

# Urbanization in China

A synthesis of local and regional case studies on land cover change

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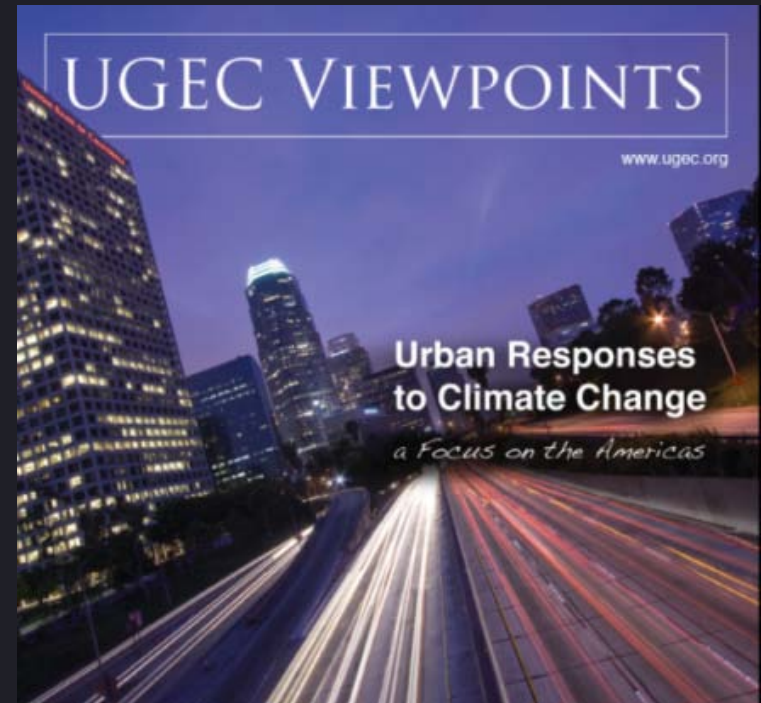
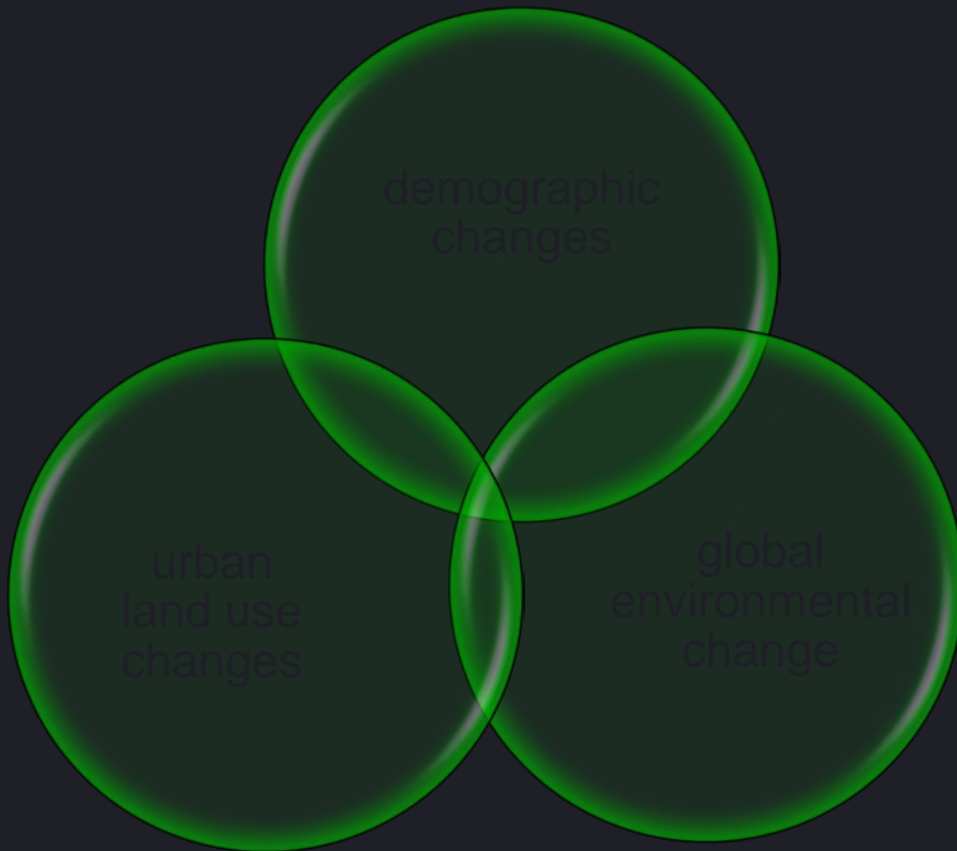
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**Land Cover-Land Use Change Program Science Team Meeting  
April 20, 2010**

# Introduction

## IHDP Urbanization and Global Environmental Change Project

Confluence of three trends:



Open Science Meeting 2010

# Urban processes that contribute to global environmental change

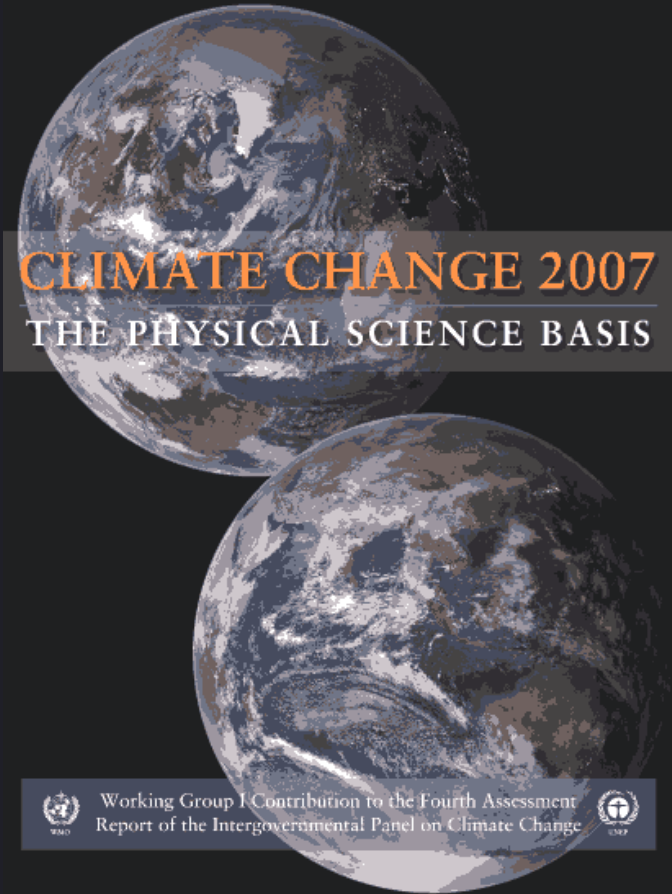
urban  
system



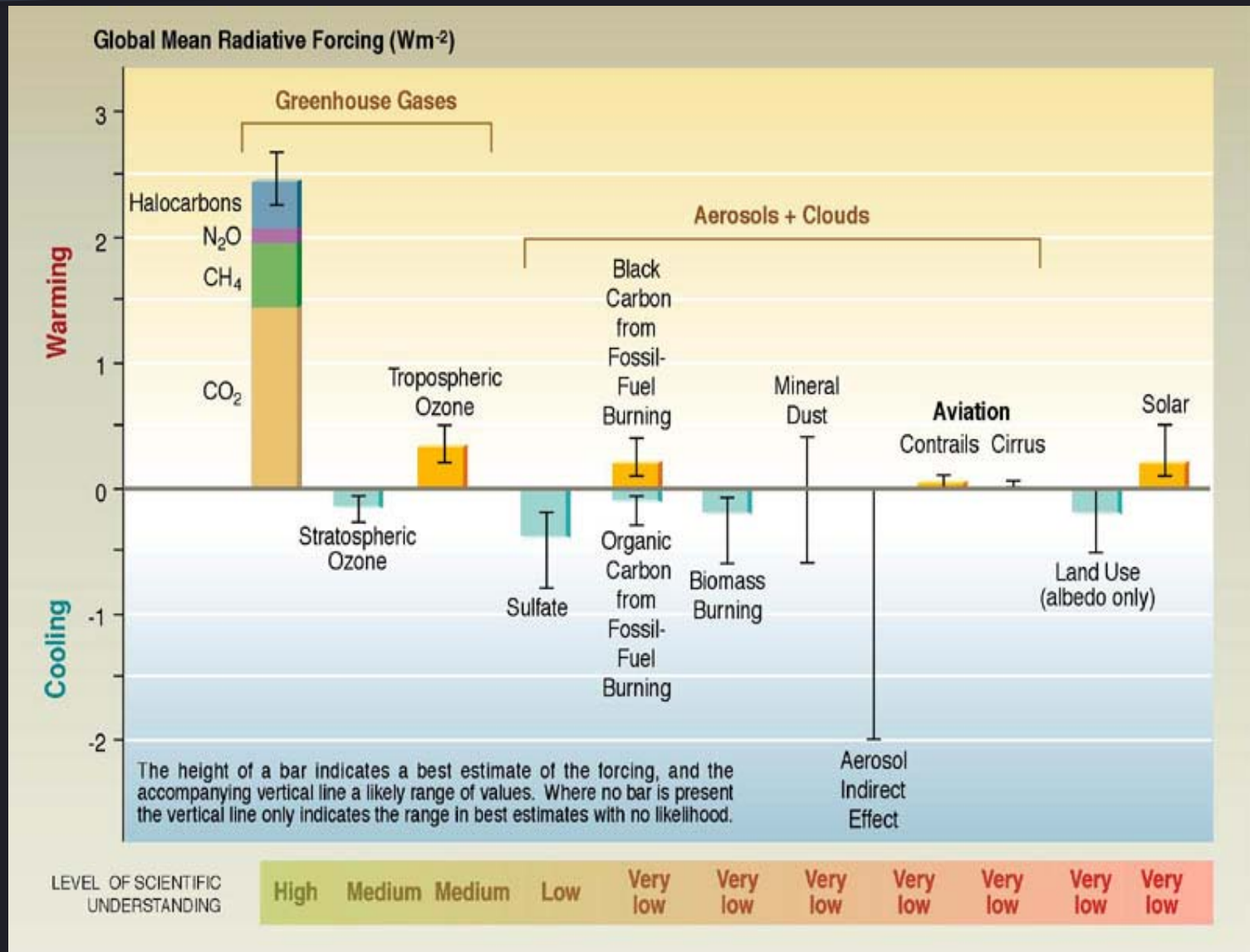
- How does urban land-use change affect global environmental change?
- How does the built environment affect energy use, carbon emissions, and climate?

# IPCC 4<sup>th</sup> Assessment Report

- Prevailing climate change science has focused on effects of anthropogenic greenhouse gases
- 4<sup>th</sup> Assessment Report of the IPCC notes emerging interest in *understanding the role of urban land use on the climate system*
- Preparations for next IPCC report focus on urban form, structure, expansion, etc.



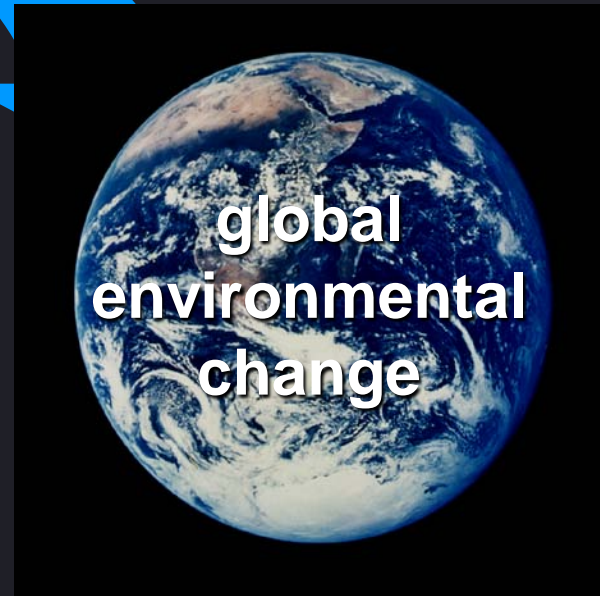
# How does urbanization affect climate?



# Urban responses to environmental change

- How can urban areas respond to climate change impacts?

**urban  
system**



- Can urban development strategies be aligned with climate change adaptation?
- How can urban planning tools be used to develop more resilient cities?

# Can planning make a difference?

## Urban planning strategies

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### energy

- reducing GHGs through use of renewables
- zoning ensures access to solar, wind energy
- higher densities can reduce building heating

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### transport

- ensure densities for efficient transport
- regulate streetscape to facilitate non-motorized travel, walk-ability
- develop mixed land use, reduce travel, energy use

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### buildings

- require green building to reduce energy use

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### industry

- performance standards for industry
- location of industry

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### carbon capture

- location, amount of parkland and open spaces
  - regulate conversion of farmland, forests for urban purposes
-

# Introduction

## Understanding urbanization in China and the Monsoon Asia region

- Monitor urban systems and land patterns regionally-globally using satellite data
- Local case-study analysis of geographically comprehensive sample of cities
- Predictive modeling, forecasting of dynamic socio-economic forces and land-based outcomes
- Evaluate causal linkages between urbanization and climate, and simulate future climate scenarios



Urbanization and Global  
Environmental Change  
AN IHDP CORE PROJECT



MICHIGAN STATE  
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# Introduction

Why study urbanization in China?

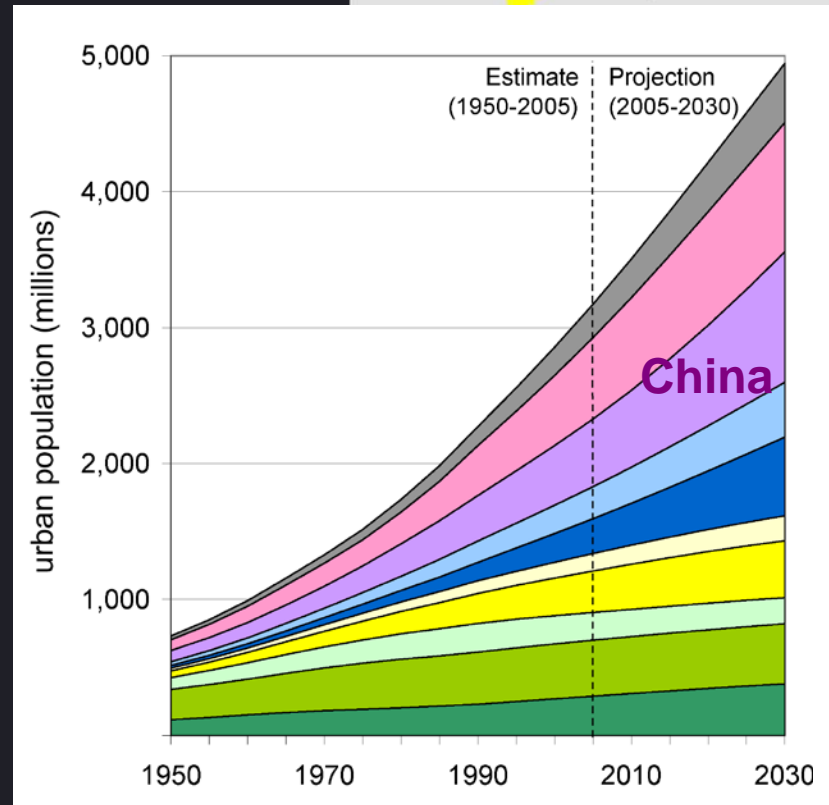
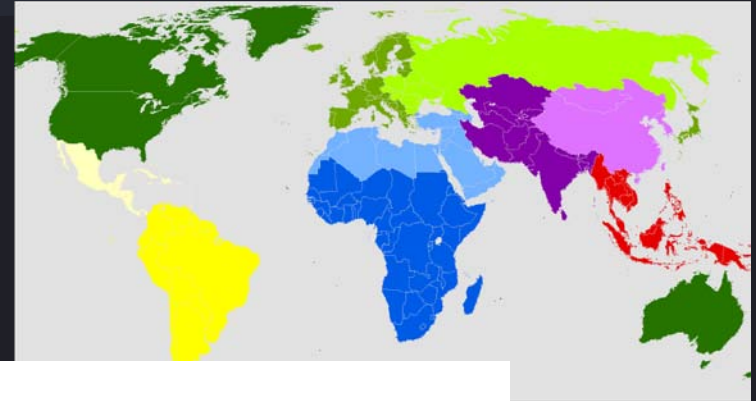
Urban population is increasing

50% of global urban population live in Asia

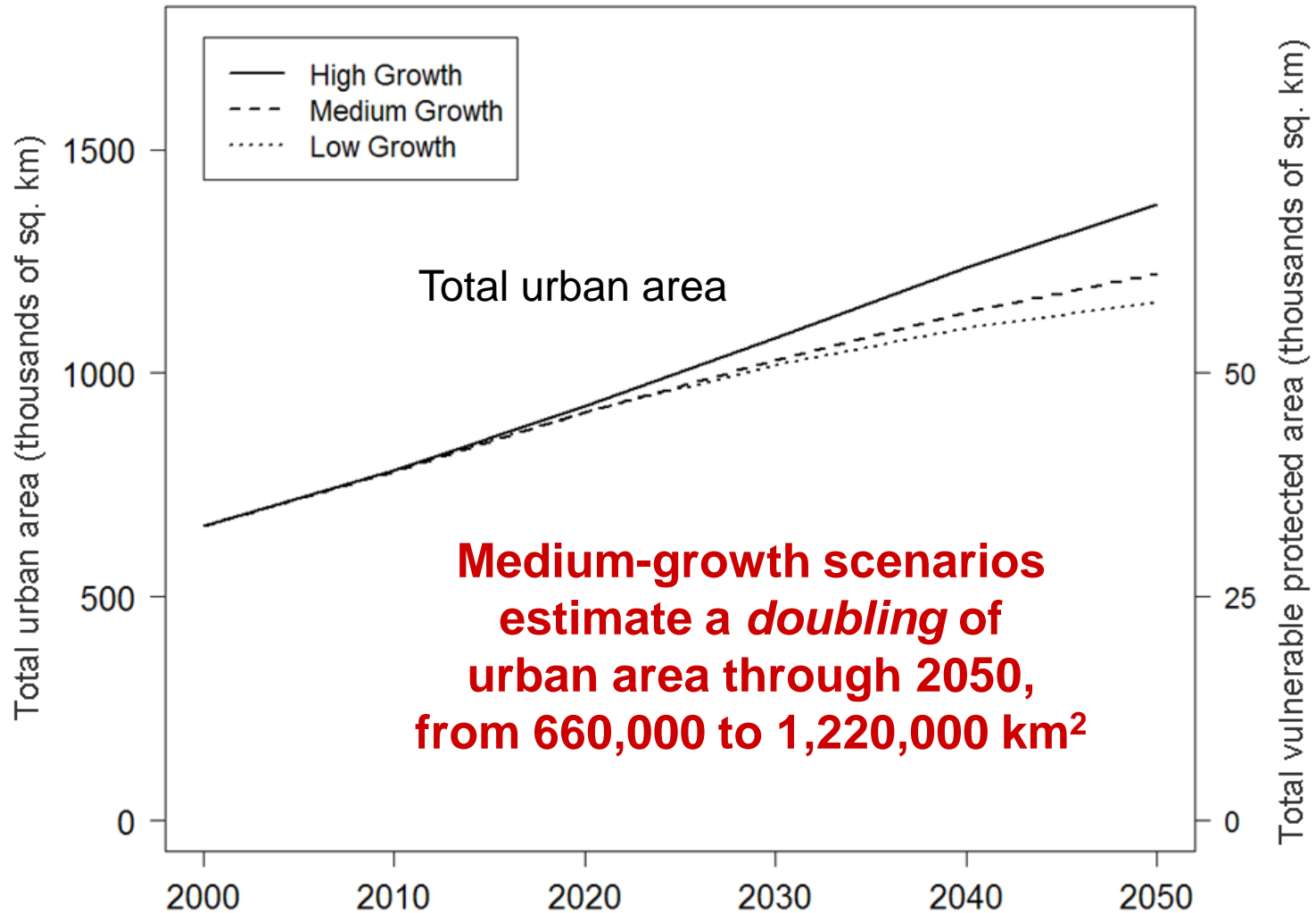
one-third will live in China or India by 2030

currently, 115 cities > 1 mil in China

**Current and projected global urban population growth 1950-2030**



# Future global urban land use requirements



# Introduction

Tremendous opportunity to shape the built environment

~85% of urban  
development on the  
ground by 2050 in  
China and India  
*will be built between  
now and then*



# Urbanization and urban expansion in China

## Policy reforms

- 1978 economic, land reforms
- decentralization
- land use rights
- liberalization of household registration system (*hukou*) and work unit (*danwei*)

## Impacts?

- rapid rural-urban migration
- rapid land use change
- agricultural expansion, intensification
- GDP 1978-2008: 8-14%
- increase in income - vehicles, housing, diet



# In-depth case studies in China

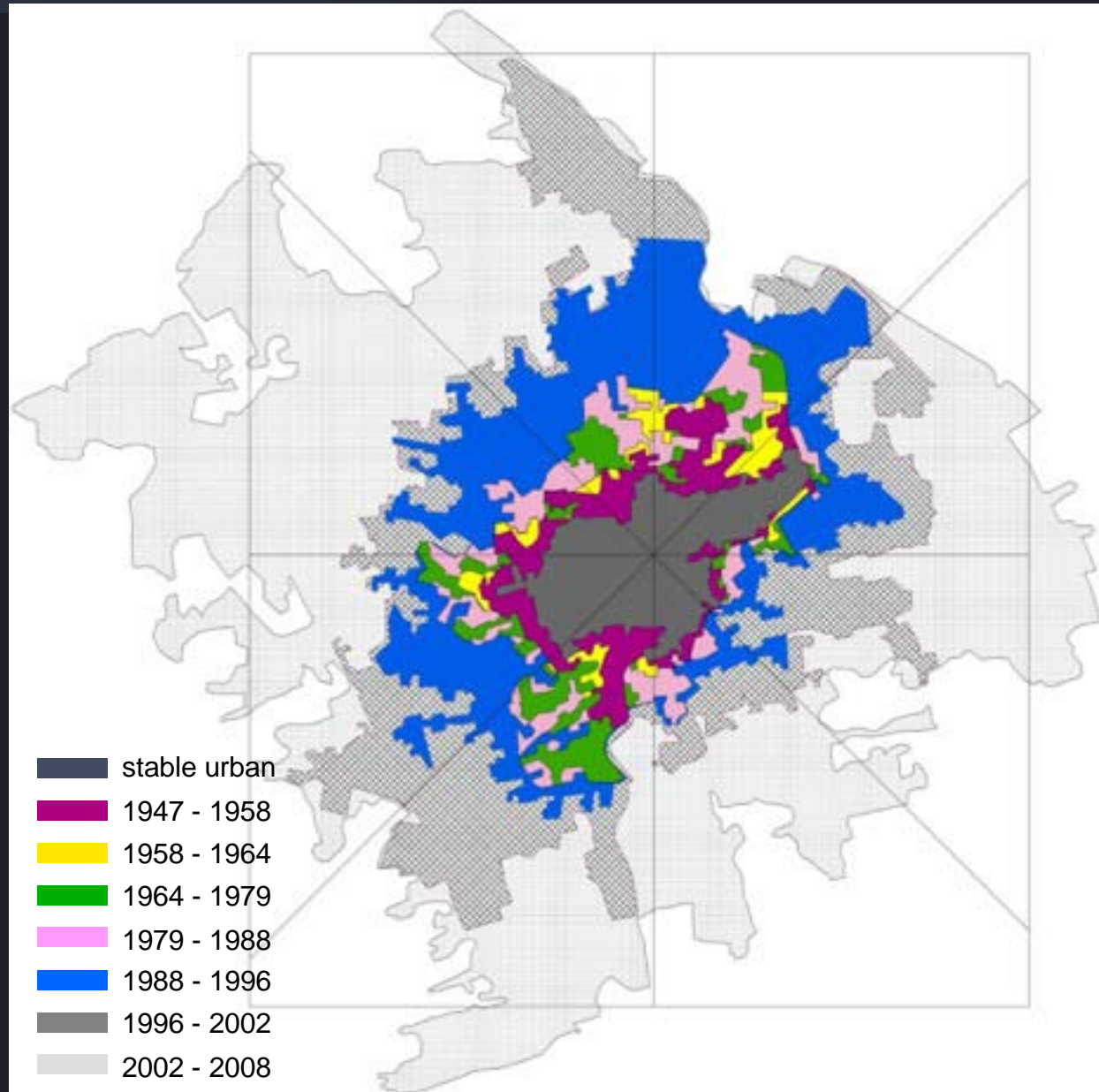


# Shanghai - development of a world city

Shanghai,  
Yangtze River Delta

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

...expanded 18 times  
1947 to 2008:  
76 to 1,462 km<sup>2</sup>



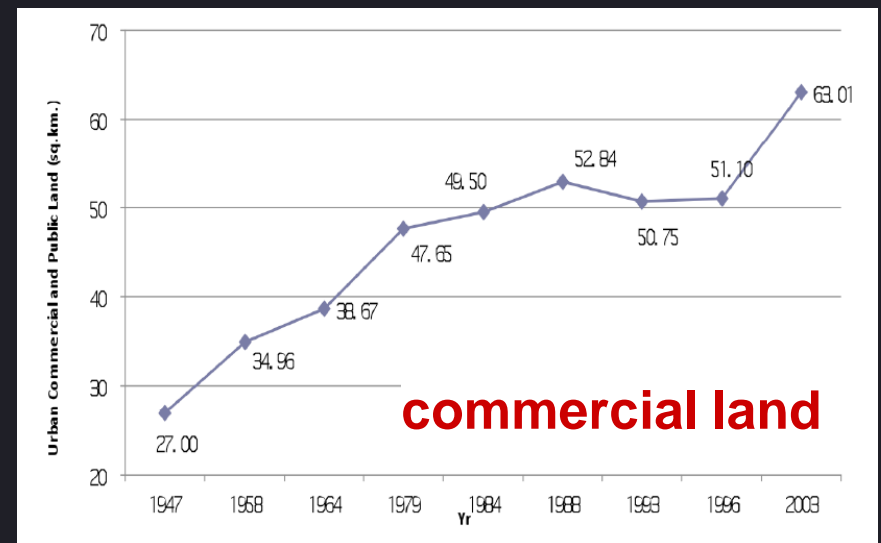
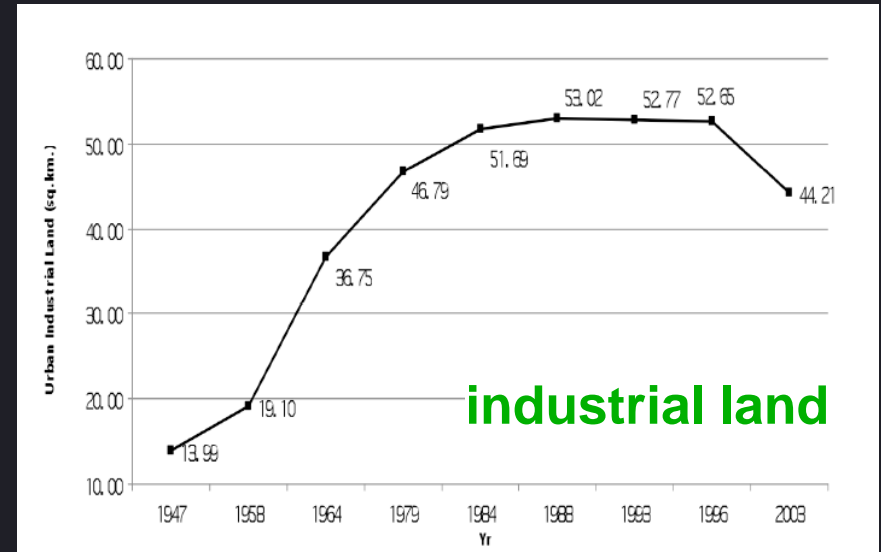
# Shanghai - development of a world city

## Development by sector

- *residential* - continuous growth
- *industrial* - declined 1996-2003  
relocation of factories
- *commercial* - climbing due to  
increased infrastructure investment,  
urban redevelopment

## Key factors?

- land, economic reforms
- migration
- preferential policy
- uneven distribution of  
foreign direct investment (FDI)
- development zones
- phases of economic transition, restructuring
- role of multi-scaled state, governance



View of Pudong from the Bund



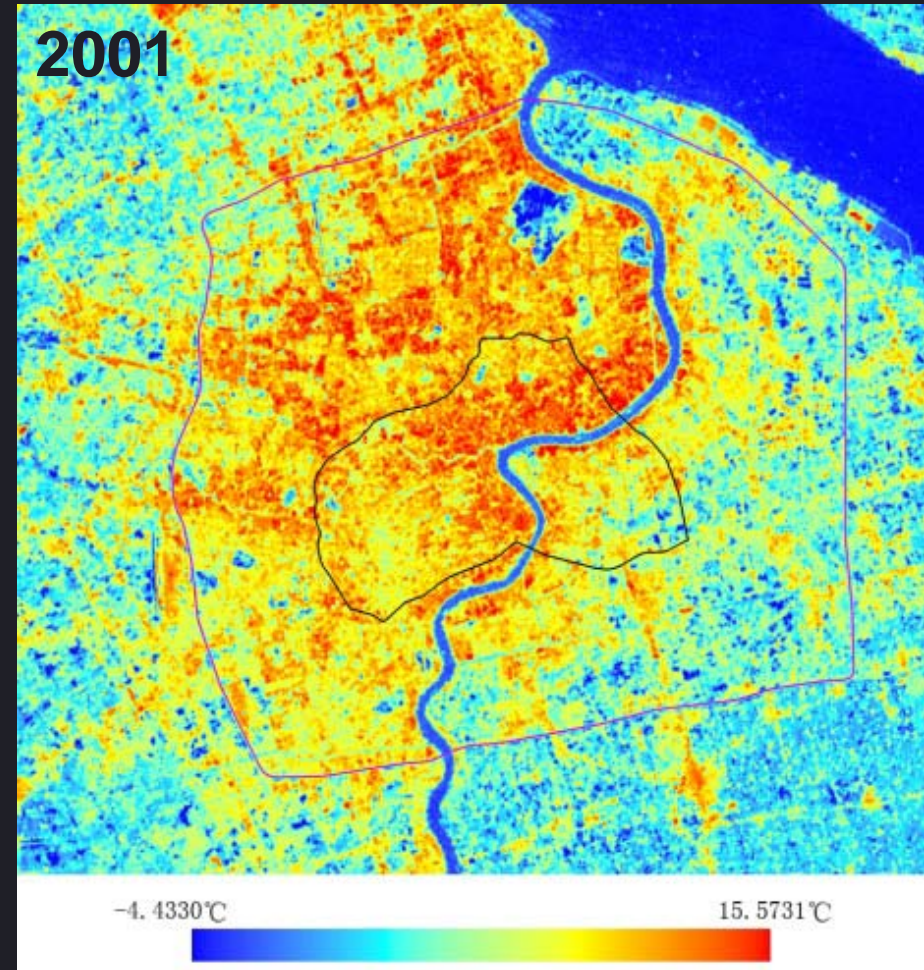
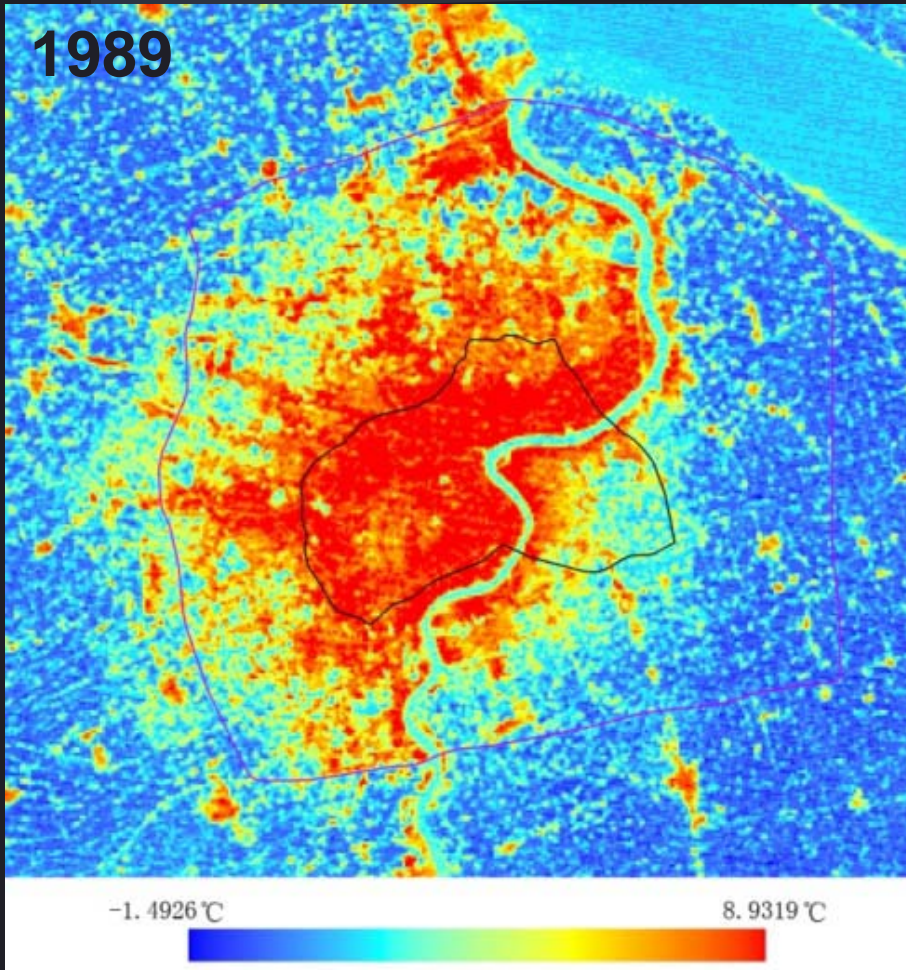




## Role of urban planning



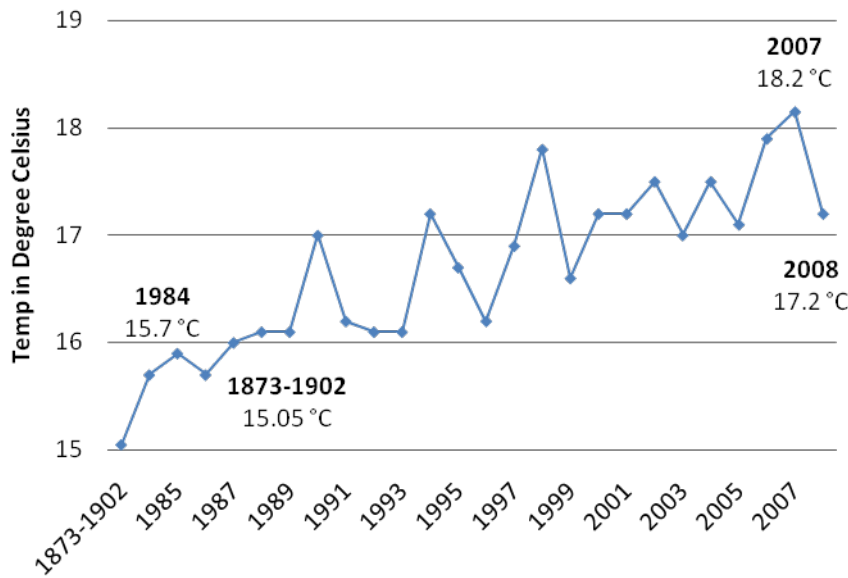
# Shanghai - development of a world city



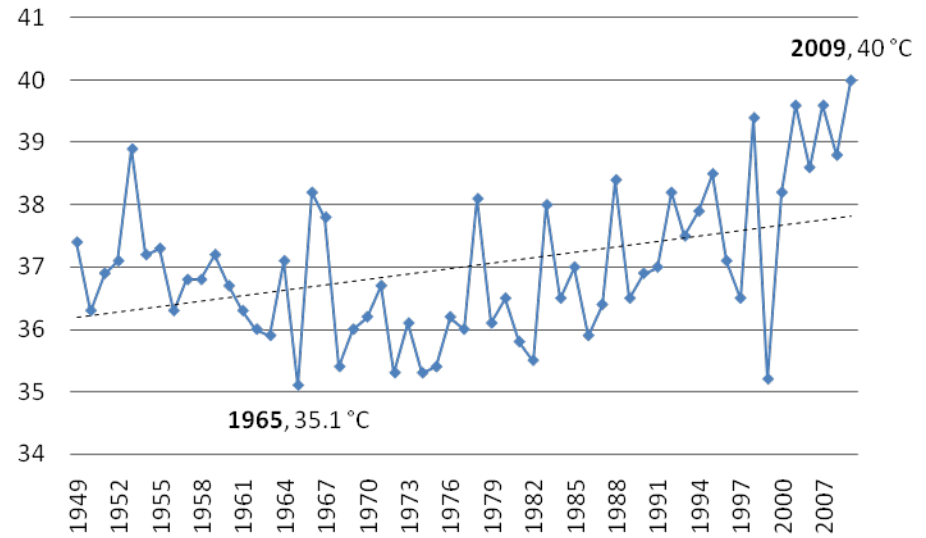
Assessing changes in urban environment -- progress?

- increase in green space per capita -- change in intensity of thermal environment at core
- spread of heat island effects to new districts, periphery

Shanghai's Annual Average Temperature



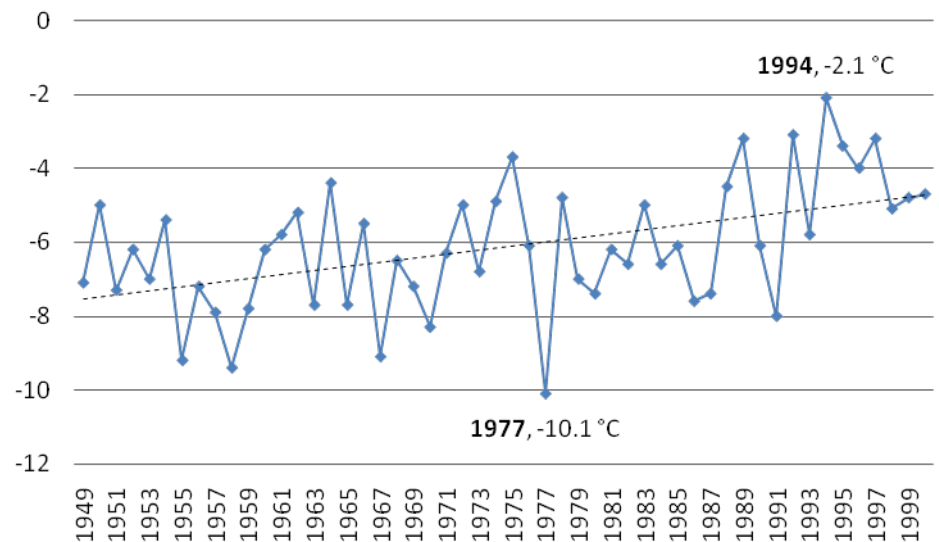
Maximum Temperature of Shanghai



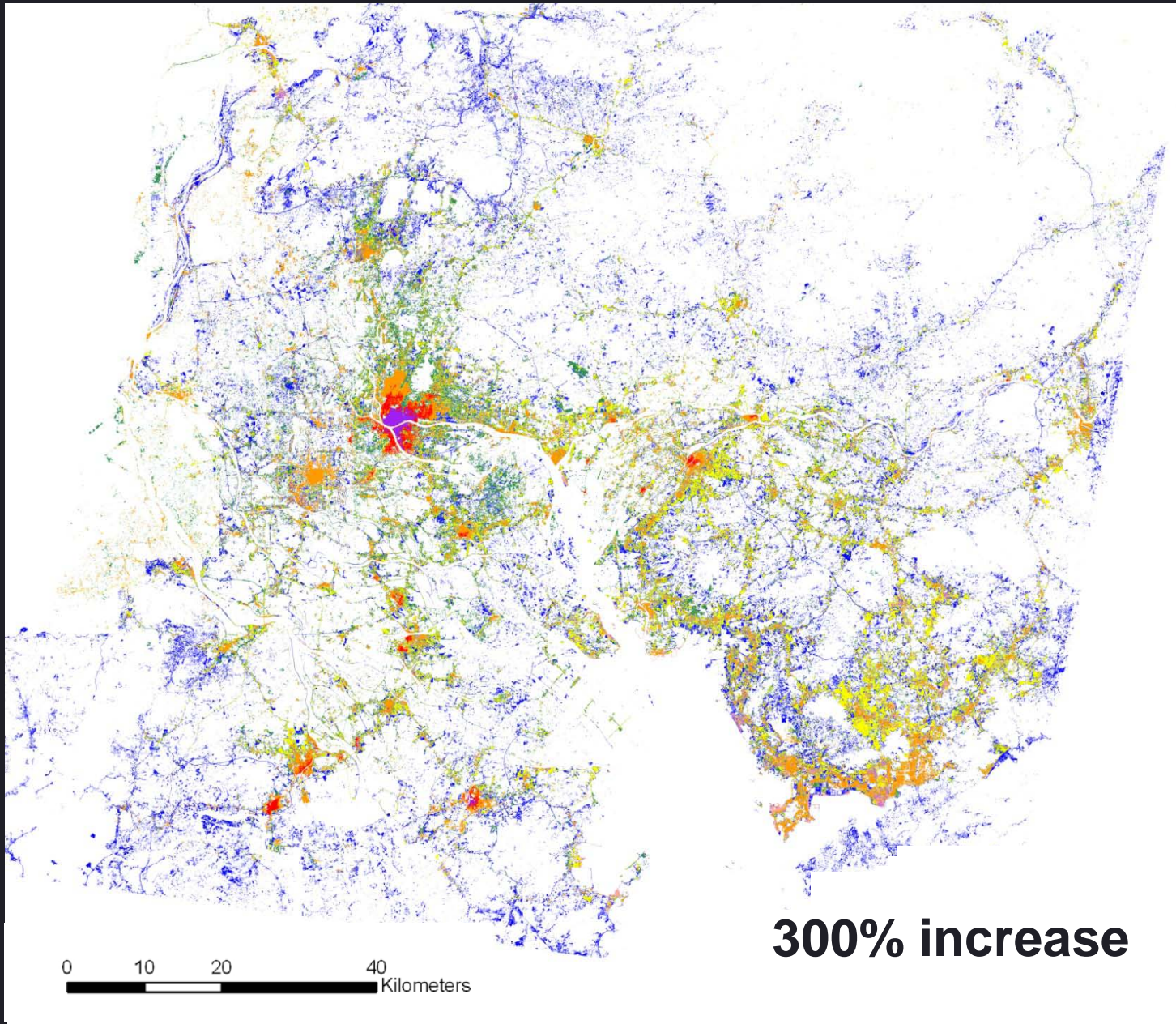
## Changing climate in Shanghai

- max temp increases 1949-2007, summer gets hotter
- min temp increases 1949-2000, warmer winters
- ongoing work links land use to climate change using regional climate models

Minimum Temperature of Shanghai



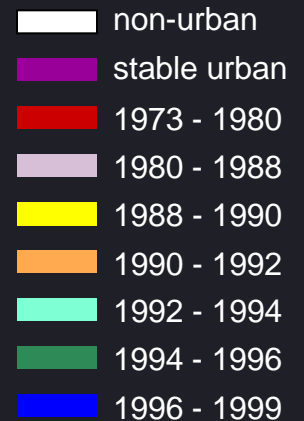
# The Pearl River Delta - explosive urbanization



In 25 years:

cropland  
converted to  
urban uses:  
>1370 km<sup>2</sup>

natural  
vegetation  
converted to  
urban: >520 km<sup>2</sup>



# The Pearl River Delta - explosive urbanization

## Patterns of expansion

## Key mechanisms

- Shenzhen - Special Economic Zone, Guangzhou - Open City
- role of foreign direct investment (proximity to Hong Kong)
- large-scale investments by overseas interests
- growth of private sector, market economy
- demise of danwei, high rate of migration
- *minor role of formal planning*





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# How does urban expansion affect precipitation?

JOURNAL OF CLIMATE

## Climate Response to Rapid Urban Growth: Evidence of a Human-Induced Precipitation Deficit

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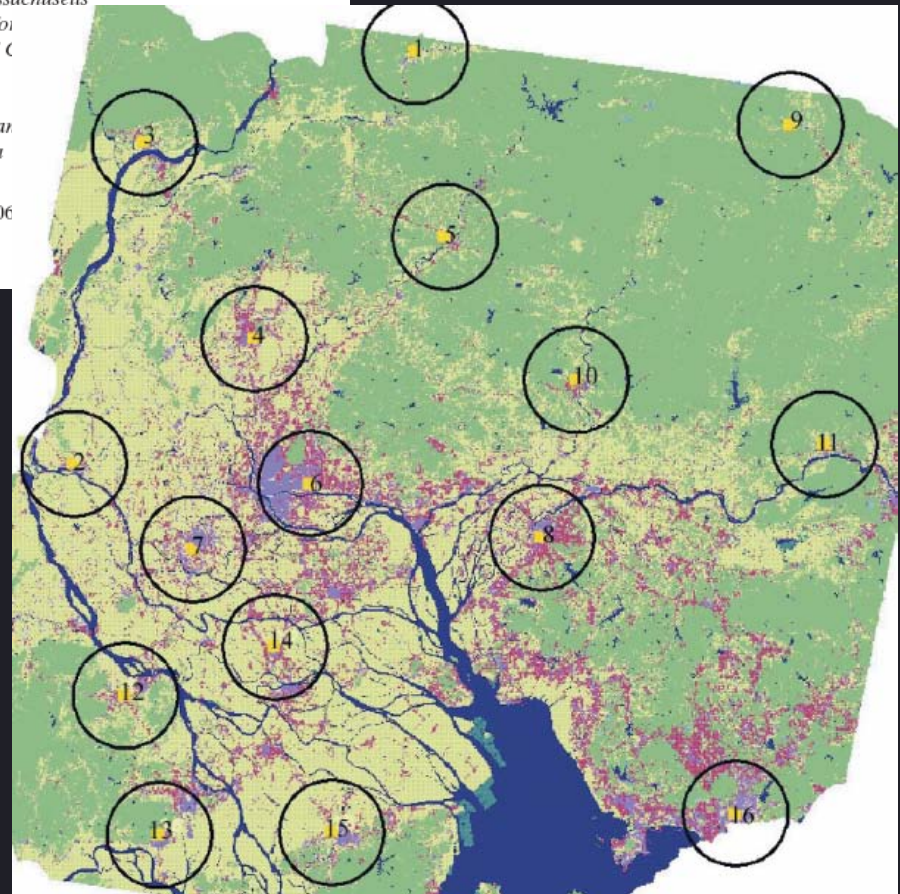
\*\* Foundation of California State University, Monterey Bay, California

(Manuscript received 15 November 2005, in final form 8 September 2006)

ABSTRACT

## Climate impacts?

- monthly climate data - 16 stations
- results show causal relationship of pattern of urbanization on local precipitation during dry season
- reduction in rainfall



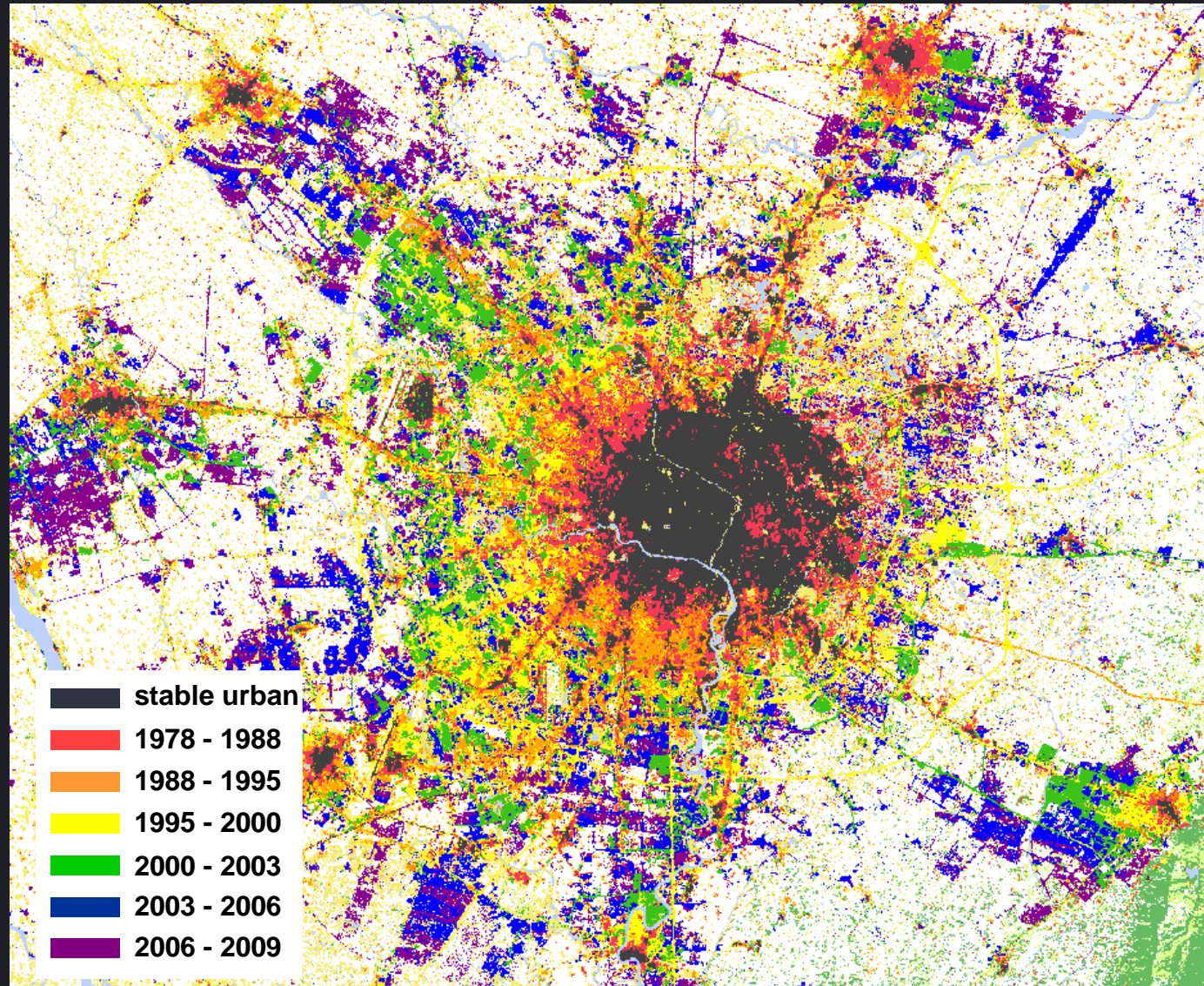
# Chengdu - impacts of the 'Go West' program

## Chengdu, Sichuan province

- fertile plain, 2500 year history
- industrial center in 1950s, 1960s
- city targeted for investment:  
high tech zones, roads, airport

loss of cropland to urban expansion:  
> 440 km<sup>2</sup>

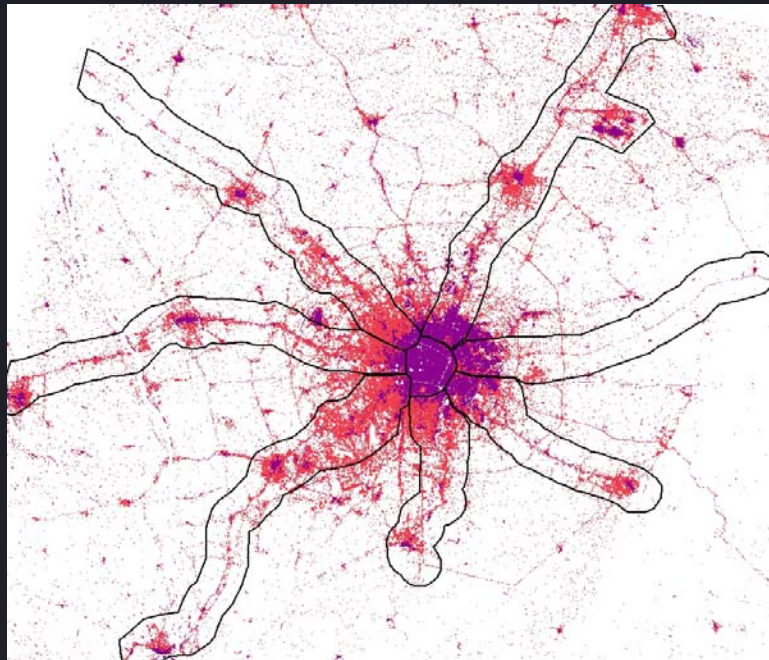
**350% increase in urban land**



# Chengdu - impacts of the 'Go West' program

## Patterns of growth

- peri-urban land development
- spatial differentiation within city
- rapid expansion in nuclei - industry relocating outside of city
- waves of growth
- role of transportation corridors





Chengdu farm villas -  
mosaic of development

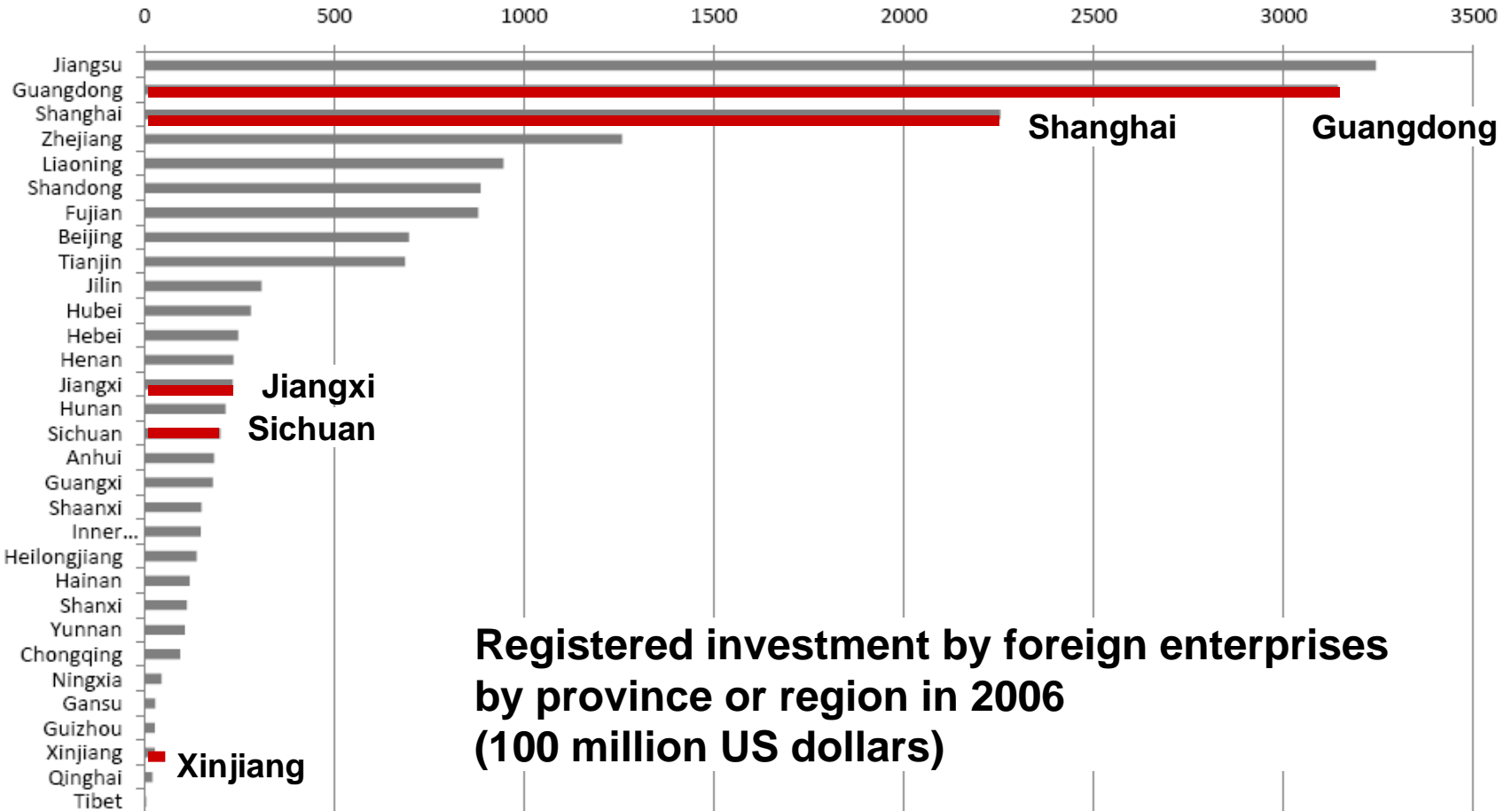
# Chengdu - impacts of the 'Go West' program

## Key factors in development

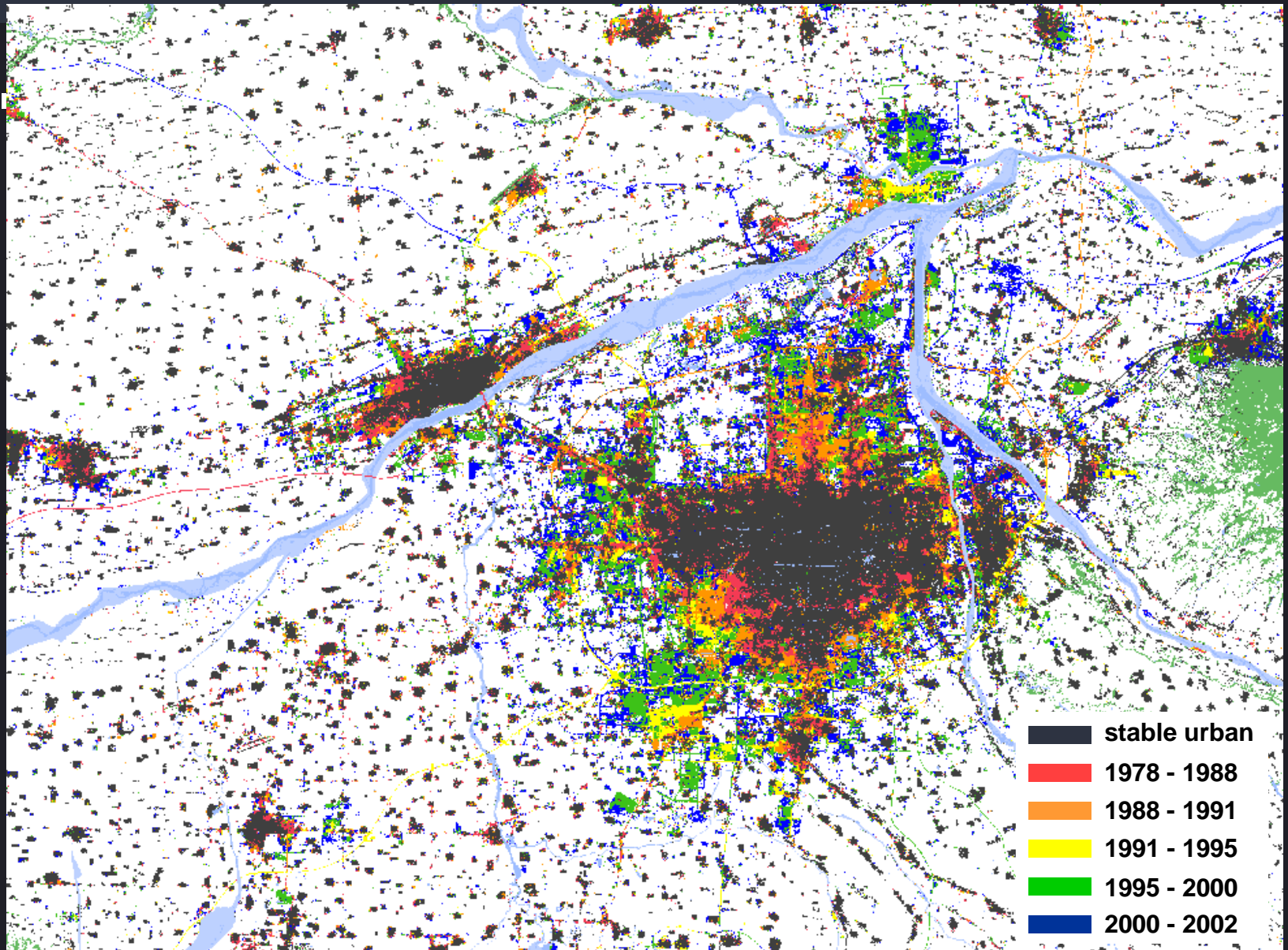
- fiscal transfers, preferential policy
- limited role of foreign direct investment
- role of local government officials
- road development prior to expansion



# Role of foreign direct investment



# Xi'An - second wave of Western development?



# Nanchang - planned expansion in second tier city

Nanchang, Jiangxi province

- second tier city, large agricultural hinterland
- continued importance of agriculture, 29% of GDP
- transition from agriculture to industry, but rapid growth of *service sector*

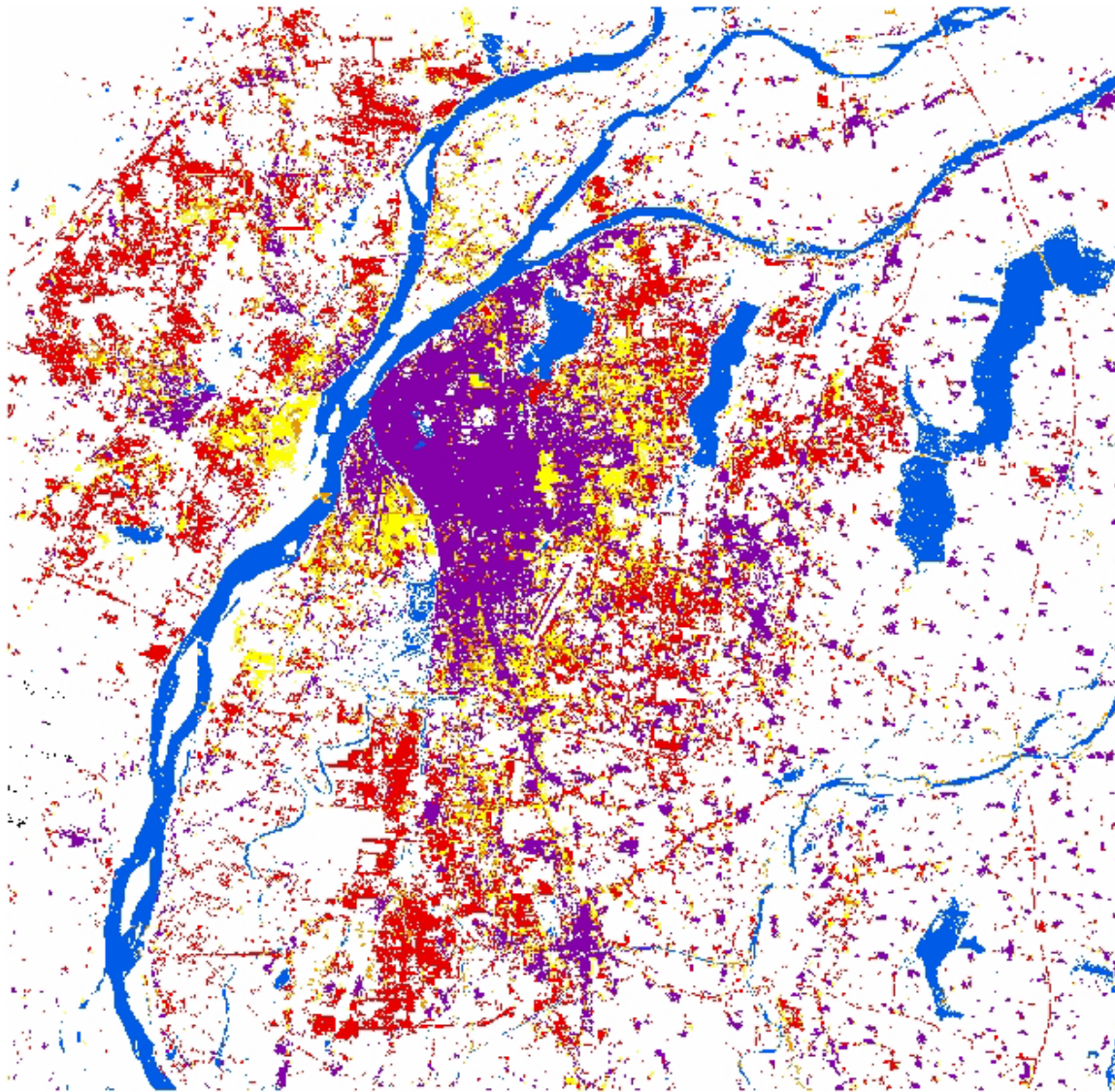
Factors:

- role of planning is critical
- multi-scaled state
- multiple government actors, competition
- economic development zones
- revenue generated by land transfer from collective to state-owned





# Nanchang - planned expansion in second tier city









Increase in urban land, 1988-2008:

**>240 km<sup>2</sup>**

Rates after 2000,  
> 8% annually

Pattern -  
nuclei absent,  
but gridded  
structure

-  non-urban
-  stable urban
-  1988 - 1993
-  1993 - 2000
-  2000 - 2008
-  water

5,000

Meters

# Nanchang - planned expansion in second tier city



Traditional urban housing



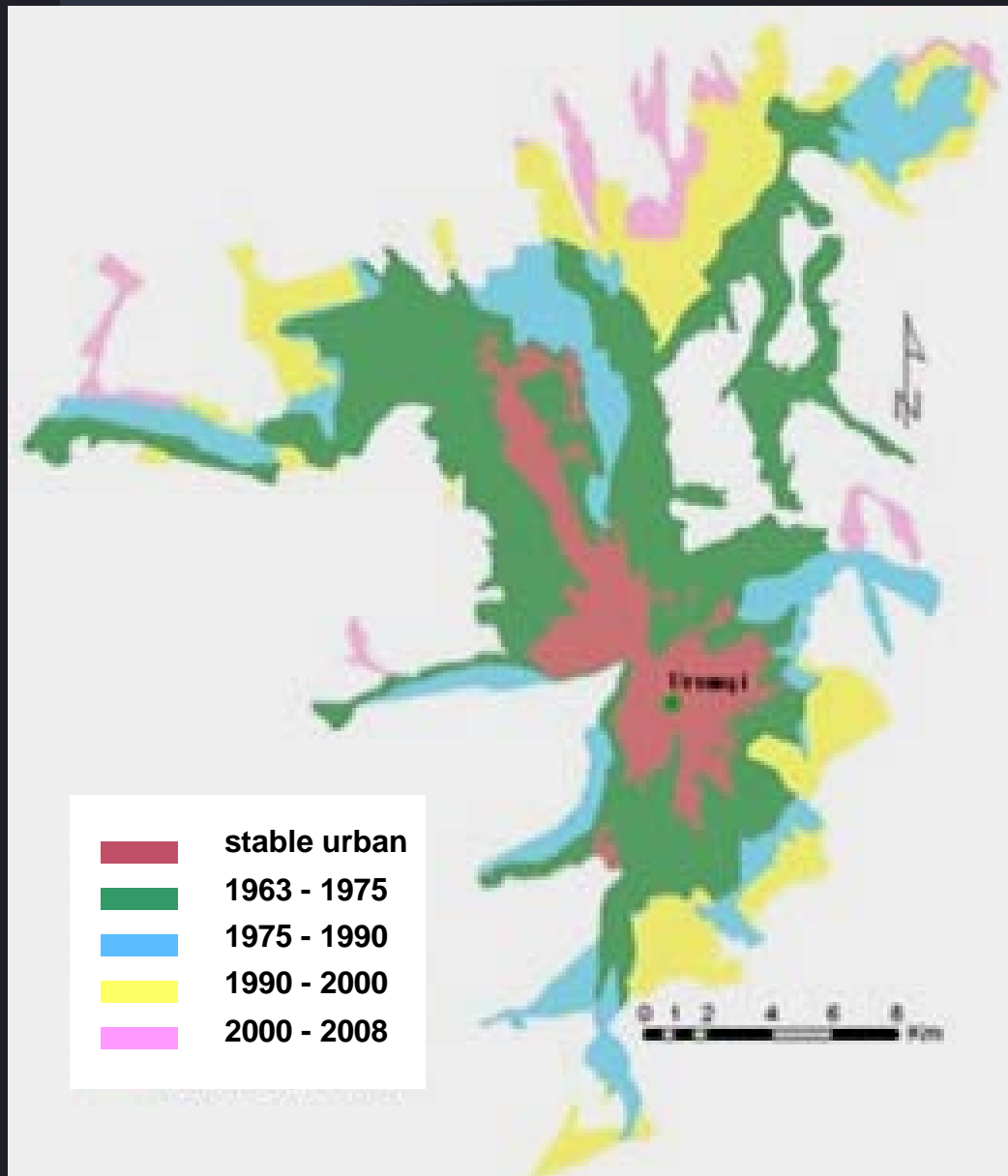
New residential areas





photo by Peilei Fan

# Urumqi - industrial development in the West



Urumqi, Xinjiang Province,  
Uyghur Autonomous Region

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

Urumqi today...

- exponential economic growth, 1990s onward
- investment in energy industry
- new growth in tertiary sector
- influence of trade with Russia, links to former Soviet states
- rise of tourism

# Urumqi

## Environmental impacts of industrialization

### Urban air pollution

- one of top ten most polluted cities in the world (WHO, 1998)
- soot and dust from coal, combined with location in valley of Tianshan Mountains



### Water resources

- scarce, severely polluted -- available water per capita is  $\frac{1}{4}$  of national average
- human impacts - overgrazing, mushroom cultivation

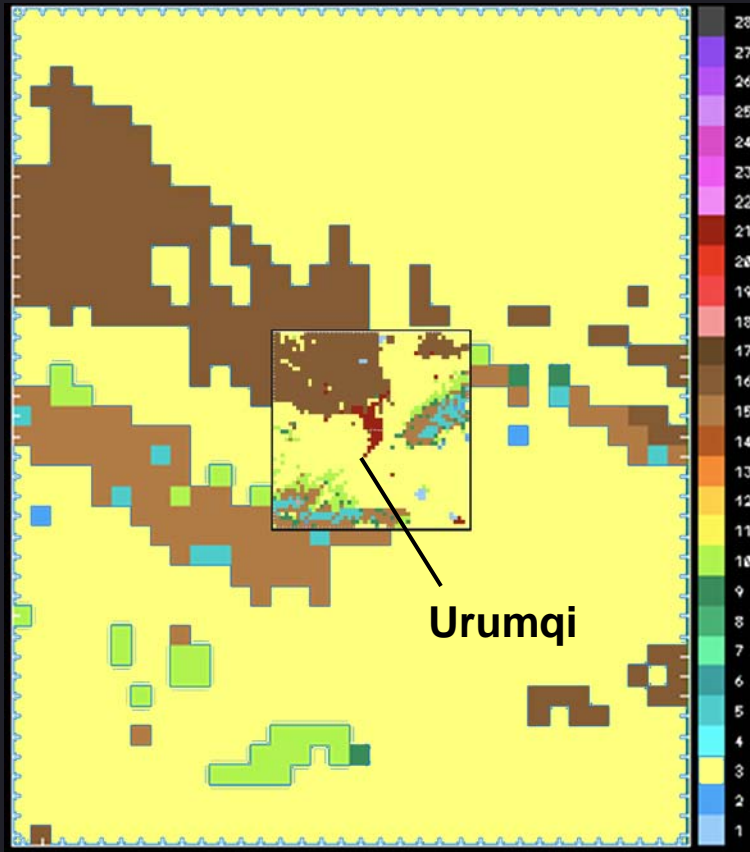
### ***Cautionary tale for urbanization --***

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

# Urumqi - understanding environmental change

## Modeling climate

- incorporate land use in Regional Atmospheric Modeling System (RAMS) 6.0
- MODIS albedo, NDVI variables added directly into land surface model



## Preliminary results

- previous work shows region will experience higher temperatures, and thus, increased threat of desertification
- changes in fractional vegetation cover - models show higher wind speeds may better disperse pollutants; may lead to better air quality

Multiple nested grids (2 and 8 km shown) of the *RAMS* model, and aggregated land cover classes

# Conclusions

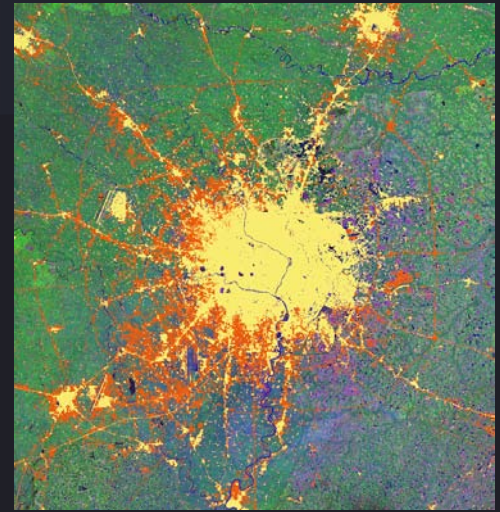
How are urban areas changing across China?  
What are the drivers and implications of these changes?

Land cover - land use change is rapid, expansive

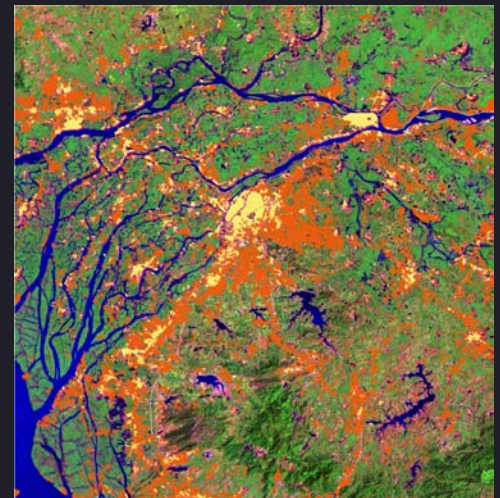
- increasing rates of growth after 2000
- role of economic transition

Understanding urban spatial patterns is critical

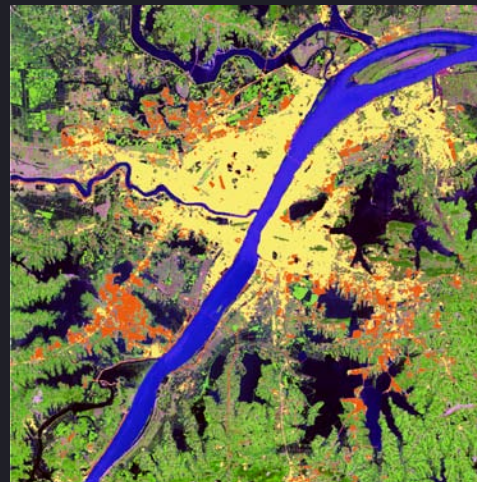
- large block development
- wide boulevards
- nuclei development
- role of economic transition



Chengdu, Western China



Dongguan, Eastern China



Wuhan, Central China



# Conclusions

How are urban areas changing across China?  
What are the drivers and implications of these changes?



Factors affecting urbanization are **multi-faceted**, vary over space, time

- multi-scale planning
- preferential policy, development zones
- foreign direct investment
- road development
- economic transition, reforms
- migration

Urbanization has a significant impact on the environment

- temperature, precipitation
- reduced vegetation cover - impact on winds
- link to urban environmental theory and economic transition

# Acknowledgments

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Curtis Woodcock (Boston University)  
Wenze Yue (Michigan, Zhejiang University)

**Datasets and publications** available at:  
<http://www.sage.wisc.edu>



Thank you