Urbanization and Global Environmental Change in Asia: Challenges and Prospects for Sustainability

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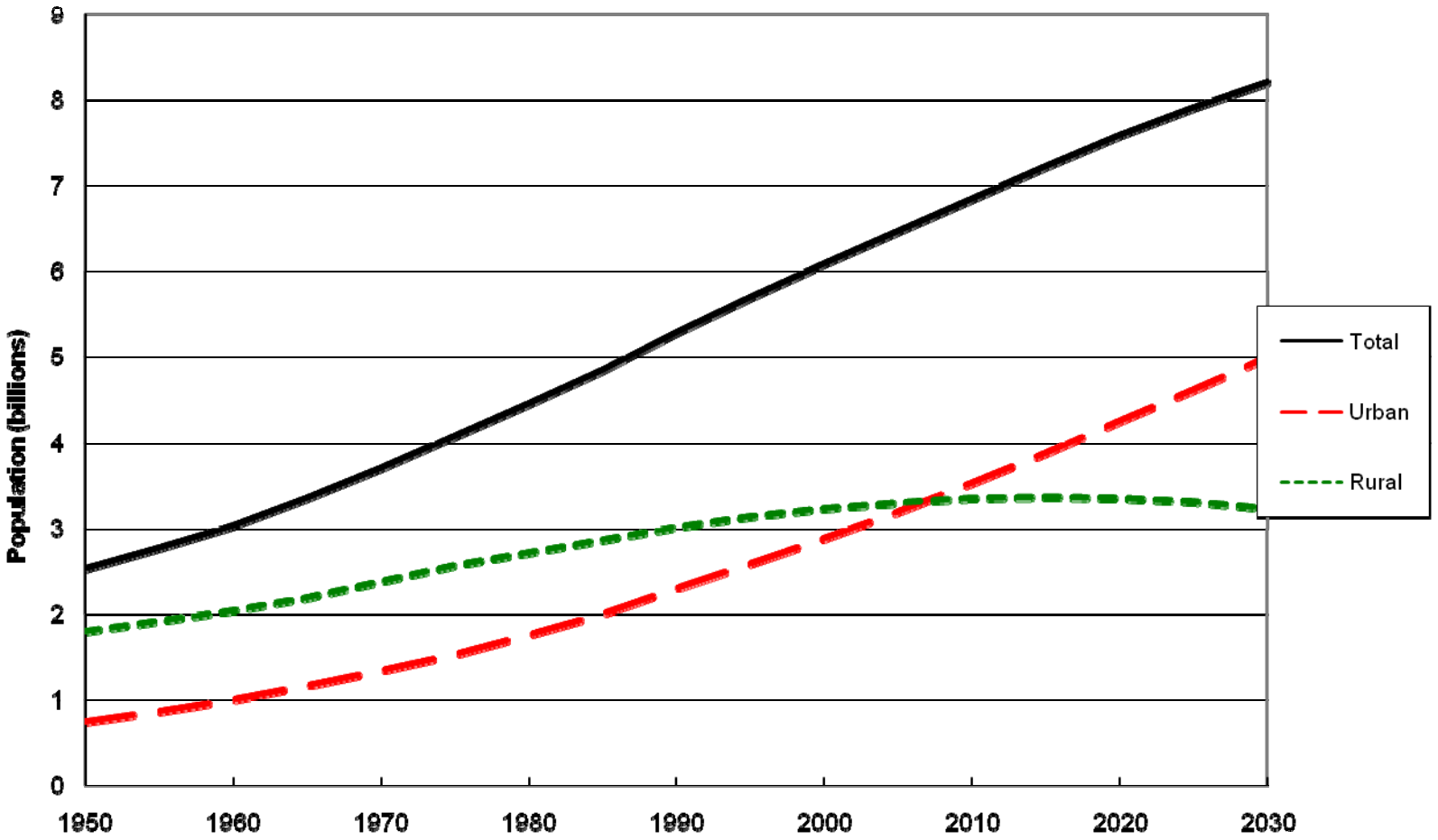
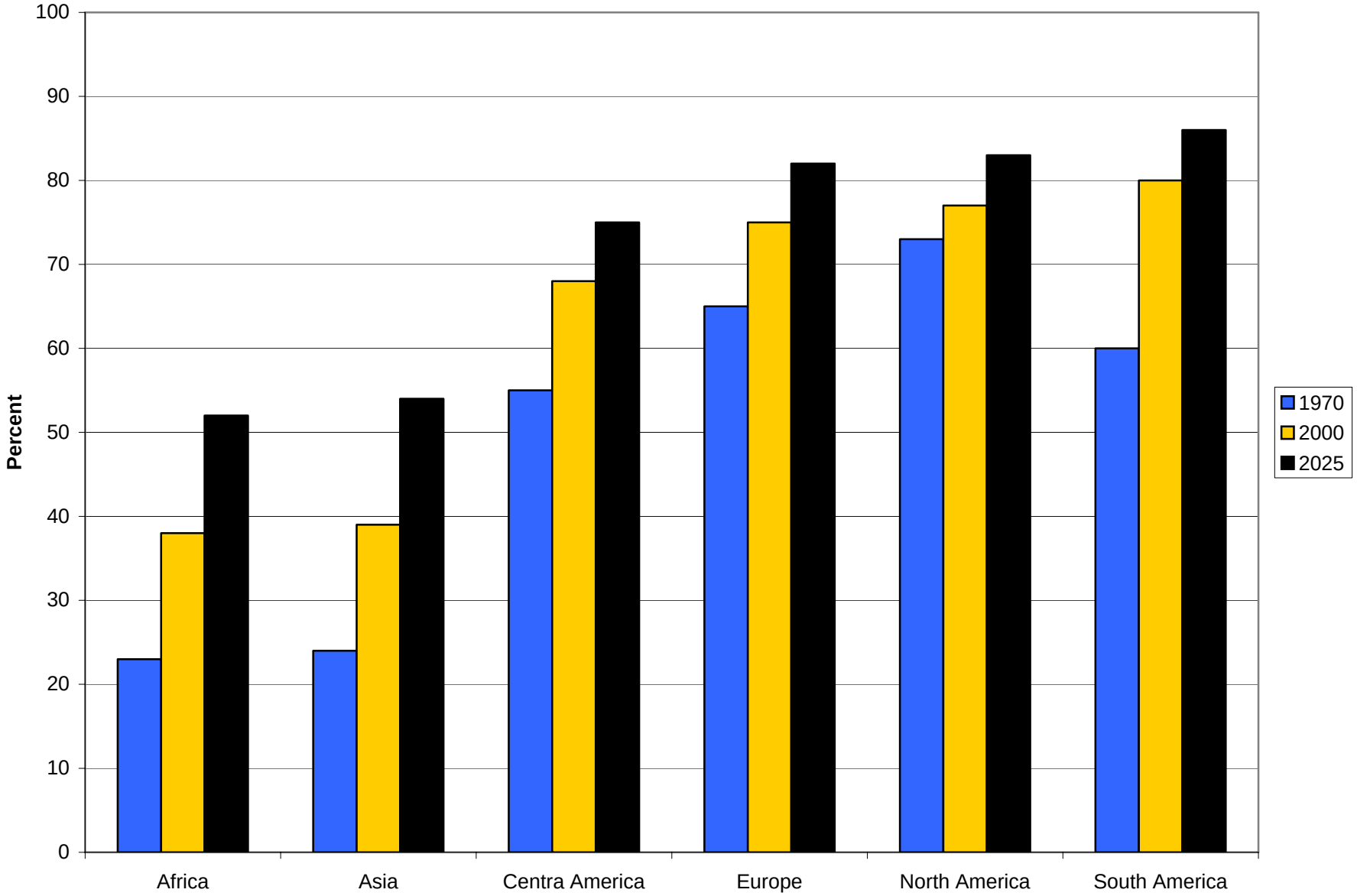
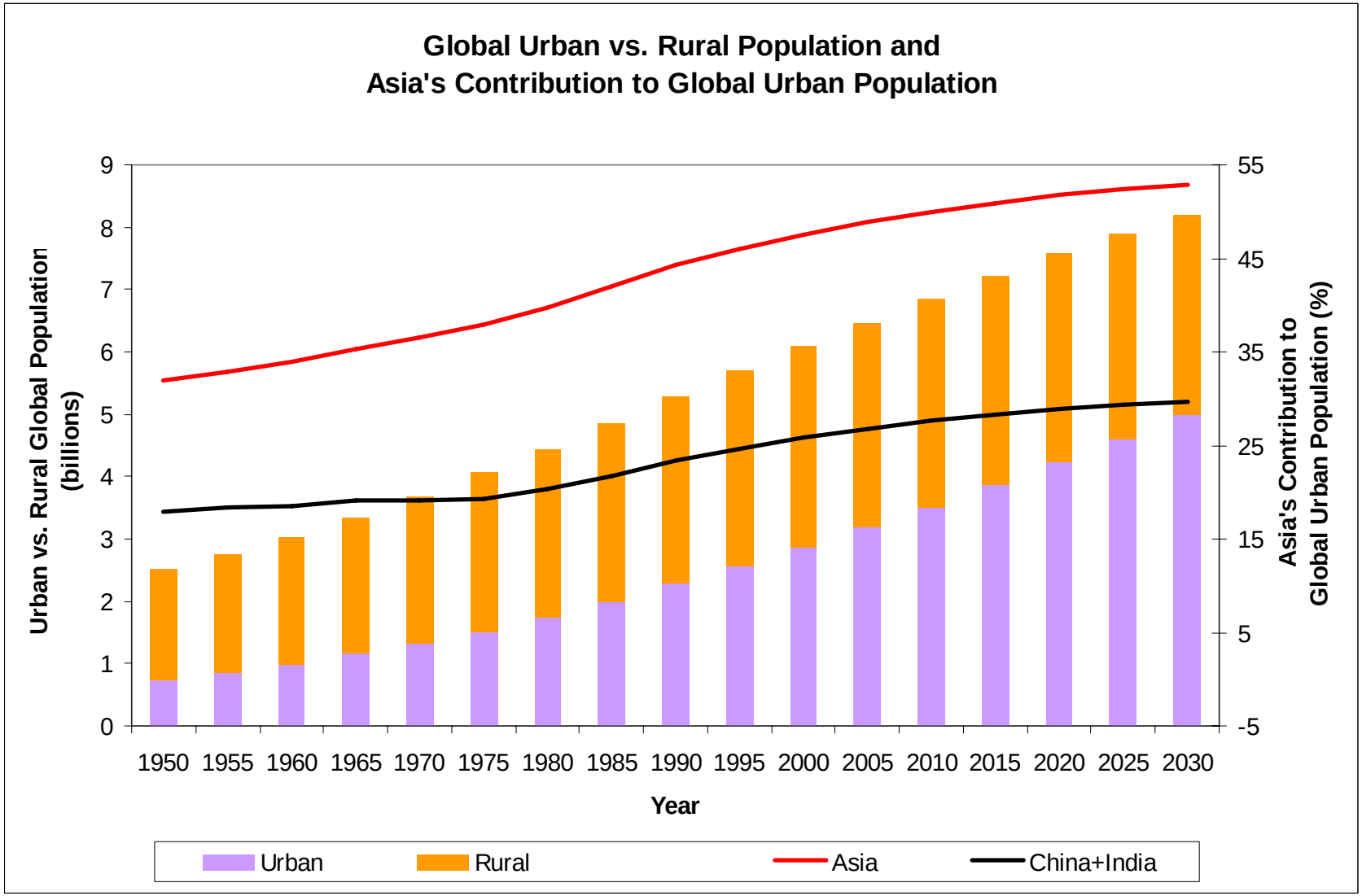
Global Population Trends



Urban Population as Percentage of Total Population

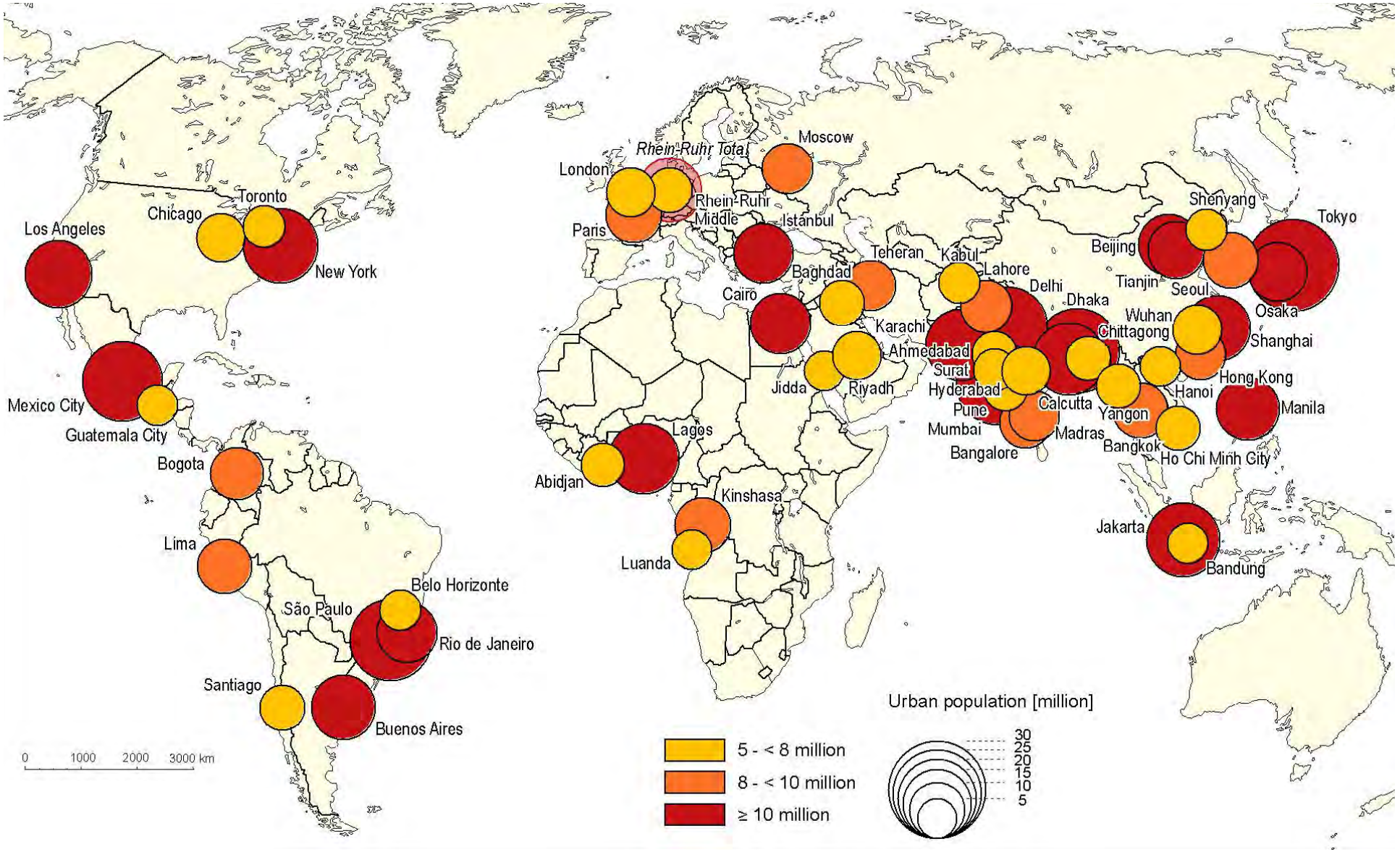


Source: United Nations, 2004. *World Population Prospects*



Source: United Nations, 2007. *World Population Prospects*

Projected Megacities, 2015



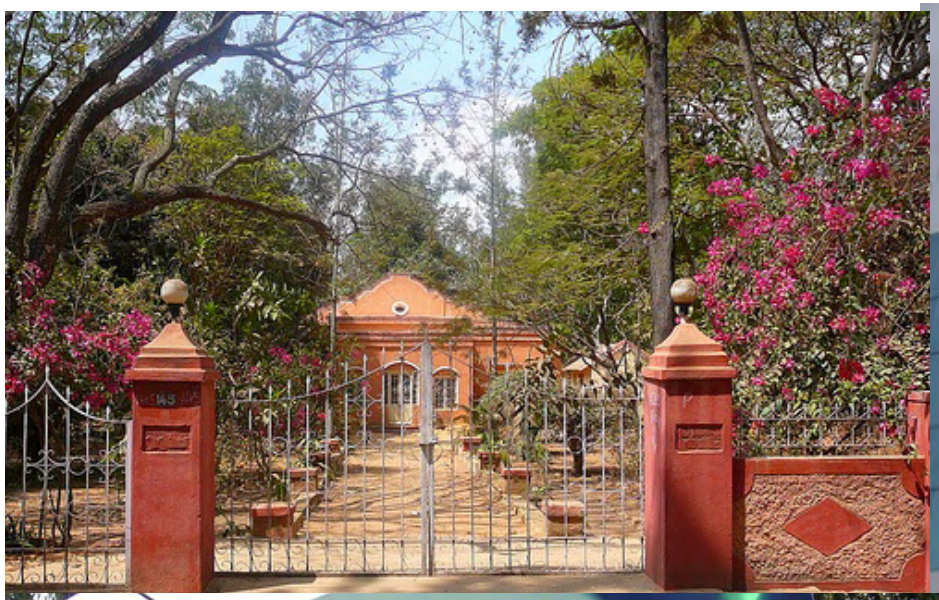
Sources: Kraas, Univ. of Cologne and United Nations, 2004

How will urban (and peri-urban) areas grow and change?

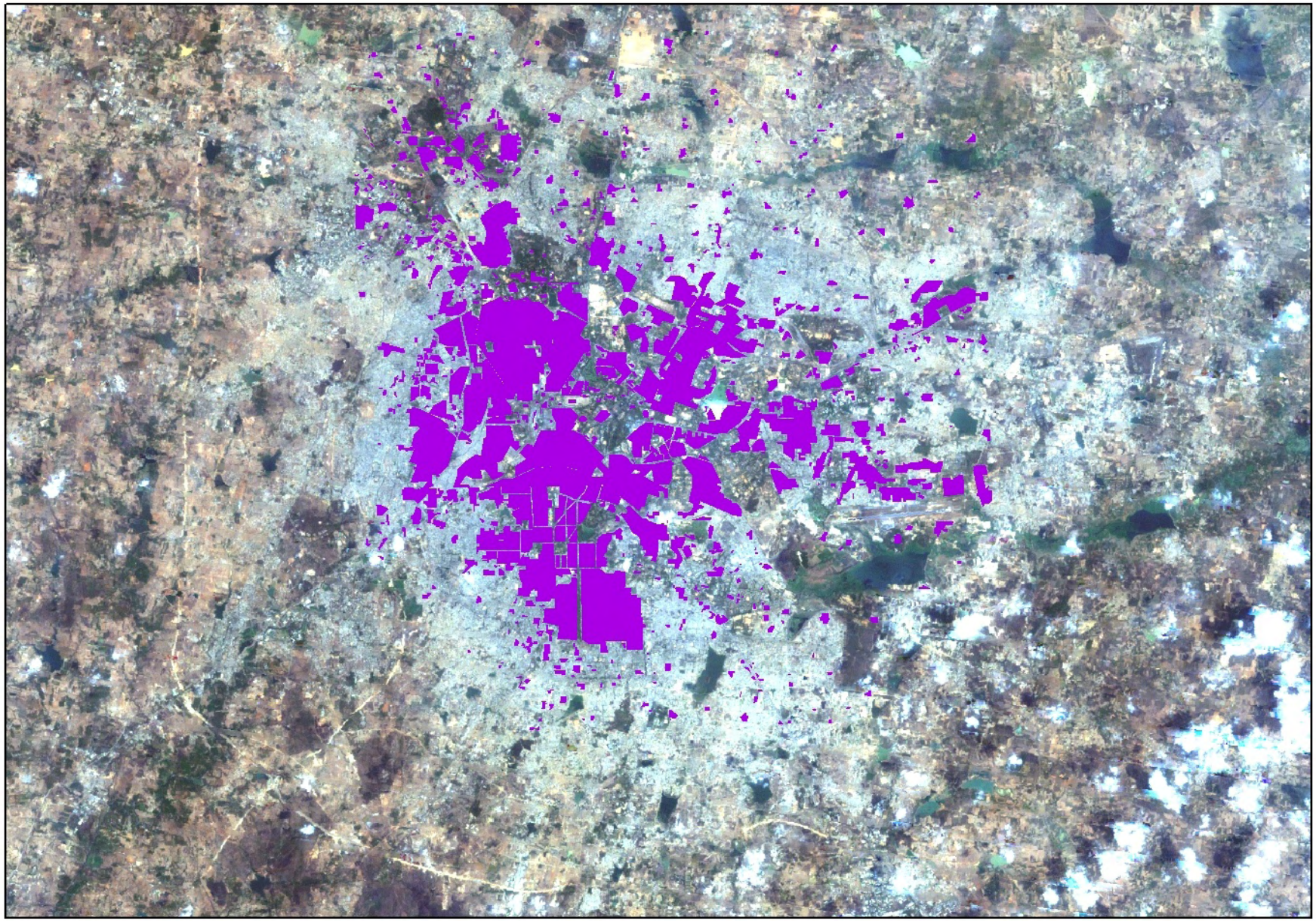
What will be the environmental consequences?

Many Regions, One Common Tale

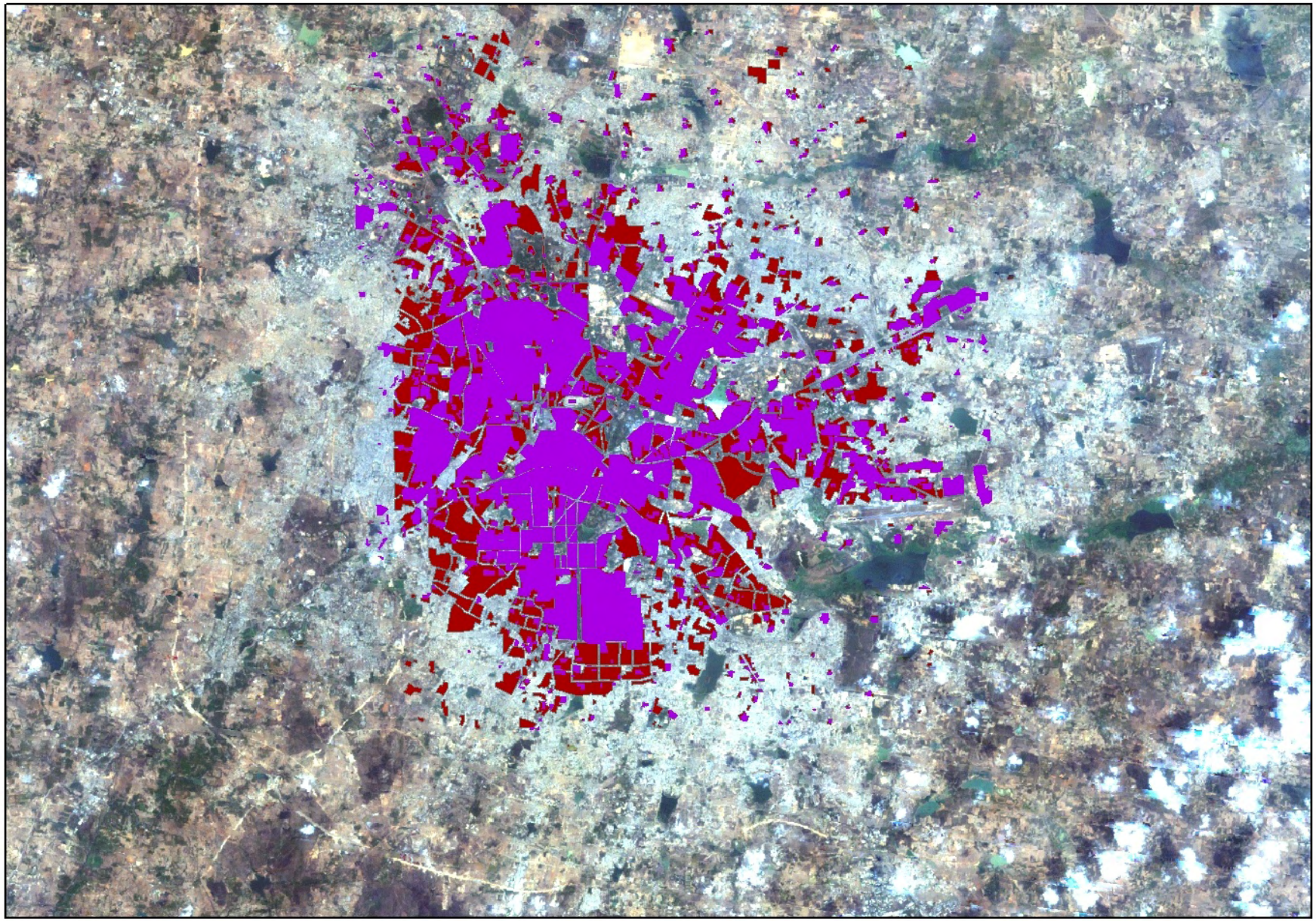
Bangalore (Bengaluru):
Garden City to High-Tech Capital



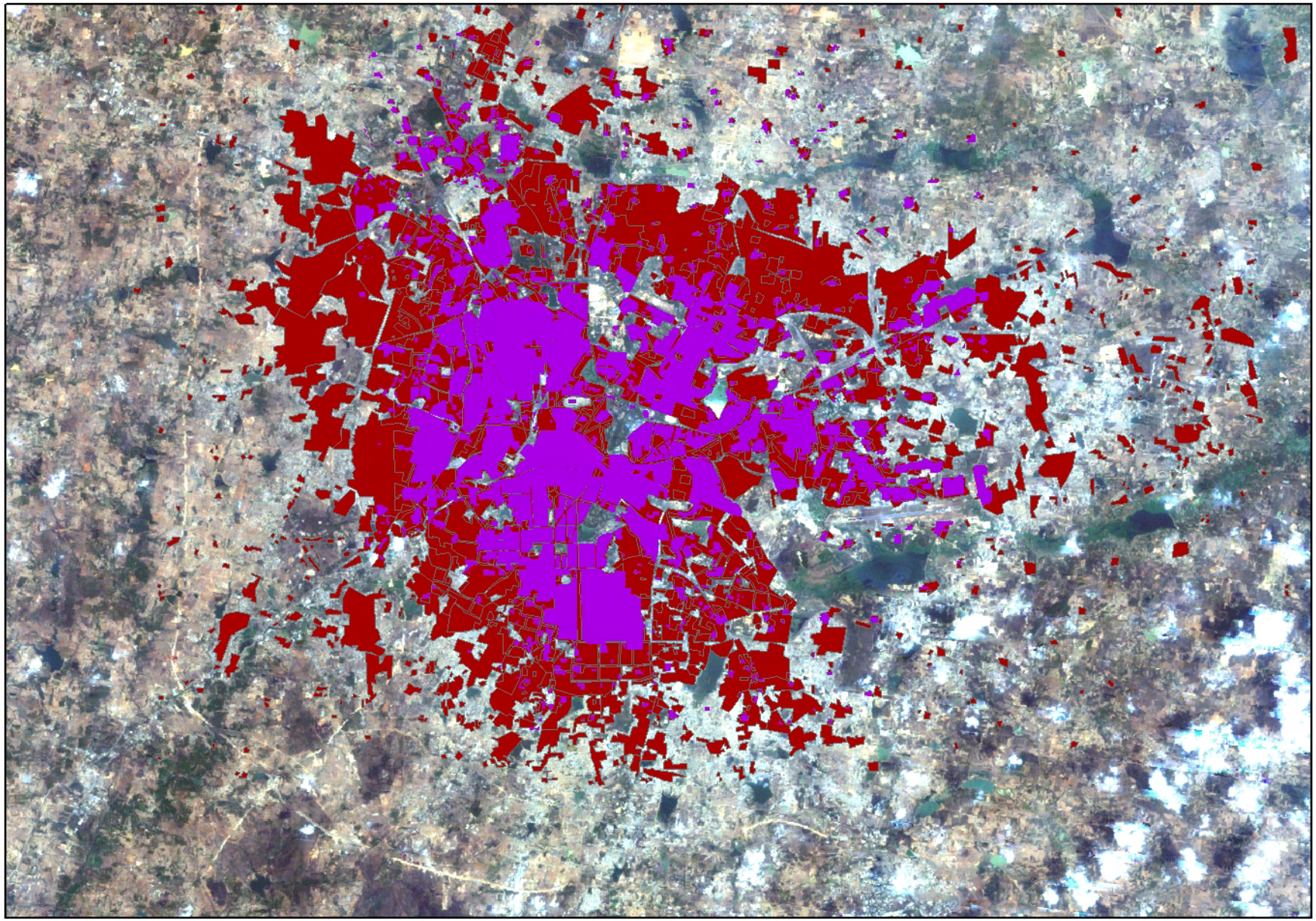
Urban Growth in Bangalore: 1980

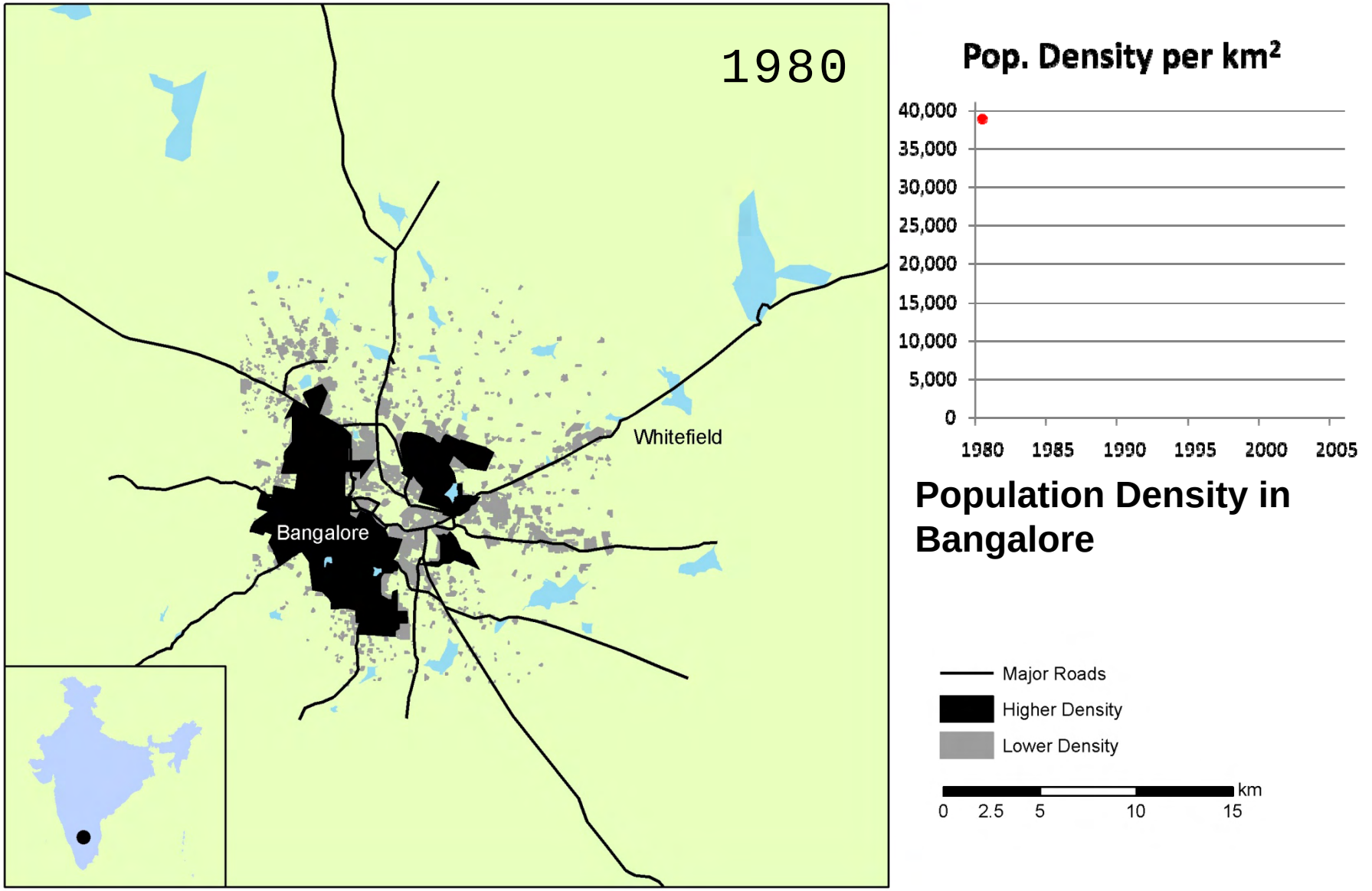


Urban Growth in Bangalore: 1990

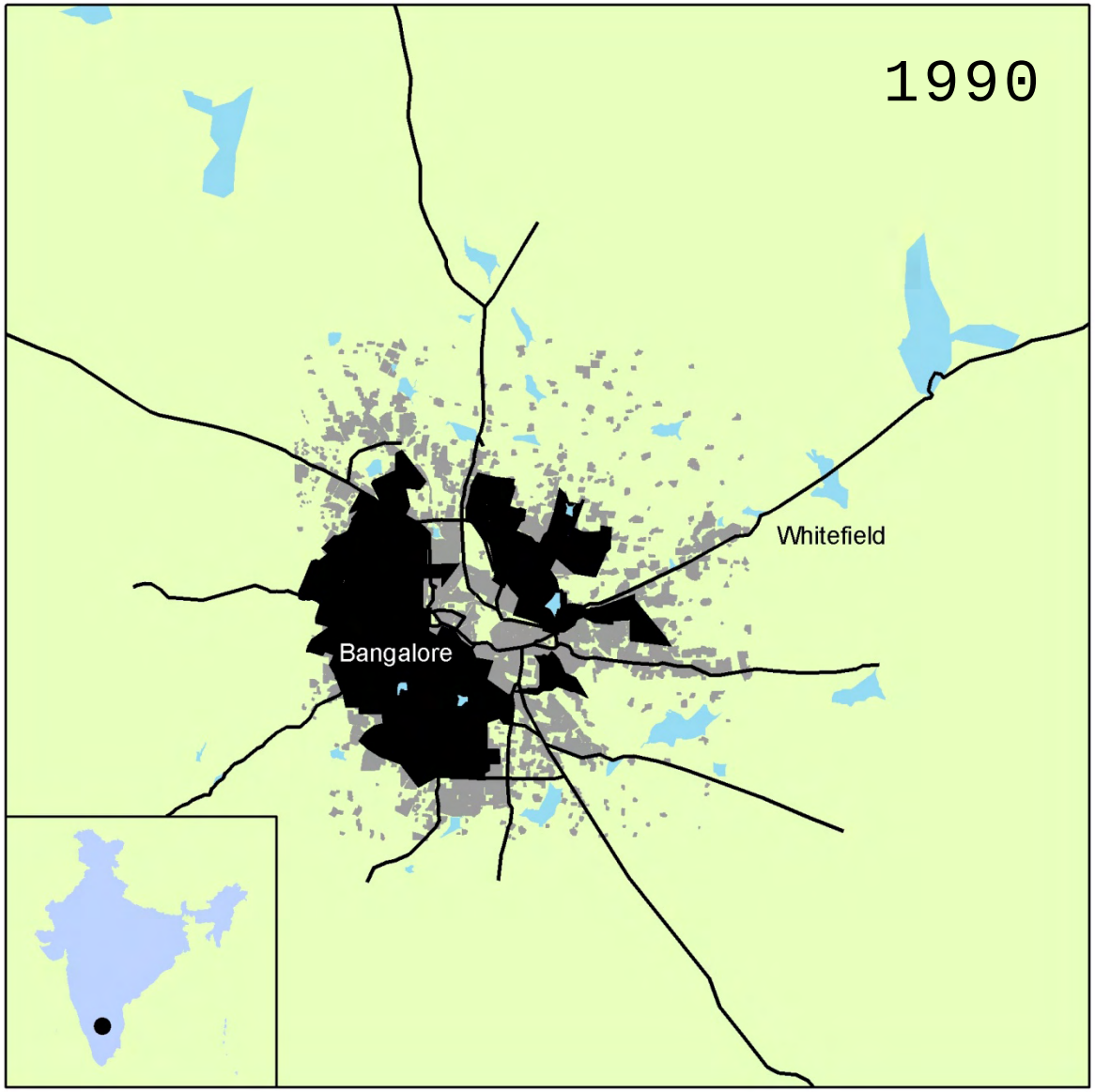


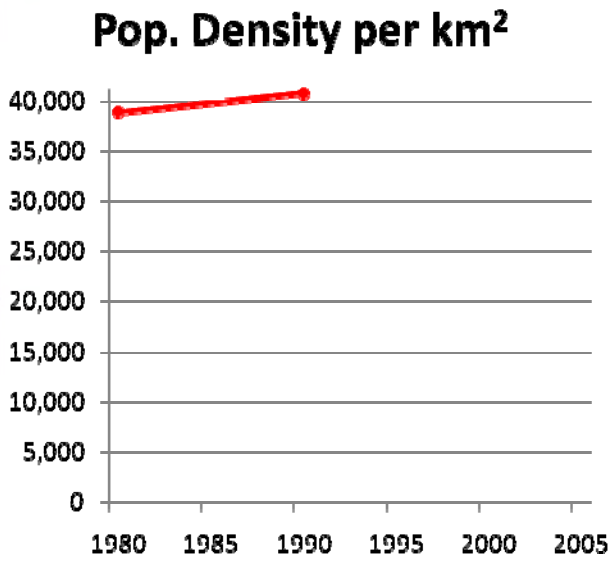
Urban Growth in Bangalore: 2005





Population Density in Bangalore

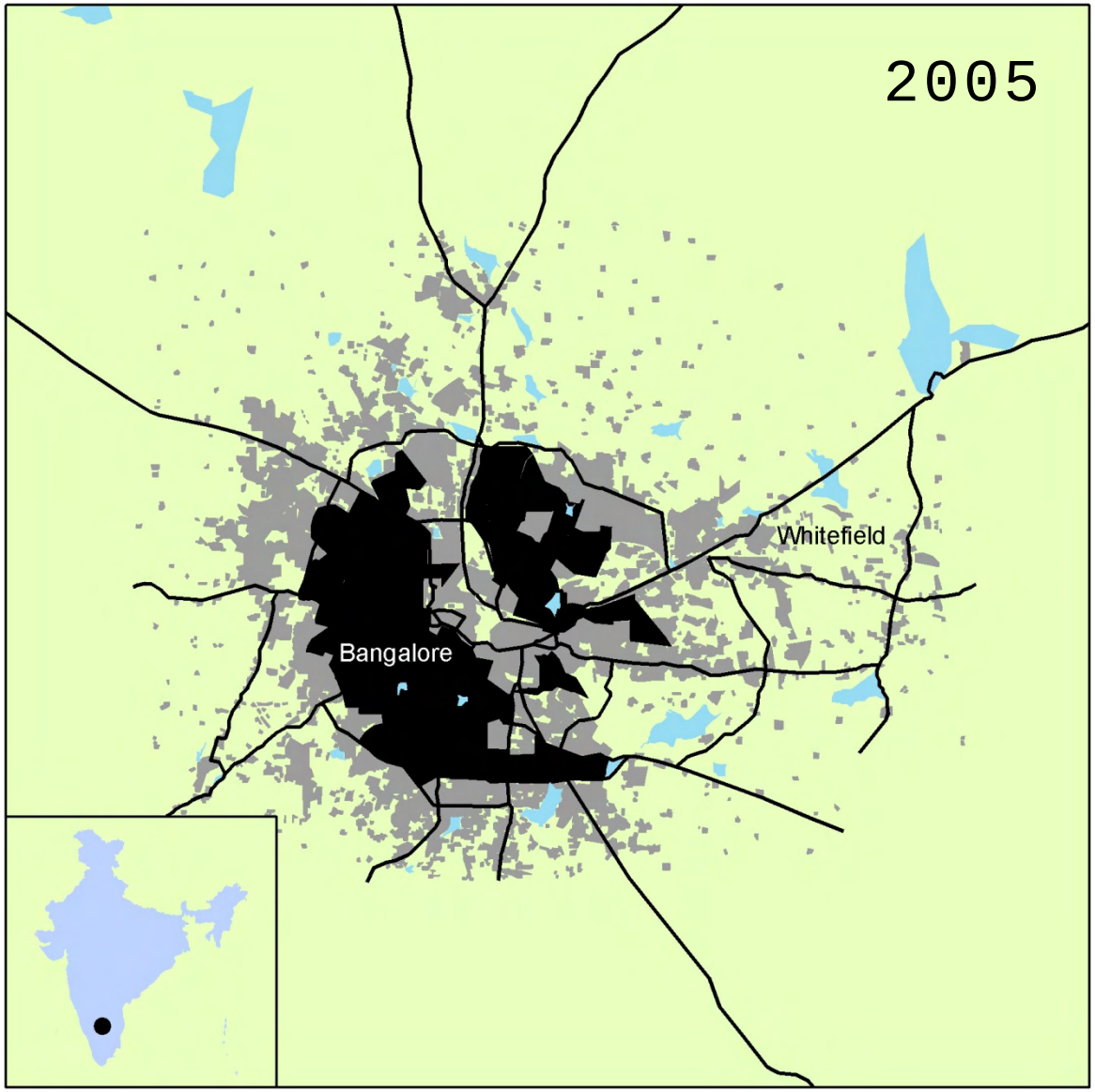


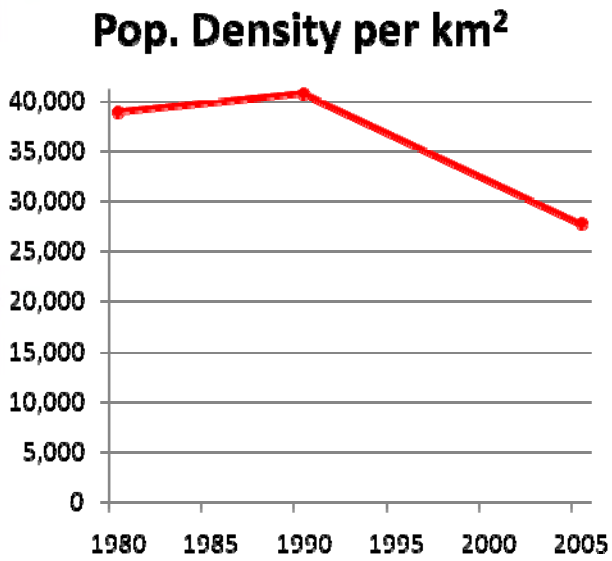


Population Density in Bangalore

Major Roads
Higher Density
Lower Density

km
0 2.5 5 10 15





Population Density in Bangalore

Major Roads
Higher Density
Lower Density

0 2.5 5 10 15 km

Bangalore

- 1980-2005: Bangalore's annual urban growth rate was 4.6% – similar to modern Las Vegas
- Approximately 1/3 size of Taipei
- 1980-1990, the city grew 7 km^2 /$1B GDP
- 1990-2005, the city grew 40 km^2 /$1B GDP
- Declining population density
- Lagging infrastructure

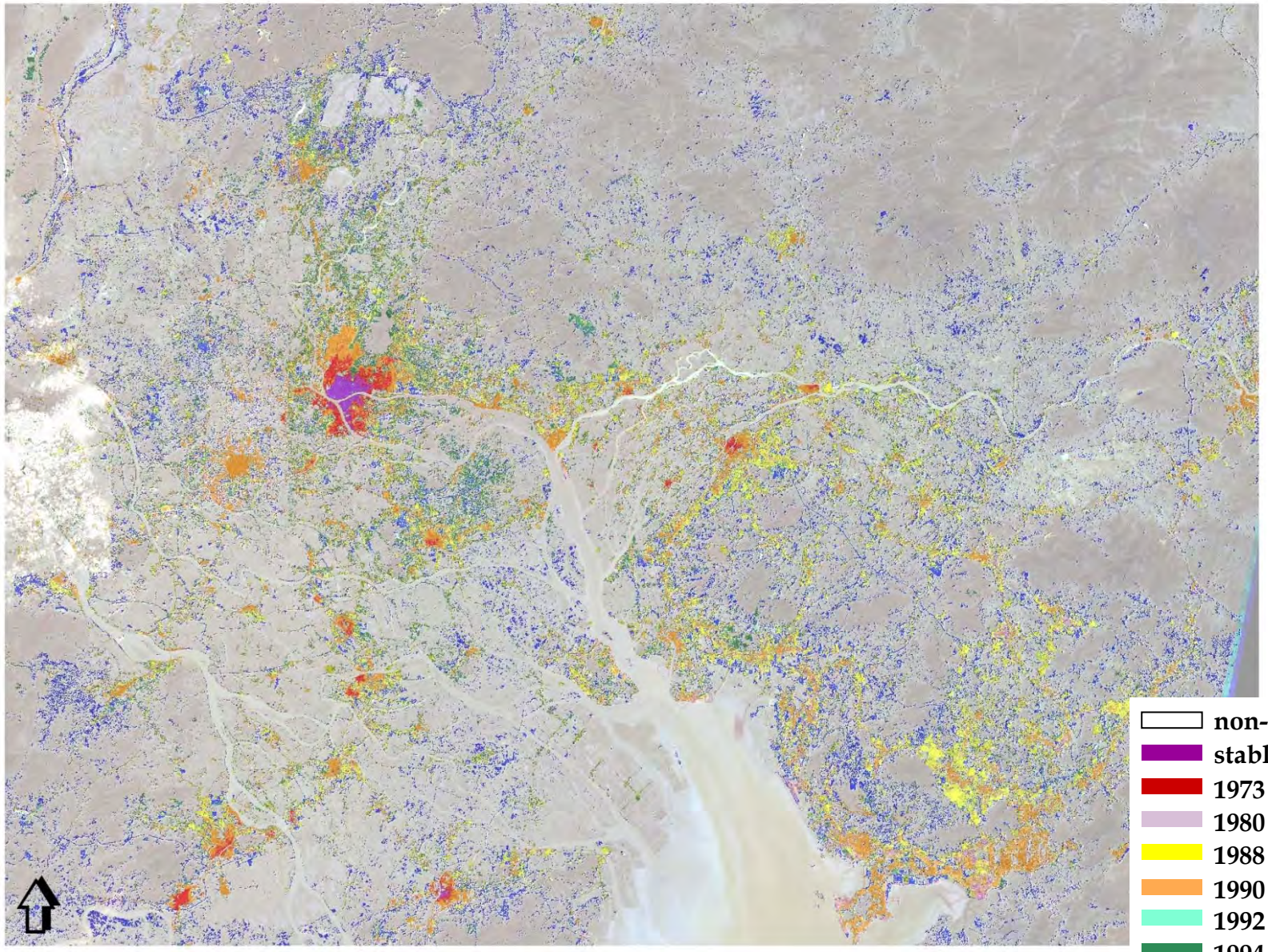
The desire to become “the next Silicon Valley” is an important driver of current urban form

“The lemming effect.”

- *Silicon Valley CEO, when asked the reason why his company had opened a development office in Bangalore*

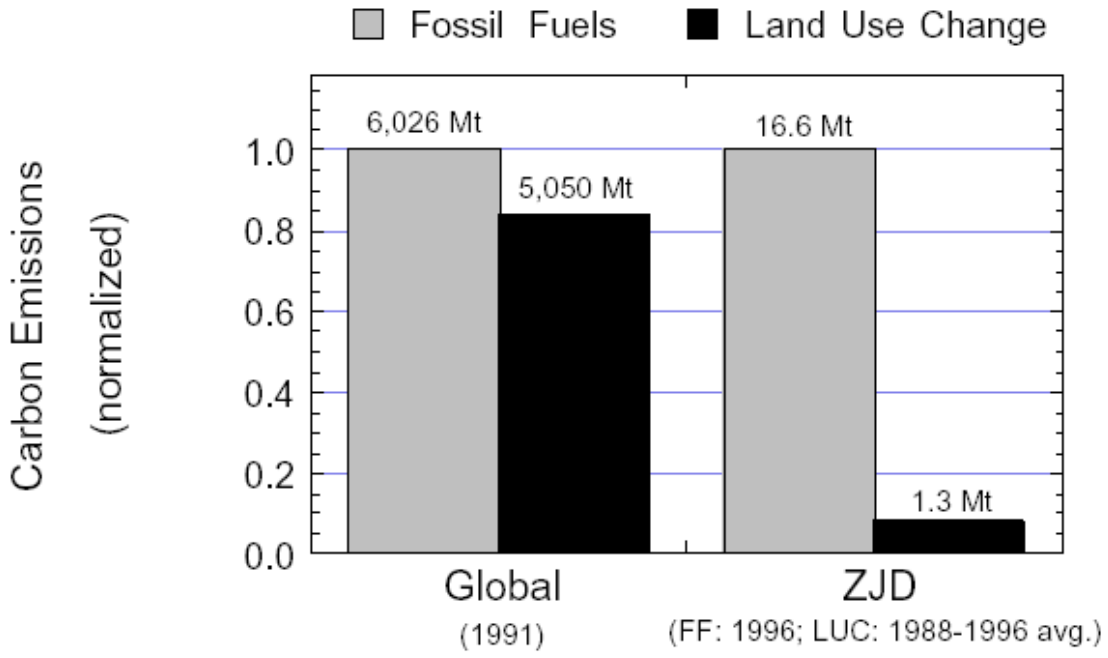
The Pearl River Delta: Explosive Urbanization

Urban Growth in Pearl River Delta, China - 1973 to 1999

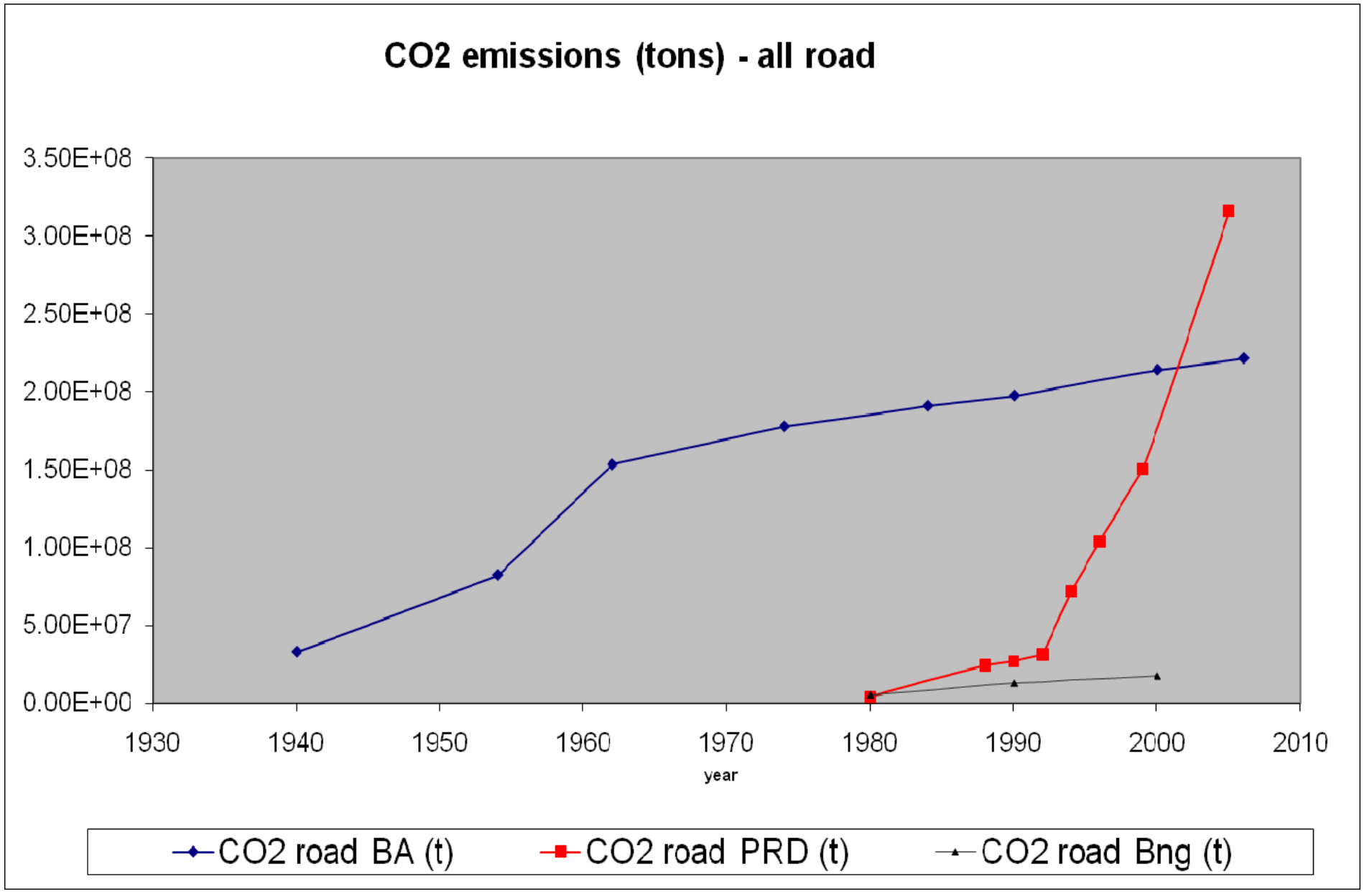


The Pearl River Delta

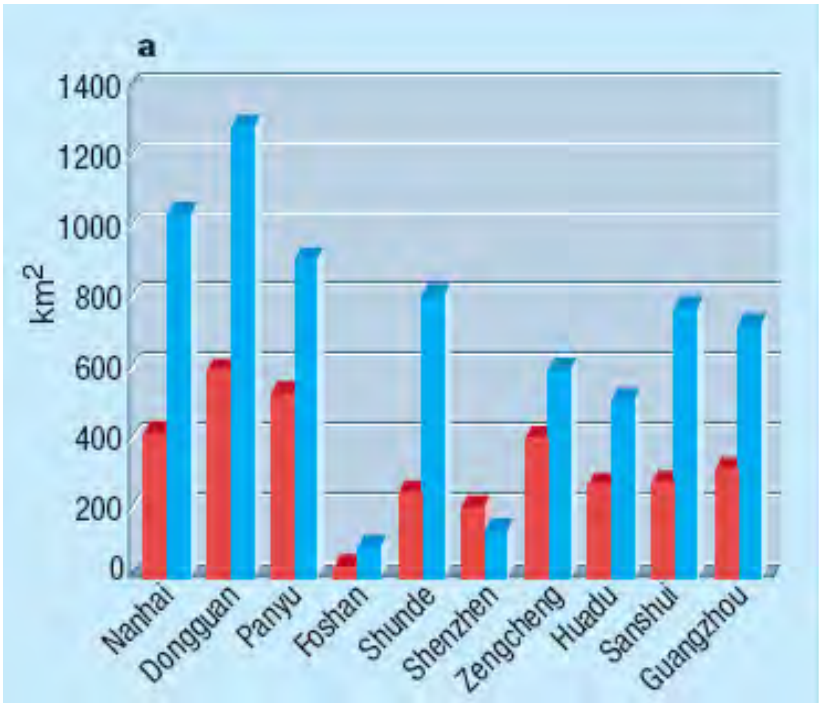
- 75x growth in urban extent, 1980-2005
- An increase of nearly 5000 km^2 of land
  - Approximately twice the size of Taipei



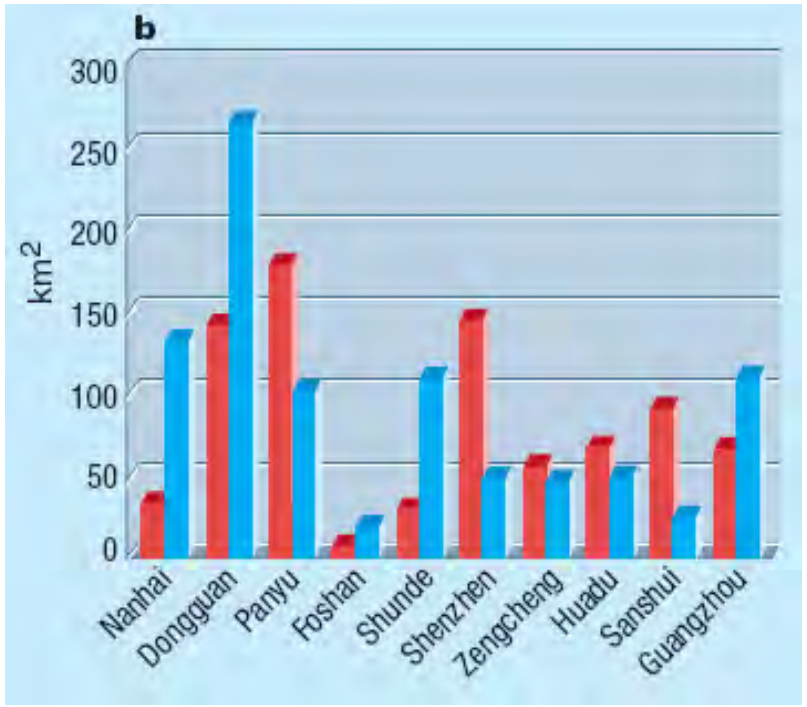
Source: Dye, 2000. *ACRS*


CO2 emissions (tons) - all road
3.50E+08
3.00E+08
2.50E+08
2.00E+08
1.50E+08
1.00E+08
5.00E+07
0.00E+00
1930
1940
1950
1960
1970
1980
1990
2000
2010
year
CO2 road BA (t)
CO2 road PRD (t)
CO2 road Bng (t)

Urbanization and Agricultural Land Loss



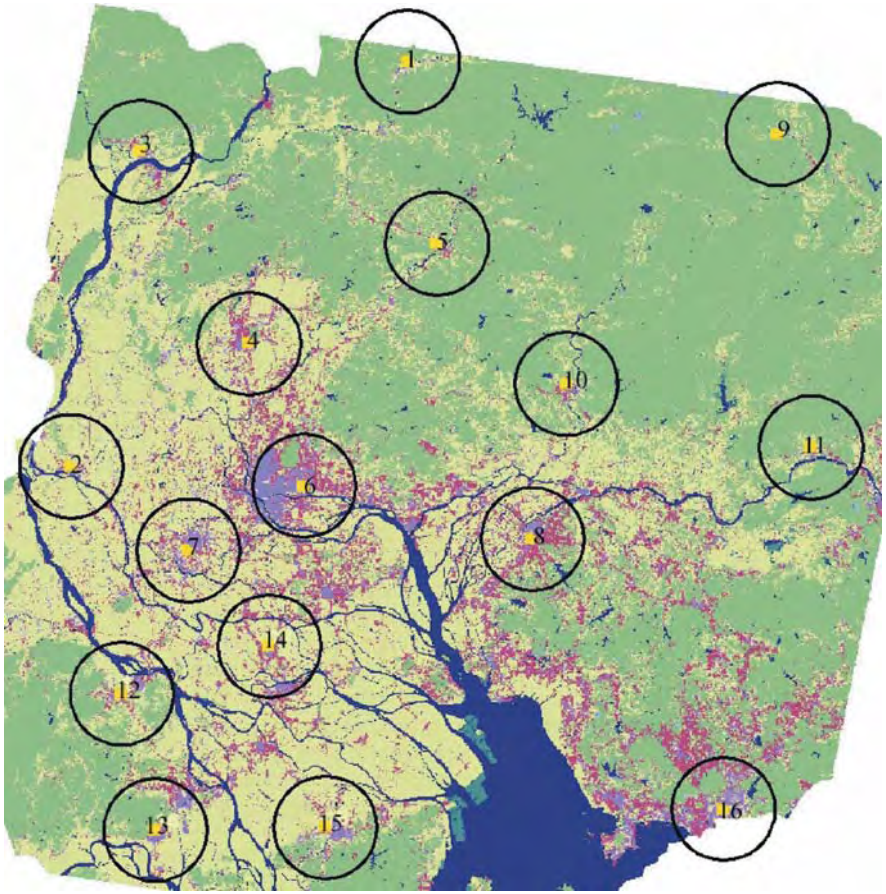
Agricultural Land



Agricultural Land Loss

Source: Seto et al., 2000. *Nature.*

Urbanization and Rainfall



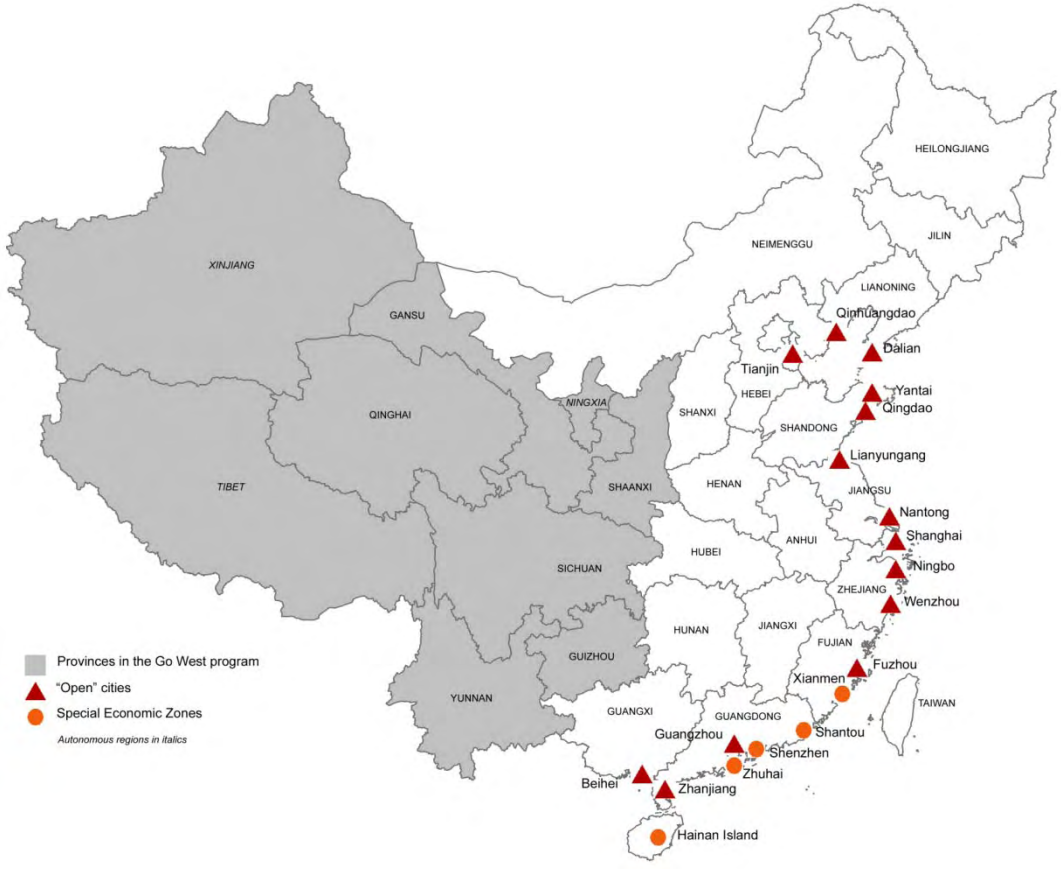
- Changes surface properties
- Slows water transfer from soil to atmosphere
- Reduced winter rainfall

Source: Kaufmann et al., 2007. *Journal of Climate.*

Common Themes

- Rapid urban expansion accompanying rapid economic expansion
- Economic transitions
  - Rural, agricultural → urban, industrial
  - Manufacturing → services
  - Farmland → factories and houses
- Regional economies dependent on international trade
- Path dependency of urban development

Common Theme: Urban growth has been jump-started by national and regional economic policies

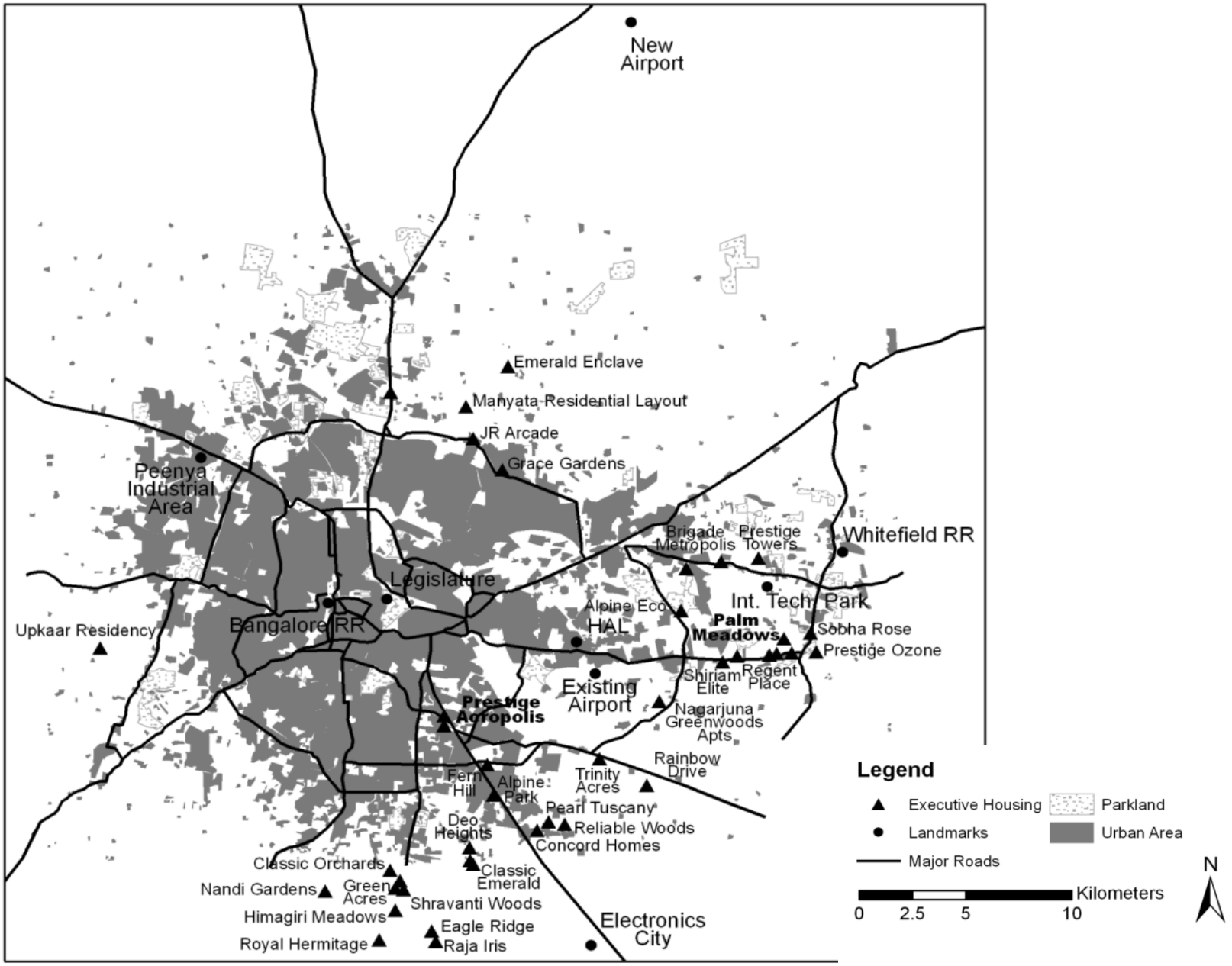


Qatar Reforms

Common Theme: Economic development policies subsidize research parks and industrial zones on the urban periphery

MPO3

Common Theme: FDI encourages atomized growth



Common Theme: Climate Change Risks

- Development near sea level, in flood plains, deltas
- Declining water quality
- Water shortages
- Heat and cold waves, health risks
- Infrastructure weak or lagging behind
- Urban land use and urban growth induced climate change

TABLE 1
Population and land area in the Low Elevation Coastal Zone (LECZ) by region, 2000

	Population and land area in LECZ				Share of population and land area in LECZ			
	Population (million)		Land ('000 km²)		Population (%)		Land (%)	
Region	Total	Urban	Total	Urban	Total	Urban	Total	Urban
Africa	56	31	191	15	7	12	1	7
Asia	466	238	881	113	13	18	3	12
Europe	50	40	490	56	7	8	2	7
Latin America	29	23	397	33	6	7	2	7
Australia and New Zealand	3	3	131	6	13	13	2	13
North America	24	21	553	52	8	8	3	6
Small Island States	6	4	58	5	13	13	16	13
World	**634**	**360**	**2,700**	**279**	**10**	**13**	**2**	**8**

Source: McGranahan et al., 2007. *Environment and Urbanization.*

Links Between Urban Land Use/Change and Regional Climate

Impact of urbanization and land-use change on climate

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impact of land-use changes on surface warming. Our results suggest that half of the observed decrease in diurnal temperature range is due to urban and other land-use changes. Moreover, our

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Interepochal Changes in Summer Precipitation in the Southeastern United States: Evidence of Possible Urban Effects near Atlanta, Georgia

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(Manuscript received 14 June 2004, in final form 9 September 2004)

ABSTRACT

Through modification of the planetary boundary layer, urbanization has the potential to have a significant impact on precipitation totals locally. Using daily summer-season precipitation data at 30 stations from 1953 to 2002, this study explores the possibility of urban effects as causes of spatial anomalies in precipitation in a zone within 180 km of Atlanta, Georgia. The time period is divided into consecutive epochs (e.g., 1953–77 and 1978–2002), and interepochal differences in precipitation totals, heavy-precipitation days, cumulative heavy precipitation, and atmospheric conditions are explored. The southern stations experienced significant decreases in precipitation, whereas significant precipitation increases occurred at central/west-central sta-

Evidence of urban-induced precipitation variability in arid climate regimes

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Received 17 May 2005; received in revised form 25 January 2006; accepted 9 March 2006
Available online 24 May 2006

Abstract

The study employs a 108-year precipitation historical data record, global climate observing network observations and satellite data to identify possible anomalies in rainfall in and around two major arid urban areas, Phoenix, Arizona and Riyadh, Saudi Arabia. The analysis reveals that during the monsoon season, locations in northeastern suburbs and exurbs of the Phoenix metropolitan area have experienced statistically significant increases in mean precipitation of 12–14% from a pre-urban (1895–1949) to post-urban (1950–2003) period. Further analysis of satellite-based rainfall rates suggests the existence of the anomaly region (AR) over a 7-year period.

Evidence for a significant urbanization effect on climate in China

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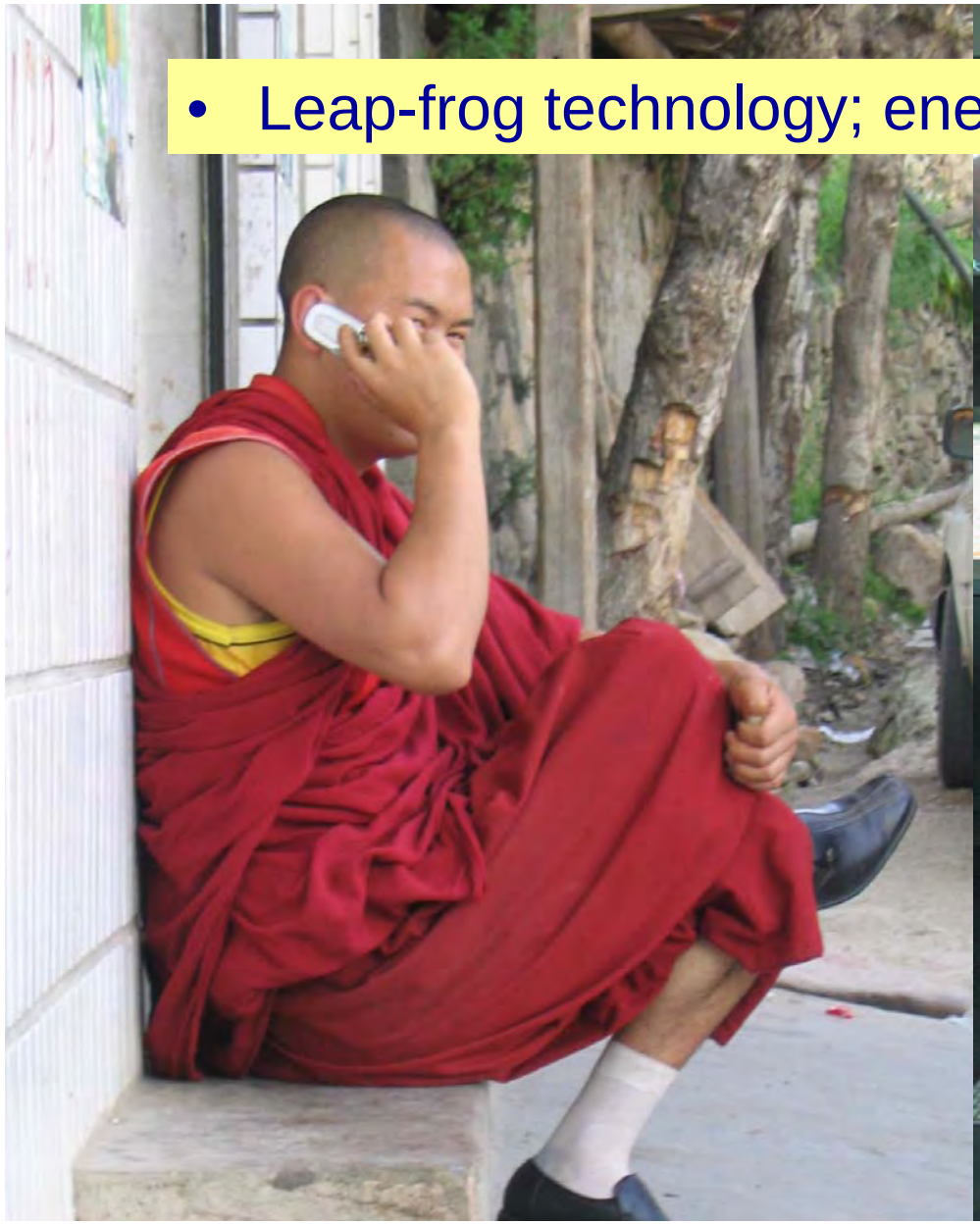
Edited by James E. Hansen, Goddard Institute for Space Studies, New York, NY, and approved April 28, 2004 (received for review January 15, 20

China has experienced rapid urbanization and dramatic economic growth since its reform process started in late 1978. In this article, we present evidence for a significant urbanization effect on climate based on analysis of impacts of land-use changes on surface temperature in southeast China, where rapid urbanization has occurred. Our estimated warming of mean surface temperature of 0.05°C per decade attributable to urbanization is much larger than previous estimates for other periods and locations. The spatial pattern and magnitude of our estimate are consistent with those of urbanization characterized by changes in the percentage of urban population and in satellite-measured greenness.

substituted recently (8, 9). *In situ* observations s
inhomogeneities caused by "nonclimatic" factor
changes in observation time, instrumentation, locatic
and latitude), and nonstandard siting (referred to as
effects hereafter) (9). These factors could introduce
long-term observations and rural–urban difference
may bias the estimate of UHI. For example, Peterso
no significant impact of UHI in the U.S. after th
temperature time series were adjusted for such inhom
The lack of an UHI effect may be caused by
local-scale impacts overwhelming the mesoscale UHI

Opportunities for sustainability

- Leap-frog technology; energy efficiency



Opportunities for sustainability

Opportunities for sustainability

- Increased public transportation

Opportunities for sustainability

Challenges for sustainability

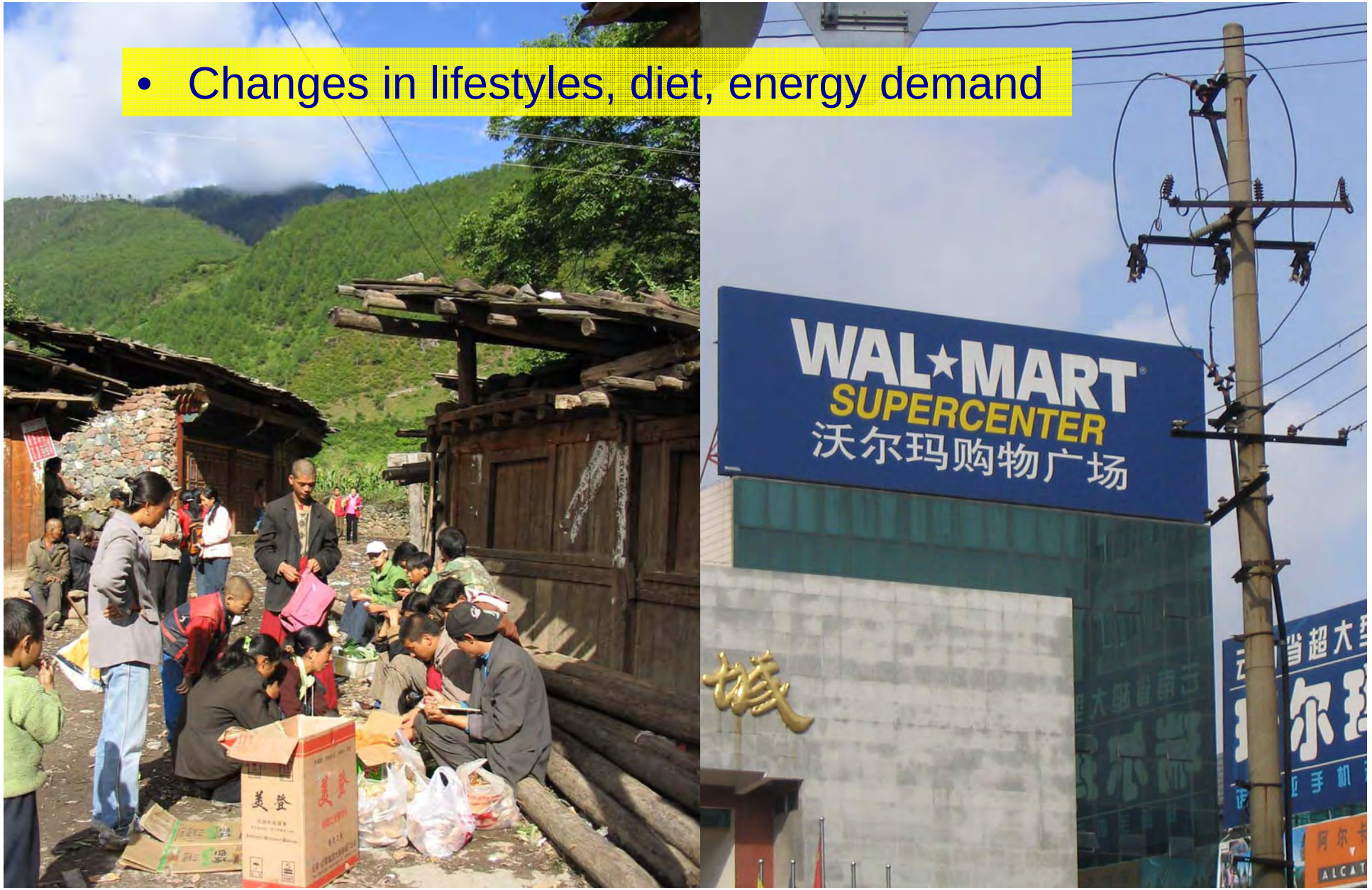
Challenges for sustainability

- Private vehicles and road-driven development

Challenges for sustainability

Challenges for sustainability

- Changes in lifestyles, diet, energy demand



Challenges for sustainability

- Urban land-use and growth impacts on regional climate

Grand Challenges: Urbanization and Global Environmental Change

- Where and how will Asia's 2.5-3 billion new urban residents live?
- What are the consequences of combined urban heat island and pollution effects, and rapidly expanding urban areas on regional and global climate?
- How will Asian cities adapt to and mitigate against the effects of climate change?

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