THE AUSTRALIAN NATIONAL UNIVERSITY

Landscape Urbanization and Food Security

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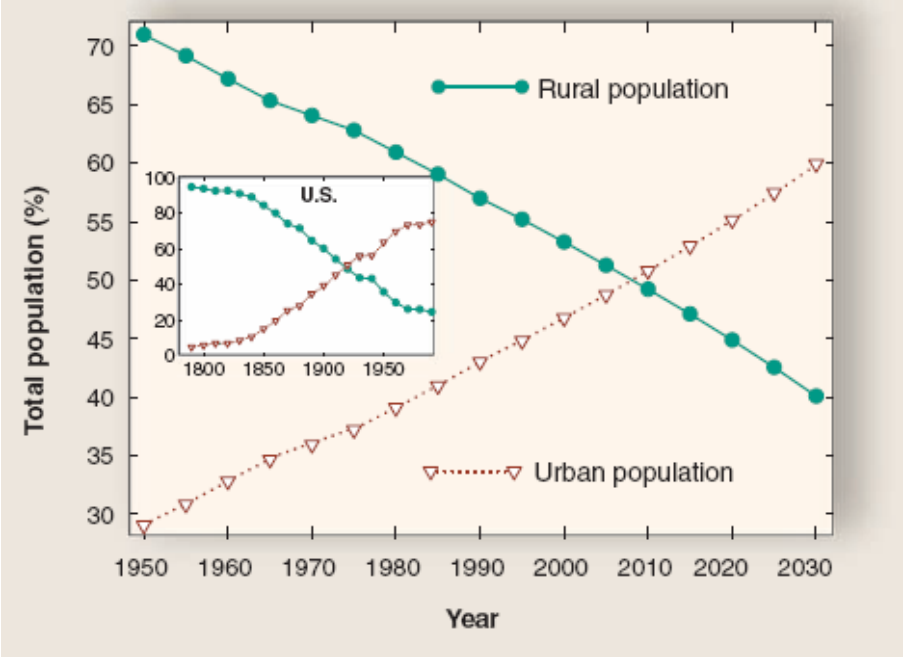
This Talk

- Urbanization
- Urbanization impacts on agriculture
  - Direct impacts on agricultural land
  - Indirect impacts on agriculture
- Urban-rural dichotomy or integrated research and policy?

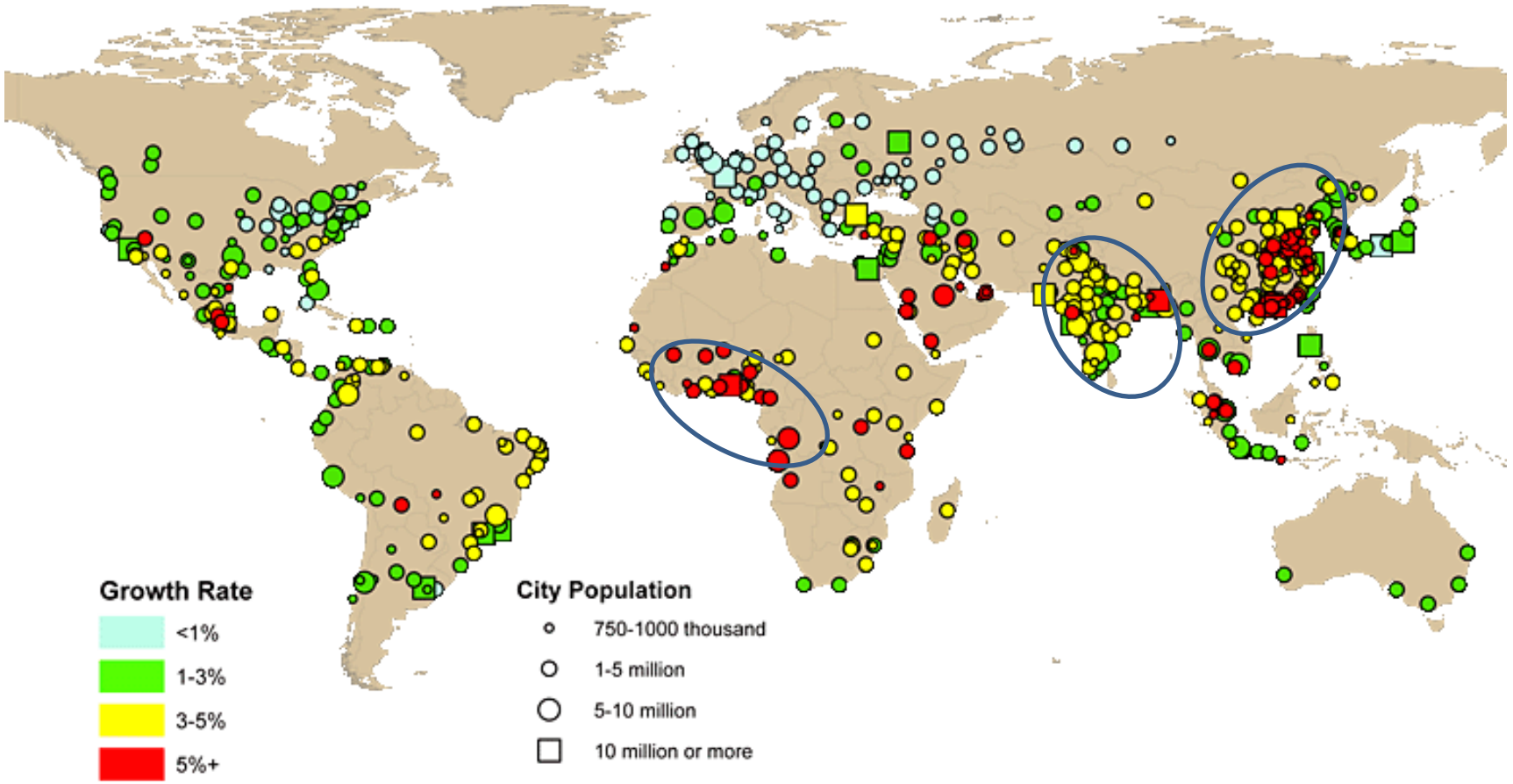
Background

- More than half the Earth's population are urban dwellers
- UN projections show an increase in urban population of 1.35 billion by 2030
- All population growth between now and 2050 – about 3 billion – will translate into additional urban growth.
- "Battle for sustainability to be won or lost in cities"



Urban vs rural population
(Source: Grimm et al 2008)

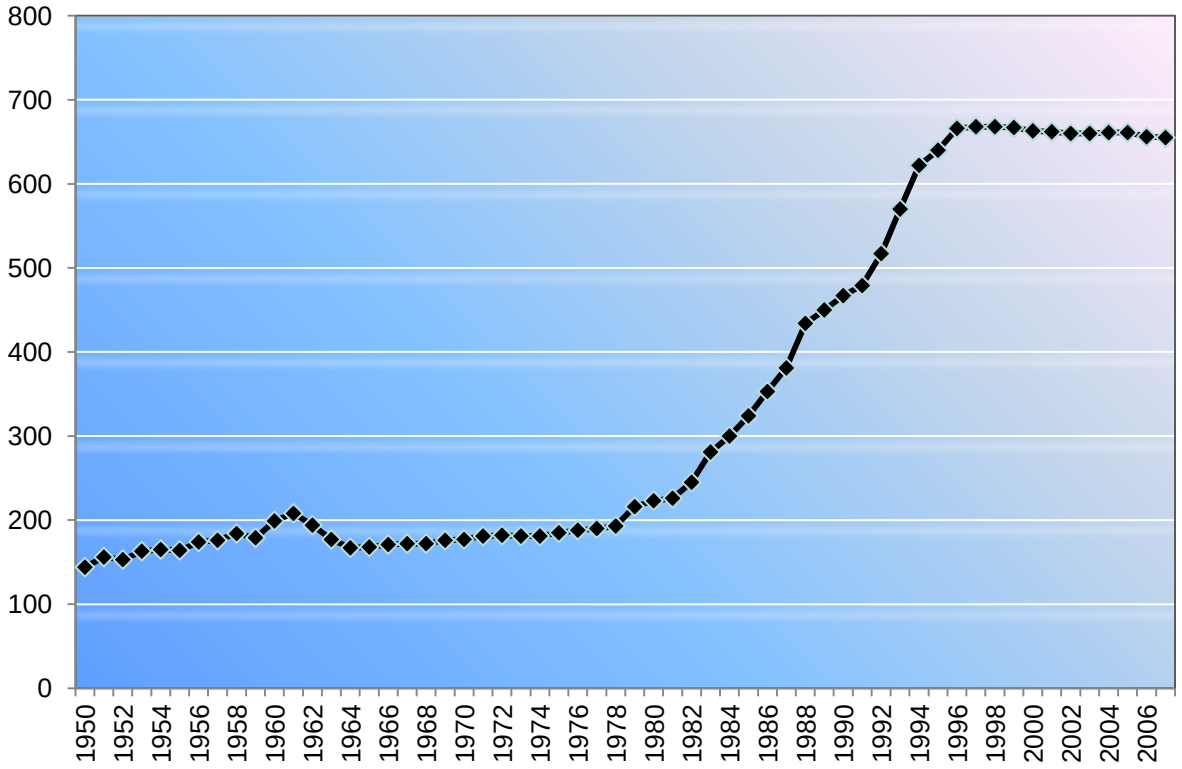
Growth Rates of Urban Agglomerations, 1970-2011.



Map 5: Growth rates of urban agglomerations, 1970-2011. These maps indicate that the annual growth rates of urban agglomerations in the past (1970-2011 period) were higher than the growth rates that are projected for the future (2011 to 2025 period). The growth of urban agglomerations will slow down, as many of them have already reached a population of 1 million or more or have become mega-cities with 10 or more million inhabitants.

(Source: United Nations, Department of Economic and Social Affairs, Population Division: World Urbanization Prospects, the 2011 Revision. New York 2012)

The Number of Cities in China



Data for 1949–1998 from Urban Social Economic Survey Team (1999); data for 1999–2004 from National Bureau of Statistics of China (2001b, 2002b, 2003, 2004 and 2005b

(Source: Bai 2008).

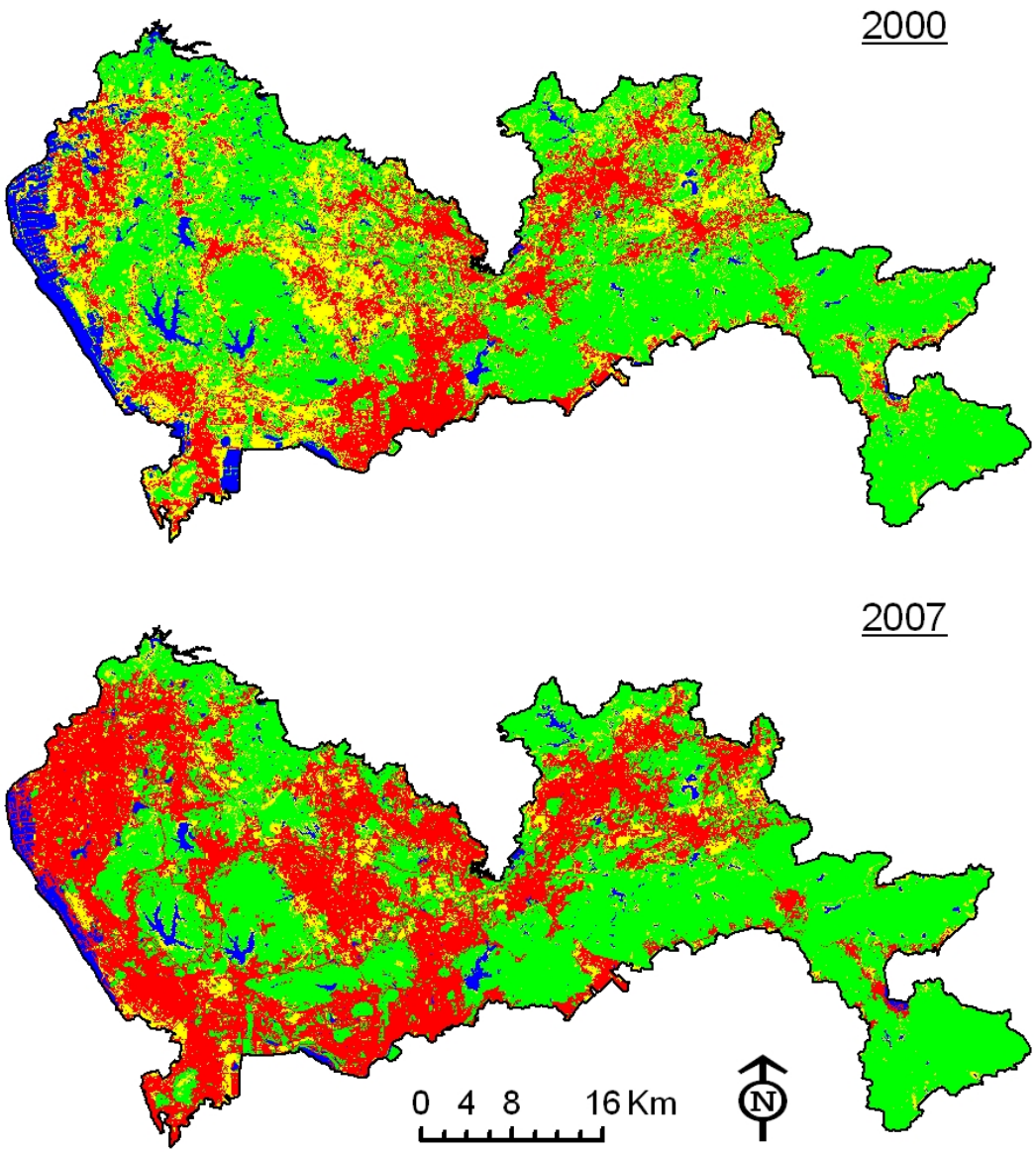
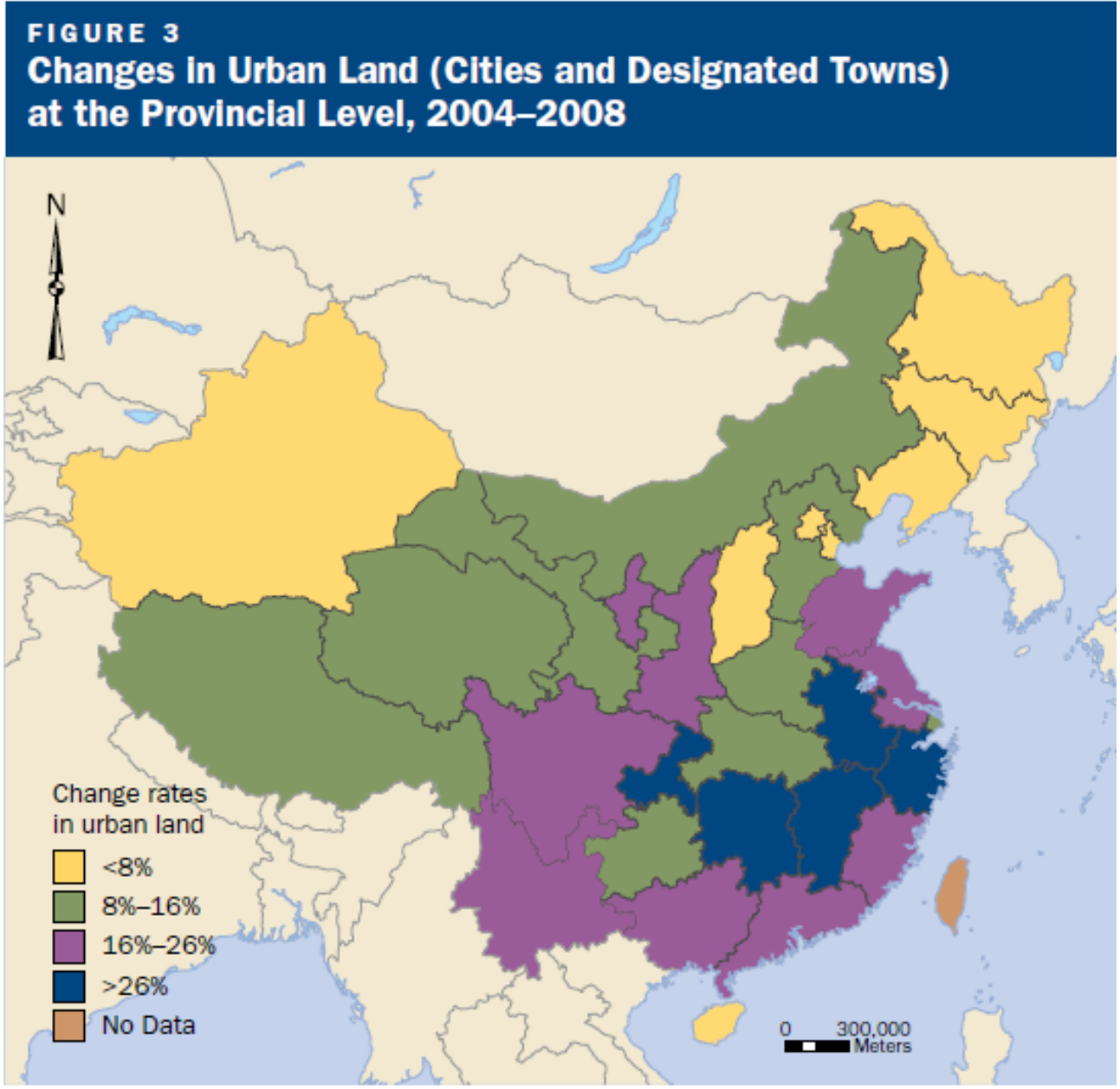


Figure 3 Rapid urban expansion of Shenzhen City from 2000 to 2007 based on remote sensing image interpretation. Red color for urban land, yellow for bare land, green for land with vegetation, blue for water body.

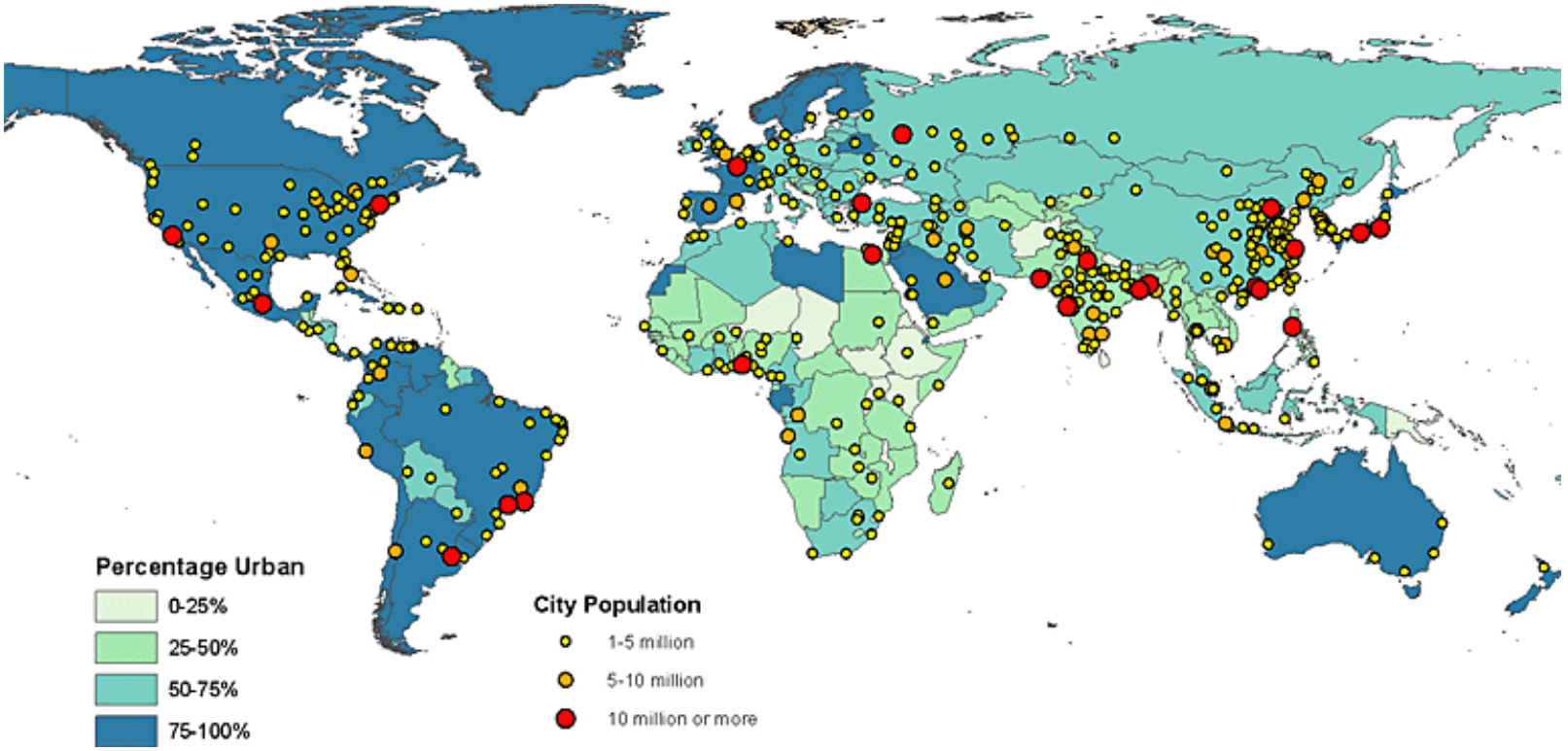
ETM+ image on Nov. 1st 2000, TM image on Sep. 15th 2000, ETM+ SLC-off composite data on Dec. 7th and Nov. 30th 2007 are used for this comparison.

(Bai et al, 2012)



Source: Ministry of Land and Resources (2008), via He et al, Land Lines, 2012.

Currently about 1% of earth surface is urban. Some forecast suggest this could be tripled by 2030.



(Source: United Nations, Department of Economic and Social Affairs, Population Division: World Urbanization Prospects, the 2011 Revision. New York 2012)

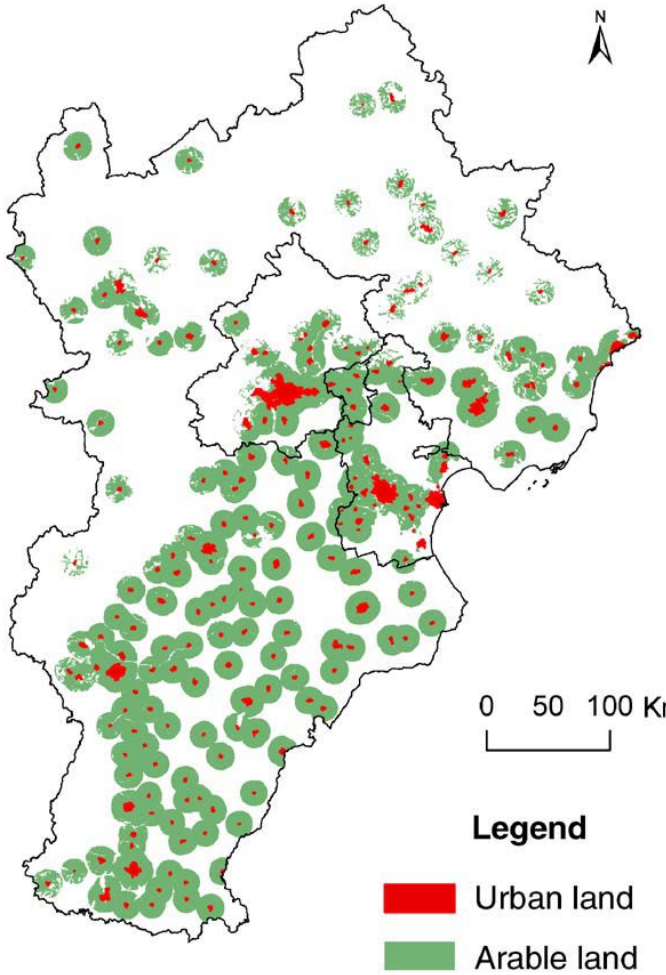
Implications for Agriculture

- While the absolute amount doesn't seem significant, urbanization has significant implications in terms of:
  - Direct impact on the amount of arable land
  - Strong, fundamental drivers
  - Indirect impacts on productivity and rural community
  - Changed quantity and structural mix of demand for food
  - Stronger pressure on food production concentrated to some vulnerable regions such as China and India

Disproportionate Impact on Arable Land

- In China, up to 80% of all agricultural land loss over the last decade was converted into urban landuse.
- Between 1997 and 2006, more than 12,000sqkm of land was converted into urban built up area.

(Bai et al 2012)



Urban landuse is often surrounded by arable land. Beijing-Tianjin-Tangshan area, China (shown in 10km radius in the figure). (Source: Tan et al 2005)

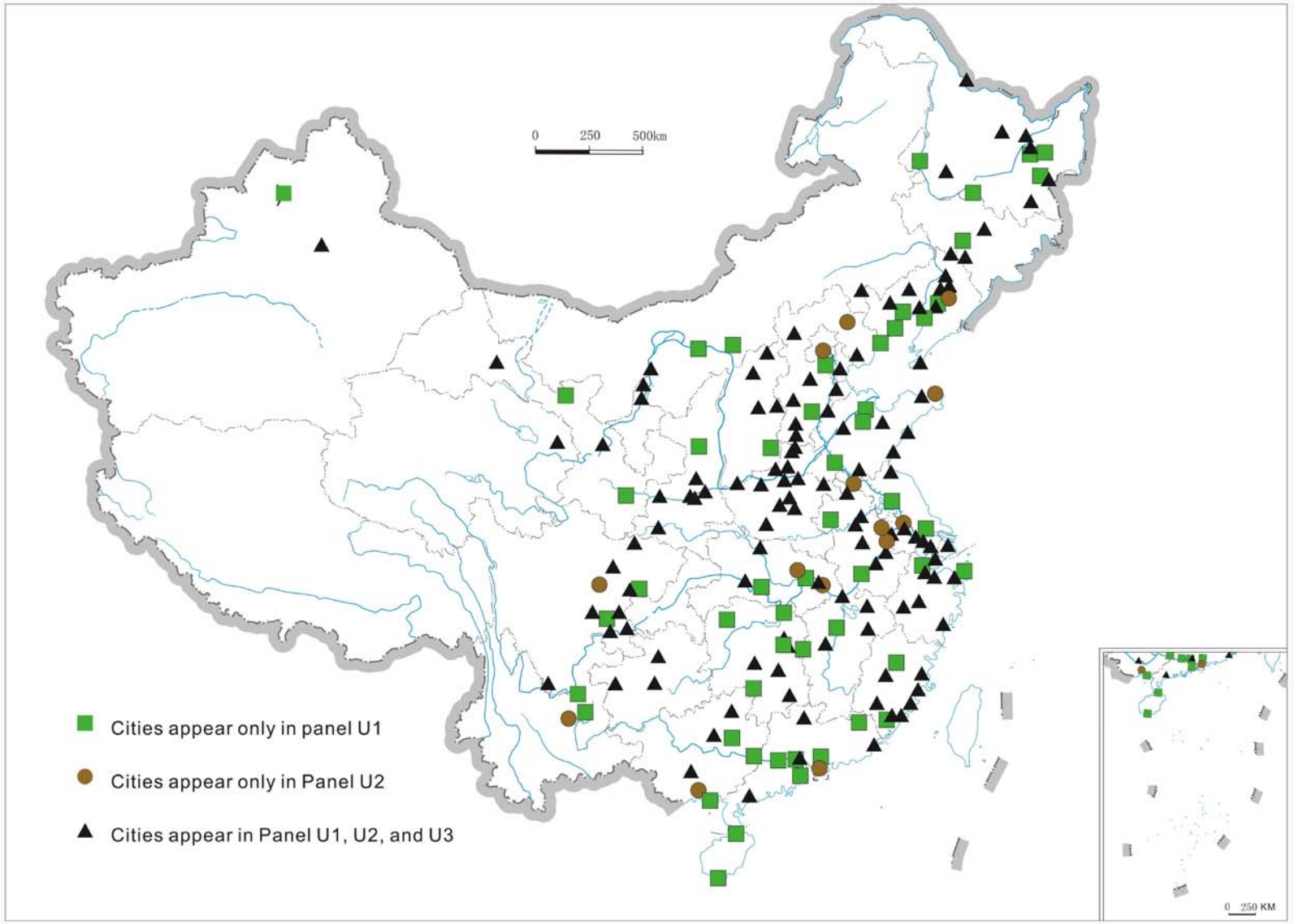


Figure 2 Spatial distribution of Chinese cities included in analysis.
Panel U1 (1990-1998) consists of 174 cities.
Panel U2 (1997-2006) consists of 135 cities.
Panel U3 (1990-2006) consists of 121 cities that appear in both U1 and U2 panel.
(Source: Bai et al, forthcoming)

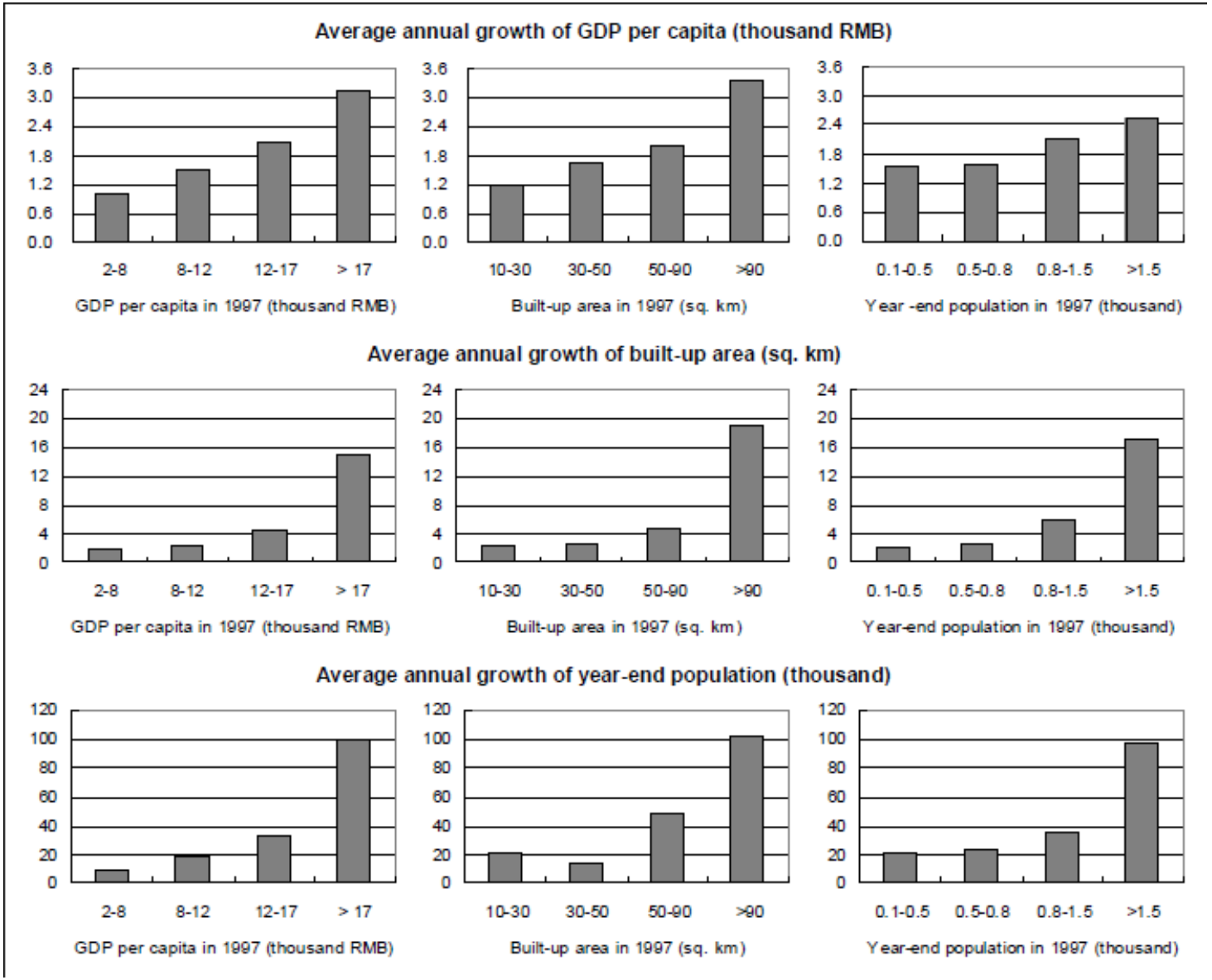


Figure 4 Average annual growth of GDP per capita, built-up area, and population of 135 Chinese cities during 1997-2006.
(Source: Bai et al, Environmental Science &Technology, 2012)

Positive Feedback Between Landscape Urbanization and Economic Growth

- 1)Larger cities tend to gain more income and richer cities tends to expand more

- 2) There is a long-term bi-directional causality between urban built-up area expansion and GDP per capita at both city and provincial level, and a short-term bi-directional causality at provincial level.

- 3) A positive feedback between landscape urbanization and urban and regional economic growth in China.

(Bai et al, ES&T, 2012)

Policy Implications

1) Urbanization, if measured by a landscape indicator, does have causal effect on economic growth in China, both within the city and with spillover effect to the region.
2) Urban land expansion is not only the consequences of economic growth in cities, but also drivers of such growth.
3) Under its current economic growth model, it might be difficult for China to control urban expansion without sacrificing economic growth.
4) China's policy to stop the loss of agricultural land, for food security, might be challenged by its policy to promote economic growth through urbanization.

(Bai et al, ES&T, 2012)

Indirect impacts on productivity and rural community

- Landuse changes associated with urbanization in developing countries can increase social vulnerability in the traditional farming communities in the peri-urban areas. (Huang et al, 2012)
- But in other areas, where the locals can seize the opportunity, tremendous increase in social/economic capital in peri-urban areas. (CCICED, 2012)
- Productivity change associated with urbanization (Bai et al ongoing research)

Global Impacts of Cities

- Although urban population growth over the past century occurred on less than 3% of the Earth's surface, the impact has been global, with
  - 78% of carbon emissions
  - 60% of residential water use
  - 76% of wood used for industrial purposes attributed to cities.

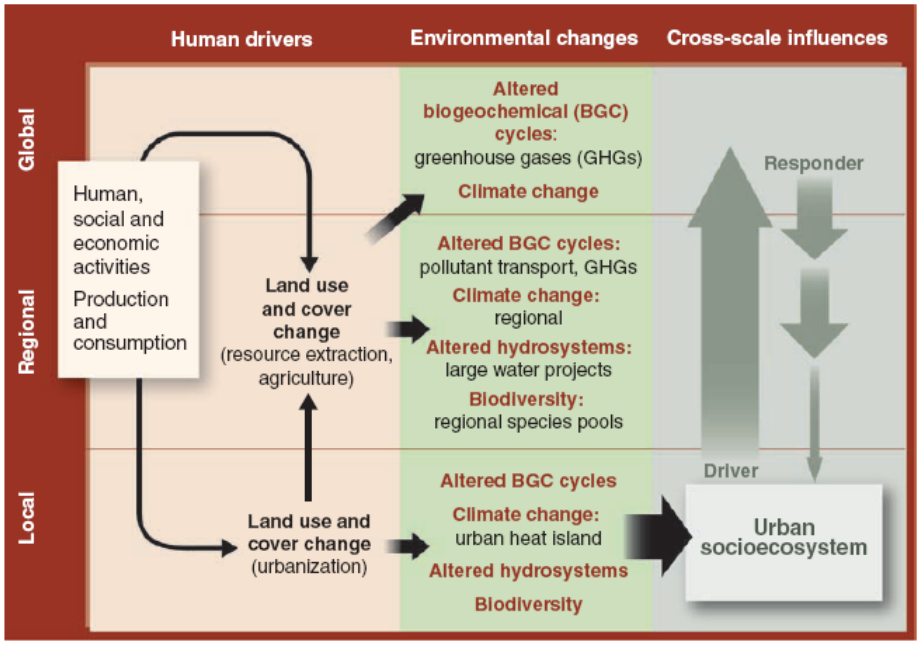


Fig. 2. Framework showing urban socioecosystem (lower right) as a driver of (upward arrows) and responder to (downward and horizontal arrows) environmental change. Land change to build cities and support their populations drives local to global alterations of biogeochemical cycles, climate, hydrosystems, and biodiversity. Large local environmental changes are greater than those that filter down from global environmental change (horizontal black arrow). Not all possible interactions and drivers are shown.

(Source: Grimm et al, Science, 2008)

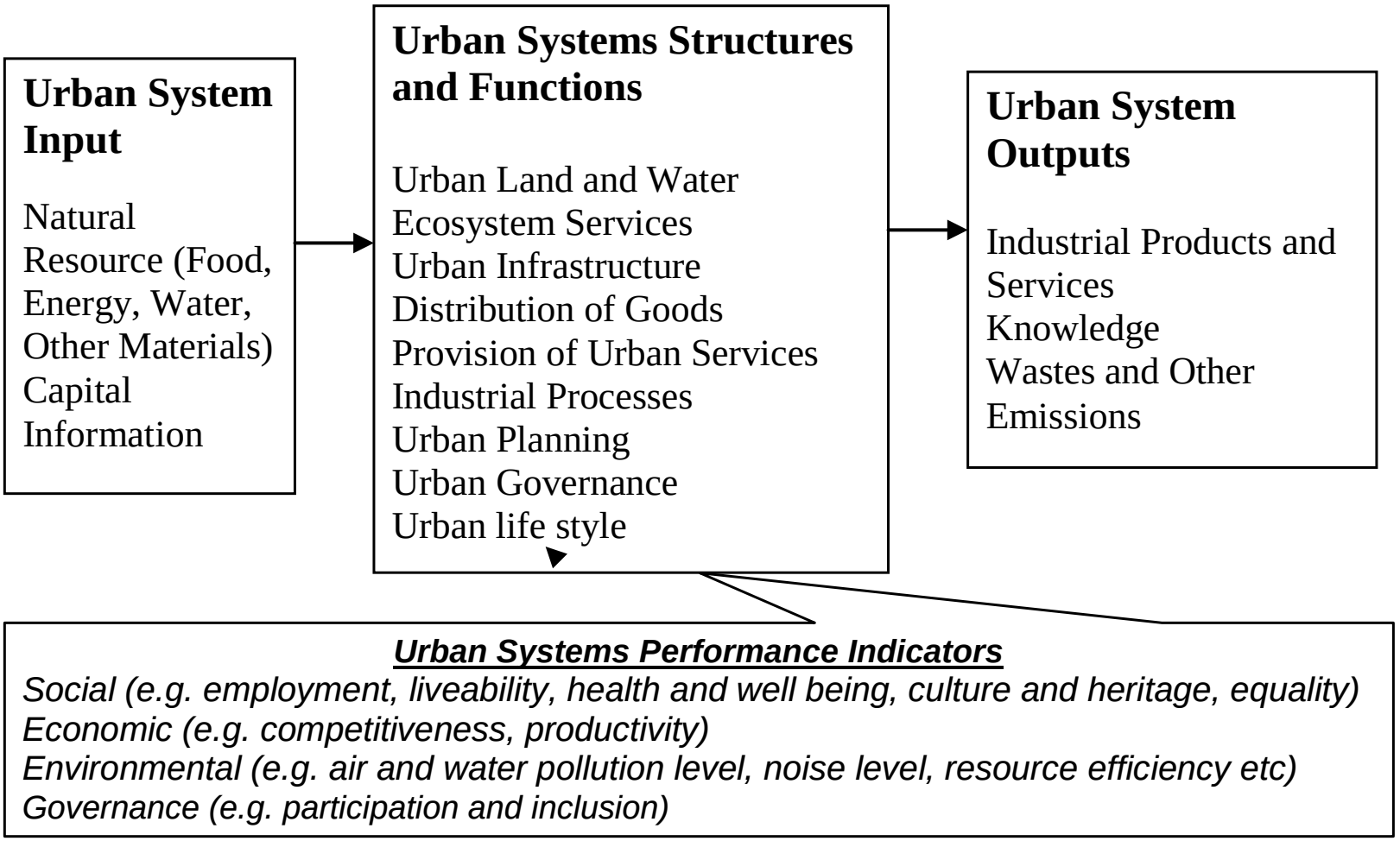


Fig. 2 Integrated urban metabolism and urban system performance indicators (Source: Bai and Schandl, 2011. In *Encyclopedia of Urban Ecology*, 2011)

Changing Dietary Structure

"What's growing faster than the Chinese economy?"

"Chinese people's waist line!"

(http://health.lilithezine.com/Obesity-in-China.html)

- More food
- Exploding growth of fast food in cities
- More meat, fish and diary products
- More animal feed

(Source: http://health.lilithezine.com/Obesity-in-China.html)

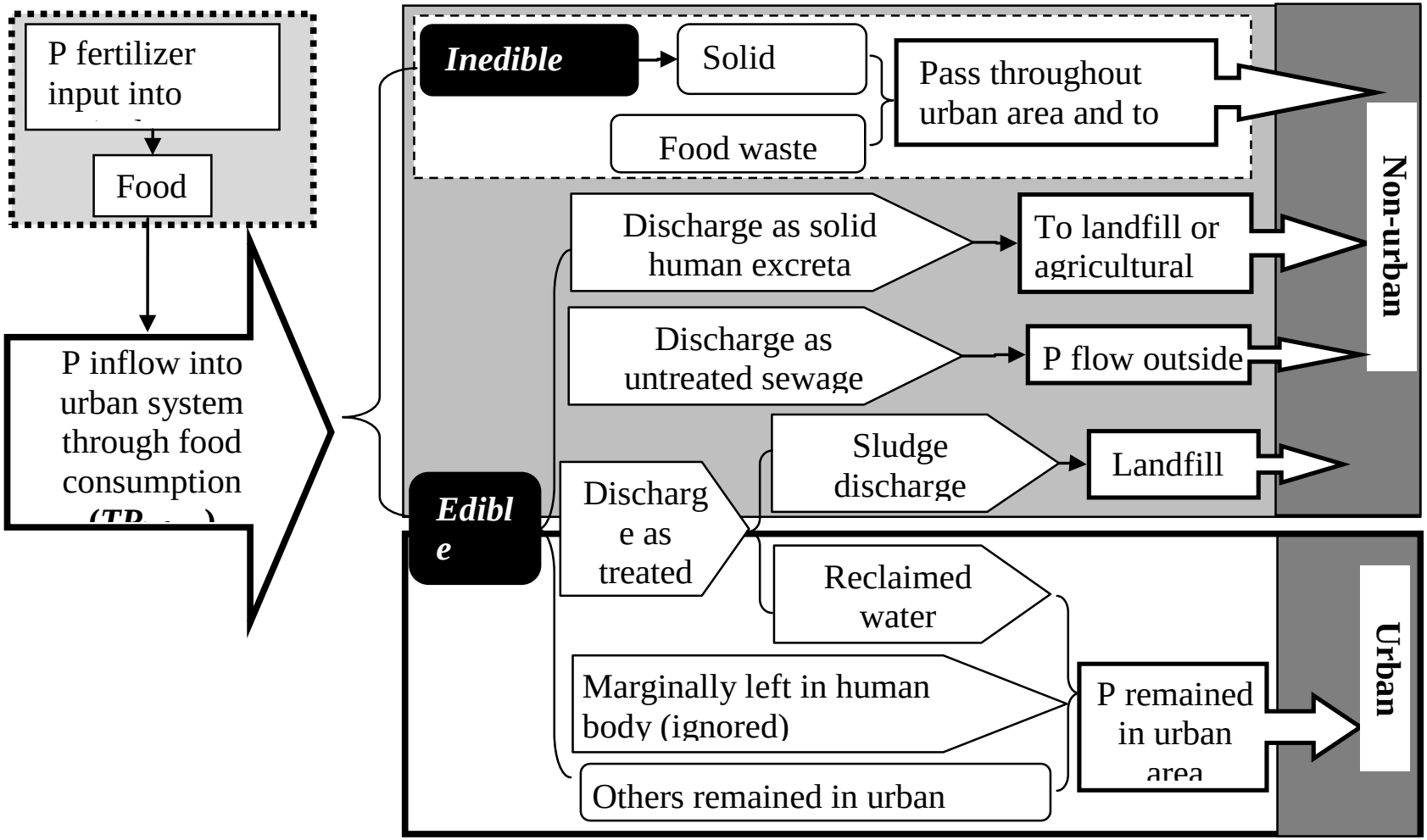
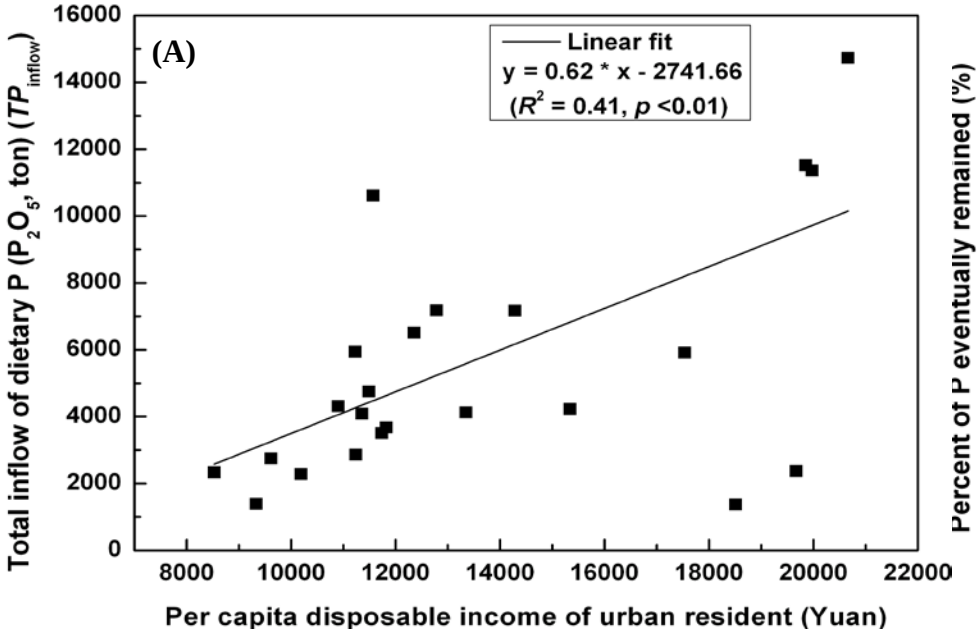
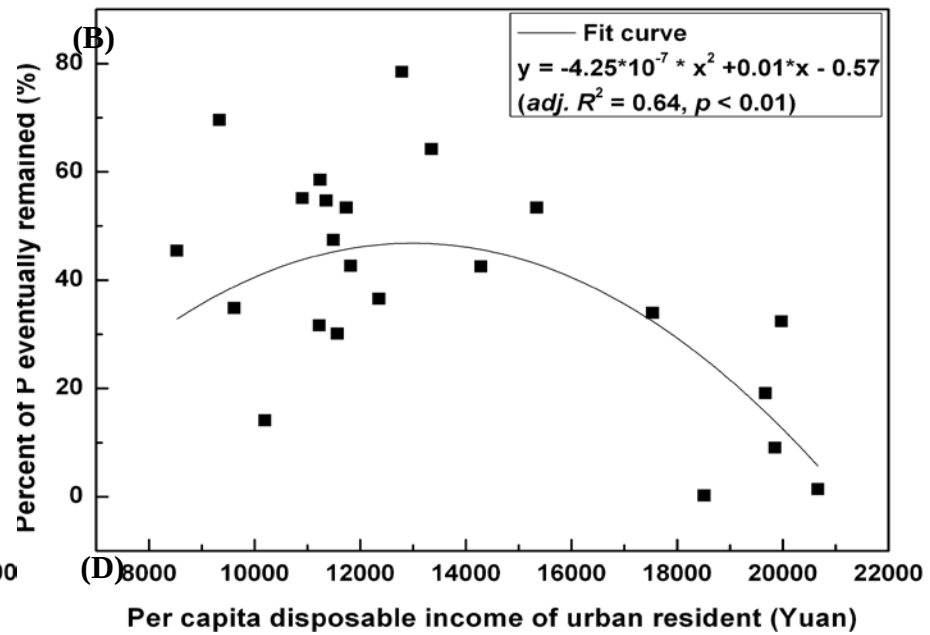


Figure 2 Conceptual model of urban dietary P flow into and out of urban system and mass balance calculation.

(Source: Li et al, *Journal of Industrial Ecology*, *2012*)





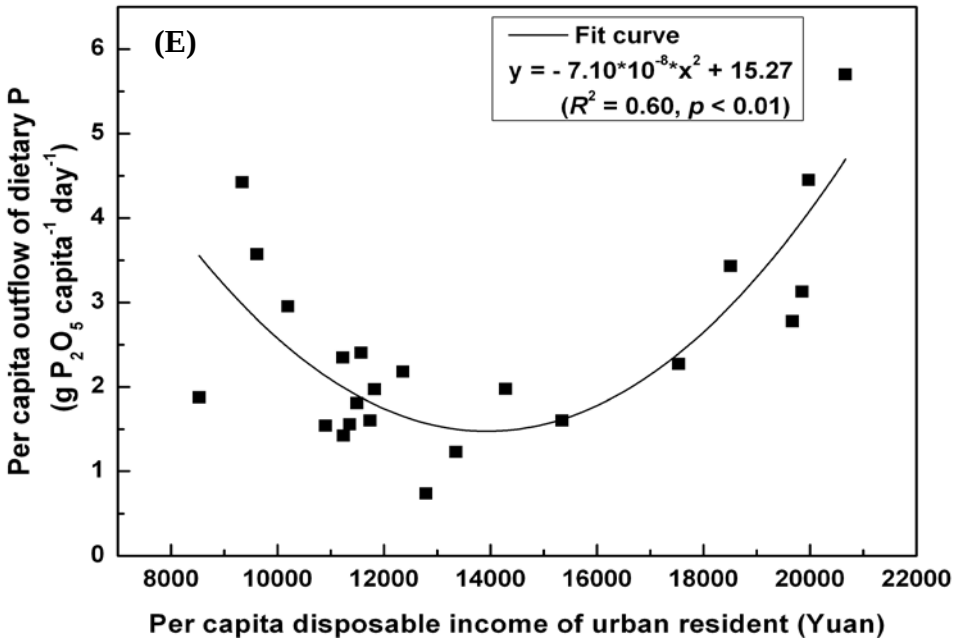


Figure 6 Relationship between per capita disposable income of urban residents and indicators related to dietary P flow in provincial capital cities of China (data for the year 2006).

(Source: Li et al, *Journal of Industrial Ecology*, *2012*)

Urban-Agriculture Linkages

- What happens in agriculture might largely be driven and determined by what happens in cities.
- Simply blaming cities for food security, wouldn't work or help.
- Urban issues are largely ignored in sustainable food production research and policy making. And vice versa.

Towards an Integrated Approach

- How to harness and maximize the positive effect bringing about by urbanization, and avoid/compensate for the negative impact?
- An integrated approach, rather than a dichotomized one, in urban development and food production debate, research, and policy making is essential.

Thank You!

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