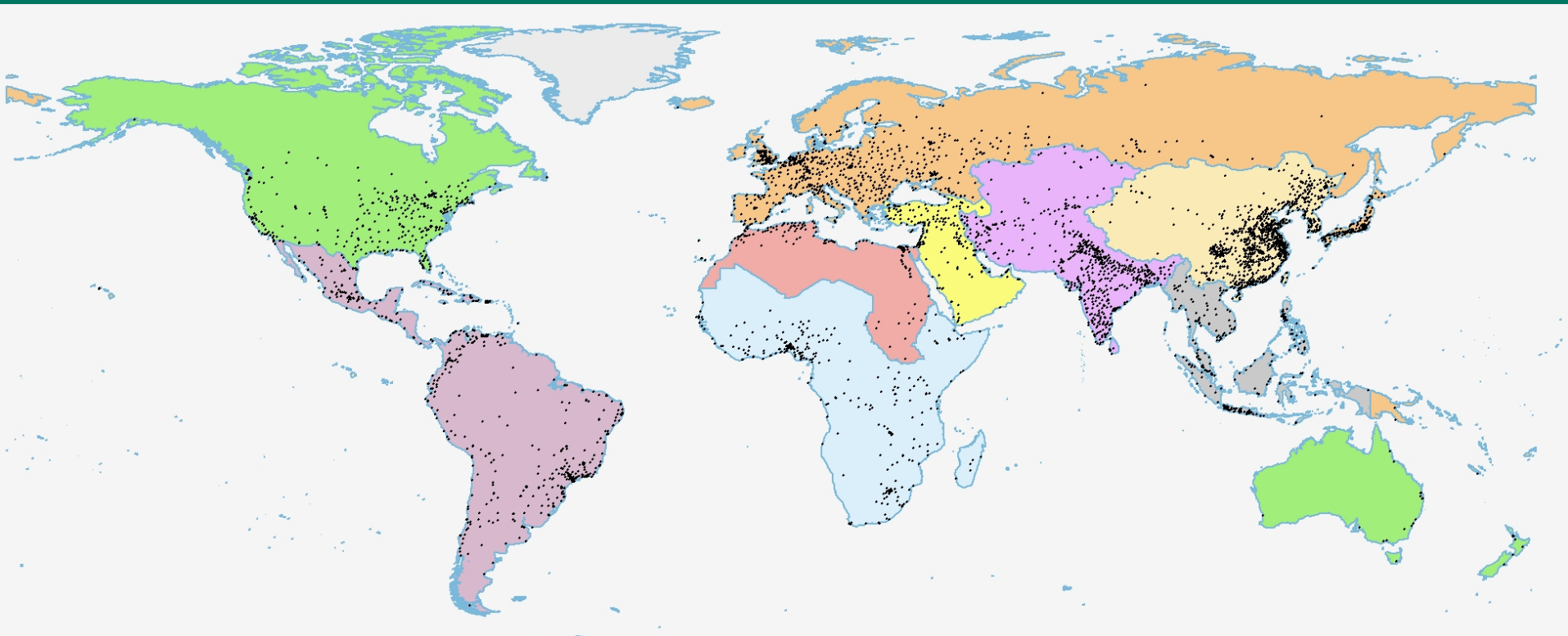


PLANET OF CITIES

The Universe of 4,000 Cities as an Object of Study



Dr. Shlomo Angel, Santa Fe Institute, 12 July 2012

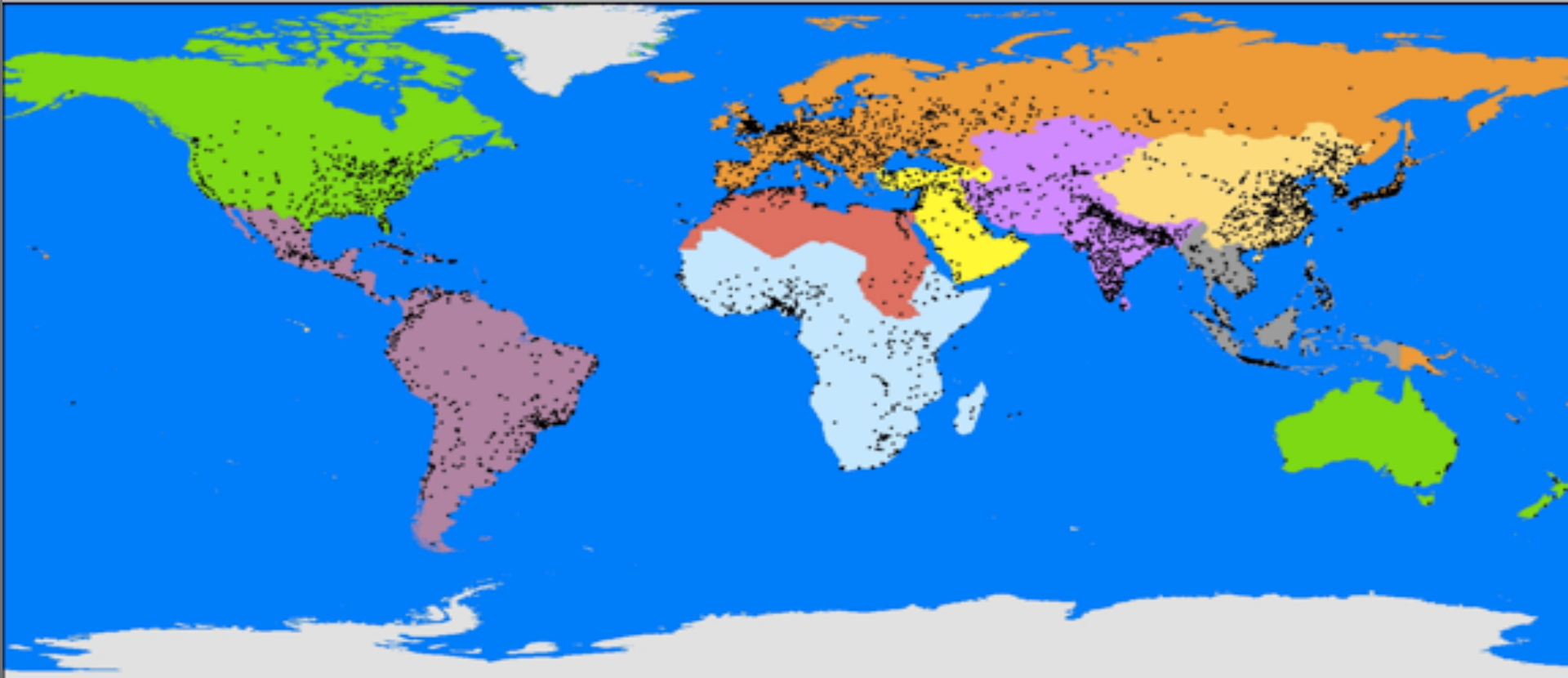
Acknowledgments

The empirical work for this study was done with the active participation of Jason Parent, Daniel L. Civco, and Alejandro M. Blei. Work in earlier phases of the research was done with Stephen Shepherd, Anna Chabaeva, Micah Perlin, Lucy Gitlin, and Alison Crawley, as well as with local consultants in 120 cities. Craig Cook and Mark Roland assisted with the graphics.

Research Support was provided by the World Bank, the National Science Foundation, NASA, and the Lincoln Institute of Land Policy.

Special thanks to Gregory Ingram, President of the Lincoln Institute of Land Policy for his generous support and invaluable suggestions along the way and to Lucy Gitlin, my life partner, for her companionship and support.

Much of this material will be published in *Planet of Cities* in the fall of 2012, together with its companion volume, the *Atlas of Urban Expansion*.

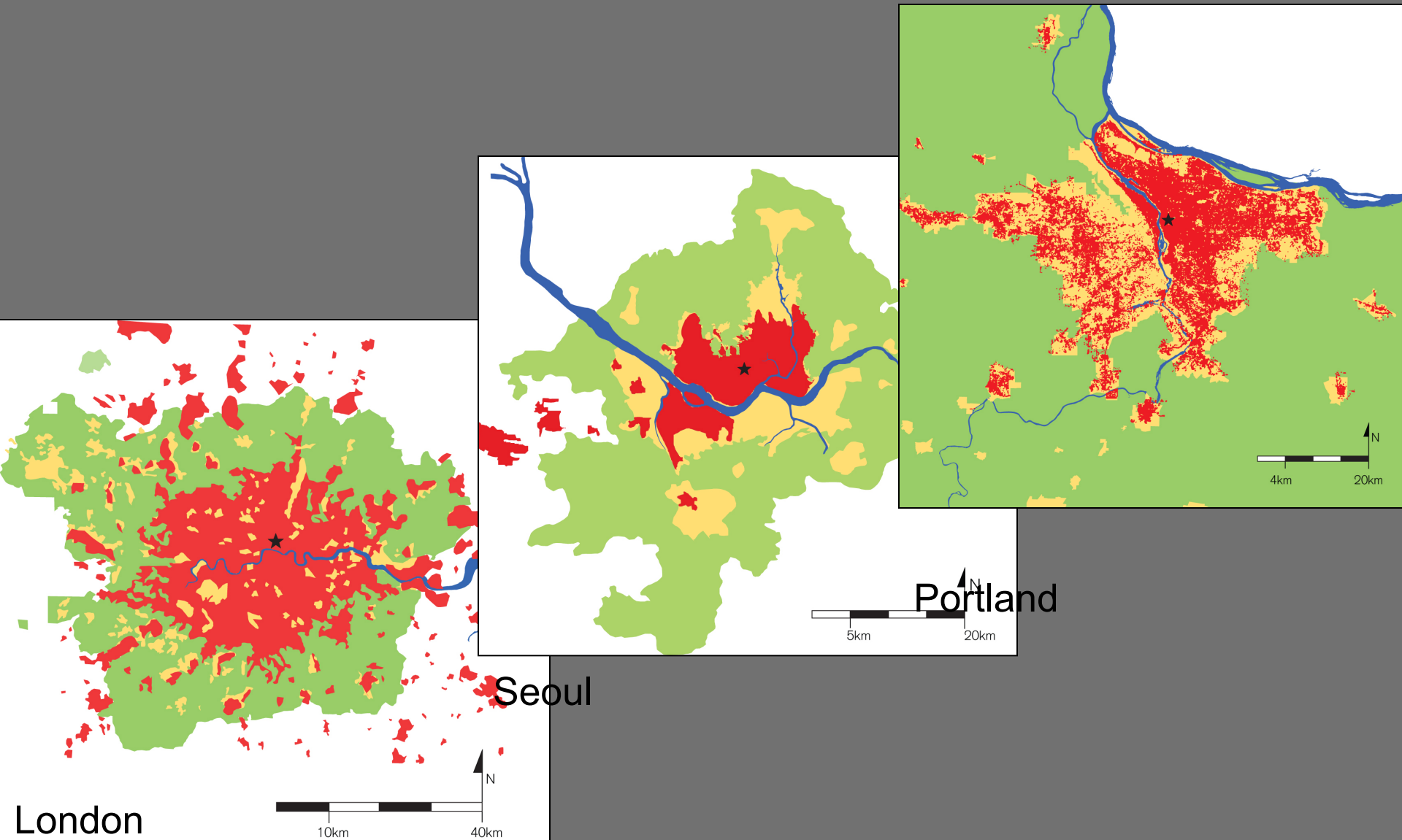


There are some four thousand cities on the planet today with populations of one hundred thousand people or more. Every one of these cities is different. Every one of these cities is unique and one of a kind...

Outline

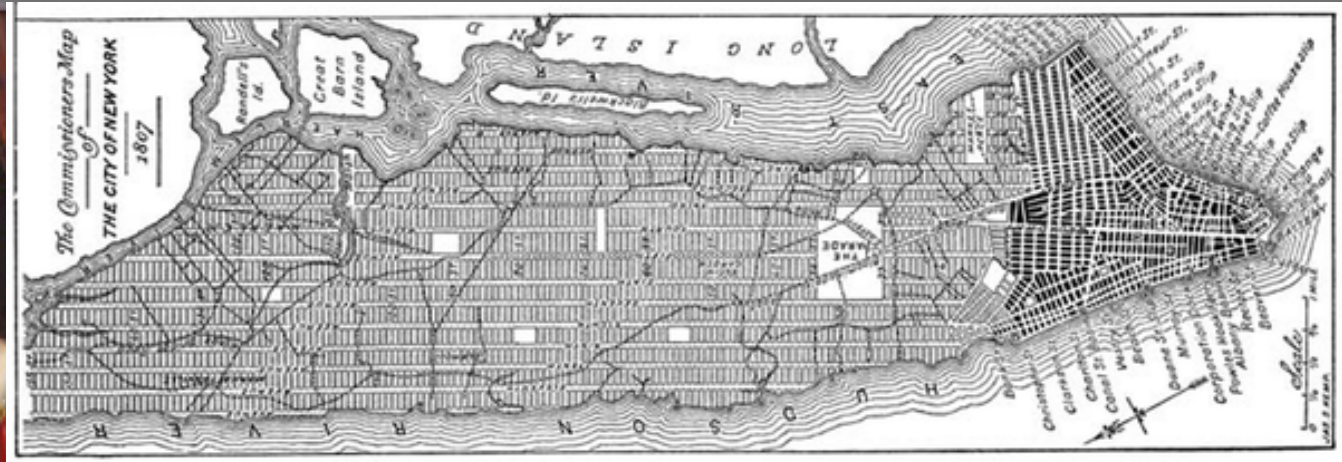
1. Coming to Terms with Global Urban Expansion
2. Sources of Data
3. Urbanization in Historical Perspective
4. The Geography of World Urbanization
5. The Global Hierarchy of Cities
6. Seven Questions Regarding Urban Expansion
7. The Making Room Paradigm

Coming to Terms with Global Urban Expansion



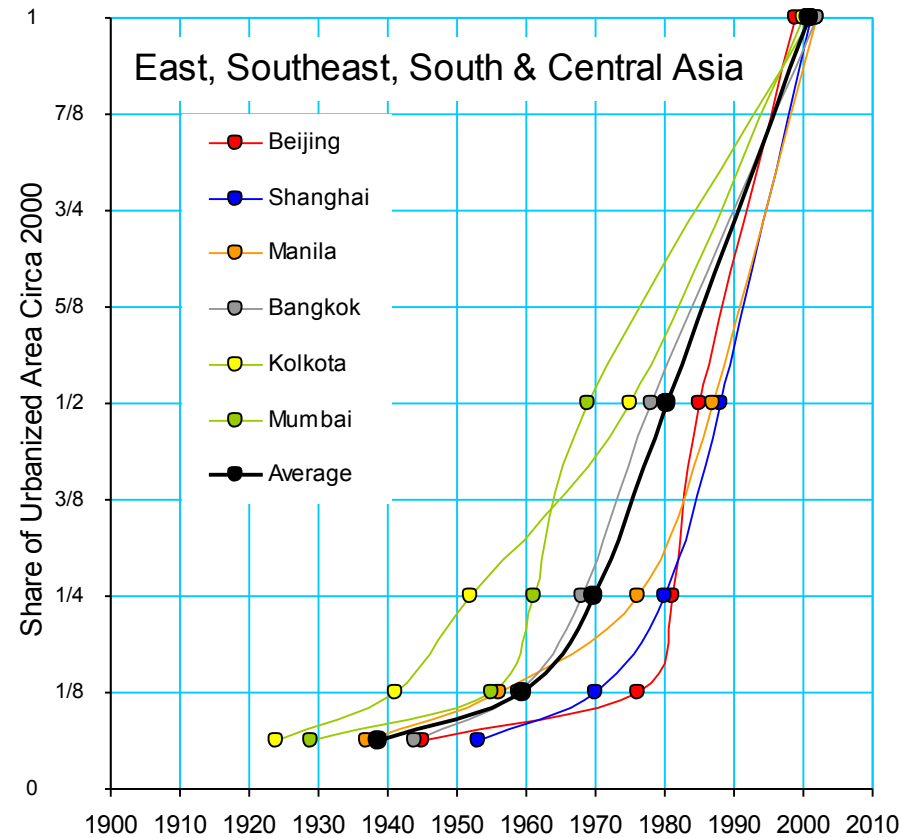
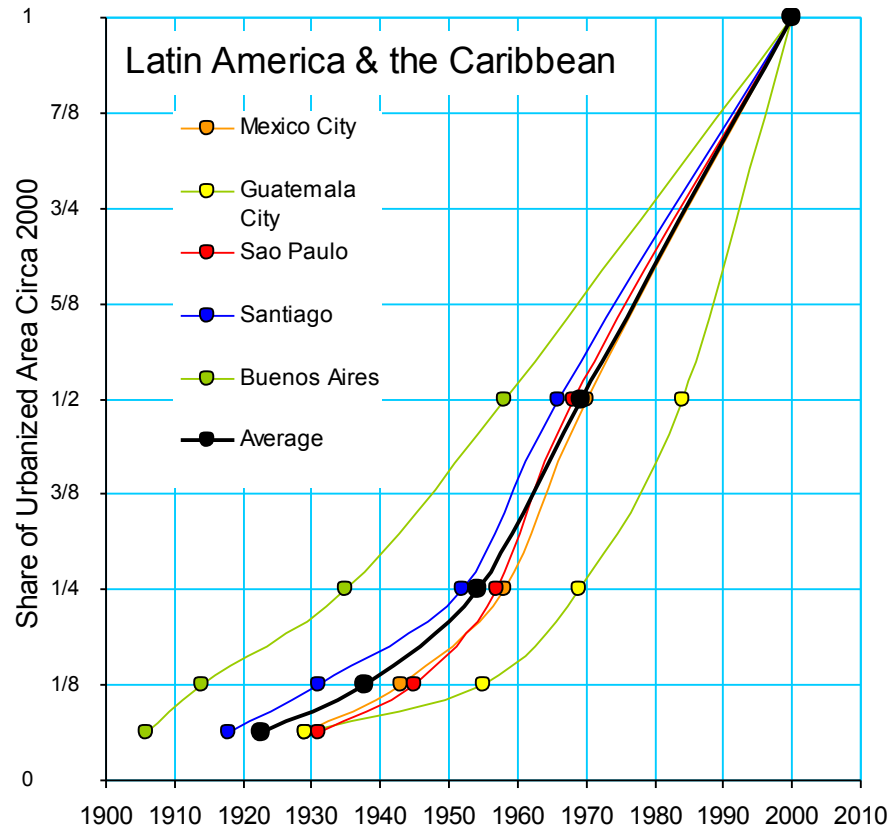
The Greenbelts of London (1973), Seoul (1972), and Portland (1979)

Coming to Terms with Global Urban Expansion



Queen Elizabeth's Plans vs. the New York 1811 and 1900 Plans

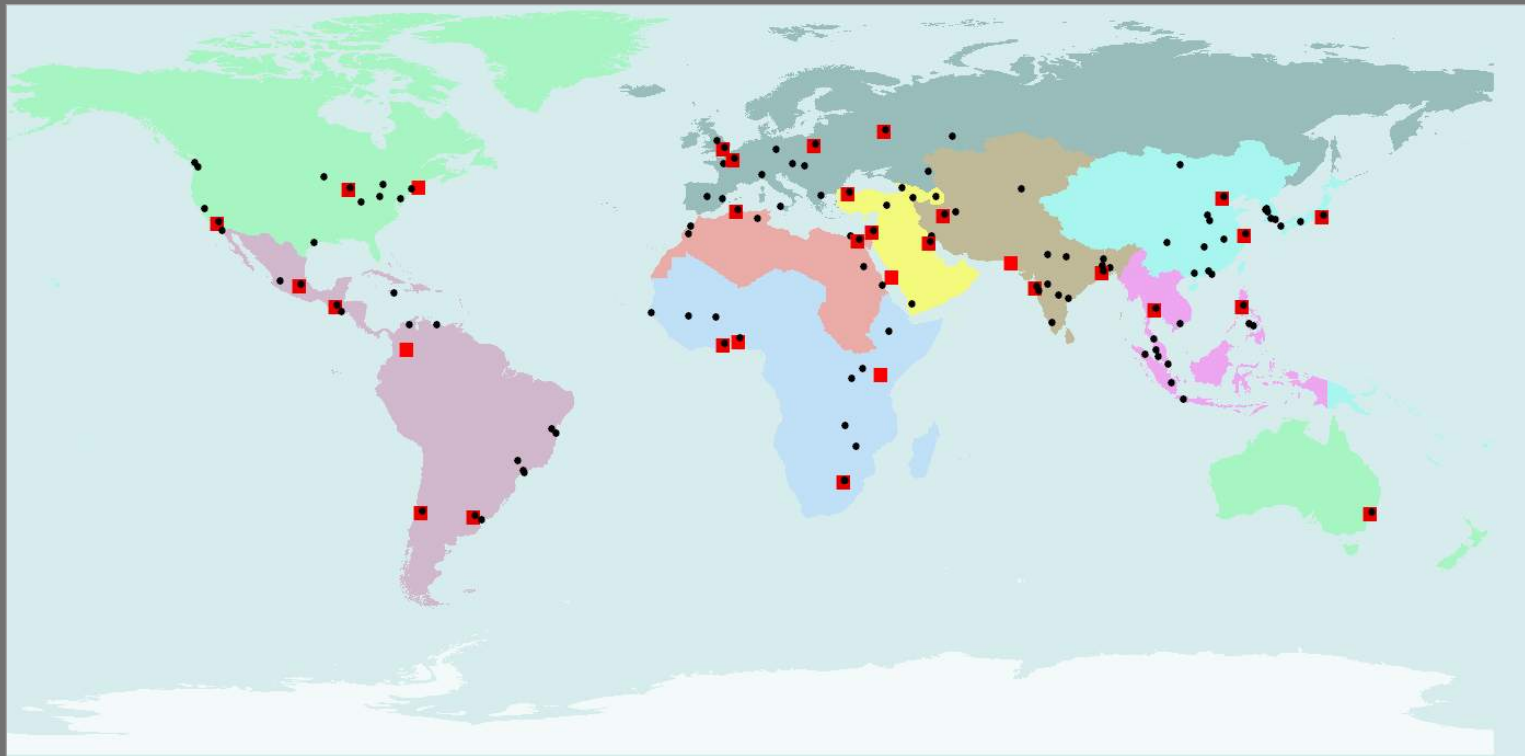
Coming to Terms with Global Urban Expansion



28 of 30 cities studied increased their built-up area 16-fold in the 20th century

Sources of Data

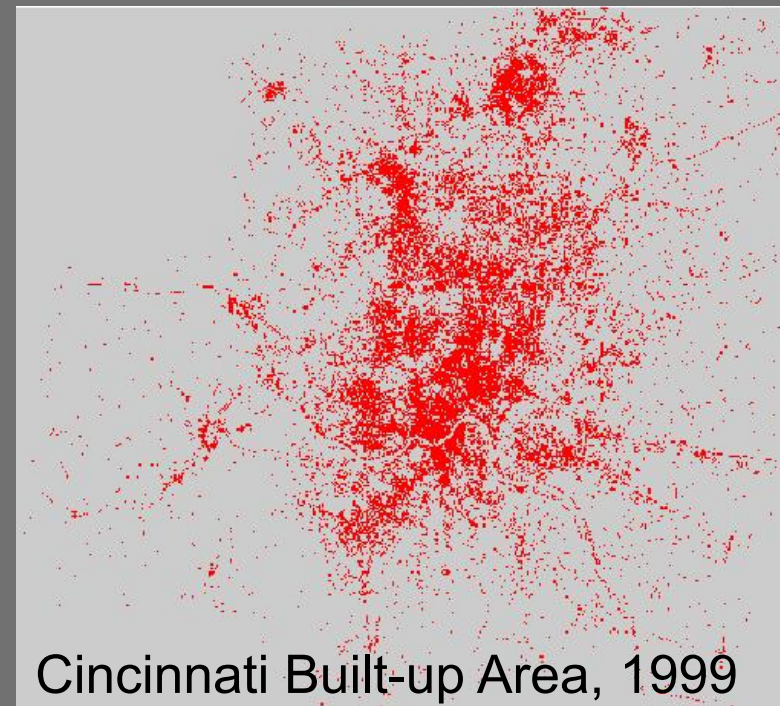
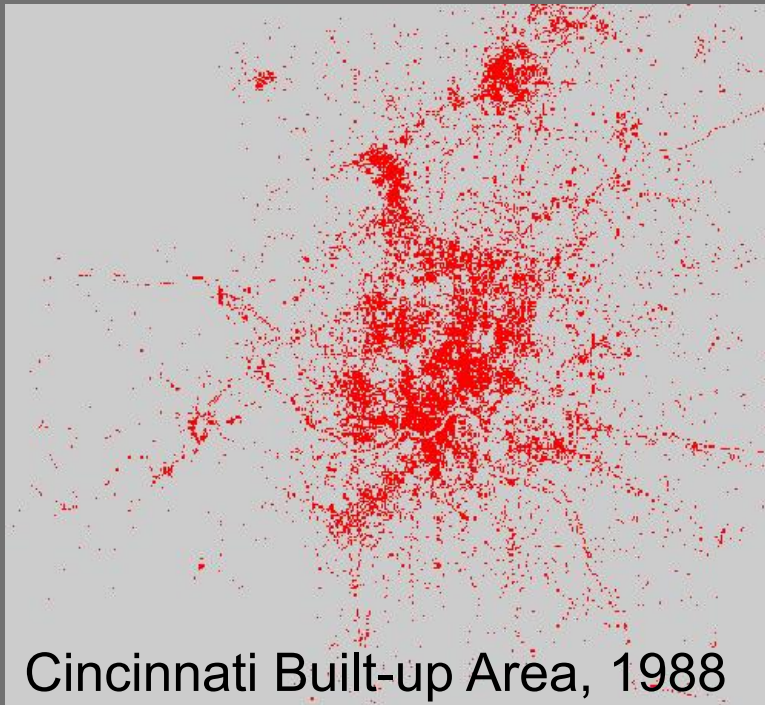
1. The Global Sample of 120 Cities, 1990-2000.
2. The Set of 20 U.S. Cities, 1910-2000.
3. The Representative Sample of 30 Cities, 1800-2000.
4. The Universe of 3,646 Cities, 2000.



The Global Sample of 120 Cities (Black Dots)

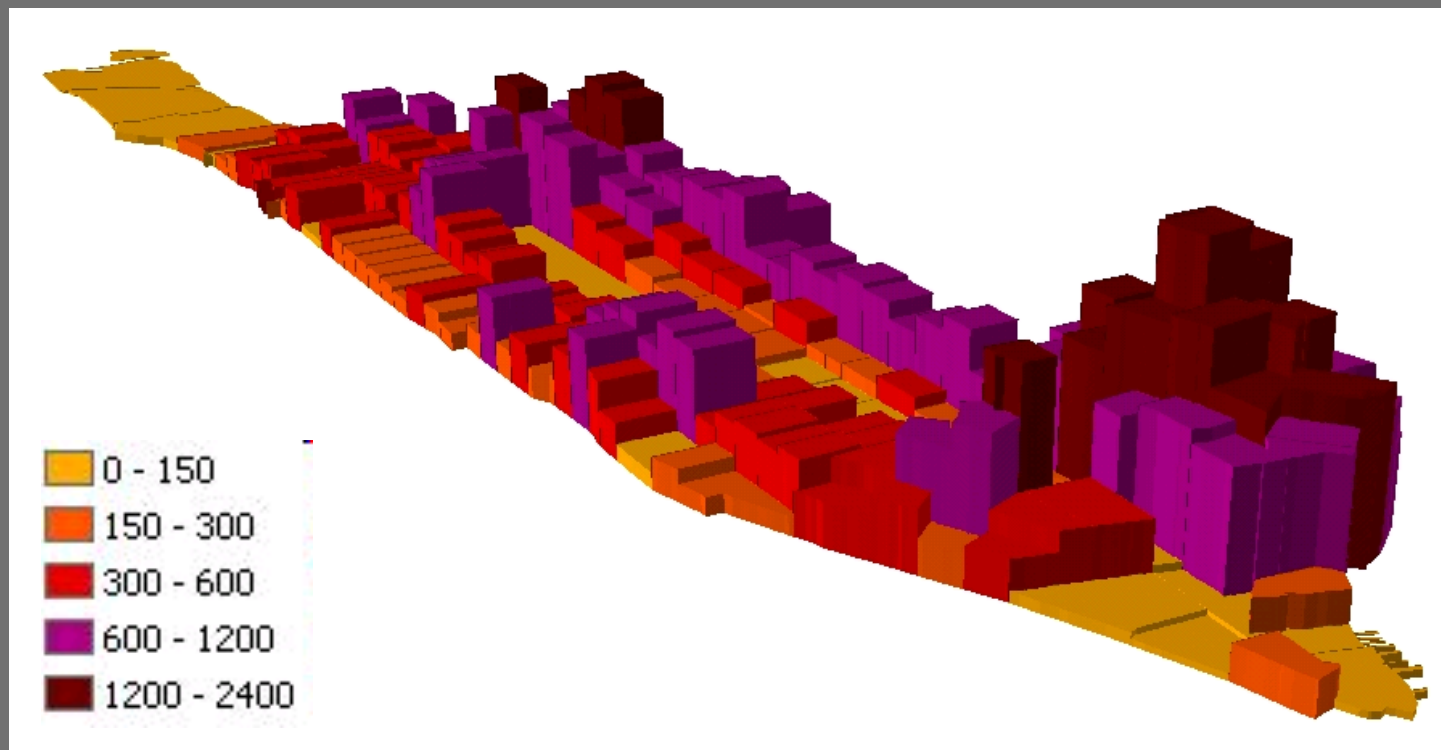
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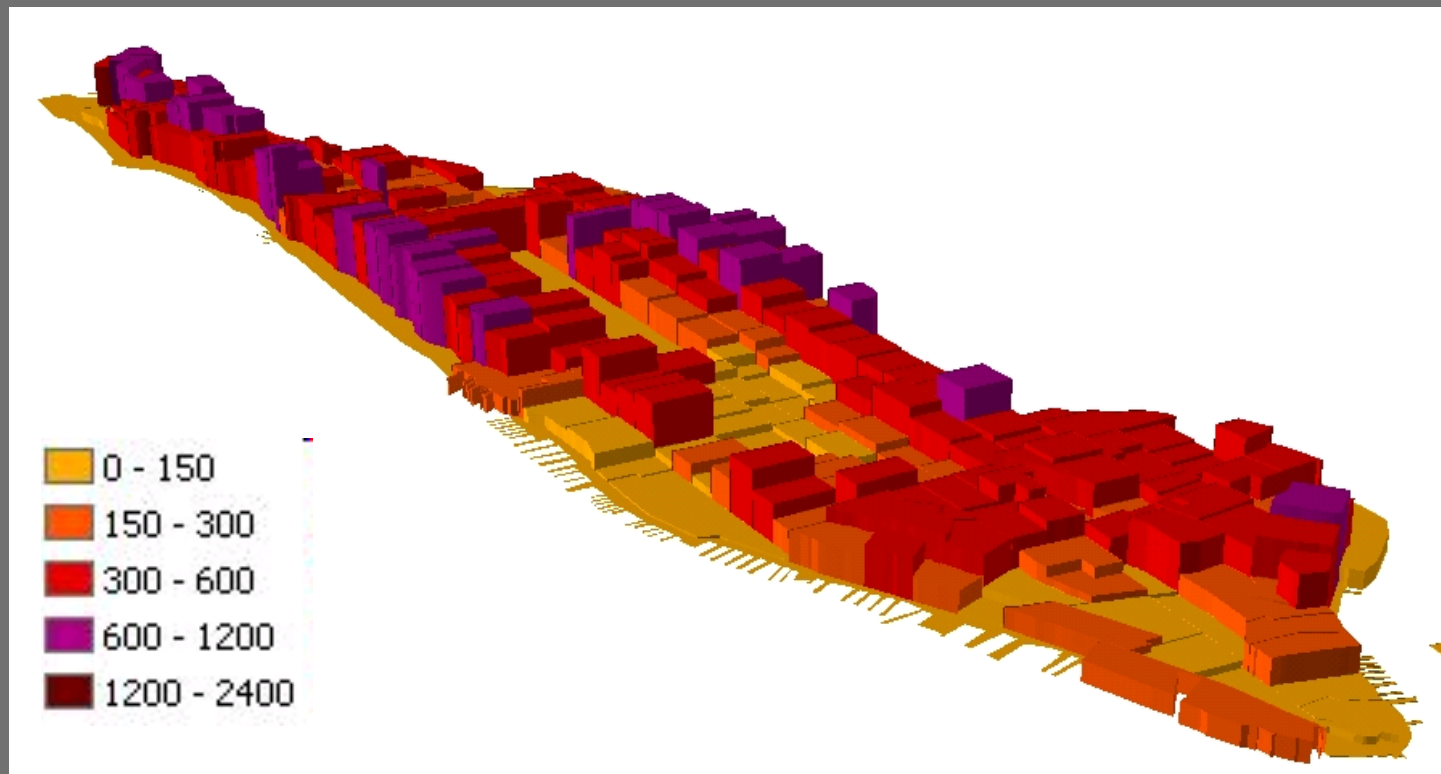
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Manhattan Census Tract Densities (persons per hectare), 1910

Sources of Data

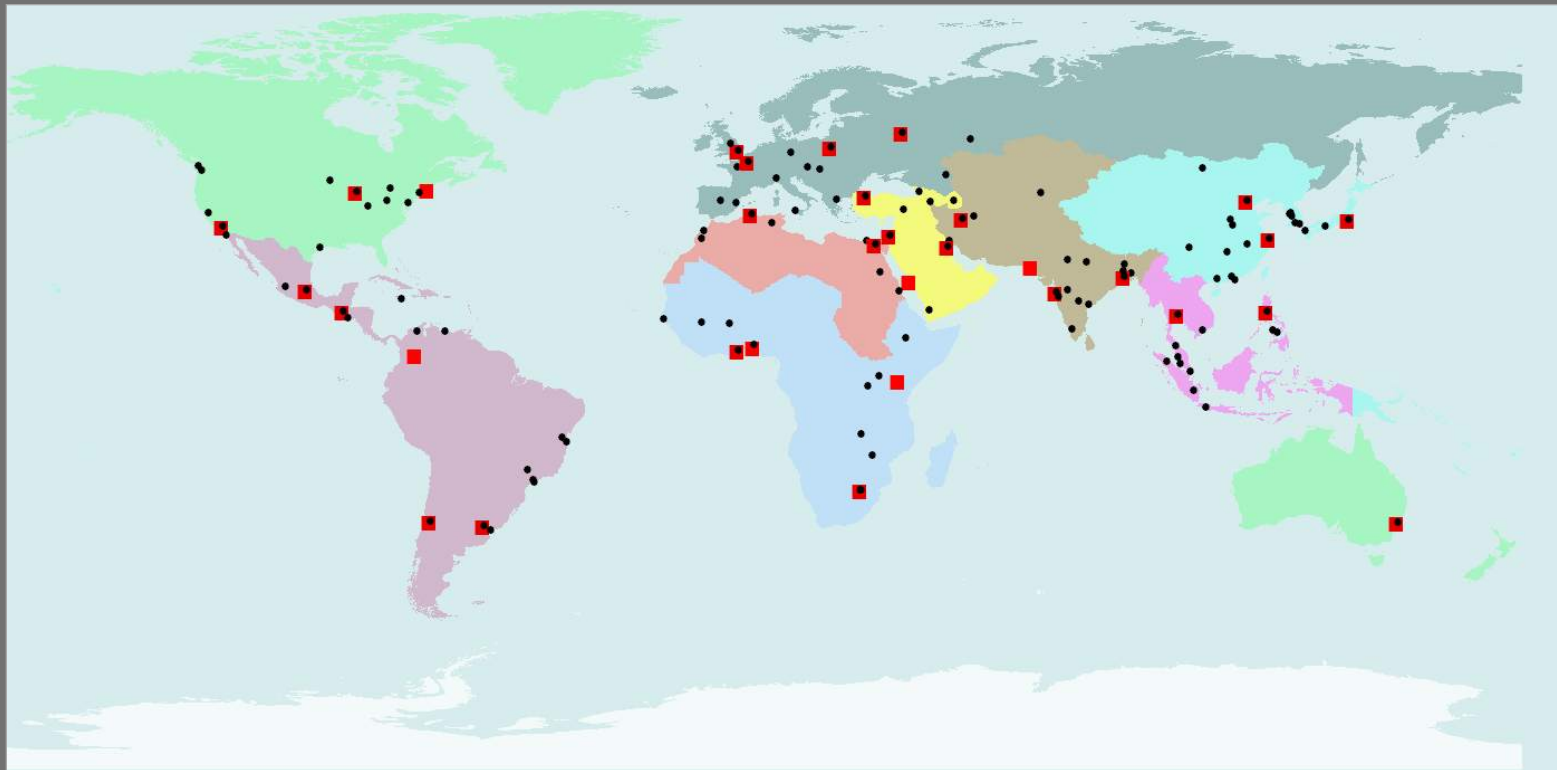
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Manhattan Census Tract Densities (persons per hectare), 2000

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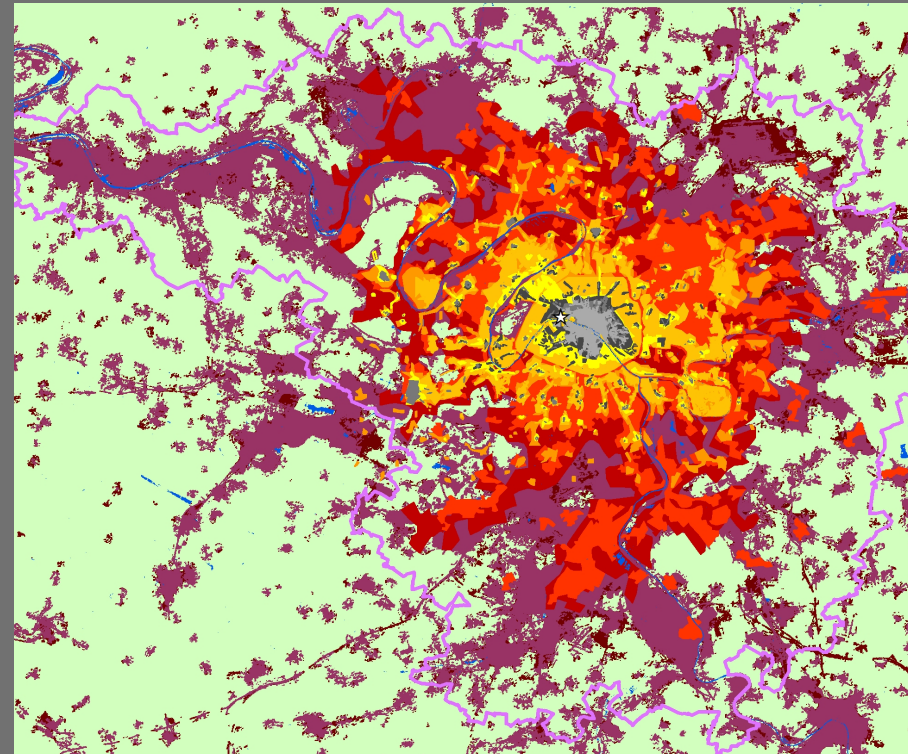
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3. The Representative Sample of 30 Cities, 1800-2000.
4. The Universe of 3,646 Cities, 2000.



The representative sample of 30 cities, 1800-2000 (Red squares)

Sources of Data

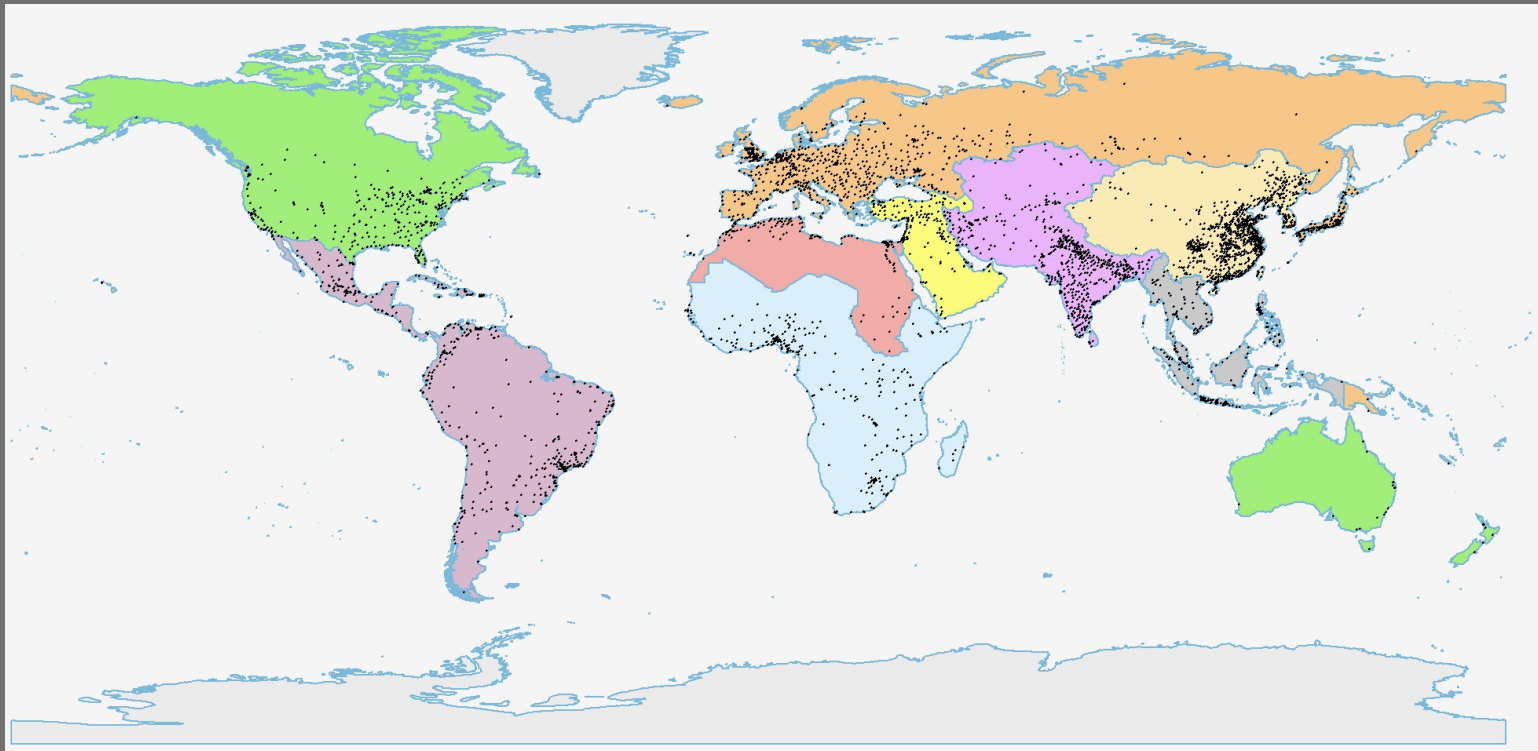
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3. The Representative Sample of 30 Cities, 1800-2000.
4. The Universe of 3,646 Cities, 2000.



Paris, France in 1834 and the expansion of the city, 1800-2000

Sources of Data

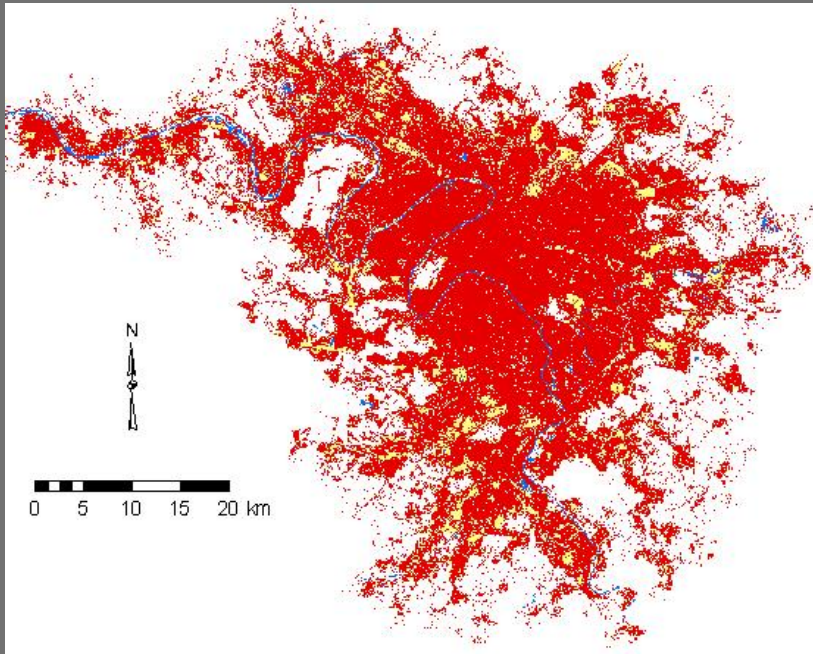
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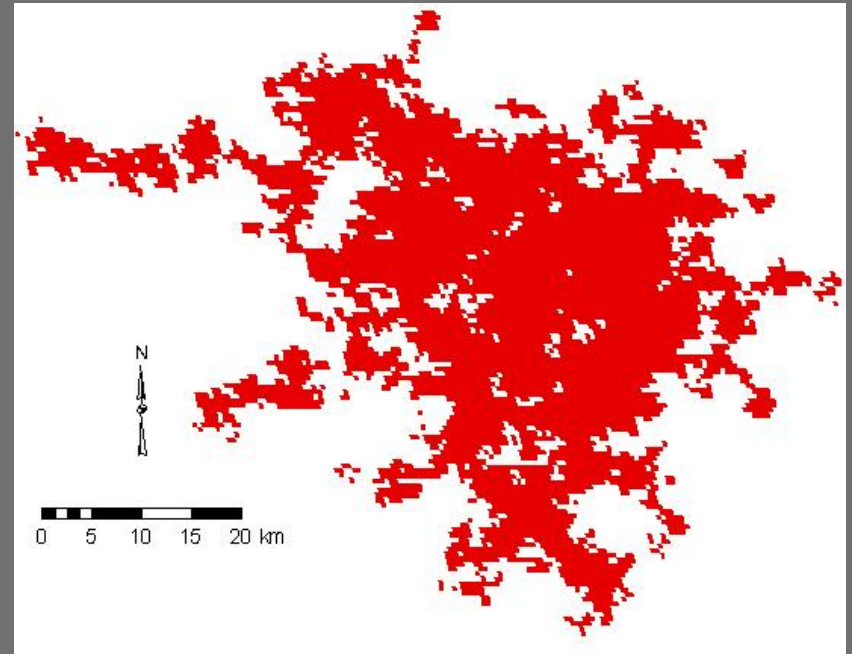
3,646 cities that had 100,000 people or more in 2000

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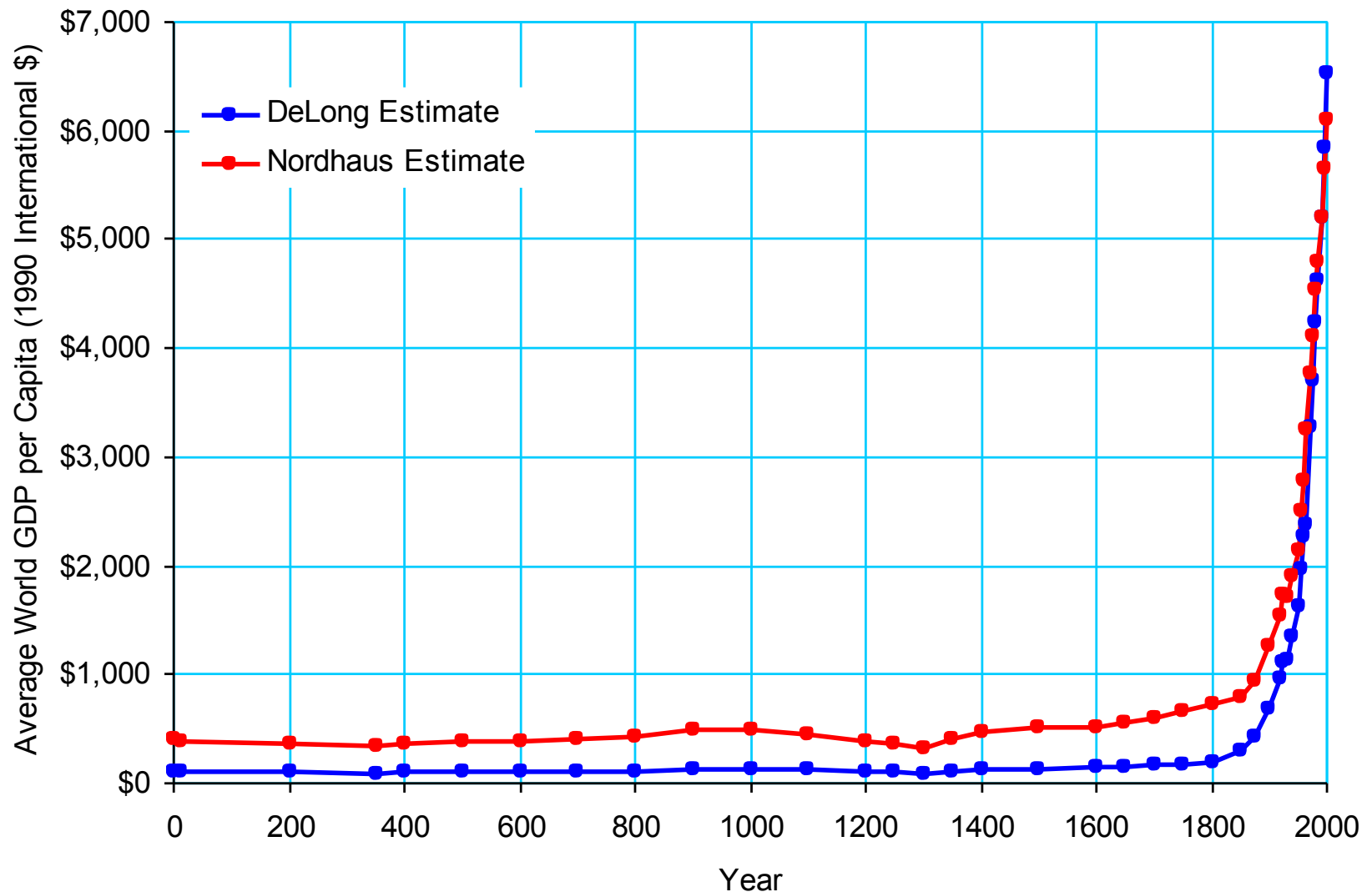
Landsat: 30-meter pixel resolution



Mod500: 463-meter pixel resolution

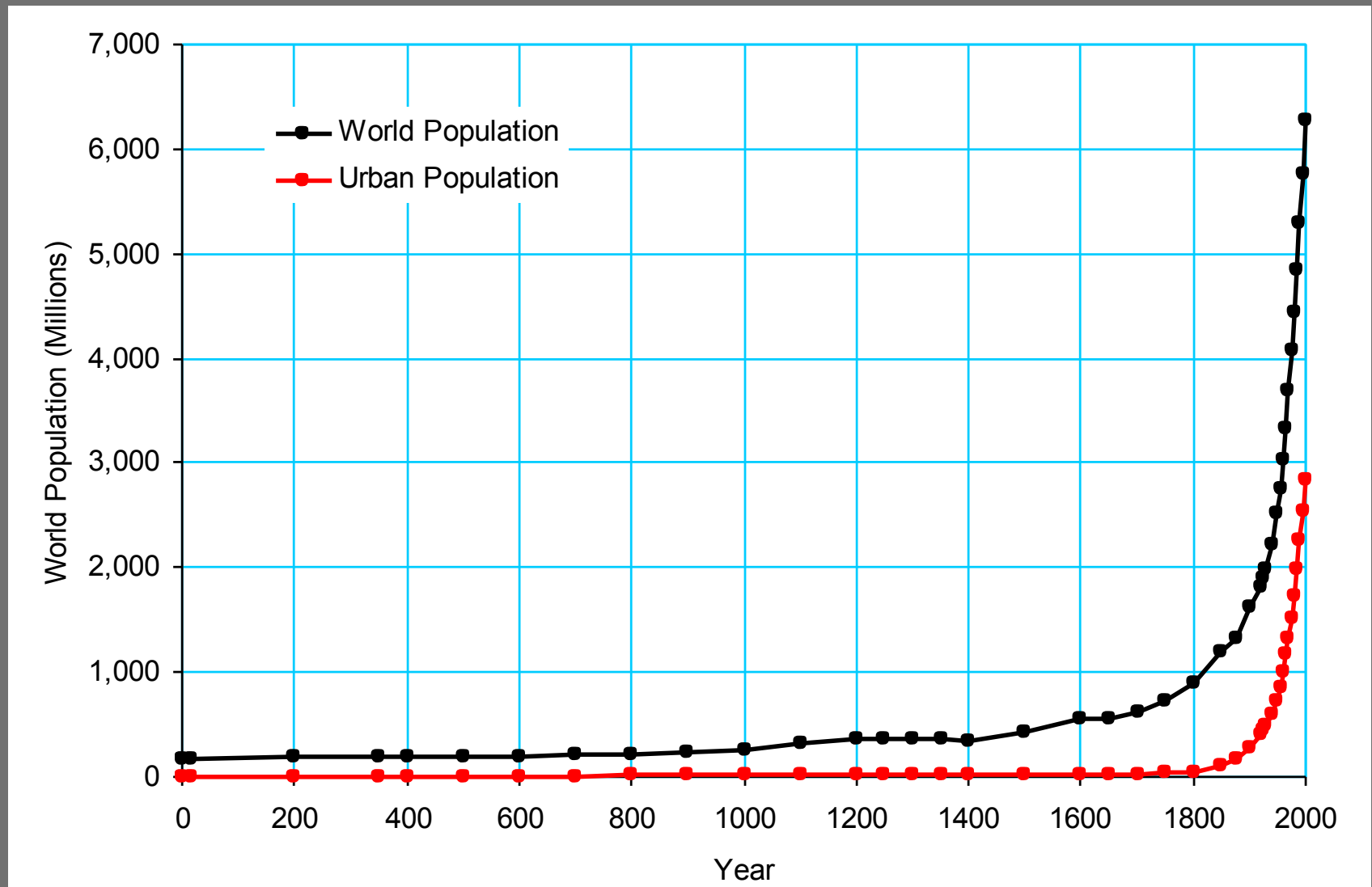
Urban land cover in Paris observed by different satellites, 2000

Urbanization in Historical Perspective



From Malthusian to Modern Economics: The world economy takes off circa 1800.

Urbanization in Historical Perspective



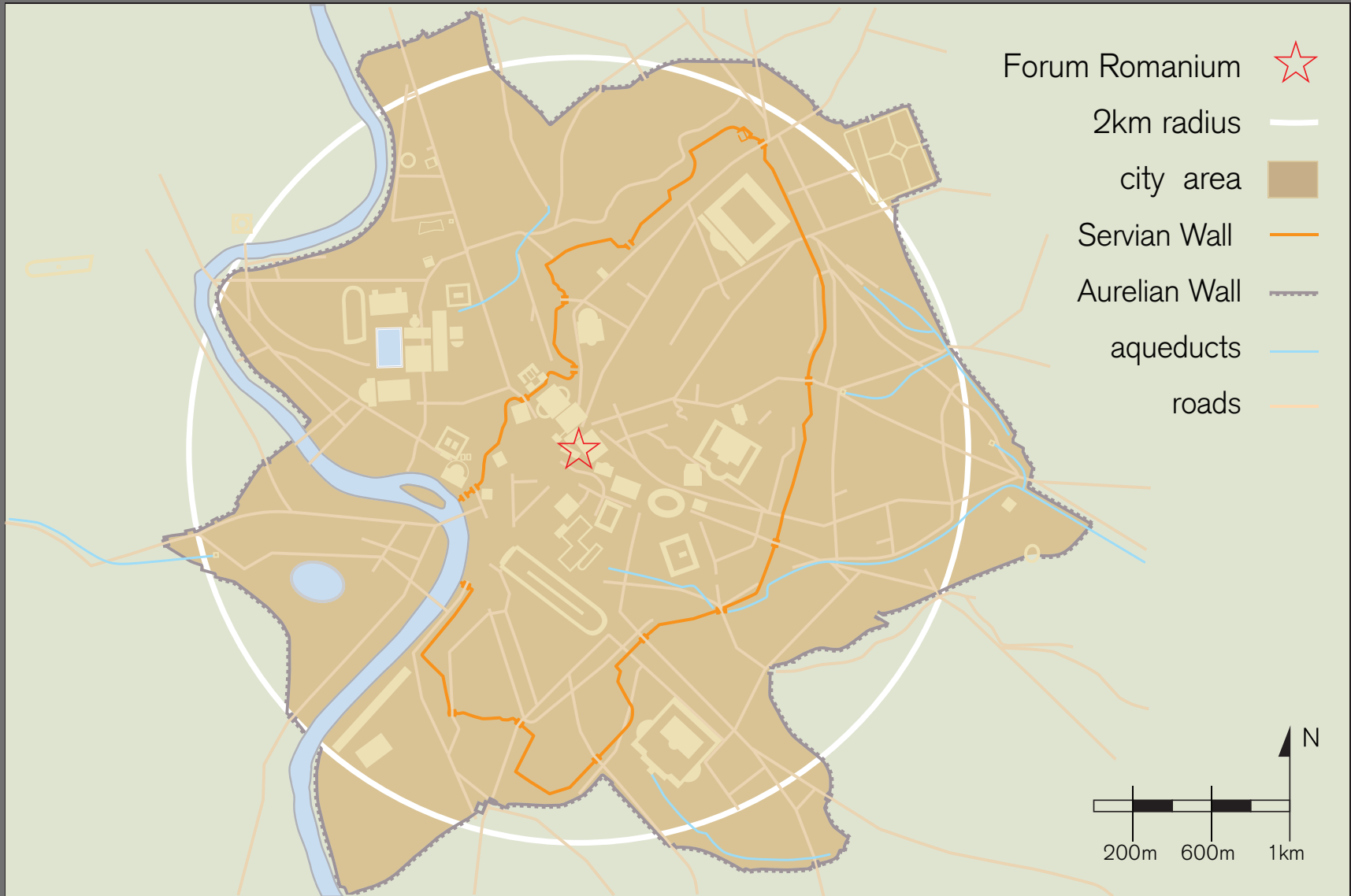
World population takes off circa 1600 and urban population growth starts to accelerate circa 1800.

Urbanization in Historical Perspective



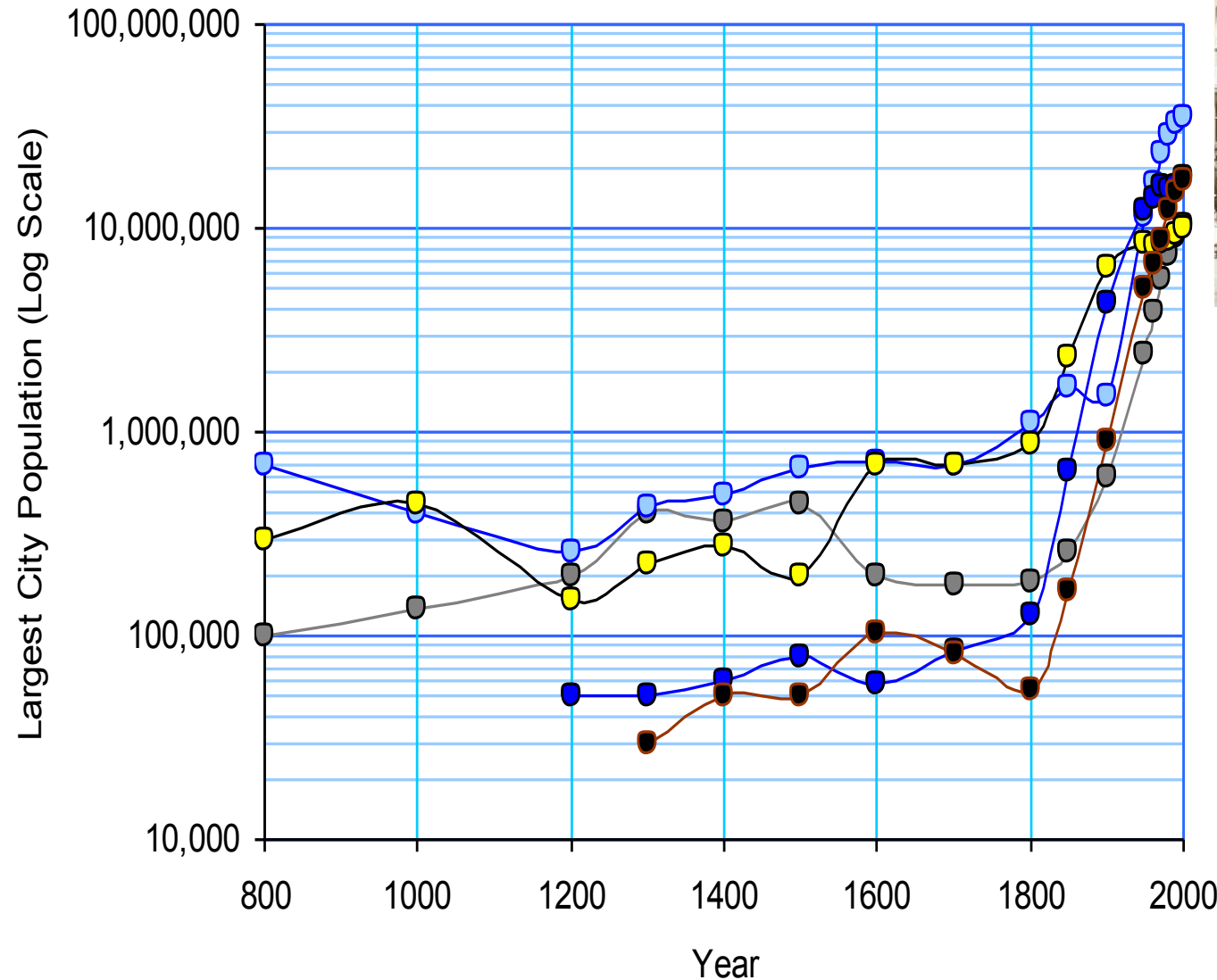
City walls came tumbling down with the end of the Napoleonic Wars, 1815

Urbanization in Historical Perspective



Rome was a Walking City of 1,000,000+ in 275 AD

Urbanization in Historical Perspective

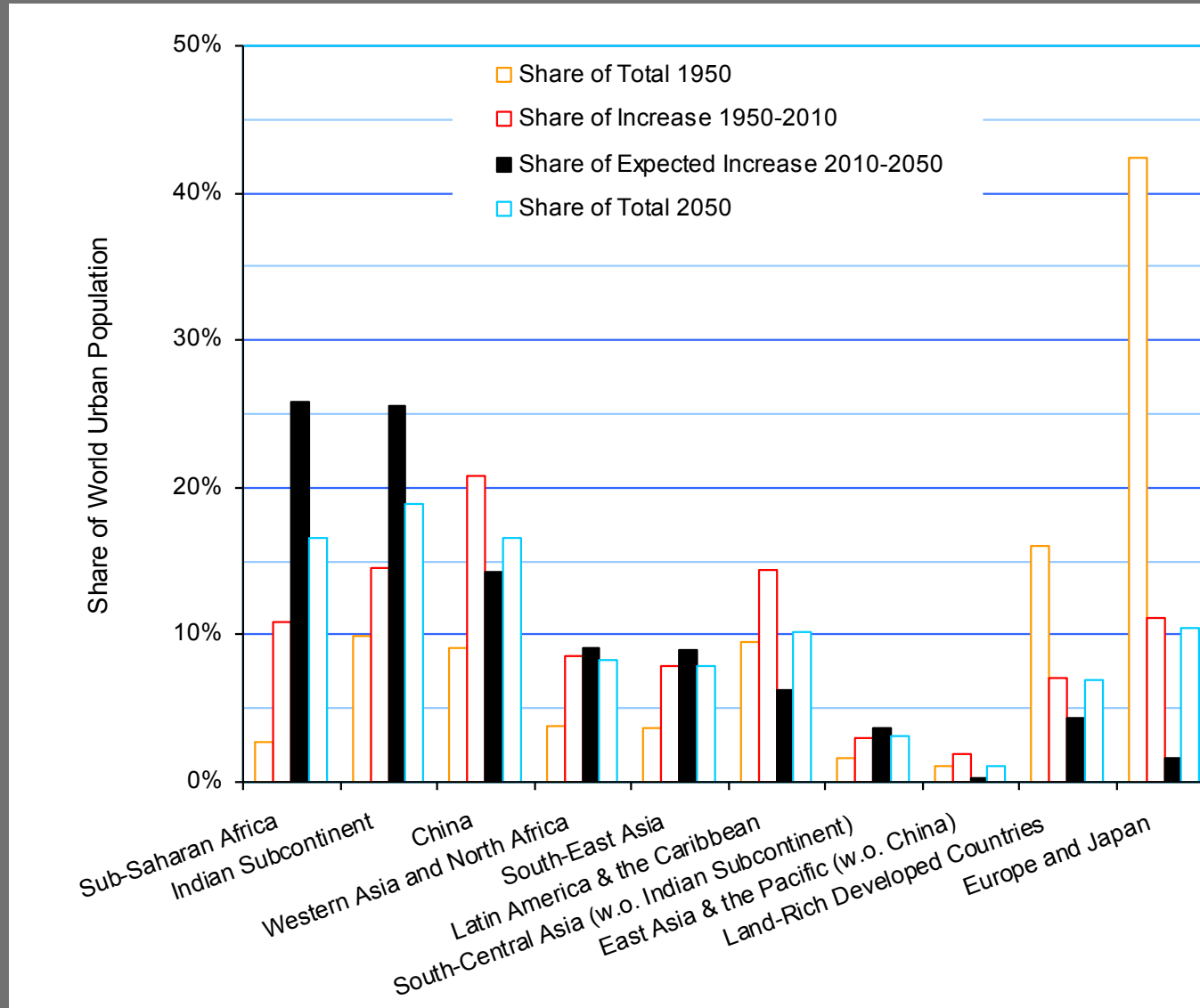


- Africa
- Asia
- Europe
- North & Central America
- South America



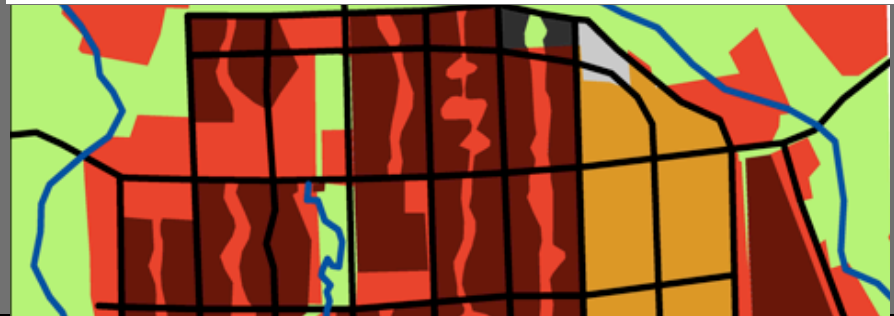
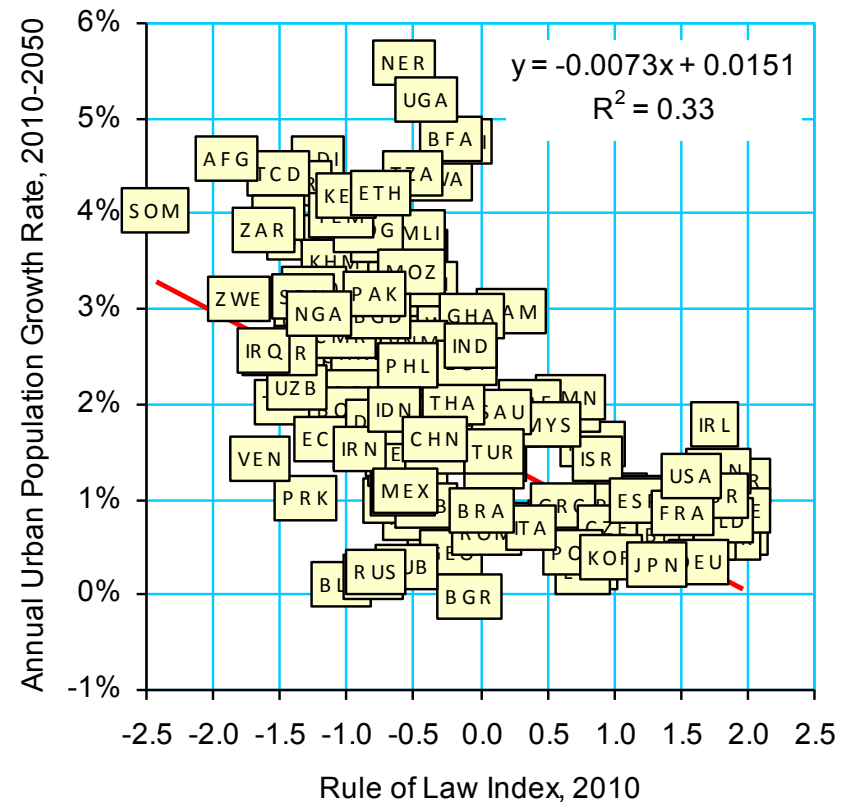
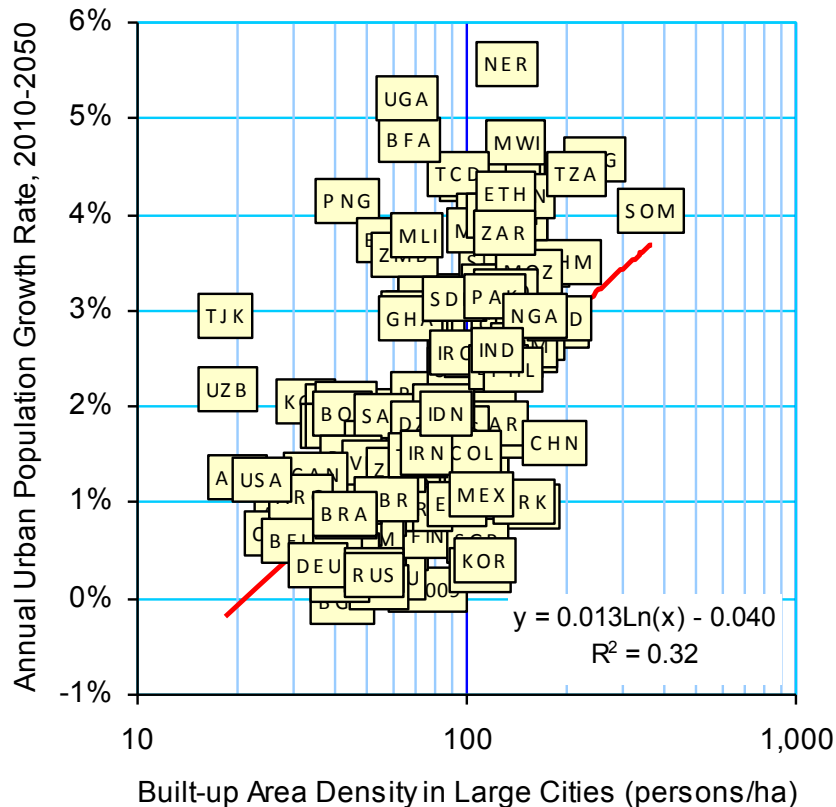
The transportation revolution and the end of the walking city began circa 1800.

The Geography of World Urbanization



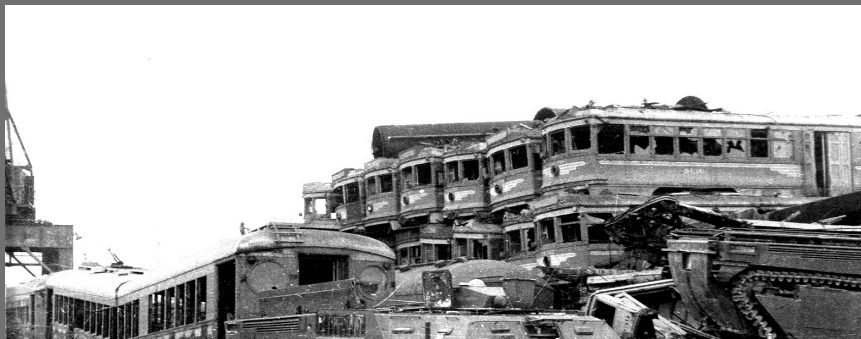
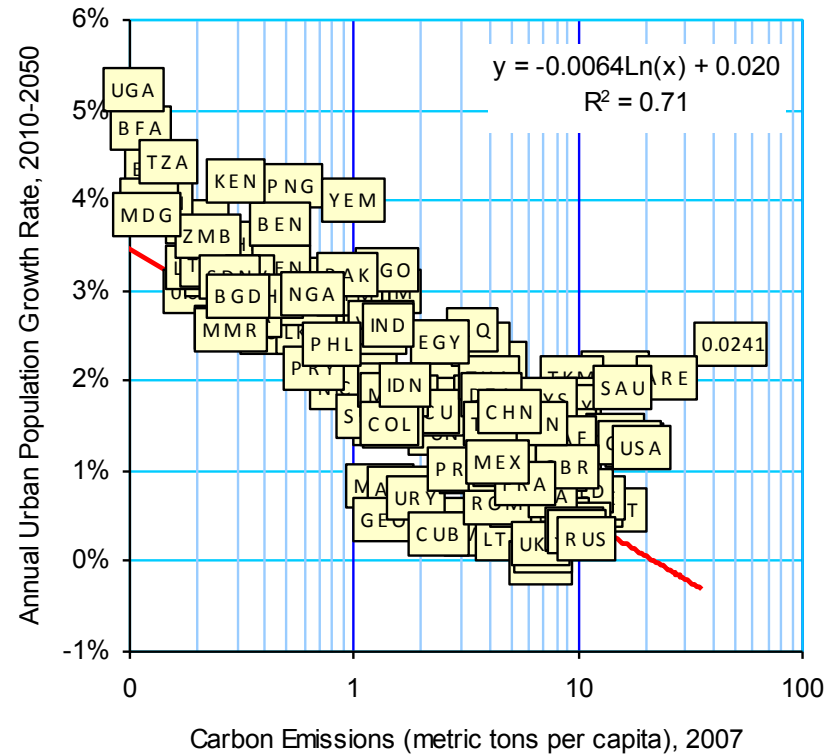
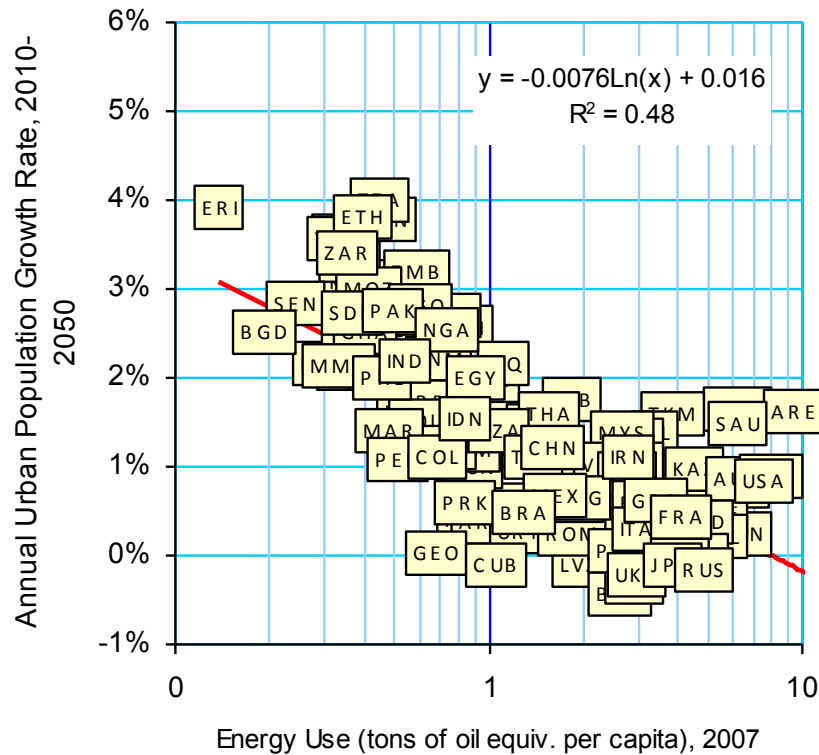
The relative shares of the world urban population in different geographic regions (in percentages), 1950-2050.

The Geography of World Urbanization



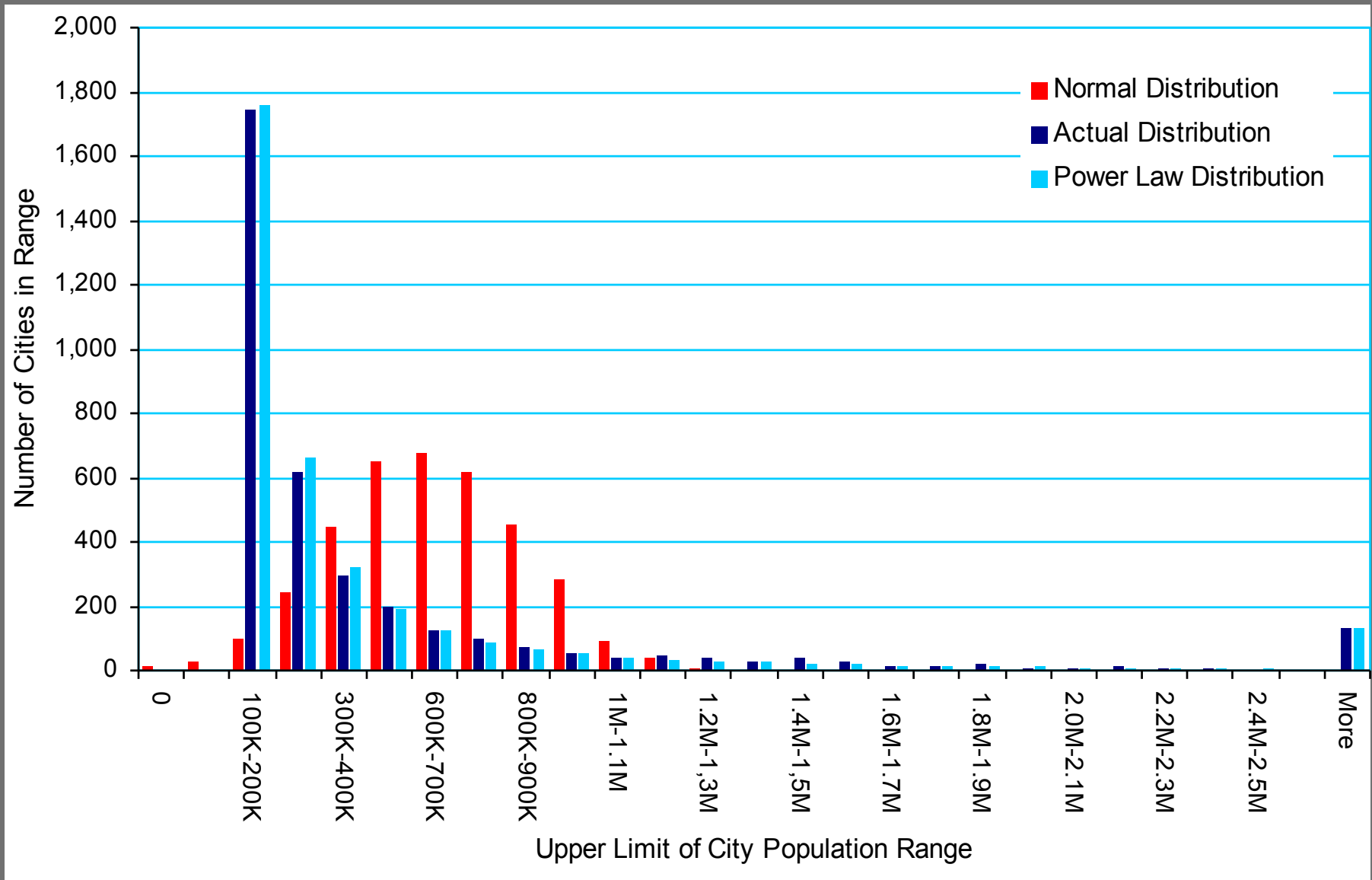
Cities in rapidly-urbanizing countries have high densities and weak rule of law

The Geography of World Urbanization



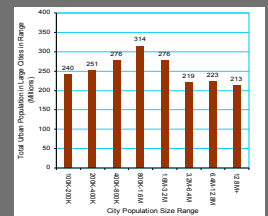
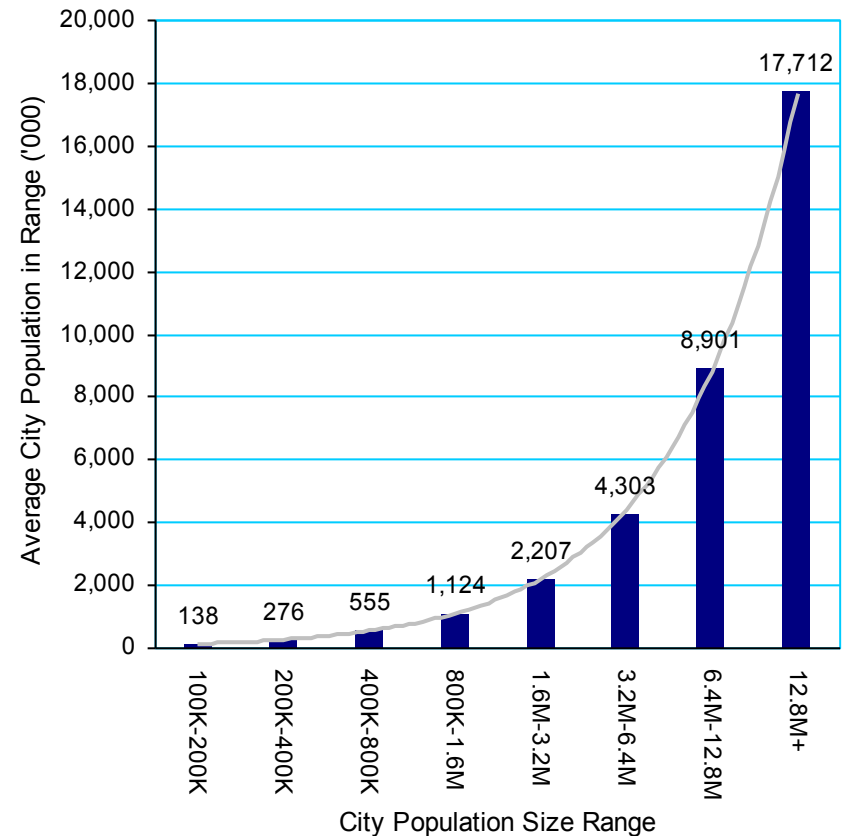
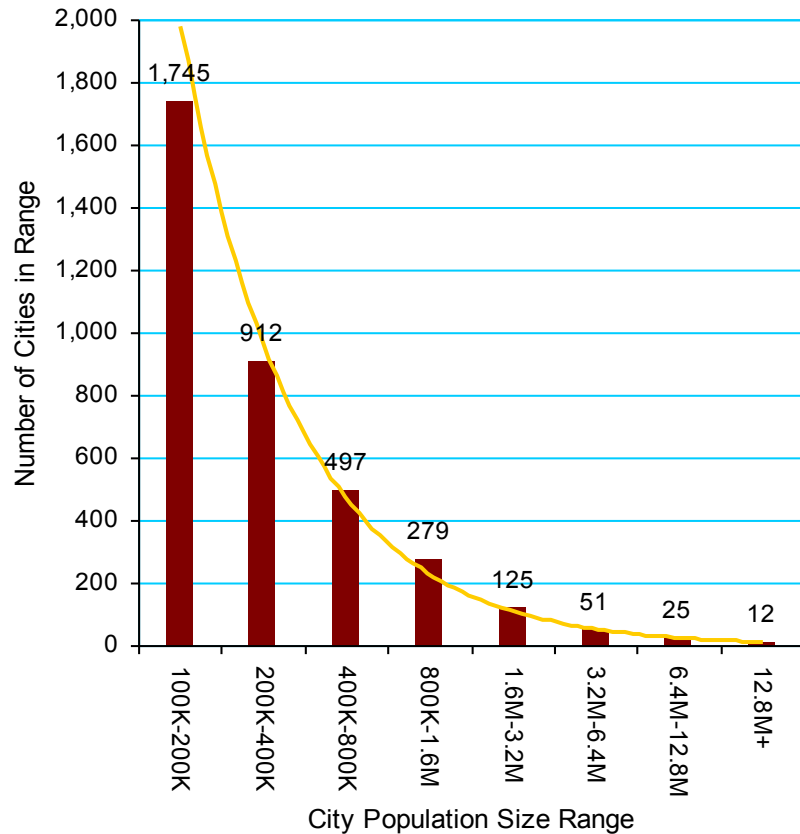
Cities in rapidly-urbanizing countries have low energy use and low carbon emissions.

The Global Hierarchy of Cities



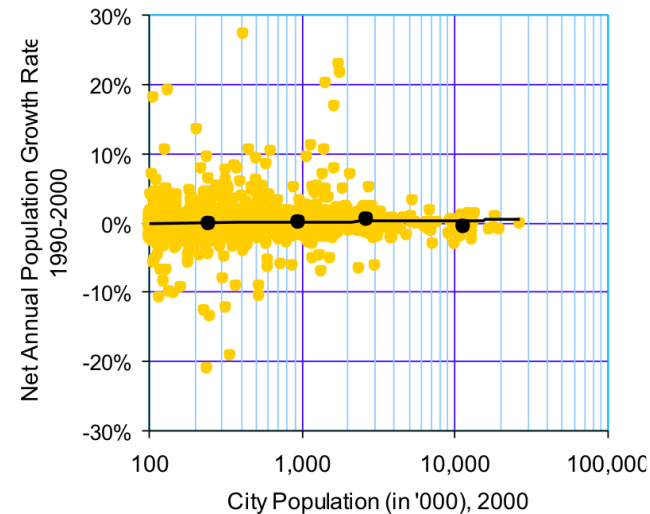
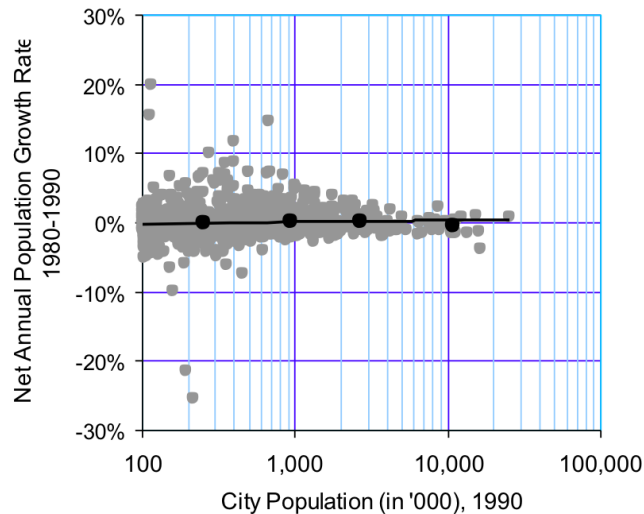
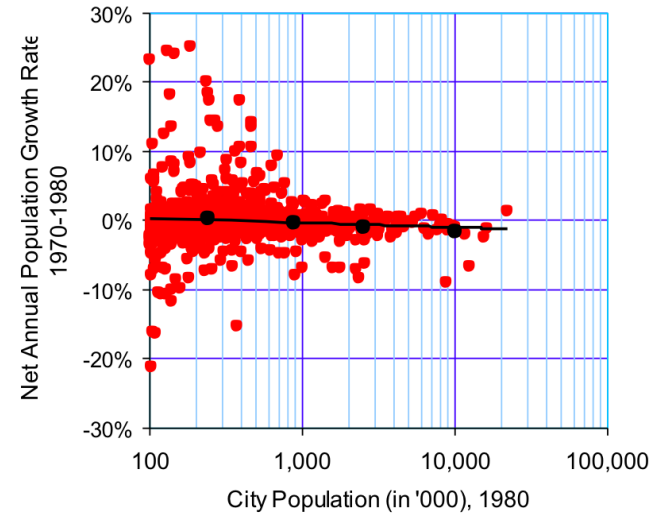
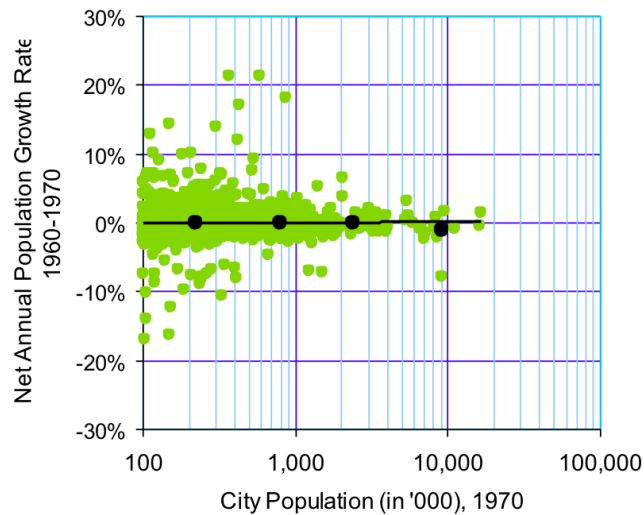
The Power Law distribution of the 3,646 Cities, 2000

The Global Hierarchy of Cities



Regularities in The Average Population and the Number of Cities in Different City Population Size Ranges in the Universe of 3,646 Cities, 2000

The Global Hierarchy of Cities



Net City Population Growth Rates in Henderson's Universe of Cities with Populations of 100,000 or more at the End of the Decade, 1960-2000

Seven Questions Regarding Urban Expansion

EXTENT: What are the extents of urban areas everywhere, how fast are they expanding over time, and why?

DENSITY: How dense are these urban areas, how are urban densities changing over time, and why?

CENTRALITY: How centralized are the residences and workplaces in cities, do they tend to disperse to the periphery over time, and if so, why?

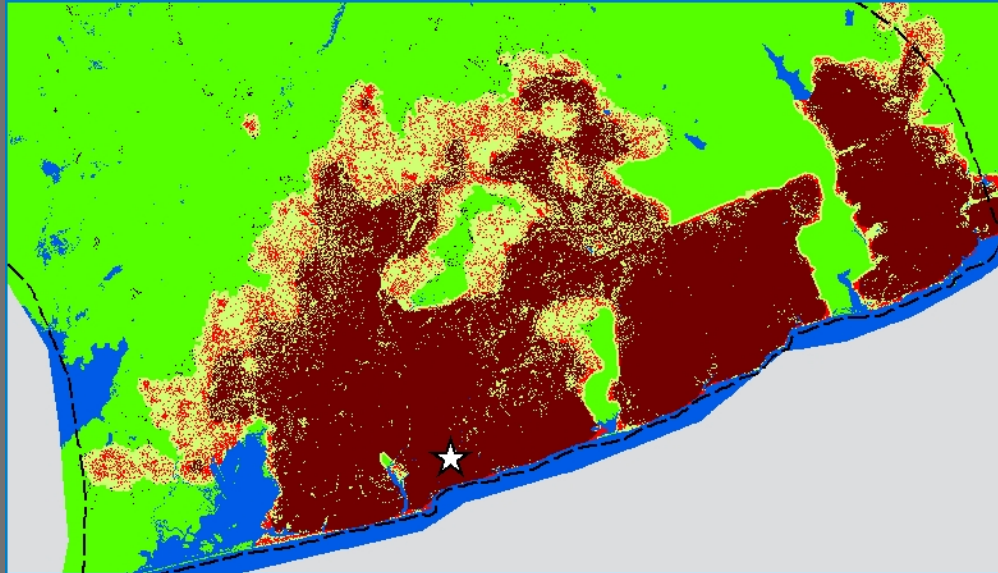
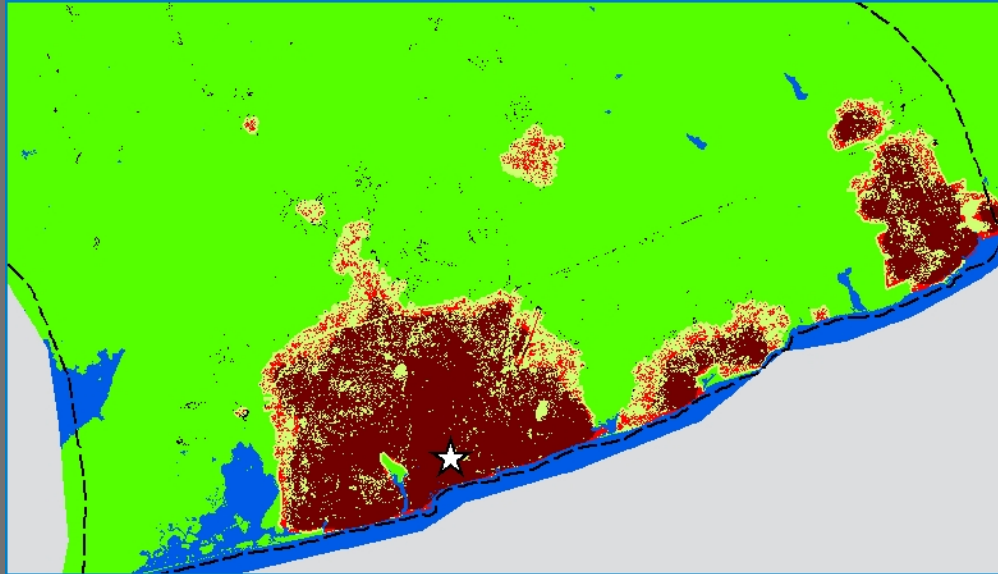
FRAGMENTATION: How fragmented are the built-up areas of cities, how are levels of fragmentation changing over time, and why?

COMPACTNESS: How compact are the shapes of urban footprints, how are their levels of compactness changing over time, and why?

EXPANSION: How much land will urban areas require in the future, and why?

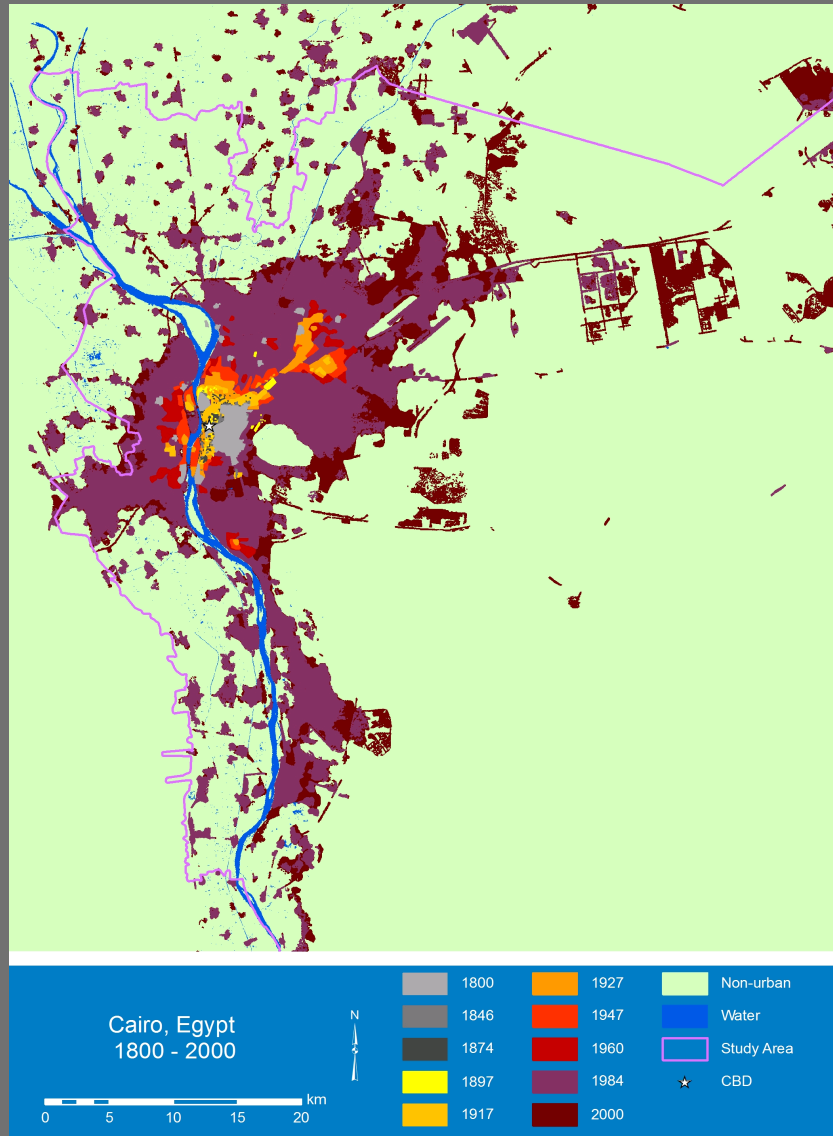
CULTIVATED LAND LOSS: How much cultivated land will be consumed by expanding urban areas and why?

1. Global Urban Land Cover and Its Expansion



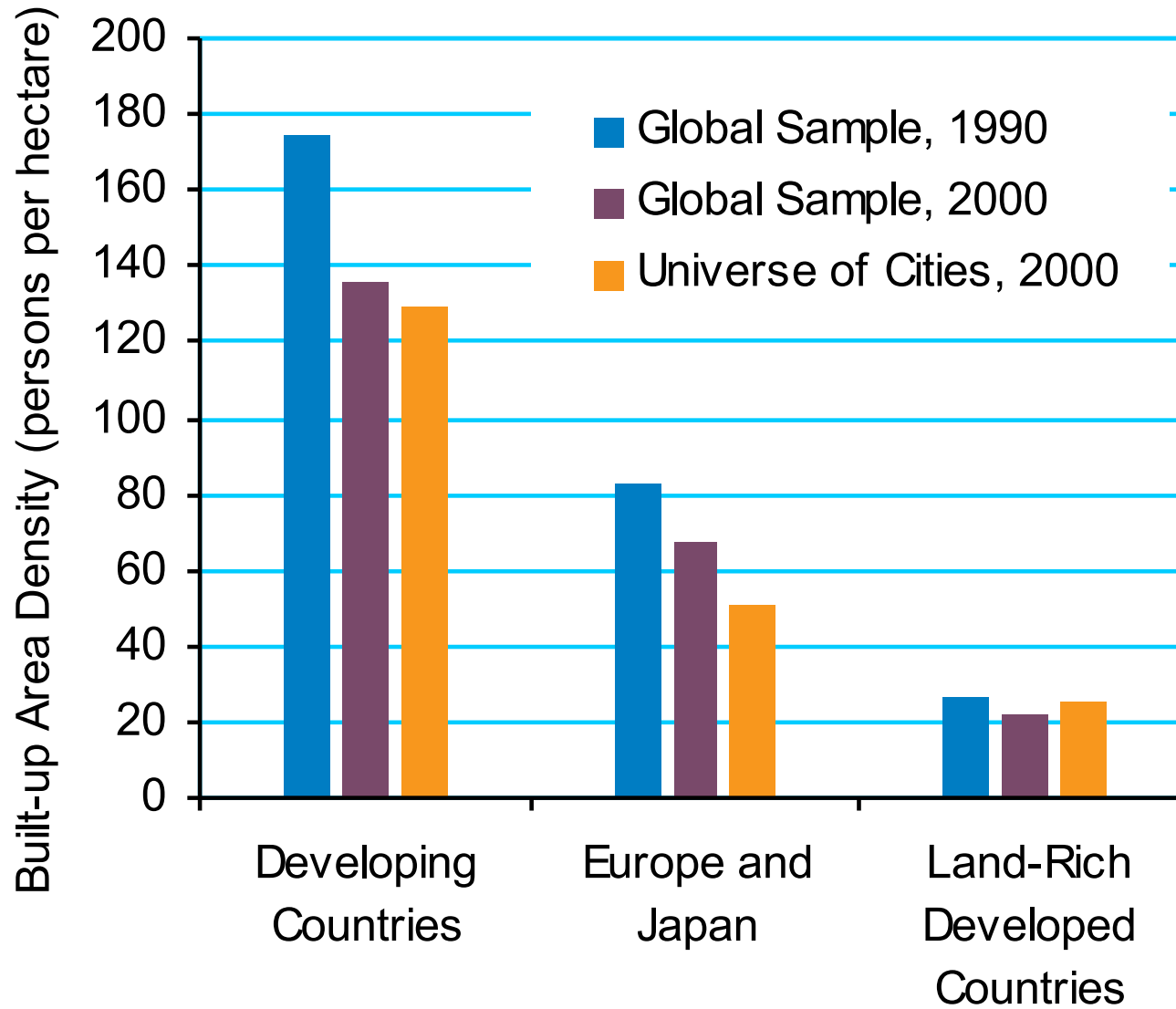
The Expansion of the Built-up Area of Accra, Ghana, 1985-2000

1. Global Urban Land Cover and Its Expansion



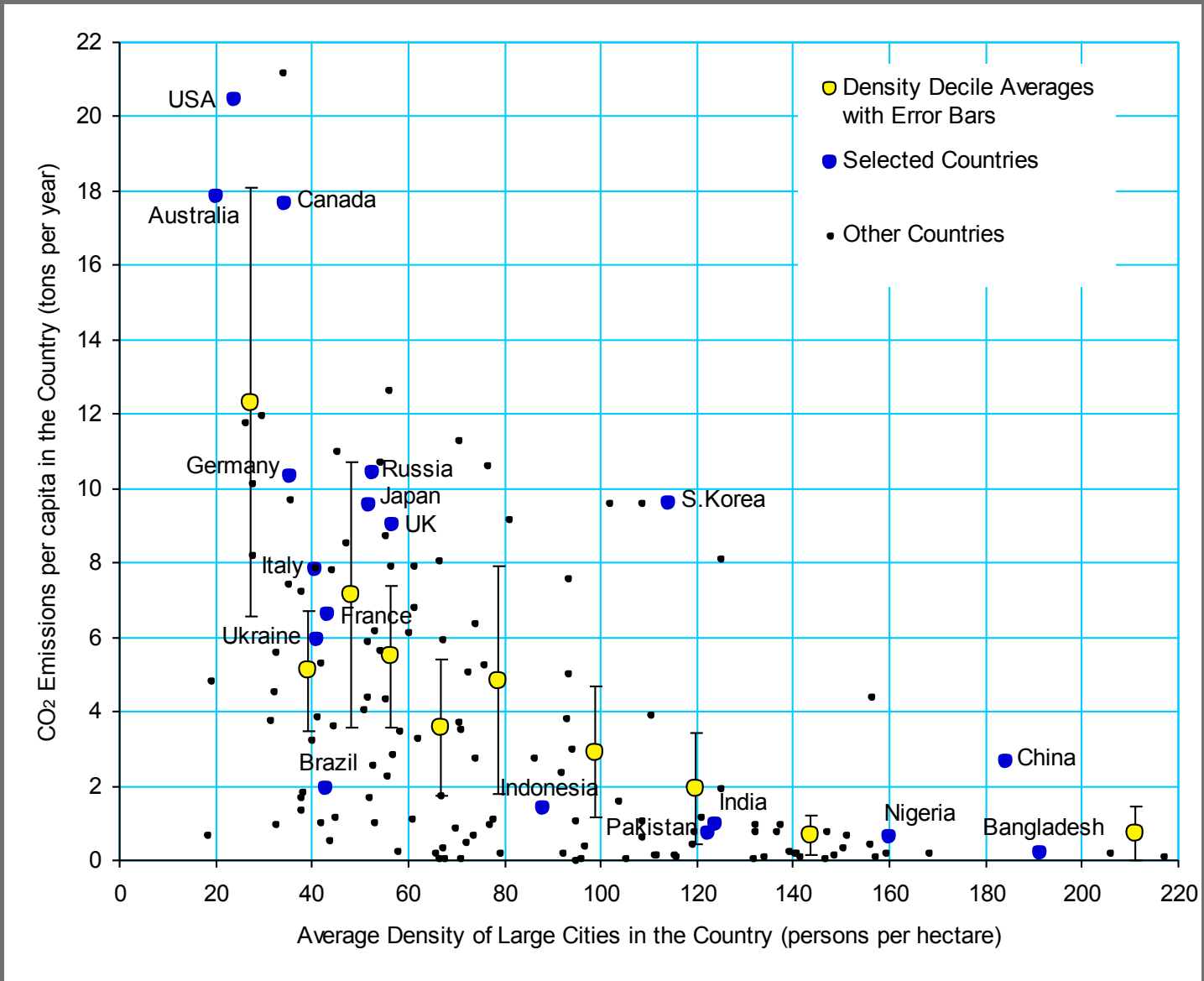
The Expansion of the Built-up Area of Cairo, Egypt, 1800-2000

2. The Persistent Decline in Urban Densities



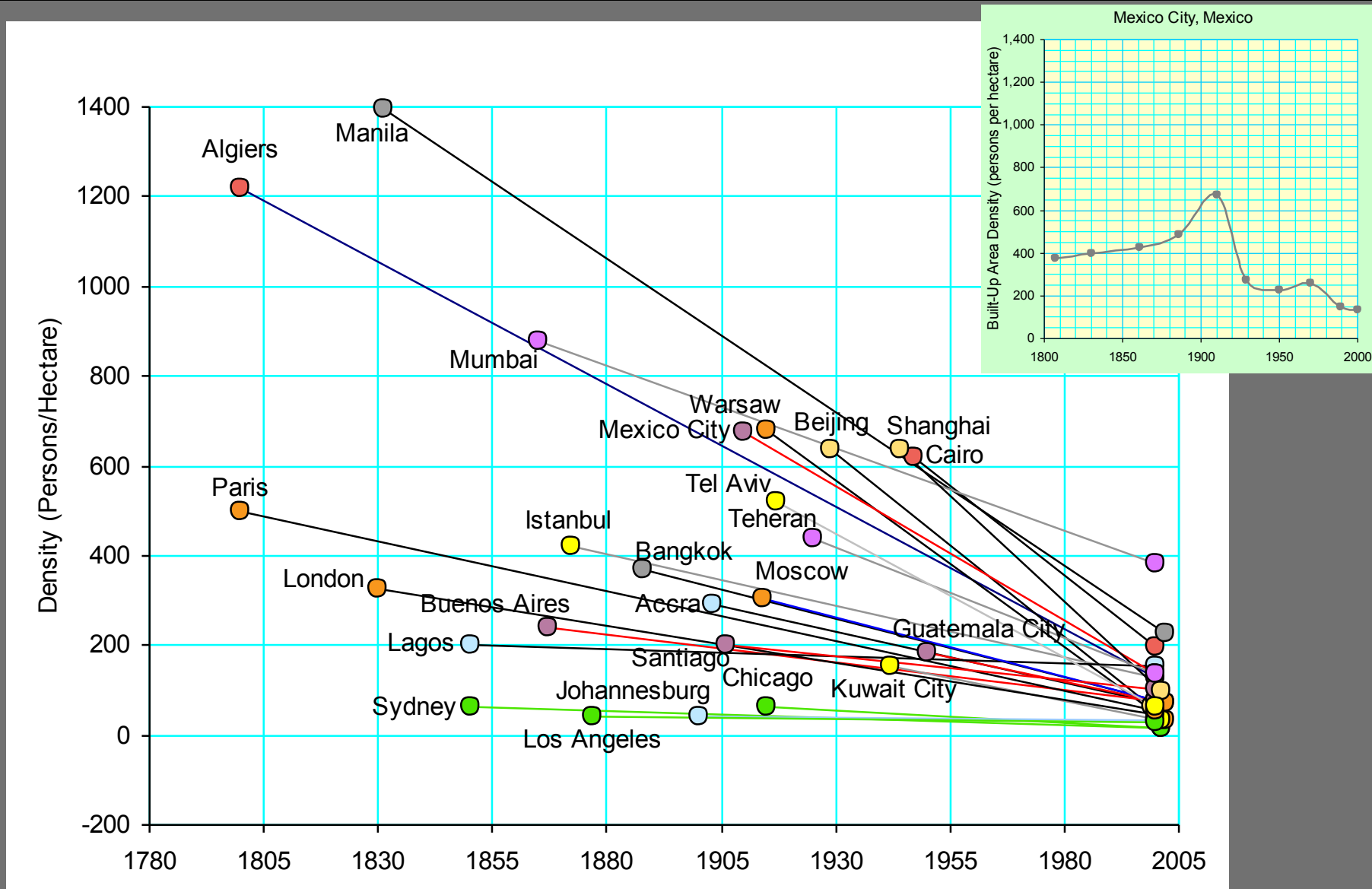
Densities vary by a factor of 30 in the global sample of 120 cities, 2000

2. The Persistent Decline in Urban Densities



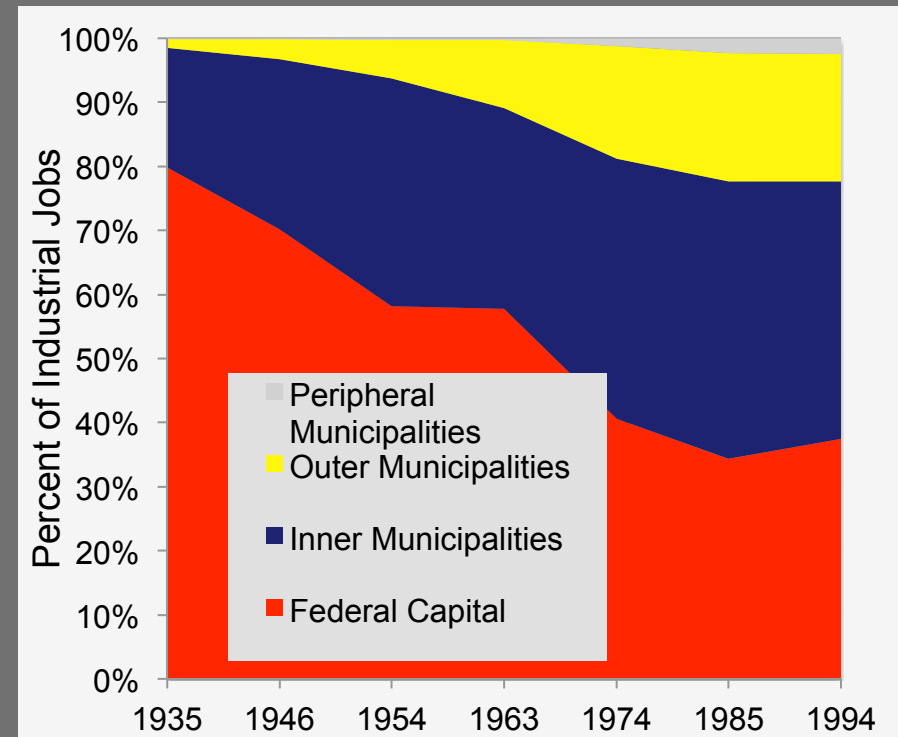
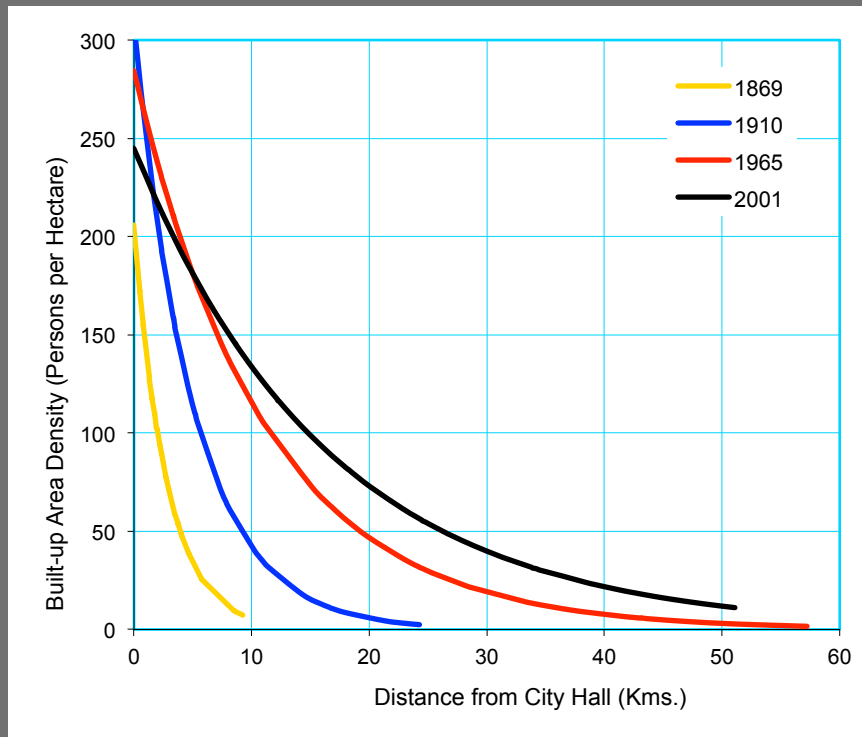
A comparison of average urban densities in large cities and average carbon dioxide emissions per capita from all sources in 145 countries, 2000

2. The Persistent Decline in Urban Densities



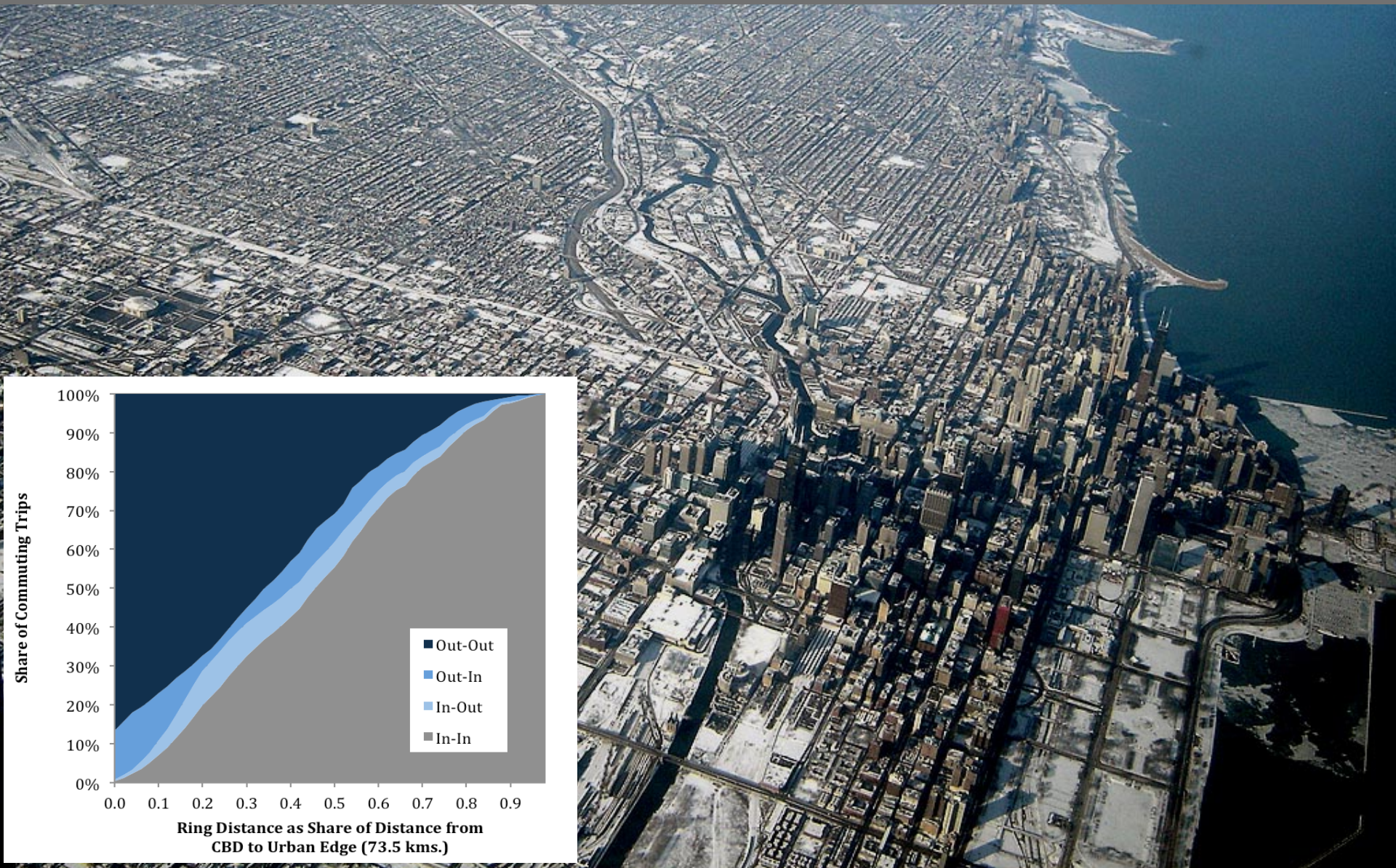
The decline from peak densities in representative cities, 1800-2000

3. From Centrality to Dispersal



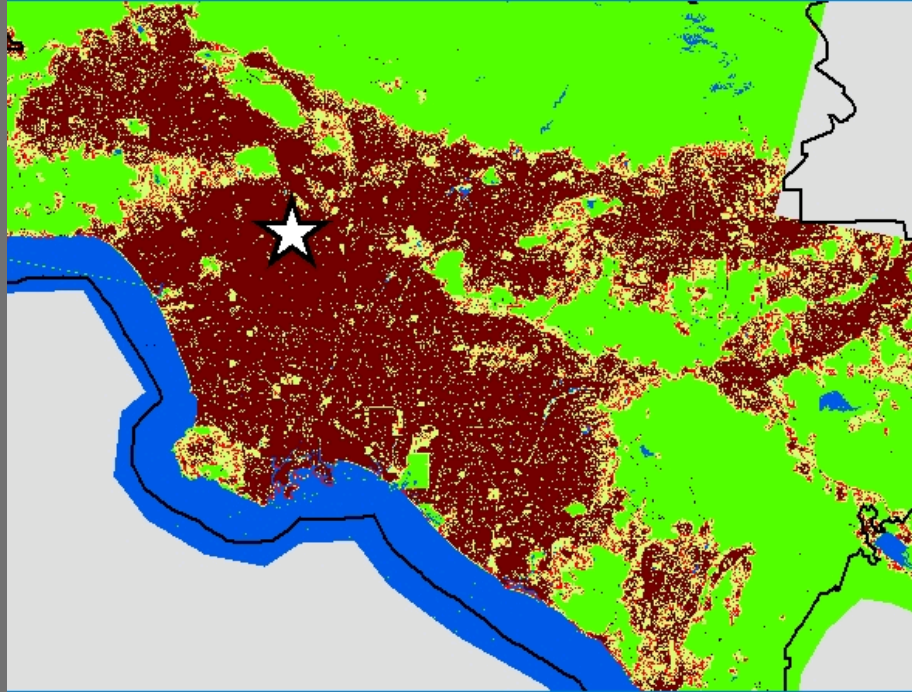
The decline from peak densities in Buenos Aires, 1869-2001; and the decentralization of industrial jobs in the city, 1935-1994.

3. From Centrality to Dispersal

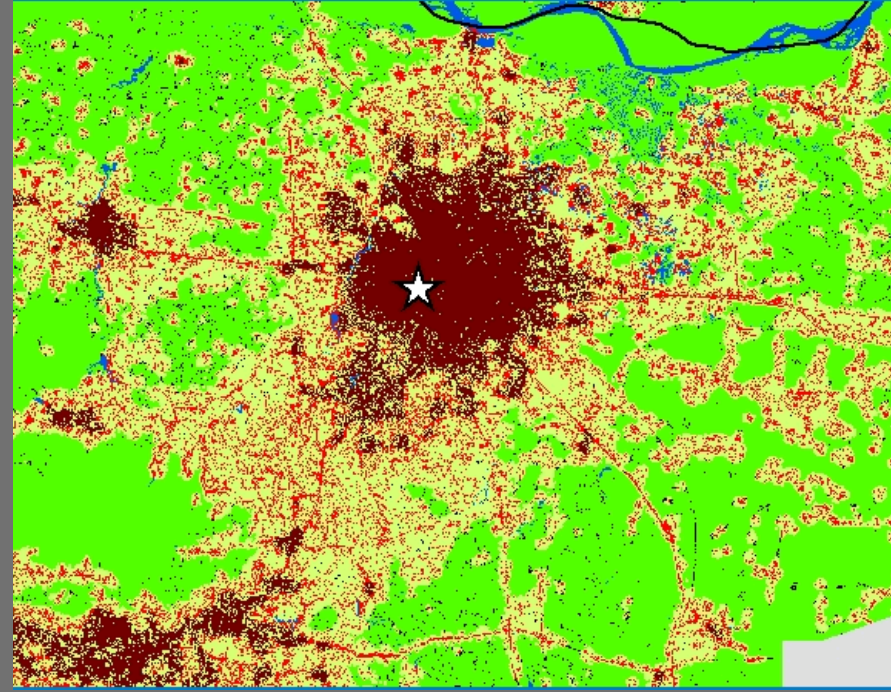


Chicago's Central Business District accommodated less than one-sixth of the total number of workplace in the metropolitan area in the year 2000

4. The Fragmentation of Urban Landscapes



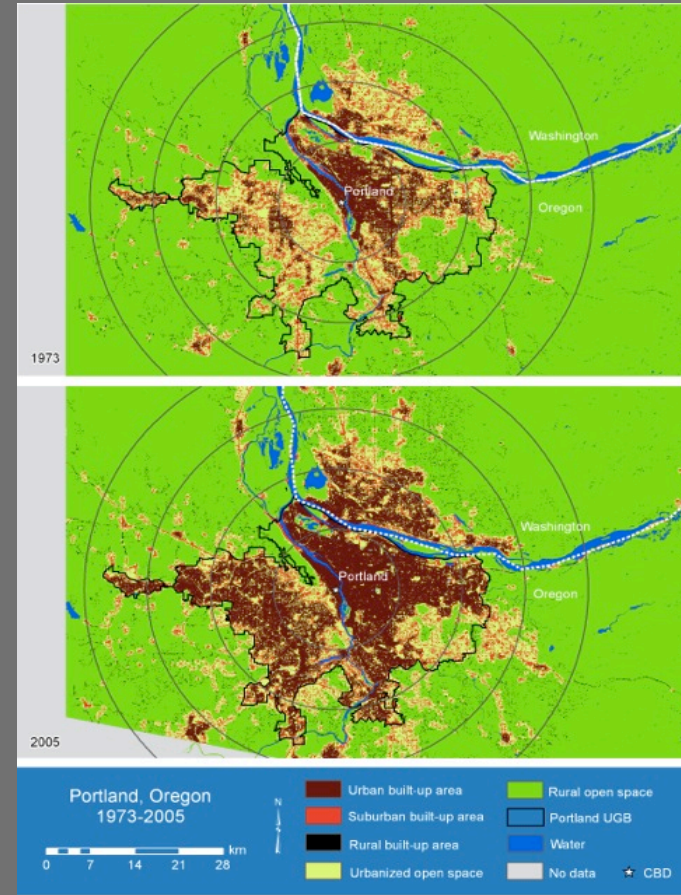
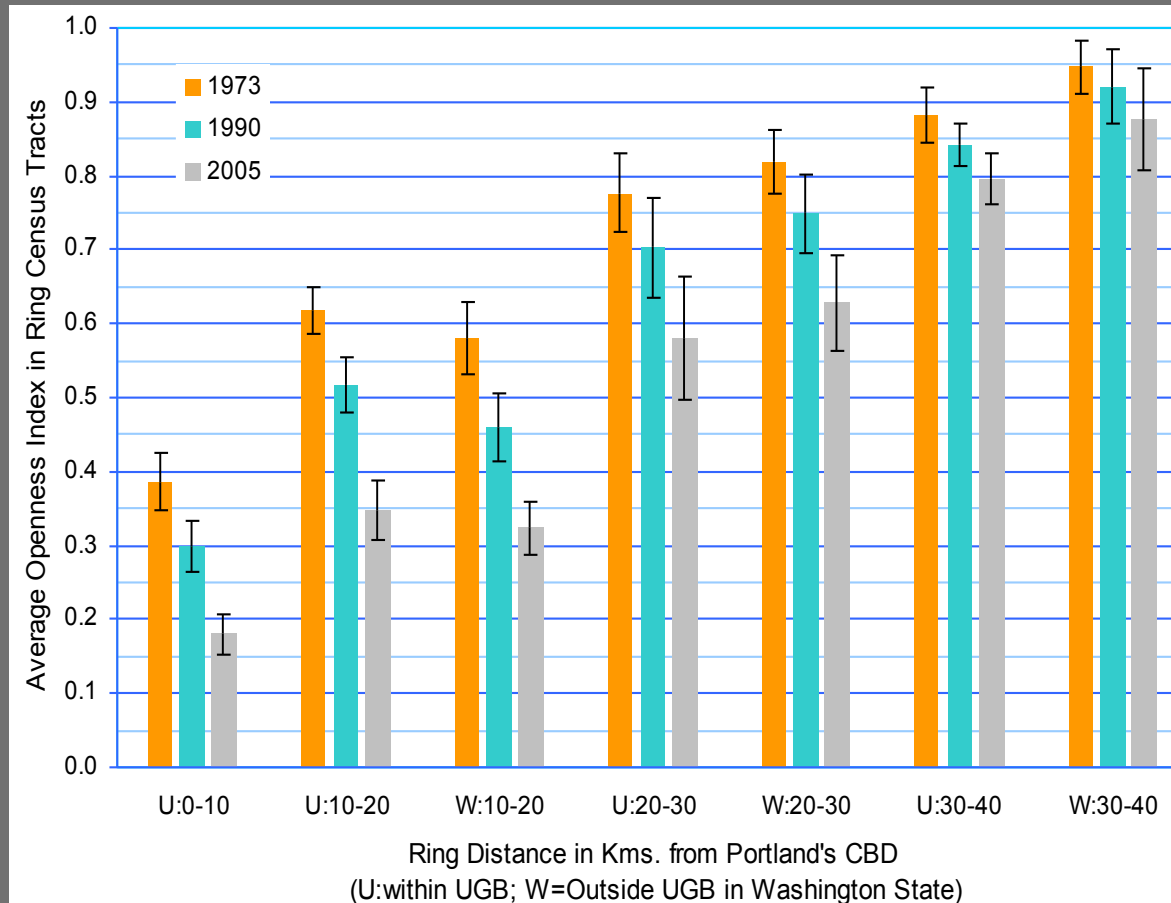
Urbanized Open Space adds 40%



Urbanized open space adds 180%

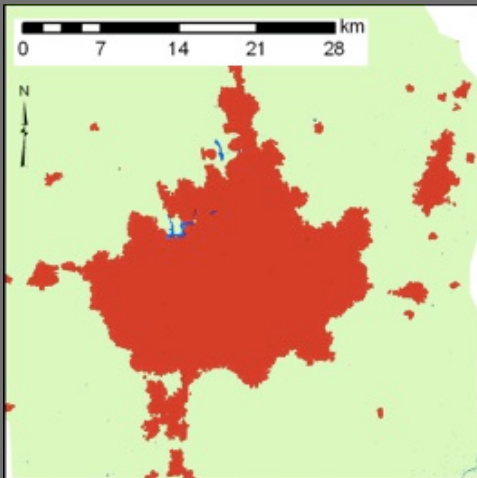
The city footprints of Los Angeles (2000) and Zhengzhou (2001)

4. The Fragmentation of Urban Landscapes

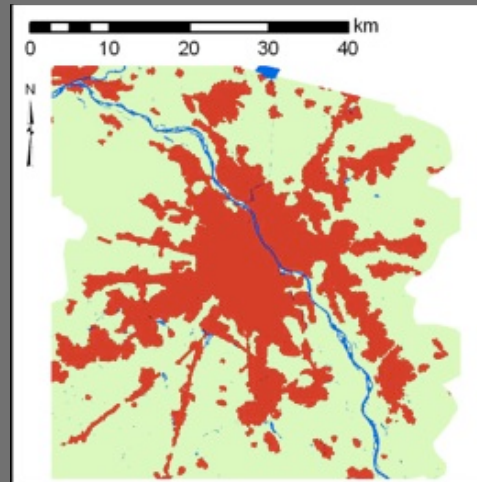


The decline in fragmentation within Portland's Urban Growth Boundary

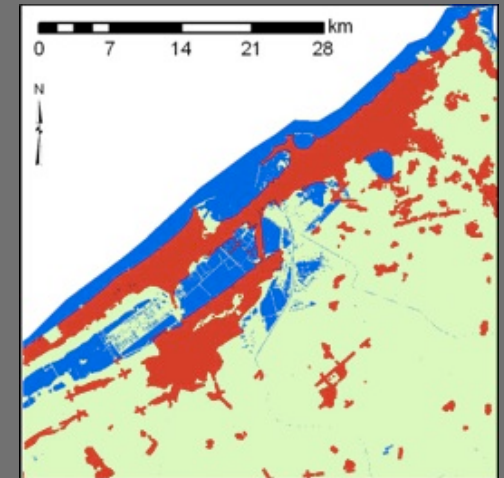
5. The Compactness of Urban Footprints



Ibadan, Nigeria



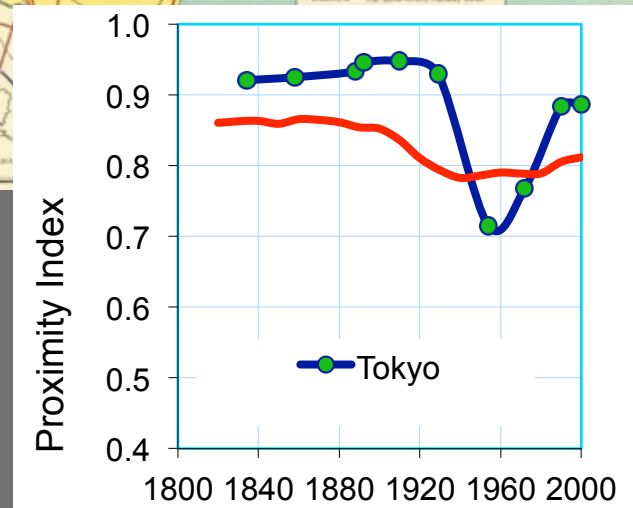
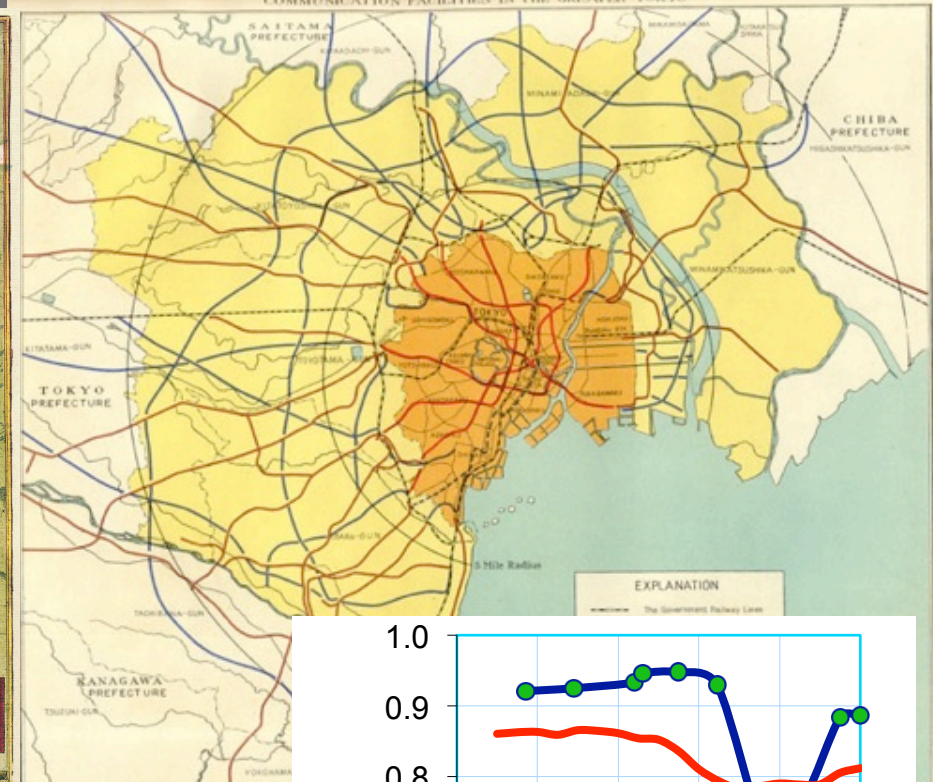
Warsaw, Poland



Alexandria, Egypt

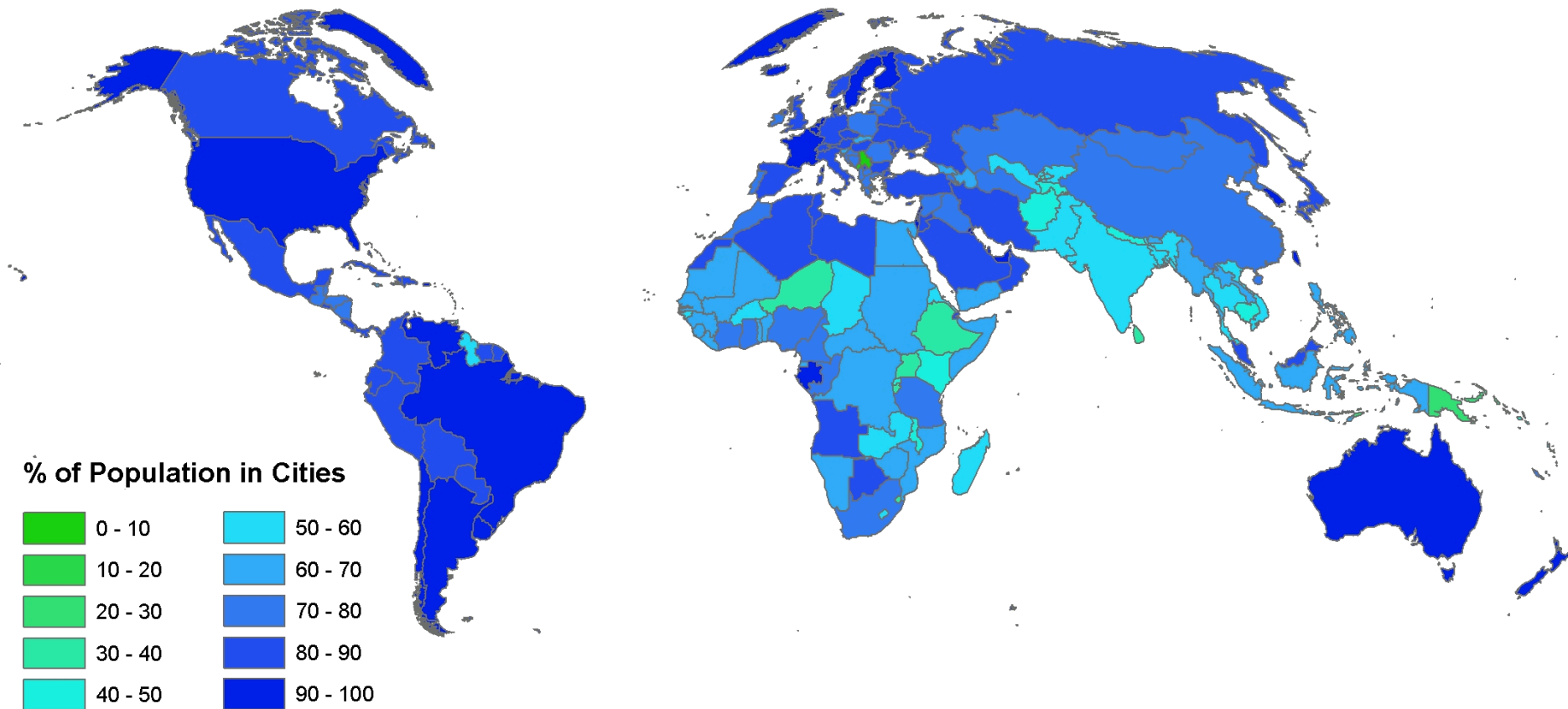
High, Medium, and Low Compactness of City Footprints in Ibadan (2000); Warsaw (2002); and Alexandria (1999)

5. The Compactness of Urban Footprints



High Perimeter Compactness in Palmanova, Italy, 1593-1623, and high Proximity Compactness in Tokyo, 1930

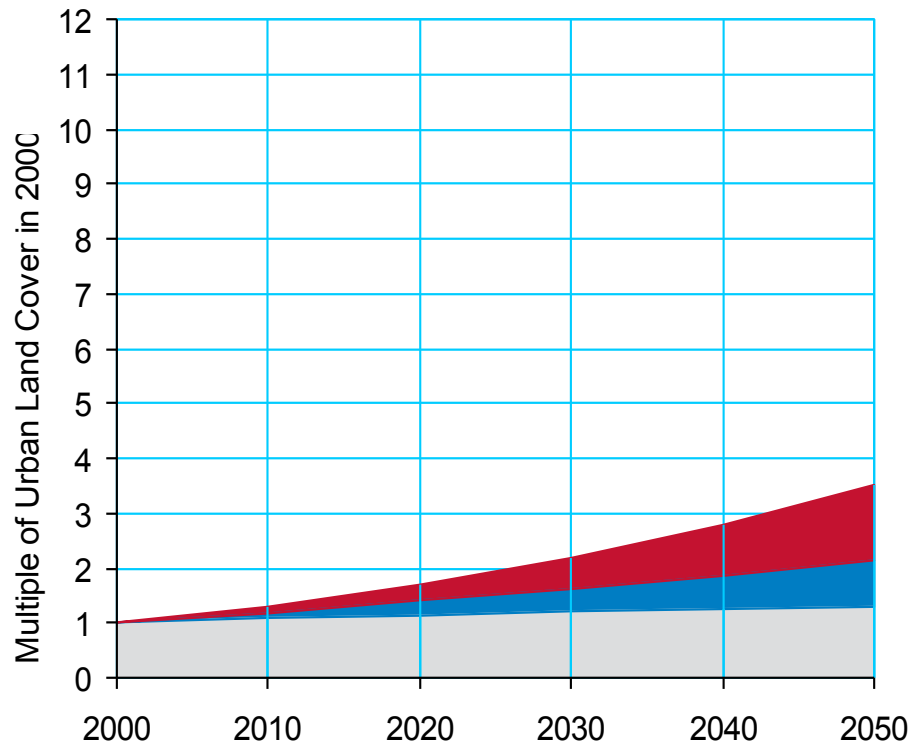
6. Urban Land cover Projections, 2000-2050



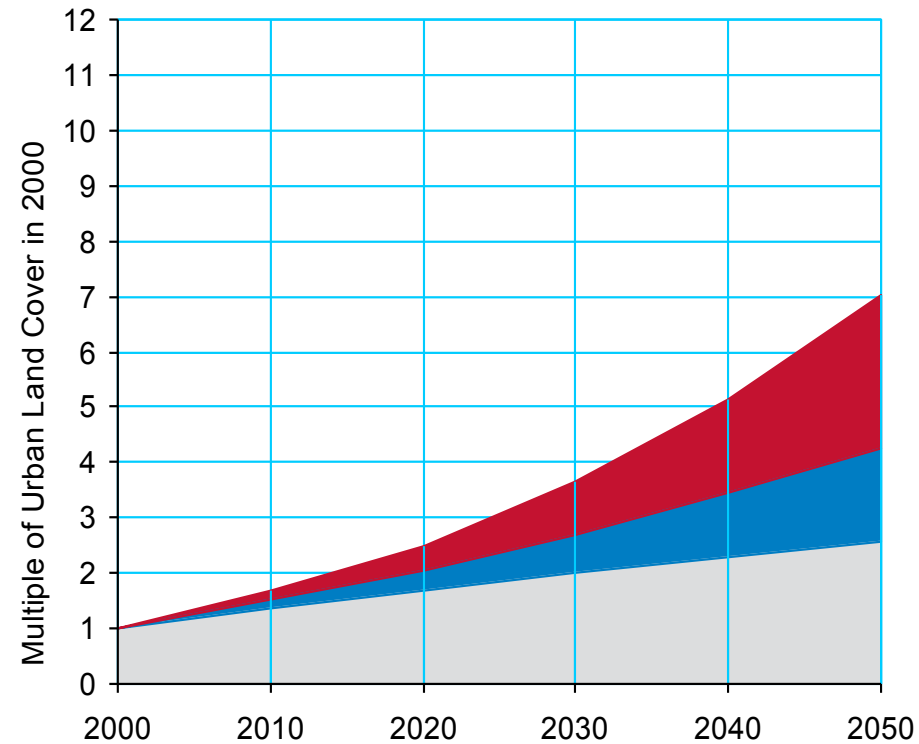
The levels of urbanization (the percentage of the population living in cities) in all countries in 2050

6. Urban Land cover Projections, 2000-2050

Developed Countries

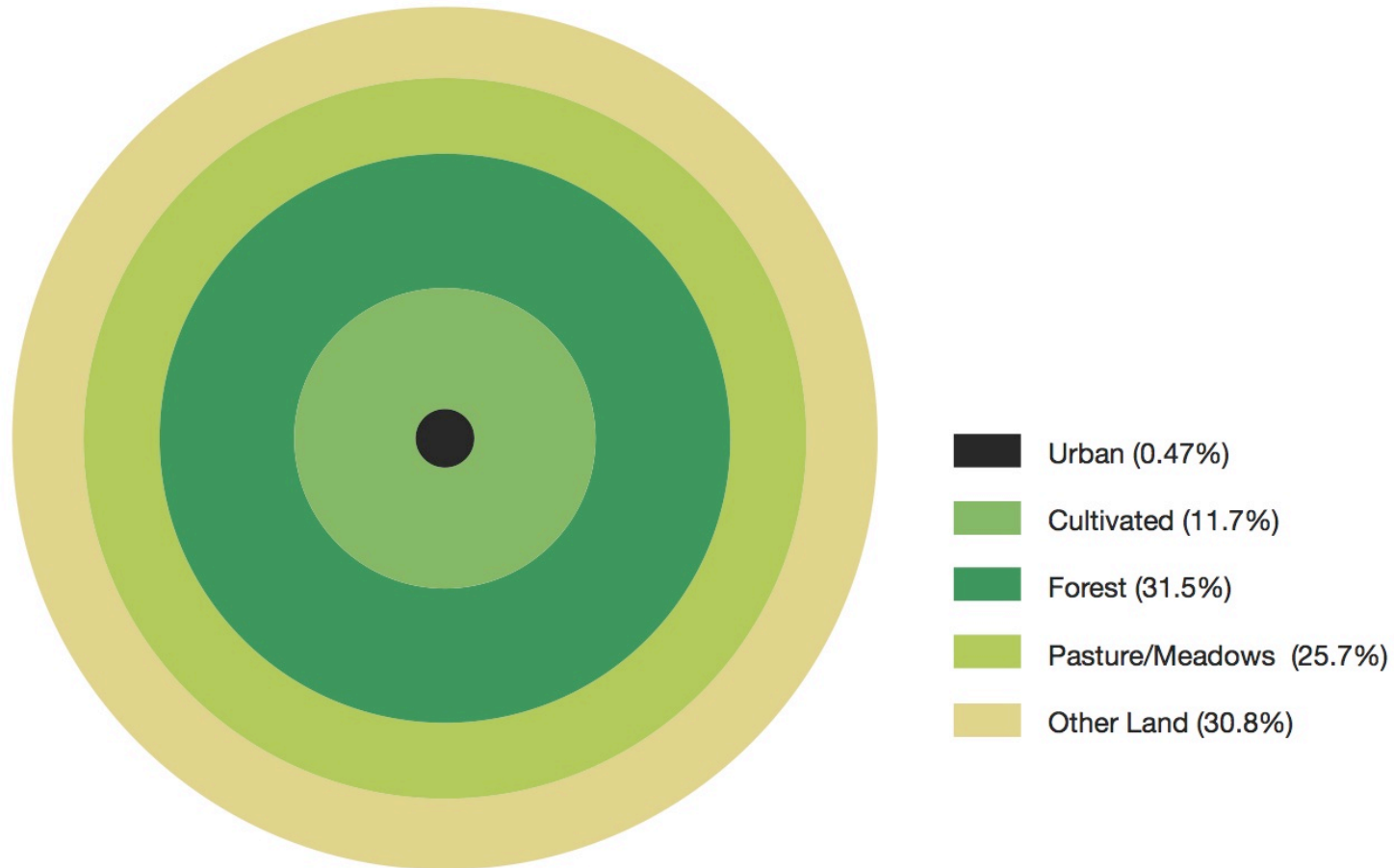


Developing Countries



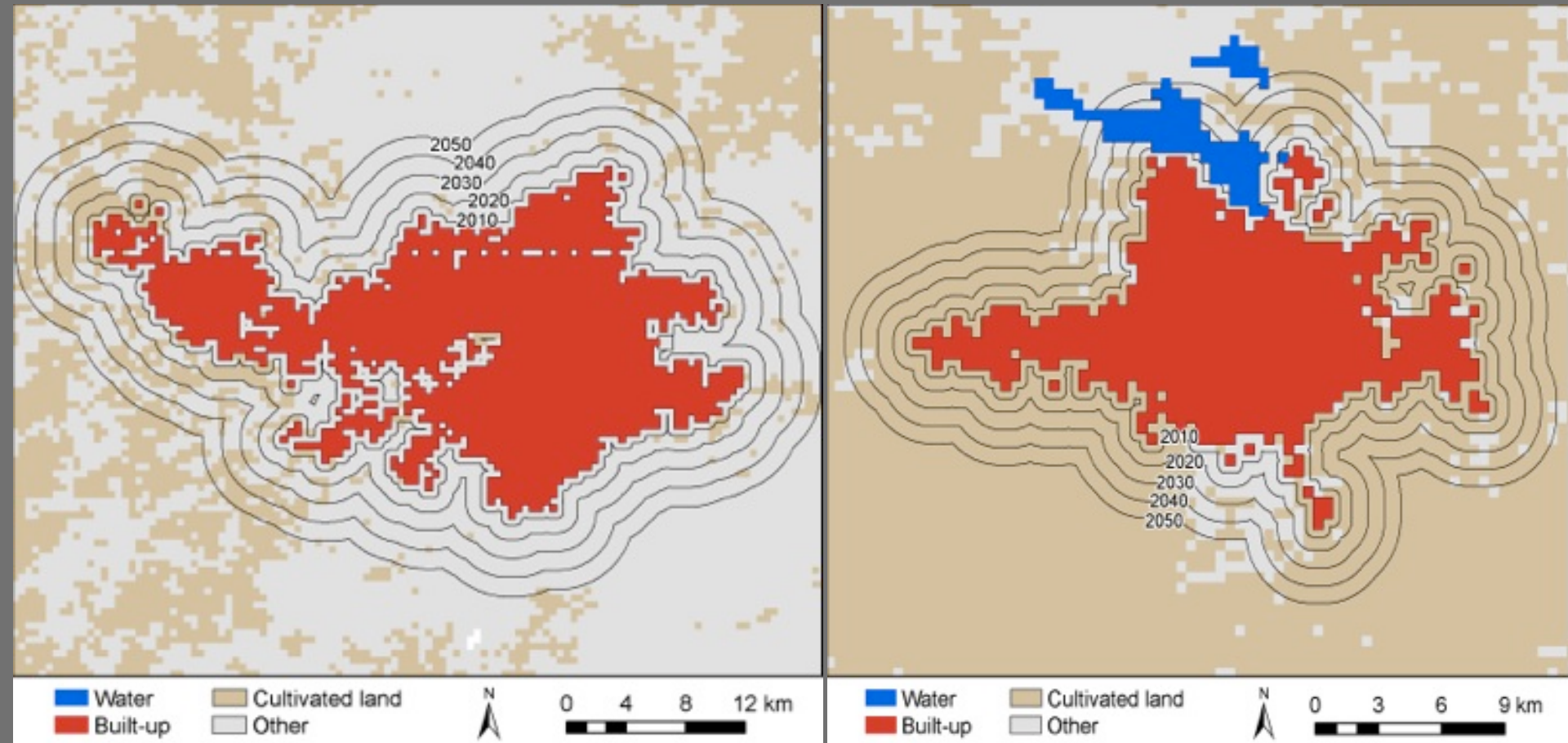
Urban land cover projections, based on (1) no density decline; (2) 1% per annum density decline; and (3) 2% per annum density decline

7. Urban Expansion into Cultivated Lands



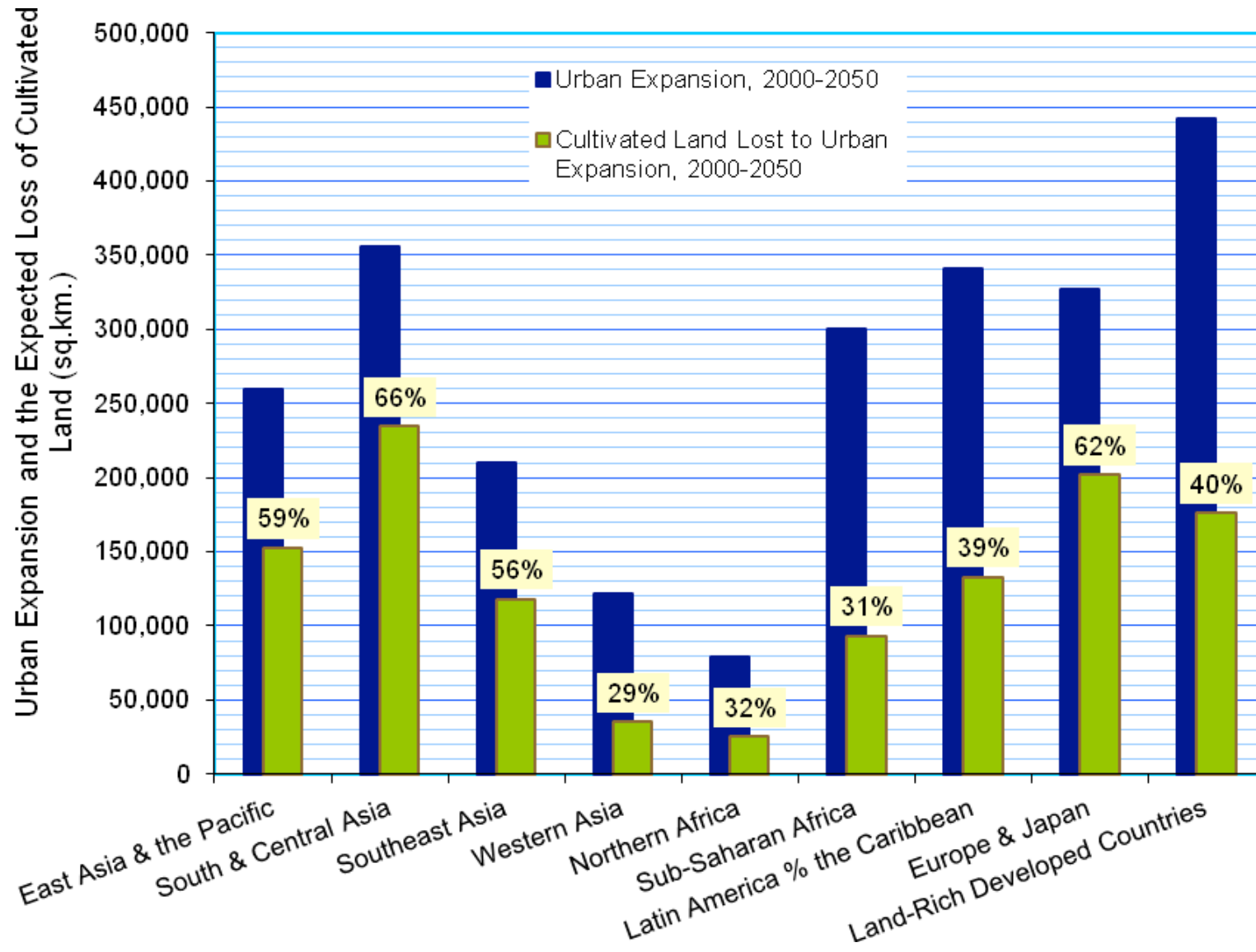
The relative shares of the land area of countries in different land uses, 2000, after Von Thünen

7. Urban Expansion into Cultivated Lands



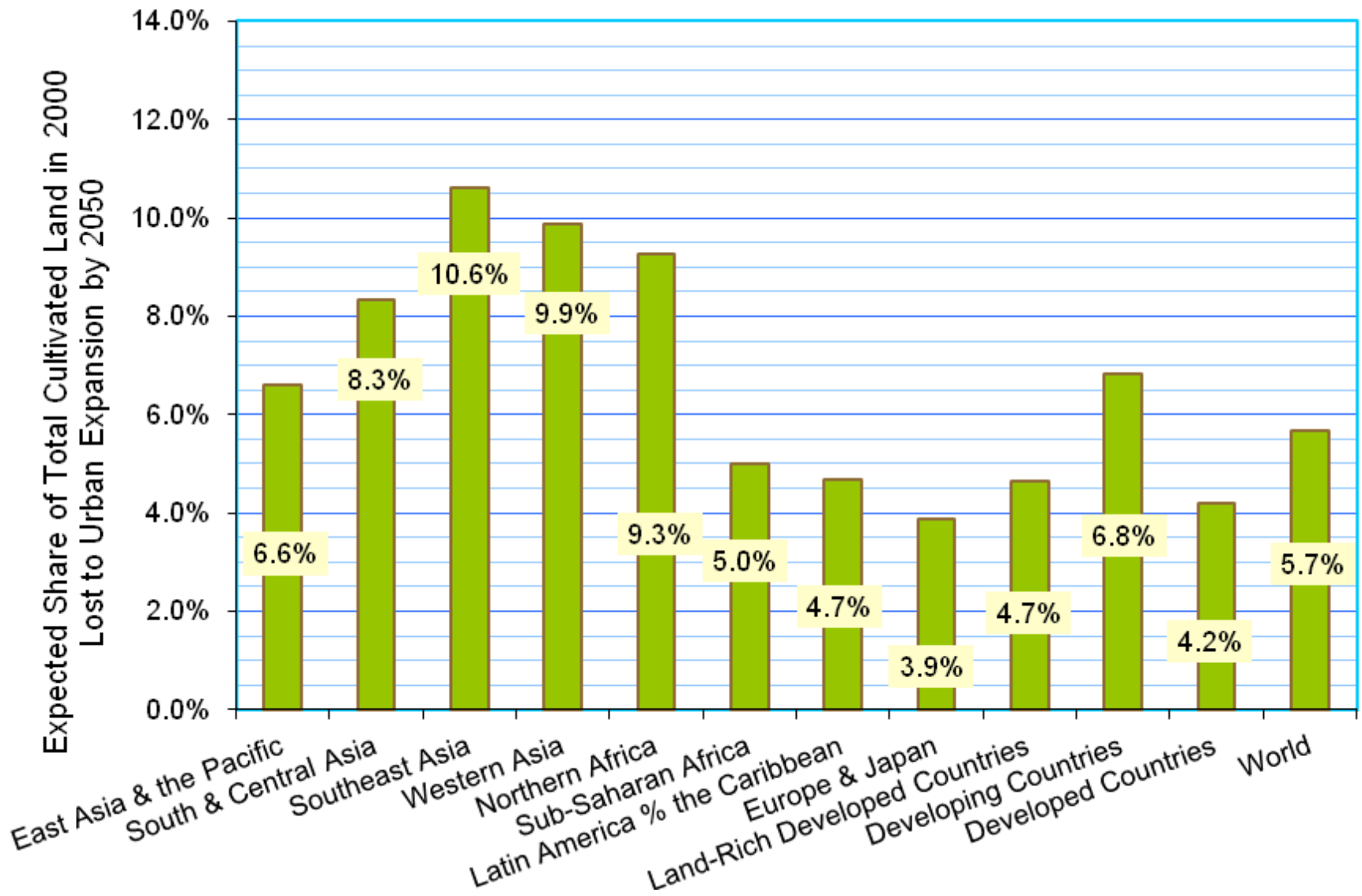
The loss of cultivated lands to urban expansion in Ankara, Turkey (left, 15%) and in Adana, Turkey (right, 85%), 2000-2050

7. Urban Expansion into Cultivated Lands



Shares of the expected areas of urban expansion 2000-2050 in world regions that will occupy cultivated land, assuming a 2 percent annual density decline

7. Urban Expansion into Cultivated Lands



Expected Loss of cultivated land due to urban expansion in world regions, 2000—2050, assuming a 2 percent annual density decline

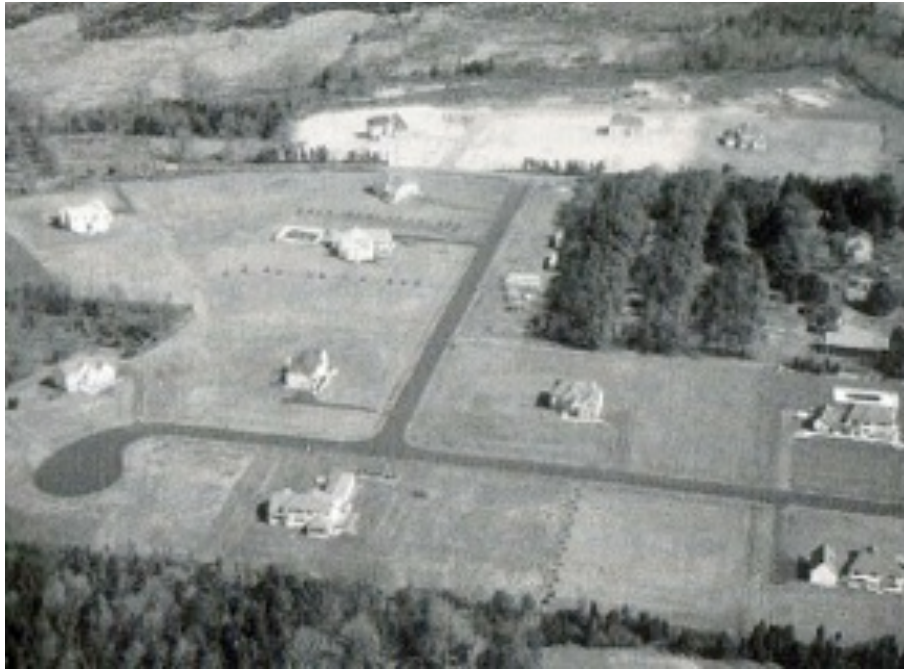
Conclusion: The Making Room Paradigm



1. *The Inevitable Expansion Proposition*: The expansion of cities that urban population growth entails cannot be contained. Instead we must make adequate room to accommodate it.

Activists protesting urban expansion in Surrey, England, 2009

Conclusion: The Making Room Paradigm



2. The Sustainable Densities Proposition: City densities must remain within a sustainable range. If density is too low it must be allowed to increase, and if it is too high, it must be allowed to decline.

Low-density sprawl in Franklin Lakes, New Jersey (left); and the high-density Karail Bastee in Mahakhali, Dhaka, Bangladesh.

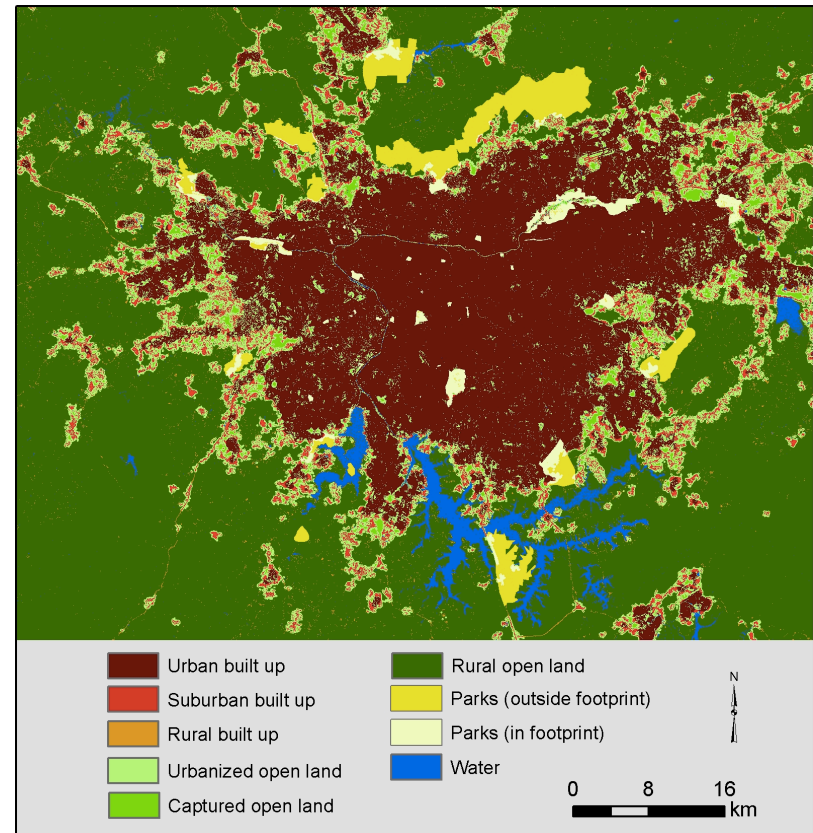
Conclusion: The Making Room Paradigm



3. The Decent Housing Proposition: Strict containment of urban expansion destroys the homes of the poor and puts new housing out of reach for most people. Decent housing for all can be ensured only if urban land is in ample supply.

Affordable housing in an urban village (Shenzhen, China) is demolished (left) to make way for unaffordable housing (Tianjin, China) because of containment.

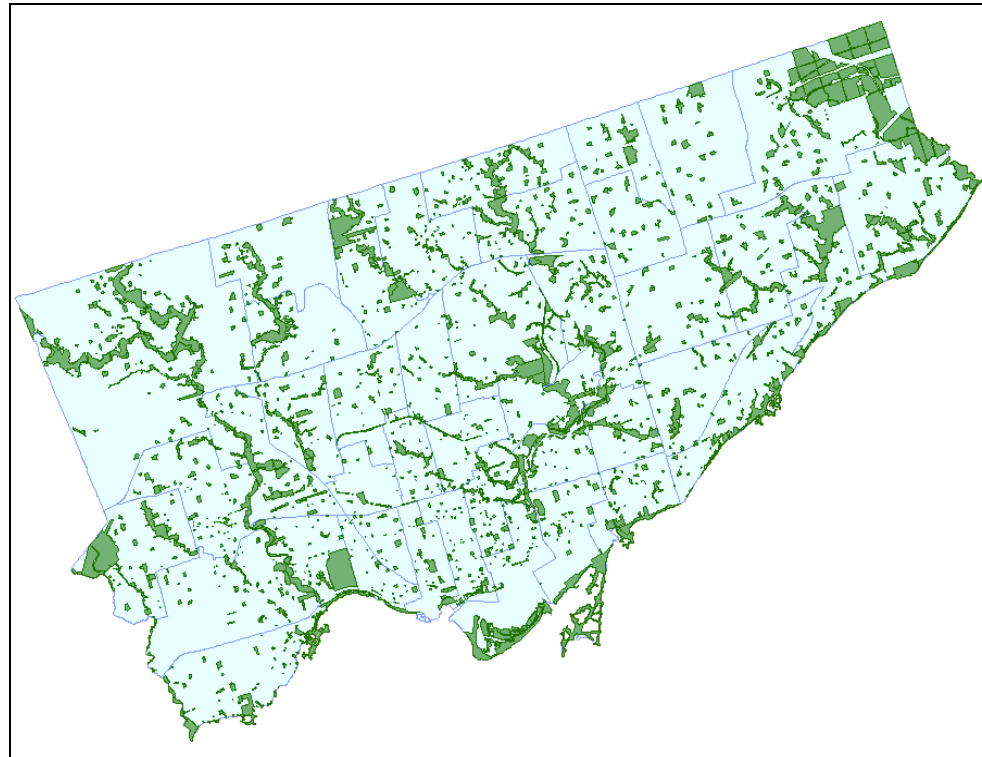
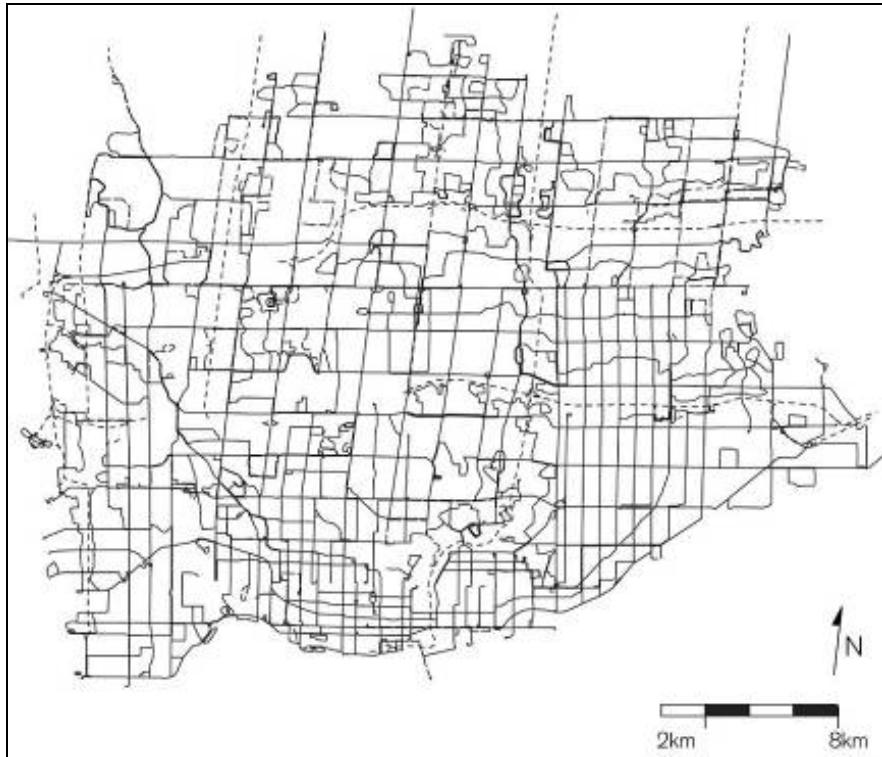
Conclusion: The Making Room Paradigm



4. *The Public Works Proposition*: As cities expand, the necessary land for public streets, public infrastructure networks, and public open spaces must be firmly secured in advance of development.

The absence of arterial roads in a 60km² suburb in northeast Bangkok, Thailand, and the absence of open space in Sao Paulo, Brazil

Conclusion: The Making Room Paradigm

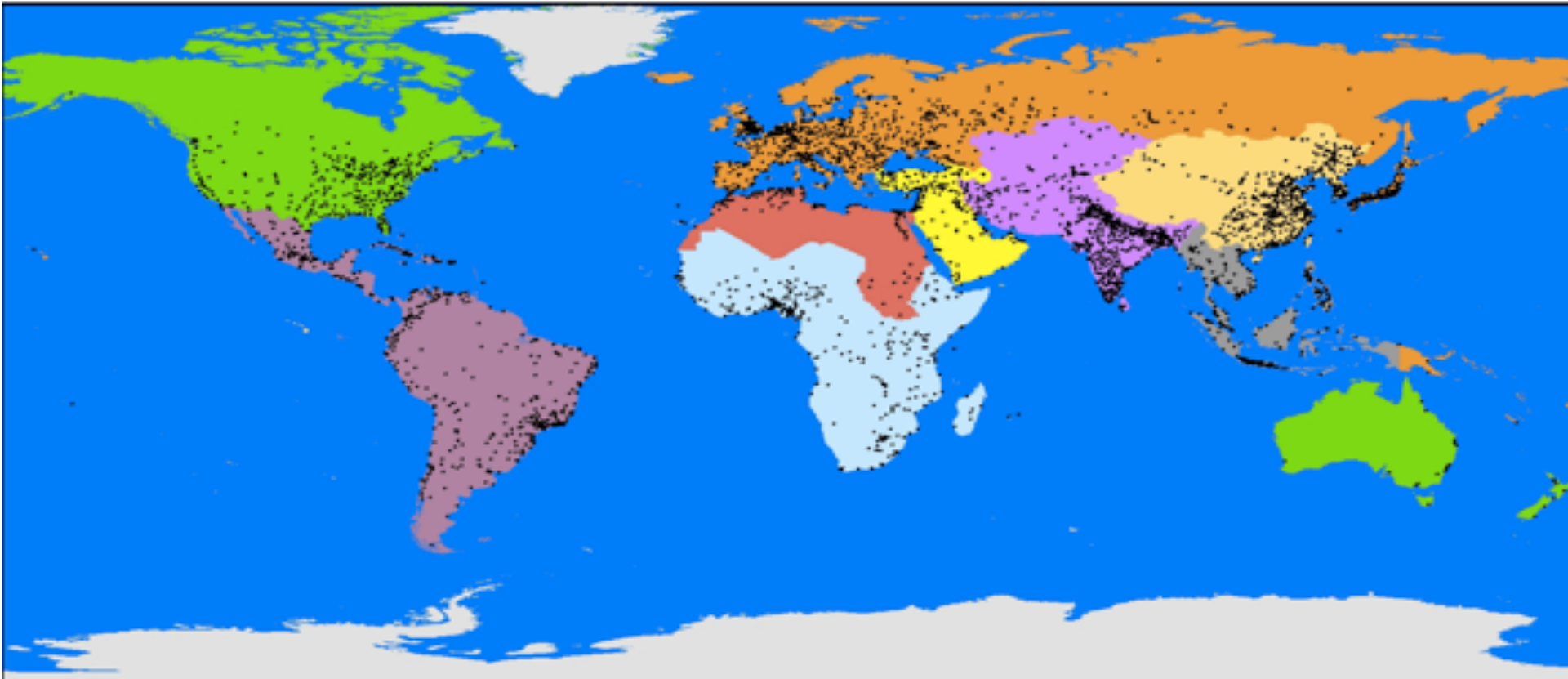


4. *The Public Works Proposition*: As cities expand, the necessary land for public streets, public infrastructure networks, and public open spaces must be firmly secured in advance of development.

The Toronto bus network (left) is located largely on its arterial road grid; 11.5% of its total land area is devoted to public parks (right).

PLANET OF CITIES

The universe of 4,000 cities could constitute a useful platform for an emerging science of cities



Thank you!