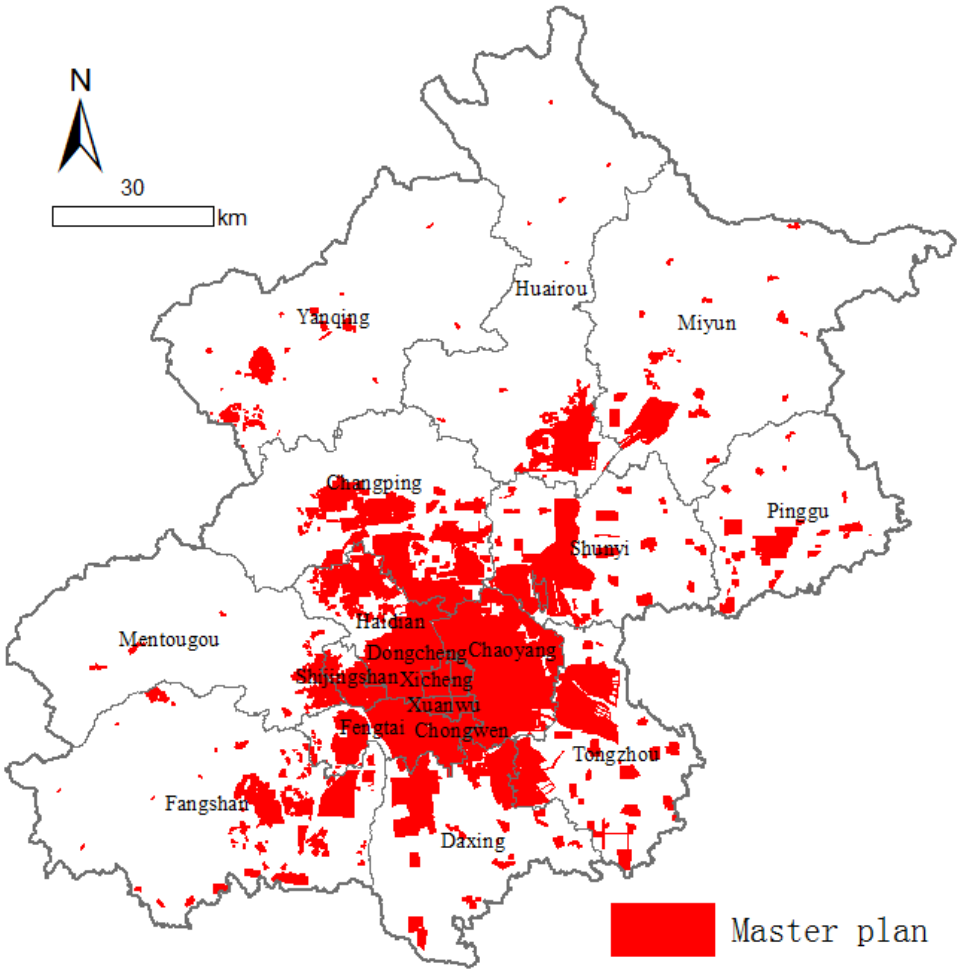
Study area

- The whole Beijing Metropolitan Area
  - 16410 sqkm
- Booming urban expansion during the recent two decades
  - Specified numbers for urban expansion
- Five master plans proposed since 1958
  - The 2004 version to be evaluated in this study



UGBs in Beijing

- Planned urban built-up areas regarded as UGBs in this study
- Four levels of UGBs in the master plan
  - The central city
  - New cities
  - Towns
  - Others isolated UGBs
    - Generally with small development scale



A glance on five master plans in Beijing

Inventory of five master plans of the BMA.

Index	g_pln58	g_pln73	g_pln82	g_pln92	g_pln04
Compilation time	1958	1973	1982	1992	2004
Implemented period	1958–2000	1973–2000	1982–2000	1991–2010	2004–2020
Spatial distribution					
Developed area (km^2)	611	465	454	1079	2389
Planned population (million)	10.0	3.70–3.80 (central city)	10.0	12.5	18.0
Urban form at the end of plan	fm76	fm81	fm91	fm04	fm08
Planning implementation rate (%)	38.5	45.6	60.9	69.2	42.9
Legal development rate (%)	55.3	59.4	34.4	59.1	76.3
Overall accuracy (%)	96.0	95.7	95.7	94.8	89.8

Bus and metro SCD

- Collected in one whole week in April 2010
  - Mode share of bus and metro 40%
- 97.9 million records for 10.9 million cardholders
- Spatiotemporal information on OD
  - Only distance-fare bus lines having complete OD
  - Metro perfect OD
- Geocoded trips: 37.6 million
  - Reflecting the large-scale human mobility
- 700 k cardholders with identified commuting trips
  - Approach see Long et al 2013

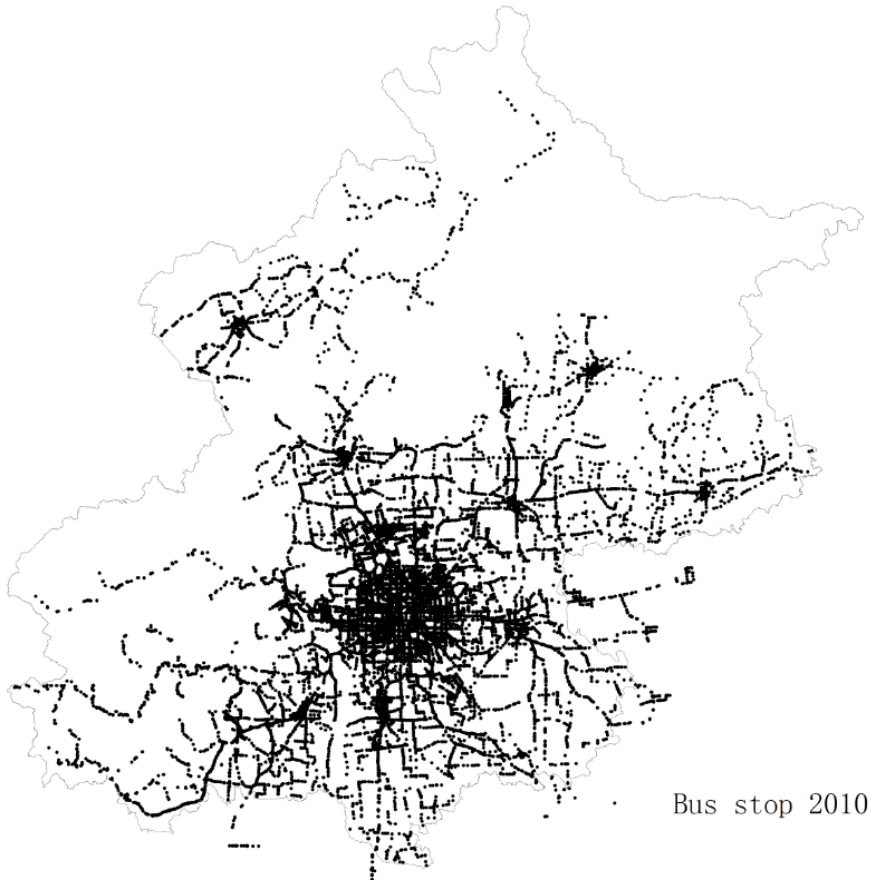


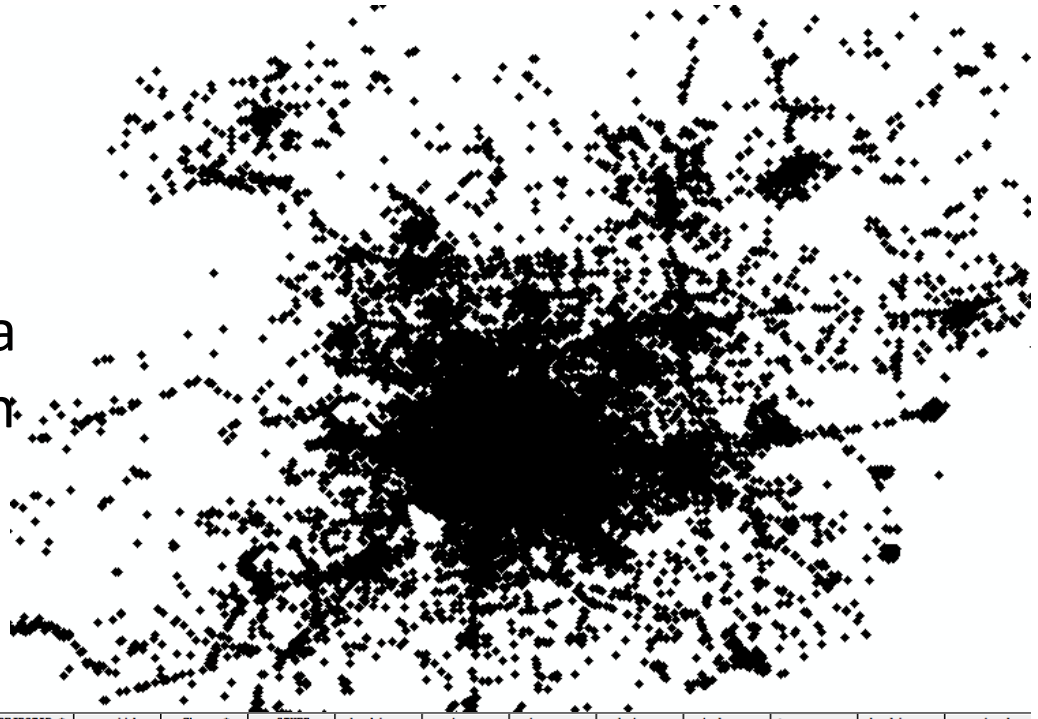
Table 1 Data structure of the SCD

Variable	**Exemplified Values**
Card ID	"100075100382599 11", "10007510150830716"
Card Type	1, 2, 3, 4
Trip ID	25, 425, 9
Route ID	602, 40, 102
Route Type	0, 1
Driver ID	11032, 332
Vehicle ID	111223, 89763
Departure Data	2008-04-08
Departure Time	"06-22-30", "11-12-09"
Departure Stop	11, 5, 14
Arrival Time	"09-52-05", "19-07-20"
Arrival Stop	3, 14, 9

Note: 0 stands for a fixed-fare route and 1 stands for a distance-fare route for the attribute "Route Type". For the attribute "Card Type", 1, 2, 3, and 4 denote normal, student, staff and month pass, respectively. The attribute "Trip ID" represents the accumulated trip count of a card since its issue, including both subway and bus journeys.

Check-ins

- Crawled from Sina Weibo during 16 May to 28 July 2013
- 102,826 POIs with at least a check-in (totally 809 million check-ins)
  - 8 types
- Each POI associated with a total check-in number



115shopping
169entertainment
19hotel and public
194sport
258firm
44housing
51education
64restraunt

OBJECTID *	poiid	Shape *	CTYPE	checkin_num	categorys	category_nam	photo_num	todo_num	herenow_use	checkin_user	postcode
38	B2094654D065A3	Point	169	1	169 171	台球厅	0	0	0	1	100000
39	B2094654D064A2	Point	64	5	64 93 94	西餐厅	3	0	0	5	100000
40	B2094654D064A2	Point	169	0	169 185	会展中心	0	0	0	0	100000
41	B2094654D064A0	Point	115	2	115 141	服装鞋帽皮具店	2	0	0	2	100000
42	B2094654D064A0	Point	64	2	64 69 257	中餐厅	0	0	0	2	100000
43	B2094654D064A0	Point	64	0	64 69 257	中餐厅	0	0	0	0	100000
44	B2094654D064A0	Point	64	0	64 69 70	综合酒楼	0	0	0	0	100000
45	B2094654D064A0	Point	19	1	19 148	美容美发店	0	0	0	1	100000
46	B2094654D064A0	Point	19	2	19 148	美容美发店	0	0	0	2	100000
47	B2094654D064A0	Point	64	1	64 69 257	中餐厅	0	0	0	1	102200
48	B2094654D064A0	Point	19	3	19 148	美容美发店	1	0	0	3	100000
49	B2094654D064A0	Point	64	4	64 69 86	火锅店	2	0	0	2	101100
50	B2094654D064A0	Point	115	4	115 119	商场	0	0	0	4	100000
1	B2094654D064A0	Point	64	0	64 69 257	中餐厅	0	0	0	1	100000
2	B2094654D064A0	Point	64	1	64 66	茶艺馆	0	0	0	1	100000
3	B2094654D064A0	Point	64	1	64 111	休闲餐饮场所	0	0	0	1	100000
4	B2094654D064A0	Point	64	1	64 66	茶艺馆	0	0	0	1	100000
5	B2094654D064A0	Point	64	0	64 69 257	中餐厅	0	0	0	1	101100
6	B2094654D064A0	Point	19	4	19 148	美容美发店	1	0	0	2	100000
7	B2094654D064A0	Point	64	0	64 69 257	中餐厅	0	0	0	0	100000
8	B2094654D064A0	Point	115	1	115 117	便民商店/便利店	1	0	0	1	100000
9	B2094654D064A0	Point	64	0	64 247	餐饮美食	0	0	0	0	100000
10	B2094654D064A0	Point	64	3	64 69 82	东北菜	2	0	0	2	100000
11	B2094654D064A0	Point	115	1	115 141	服装鞋帽皮具店	1	0	0	1	100000
12	B2094654D064A0	Point	64	43	64 69 257	中餐厅	8	0	0	42	100000
13	B2094654D064A0	Point	64	2	64 69 82	东北菜	0	0	0	1	100000
14	B2094654D064A0	Point	194	1	194 230	足球场	0	0	0	1	100000
15	B2094654D064A0	Point	19	0	19 148	美容美发店	0	0	0	0	100000
16	B2094654D064A0	Point	64	5	64 65	咖啡厅	1	0	0	5	100000
17	B2094654D064A0	Point	115	5	115 119	商场	3	0	0	6	100000
18	B2094654D064A0	Point	64	0	64 69 87	特色／地方风味	0	0	0	0	100000
19	B2094654D064A0	Point	64	2	64 65	咖啡厅	0	0	0	2	100000
20	B2094654D064A0	Point	64	1	64 66	茶艺馆	1	0	0	1	102600
21	B2094654D064A0	Point	194	4	194 224	综合体育馆	0	0	0	4	100000

Taxi OD

- Type: the longtiude and latitude of the orign and destination of a taxi trip
- Num: 2,254,068 records of about 20,000 taxis
- Date: 11/7/2011-11/13/2011

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Method and results

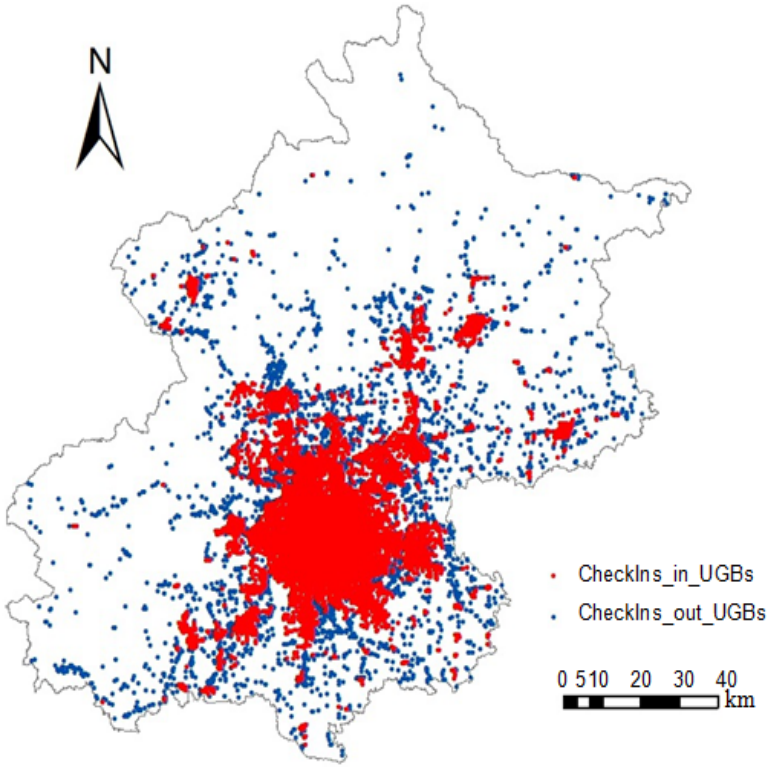
Effectiveness in terms of urban activities

- Using check-ins for representing urban activities
- E_a = *#check-ins within UGBs / #all check-ins*
  - The effectiveness in terms of urban activities
  - Entertainment (169) and sport (194) check-ins not accounted to avoid bias, e.g. national sites not related with UGBs

Effectiveness in terms of urban activities

- Result

Ea=#check-ins within UGBs/
#all check-ins
=7187191/7416012=96.91%



Estimating densities of UGBs

- Density of various UGBs in Beijing
  - Check their coincidence with those specified in master plans (population density for the central city and new cities)
  - E_d = the average coincidence of all UGBs of the central city and new cities
    - Since no population total specified for towns in the 2004 master plan

Estimating densities of UGBs

- Result of

Chi Square Test

$$\chi^2 = 3491957.5$$

$$\chi^2_{0.05}(11) = 19.7$$

$$\chi^2 >> \chi^2_{0.05}(11)$$

not statistically significant

Table 3 Chi Square Test of Check-ins (Central City include)

UGB	Actual Check-ins(A)	Excepted Check-ins(B)	(A-B)^2/B
Central City	7,251,872	4,696,279.7	1,390,686.3
Huairou	50,960	193,376.2	104,885.6
Shunyi	84,831	497,253.2	342,063.3
Mentougou	8,937	138,125.9	120,830.1
Miyun	32,729	193,376.2	133,457.6
Fangshan	46,381	331,502.1	245,229.3
Yanqing	11,001	82,875.5	62,333.8
Tongzhou	113,512	497,253.2	296,141.5
Pinggu	8,069	141,993.4	126,313.9
Changping	75,057	331,502.1	198,382.1
Daxing	89,178	331,502.1	177,136.0
Yizhuang	49,265	386,752.5	294,497.9
Sum	7,821,792	7,821,792	3,491,957.5

Estimating densities of UGBs

- Result

Table 2 Check-ins and Planned population of central city and new cities in Beijing

UGB	Check-ins	Planned Pop in 2020	Area(km2)	Density of Check-ins	Density of Planned Pop
Central City	7,251,872	8,500,000	1,196.4	6,061.6	7,104.8
Huairou	50,960	350,000	41.0	1,243.8	8,542.6
Shunyi	84,831	900,000	130.2	651.4	6,911.0
Mentougou	8,937	250,000	36.4	245.8	6,876.0
Miyun	32,729	350,000	56.0	584.9	6,255.2
Fangshan	46,381	600,000	65.6	707.3	9,149.7
Yanqing	11,001	150,000	18.5	596.2	8,129.5
Tongzhou	113,512	900,000	89.9	1,262.9	10,013.2
Pinggu	8,069	257,000	27.9	289.8	9,229.1
Changping	75,057	600,000	73.42	1,022.3	8,171.8
Daxing	89,178	600,000	71.93	1,239.8	8,341.2
Yizhuang	49,265	700,000	101.4	485.7	6,901.8

Estimating densities of UGBs

- Result of

  Chi Square Test

$$\chi^2 = 64558.1$$

$$\chi^2_{0.05}(10) = 18.3$$

$$\chi^2 >> \chi^2_{0.05}(10)$$

not statistically significant

Table 4 Chi Square Test of Check-ins (Central City excluded)

UGB	Actual Check-ins(A)	Excepted Check-ins(B)	(A-B)^2/B
Huairou	50960	34995.1	7283.3
Shunyi	84831	89987.4	295.5
Mentougou	8937	24996.5	10317.7
Miyun	32729	34995.1	146.7
Fangshan	46381	59991.6	3087.9
Yanqing	11001	14997.9	1065.2
Tongzhou	113512	89987.4	6149.8
Pinggu	8069	25696.4	12092.2
Changpin	75057	59991.6	3783.3
Daxing	89178	59991.6	14199.4
Yizhuang	49265	69990.2	6137.0
Sum	569920	569920	64558.1

Estimating densities of UGBs

- Result of Correlation Analysis
  - Central City included

Table 5 Correlation Analysis (Central City included)

		Checkins	Pop
Checkins	Pearson Correlation	1	.655*
	Sig. (2-tailed)		.021
	N	12	12
Pop	Pearson Correlation	.655*	1
	Sig. (2-tailed)	.021	
	N	12	12

*. Correlation is significant at the 0.05 level (2-tailed).

Estimating densities of UGBs

- Result of Correlation Analysis
  - Central City excluded

Table 6 Correlation Analysis (Central City excluded)

		Checkins	Pop
Checkins	Pearson Correlation	1	.881**
	Sig. (2-tailed)		.000
	N	11	11
Pop	Pearson Correlation	.881**	1
	Sig. (2-tailed)	.000	
	N	11	11

**. Correlation is significant at the 0.01 level (2-tailed).

Legal and illegal flows

- Identifying commuting trips from the 2010 SCD

To identify a cardholder's workplace, we queried one-day data on a MS SQL Server and repeated the work for seven days based on these rules (see Long et al., 2013 for more details):

- The card type is not a student card;
- Dj>=6 hours, where Dj is the duration that a cardholder stays at place j, which is associated with all bus stops within 500 meters of one another;
- j <>1, which means that j is not the first place in a weekday that the server records.
- The place where a cardholder visited most frequently in five weekdays will be defined as the final workplace of the cardholder in this study.

Similarly, we deduced from the data queries that a place would be a cardholder's home if the data meet these conditions:

- The cardholder has an identified workplace;
- The card type is not a student card;
- Dh>=6 hours, where Dh is the duration that a cardholder stays at place h, which is associated with all bus stops within 500 meters of one another;
- Fh >= Fj, where Fh is the first and the most frequent place a cardholder starts a bus trip of a day within the week, Fj is the trip frequency to or from j that the cardholder has.

Legal and illegal flows

- Aggregating flow-in in the platform level
  - Each platform corresponds to a UGB
- Legal flows: inter UGBs and intra UGBs flows
  - Both legal and informal flows in this study are limited to commuting and schooling trips
- Illegal/informal flows: between inside UGBs and beyond UGBs
- E_f = *#Legal flows / #All flows*
  - The effectiveness in terms of flows

Legal and illegal flows

- Result

SCD flows:

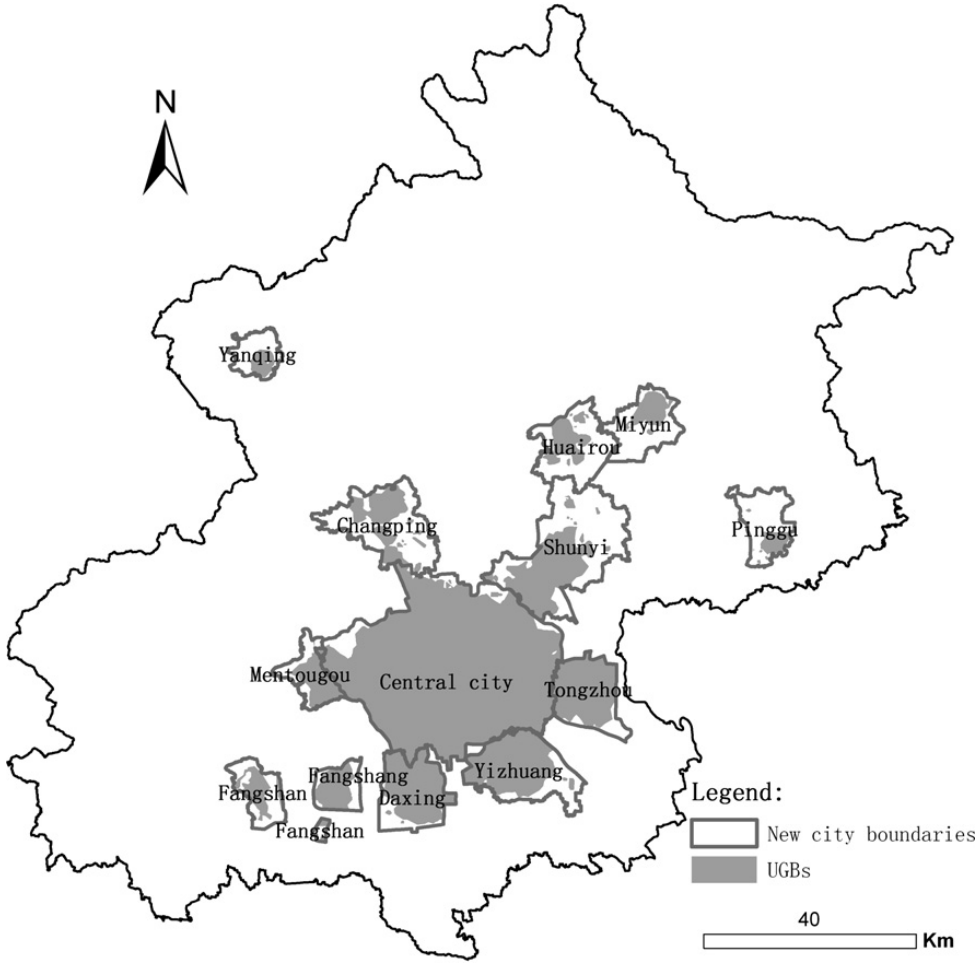
E_f = #Legal flows / #All flows=664968/703293=94.6%

Taxi flows:

E_f =#Legal flows / #All flows=2185777/2253437=97.0%

Flows between UGBs

- Estimate the connections between UGBs using all SCD trips and taxi ODs
  - Limited to UGBs of the central city and new cities
  - E.g., connections between new cities, the central city with new city
- Examine the connection strengthen between UGBs with that specified in the 2004 master plan
  - E.g. the plan report and drawings
  - **Effectiveness of UGBs could meanwhile be evaluated**



Flows between UGBs

- Results (SCD)
  – connections between UGBs

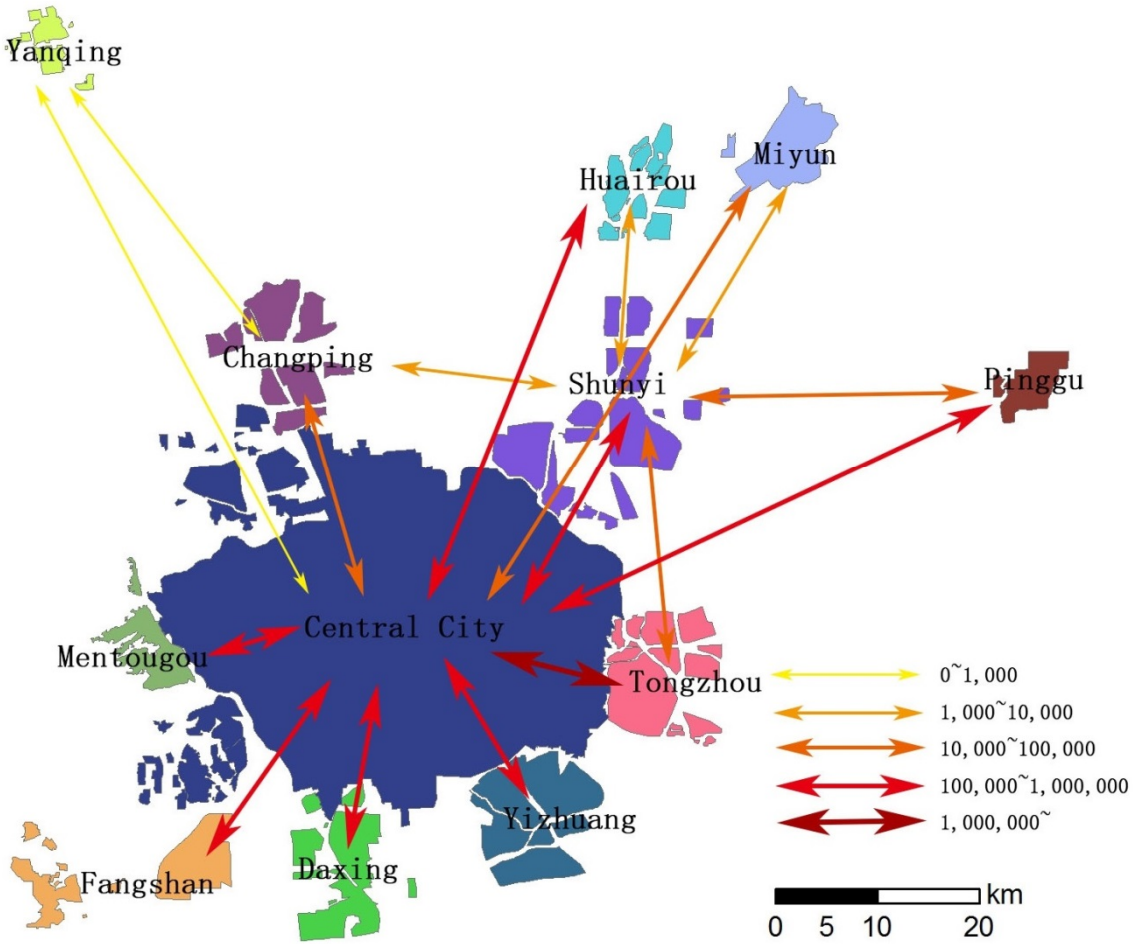
Table 7 SCD Flows among different kinds of UGB and OOU

Type	Flows	Percentage
Inside CC	31,475,282	73.6%
Inside NC	1,259,894	2.9%
Between NCs	51,388	0.1%
Between CC and NCs	2,813,781	6.6%
Inside UGBs	**35,600,345**	**83.0%**
Inside OOU	1,878,338	4.4%
Between CC and OOU	2,607,835	6.1%
Between NCs and OOU	2,825,294	6.6%

*‘CC’ for Central City, ‘NC’ for New City and ‘OUG’ for Out Of UGBs

Flows between UGBs

- Results (SCD) – connections between UGBs



Flows between UGBs

- Results (Taxi)
  - connections between UGBs

Table 9 taxi Flows among different kinds of UGB, OOU and the area out of Beijing

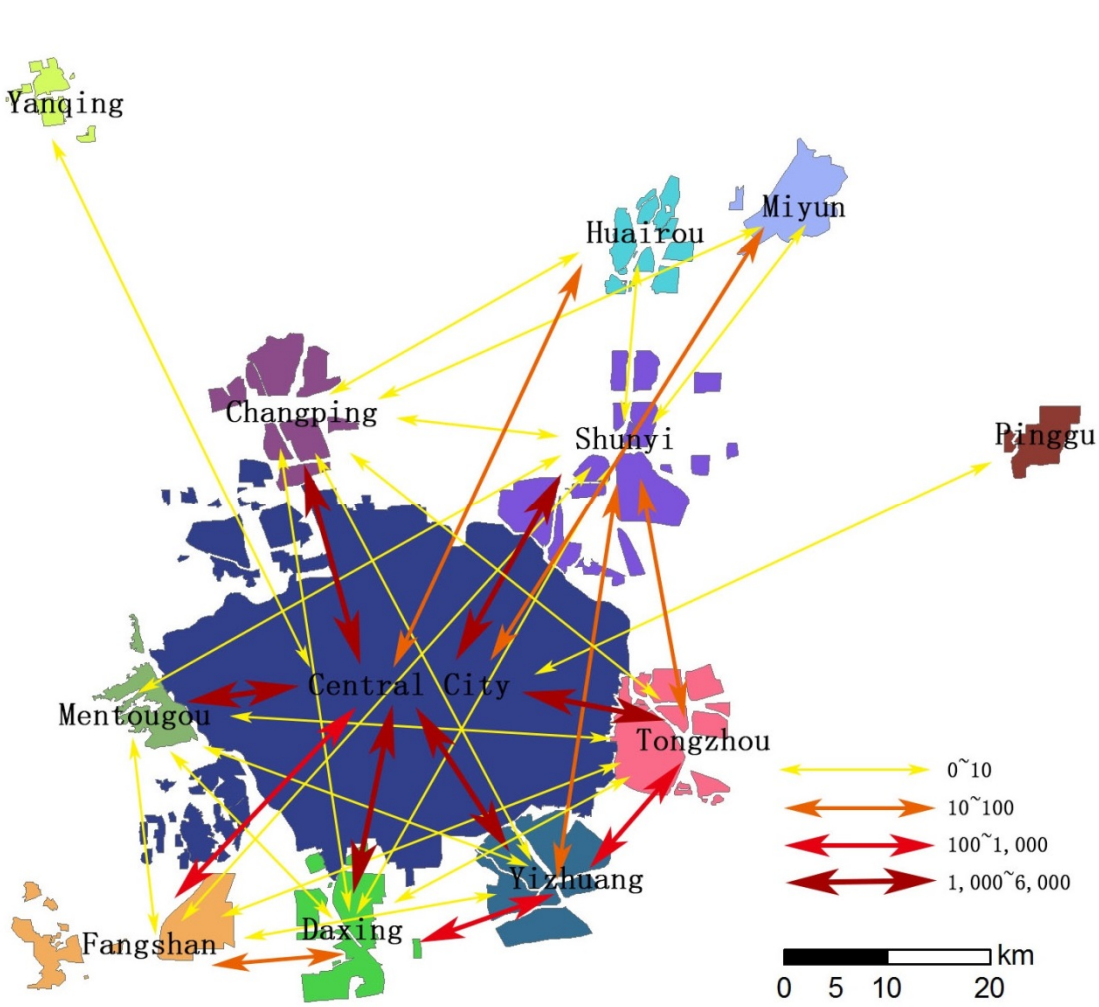
	CC	NC	OOU	Out of Beijing
CC	2,120,745 (94.1%)	/	/	/
NC	21,635 (1.0%)	14,173* (0.6%)	/	/
OOU	63,985 (2.8%)	6,587 (0.3%)	26,312 (1.2%)	/
Out of Beijing	245 (0.0%)	16 (0.0%)	38 (0.0%)	332 (0.0%)

* Inside NC: 13,827; between NCs: 346;

**'CC' for Central City, 'NC' for New City and 'OUG' for Out Of UGBs

Flows between UGBs

- Results (Taxi) – connections between UGBs



Flows between UGBs

- Results (SCD)
  - Examine the connection strengthen between UGBs with that specified in the 2004 master plan

    - Efficient UGBs (83.0% within UGBs);
    - Highly Primate Central City(73.4% within CC);
    - Three Agglomerative Tongzhou(36.4%), Yizhuang(24.8%) and Shunyi(7.9%, not so promident);
    - Weak connection between CC and NCs (6.6%, nearly equal to CC-OOU flows and NCs-OOU flows);
    - Weak connection among NCs。

Flows between UGBs

- Results (Taxi)
  - Examine the connection strengthen between UGBs with that specified in the 2004 master plan
    - Weak connections among new cities. The numbers of flows between two new cities are nearly less than 100.
    - New cities can be classified into three classes according to the strength of their connections with the central city.

New Cities	Number of Taxi flows	Strength
Yizhuang, Daxing, Tongzhou, Shunyi, Mentougou, Changping	(1000,6000]	Strong
Fangshan	(100,1000]	Medium
Huairou, Miyun, Yanqing, Pinggu	(0,100]	Weak

4

Discussion

Discussion on the results

- Our findings

Contributions

- Human mobility and urban activities reflected in evaluating physical UGBs
  - The first exploration in the world to the best of our knowledge
- Four indicators proposed to quantitatively evaluate the effectiveness of UGBs
- Linkage between UGBs identified

Potential bias and next steps

- Human mobility and urban activities not by all citizens
  - Netizens and bus/metro riders
    - Limited to commuting trips to estimate legal and informal flows
  - But already a large proportion (40% public transportation share in 2010 in Beijing)
- To include taxi trajectories in the near future
  - Using data released by MSRA in 2010
- Introduce space syntax into a more detailed scale of UGBs evaluation
  - Reflecting the relationship between land use and human mobility & behavior

5

Conclusions

Concluding remarks

- TBE

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这套课件为龙瀛及其合作者近年来在城市模型领域研究的部分合集，包括传统的城市模型、基于大数据的城市模型、大模型这一城市与区域研究新范式，以及最近的面向规划设计应用的初步探索。

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