A Tale of Two Cities: Drivers and Outcomes of Urban Growth

Karen C. Seto
Department of Geological and Environmental Sciences
and
Stanford Institute for International Studies
Stanford University
What is urbanization?

**Anthropogenic Drivers**
- Social Process
  - Demographics
  - Rural-urban migration
  - Consumption patterns
  - Livelihoods
  - Social networks
  - Economics
  - Policy

**Ecosystem Change**
- Landscape Transformation
  - Land use change
  - Cropland loss
  - Surface albedo
  - Carbon storage and fluxes
  - Hydrology
  - Biodiversity
  - Ecosystem goods & services
What is urbanization?

**Anthropogenic Drivers**

- Population

**Ecosystem Change**

- *Landscape Transformation*
  - Land use change
  - Cropland loss
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What is urbanization?

**Anthropogenic Drivers**
- Population
- Multiple levels
- Interactions

**Ecosystem Change**
- Urban growth magnitude
- Urban growth patterns

- Two processes often used interchangeably
- Assumption: social and physical processes equal
- E.g. Largest urban areas defined by population, not area
- Highest urbanization rates: population, not landscape change
Global Comparative Urban Analysis

• What are the global patterns of urbanization as a landscape transformation process?
• What are the rates of urbanization in cities across the world?
• How have the size and shape of cities changed?
• What factors explain the range of rates and patterns of urbanization globally?
• Motivation: link social and landscape processes
Remote Sensing of Urban Areas

- Traditional urban mapping
  - Aerial photography
  - Land surveys
- Consistent and recurrent observations
- Synoptic views of landscape
- Explicit patterns of land use
- Track land development processes
- Link between patterns and processes
Satellite Remote Sensing

- Global observations (AVHRR, MODIS)
  - 250m-1km
  - Daily observations

- High spatial resolution (Landsat TM, IKONOS)
  - 1m-30m
  - 1-16 day repeat cycle

- Long observational record
Global Comparative Urban Analysis

1. Reliable & accessible disaggregated socioeconomic data
2. Cities with population > 1 million
Sacramento, U.S.
concentrated growth in clusters

Curitiba, Brazil
patchy growth along urban-rural boundary

Monterrey, Mexico
growth along corridors

urban land cover
urban change 1990 - 2000
Global Change and Urbanization in China

- One quarter of world’s 500 largest urban areas in China
- 2030: China’s urban population increase by U.S. pop.
- Complex factors
  - socioeconomic, political, institutional, cultural
- Globalization, decentralization, migration, restructuring
- Transformation of rural communities
- Unique spatial configuration
Policy Reforms and Urban Growth

- Began in 1978
- Decentralization
- Open-door, FDI
- Agricultural reforms
- Land-use rights
- Household registration system (*hukou*)
- Work unit (*danwei*)

- Rural-urban migration
- Rapid land-use change
- Agricultural expansion & intensification
- GDP, 1978-2002: 8-14%
- Increase in income
  - vehicles
  - housing
  - changes in diet
Pearl River Delta, China

- Major agricultural region
- Special Economic Zones
- Geographic proximity to Hong Kong
- Cultural ties to overseas Chinese investors
- 33-48 million
1980s: Coast — 1990s: West

Chengdu
Chengdu, Sichuan Province

- Administrative, cultural center with 2500 year history

- City: 2.5 million. Municipality: 11 million

- Fertile plain - triple cropping system

- 1950s, 1960s: Industrial center

- City chosen for investment
Spatial Patterns of Urban Growth

- Quantify changes in landscape patterns, urban form
- Indicators of patchiness and fragmentation
- Indicators of shape and complexity
- Gradient analysis
- Time series gradient analysis
Pearl River Delta

• 1988-1996: Urban Area ↑ 364%
• 1905 km² of land converted
• 1376 km² of agricultural land

Pearl River Delta Social Indicators

<table>
<thead>
<tr>
<th></th>
<th>1973</th>
<th>2002</th>
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<tbody>
<tr>
<td>Population</td>
<td>~8 million</td>
<td>33-48 million</td>
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<tr>
<td>Residential floor space pp</td>
<td>4 m²</td>
<td>21 m²</td>
</tr>
<tr>
<td>Life expectancy</td>
<td>63</td>
<td>72</td>
</tr>
<tr>
<td>Motor vehicles</td>
<td>&lt;30,000</td>
<td>&gt; 2,200,000</td>
</tr>
</tbody>
</table>

Source: Guangdong Statistical Yearbook
Urban Growth Characteristics

[Graphs showing various metrics such as mean patch size, number of patches, and patch size coefficient of variance for different cities over different years.]
Carbon Emissions Associated with Urban Growth

Dye et al., 2004. *Asian Journal of Geoinformatics*
Chengdu, 1973-2002: 300% ↑

Schneider et al., 2003.
World Bank/Asia Pacific Research Center Discussion Paper.
Physical Trends in Urban Growth

- Mean patch size
- Ring road analysis
- Zone analysis
- Corridor analysis
Urban Land-Use Efficiency

<table>
<thead>
<tr>
<th>Chengdu's districts</th>
<th>change land/change pop (m²/person)</th>
<th></th>
<th>change land/change gdp (m²/yuan)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Jinniu</td>
<td>0.19</td>
<td>0.09</td>
<td></td>
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<tr>
<td>Chenghua</td>
<td>0.06</td>
<td>0.09</td>
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<tr>
<td>Qingyang</td>
<td>0.23</td>
<td>-0.67</td>
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<tr>
<td>Jinjiang</td>
<td>0.38</td>
<td>-0.19</td>
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<tr>
<td>Wuhou</td>
<td>0.22</td>
<td>6.54</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chengdu total</td>
<td>0.03</td>
<td>0.04</td>
<td>0.18</td>
<td>0.36</td>
</tr>
</tbody>
</table>
Three Trends in Urban Form

1. Reorganization around multiple sectors
   • Targeted development zones outside city
   • Spatial concentration, cluster dynamics
   • New development estates
2. District specialization for residential, industrial, and commercial activities

- high-tech zones
- new industrial areas, driven by private sector
- new residential zones: high-rise apartments, low density farm villas, luxury housing

3. Peri-urban growth

- Increased fragmentation
- Peri-urbanization as far as 50km
- Concentrated patches of investment
Summary

- Loss of cropland: increase in productivity? E.g. Silicon Valley
- Increase in land use efficiency?
  - $\Delta \text{Land}/\Delta \text{Pop}, \Delta \text{Land}/\Delta \text{HH}, \Delta \text{Land}/\Delta \text{GDP}$
- Social consequences: increase in welfare indicators
- Ecological consequences: indirect effects on CO$_2$ greater than direct effects
- Common trajectories of urban growth: path dependency?
Conclusions

- Local, regional, national, international drivers

- Disparity between planning and government objectives, and the reality on the ground

- Spatial trends: district specialization in Chengdu and PRD

- Amounts of growth: unexpectedly similar

- Directed growth is possible, but has limitations

  - Private sector actors, domestic and foreign investment play a larger role
Chengdu
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Urban Growth in Shenzhen, 1988-1996