



# OVERVIEW OF URBANIZATION IN CHINA STUDIES

Peilei Fan

Anne-Marie Schneider

Michigan State University

University of Wisconsin-Madison

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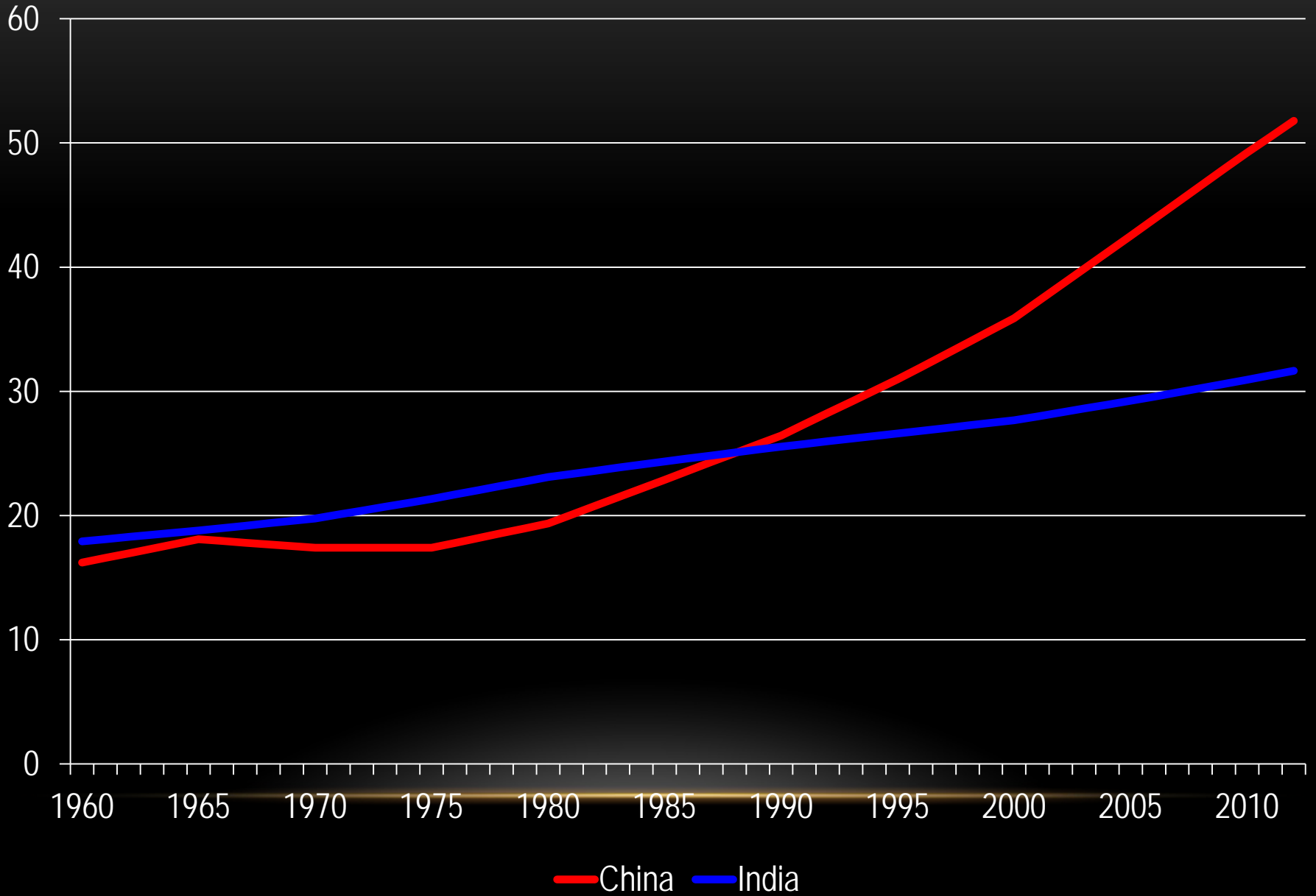
# OUTLINE

1. Urbanization in China: an overview
  2. Urban LCLUC: Patterns and characteristics
  3. Urban LCLUC: Drivers and spatial determinants
  4. Impact of urbanization and urban sprawl
  5. Towards a synthesis for urbanization in China
-

An overview

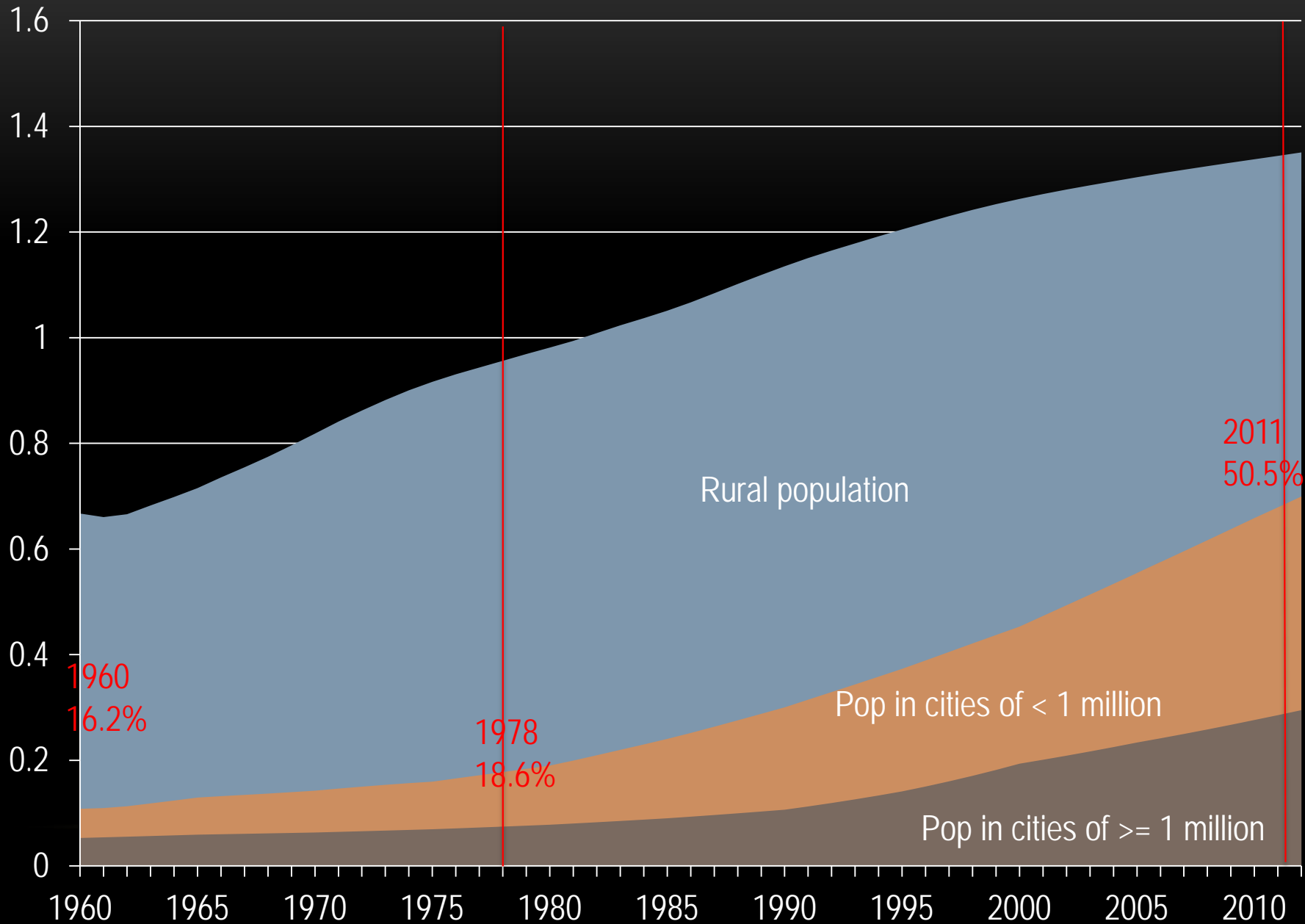
# 1. URBANIZATION IN CHINA

# Urbanization in China and India (1960-2012, in %)



Source: Fan made this figure based on data from World Bank (2014)

# China's population dynamics (1960-2012, in billion)



Source: Fan made this figure based on data from World Bank (2014)

Patterns and characteristics

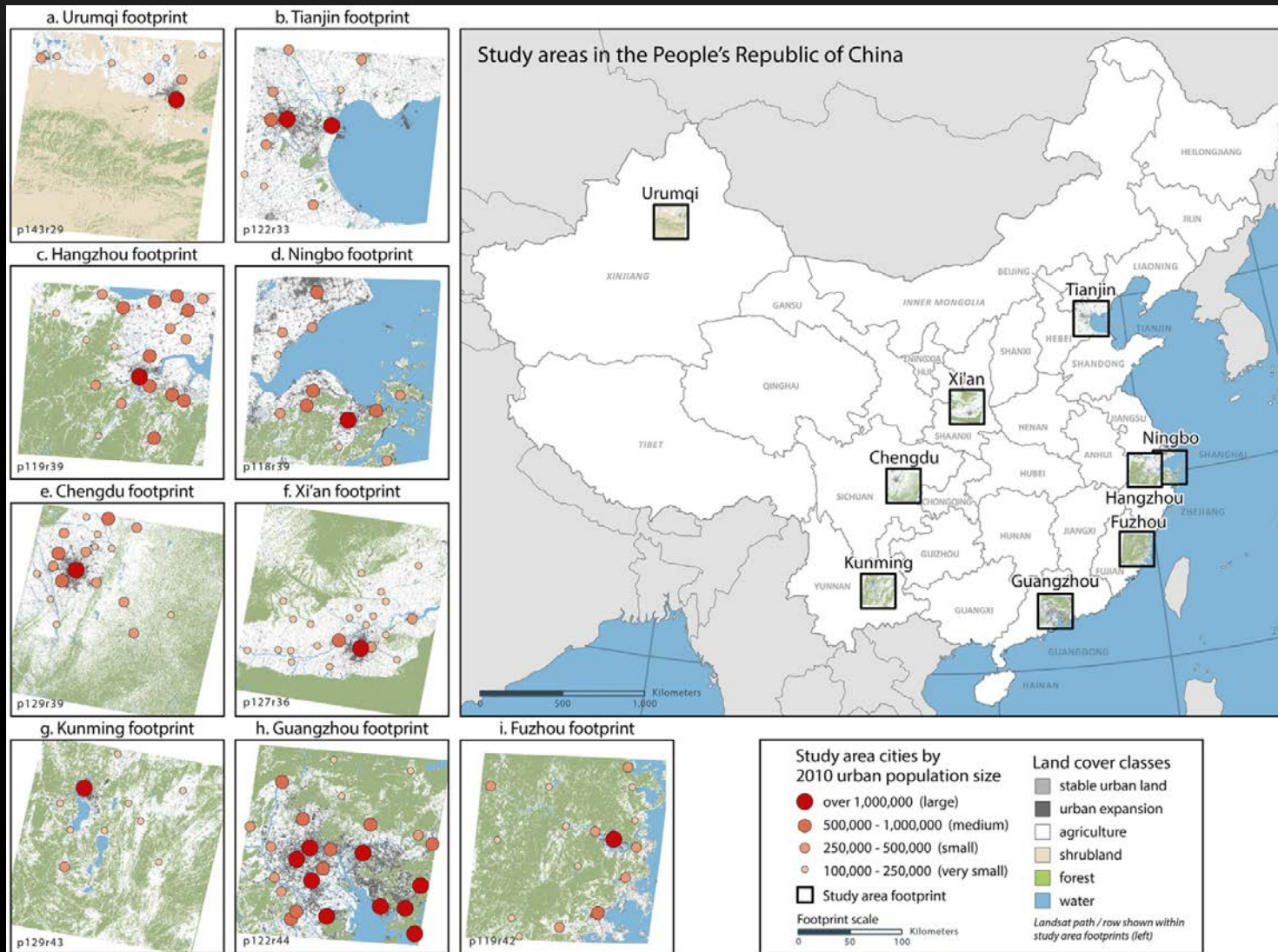
## 2. URBAN LCLUC IN CHINA



## 2.1 CHARACTERISTICS OF CHINA'S URBANIZATION

- Regional Variation (East vs. West)
- Temporal Variation (1980s, 1990s, 2000s)
- Variations in urban agglomeration sizes (Large, medium and small sizes)

# URBAN LAND COVER-LAND USE CHANGES IN CHINA







### LARGE CITIES

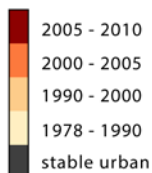
5 kilometers

### MEDIUM, SMALL, and VERY SMALL CITIES

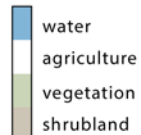
5 kilometers

5 kilometers

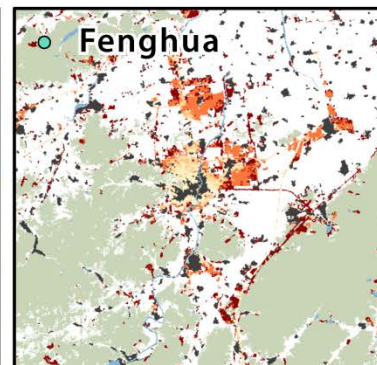
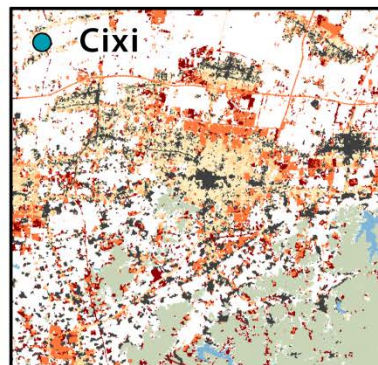
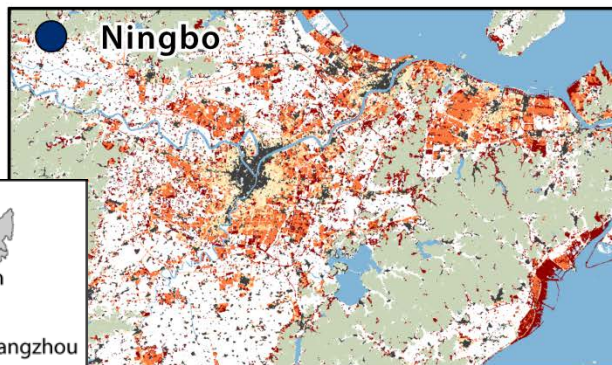
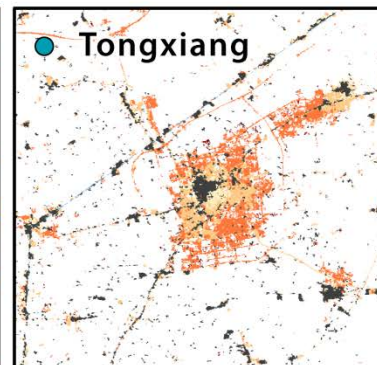
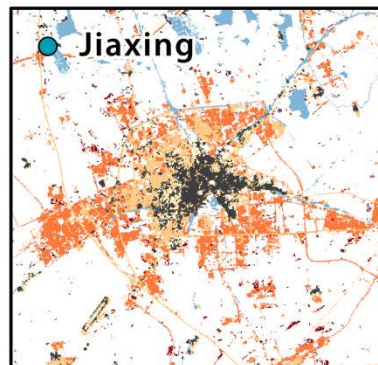
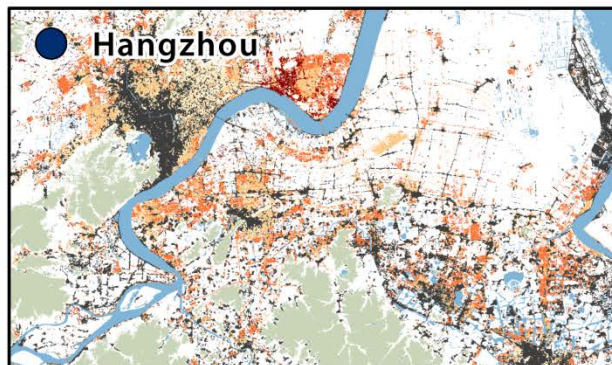
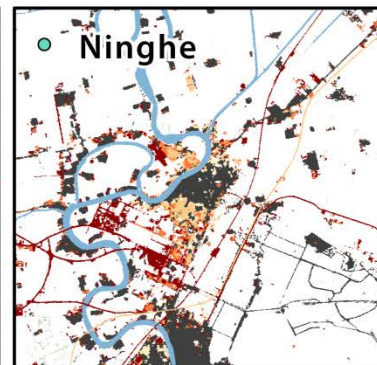
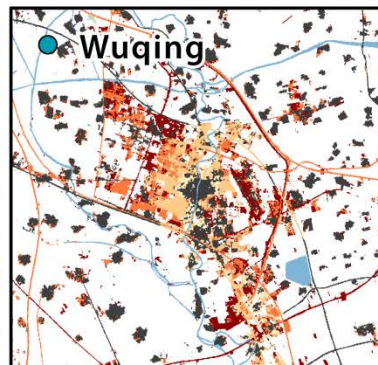
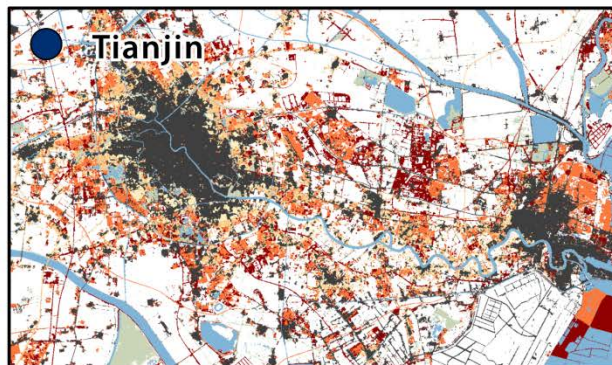
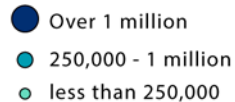
#### Urban classes

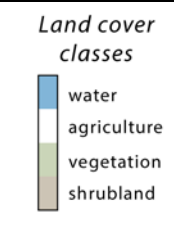
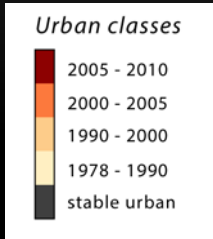
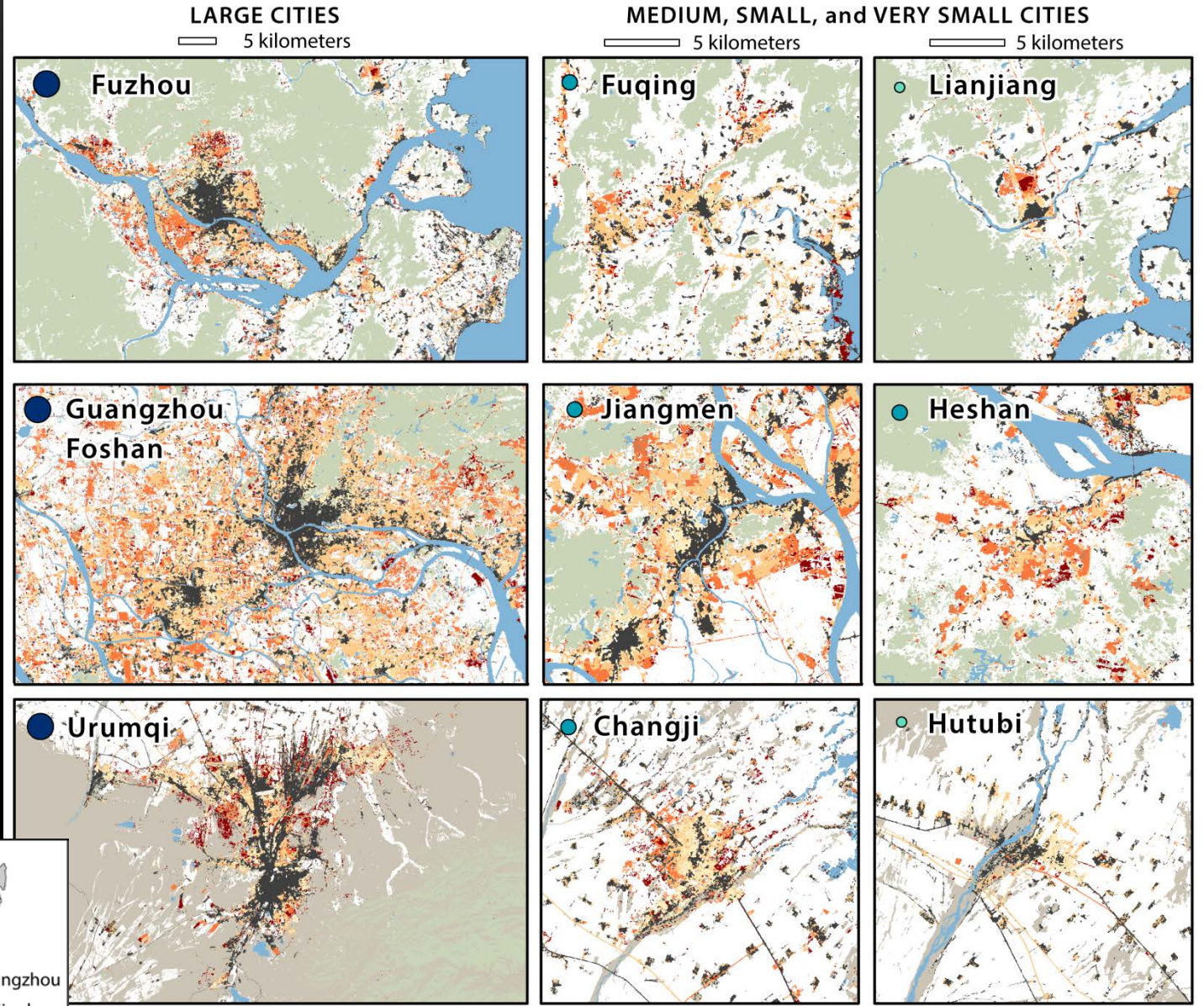


#### Land cover classes

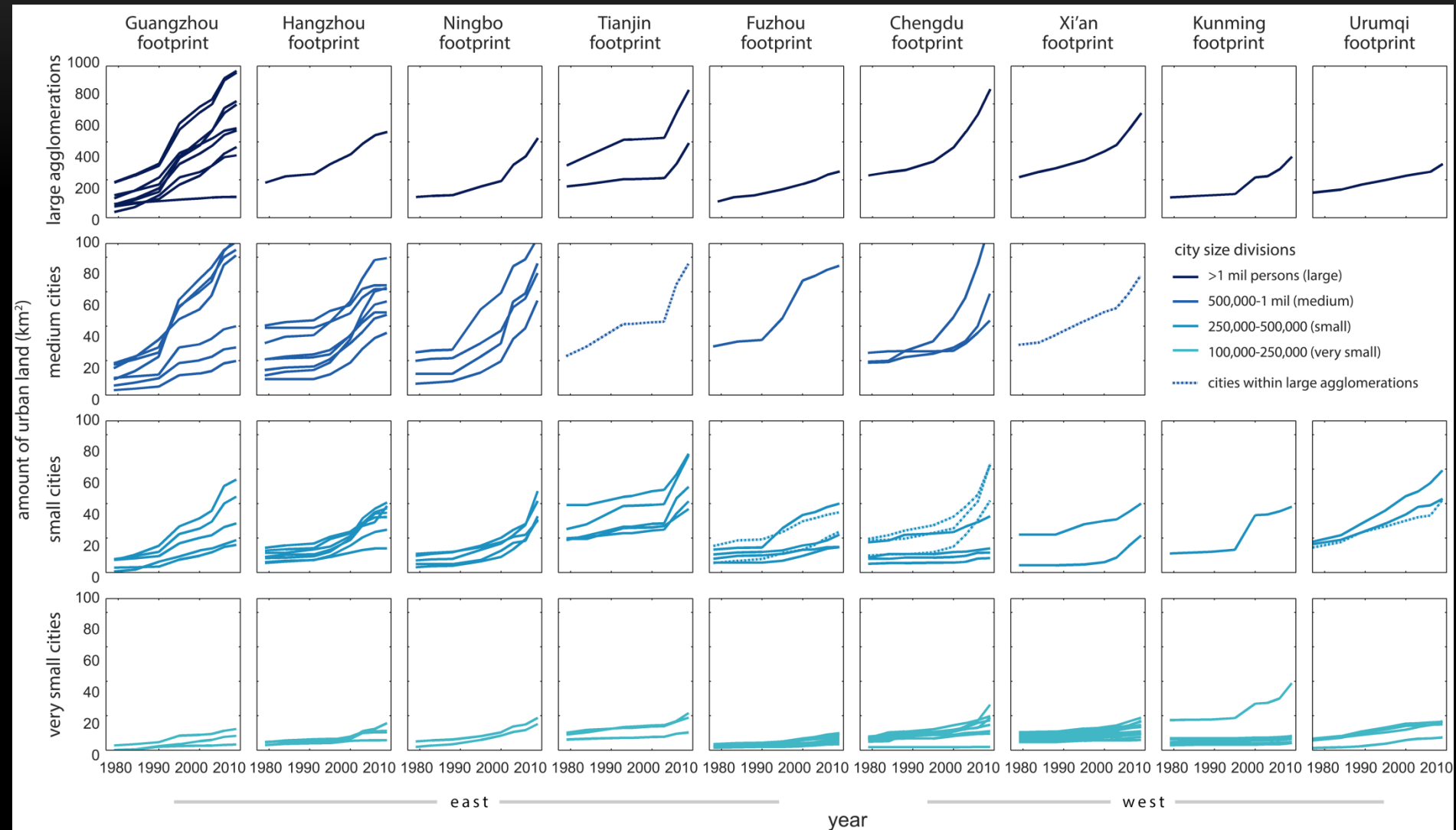


#### City size class



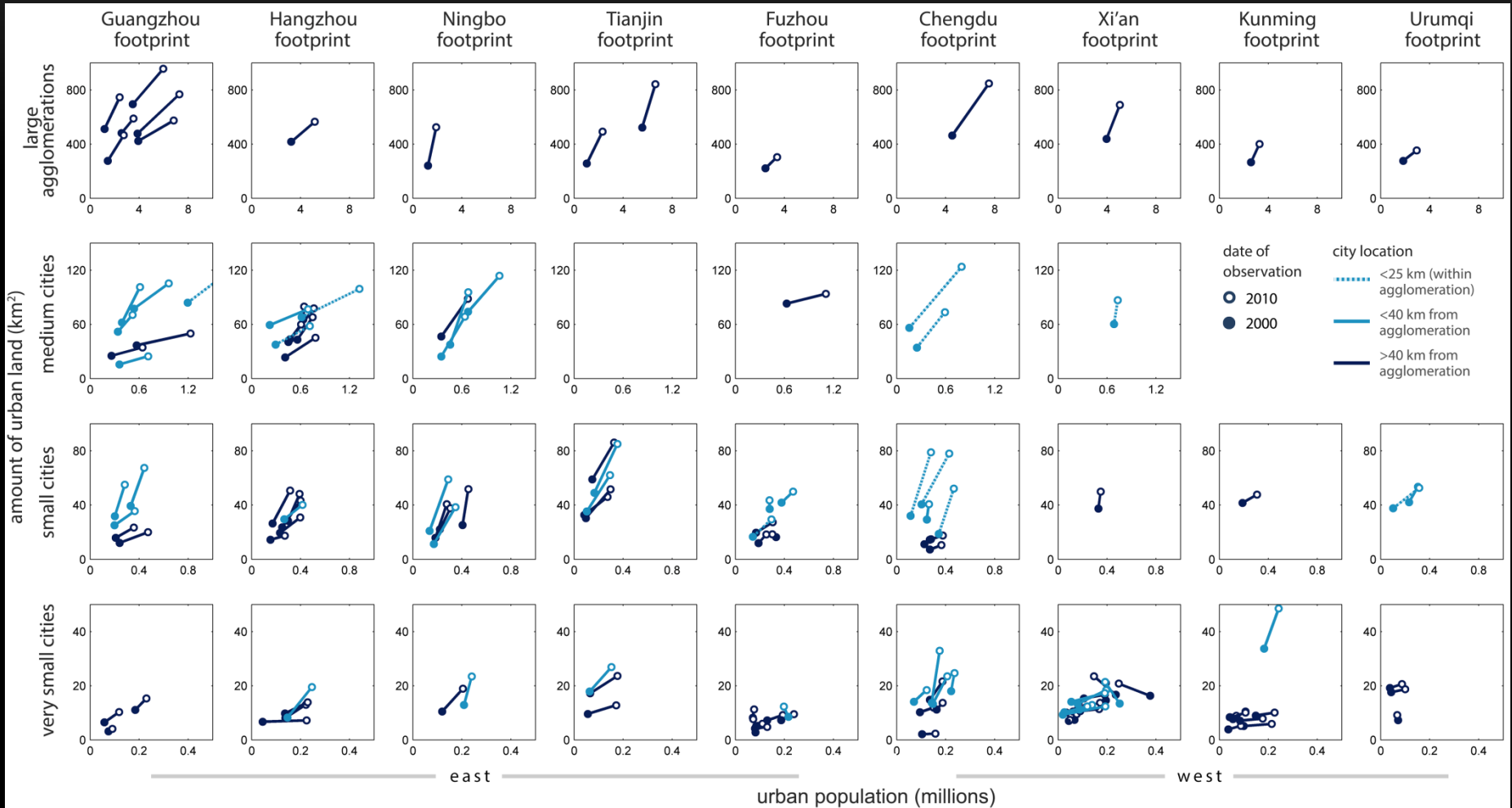


# AMOUNTS OF URBAN LAND EXPANSION, 1978-



Note: *Large agglomerations* are those with 2010 populations >1 mil persons, *medium cities* are those with 500,000-1 mil, *small cities* are those with 250,000-500,000, and *very small cities* are those with 100,000-250,000. The plots for *medium cities* in the Kunming and Urumqi footprints are not shown due to a lack of cities in this category. Cities within *large agglomerations* are those located within the 25 km radial zone; since these cities are governed independently, they are included in the *small* and *medium* categories.

# CHANGE IN URBAN POPULATION VS. URBAN LAND, 2000-2010

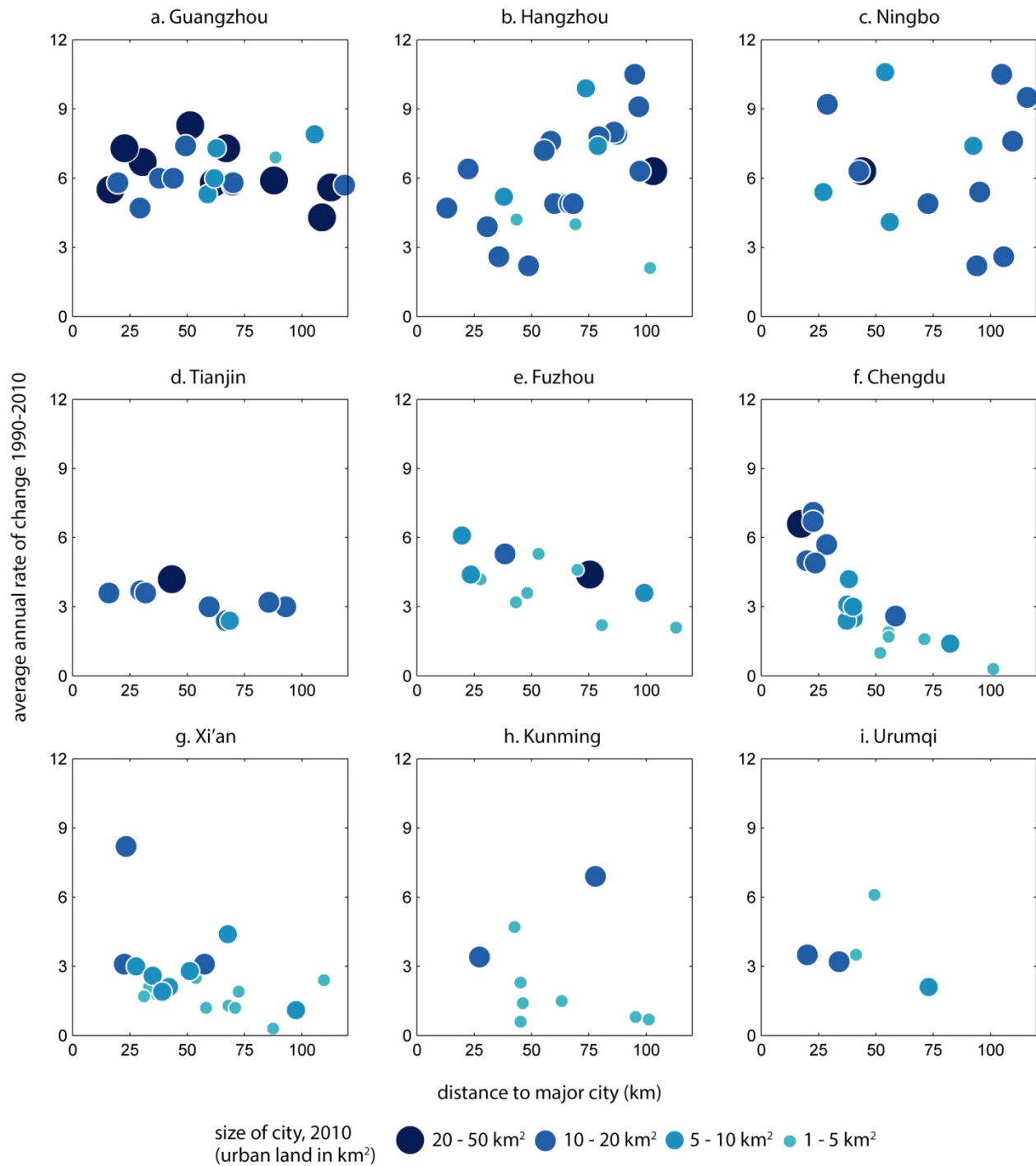


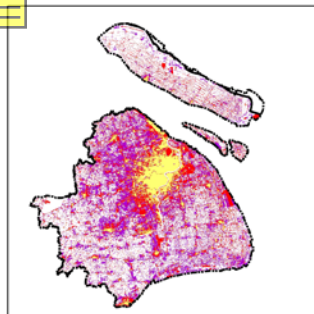
Note: Large agglomerations are those with 2010 populations >1 mil persons, medium cities are those with 500,000-1 mil, small cities are those with 250,000-500,000, and very small cities are those with 100,000-250,000. The plots for medium cities in the Tianjin, Kunming and Urumqi footprints are not shown due to a lack of data. Cities within large agglomerations are those located within the 25 km radial zone; since these cities are governed independently, they are included in the small and medium categories.

# EMERGING POLYCENTRICITY

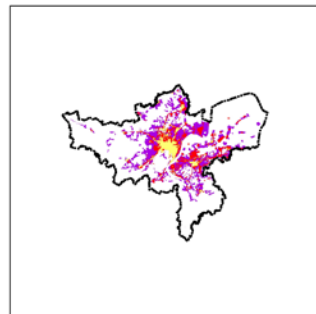
- East: Polycentricity  
(distance to metro area does not matter)

- West:  
Multi-nucleated (distance matter)

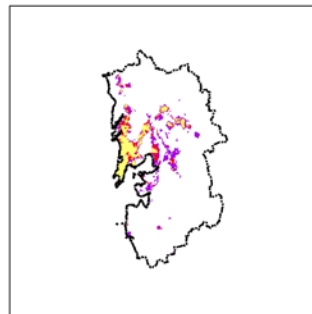




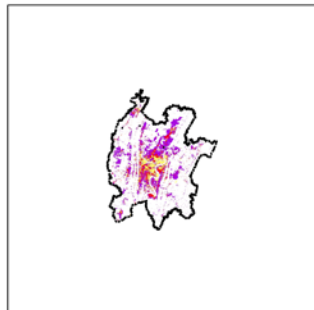
a) Shanghai, China



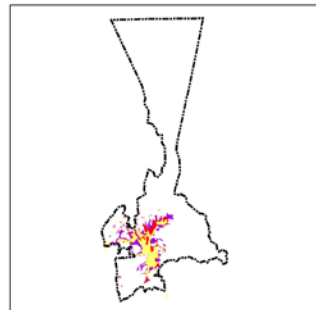
b) Hangzhou, China



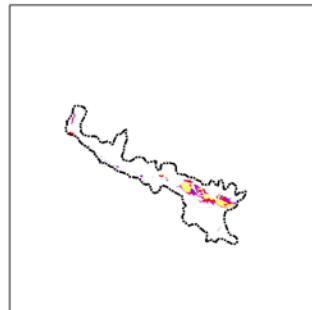
c) Mumbai, India



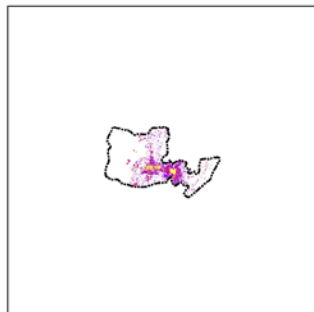
d) Chongqing, China



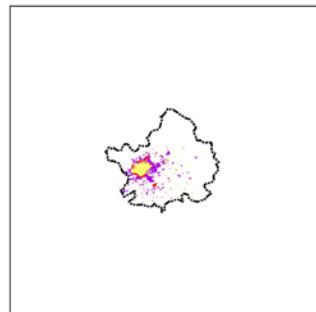
e) Urumuqi, China



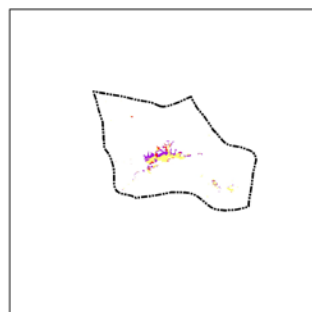
f) Lanzhou, China



g) Yinchuan, China



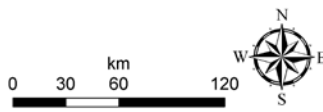
h) Hohhot, China



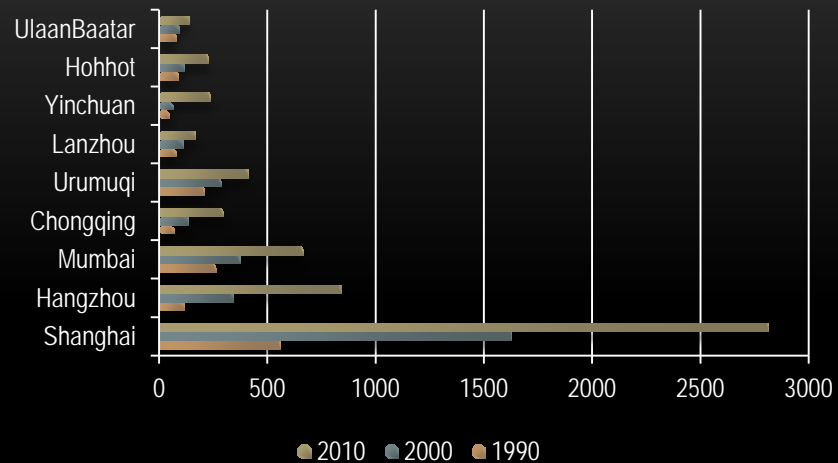
i) Ulaanbaatar, Mongolia

**Legend**

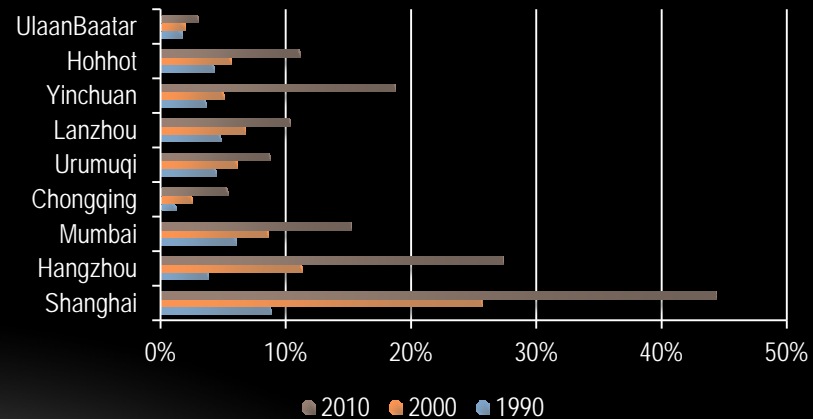
- City boundary
- Urbanized areas by 1990
- Urbanization from 1990 to 2000
- Urbanization from 2000 to 2010



**Urban built-up area (km<sup>2</sup>)**



**Urban land density (% of urban built up to the total area of the city)**



## Case 1. Shanghai



### -General

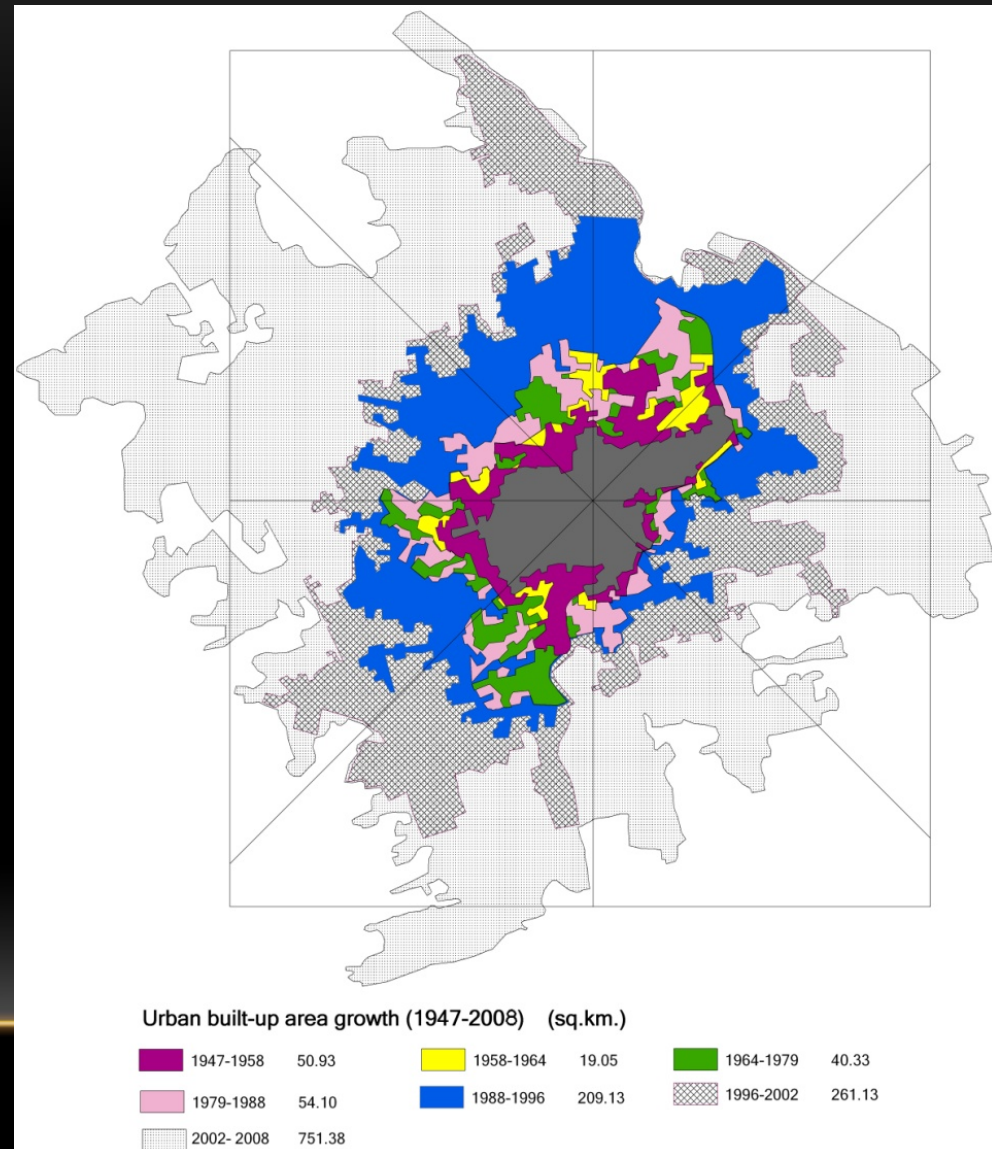
- A globalizing city
- largest economic center since 1850
- manufacturing center during Maoist period (1949-78) (>70% of output)
- transition to tertiary sector
- international prominence

### Urbanization

- 59% (1978) => 86% (2007)

### Urban sprawl

- Expanded 38 times:
  - 76 (1947) to 2911 km<sup>2</sup> (2010)
- Expanded almost 6 times
  - 530 (1986) => 2911 km<sup>2</sup> (2010)

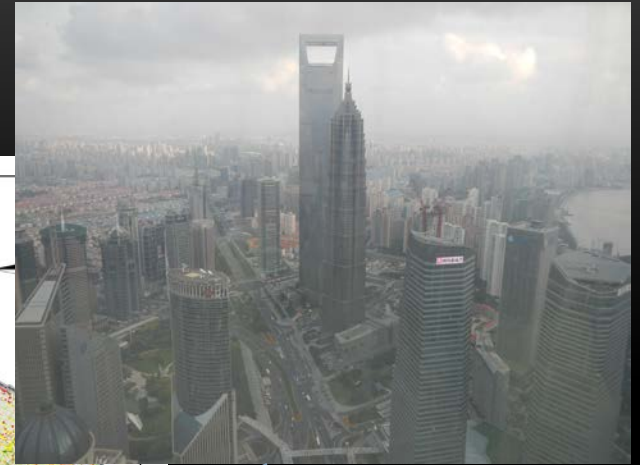
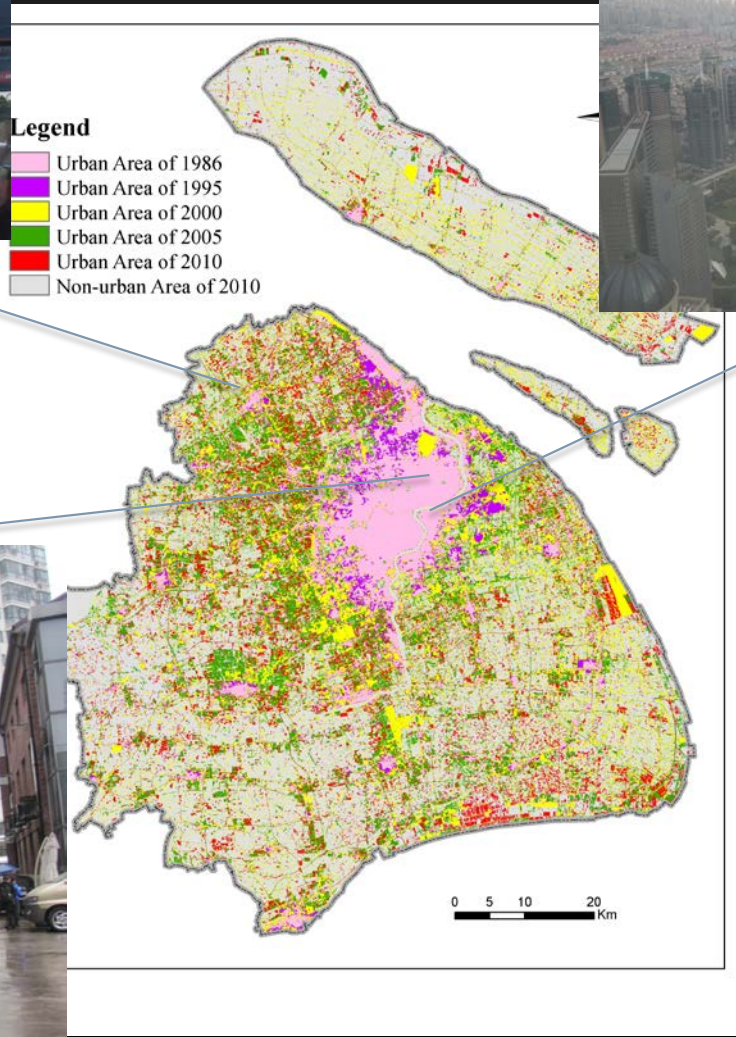


Source: Yue et al, 2010; Fan et al, 2012



Suburban low-density industrial zone

Redevelopment at old urban district



Rising new CBD in Lujiazui, Pudong



## Case 2: Hangzhou's urban sprawl (1995-2005)

- Infill growth: 18% (close to city center)
- Edge growth: 31%
- Leapfrog growth: 51% (mostly farmland=> urban built-up for college town and ETDZ, outer suburb)

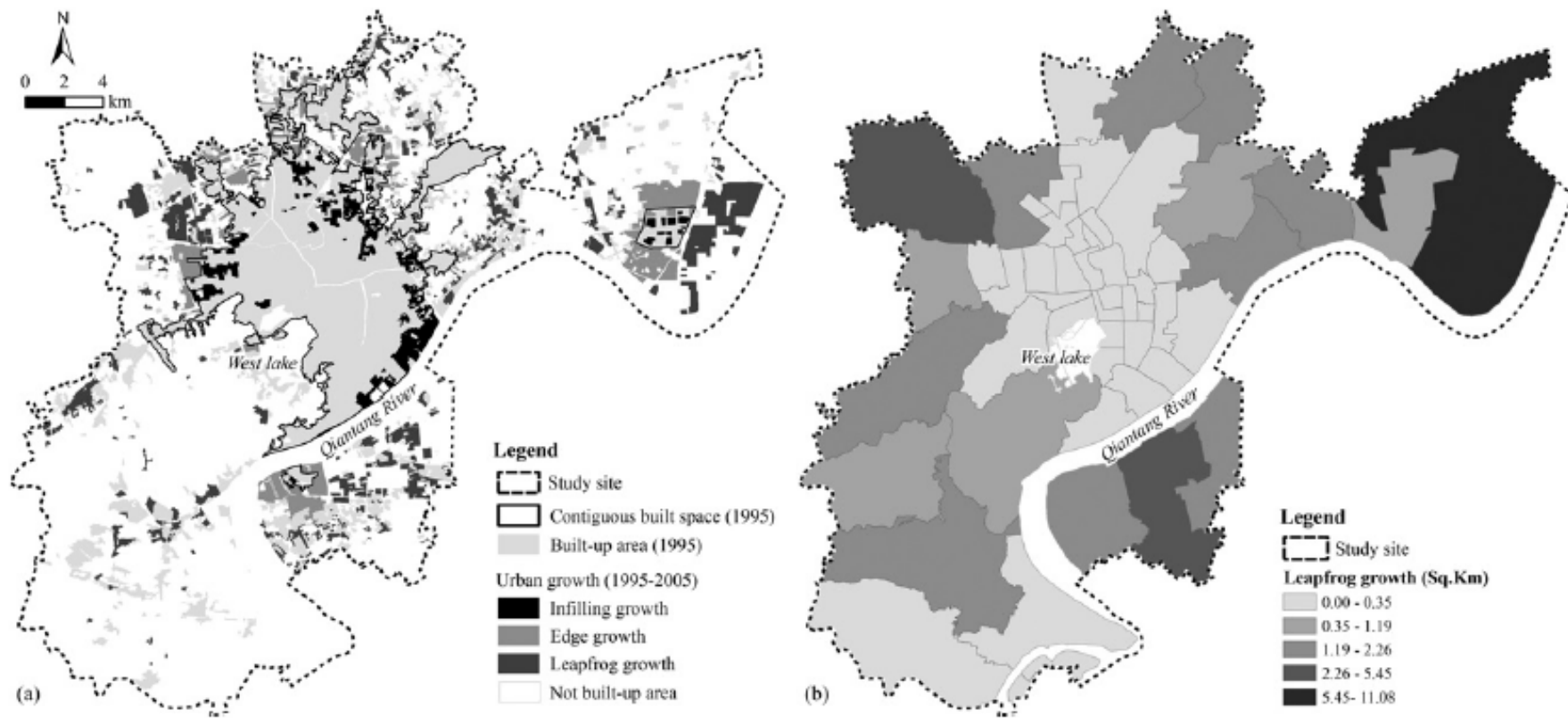


Fig. 2. Three types of urban growth and leapfrog development at street-towns (1995-2005). (a) Three types of urban growth and (b) Leapfrog growth statistics in each street-town.

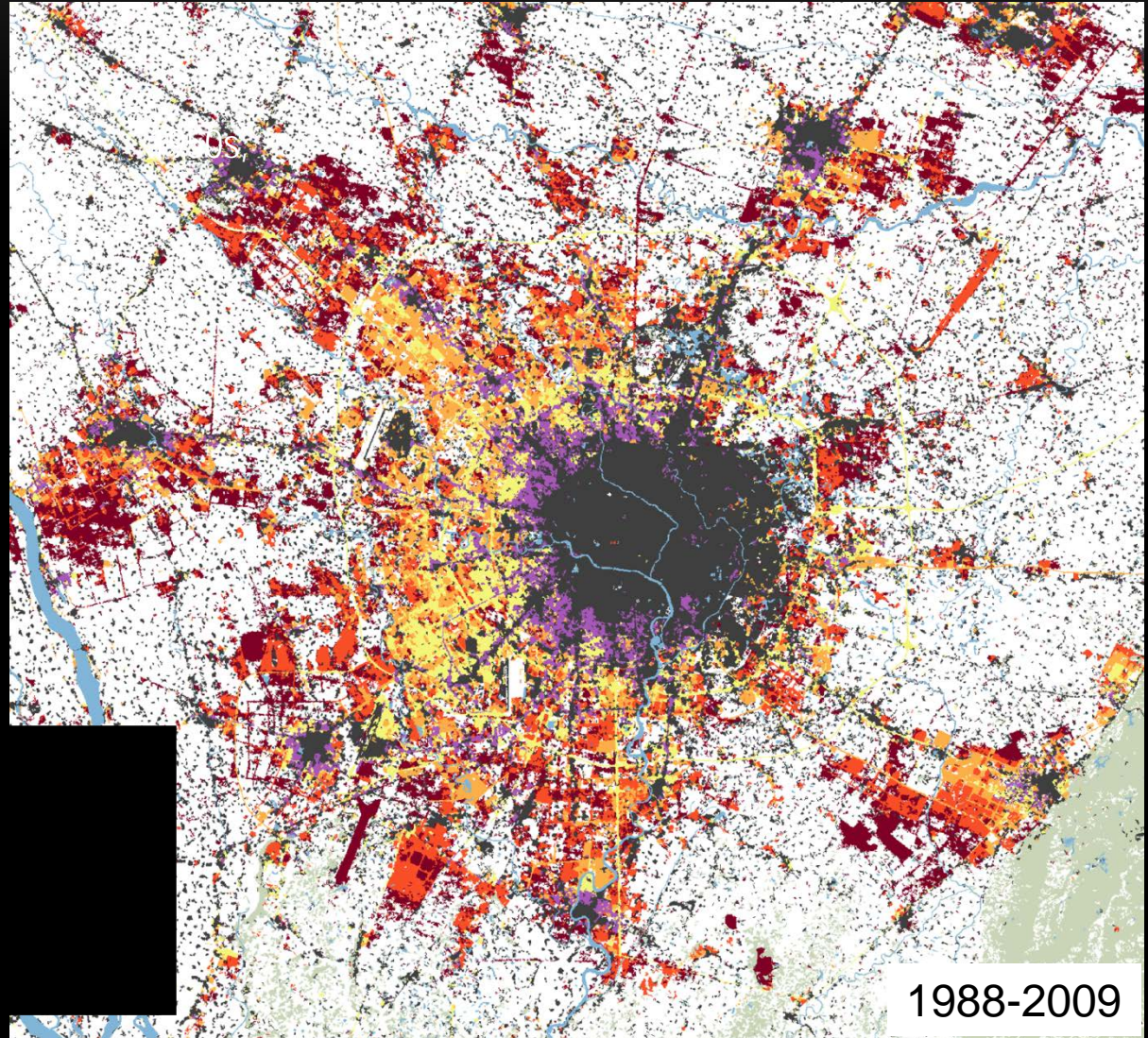
# CASE 3: CHENGDU - IMPACTS OF THE 'GO WEST' PROGRAM

## Chengdu, Sichuan Province

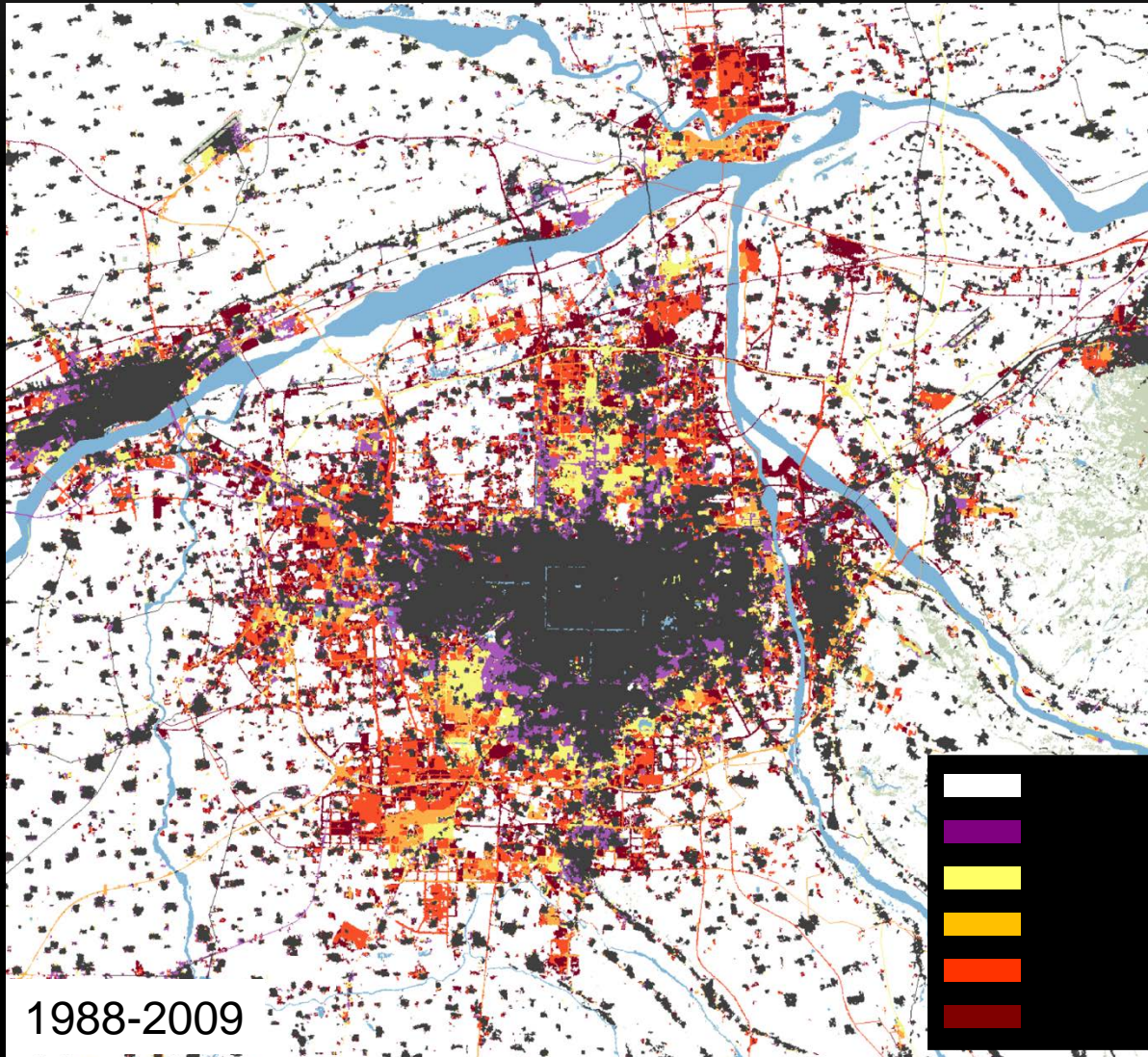
- fertile plain, 2500 yr history
- industrial center in 1960s
- city targeted early for investment:  
high tech zones, roads, airport

loss of cropland  
to urban expansion:  
> 988 km<sup>2</sup>

400% increase  
in urban land  
1978-2009



# CASE 4: XI'AN - SECOND WAVE OF WESTERN DEVELOPMENT?



## Xi'an, Shaanxi Province

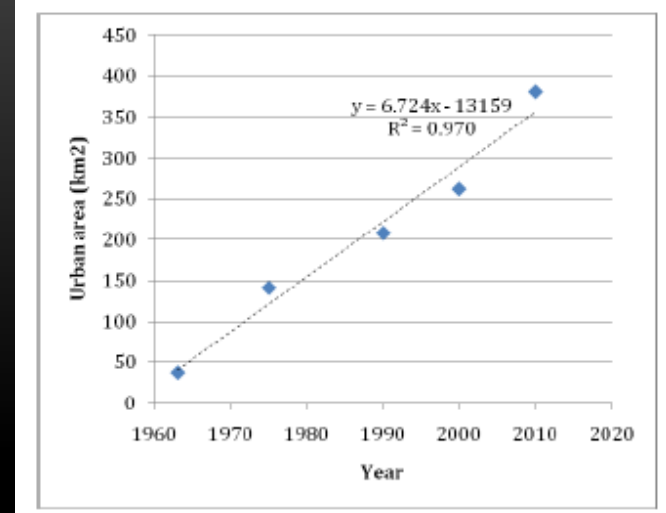
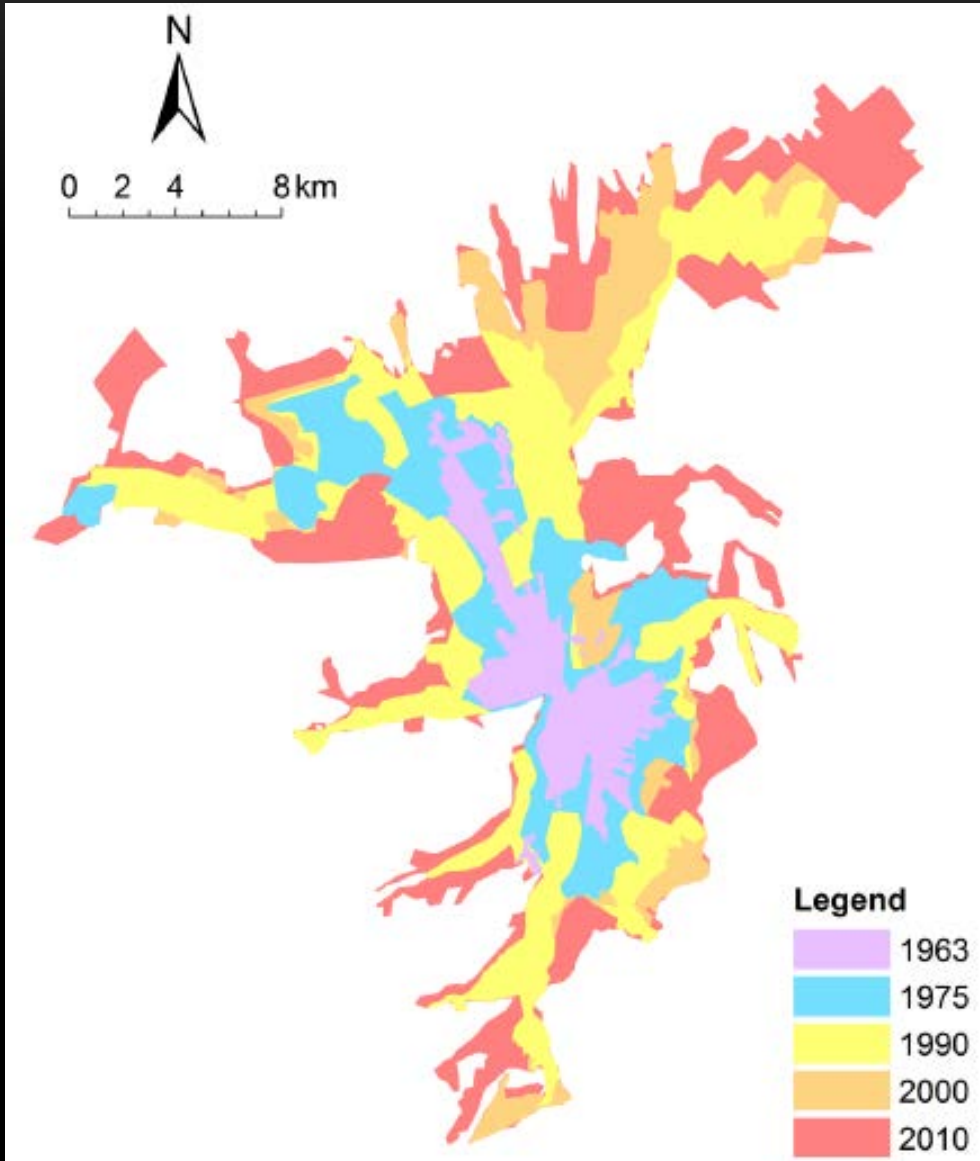
- fertile plain
- emerging leader in telecommunications, aerospace industry
- city targeted for investment:  
high tech zones, roads

loss of cropland to urban expansion:  
> 463 km<sup>2</sup>

84% increase  
in urban land

## Case 5: Urumqi urban sprawl (1963-2010)

38 km<sup>2</sup> in 1963, 238 km<sup>2</sup> in 1990, 381 km<sup>2</sup> in 2010



### Urumqi, Capital of Xinjiang

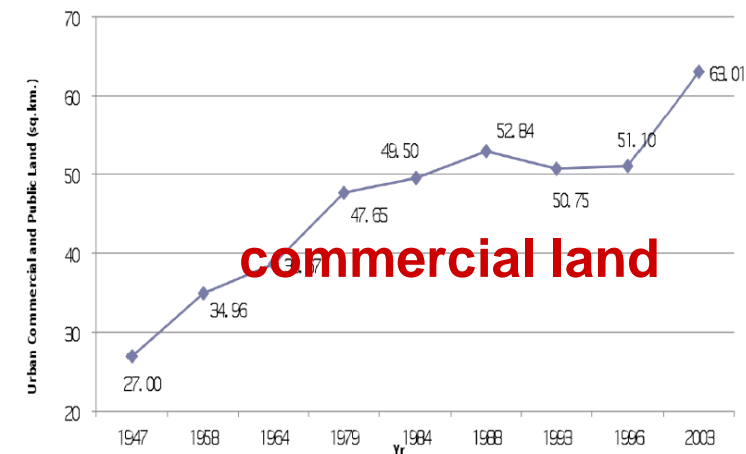
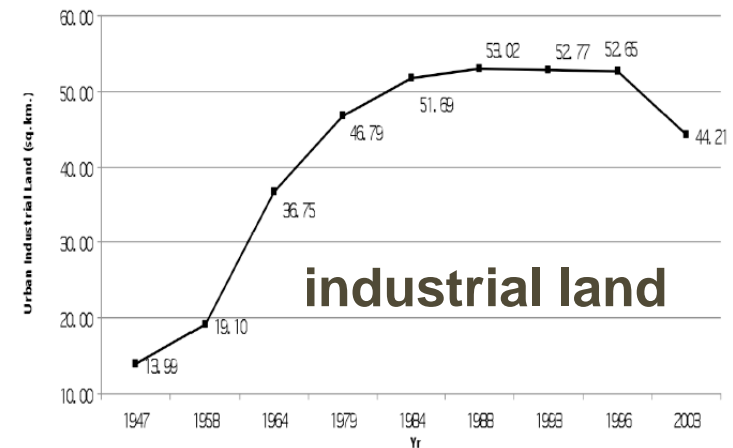
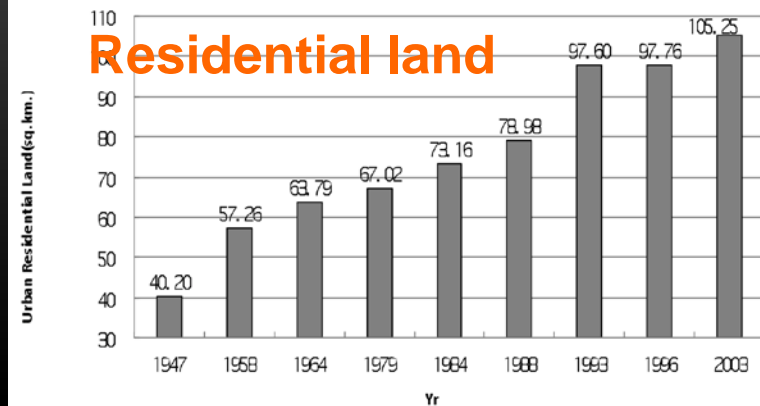
- important trading center for centuries
- military base
- westward migration - factor in industrialization

### Urumqi today...

- exponential economic growth 1990s onward
- investment in energy industry
- new growth in tertiary sector
- Int'l trade with Russia, tourism

## 2.2 URBAN LAND USE BY TYPES CASE OF SHANGHAI

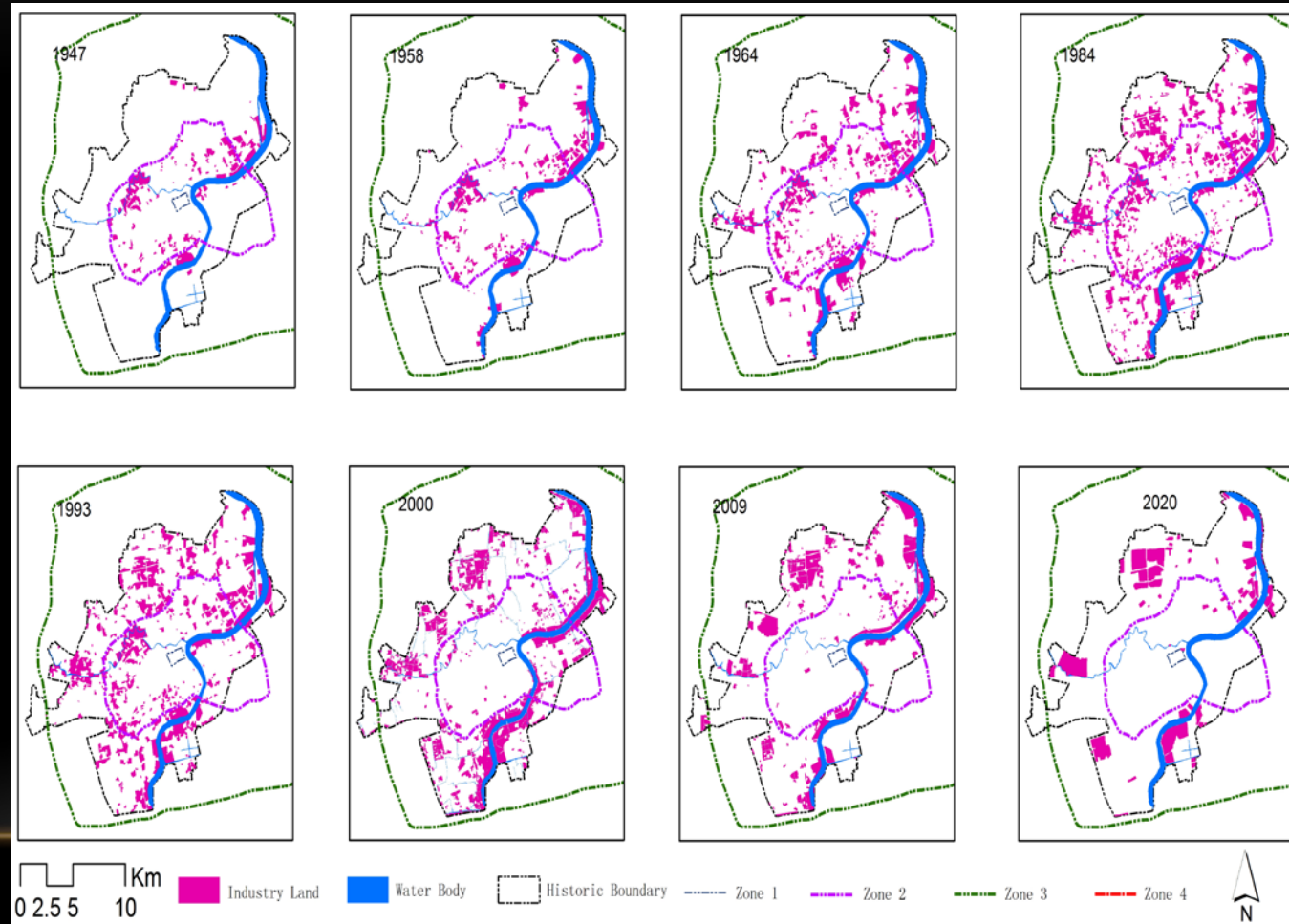
- *residential* - continuous growth
- *industrial* - declined 1993-2003  
relocation of factories
- *commercial* - climbing due to  
increased infrastructure investment,  
urban redevelopment



first increased rapidly 1947 - 1984, then started decreasing from 1993

a hybrid monocentric pattern => a specialized polycentric pattern

## Shanghai – Evolution of urban industrial land



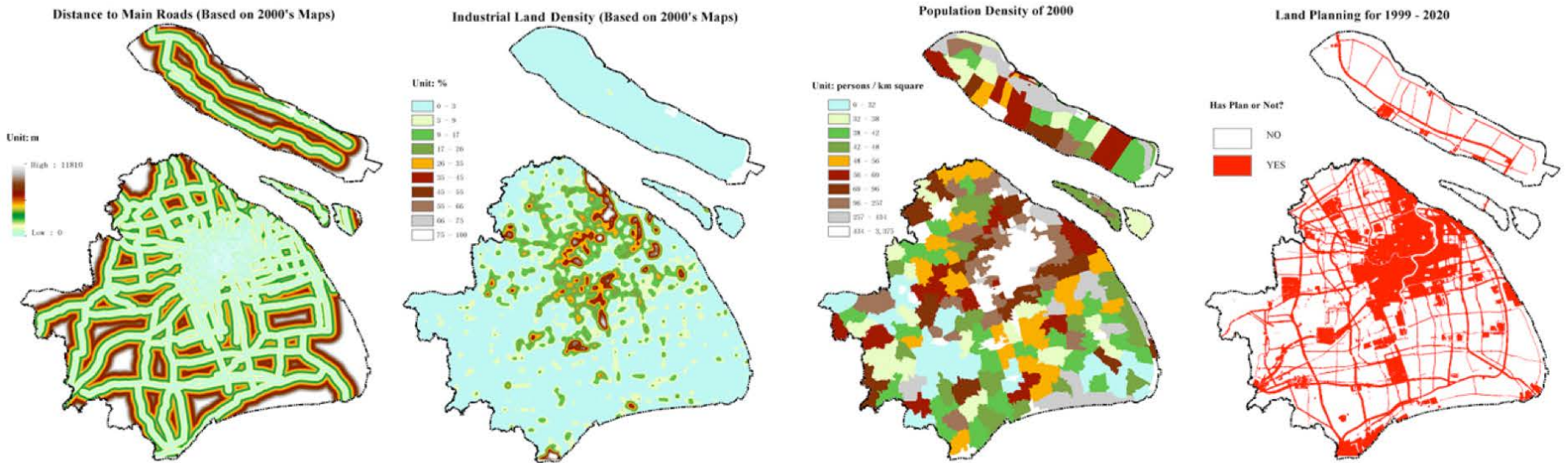
### 3. DRIVERS OF URBAN LAND CONVERSION AND FUTURE LCLUC SIMULATION

Spatial determinant of urban land conversion in large Chinese cities

## 3.1 DRIVERS OF URBAN LAND EXPANSION

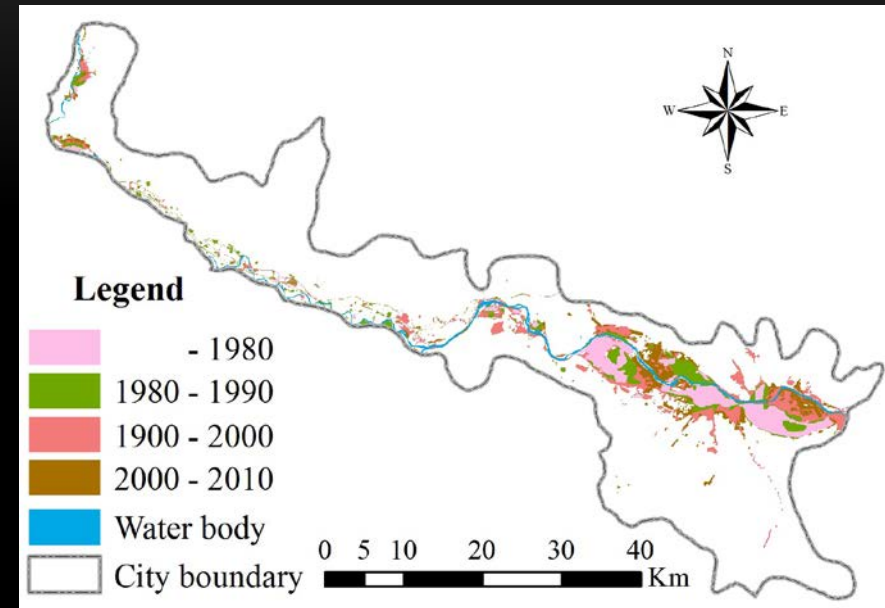
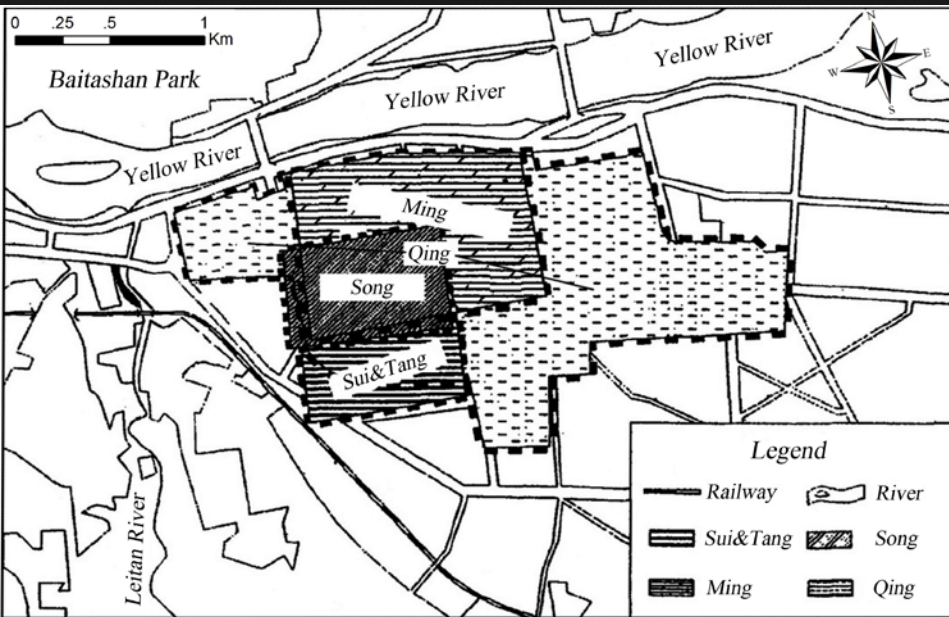


# CASE 1: SHANGHAI: 4 SPATIAL DETERMINANTS URBAN LAND CONVERSION



# CASE 2: LANZHOU

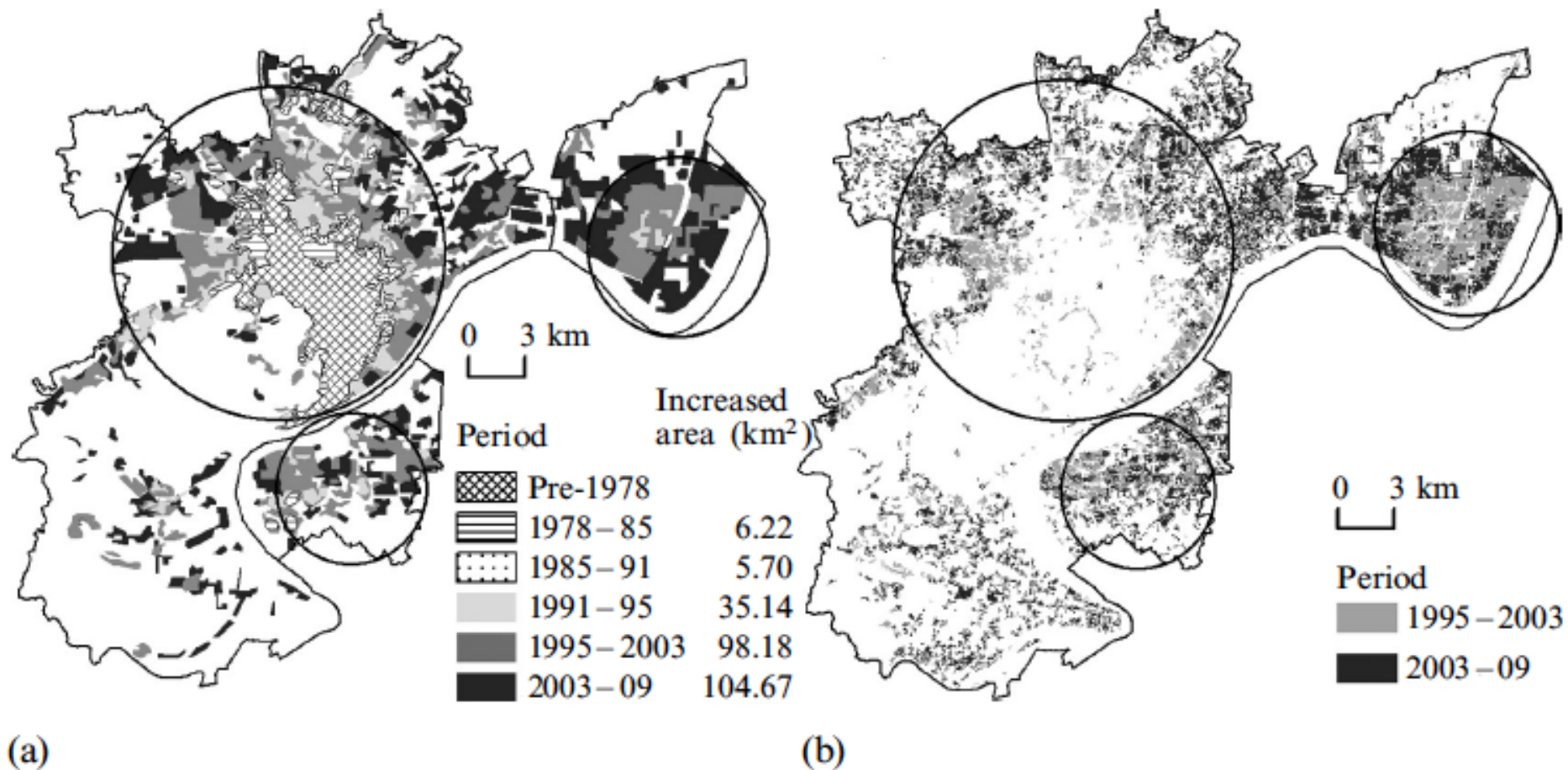
## HISTORICAL VS MODERN PHASES



- Urban expansion: dependent on the waterway of the Yellow River and its surrounding geography
- Population fluctuation– position as a bordering cities between different geographic regions and controls of ethnic/cultural groups

- Rapid urban expansion (decreasing farmland and vegetation land)
- Propelled by industrialization policies of national government

# CASE 3: HANGZHOU



**Figure 3.** Urban land-use conversion of Hangzhou mapped by (a) manual interpretation and (b) the hybrid approach. Figure (a) was delineated using Landsat MSS (1978), Thematic Mapper (1985, 1991, 1995) and Enhanced Thematic Mapper Plus (2003, 2009) images. Most of these images were downloaded from the websites of USGS (<http://edcns17.cr.usgs.gov/EarthExplorer/>).

# HANGZHOU: MAJOR SPATIAL DETERMINANTS OF URBAN DEVELOPMENT (1995-2009)

**Table 2.** Estimation of logistic regression model for urban development. For definitions of abbreviated variables see table 1.

Variables	1995–2003				2003–09			
	$\beta^a$	SD	<i>p</i> -value	$\exp(\beta)^b$	$\beta^a$	SD	<i>p</i> -value	$\exp(\beta)^b$
DCBD	0.133	0.013	0	1.143	0.076	0.012	0	1.079
INDC	-0.169	0.015	0	0.844	-0.141	0.016	0	0.869
ROAD	-0.322	0.037	0	0.725	-0.531	0.086	0	0.588
QTR	-0.021	0.011	0.066	0.980	-0.033	0.010	0.002	0.967
BUA	0.022	0.004	0	1.023	0.012	0.004	0.002	1.012
AVAIL	-0.014	0.003	0	0.986	0.009	0.003	0.002	1.009
MPLACE	1.550	0.354	0	4.711	0.735	0.221	0.001	2.086
PLAN	1.006	0.113	0	2.734	0.363	0.097	0	1.438
Constant	0.136	0.289	0.638		-0.863	0.291	0.003	
Likelihood-ratio statistic	749.06				429.41			
Relative operating characteristic value	0.777				0.717			
Number in sample	3000				3000			

<sup>a</sup>  $\beta$  = coefficients.

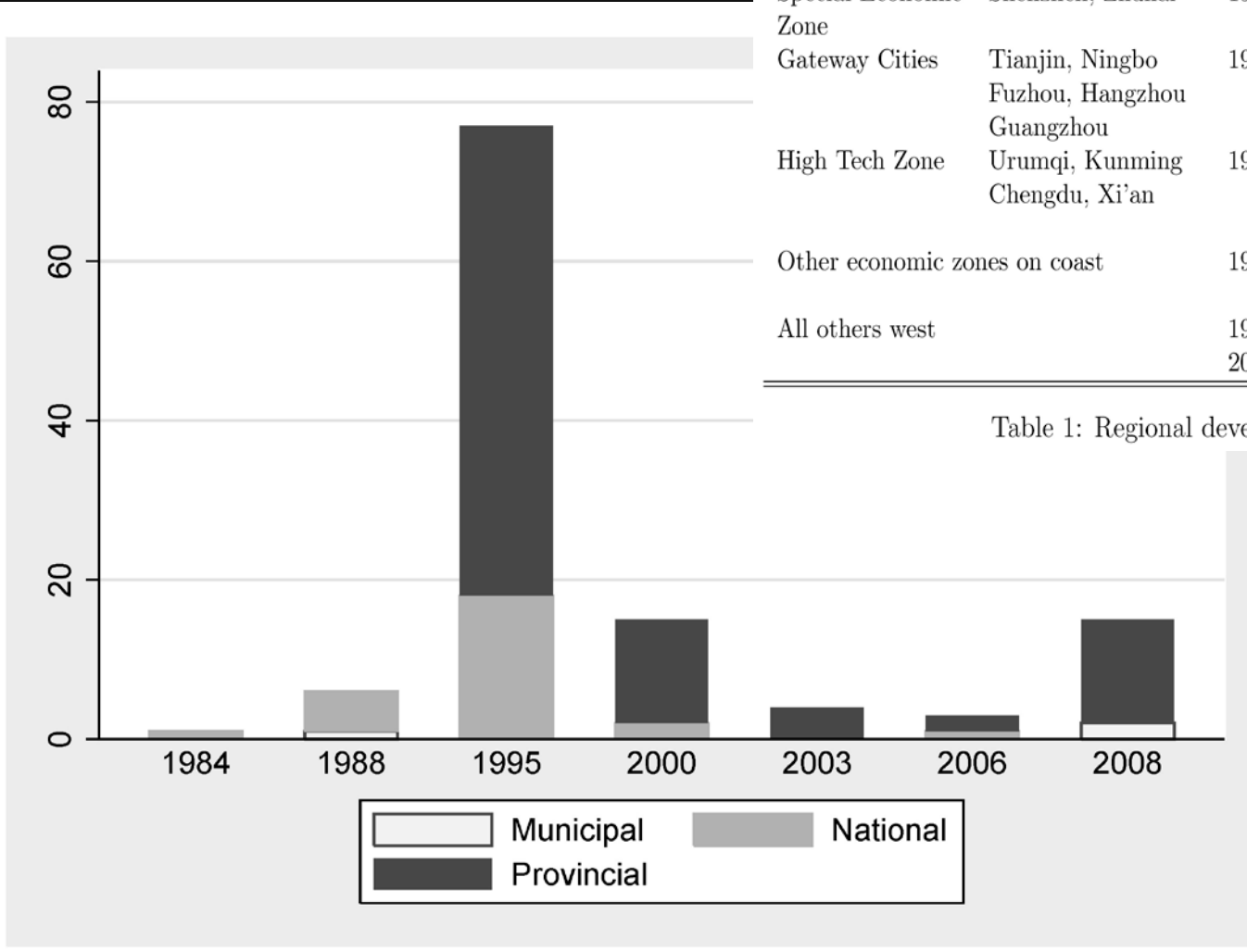
<sup>b</sup>  $\exp(\beta)$  = factor change in odds for unit increase in variables.

- accessibility to the CBD, industrial centers, roads, and the Qiantang River,
- the amount of built-up area in the neighborhood,
- location of markets
- spatial policies
- availability of land in the neighborhood

# ECONOMIC DEVELOPMENT ZONES AS A DRIVER?

## - OVERVIEW OF ECONOMIC ZONE

Number of zones by type and year



Policy	Cities in our sample	Start date	Lowest tax rate
Special Economic Zone	Shenzhen, Zhuhai	1980	15% on production & non-production industries
Gateway Cities	Tianjin, Ningbo Fuzhou, Hangzhou Guangzhou	1984	24% on production industries
High Tech Zone	Urumqi, Kunming Chengdu, Xi'an	1992	15% on hi tech until 2001, then 15% on all
Other economic zones on coast		1985-1993	24% on production industries
All others west		1980 2001	33% 15% all

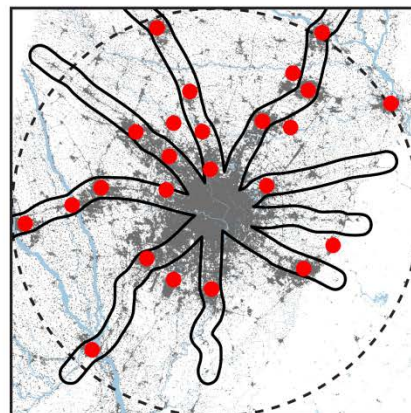
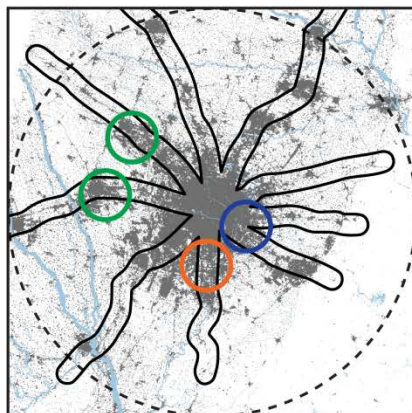
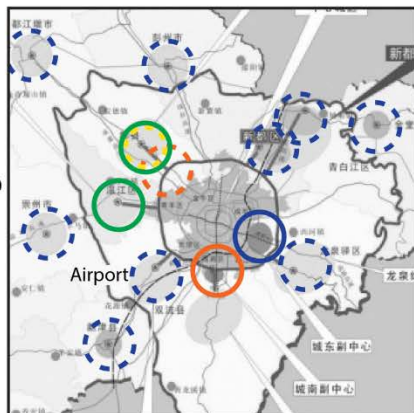
Table 1: Regional development policies

Planned development zones

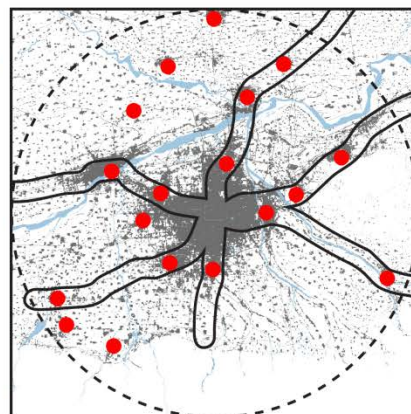
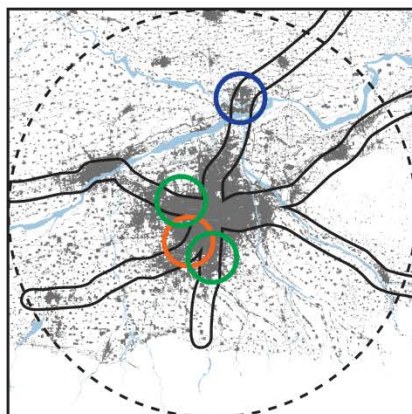
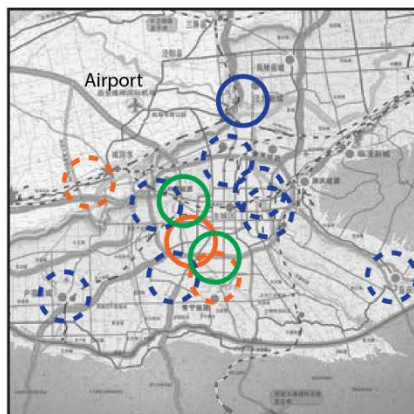
Corridors & selected zones

Corridors & satellite cities

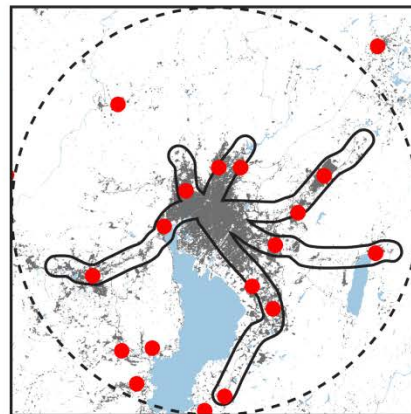
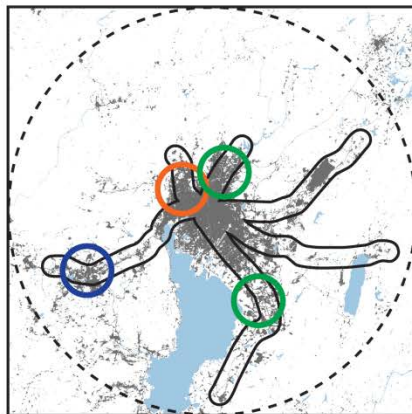
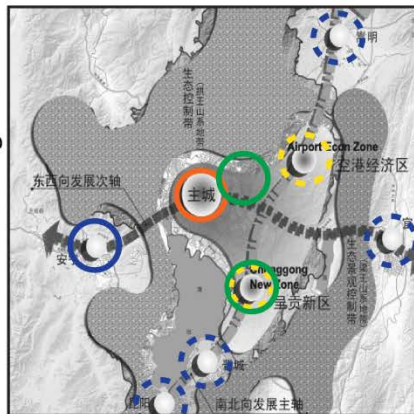
Chengdu



Xi'an



Kunming



development zones:

- high-tech
- industrial
- residential
- commercial

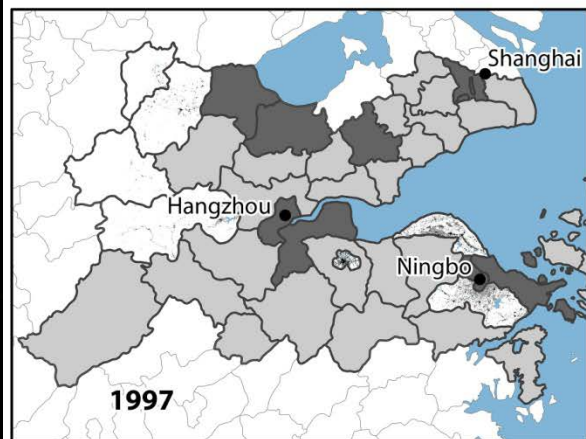
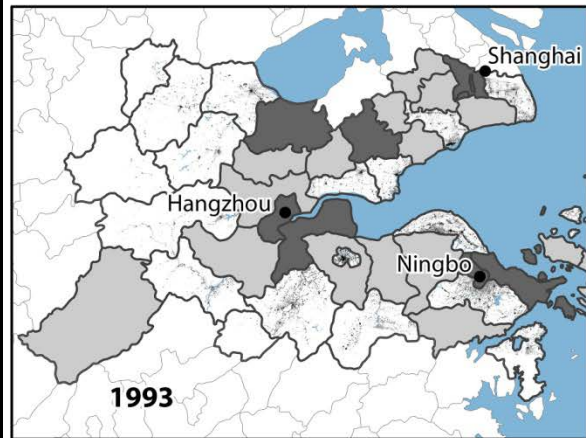
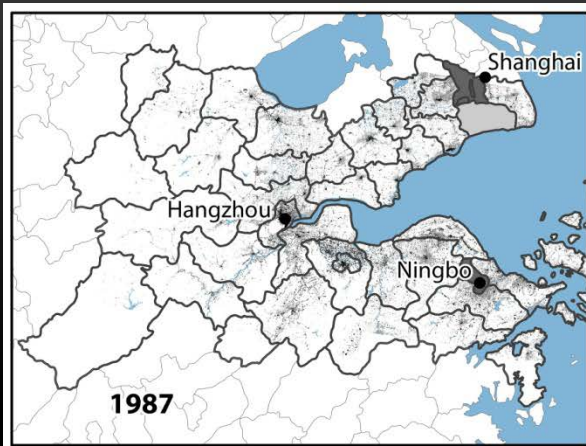
standardized extent: 40 km radius from city center

2009 urban extent

satellite cities

# DRIVERS OF URBAN LAND CONVERSION

# SPECIAL ECONOMIC ZONES AS A DRIVER



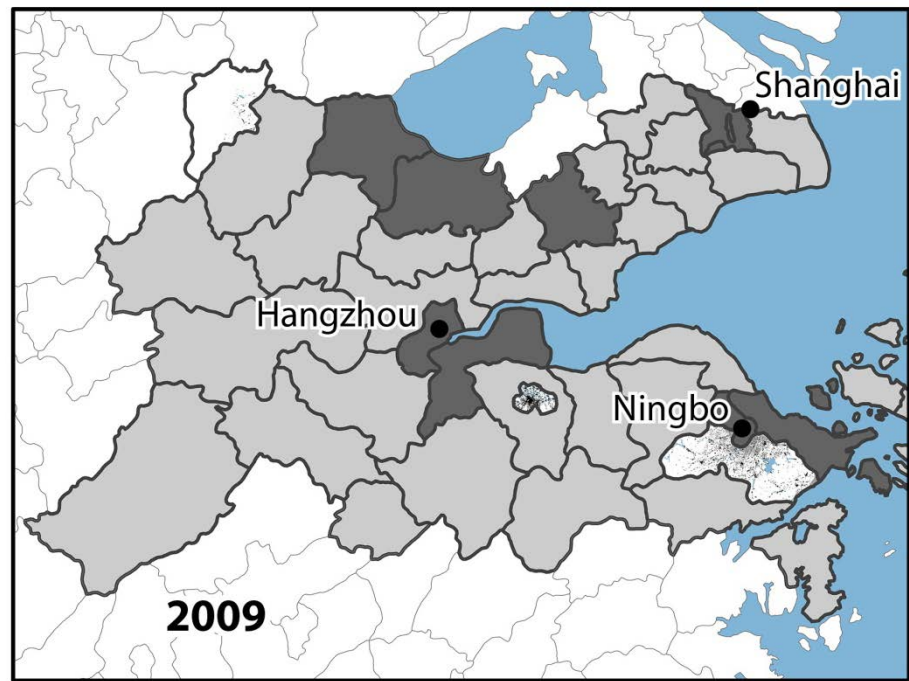
Economic zones (left, by period)

■ national level

■ provincial - municipal level

Study area scale (left)

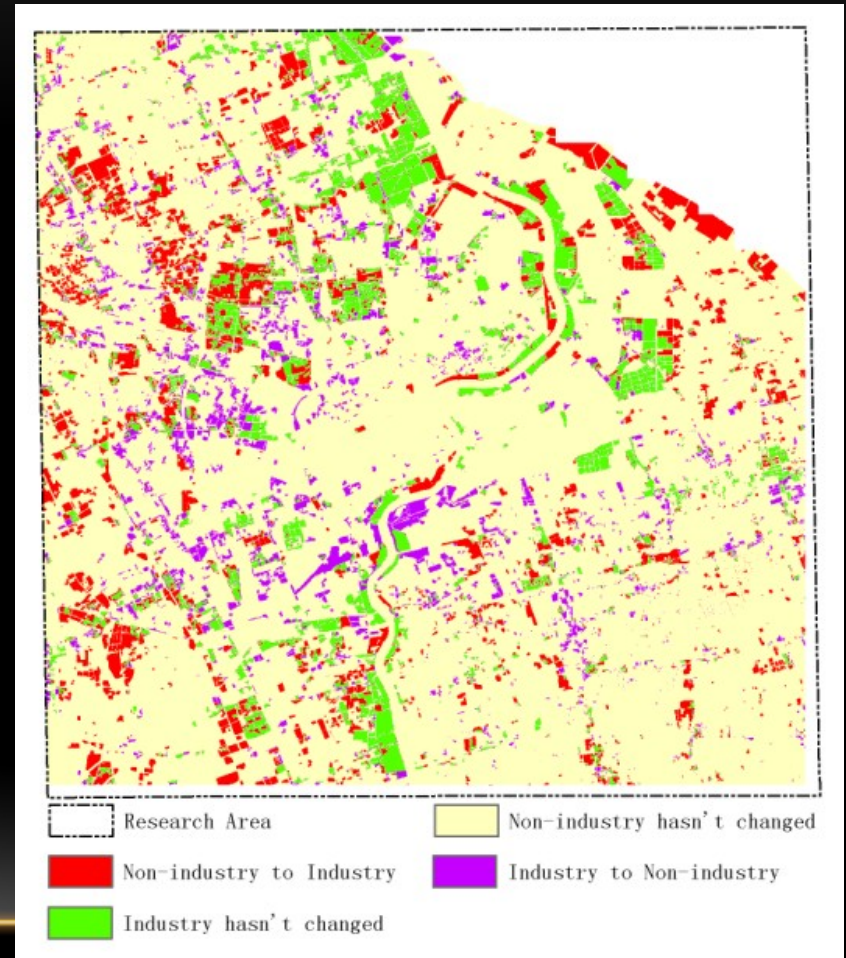
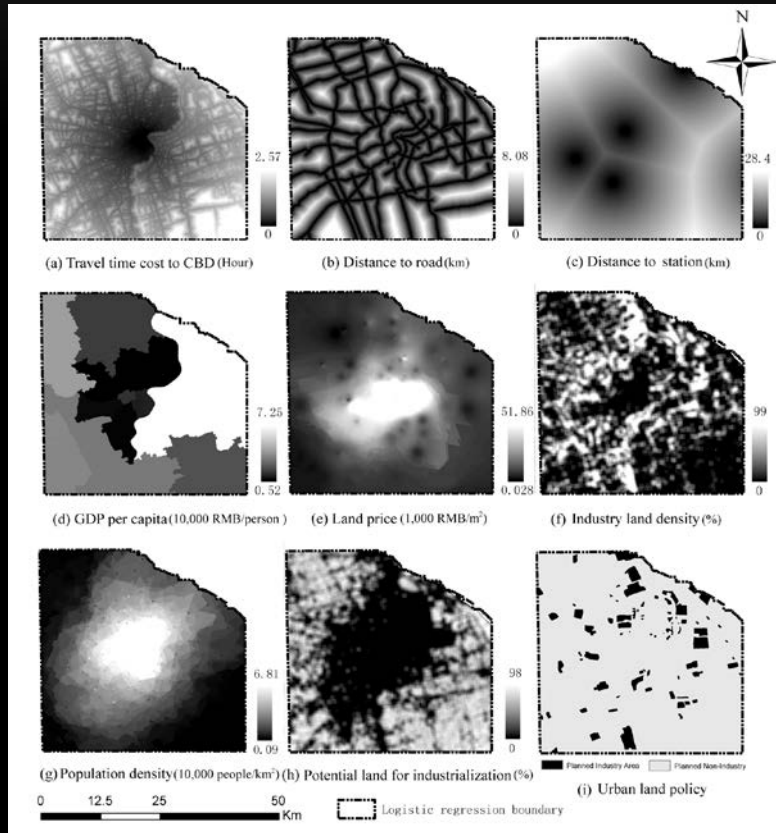
0 50 100 Kilometers



## 3.2 DRIVERS FOR SPECIFIC TYPES OF URBAN LAND USES



# SHANGHAI – SPATIAL DETERMINANTS OF URBAN INDUSTRIAL LAND CONVERSION (2002-2009)

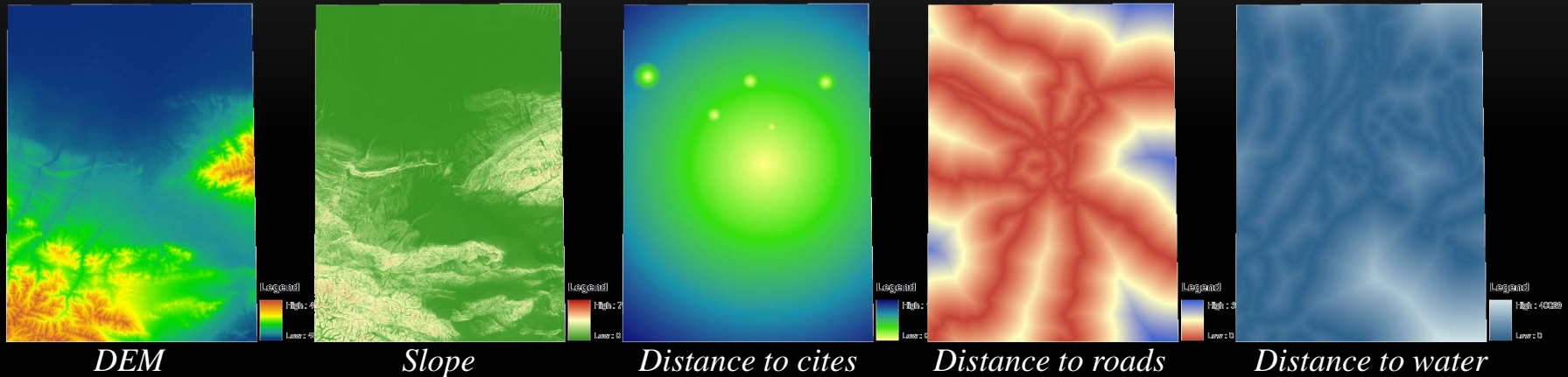


Major spatial determinants:  
land price, existing industrial land, land policy

What's going to happen?

## 3.3 SIMULATION OF CURRENT AND FUTURE LCLUC OF CHINESE CITIES

# URUMQI: DYNA-CLUE: DRIVING FACTORS



$$\text{Log}\left(\frac{P_i}{1 - P_i}\right) = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \dots + \beta_n X_{ni}$$

Where:

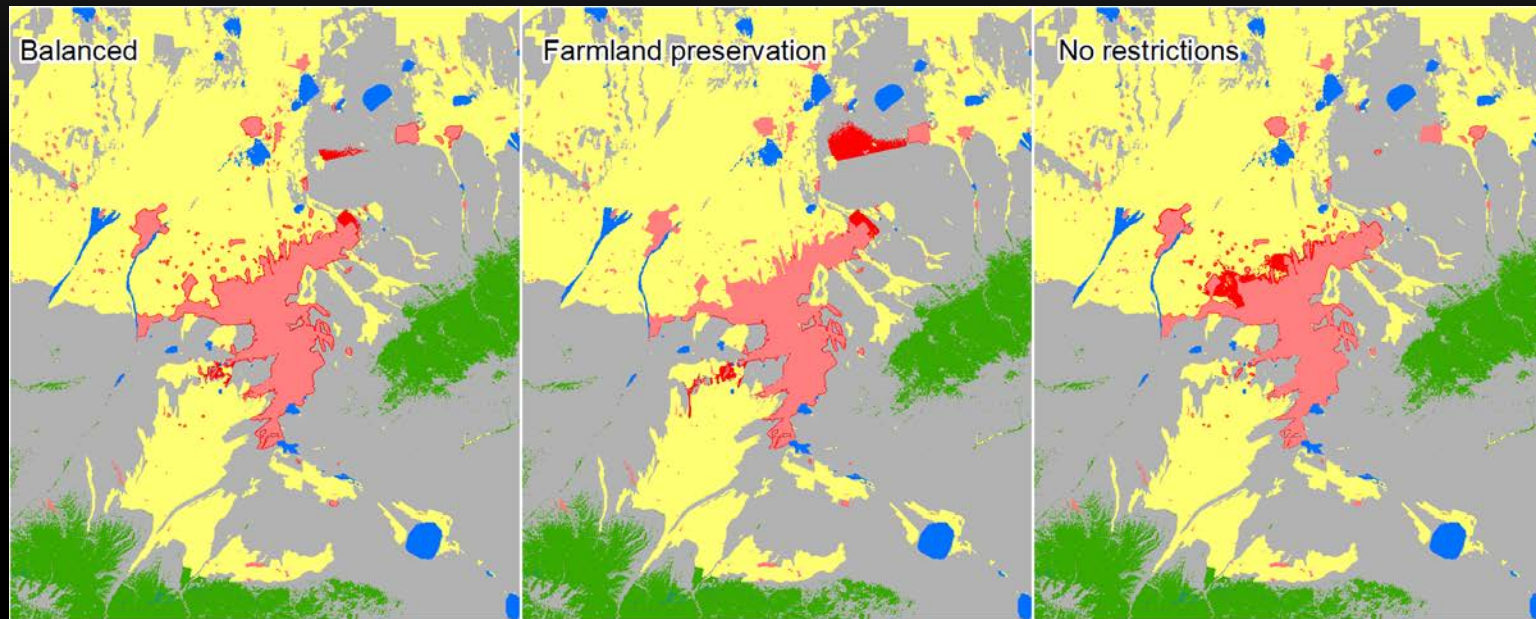
$P_i$  is the probability of a grid cell for the occurrence of the considered land use type on location  $i$ ;  
 $X$ 's are the location factors.

var.	intercept	dem	slope	city	road	water
estimates	3.880e+00 *	-1.211e-03 *	-1.518e-01 *	-5.710e-05 *	-8.680e-05 *	5.385e-05 *
D <sup>2</sup>	0.4678					

Signif. codes: 0 '\*\*' 0.001

D<sup>2</sup> = 1-(residual deviance/null deviance)

# DYNA-CLUE: SIMULATION RESULTS FOR URUMQI



■ Urban\_2010   
 ■ Urban\_2020   
 ■ Agriculture   
 ■ Low density vegetation   
 ■ High density vegetation   
 ■ Water

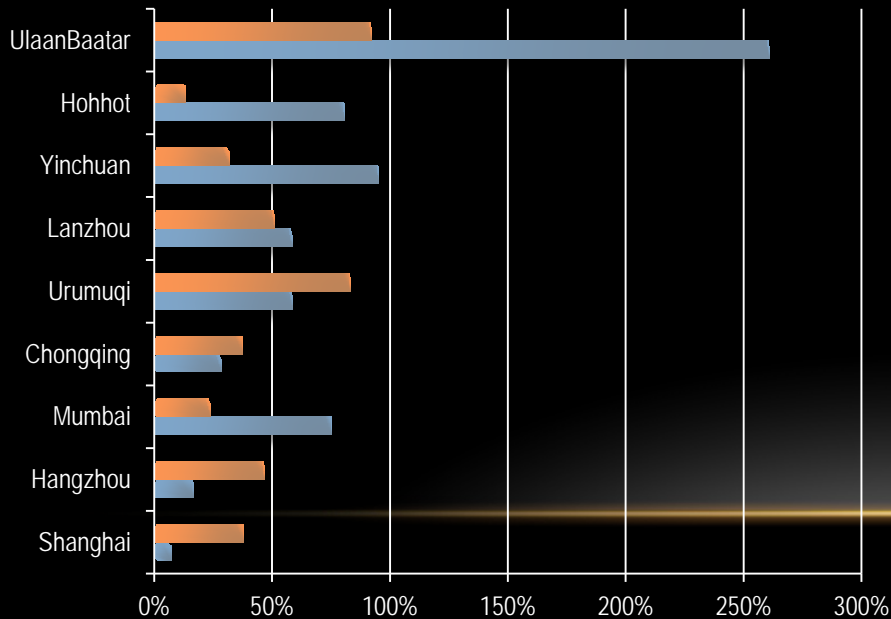
From\To	Balanced	Farmland preservation	No restrictions
U	56220.8	56220.8	56220.8
A	<b>4078.44</b>	<b>1118.88</b>	<b>7077.6</b>
LV	<b>5335.56</b>	<b>8232.48</b>	<b>1845.0</b>
HV	0.00	0.00	0.00
W	0.00	0.00	0.00

## 4. IMPACT OF URBANIZATION AND URBAN SPRAWL

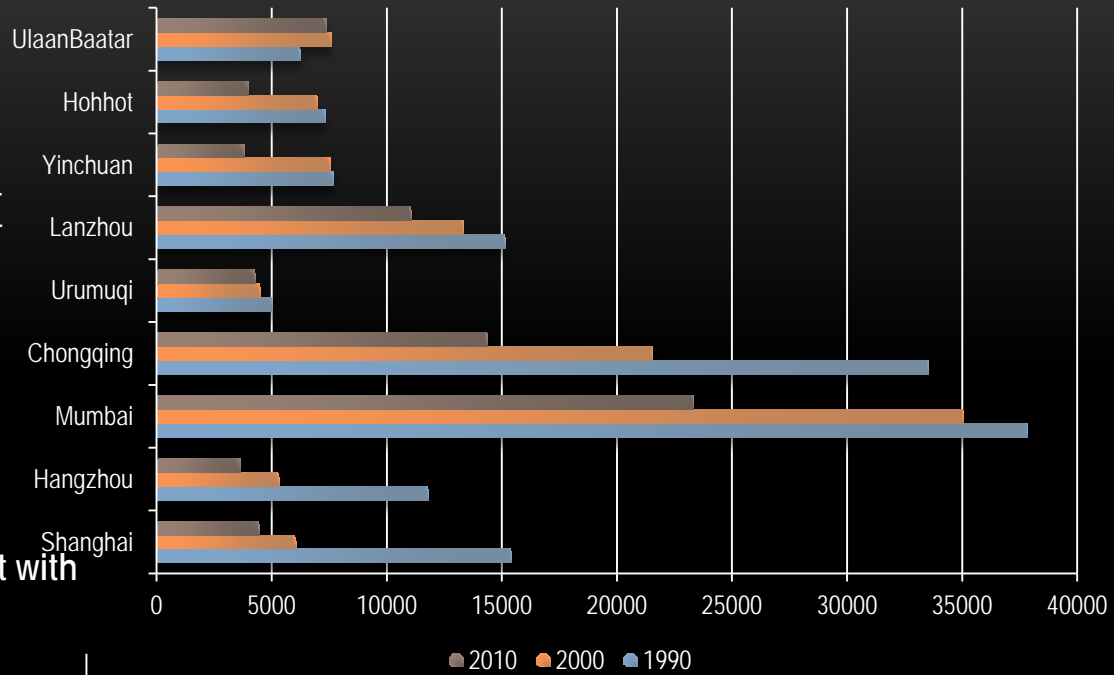
## 4.1 DIRECT IMPACT ON LAND

- URBAN POP DENSITY DECREASE
- LOSS OF AG. LAND (=> URBAN LAND)

### Urban density change (Population growth in contrast with urban growth, person/km<sup>2</sup> )



### Urban population density (person/km<sup>2</sup>)





## 4.2 DEGRADED URBAN ENVIRONMENT FROM URBANIZATION --CASE OF URUMQI

### Urban air pollution

- one of the top ten most polluted cities in the world (WHO, 1998)
- soot and dust from coal, combined with location in the valley of Tianshan Mountain; it is getting better

### Water resources & consumption

- scarce, severely polluted -- available water per capita is  $\frac{1}{4}$  of the national average
- human impacts – overgrazing, industrialization, urbanization

### *Cautionary tale for urbanization --*

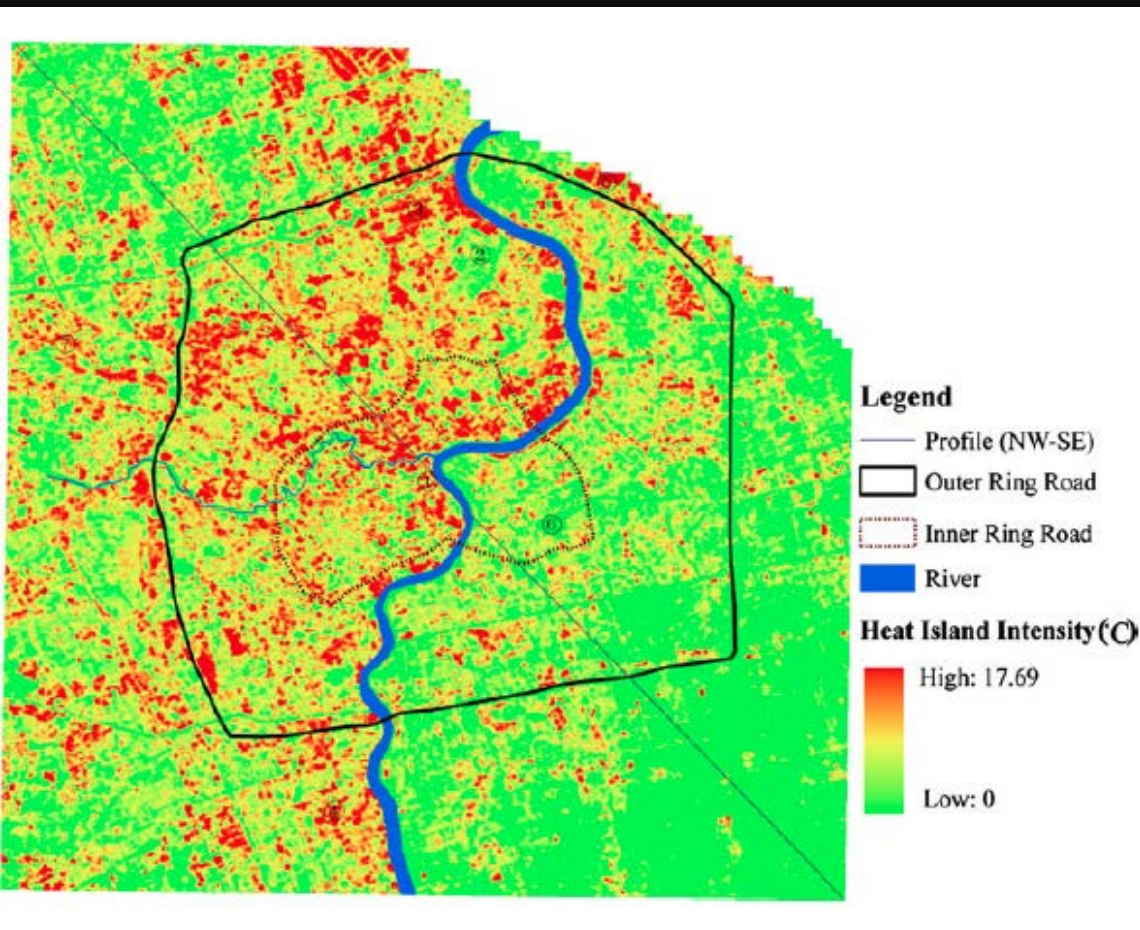
- over-dependence on industries based on fossil fuel resources can lead to rapid economic development, with unintended consequences



High rise condominiums (left), government buildings (up right), and residential houses (lower right) burn coals for heating. Photos were taken by Dr. Qingdong Shi at Xinjiang University, Urumqi, China, on Jan. 30, 2009.



## 4.2 DEGRADED URBAN ENVIRONMENT FROM URBANIZATION --CASE OF SHANGHAI – URBAN HEAT ISLAND



- PCA results identified 3 Components (76.58 % of the variance)
- Urban–rural gradient (building density and vegetation Index),
  - Landscape configuration (SHDI and contagionIndex),
  - Industrial sites.

# 5. TOWARDS A SYNTHESIS OF URBANIZATION IN CHINA

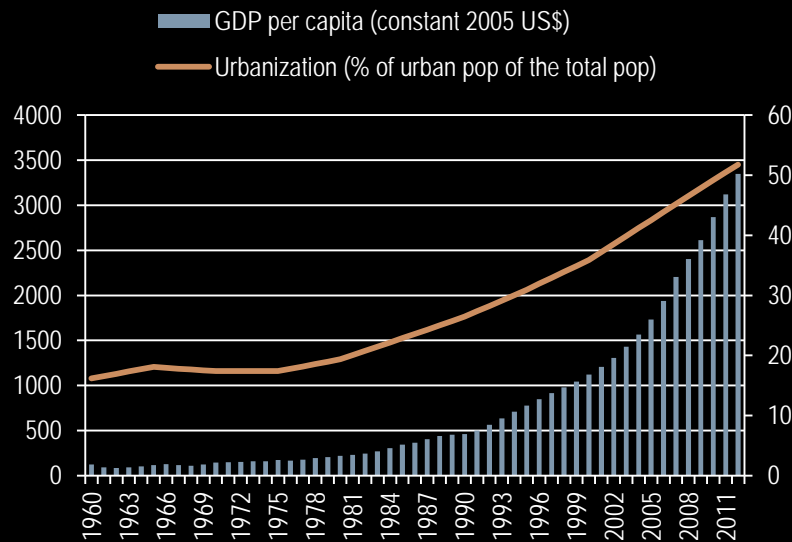
# CHARACTERISTICS OF URBANIZATION IN CHINA

- Urbanization as an integrated system
  - Socio-economic driving forces (market + planning)
  - Urbanization (population) and urban LCLUC
  - Impact and urban environment change
- Variations in patterns of urbanization
  - Regional, eco dev level, sizes of cities
- Multi-scale
  - metro, urban built-up, district, street
- Temporal:
  - historical, current, future (simulation)

# URBANIZATION AND ECONOMIC DEVELOPMENT

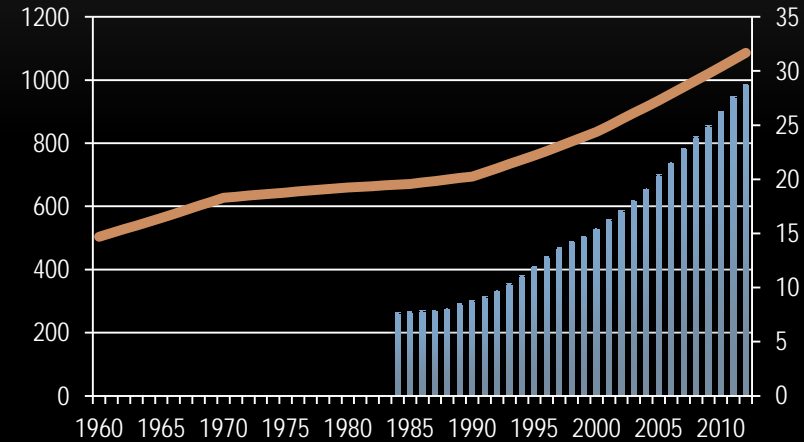
Vietnam

## China



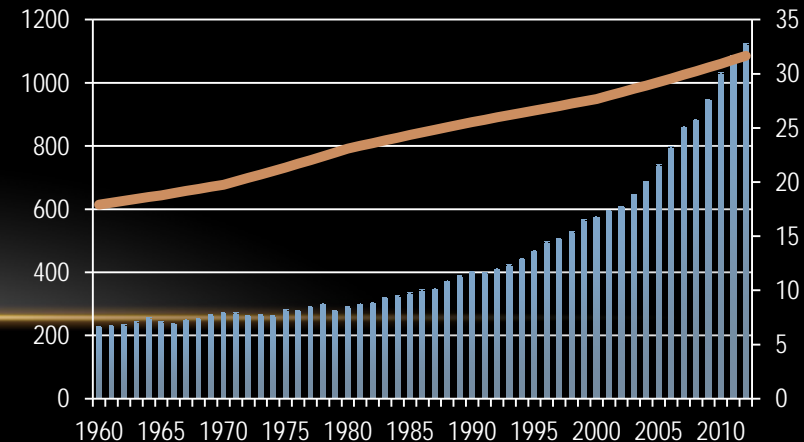
Urbanization as an indicator of economic development, especially industrialization (Davis, 1966)

Legend for Vietnam:  
■ GDP per capita (constant 2005 US\$)  
— Urbanization (% of urban pop of the total pop)

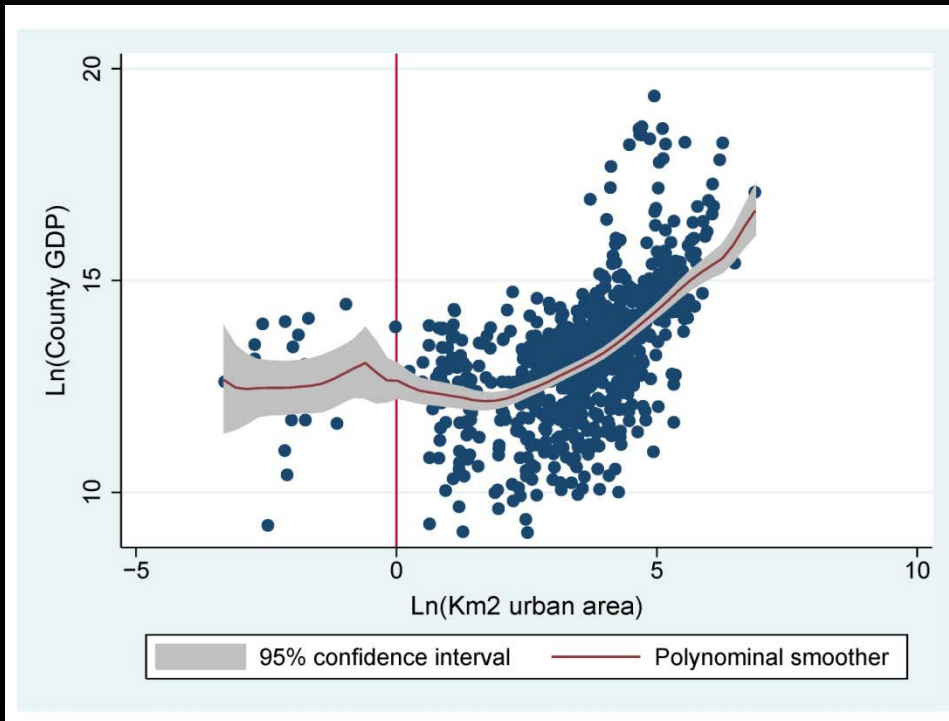


## India

Legend for India:  
■ GDP per capita (constant 2005 US\$)  
— Urbanization (% of urban pop of the total pop)



## GDP and urban land area



- Higher levels of urbanization are strongly correlated with higher levels of GDP (Bairoch 1988, Acemoglu et al. 2002)
- $\leq$  China: GDP per capita by year and the percent of the population in cities of greater than one million inhabitants.

# LCLUC & IMPACTS

## LCLUC

- Urban sprawl ++
- Different dynamics of different types of urban land (e.g., ind. Land)
- Spatial determinants (location matter! Economic Zone!)
- Land simulations & policies
- **Urban China in a transitional economy: spatial policy + market force**
- Impact of urbanization & urban sprawl
  - Land (density, conversion of farm land)
  - Urban environment
    - degradation
    - Microclimate: significantly affected by landscape configuration



Spatial policy plays a critical role: Urban Planning Museums of Shanghai (top) & Urumqi (down)\*

\*Fan, Peilei. *Forthcoming*. Producing and Consuming Urban Planning Exhibition Halls in Contemporary China. *Urban Studies*.

# Monitoring and Modeling Urbanization in China: A Mixed Methods and Multi-Scale Approach

Research team,  
University of Wisconsin-Madison

Annemarie Schneider, Kurt Paulsen,  
and Jennifer Alix-Garcia



Graduate students Carly Mertes, Chaoyi Chang, Zhiwei Ye, and Na Zhao



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# China's urbanization and its sustainability under future climate change



Peilei Fan



Joseph Messina



Nathan Moore



Jianjun Ge

## Research Team: Michigan State University

Peilei Fan (Michigan State U)  
Joseph Messina (Michigan State U)  
Nathan Moore (Michigan State U)  
Jianjun Ge (Oklahoma State U)  
Peter Verburg, (VU University Amsterdam)  
Wenze Yue (Michigan State U & Zhejiang U)  
William Salas, Nathan Torbick (AGS)

## Students:

Michelle (Xue) Li (Michigan State U)  
Huiqing Huang (Michigan State U)

LCLUC of NASA (Grant No. NNX09AI32G)



Peter Verburg



Wenze Yue



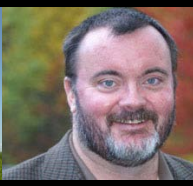
Huiqing Huang



Michelle Li



Nathan Torbick



William Salas

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