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Water and Sanitation in the World's Cities: Global Challenges in a Dynamic World

presented at 2008 Blueprints for Sustainability
Conference (December 9-12, 2008)

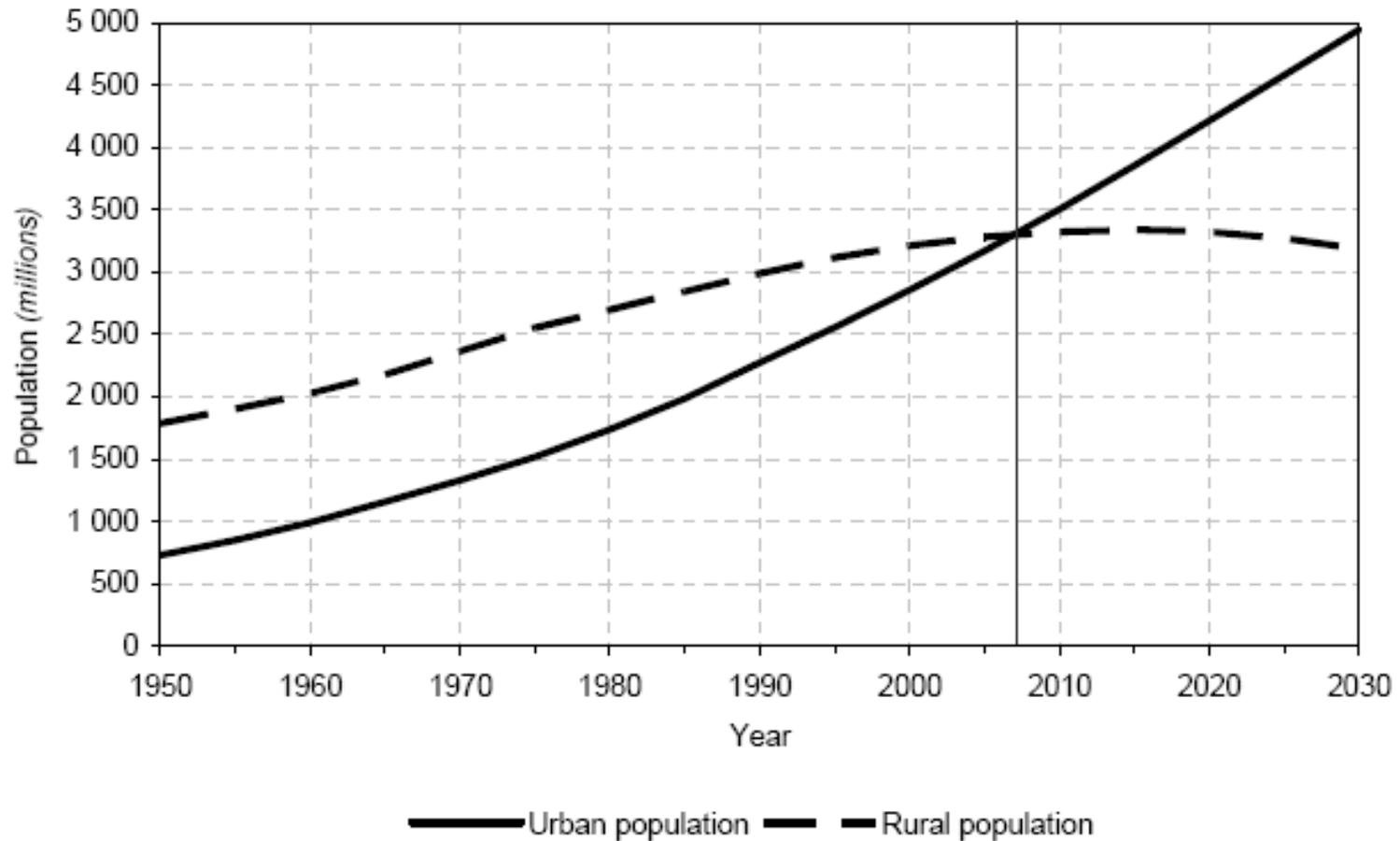
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From State of World's Cities – 2008/2009, UN Habitat

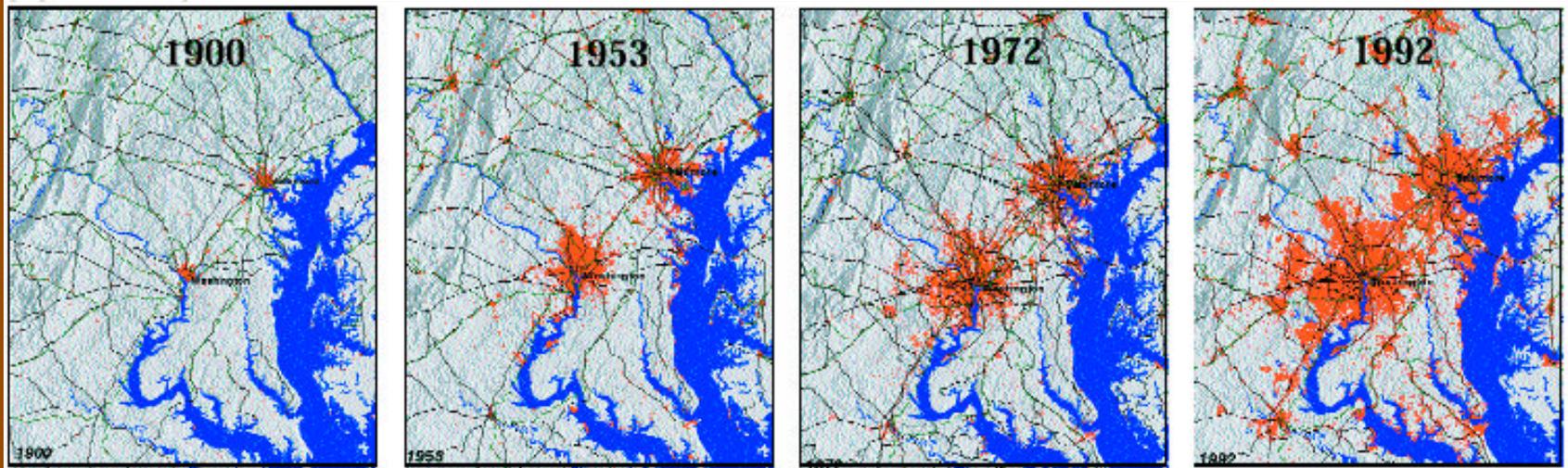
Half of humanity now lives in cities, and within two decades, nearly 60% of the world's people will be urban dwellers. Urban growth is most rapid in the developing world, where cities gain an average of 5 million residents every month.

As cities grow in size and population, harmony among the spatial, social and environmental aspects of a city and between their inhabitants becomes of paramount importance. This harmony hinges on two key pillars: equity and sustainability.

Urban and rural populations of the world: 1950-2030



Growth of the built environment in the Baltimore-Washington D.C. Metropolitan Area during the last century (from USEPA, 2001)



Built environment and flow of raw materials

(from Wagner, 2002)

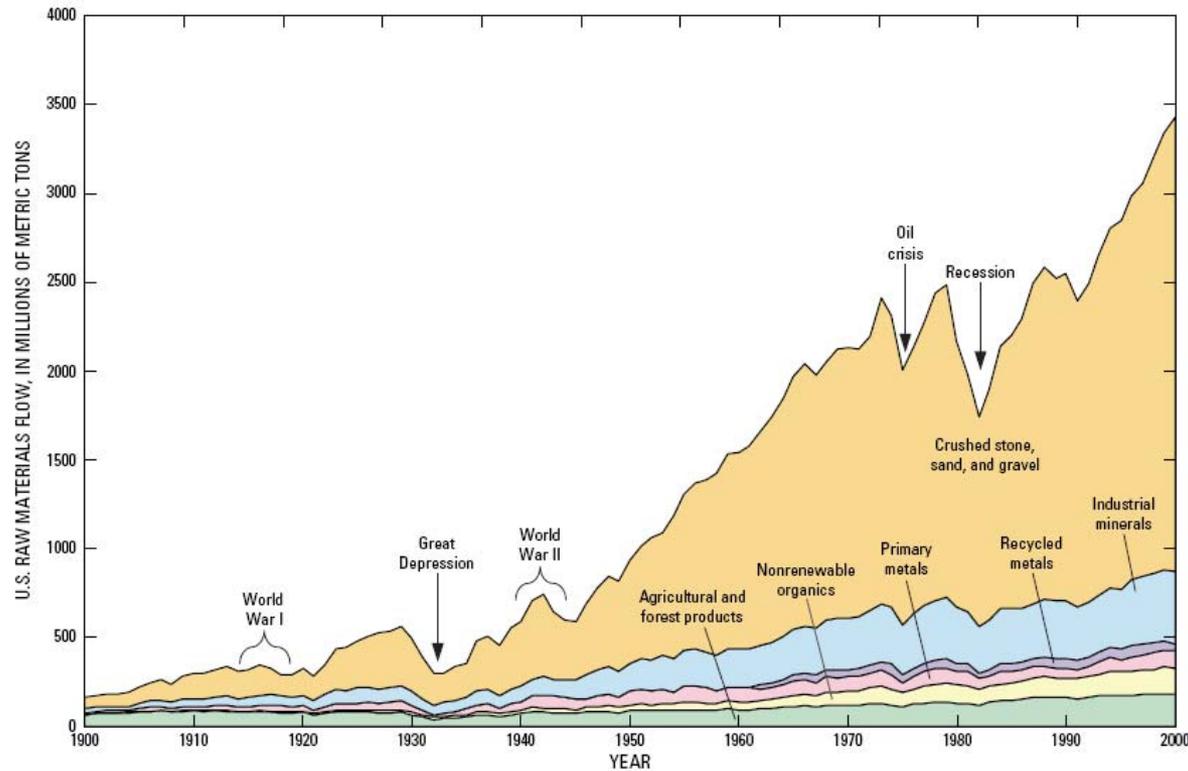


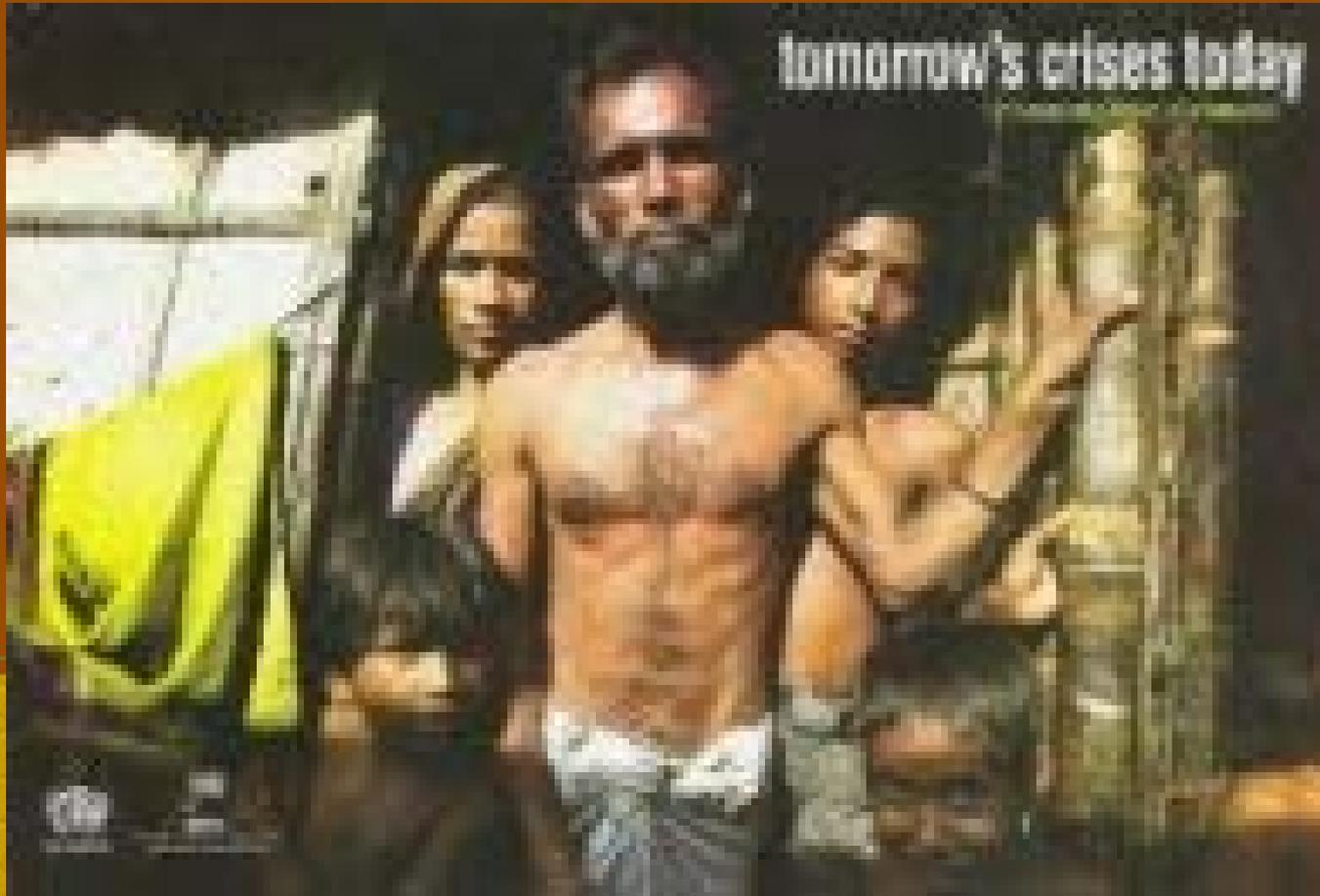
Figure 4. U.S. flow of raw materials by weight, 1900–98. The use of raw materials dramatically increased in the United States throughout the 20th century (modified from Matos and Wagner, 1998, fig. 3).

Existing and Emerging Environmental Issues (UNEP, 2002).

1. Globalization, trade & development
2. Coping with climate change & variability
3. The growth of megacities
4. Human vulnerability to climate change
5. Freshwater depletion and degradation
6. Marine and coastal degradation
7. Population growth
8. Rising consumption in developing countries
9. Biodiversity depletion
10. Biosecurity

Humans are a feature of the built environment (photo from UN Habitat)

(photo from UN Habitat)



Urban features also include CHILDREN, the first casualties of slums.



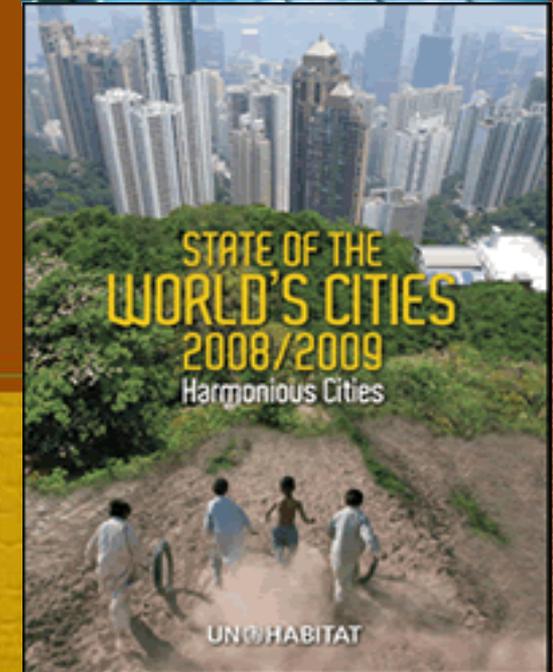
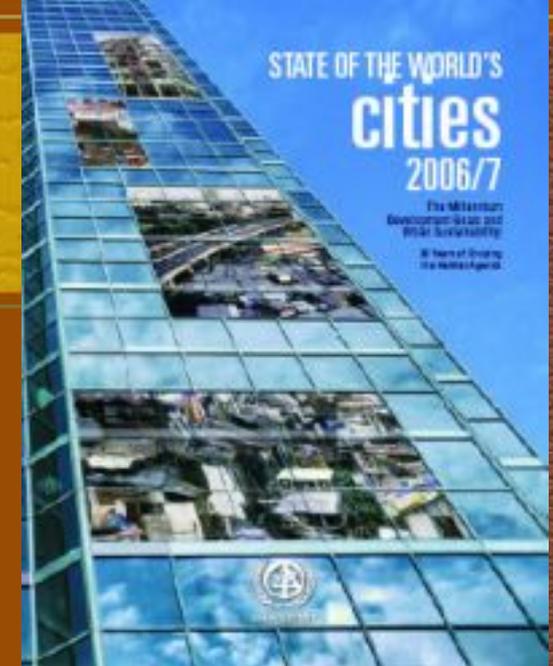
Source: Zerofootprint,2008

The average age of the developing world is 16 years, compared to a global average of 28 years



What is the state of the world's cities?

- **Roughly half the people in African and Asian cities lack healthy and convenient water and sanitation**
- **5.8% of children in cities of the developing world die before reaching the age of five.**
- **29% of cities in the developing world have areas considered as inaccessible or dangerous to the police. In Latin America and the Caribbean, this figure is 48%.**
- **In cities of the developing world, one out of every four households lives in poverty. 40% of African urban households and 25% of Latin American urban households are living below the locally defined poverty lines.**



Remainder of this morning's talk

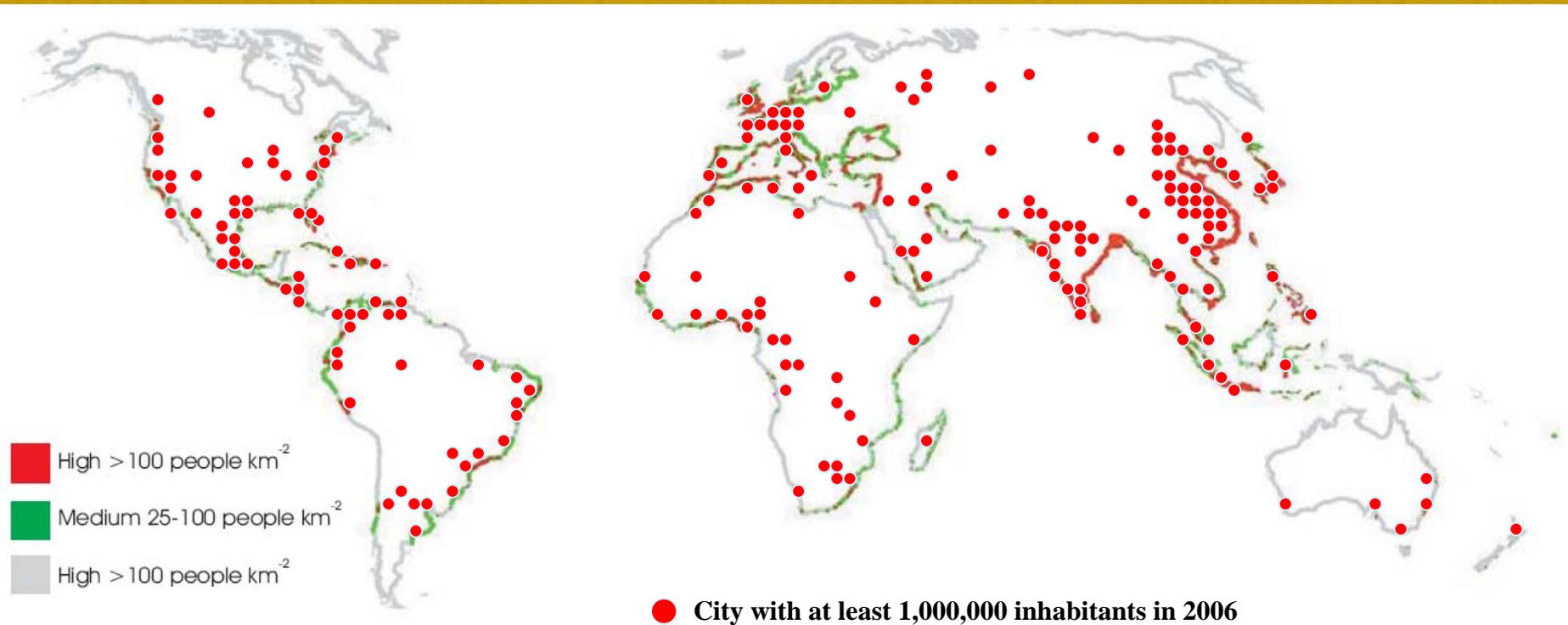
What is the urban phenomenon of this century?

What is the extent of the built environment/water interface?

How does a dynamic world provide additional challenges to providing infrastructure?

How should the design criteria of performance be changed to meet global sustainability challenges?

Population Pressure - Global Coastal Zones

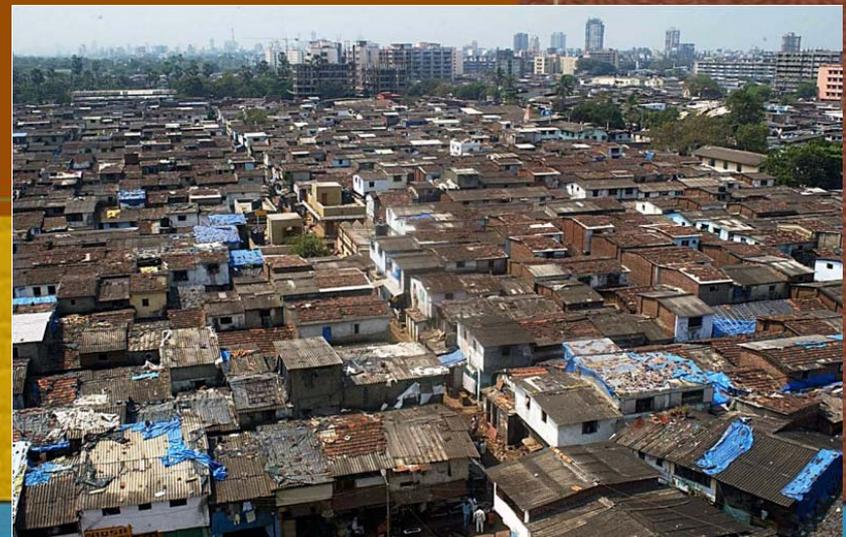


Source: UNEP, 2005

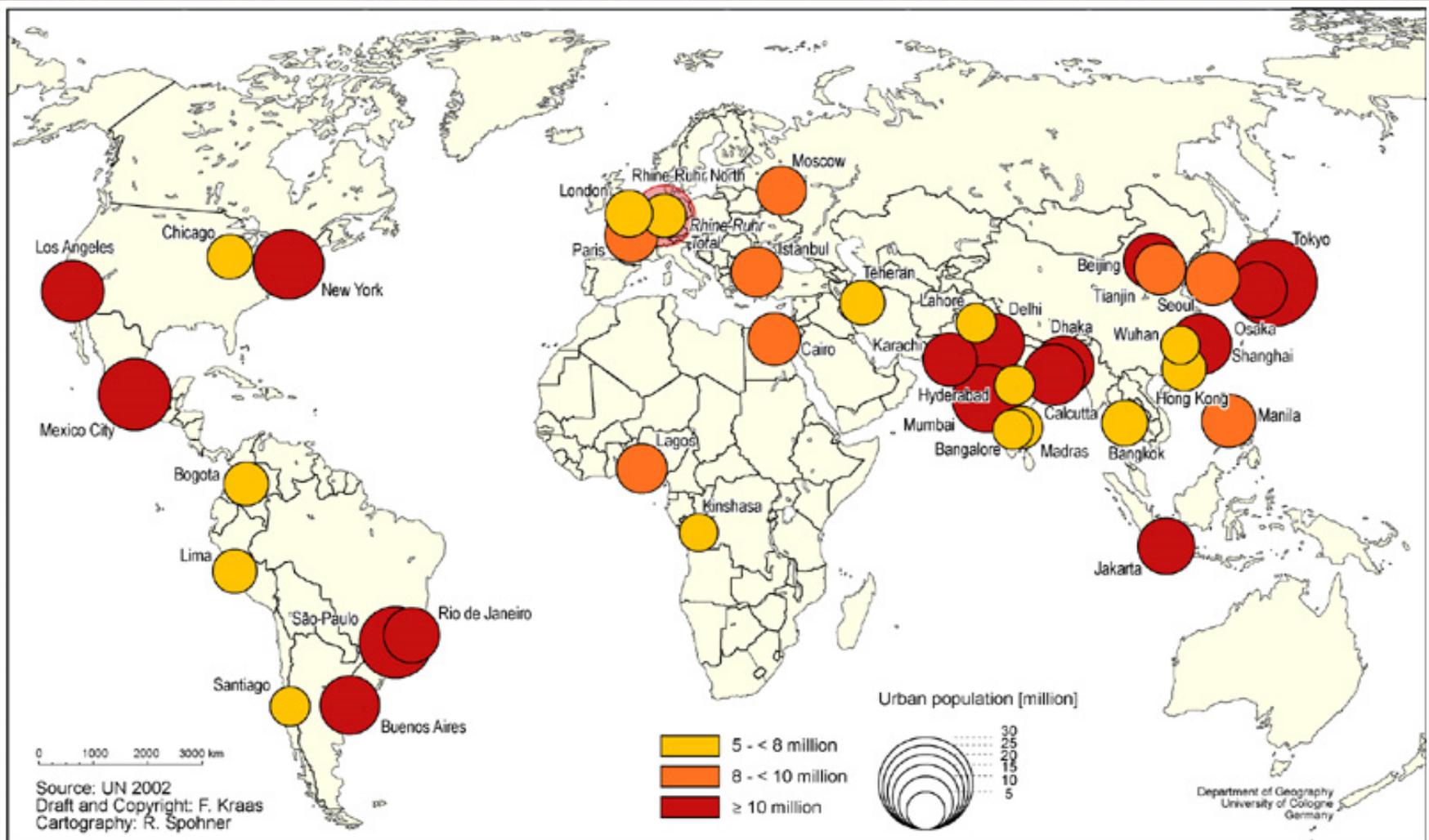
The urban phenomenon of this century will be **megacities**, a high-density metropolis with > 10 million inhabitants.

As hubs of trade, culture, information and industry, they will be vested with such power that at many levels they will act as city states that are independent of national and regional mediation

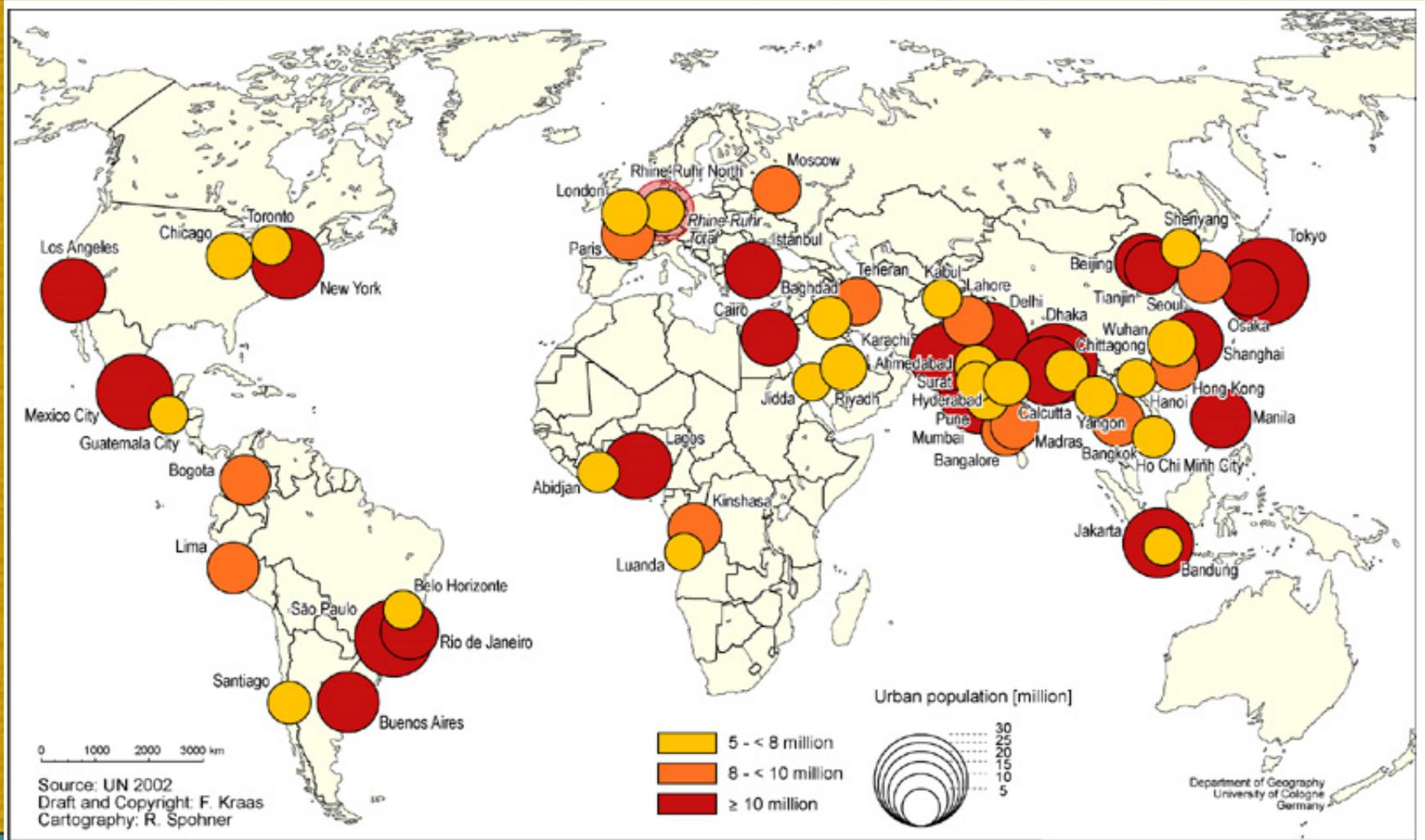
UN Habitat



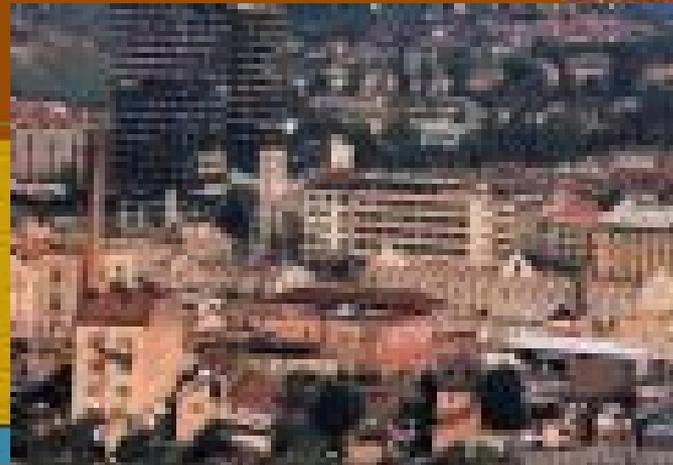
Megacities in 2000



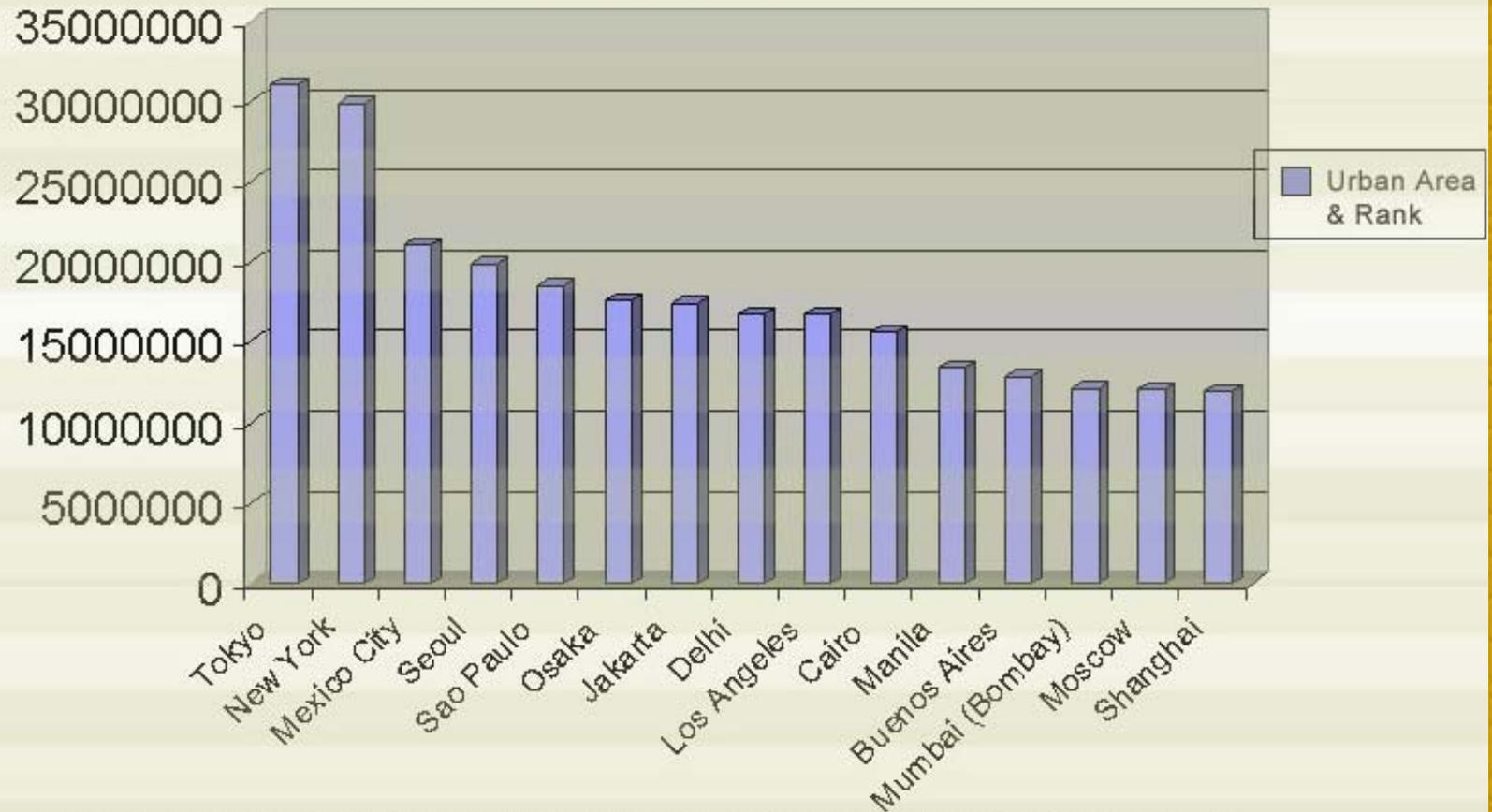
Megacities in 2015



And then there is the **metacity**, a massive sprawling conurbation of > 20 million.



World's most populous urban concentrations



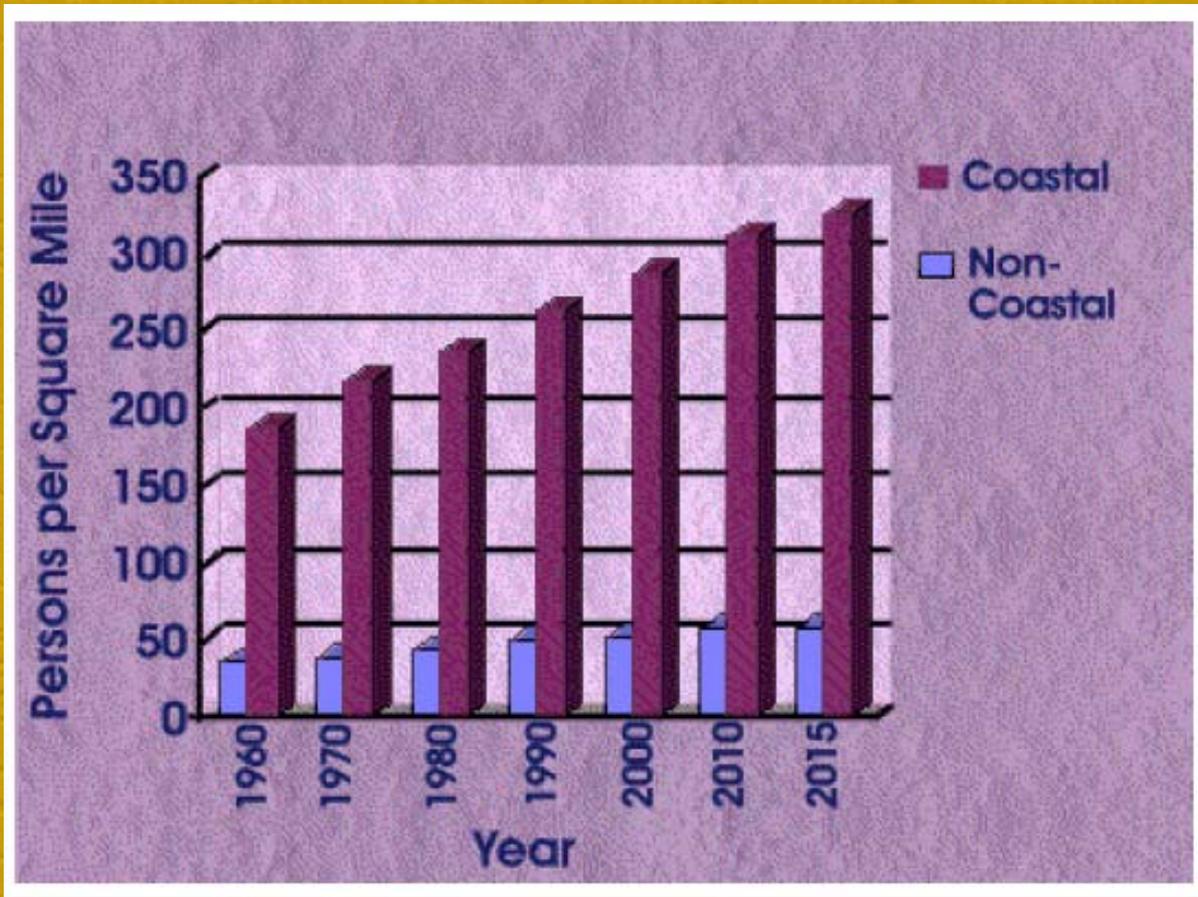
Source: World Almanac and Book of Facts, the U.S. Census Bureau, United Nations' sources

The built environment/water interface.....



Jakarta
13.67 million people
7th largest city

Coastal versus Non-Coastal Population Density in the U.S: 1960-2015



Note: Does not include Alaska

Sources: U.S. Bureau of the Census, 1997; National Planning Association, 1995

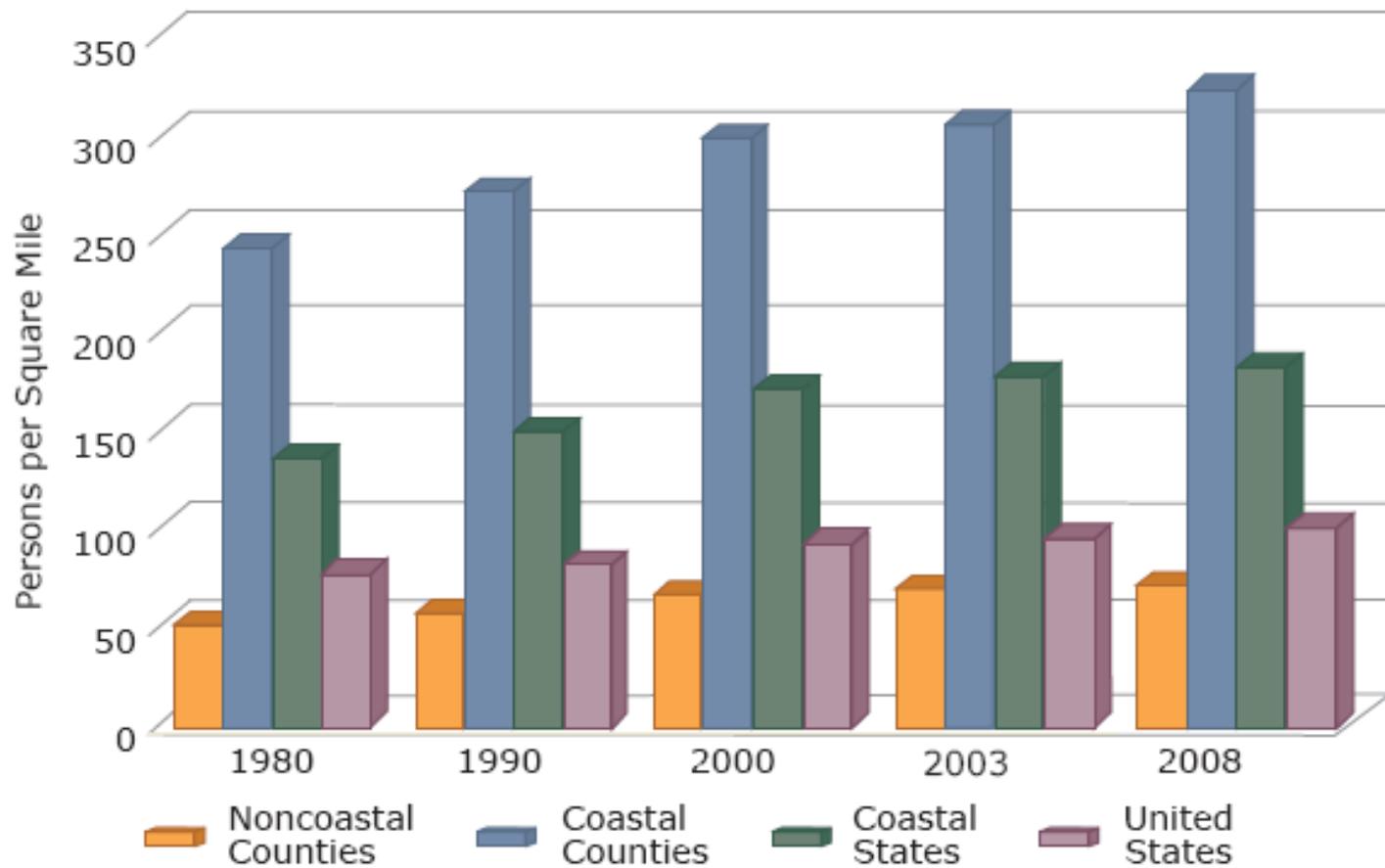
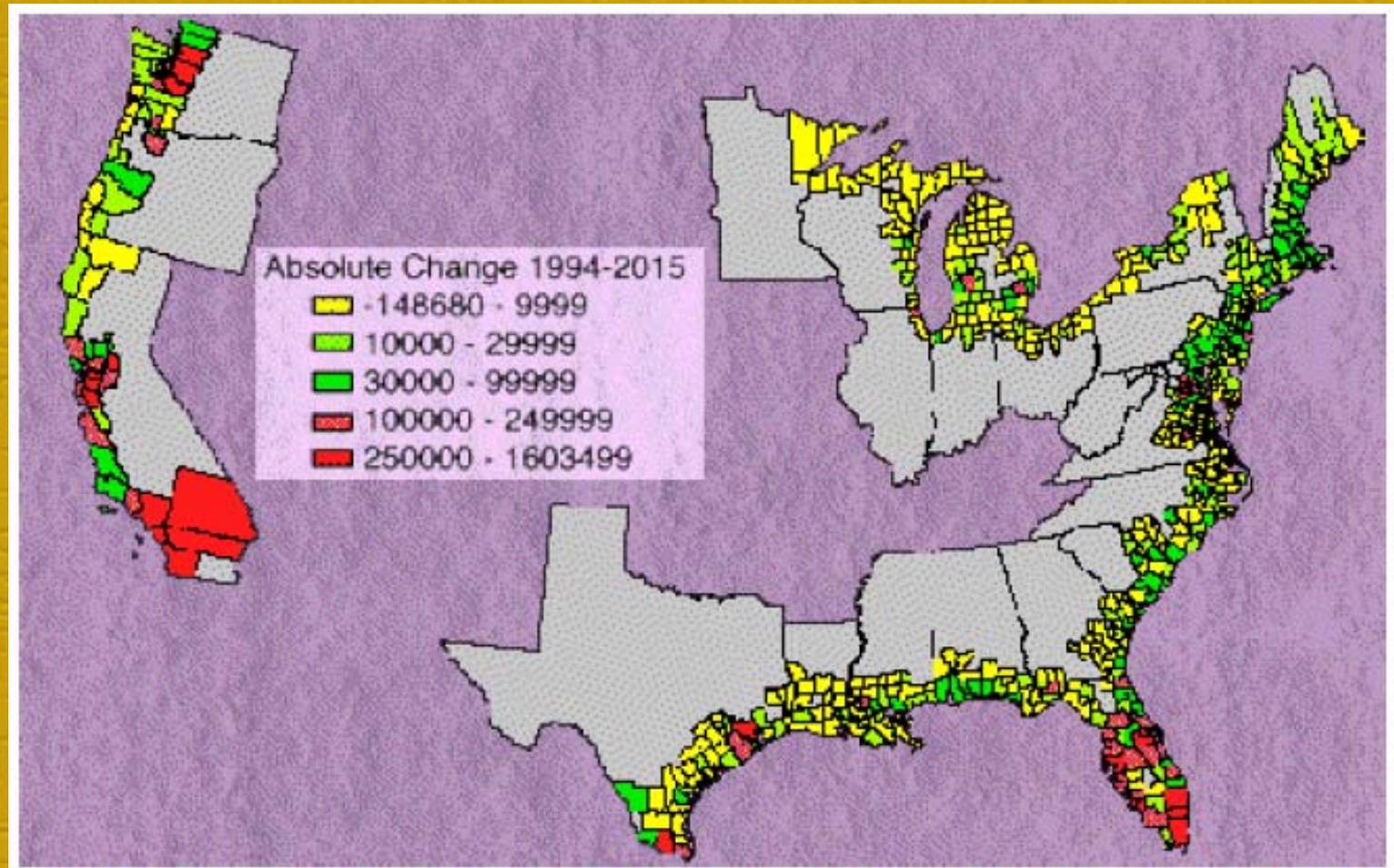


FIGURE 4. Population density of the United States, coastal states, coastal counties and noncoastal counties from 1980 to 2008

Source: U.S. Census Bureau and W&PE, Inc.

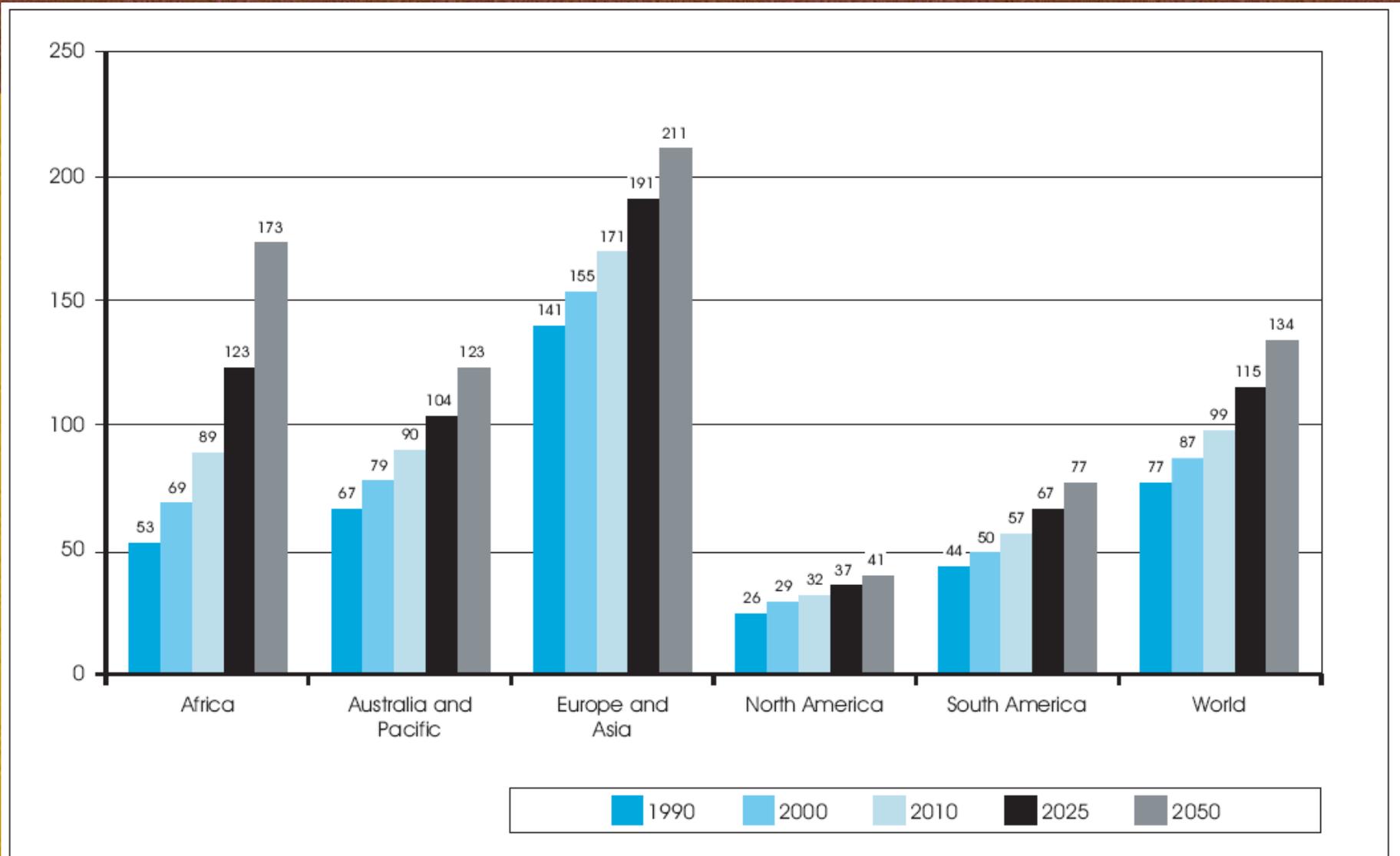
Project Population change from 1994 – 2015: absolute numbers (U.S)



21 of world's 33 mega-cities are located in coastal areas.

Average population density in coastal areas is twice the global average while the biodiversity of aquatic ecosystems continues to decline.

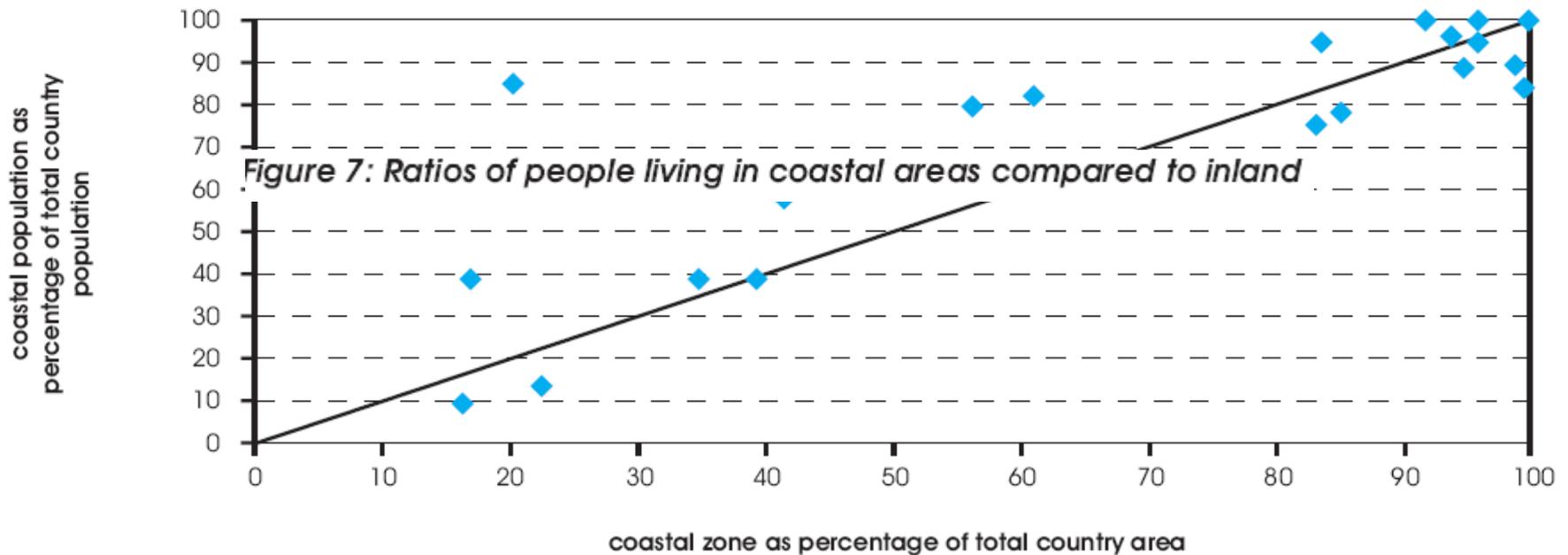
Global population in coastal zones (people/km²)



Source: UNEP, 2005

Ratio of people living in coastal areas compared to inland (developed countries)

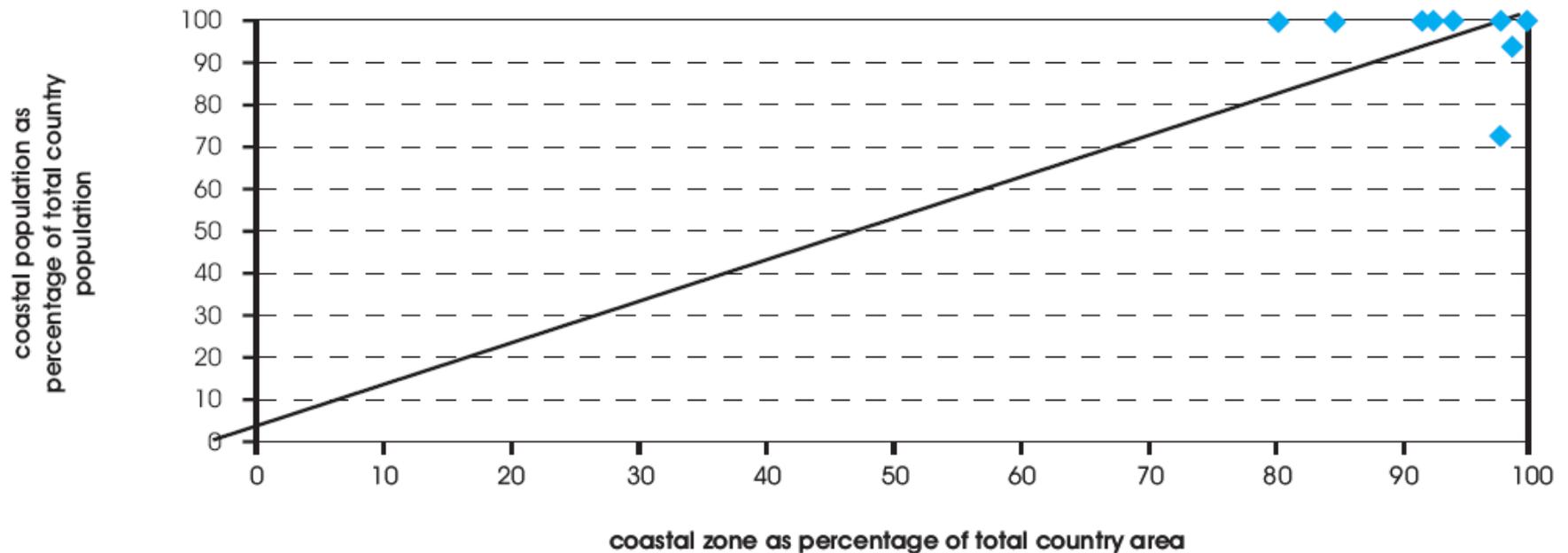
a. Developed Countries



Source: UNEP, 2005

Ratio of people living in coastal areas compared to inland (small nations/island states)

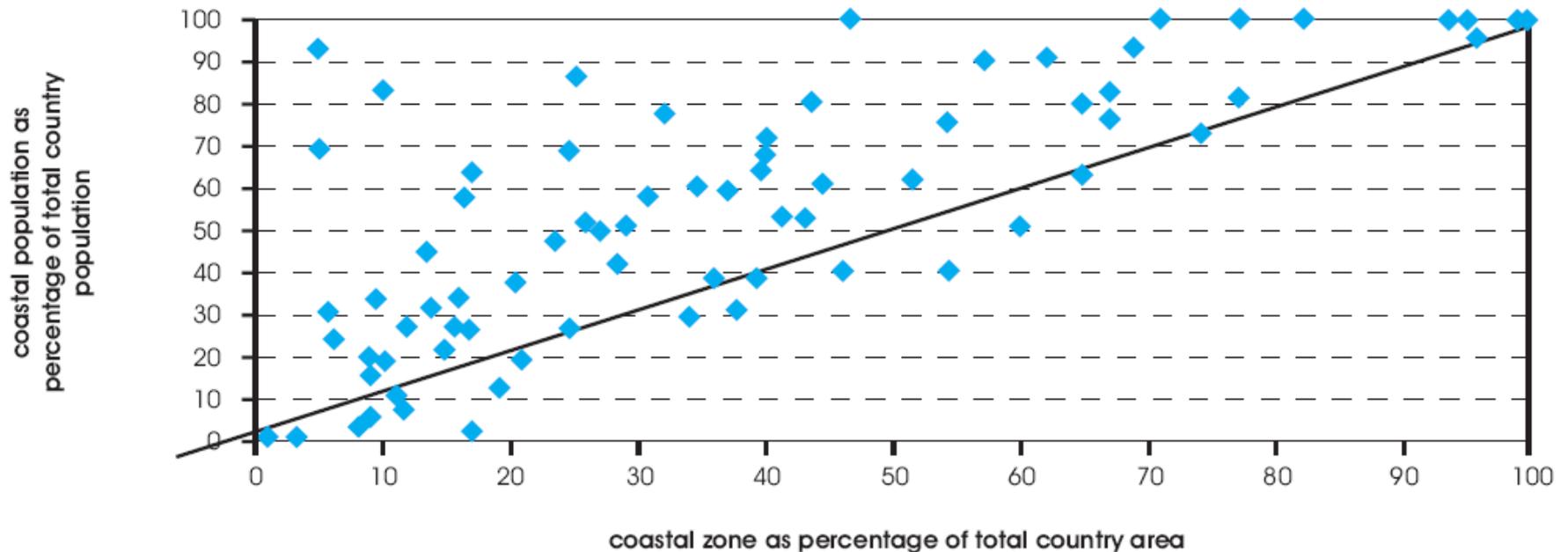
c. Small Nations and Island States



Source: UNEP, 2005

Ratio of people living in coastal areas compared to inland (developing countries)

b. Developing Countries



Source: UNEP, 2005

Table 1: Per Cent of Population and Land Area in Low Elevation Coastal Zone by Region, 2000

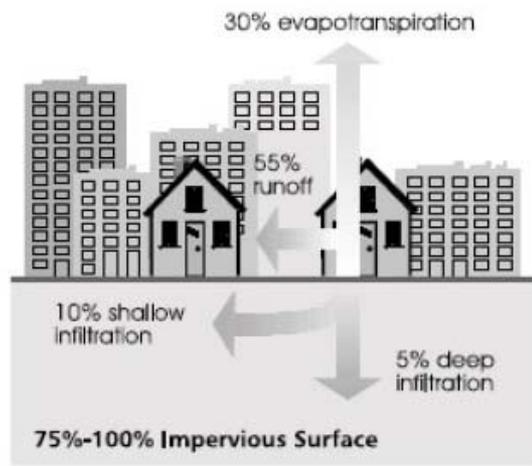
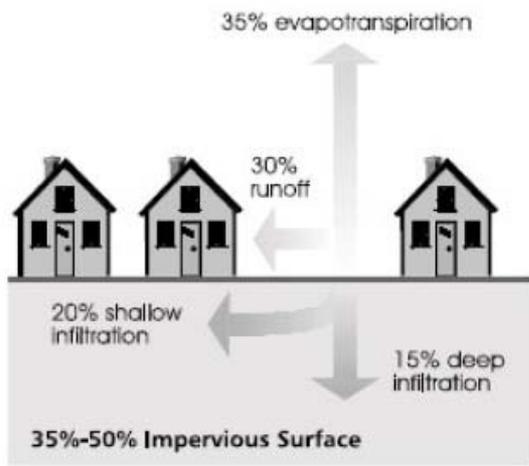
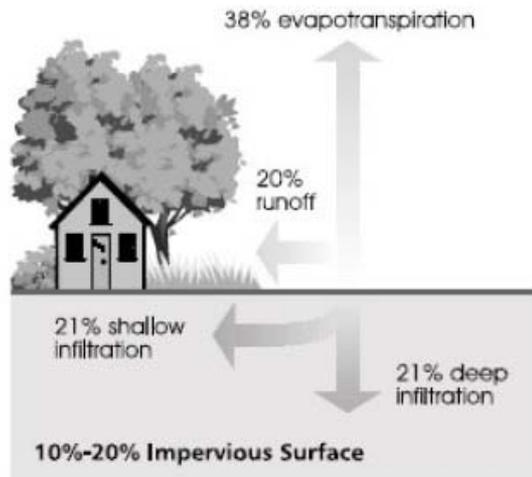
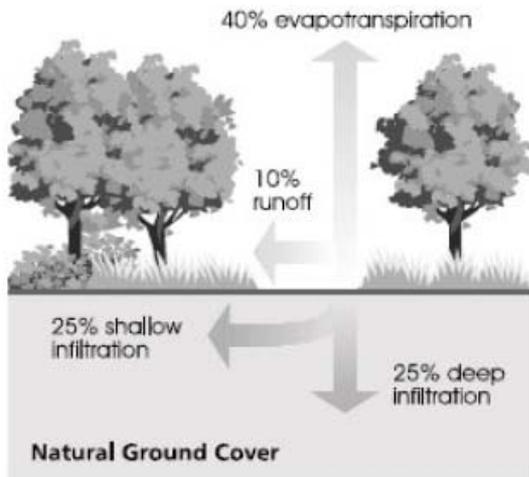
Region	Shares of region's population and land in LECZ			
	Total Population (%)	Urban Population (%)	Total Land (%)	Urban Land (%)
Africa	7	12	1	7
Asia	13	18	3	12
Europe	7	8	2	7
Latin America	6	7	2	7
Australia and New Zealand	13	13	2	13
North America	8	8	3	6
Small Island States	13	13	16	13
World	10	13	2	8

Source: McGranahan, G., D. Balk and B. Anderson. Forthcoming. "The Rising Risks of Climate Change: Urban Population Distribution and Characteristics in Low Elevation Coastal Zones." *Environment and Urbanization*.

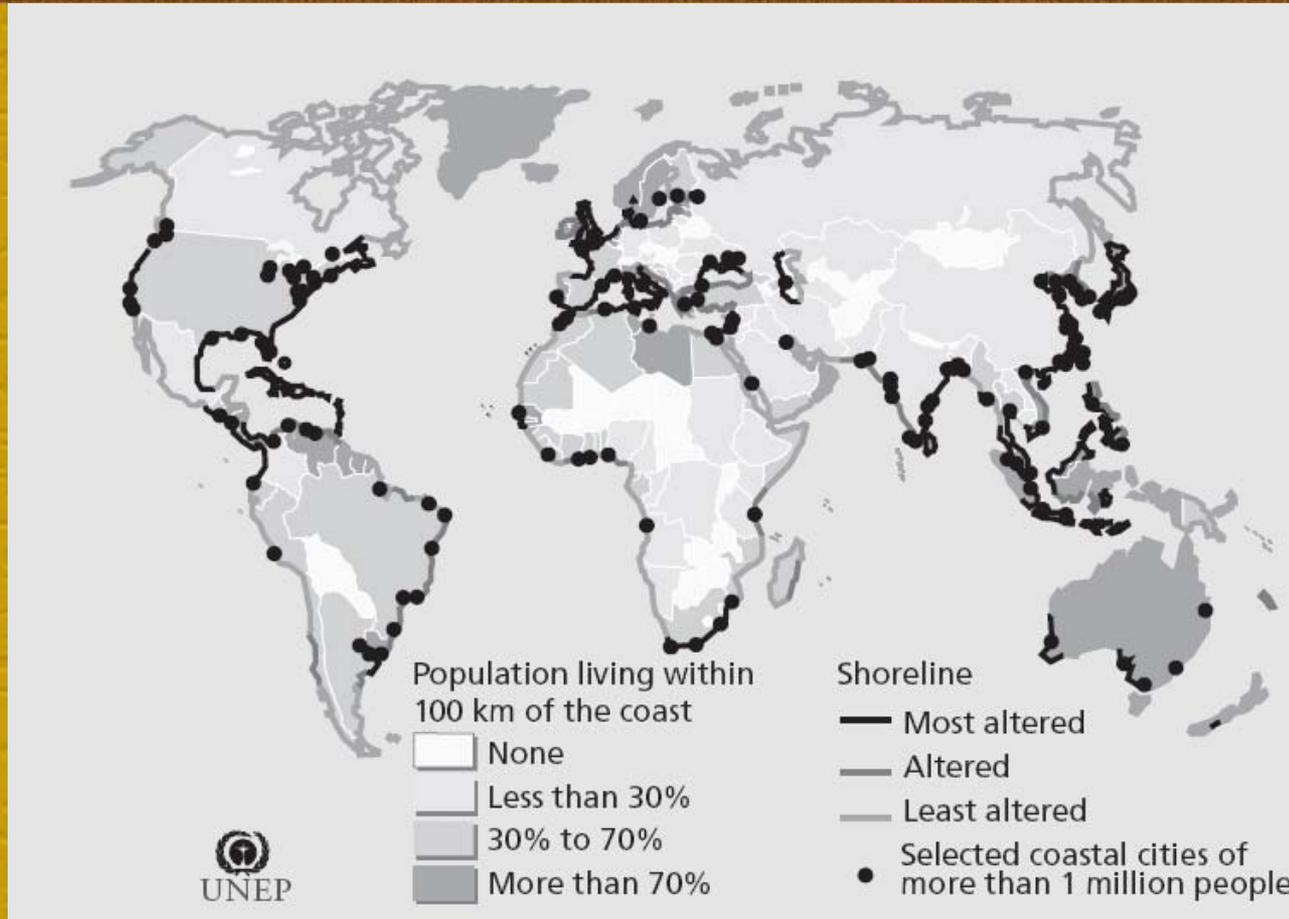
Land cover distribution in global coastal zones



Source: UNEP, 2005



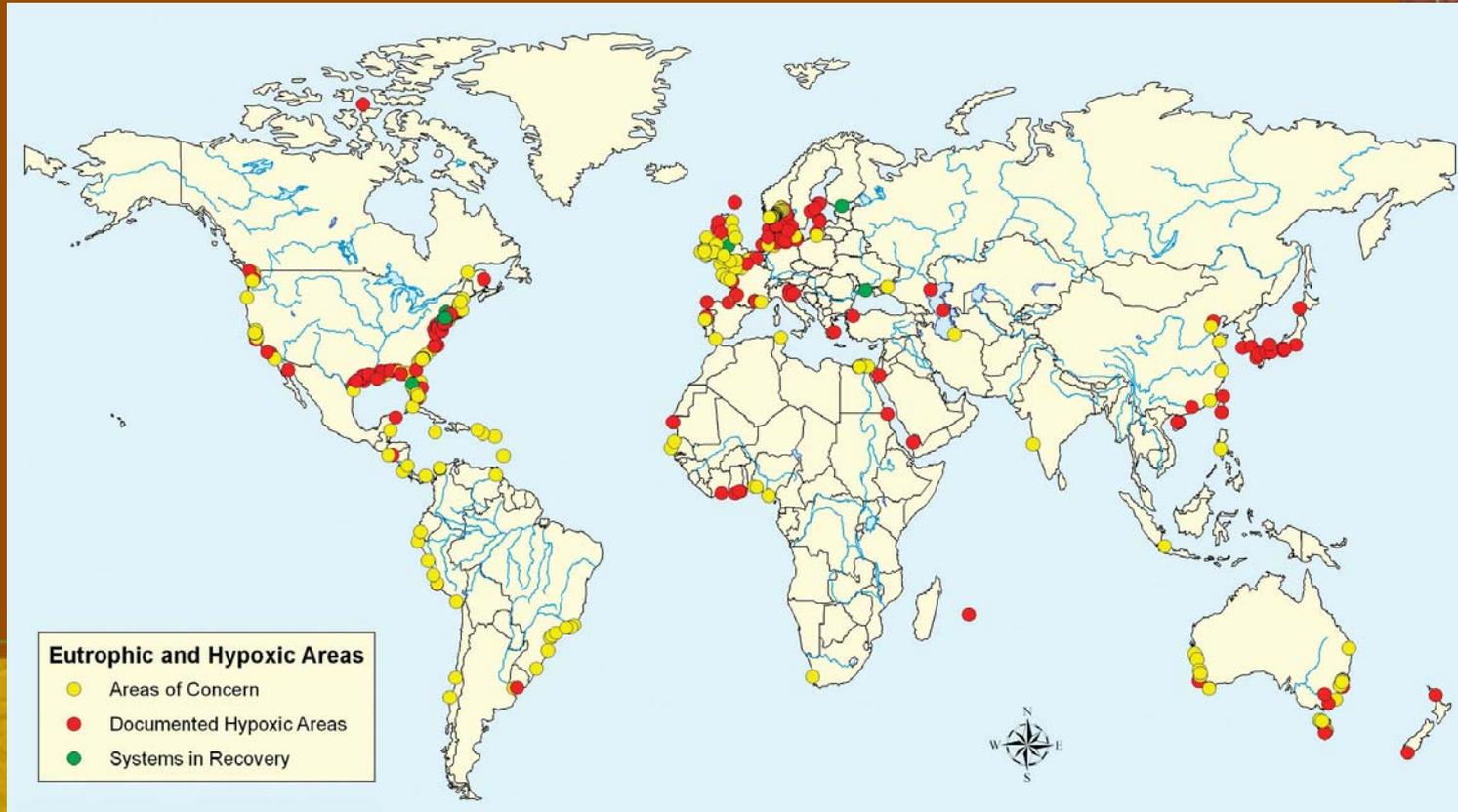
Coastal Population and Shoreline Degradation



SOURCES: Laretta Burke et al., *Pilot Analysis of Global Ecosystems: Coastal Ecosystems* (2001); and Paul Harrison and Fred Pearce, *AAAS Atlas of Population and Environment 2001*(2001).

Coastal eutrophic and hypoxic zones

(identified by Selman et al. 2008)

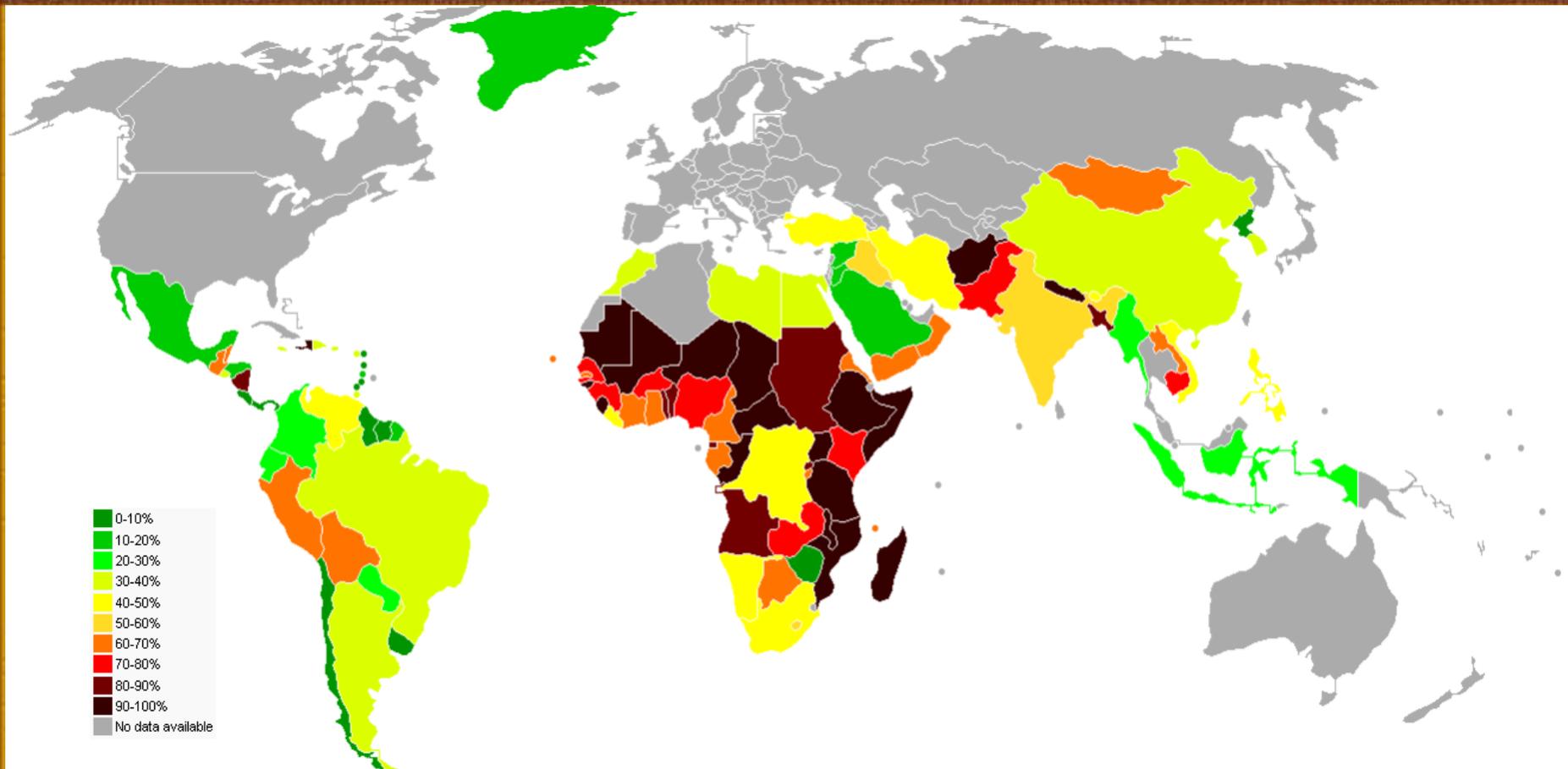


The phenomenon of the urban slum



Slum in Beirut,
Lebanon

Countries of the world based on the percentage of the population living in slums



Source: UN-HABITAT, Global Urban Observatory, 2001 estimates

Water and Air Pollution in Urban Slums

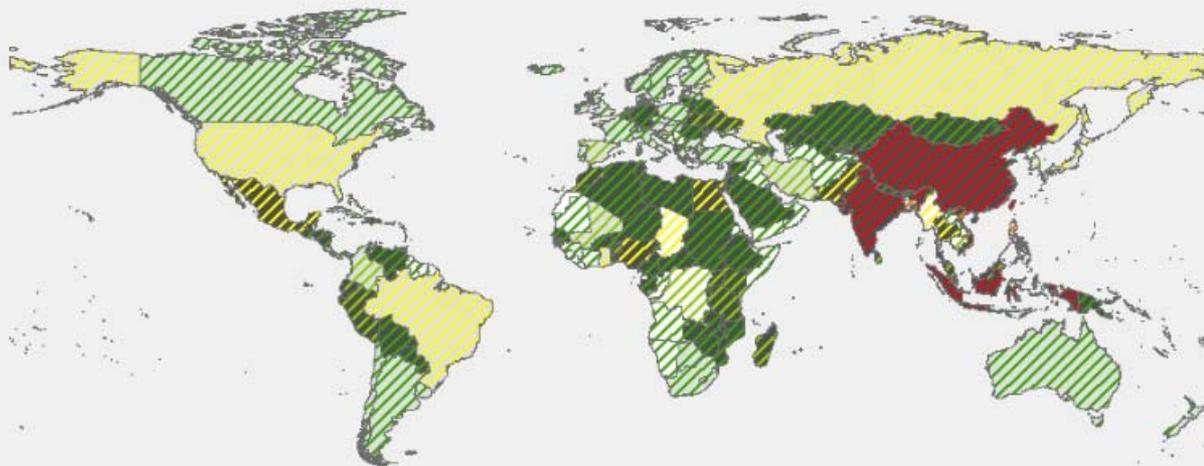


Open Sewers



The Economic Link of Sanitation to Water

(Figure courtesy of Lauren Fry)



Water Quality Index

Light Gray	Better than average
Dark Gray	Worse than average
White	Unknown

Number of Fishers in Country

Diagonal Green Lines	0 - 55547
Diagonal Yellow Lines	55548 - 176928
Solid Yellow	176929 - 610000
Diagonal Orange Lines	610001 - 1320480
Diagonal Red Lines	1320481 - 12233128

Issues of Solid Waste



What we are talking about are not only engineering and planning issues, but issues of justice



HOUSING FOR ALL:

*The Challenges of Affordability,
Accessibility and Sustainability*



*The Experiences and Instruments from
the Developing and Developed Worlds*

Financing this crisis

The cost of meeting the Millennium Development Goal , Target 11, committed to improving lives of at least 100 million slum dwellers is \$67 billion.

However, another 400 million people will be in slums by 2020. These people will require an additional \$300 billion if they are to have access to basic services and decent housing.

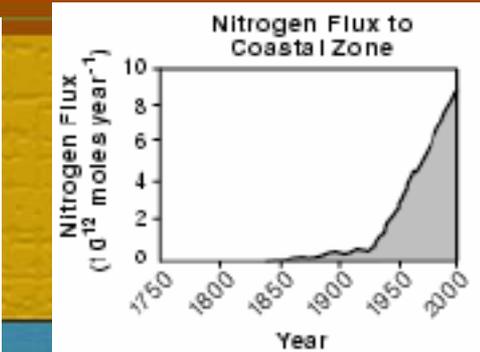
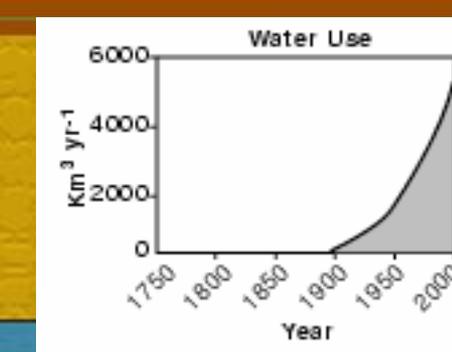
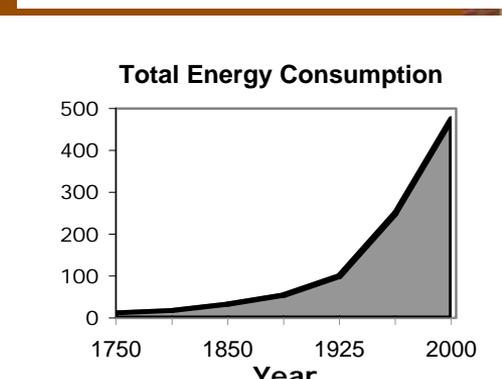
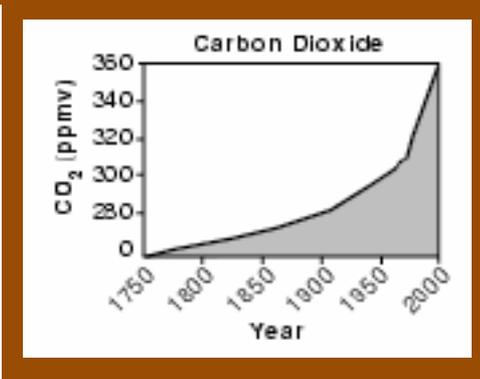
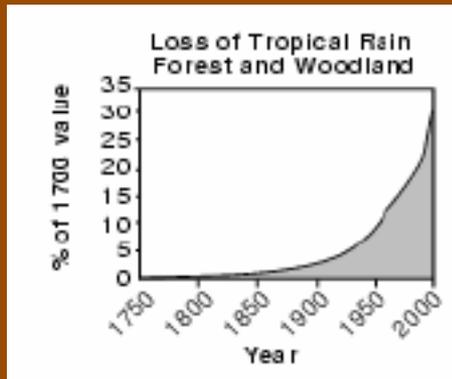
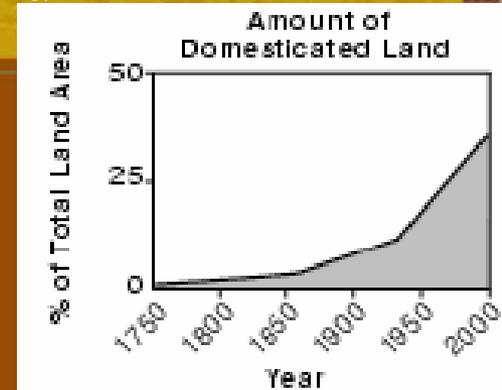
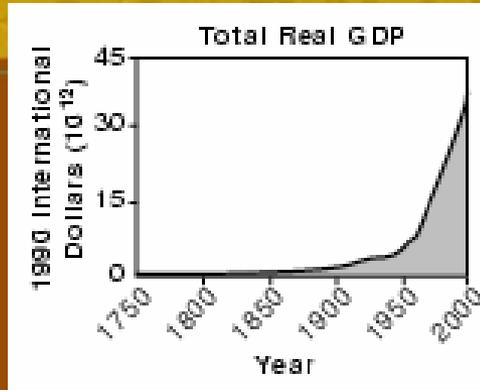
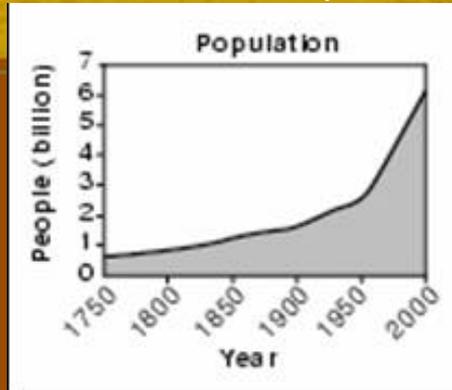
Solving the crisis, Definition of Sustainable Design

(Mihelcic et al., Sustainability Science and Engineering: Emergence of a New Metadiscipline,”
Environmental Science & Technology, 37(23):5314-5324, 2003)

“Design of human and industrial systems to ensure that humankind’s use of natural resources and cycles do not lead to diminished quality of life due either to losses in future economic opportunities or to adverse impacts on social conditions, human health, and the environment”

But now we also live in “the dynamic world”

(Zimmerman et al, “Global Stressors on Water Quality and Quantity: Sustainability, Technology Selection, and Governance in a Dynamic World,” *Environmental Science & Technology*, 42(4):4247-4254, 2008.



Where does this take us?

To meet sustainability challenges, the design criteria of "performance" must be expanded beyond the traditional considerations of function, cost, quality, and safety to include local and global considerations of environment, human health, cultural appropriateness, and social wellbeing.

Furthermore, the design process must also evolve to include issues critical to sustainable solutions such as those related to 1) resiliency, 2) life cycle, 3) the surrounding system, 4) public health and welfare, and 5) intended lifetime.

It is also critical to recognize that innovative solutions to sustainability challenges can and have progressed in a wide range of communities, including those in the developing world.

Resiliency

Resilience is the capacity of a system to survive, adapt, and grow in the face of unforeseen changes, even catastrophic incidents .

Life Cycle Thinking

- n *Life cycle* considerations account for environmental performance of a design through all phases of implementation; from raw materials acquisition, to refining those materials, manufacturing, use, and end-of-life management.
- n The entire life cycle needs to be considered because different environmental impacts can occur during different stages. That is, the most significant environmental burden may occur during extraction and processing (i.e., aluminum production) compared to another design where the bulk of stress occurs during the use phase (i.e., automobile; buildings).

The Surrounding System

Systems-thinking considers component parts of a system as having added characteristics or features when functioning within a system rather than when isolated.

Public Health and Welfare

- n *Public health and welfare* need to be principal overarching goals of many engineering efforts. In fact, the concept of public health is based on insight that health and illness have causes or conditions that go beyond the individual.

Intended Lifetime

The *intended lifetime* is a key design consideration not only to bring end-of-life issues upfront, but perhaps more importantly, to force the consideration of the likely conditions in which the design will function throughout its lifetime.

This becomes increasingly important when designing systems, such as water and transportation infrastructure, where there is a designed lifetime on the order of decades, but, there is great dependence on environmental conditions that are undergoing rapid and increasing dynamic change.

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