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The Security of Cities

Ecology and Conflict on an Urbanizing Planet

Peter Engelke, Ph.D.
Senior Fellow
Strategic Foresight Initiative
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Atlantic Council
1030 15th Street, NW, 12th Floor
Washington, DC 20005
Telephone: 202.778.4952
Fax: 202.463.7241
www.atlanticcouncil.org

Stimson
1111 19th Street, NW, 12th Floor
Washington, DC 20036
Telephone: 202.223.5956
Fax: 202.238.9604
www.stimson.org

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—Peter Engelke

About the Author

Peter Engelke is currently a Senior Fellow with the Atlantic Council's Strategic Foresight Initiative. Previously, he was a Visiting Fellow with the Stimson Center's Environmental Security Program. In 2011, he received his doctorate in History from Georgetown University. Dr. Engelke is also a former Bosch Fellow with the Robert Bosch Foundation.

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I. Introduction

"Urbanization… is the world's most important phenomenon."[1]

Humankind recently crossed a historic threshold: over half of all human beings now live in cities. In contrast to most of human history, cities have become the default condition for human habitation almost everywhere on earth. Urbanization is proceeding rapidly and at unprecedented scales in Asia, Africa and the Middle East. These regions are poised to join Latin America, Europe, North America, and Australia as having more people living in cities than in rural areas.[2] Between 2010 and 2050, the world's urban population is expected to grow by 3 billion people—a figure roughly equal to the world's total population in 1950—with the great majority living in developing-world cities.[3] Our species, in other words, is already an urban one and will become even more so throughout this century.

During the 21st century, cities will increasingly shape social, political, economic, and environmental conditions at all scales. Urban processes are critical drivers of local, regional, and global environmental outcomes. Cities create local water and air pollution, for example. Regionally, cities draw natural resources from far-flung hinterlands (energy, water, wood and forest products, fish, and agricultural products to name only a few). Globally, cities consume 60 to 80 percent of all energy used on earth and release about the same share of carbon dioxide (CO2) into the atmosphere. Cities and their inhabitants are greatly affected by all of these changes. Local pollution burdens most often fall heaviest on the poorest residents of poor cities. A city's demand for regional resources places strains on ecosystems hundreds or even thousands of miles distant. Global climate change adds to the mix of challenges cities will face, increasing coastal flooding risks for low-lying cities, exacerbating urban heat island effects, and increasing the frequency of heat wave-related fatalities.

Given the swift pace and enormous scale of urbanization, cities must become an increasingly important part of the foreign and security policy discussion.[4] Urbanization intersects with multiple issues within the environmental security arena, including food security, energy security, climate change, fresh water use, public health and disease, and natural disaster planning and relief. It also intersects with more traditional foreign and security issues. These include economic development, trade, violence, conflict, civil and international conflict, terrorism, state fragility and global trafficking—in drugs, weapons and human beings.

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1 Daniel Hoornweg et al., *Cities and Climate Change: An Urgent Agenda* (Washington, DC: The International Bank for Reconstruction and Development/The World Bank, December 2010), p. 7.

2 United Nations Human Settlements Programme (UN-Habitat), *State of the World's Cities 2010/2011: Bridging the Urban Divide. Overview and Key Findings* (Nairobi: UN-Habitat, 2010b), p. 3.

3 Jack A. Goldstone, "The new population bomb: the four megatrends that will change the world," *Foreign Affairs*, January/February 2010, p. 38.

4 On this issue, see Peter Engelke, *Foreign Policy for an Urban World: Global Governance and the Rise of Cities* (Washington, DC: Atlantic Council, August 2013).

Unfortunately, little attention is paid to the urbanization-security nexus. While there are some advanced research and policy initiatives that address parts of this nexus (as with public health or urban violence), as yet there has been no systematic attempt to integrate the global reality of urban growth and development into the security paradigm. Global urbanization is moving so swiftly and at such scale that its reality is well ahead of the security discourse. However, there is also enormous opportunity for crafting a dialogue between the foreign and security policy fields and those fields traditionally focused on cities.

This logic applies to both the developed and developing worlds. Climate change, tightening oil and fresh water supplies, global pandemic disease outbreaks, global and regional migration patterns, narcotics and arms trafficking, the transnational organization of crime, and other issues will impact rich countries and cities as well as poor ones. For cities in low- and middle-income countries, the challenges are acute, ranging from finding ways to house, feed, and employ billions of impoverished residents to dealing with the strains imposed by hundreds of millions, perhaps billions, of people who will become new middle-class consumers. For cities in the wealthier parts of the world, the challenges are slightly different but no less important. While these cities have fewer problems associated with mass urban poverty, during the 21st century rich-world cities will have to find ways to consume fewer natural resources and emit less waste while maintaining the high standards of living to which their residents have become accustomed. The challenges facing rich- and poor-world cities are intertwined and significant. For example, the conditions associated with poverty in developing-world cities can give rise to pandemic diseases that are transmitted rapidly to other cities and their populations in distant parts of the world. How India, China and other emerging-economy countries manage their rapid urbanization will have significant effects on the supply, and therefore the prices, of critical global commodities including oil and foodstuffs. In similar fashion, how developed countries manage their urban (re)development patterns will also impact global commodity supply and demand levels as well as the degree of global ecosystem burdens such as climate change.

Before proceeding, two claims are worth highlighting. First, urbanization ought to be treated as a permanent and irreversible phenomenon. The urbanization process has an almost inevitable logic to it. In purely economic terms, cities thrive because they provide agglomeration benefits arising from spatial proximity.[5] Firms need not only workers who live nearby, for example, but ready access to capital, transportation systems, suppliers and customers. This logic is as true for the production of physical goods in factories as it is for the production of intellectual goods in tertiary sectors such as banking—all participants in the urban economy benefit from resources ranging from services to goods to ideas that only the city's close proximity can provide. Since the onset of the Industrial

5 Cities have always existed for other reasons as well, for instance for political organization or for military defense.

Revolution,[6] every society that has become wealthy has done so because it has urbanized. "No country has developed without the growth of its cities," as the World Bank put it in its 2009 World Development Report.[7] Until recently, the Bank's assertion would have been considered anathema inside the development community, which has always placed heavy emphasis on rural development. But the 2009 report confirmed a shift in thinking that is now well underway across the institutions that focus on global development issues, namely that urbanization is at the very center of the development process and is a key to national prosperity. (One significant caveat, however, is that this process is not a given. Urbanization does not automatically cause strong national economic growth, as has been the historical norm.)

Second, global urbanization could turn out to be a net positive, rather than a negative, for humankind and the natural environment over the long run. Cities have many virtues. They house the bulk of the world's political institutions, universities and businesses. They are the engines of economic growth and dynamism, of learning and innovation, and of social and political life. Social service provision (e.g., medical care) tends to be easier and cheaper in cities because of the closer proximity between residents and service centers. Demographically, urban living long has been correlated with lower fertility rates—contemporary and historical evidence from all over the world indicates that urban life plays a significant if imperfectly understood role in inducing women to have fewer children.[8] Moreover, cities can be safe, pleasant, and environmentally sustainable places when designed and managed correctly. Those cities that are the strongest economic performers are also often regarded as the most environmentally sustainable and the most 'livable' (a catchall term denoting a combination of pleasantness, safety, cleanliness and sense of place). Those cities that strive to use fewer resources, produce less pollution, and create interesting and dynamic social spaces acquire positive global reputations, which enable them to attract investment and skilled labor.

One of the best such livability indicators is the attention being paid by multinational corporations to 'green' or sustainable urbanism. The Siemens Corporation, for example, has formulated a "Green City Index" that measures and rates cites across dozens of indicators of environmental sustainability – carbon dioxide emissions, energy, buildings, transportation, water, waste and

6 Cities existed before the Industrial Revolution, but several sets of changes allowed cities to grow to sizes much larger than at any time beforehand. In Great Britain during the eighteenth and nineteenth centuries, improved agricultural production meant fewer people were needed to produce food, hence more could live in cities (i.e., not producing food) than before. European colonial expansion during these centuries also globalized foodstuffs, increasing long-distance trade in food and reducing local pressure for production (e.g., during the nineteenth century Great Britain became a net food importer). The Industrial Revolution itself greatly expanded the amount of economic activity within cities, in particular through the application of fossil fuel-derived energy to factory production.

7 The International Bank for Reconstruction and Development / The World Bank, *World Development Report 2009: Reshaping Economic Geography* (Washington, DC: World Bank, 2009), p. 48.

8 Demographers stress the role played by cities in shaping attitudes via new and complex social networks, better access to family planning and health services, and increased educational and professional opportunities for women. A very short summary is provided in M.R. Montgomery, R. Stren, B. Cohen, and H.E. Reed, eds., *Cities Transformed: Demographic Change and its Implications in the Developing World* (Washington, DC: National Research Council, 2003), pp. 20-2.

land use policies, air quality and environmental governance. Siemens has rated hundreds of cities worldwide using this system, releasing its findings in a series of high-profile reports.[9] A premise behind Siemens' rating system is that the most economically viable cities are also the greenest. The firm's interest in sustainable urban development is grounded in a business model emphasizing the profits to be made from the expanding global green urban technology market. Siemens is betting that it can take advantage of an expanding global market for products and services designed to make cities more sustainable and has invested considerable resources in developing a reputation as a leader in this field.[10]

The remainder of this report is divided into three major sections. The first provides a brief overview of global urbanization's massive scale. The second assesses the relationship between cities (and their residents) and the natural environment, treating cities as important causes of environmental change as well as being vulnerable to these very changes. The third analyzes how the environmental security field would benefit from a more systematic inclusion of cities into its purview. The section provides examples of the dynamic between cities, the natural environment and security issues. A short conclusion ends the report.

II. The scale of global urbanization

The 21st century has been billed as the "century of the city,"[11] an appellation reflecting the enormous scale of contemporary urban growth. While there is no universally accepted definition of a city (see sidebar), a bit more than 50 percent of humankind now lives in urban areas, totaling more than 3.5 billion people. In 1950 there were 75 cities worldwide with populations greater than one million people; in 2011, there were 447. In 1950 the average size of the 100 largest cities was 2 million people; in 2011 it was 7.6 million. By 2020, the UN projects there will be 527 cities of more than a million residents. Globally, by 2030, some five billion people will live in cities; by 2050, the figure will be 6.4 billion people, representing perhaps 70 percent of all human beings.[12]

The 19th and 20th centuries were also urban centuries, although the location and pace of urbanization differed compared with current trends. In brief, mass urbanization is a modern phenomenon, the result of processes that have accelerated since the onset of the Industrial Revolution. Urbanization proceeded much faster and in more places in the wake of the Industrial Revolution compared with all previous history. In 1800, there were fewer than 90 cities with populations of at least 100,000 people. The largest city in the world, London, had less than a million residents. Over the succeeding two centuries, urbanization proceeded rapidly wherever industrialization occurred—Europe, North America,

9 Economist Intelligence Unit and Siemens AG: *European Green City Index* (Munich: Siemens AG, 2009); *Latin American Green City Index* (2010); *US and Canada Green City Index* (2011); *Asian Green City Index* (2011); *African Green City Index* (2011); *German Green City Index* (2011).

10 See Siemens' sustainable urbanism website: http://www.siemens.com/entry/cc/en/urbanization.htm

11 From Neal R. Peirce and Curtis W. Johnson with Farley M. Peters, *Century of the City: No Time to Lose* (New York: The Rockefeller Foundation, 2008).

12 Hoornweg et al. 2010, Figure 6, p. 16.

What is a city?

While the concept of a city is intuitive and broadly understood, the term is operationally imprecise. Each country sets its own population threshold for defining a city as a city, and may also establish multiple definitional categories of what constitutes a 'city,' 'metropolitan area,' 'urban area,' and so forth. The United States, for example, defines a 'metropolitan area' as the built-up area surrounding a dense urban core of at least 50,000 people. Further, much of the world's urban growth is occurring in areas outside officially designated urban boundaries. As a result, global estimates of urban growth are just that—estimates. Even the most authoritative sources, such as the United Nations, must compile global data from inexact national sources. It is likely that U.N. data underestimates the true rate of global urbanization.

Source: Neal R. Peirce and Curtis W. Johnson with Farley M. Peters, *Century of the City: No Time to Lose* (New York: The Rockefeller Foundation, 2008), pp. 33-4.

and Japan in the 19th century, nearly everywhere in the 20th. The first megacities in world history arrived—London expanded to five million residents during the 19th century, New York became the first to have 10 million residents around 1930, and by the 20th century's end, the Tokyo metropolitan region had more than 30 million people. After 1950, urban population growth in the developed world had slowed and in many places stopped, whereas urban population growth in the developing world exploded.[13] In 1950, around 700 million people lived in cities, with the bulk of these in the developed world. By 2000, 2.9 billion people lived in cities, with the majority in the developing world.[14]

Currently, developing-world cities grow by at least 60 million people a year, while developed-world cities are either growing slowly or are even shrinking. The developed/underdeveloped world distinction is not absolute, however. The Latin American region is on par with Europe, North America and Australia/New Zealand in degree of urbanization. All of these regions are defined as being at 'advanced' stages of urbanization, meaning greater than 70 percent urbanized. Most Asian and African countries, in contrast, are at the early (below 40 percent) or intermediate (40-70 percent) stages of urbanization, although there are exceptions (as shown in Table 1, Kuwait, Saudi Arabia, Libya, the UAE and Gabon are over 75 percent urbanized). Demographers predict cities in the developing world will have 5.3 billion residents in 2050, of which Asia will have 3.3 billion and Africa 1.3 billion. Of the world's largest cities, nearly all are found in Asia and Latin America.

13 A good historical overview is Kenneth T. Jackson, "Cities," in Richard W. Bulliet, ed., *The Columbia History of the 20th Century* (New York: Columbia University Press, 1998), pp. 528-42.

14 Hoornweg et al. 2010, Figure 6, p. 16.

Table 1: Basic urban indicators, selected Asian and African countries (2009-2010)

Country	Urbanization rate (% of total population in cities)	Urban population (millions)	% of urban population in largest city
Kuwait	98%	2.7	86%
Gabon	86%	1.3	49%
Saudi Arabia	84%	22.9	21%
Libya	78%	5.0	22%
UAE	78%	5.8	27%
Malaysia	72%	20.5	7%
Iran	70%	51.4	14%
South Africa	62%	30.8	12%
Botswana	61%	1.2	16%
Indonesia	**54%**	**128.8**	7%
China	**45%**	**600.9**	3%
Egypt	43%	34.7	32%
Pakistan	37%	64.2	20%
Yemen	32%	7.6	31%
India	**30%**	**352.5**	6%
Vietnam	28%	25.0	25%
Tanzania	26%	11.8	28%
Cambodia	23%	3.2	48%
Kenya	22%	9.0	39%
Ethiopia	18%	14.6	20%
Sri Lanka	15%	3.1	22%

Source: World Bank population estimates & United Nations World Urbanization Prospects (various tables), at http://data.worldbank.org/topic/urban-development

In 2007, New York, Los Angeles and Moscow were the only North American and European cities to make the list of the 19 largest cities. The 20th century's archetypal city, New York City, placed third in size behind Tokyo and Mexico City; in 2025, it will rank seventh.[15]

Cities grow because of rural-to-urban migration, natural population increases and mortality rate decreases. Rural migrants are either 'pushed' to cities owing to a lack of economic opportunities or political strife, or are 'pulled' to them by the attraction of better jobs or social services and, often, family or other social ties. Urban population growth can continue long after rural-to-urban migration has slowed and stopped due to large youth cohorts that swift in-migration often produces. Even though urban living induces lower fertility rates across generations, these large cohorts – and their children – initially will continue adding to the urban population. Lower urban mortality rates, which tend to decrease faster than fertility rates, also contribute to urban population

15 United Nations Human Settlements Programme (UN-Habitat), *State of the World's Cities 2008/2009: Harmonious Cities* (London: Earthscan, 2008), pp. 6, 11-12, 15.

What is a slum?

While the word "slum" is now rarely used in American parlance to describe poverty-stricken settlements within the United States, the term is still used to describe such places in other parts of the world. In 2003, the United Nations Human Settlements Program (UN-Habitat) first attempted to operationalize the term for the international development community. While it acknowledged the global diversity in the use of the word, UN-Habitat defined a "slum" as a settlement that possesses some combination of the following:

- Inadequate access to safe water, sanitation, and other critical infrastructure;
- Poor structural quality of housing;
- Overcrowding;
- Insecure residential status (lack of legal tenure to housing).

Source: United Nations Human Settlements Programme, *The Challenge of Slums: Global Report on Human Settlements 2003* (London: Earthscan, 2003), pp. 9-12.

growth. (Mortality rates vary dramatically, however, depending on location, income and other factors; there is some evidence that mortality rates in poor areas of the world's poorest cities can be as high as or higher than in rural areas.) During the 19th and 20th centuries, advances in sanitation, medicine, and social service provision greatly reduced urban mortality rates, enabling urban residents to live longer than rural residents. Historically, before these public health changes occurred, urbanites lived shorter lives than their rural counterparts.[16]

Urbanization in Africa and Asia is the most dynamic in the world. African urban growth rates are the world's highest (3.3 percent during the early 2000s). Africa's growth rates result from strong rural-to-urban migration and 'natural' increase from high fertility rates and large youth cohorts. African urbanization tends to be characterized by concentration in the largest city in a given country, sometimes the capital city—a phenomenon known as 'urban primacy.' Unfortunately, urbanization in some African countries has not driven strong economic performance, leading observers to fear that poverty will remain a bigger problem in African cities than elsewhere. (Massed urban poverty, however, is a global phenomenon, gripping cities ranging from Dhaka to Mumbai to Karachi to São Paulo. Slum formation is an ongoing characteristic of rapid urbanization and is forecast to continue well into the future.) Between

16 Montgomery et al. 2003, p. 23; Julie E. Fischer and Rebecca Katz, "The International Flow of Risk: The Governance of Health in an Urbanizing World," *Global Health Governance*, 4, 2 (Spring 2011), p. 10. On urban mortality shifts in historical context, see Gerry Kearns, "The Urban Penalty and the Population History of England," in Anders Brandstrom and Lars-Goran Tedebrand, eds., *Society, Health and Population during the Demographic Transition* (Stockholm: Almqvist and Wiksell International, 1988), pp. 213-36. Japanese cities may have been much healthier than European cities before the Industrial Revolution. See Susan B. Hanley, "Urban sanitation in preindustrial Japan," *Journal of Interdisciplinary History 18*, 1 (Summer 1987), pp. 1-26.

1990 and 2000, the rate of slum formation in African cities matched the continent's urbanization rate at around 4.5 percent per year.[17] Sub-Saharan Africa has the world's highest percentage of urban residents living in slums, at 63 percent in 2005 (the developing world average was 37 percent; Northern Africa's was 15 percent).[18]

Asian urbanization is high at around 2.6 percent per year, but the overall growth rate has been declining. Nonetheless, Asia contains the bulk of the world's current urban population. Despite declining fertility rates in many parts of the continent (in East Asia, fertility has dropped to replacement levels), natural growth and rural-to urban migration will mean that Asia will supply much of the world's growth in future urban population.

The numbers are indeed staggering. Between 1950 and 2008, Asia's urban population increased sixfold, from about 234 million to 1.5 billion.[19] In 1950 in South Asia, there were some 91 cities of 100,000 or more residents, totaling 31.5 million people. In 2007, there were 550 such cities, totaling 477 million people. Of these 550 cities, 56 had at least one million people and 10 were 'mega-cities' of 5 million or more people. Growth rates were extraordinary just about everywhere. Mumbai, for example, grew by 662 percent over the period, while Dhaka's population increased by 3,177 percent. By 2005, South Asia had more urbanites than Africa, South America or North America, and lagged behind only East Asia and Europe.[20]

Consider the Chinese situation. In terms of absolute scale, China's urban development has been unprecedented. In 1949, only 10 percent of the country's population lived in cities. In 1980, the figure was still less than 20 percent. Since then, however, China's urbanization has been spectacular; now, a bit less than half the population lives in cities. Over 600 million people live in China's cities, a figure almost twice the total population of the United States. Nearly 50 of China's cities have populations greater than one million (the United States has nine). In 2003, during the country's boom construction phase, China built in a single year new housing equivalent to one-eighth the total American housing stock. While much of China's new urban development occurred within existing and densely built urban settings, a significant fraction of it had parallels to America's mid-20th century suburban development. Big box retailers, single-family homes, and mass motorization characterized much of this new development in China. The country's heavy investment in transportation infrastructure has been designed to encourage motorization. (In 2009, China surpassed the United States in annual auto sales). Thirty years ago, China's highway system was virtually non-existent. Now, it is second in length only to America's Interstate system and is on pace to become the largest such system by 2020 at the very latest. In sum, as one observer

17 UN-Habitat 2008, pp. 17-18.

18 UN-Habitat 2008, Table 2.4, p. 90.

19 UN-Habitat 2008, p. 19.

20 James Heitzman, *The City in South Asia* (New York: Routledge, 2008), pp. 175-8.

has written in astonishment at the scale of this transformation, China "is a hundred Dubais, with a thousand times its ambition."[21]

Nor are such processes coming to a close. As shown in Table 1, in 2009-2010, China, India and Indonesia had nearly 1.1 billion people living in cities – almost four times the total number of people living in the United States. Yet, in percentage terms, these are under-urbanized countries by global standards. Indonesia's 130 million urbanites represent only 54 percent of the country's population, China's only 45 percent, India's only 30 percent. If these three countries begin to approach urbanization levels found elsewhere in the next few decades, as is probable, they will add a billion or more people to the world's urban total. India alone could add 700 million urban residents by 2050. Like China, India's urbanization will require massive investments in housing, infrastructure, and other physical manifestations of the built environment, with enormous resource and waste implications. By the 2020s, India's added urbanization will require 160 gigawatts of electricity generation, 200 million water connections, and 30 million housing units. Some 250 million more people will need sanitation services. All told, the public cost could be upward of a trillion dollars just over the next decade.[22]

III. The ecology of place: cities and the environment

Before the Industrial Revolution, there were few cities on earth, and most of them were tiny by today's standards. Cities had to be small, for the agricultural surplus was small, meaning that most human beings had to be engaged in food production on the land. Additionally, because transport and goods production costs were very high, cities drew much of their natural resources from relatively small surrounding hinterlands. Only a very few cities were in a position to draw significant amounts of natural resources and commodities from distant locations. Before the onset of Great Britain's industrialization, London could command resources from imperial possessions in North America, the Caribbean, South Asia and elsewhere. London could do this only because it was the center of the world's largest empire, and a maritime one to boot. The situation generally began to change only after the onset of the Industrial Revolution. Rapid urbanization accompanied industrialization, spreading outward from Great Britain and continental Europe to North America, Japan and eventually the entire globe. Rural residents started streaming to the new industrial cities, 'pushed' by lack of opportunities in rural areas as well as 'pulled' by new

21 Thomas J. Campanella, *The Concrete Dragon: China's Urban Revolution and What it Means for the World* (New York: Princeton Architectural Press, 2008), pp. 13-25 (quotation, p. 15); Tian Ying, "China Ends U.S.'s Reign as Largest Auto Market (Update2)," *Bloomberg News*, January 11, 2010. http://www.bloomberg.com/apps/news?pid=newsarchive&sid=aE.x_r_l9NZE. For timelines of China's urbanization, see Anthony M. Orum and Xiangming Chen, *The World of Cities: Places in Comparative and Historical Perspective* (Malden, Mass.: Blackwell, 2003), Table 4.1, pp. 101-03, and Wang Guangtao, ed., *The State of China's Cities* 2010-2011: *Better City, Better Life* (Beijing: Foreign Language Press, 2010), pp. 8-9.

22 Booz & Company Inc., *A Report on Intelligent Urbanization: Roadmap for India* (New Delhi: Confederation of Indian Industry, 2010), pp. 7-14.

opportunities in urban factories. Fossil fuel-based transport technologies – the steamship and railroad – hastened this process. Cities used these technologies to dramatically extend their geographic reach for ecosystem services in order to service their burgeoning populations and fuel their growing economies. The railroad was particularly important, as it enabled cities to reach into areas far removed from navigable watercourses. Chicago's transformation of the American Midwest during the 19th century is perhaps the best known example of this process. Nature's Metropolis, by the environmental historian William Cronon, describes how railroads emanating outward from Chicago allowed the city to extend its influence into inland areas over hundreds of miles to its north, south and west. Chicago's ravenous appetite for raw materials of all types – wood and forest products, grain and farm animals – transformed the American interior, helping to reduce complex ecosystems and replacing them with the simplified, intensely managed landscape now known as the American Midwest.[23]

Chicago's story – since repeated hundreds if not thousands of times – underscores the centrality of cities within the human/nature relationship. It illustrates that cities are not complete ecosystems. Rather, cities require support from ecological processes extending well beyond their boundaries. Urban residents need constant supplies of energy, raw materials, foodstuffs, commodities, water, and finished goods in order to survive. These inputs are processed into either useful forms (ranging from materials used for buildings and streets or finished goods such as furniture and appliances) or into waste. Much, but not all, waste is exported beyond urban boundaries in the form of air, water and soil pollution. Cities therefore utilize both ecological sources and sinks: forests, rural landscapes, fresh water bodies and oceans. The exchange between urban and non-urban areas is not neutral. As "intense nodes of energy and material transformation and consumption," cities consume a net inflow of ecosystem services while producing a net outflow of ecosystem burdens.[24]

Observers have long recognized this truth about cities and have developed metaphors to describe and measure the urban-ecological transformation. Among the most popular have been the urban metabolism and ecological footprint metaphors. The urban metabolism metaphor has intellectual roots in the late 19th and early 20th centuries, but is more recently associated with Abel Wolman, a Baltimore engineer who published a seminal paper on the subject in 1965. Wolman's argument was that cities can be thought of as metabolic systems characterized by flows of resource inputs (materials and energy) and waste outputs (sewage, pollution, etc.). He argued that cities are centers of ecological transformation, wherein useful forms of material and energy (low entropy) are transformed into less useful forms (high entropy). The scientists and engineers who now dominate this niche focus on tracking and understanding material and energy flows through cities, and on developing mechanisms for increasing flow

23 William Cronon, *Nature's Metropolis: Chicago and the Great West* (New York: W.W. Norton, 1991).

24 Gordon McGranahan et al., "Urban Systems," in Rashid Hassan, Robert Scholes, and Neville Ash, eds., *Ecosystems and Human Well-being: Current State and Trends. Findings of the Condition and Trends Working Group of the Millennium Ecosystem Assessment* (Washington, DC: Island Press, 2005), pp. 798, 804-06 (quotation, p. 798).

efficiency. Among other things, the metaphor places priority on understanding, identifying, and quantifying the material and energy flows into and out of cities and building accounting systems to keep track of these flows. Perhaps most critically, the metaphor provides theoretical support for the notion that cities must reduce their dependence on those natural sources and sinks existing outside their boundaries.[25]

The ecological footprint metaphor is familiar to nearly everyone. It was originally created by a city planner, William Rees (and a graduate student of his, Mathis Wackernagel), and first applied in an urban context as part of a critique of urban economics' treatment of natural resource issues. In a 1992 paper defining the subject, Rees argued that cities "occupy" virtual amounts of land much larger than their actual boundaries. "In effect," he wrote, "through trade and natural flows of ecological goods and services, all urban regions appropriate the carrying capacity of distant 'elsewheres,' creating dependencies that may not be ecologically or geopolitically stable or secure." Rees's footprint metaphor emphasized global imbalances in the "competition for remaining stocks of natural capital," asserting that wealthy countries (and, by definition, their cities) "appropriate more than their fair share of the planet's carrying capacity."[26] The footprint metaphor proved so powerful that it has since been extended to nearly every type of material and energy flow (water footprint, carbon footprint, etc.) and operates at almost every level of analysis (e.g., individual footprints, corporate footprints, national footprints).

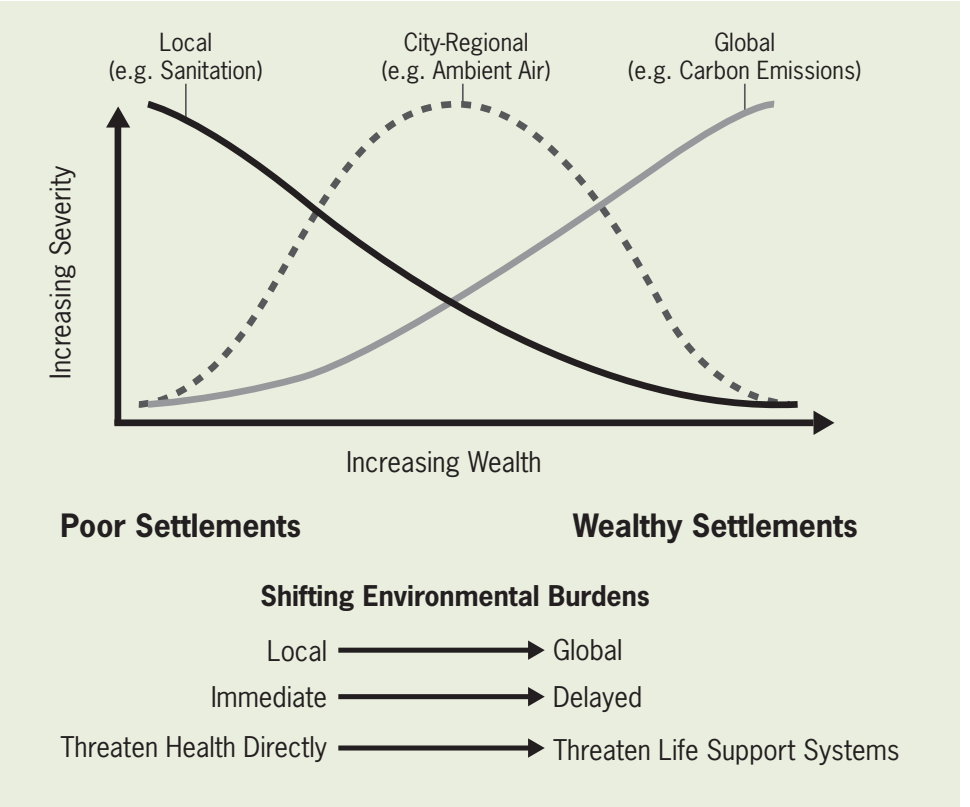
There are other models that define and operationalize the relationship between urbanization and wealth on the one hand and ecological impact on the other. One of the simpler but conceptually useful models is illustrated in Figure 1 and summarized in Table 2. Here, increasing urban wealth shifts the ecological burden in three ways. Spatially, it shifts the burden from the local to the regional and to the global scale. Temporally, it shifts the burden from the immediate present to the distant future. And ecologically, it shifts the burden from immediate human health threats to the planet's "life-support systems"—the set of global ecosystems upon which all life on earth depends.

This model enables us to think about urban ecology in terms of wealth, immediacy of impact and time. Poorer cities experience intense local urban-ecological problems posing immediate threats to human health and well-being. The communicable disease burden resulting from inadequate urban sanitation exemplifies the immediate and highly localized pollution burden felt by poor people in poor cities. As cities become wealthier, such intense, immediate, and local problems begin to decline. Wealth accumulation enables a city to invest in the infrastructure and services that reduce the health consequences of intense urban poverty. The development of modern water infrastructure, including

25 For a review of the urban metabolism metaphor, see Tisha Holmes and Stephanie Pincetl, *Urban Metabolism Literature Review* (Los Angeles: Center for Sustainable Urban Systems, UCLA Institute of the Environment, Winter 2012). http://www.environment.ucla.edu/media/files/Urban-Metabolism-Literature-Review2012-44-fea.pdf.

26 William E. Rees, "Ecological footprints and appropriated carrying capacity: what urban economics leaves out," *Environment and Urbanization* 4, 2 (October 1992), pp. 121-30 (quotations on p. 121).

Figure 1: Economic conditions and urban environmental burdens



Source: McGranahan et al. 2005, Box 27.3, p. 807

water treatment plants, piped sewer systems and filtered drinking water systems, is the classic example. However, middle-income cities begin to experience greater regional air and water pollution from factories and other sources. Regional pollutants still pose health hazards, but their ill effects often are not as immediate. Finally, as cities move into the highest levels of wealth, the city-regional environmental problems are replaced by a suite of global environmental burdens. Residents of such cities shift the problem both spatially, to a set of global ecosystems, and temporally, into the more distant future. Wealthy urbanites' consumption patterns (electrical appliances and gadgets, automobiles, etc.) begin to dominate the urban-ecological equation. At some risk of overgeneralization, residents of the world's wealthy cities are responsible for global greenhouse emissions far in excess of residents living in the world's poor cities.

Air pollution is a good example of this process. The poorest residents of poor cities often use cooking fuels that produce toxic indoor air pollution. While increased wealth reduces dependence on such cooking systems, the industrialization that enables such wealth itself generates new kinds of air pollution. Coal-fired air pollution from industry and power generation can kill people quickly, as happened famously in the London (1952) and Donora,

Table 2: Urban-ecological problems at three spatial scales

	Local scale	Regional scale	Global scale
Main problem	Unhealthy/unpleasant conditions	Deterioration of adjoining ecosystems	Excessive environmental footprints
Locus of problem	Low-income neighborhoods, districts, and cities	Large cities, often industrial and mid-income	Affluent cities, industrial cities
Indicators of problem	Unsafe water, poor sanitation, dirty fuels, insufficient land for housing	High air pollution, groundwater degradation, river pollution, resource plundering, land use pressure	Greenhouse gas emissions, importation of resource and waste-intensive goods
Drivers of problem	Rapid population growth, poverty & inequality, development that ignores ecology of disease	Industrialization, motorization, development that ignores regional ecosystems	Affluence, high waste generation, development that ignores global ecosystems
Negative effects	Infectious diseases, low human welfare/dignity	Loss of ecosystem services, chronic diseases, declining agro-ecosystem productivity	Global effects: climate change, biodiversity loss, depletion of scarce natural resources
Example of historic responses	Sanitation reform movement	Air and water pollution controls	Sustainable cities movement?

Source: adapted from McGranahan et al. 2005, Table 27.9, p. 806.

Pennsylvania (1948) air inversion events. In these two events, temporary local atmospheric conditions that trap colder air in the lower atmosphere (called "inversions") prevented coal-based smoke from escaping into the upper atmosphere, causing intense air pollution that sickened and killed local residents (20 people died in Donora, several thousand in London). Similar coal-based air pollution inversions now occur occasionally in Chinese cities, for instance in Beijing in January 2013.[27] Wealthier societies invest in pollution control technologies and benefit from fuel-switching strategies, as when coal-fired power plants shift to natural gas, eliminating coal-based smog events. The air pollution consequences of increased wealth also manifest themselves through oil-based pollution from vehicle exhaust. Oil-based smog (ground-level ozone) is a common air pollutant that results from a combination of sunlight and automobile exhaust. This type of smog, originally identified in Los Angeles during World War II but now found nearly everywhere, is still deadly but not in acute form. Increased mortality results from exposure to oil-based smog over long stretches of time, although some populations (e.g., people with asthma and pneumonia) may suffer greater mortality in the shorter run from elevated smog levels.[28]

27 See Edward Wong, "Beijing Takes Steps to Fight Pollution as Problem Worsens" *The New York Times* (January 31, 2013, p. A4): http://www.nytimes.com/2013/01/31/world/asia/beijing-takes-emergency-steps-to-fight-smog.html?_r=0.

28 Michael Jerrett et al., "Long-term ozone exposure and mortality," *The New England Journal of Medicine* 360 (March 12, 2009), pp. 1085-95. http://www.nejm.org/doi/full/10.1056/NEJMoa0803894#t=article.

The model represented in Figure 1 and Table 2 oversimplifies the situation. Cities sit along a development continuum rather than in discrete wealth categories. Cities that we might characterize as "poor" will have upper and middle classes in them, and vice-versa. The megacities of the developing world have millions living in poverty and face intense burdens related to water supply, sanitation and communicable diseases. Yet these cities also have millions who are in the middle or upper classes and live accordingly. Wealthier residents of these cities are as integrated within the global consumer society as any in the developed world, trading in long-distance and mass-marketed products in much the same way as their counterparts in Australia or Japan or the United States. They reach into global ecosystems, appropriating water, energy, meat and fish, forest products, and other resources for their own use, while exporting high-entropy wastes. The solid waste problems that have beset American cities for decades are becoming common elsewhere as consumerism increases – in Asia, for example, per-capita urban solid waste generation tends to be higher in richer countries and lower in poorer ones.[29]

The developing world's cities often face such a cauldron of difficulties, beset by different combinations of housing, sanitation, air and water pollution, solid waste, energy supply, and other problems reflective of wealth and poverty mixtures. In Mexico City, for instance, although conditions in low-income areas have improved over the past several decades, there are still many areas with inadequate housing and sanitation services. The city's massive size (about 20 million people) has placed strains upon its fresh water supply, much of it groundwater, resulting in land subsidence, flooding, and pollution from human and industrial wastes. The city also faces notoriously bad air pollution caused by a combination of local geography (the city sits at high altitude and is ringed by mountains), heavy industry and mass motorization. Like all big cities, Mexico City faces a sizable solid waste problem. The city generates a large fraction—perhaps a quarter—of Mexico's solid waste, much of which goes uncollected and is thus dumped illegally. Finally, the city's prodigious growth has altered all of the local ecosystems, including almost all of the lakes and forests that used to characterize the city's environs.[30]

Outside of resource inputs and waste outputs, cities have ecologically significant land-use effects. Globally, cities occupy only about 3 percent of the world's terrestrial surface.[31] By concentrating a higher percentage of the world's population into a very small area, global urbanization serves to depopulate much larger swathes of the earth's surface. Theoretically, this could leave more room for afforestation and other processes that might restore landscapes degraded by intensive cultivation, particularly through subsistence farming and slash-and-burn livestock operations in the tropics

29 In 1995, per-capita solid waste generation in South Korean and Japanese cities was roughly three times that in Bangladesh, India, and Nepal. See United Nations Human Settlements Programme (UN-Habitat), *The State of Asian Cities* 2010/11 (Fukuoka: UN-Habitat, Regional Office for Asia and the Pacific, 2010a), Table 5.1, p. 177.

30 James B. Pick and Edgar W. Butler, *Mexico Megacity* (Boulder: Westview Press, 2000), pp. 147-202.

31 Nancy B. Grimm et al., "Global change and the ecology of cities," *Science* 319 (February 6, 2008), p. 756.

and elsewhere. "Many of my contemporaries in the developed world regard subsistence farming as soulful and organic, but it is a poverty trap and an environmental disaster," the environmental iconoclast Stewart Brand has argued. "When subsistence farms are abandoned [through rural-to-urban migration], the trees and shrubs, no longer gathered for firewood, quickly return, and so do the wild animals no longer hunted and trapped for bush meat." [32] Yet this is a highly debatable argument, as a few farmers using modern machinery can be at least as destructive to rural landscapes as many people doing the same at lower levels of intensity and production. Moreover, urban density levels decrease over time, which means that today's high-density Asian and African cities are likely to be far less dense in the future. The degree to which density declines will have profound aggregate effects on the amount of land cities occupy (see Table 4 on page 32).

Regionally, urban growth means expansion into adjacent rural and forested landscapes. Expansion typically occurs along roadways and other transportation routes, can skirt rough terrain, responds to uneven real estate investments, or occurs through other differentiated means. The areas that adjoin cities often resemble patchwork environments consisting of built-up areas plus farmland, forested land and other environments. These fragmented landscapes—labeled 'peri-urban environments'—extend dozens or even hundreds of kilometers from city centers. Over time, fragmented landscapes may be filled in by new urban development.[33] Landscape fragmentation cuts larger tracts of surrounding forests into smaller patches, which affects plant and animal biodiversity. Expansion of the built environment contributes to soil compaction and erosion (soil erosion is accelerated by increased rainwater runoff from hard surfaces) and typically increases local and regional water pollution loads.[34] And, of course, such expansion reduces the amount of nearby agricultural land, thus increasing distances from agriculturally productive rural areas to city centers. If enough farmland is lost in aggregate from urban growth, national agricultural production can be affected. China, for example, lost about 50 thousand square miles of agricultural lands—an area roughly the size of Pennsylvania—to urban growth during just two decades, the 1990s and 2000s.[35]

Finally, the model described in Figure 1 and Table 2 suggests that affluent cities will also be responding to their global impacts by turning to the 'sustainable cities' paradigm. Indeed, many of the world's most sustainable cities are also among the richest cities. Northern and central European cities are well-known for their engagement in urban sustainability issues. Freiburg, an affluent city in Germany, one of the world's richest countries, has a sterling reputation for global leadership in the sustainable cities movement. The city government has long invested in renewable energy systems (Freiburg is home to much of Germany's

32 Stewart Brand, *Whole Earth Discipline* (New York: Penguin, 2009), p. 26.

33 For a discussion of fragmentation, see Shlomo Angel, *Making Room for a Planet of Cities* (Cambridge, Mass.: Lincoln Institute of Land Policy, 2011), pp. 28-38.

34 Grimm et al. 2008, pp. 756-7.

35 Thomas J. Campanella, *The Concrete Dragon: China's Urban Revolution and What it Means for the World* (New York: Princeton Architectural Press), p. 17.

solar industry), energy efficiency, waste recycling, 'green' buildings, alternative transportation, public green space, and a host of other areas. The city of Freiburg trades on this reputation in the expectation that its economy will benefit from association with urban sustainability.[36]

But the rich world does not have a monopoly on urban sustainability concepts and practices. Some of the world's foremost practitioners are in low- and middle-income countries, or in countries that have recently become wealthy. Singapore, for example, is a recent entrant into the global ranks of the wealthy. It has routinely scored very high marks for its sustainability efforts, and its planning in this regard is justly respected abroad.[37] In the 1950s and 1960s, Singapore faced many of the problems that now beset cities across Asia, including poverty, slum settlements, overcrowding, and water pollution and sanitation problems. From about the middle of the 1960s forward, Singapore set about transforming the physical infrastructure of the entire island. Urban renewal schemes and generous housing subsidies eliminated the colonial-era informal settlements (kampongs) and replaced them with modern high-rise apartment buildings. Because the city's increasing wealth was likely to increase automobile use and therefore congestion, the government introduced tax and licensing measures to make it more difficult and costly to purchase an automobile. At the same time, it invested in a high-quality and technologically advanced public transit system. Likewise, the city upgraded water and sewerage systems. By 1980, nearly everyone on the island had access to municipal water. As a result, Singapore's disease burden changed from communicable diseases such as cholera to chronic diseases more characteristic of wealth and longevity (heart disease, cancer). Singapore's experience is unique, as it possesses comprehensive planning tools that may not be available elsewhere. Yet its experience shows that a city can successfully address the challenges of overcoming urban poverty while driving swift economic development. Environmental sustainability is now high on the government's agenda, reflecting an awareness of the city's natural resource situation (scarce developable land, non-existent fossil fuel supply, and limited fresh water supply), the economic gains to be had from improving environmental performance, and an understanding that these activities will enhance Singapore's global standing.[38]

The Brazilian city of Curitiba also matches cities such as Freiburg and Vancouver in global reputation. Curitiba's flirtation with urban-ecological issues started

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36 Freiburg markets its green credentials globally, billing itself as an urban sustainability innovator. See, e.g., the "Freiburg Green City" campaign at http://www.fwtm.freiburg.de/servlet/PB/menu/1182949_l2/index.html.

37 Economist Intelligence Unit and Siemens AG: *Asian Green City Index*, pp. 104-06.

38 Ooi Giok Ling and Kenson Kwok, "Introduction: Planning Singapore," in Ooi Giok Ling and Kenson Kwok, eds., *City & the State: Singapore's Built Environment Revisited* (Singapore: Oxford University Press, 1997), pp. 1-12; C.M. Turnbull, *A History of Modern Singapore*, 1819-2005 (Singapore: NUS Press, 2009), pp. 317-19, 349, 369; Peter White, "Transport Communications Cities," in Seetharam Kallidaikurichi and Belinda Yuen, eds., *Developing Livable Cities: From Analysis to Action* (Singapore: World Scientific Publishing, 2010), pp. 107-25; Tai-Chee Wong and Charles Goldblum, "Sustainability Planning and its Theory and Practice: An Introduction," in Tai-Chee Wong, Charles Goldblum, and Belinda Yuen, eds., *Spatial Planning for a Sustainable Singapore* (Singapore: Springer Science + Business Media B.V., 2008), pp. 1-13; Economist Intelligence Unit and Siemens AG 2011b, p. 107.

in the 1960s, well before the word 'sustainability' was common parlance and perhaps a decade or more before Freiburg's own serious involvement with these issues began. Curitiba has since developed solutions to various types of urban problems in transportation, housing, air pollution control, waste management and flood control, among other areas. All of the city's innovations have placed emphasis upon low-cost solutions that address both environmental sustainability and social inclusivity. The city's public bus system, for instance, has won international plaudits for decades for its innovativeness, particularly in its focus on providing swift, efficient, low-cost and high-quality service. This transit model, now known as Bus Rapid Transit (BRT), has been exported around the world, including to rich cities in rich countries. In 2010, Siemens gave Curitiba the highest ranking in its sustainability index of 17 major Latin American cities.[39]

IV. Cities and environmental security

Environmental security focuses on how environmental factors affect national and global security outcomes.[40] Its central insight is that changing environmental conditions can affect traditional or 'hard' security conditions on the ground. There are two main pathways for doing so. First, environmental change can lead to conflict and violence between states and among groups within states. Here, the idea is that the scarcity or abundance of natural resources such as fossil fuels, minerals, and fresh water can destabilize relationships between states and among groups within states, leading to conflict. Ecosystem degradation resulting from overexploitation, extreme pollution, and the effects of climate change can have the same negative consequences. Second, some in the field argue that environmental change conversely can induce more peaceful cooperation between states and among groups within states. Here, the idea is that environmental cooperation on environmental issues (e.g., cooperation on transboundary fresh water resources) can lead to greater trust between adversarial states and eventually spill over into more traditional hard security arenas, thereby fostering peacemaking.

Environmental security's conceptual roots can be traced to the Cold War, specifically to the 1970s and 1980s. The field took shape during these decades amid heightened attention to the world's stock of natural resources and on its set of ecosystems. Generalized fears related to pollution and its consequences, to food shortages resulting from overpopulation and climate shocks, and to other natural resource shortages became commonplace concerns. While these concerns often were tied to influential but speculative forecasts such as the 1972 Club of Rome report Limits to Growth, other developments were very real. The most significant of these were the 1973 and 1979 oil shocks, which sent western economies into a tailspin and turned oil into a geostrategic

39 Bill McKibben, *Hope, Human and Wild. True Stories of Living Lightly on the Earth* (Minneapolis: Milkweed Editions, 2007), pp. 59-111; Jonas Rabinovitch, "Curitiba: towards sustainable urban development," *Environment and Urbanization* 4, 2 (October, 1992), pp. 62-73.

40 The author thanks the Stimson Center's David Michel and Russell Sticklor for their thoughtful insights about this section.

question for policymakers around the world. During the 1980s, the list of worries became longer. Discovery of the "ozone hole" above Antarctica, mounting evidence in support of the climate change hypothesis, and concern about tropical deforestation suggested that humankind had a serious ecological problem on its hands.

During the late 1980s and early 1990s, the environmental security field became institutionalized. In 1987, the Brundtland Commission produced Our Common Future, to this day the most famous articulation of the sustainable development concept. Among other things, it argued that the environment could be a cause of human conflict and violence. Conversely, the report linked war and preparation for war to environmental degradation. As if to channel these ideas, in 1988 and 1989, the Soviet Union's Mikhail Gorbachev proposed "ecological security" as an international relations priority. Gorbachev wanted environmental concerns to rise to the top of the United Nations agenda through formalized institutional change.[41]

While the Soviet leader's ideas went nowhere, the end of the Cold War nonetheless provided environmental security with a boost. Searching for frames to make sense of the post-Cold War world, scholars such as Thomas Homer-Dixon articulated foundational concepts that still inform the field. He and others argued that natural resource scarcities, driven by increased demand, declining supply, or unequal access could threaten national and international security. Counterintuitively, they made similar arguments with respect to environmental abundance, wherein control of critical natural resources (oil, precious minerals, etc.) might drive regional conflicts; this is the so-called "blood diamond" thesis. Finally, they argued that human disruption of the Earth's ecosystems will worsen environmental problems such as drought and disaster. Climate change, for example, will alter freshwater regimes around the world, increasing pressures on agricultural production, and is likely to increase natural disasters through more frequent and powerful storms. Skeptics doubted these claims, contesting the environment's relevance for traditional security questions, noting the extreme difficulty in teasing out causal relationships between the environment and conflict, and arguing that the empirical evidence in support of the environment-conflict relationship is mixed at best.[42]

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41 Geoffrey D. Dabelko, "An Uncommon Peace: Environment, Development, and the Global Security Agenda," *Environment: Science and Policy for International Development* (May/June 2008); World Commission on Environment and Development [Brundtland Commission], *Our Common Future* (Oxford: Oxford University Press, 1987).

42 See generally: Thomas Bernauer, Tobias Böhmelt, and Vally Koubi, "Environmental Changes and Violent Conflict," *Environmental Research Letters 7* (2012), pp. 1-9; Thomas F. Homer-Dixon, "Environmental scarcities and violent conflict: evidence from cases," *International Security* 19, 1 (Summer 1994), pp. 5-40; Thomas F. Homer-Dixon, "On the threshold: environmental changes as causes of acute conflict," *International Security* 16, 2 (Fall 1991), pp. 76-116; Sanjeev Khagram and Saleem Ali, "Environment and Security," *Annual Review of Environment and Resources* 31, 14 (November 2006), pp. 14.1-14.7; John-Andrew McNeish, *Rethinking Resource Conflict*. World Development Report 2011 *Background Paper*. (Washington, DC: World Bank Group, September 17, 2010). For a critique, see Daniel Deudney, "The case against linking environmental degradation and national security," *Millennium – Journal of International Studies* 19, 3 (1990), pp. 461-76.

The environmental security field has not excluded cities entirely from its purview, but it has also failed to integrate them into a comprehensive critique. "Students of environmental security early recognized," the Stimson Center's David Michel argues, "that coastal cities from Alexandria to Amsterdam would be susceptible to storm surges and sea level rise. But to the extent that environmental security did consider cities, it treated them as cases, rather than as a class [of analysis]."[43] This observation is on point. The fact is that cities have been little more than a curiosity within the environmental security field, their existence treated as an afterthought and their significance poorly understood. This relative inattention might have to do with the notion, common among those who work on the environment in one fashion or another, that the "environment" is synonymous with "nature," which in turn is defined as something existing outside of the human experience. In this view, the environment consists of the world's natural ecosystems, meaning the rivers, wetlands, forests, oceans, the atmosphere, and other systems upon which all life ultimately depends. In this paradigm, environmental security's proper focus is on how humans are interfering in these systems, most often causing their degradation, and on how this degradation boomerangs and causes human suffering. Adopting this mental map of the world almost demands that cities be seen as the ultimate human artifacts, outside of nature entirely and, therefore, outside of the discussion. (There is nothing unusual in this: there are strong intellectual parallels within the history of the environmental movement itself.) A logical corollary is that environmental security's human subjects are rural and indigenous populations, i.e., the people who live within and interact directly with "nature" and thus directly dependent on fisheries, forests, grasslands, and subsistence farming for their survival. These are the rural and indigenous poor, not the urban poor.

In 2010, Christine Parthemore and Will Rogers of the Center for a New American Security (CNAS) authored a report about the need for policymakers to take environmental security seriously.[44] In an otherwise brilliant articulation of environmental security and its linkage to traditional national security concerns, Parthemore and Rogers nonetheless penned an essay containing both of the above intellectual blinders. The authors focused all their attention on fisheries, agriculture, irrigation, deforestation, soil erosion, loss of biodiversity, groundwater, minerals and energy. In short, they focused on just about every subject except cities. If one were to read their report with no knowledge of urban ecology, one would come to the conclusion that cities are scarcely relevant to environmental and natural resource issues. Moreover, the report focused on just about everyone except people living in cities—a striking omission of more than half the global population. The authors concentrated on rural and indigenous people, specifically the rural poor, and even more specifically the rural poor living in an arc of instability ranging from western Africa through the Middle East to Central and South Asia. This fixation was likely not an accident. The authors appeared to accept that the proper role of environmental security is to

43 Personal communication to the author, June 2013.

44 Christine Parthemore with Will Rogers, *Sustaining Security: How Natural Resources Influence National Security* (Washington, DC: Center for a New American Security, June 2010).

make the environment relevant to the regions, conflicts, and groups getting the current attention of national security policymakers. In the CNAS case, these regions are in this particular arc of instability, these conflicts are the ones that vexed America's military planners during the 1990s and 2000s, and—here is the point—these groups are the rural poor, who are viewed as most susceptible to environmental degradation and thus likely to become an unstable presence for their countries and the rest of the world.

The remainder of this section is a modest attempt at illustrating how the environmental security field might benefit from removing its urban blinders.

A. Cities and resource security

Writing in the journal International Security in 1983, Richard Ullman provided a classic definition of the relationship between natural resources and international security: "At the root of most of the violent conflicts in history has been competition for territory and resources," he wrote. Over the coming decades, "conflict over resources is likely to grow more intense as demand for some essential commodities increases and supplies appear more precarious."[45] In a telling passage, Ullman argued that rising population was primarily to blame for rising demand, particularly rising population in the developing world. Population increases were forcing "Third World villagers" to cut down forests for fuelwood, denude their local soils, and degrade their local environments. This degradation was causing them to join the "worldwide migration from the countryside into the cities," where they entered a world of sheer hopelessness. Their presence in the "swollen cities" of the global south was contributing to the breakdown of law and order, leading to possible revolution.[46]

Ullman's reading of the causes and dangers of rising global resource demand continues to have validity—the rural poor can in fact demand more resources than their local environments can provide, leading to degradation and thus rural-to-urban migration. But the rural poor are certainly not the primary reason why global demand for natural resources is rising. The culprits are people who live in cities. Even more specifically, the culprits for rising global demand are people with money who live in cities. Per the Chicago example from the 19th century above, the main reason why fossil fuels are mined from the ground, natural forests are felled and replaced with monocultured stands, grasslands are turned into corn fields, and coastal mangroves are turned into fish farms is because billions of wealthy urbanites want it that way. Money, more than poverty, drives global ecological transformation.

The environmental security field long has worried about conflict and violence arising from environmental scarcity on the one hand and control over high-value resources on the other, especially in areas where the rural poor live. This

45 Richard H. Ullman, "Redefining Security," *International Security* 8, 1 (Summer 1983), pp. 139-40.
46 Ullman 1983, pp. 141-2.

is a fully understandable and justifiable focus.[47] However, this focus is also slightly misplaced, akin to worrying about consequences rather than causes. Environmental degradation in areas where the rural poor live has a great deal to do with people they have never met, people who often live on the other side of the world. So too does the valuation of those natural resources over which different groups fight to control—oil, precious minerals and so on. To come to grips with these causes, we need to look more to cities.

Cities and energy security

The world's cities account for about two-thirds of the world's energy consumption. The International Energy Agency expects that this share will rise to 73 percent of the global total by 2030. Urbanization in developing countries is the most important reason why global urban energy demand will increase, as the IEA estimates that developing-world cities will account for 81 percent of the growth in global urban energy consumption by 2030. Again the explanation for these increasing trends has to do with rapid urbanization and accompanying wealth accumulation in emerging market economies. China's urban residents now consume about twice the amount of energy compared with China's national average.[48]

Cities consume energy through several pathways. First, cities (specifically the firms, municipalities, utilities and residents located in them) consume energy directly, from fossil fuels burnt within the city, for example energy consumed by motor vehicles. Second, they consume energy indirectly, when energy that is used within a city is generated from outside its boundaries. Much of the electrical power used in cities is generated by coal, oil, natural gas, hydroelectric, and nuclear power plants located outside urban boundaries. Third, cities contain 'embodied' energy, meaning the energy that was used to create the built environment and the things used by urban residents. The concrete, steel and glass contained in buildings, streets and infrastructure, and the goods and commodities that flow into the city constitute embodied energy. All of these require energy, both for their creation and shipment into the receiving city.[49]

Urban residents in developing countries typically consume more energy per capita than rural residents. Electricity service provision is part of the explanation for this gap. This is true even in places with low urban service provision (in sub-Saharan African cities, only 51 percent of urban residents have electricity, but this still outpaces rural provision, at 7 percent.)[50] But a big part of this difference also owes to lifestyle changes resulting from the increased wealth

47 For discussion of the relationships between natural resources and conflict, see OECD Development Assistance Committee, *Overview of the Links Between the Environment, Conflict, and Peace* (Paris: OECD, 2005); Homer-Dixon 1994; Khagram and Ali 2006; McNeish 2010.

48 International Energy Agency, *World Energy Outlook 2008* (Paris: OECD/IEA, Office of the Chief Economist, 2008), pp. 179-92.

49 Shobhakar Dhakal, "Climate change and cities: the making of a climate friendly future," in Peter Droege, ed., *Urban Energy Transition: From Fossil Fuels to Renewable Power* (Oxford: Elsevier, 2008), p. 176.

50 Pierre- Noël Giraud et al., *Energy and Urban Innovation* (London: World Energy Council, 2010), Table 23, p. 26.

and consumption created by urbanization itself. Direct, indirect, and embodied energy consumption increases as households become richer and acquire appliances, cars, larger homes, and a more diverse range of goods. Ongoing urbanization in the developing world therefore is a key driver of global increases in energy demand and greenhouse gas (GHG) emissions. As the authors of an OECD report on urban energy use put it, "growing urbanization will lead to a significant increase in energy use and CO2 emissions, particularly in non-OECD countries in Asia and Africa where urban energy use is likely to shift from CO2-neutral energy sources (biomass and waste) to CO2-intensive energy sources."[51] Paradoxically, however, developing-world cities confront a dual problem with respect to energy, one they also confront regarding water and other service provision. They must find ways to provide electricity and motor fuel for legions of newly wealthy urbanites while simultaneously providing basic energy services to the large numbers of underserved poor people who exist in 'energy poverty,' meaning non-existent or low access to modern forms of energy supply. In both cases, the problem is typically defined as creating enough energy supply (and service provision) to meet increasing demand.

A combination of fuel switching, increased efficiency of energy production and consumption, lifestyle changes, and intelligent city planning can alter this energy equation dramatically. With respect to supply, lower-carbon fossil-fuels (natural gas versus coal or oil) and renewable sources such as solar power are viable options. Community-based renewable energy initiatives using locally-owned assets such as wind and solar power have arisen in Northern and Central Europe. Energy production efficiencies can be maximized through the greater utilization of cogeneration plants (also known by the acronym CHP, for combined heat and power plants). Such plants capture waste heat from the electricity production process and redirect it toward useful purposes, specifically hot water and indoor heating provision for nearby residential and commercial buildings. This practice is commonplace in Scandinavian and other European countries. On the demand side, green building design not only can lead to substantial reductions in energy consumption, the economic, public health, and emissions benefits can greatly outweigh the slightly higher costs involved in constructing buildings to higher environmental standards (see sidebar).[52]

The total amount of energy consumed in a city is a function of how multiple parts of an urban equation intersect with one another. If this larger equation is ignored and the component parts are designed in isolation, a city is likely to consume far more energy than it otherwise might. Conversely, if the larger equation is embraced, a city has the opportunity to realize significant gains in total energy efficiency. For example, a building that is constructed according to green building standards will maximize the efficient use of energy for its internal use (lighting, heating/cooling, etc.), but these gains will be wiped away

51 Kamal-Chaoui and Roberts 2009, p. 9; Giraud et al., pp. 20-1.

52 These arguments are summed up in Peter Droege, "Urban energy transition: an introduction," in Peter Droege, ed., *Urban Energy Transition: From Fossil Fuels to Renewable Power* (Oxford: Elsevier, 2008), pp. 1-14, and Peter Droege, *The Renewable City: A Comprehensive Guide to an Urban Revolution* (West Sussex: Wiley-Academy, 2006).

Why does green building matter?

Green buildings are designed to use fewer resources such as energy and water while supporting the health of those who live and work in them. Green building designers pay close attention to how multiple factors involved in the design, construction, and use of the building interconnect to reduce energy and water use while maximizing human health. Evidence from the American context indicates that such buildings add only a small premium (circa 2%) compared with conventional buildings, while delivering a host of long-run benefits.

Buildings account for about 45% of U.S. total energy consumption. Advocates argue that the widespread adoption of green building techniques would create considerable benefits for the U.S., including large energy and water savings, avoided CO_2 emissions, increased renewable energy investments (green buildings are 30 times more likely to include power from on-site renewable energy systems), health and productivity gains, increased employment, and financial savings.

Source: Greg Kats, with Jon Braman and Michael James, *Greening our Built World: Costs, Benefits, and Strategies* (Washington: Island Press, 2010), Introduction and Part IV.

if the building is placed in a remote location that is reachable only by automobile. Depending on such locational factors, the energy used to transport people to and from the building might be as high or higher than the energy used by the building itself. Green building advocates assert that the biggest energy efficiency gains will come from paying attention to such "urban morphology" considerations. Population density levels, the mix or separation of land use types (housing, retail, commerce, etc.), urban transportation and public utility infrastructure, the types of technologies that are employed in each sector, and so forth all intersect to determine this total urban energy equation.[53]

Getting this energy equation right is far from an idle consideration. Urban morphology is critical in determining how much energy – primarily oil – a city needs for transportation purposes. There is significant variation in the amount of energy used by the different 'modes' or types of transportation that urban residents use to get around. The private automobile is the most energy-intensive form, motorized public transit is less energy intensive, and non-motorized forms of transportation are the least intensive by far (see text box). Jeffrey Kenworthy, a transportation planner, has studied global travel and land use patterns for decades. His analyses routinely show a correlation between urban land use and transportation infrastructure patterns, travel behavior and

53 An excellent summary of the urban morphology, energy use, and greenhouse gas emission argument is contained in Michael Mehaffy, Stuart Cowan, and Diana Urge-Vorsatz, "The factors of urban morphology in greenhouse gas emissions: a research overview," draft paper presented at the IARU Scientific Congress, Copenhagen, 10-12 March 2009. http://www.tectics.com/IARU.htm.

oil consumption. Those cities that are the least dense, separate different land uses the most (housing from industry, recreation, commerce, etc.), invest the most in auto-oriented infrastructure, and have the lowest fuel taxes also have the highest levels of automobile ownership and use and therefore oil consumption. Variation is significant even across cities at similar levels of wealth. Residents of Australian, Canadian and American cities, for example, far outpace urbanites in other rich Asian and European cities in auto ownership, kilometers driven, oil consumption and CO2 production from transport, while lagging behind in bicycling, walking and transit use. While there are many explanatory variables, cities in the former group of countries tend to have much lower density levels than in the latter group, invest more in auto infrastructure and less in infrastructure for alternative travel modes, and so on. Kenworthy insists that intelligent planning, including the maintenance of high urban densities, is key to reducing the impact of mass motorization—and therefore oil dependence—in developing-world cities.[54] The same logic applies to developed-world cities as well, with recent studies suggesting that more compact urban development in the United States would lead to reduced automobile dependence and lower greenhouse gas emissions from the transportation sector.[55]

Keeping cities from spreading may prove extremely difficult. As cities get richer, they also expand outwards, becoming less dense. Population growth, wealth accumulation, and increased motorization causes peri-urban growth almost everywhere, including in the fastest-growing Asian and African cities. Shlomo Angel of the Lincoln Institute of Land Policy recently led a team of researchers who conducted a comprehensive, global assessment of urban land use data. Their study's aim was to project global urban growth rates out to 2050 based on historical expansion patterns. At constant density rates, Angel's team projected that population growth alone will lead developing-world cities to consume more than twice as much land in 2050 as in 2000. But the problem, as Angel's team indicates, is that few if any cities hold densities constant over time. "Very few cities in the world have densities that are increasing and, to the best of our knowledge, no city has long-term density increases as a result of conscious policies," they write.[56] Thus, if average densities decline by 2 percent per year—corresponding to the average global rate during the 1990s—developing-world cities would expand to cover some 2.1 million square kilometers of land while developed-world cities would expand from about 305,000 to 1.1 million square kilometers. To put this in some perspective, 2.1 million square kilometers of land is an area larger than Mexico; 3.2 million square kilometers (the global urbanized total in this scenario) is an area about the size of India (Table 4). The rate of urban expansion therefore is no trivial question, as the cumulative effects will extend well beyond local and regional

54 Jeffrey Kenworthy, "Energy use and CO_2 production in the urban passenger transport systems of 84 international cities: findings and policy implications," in Droege 2008, pp. 211-36. Although a bit dated, an outstanding book-length treatment is Peter Newman and Jeffrey Kenworthy, *Sustainability and Cities: Overcoming Automobile Dependence* (Washington, DC: Island Press, 1999).

55 See the assessment of studies conducted by Cambridge Systematics (2009), the Urban Land Institute (2008), and the Transportation Research Board (2009) in Urban *Land Institute, Land Use and Driving: The Role Compact Development Can Play in Reducing Greenhouse Gas Emissions* (Washington, DC: Urban Land Institute, 2010).

56 Angel 2011, p. 27.

Why does urban transportation matter?

Table 3 attempts to standardize the amount of energy used by the different 'modes' or types of urban transport. The table is meant to be illustrative, as multiple assumptions are built into the data (e.g., average fuel consumption rates per type of automobile, operating efficiencies of transit vehicles, number of transit and vehicular passengers, personal effort expenditure and thus calories consumed for walking and bicycling). Nonetheless, even if inexact, the data indicates a wide discrepancy between modes. The private automobile is the most energy-consumptive form of urban transportation, although there is wide variability in energy use within this category. Bicycling and walking sit at the other end of the scale. The bicyclist (60 kJ per passenger-kilometer) uses roughly one percent the amount of energy as the person driving an SUV by him/herself (5,950 kJ) and just 5.5% the amount of energy needed to move a three-person compact car. Public transit is in between travel by automobiles and non-motorized forms of transportation. Even at half or less capacity, transit systems (bus and rail) are still more energy efficient than travel by fuel-efficient automobiles containing several passengers.

Table 3: Energy consumption by urban transport mode

Urban transport mode	**Energy consumed** (kJ per passenger-km)	**Relative energy use** (energy used relative to bicycling)
SUV with 1 passenger*	5,950	99.2 (times bicycling)
Mid-sized car with 1 passenger**	4,200	70
Compact car with 1 passenger***	3,150	52.5
Compact car with 3 passengers***	1,100	18.3
Diesel bus (50% capacity)	800	13.3
Electric subway (40% capacity)	280	4.7
Walking	150	2.5
Bicycling	60	--

Source: adapted from Gagnon 2006, Table 3, p. 6.
* At 17 liters gasoline per 100 km traveled. ** At 12 liters gasoline per 100 km traveled.
*** At 9 liters gasoline per 100 km traveled.

conditions to encompass global ones as well, ranging from commodity supply and demand (e.g., oil) to global ecosystem effects.

Cities and water security

Cities and their residents are significant direct consumers of fresh water. Their indirect consumption – largely through food – is even greater. As is true of energy, the world's urbanites are responsible for consuming much of the world's stock of fresh water.

The relationship between cities and fresh water is exceedingly complex. All inhabitants of a city require a reliable supply of usable water for daily needs,

Table 4: Global urban land cover in 2000 and 2050

Region	Urban land cover, 2000 (1,000 km²)	Annual decline in urban density (%)	Urban land cover projections, 2050 (1,000 km²)	Approximate area of land urbanized in 2050
Developing-world cities	300	0	775	
		1	1,278	
		2	2,107	Mexico, or more than 4 Spains
Developed-world cities	306	0	395	
		1	652	
		2	1,075	Ethiopia, or more than 2 Spains
Global total	606	0	1,171	
		1	1,930	
		2	3,182	India, or more than 6 Spains

Source: adapted from Shlomo et al., Table 4.4, p. 48. Country area data from the World Bank, at http://data.worldbank.org/indicator/AG.LND.TOTL.K2. Country area data excludes inland water bodies. All figures are rounded.

although the definition of "usable" varies by type of user (individuals and households require potable drinking water, while factories and utilities typically require water at a lesser quality). Urbanites also produce wastewater that is either discharged untreated to water bodies or is treated before being returned. There is thus a perpetual interaction in cities between fresh water supply, demand and quality, involving multiple users with competing interests. This interaction is never static, as aggregate water demand grows with both rapid urbanization and the increasing levels of wealth that accompany the urbanization process.

Urbanization is altering the freshwater equation around the world for two primary reasons. First, urbanization is almost always accompanied by increased energy and goods production, meaning more factories and utilities that require fresh water for their operations. The energy sector is a prodigious water user. The median coal-fired power plant in the United States withdraws some 15,000 gallons of water from nearby fresh water sources per megawatt hour of electricity produced, for example.[57] A typical coal-fired power plant therefore uses billions of gallons of water annually, while nuclear power plants use even more (natural gas-fired power plants, however, tend to use much less water). Globally, industry is the second largest water consumer after agriculture. In China, industry is expected to increase its demand by 300 billion cubic meters of water annually by 2030, more than the expected increase for agriculture. Thermal power will account for about a third of China's industrial water withdrawals in 2030.[58] Power plants and heavy industry therefore are highly vulnerable to climatological

57 K. Averyt et al., *Freshwater use by U.S. power plants: Electricity's thirst for a precious resource. A report of the Energy and Water in a Warming World initiative* (Cambridge, Mass.: Union of Concerned Scientists, November 2011), Figure 6, p. 17.

58 World Business Council for Sustainable Development, *Water: Facts and Trends* (Geneva: WBCSD, August 2005), p. 4. Data from 2030 Water Resources Group, *Charting Our Water Future: Economic frameworks to inform decision-making* (2009), Exhibits 5 (p. 45) and 15 (p. 58).

variation, in particular to prolonged drought and heat waves that reduce surface water supplies and increase water intake temperatures. In the American context, recent droughts and heat waves have negatively affected power plant operations in Texas (2011) and along the Tennessee River (2007, 2010 and 2011). If severe enough, such water-related strains can shut down power plants and threaten electrical grid reliability.[59]

Second, urban residents consume more water as they become wealthier. Municipally-supplied piped water leads to more water consumption through personal use (showers, flushed toilets, etc.), household appliances (dishwashers, etc.), and other direct forms of use (for watering gardens and lawns or washing automobiles). Urbanites also use water indirectly, in a fashion similar to 'embodied' urban energy use. As wealth increases, urbanites demand more goods (and a wider range of goods), thereby indirectly demanding more water through increased goods consumption. Factories use water in production processes and in the finished goods themselves (think of water contained in everyday household items such as dish soap). This indirect form of water consumption is known as embodied or 'virtual' water consumption, referring to the water that was required to create the final product.[60]

Commercial food and beverages provide good examples. Increased wealth often changes dietary patterns that lead to more water consumption. When people become wealthier, they tend to eat more meat, which requires more water (and land) than food from plants. The UN's Food and Agriculture Organization (FAO) estimates that it takes about 1.5 cubic meters of water to produce a kilogram of cereals, versus six cubic meters for poultry production, 10 for sheep and 15 for bovine.[61] The UN has very recently forecast that agriculture will need to consume 19 percent more water by 2050 in order to feed the world; this increase is required in part because developing-world urbanites are eating more meat.[62] Similarly, wealth enables people to afford a wider range of drinks, many of which require significantly more fresh water to create than is contained in the beverage itself. A glass of beer, for instance, takes around 300 liters of fresh water to produce if everything involved in beer production (e.g., growing barley) is counted.[63] The urbanization-wealth-diet nexus has significant aggregate effects on global fresh water consumption.

In sum, urbanization and accompanying wealth creation tend to make citizens consume more water, whether through direct or indirect consumption. (Note: water use data by nationality is notoriously unreliable and is difficult to interpret owing to variations in national and regional precipitation patterns, globalized trade in water-intensive commodities such as beef and cotton, and other

59 Averyt et al. 2011, chapter 4.

60 WBCSD 2005, p. 5.

61 World Water Assessment Programme, *Water for People, Water for Life - UN World Water Development Report (WWDR). Executive Summary* (Paris: UNESCO/WWAP, 2003), Table 2 (p. 17).

62 World Water Assessment Programme, The United Nations World Water Development Report 4: Managing Water Under Uncertainty and Risk, vol.2 (Paris: UNESCO, 2012), p. 451.

63 Peter H. Gleick et al., *The World's Water: The Biennial Report on Freshwater Resources. Volume 7* (Washington, DC: Island Press, 2011), Data Table 19, p. 337.

factors).[64] Water consumption patterns within countries also shift as wealth increases. Demand from industrial and domestic sources begins to outstrip demand from agricultural sources. For low- and middle-income countries, agriculture accounts for the greatest share (82 percent) of water use, followed by industrial (10 percent) and domestic (8 percent) uses (Figure 2). For wealthy countries, however, those figures are 30 percent, 59 percent, and 11 percent respectively. Globally, the figures are 70 percent, 22 percent, and 8 percent.[65] While it would be inaccurate to sum the industrial and domestic figures to arrive at a generic category of 'urban' water use, nonetheless these figures underscore the significance of wealth/urbanization process with respect to water consumption.

To compound the fresh water problem, urban water demand often does not meet geographic supply.[66] Cities that are located on or near rivers have a supply of surface water, but the amount of water flowing through the city is rarely sufficient when cities begin to grow rapidly. River flows, moreover, are subject to seasonal fluctuations (particularly in arid and semi-arid regions) and are thus not always reliable. Local groundwater withdrawals are another ready supply, but groundwater withdrawals easily can outstrip groundwater recharging rates—a form of water 'mining' that is unsustainable over the long run. As cities quickly outgrow local fresh water supplies, they are forced to tap water from distant sources. This is an ancient practice—the Romans, for example, built extensive aqueduct systems to quench their cities' thirst. More recently, New York City tapped upstate water in the 19th and early 20th centuries. Many other cities have done the same, often sparking bitter battles over water rights between urban and rural residents. During the 20th century, Los Angeles and San Francisco, to name just two cities, both had to fight rural and environmental interests over rights to water found elsewhere in California. (The birth of the modern wilderness movement in the United States arose in part from fights over San Francisco's fresh water supply.)

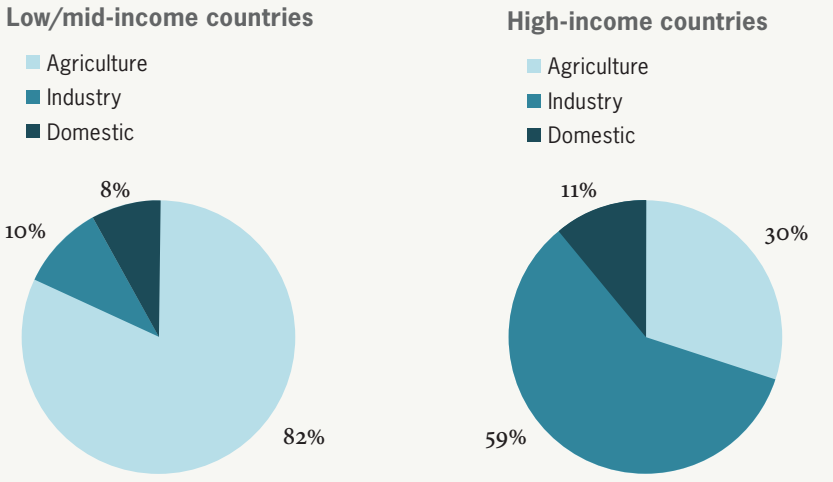
Beijing offers a contemporary example of a major city that has been forced to find ever more distant sources of water. While several small rivers run through or near Beijing, these are nowhere near large enough to feed the city's enormous industrial base and population of 20 million people. Beijing's demand outstrips its local water supplies by some 1.3 billion cubic meters per year (around one-third of the city's total water use). Long-running drought conditions in northern China have depleted the two reservoirs used by the city, making Beijing's water shortage even more acute. In response, the city has drilled deeper for groundwater and begun to tap even more distant surface water sources. As was true of Los Angeles and San Francisco, Beijing's efforts have had consequences for people and ecosystems in rural areas far removed from the city, who now suffer from their own acute water shortages. The city's water mining has dropped aquifer levels in areas surrounding

64 Gleick et al. 2011 provide a short sum of these problems in Data Table 2, pp. 221-2.

65 UNESCO/WWAP 2003, p. 19.

66 Shu-Li Huang, Chia-Tsung Yeh, and Li-Fang Chang, "The transition to an urbanizing world and the demand for natural resources," *Current Opinion in Environmental Sustainability* 2010, 2, p. 137.

Figure 2: Water use, by national income level and sector, 2001



Source: UNESCO/WWAP 2003, p.19.

Beijing dramatically, forcing rural residents to sink ever-deeper wells. Farmers have had to change crop patterns or reduce tillage because their local surface water sources have been captured by Beijing. The city's water plight is ongoing. Within the next few years, the city will begin paying for water from the South-North Water Transfer, a massive infrastructure project designed to divert water from southern to northern China. The city is also contemplating turning to desalinization. Both of these latter solutions—long-distance water transfers and desalinization — require enormous amounts of energy inputs; energy production, in turn, requires significant fresh water inputs.[67]

Finally, climate change will add to cities' water problems in the coming decades by acting as an additional stressor on local and long-distance fresh water sources.[68] As is probably the case with the northern Chinese drought, climate change likely will create longer and more frequent droughts in many regions; Beijing's search for distant water sources may already have been exacerbated by climate change-induced drought. Even absent drought conditions, higher temperatures and shifting precipitation patterns will affect both the amount and seasonal availability of fresh water for many cities. Cities in arid or semi-arid regions that depend on snowmelt-fed river systems (e.g., Las Vegas and the Colorado River) will be significantly impacted. Climate change can also impact water quality in a number

67 Nadya Ivanova, "Off the Deep End — Beijing's Water Demand Outpaces Supply Despite Conservation, Recycling, and Imports," May 3, 2011. http://www.circleofblue.org/waternews/2011/world/off-the-deep-end-beijings-water-demand-outnumbers-supply-despite-conservation-recycling-and-imports/

68 For an attempt at modeling the future effects of climate change on cities, see G. Darrel Jenerette and Larissa Larsen, "A global perspective on changing sustainable urban water supplies," Global and Planetary Change 50 (2006), pp. 202-11.

of ways, for instance through higher sea levels, which will increase saltwater intrusion into coastal cities' groundwater supplies. This would worsen an already difficult problem. As the OECD has reported, "cases of saltwater intrusion [in groundwater] are nearly ubiquitous among coastal cities, documented in diverse environments including the eastern United States, the coast of Thailand, as well as both Chinese and Vietnamese deltas."[69]

There is one caveat to this otherwise troubling picture of urban water use. The relationship between wealth, urbanization, and population growth on the one hand and total water consumption on the other does not have to be linear. As is true of energy and transportation, water consumption patterns can vary substantially across cities of similar size and wealth. Americans are amongst the world's biggest freshwater consumers in large part because there is little in the way of cultural cues, economic constraints, and public policies that work to reduce water consumption, particularly for urban uses. (In 2005, roughly half of water withdrawals in the U.S. went to industry and power generation and another 13% to household and municipal uses; only 41% went to agriculture).[70] "Put bluntly," as the Urban Land Institute notes, "water profligacy is an American way of life: long showers; daily lawn watering; running half-empty dishwashers or washing machines; and running the faucet while brushing teeth are a few common examples."[71] Asian, Latin American, and European urbanites consume less water than their North American counterparts on average, and in some cities by significant margins. A recent survey by the Economist Intelligence Unit found that residents of American and Canadian cities consumed about twice as much water as urban residents surveyed elsewhere, with the best-performing North American cities rating only average on an international scale.[72]

Water conservation is a critical factor in explaining differences in per-capita consumption across cities at similar levels of wealth. A number of cities around the world have introduced water-conservation policies that have proven effective at reducing, or at least limiting the growth of, water consumption. Residents of Amsterdam, for instance, consume only half as much water as their counterparts in other European cities. Among other things, Amsterdam's city government meters household water consumption to make consumers aware of water's economic price, and it pays close attention to water system leakage.[73] Australia has also initiated aggressive policies to reduce urban water use ranging from mass installation of water-efficient appliances and devices in households (low-flow shower heads, dual-flush toilets) to water restrictions (e.g., yard watering bans) to publicly-subsidized xeriscaping programs. Australian planners have begun using green infrastructure to collect and use stormwater and to reuse 'gray' water (recycled water). Finally, Australian residents pay the full cost of municipal water provision rather than just

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69 Kamal-Chaoui and Robert 2009, p. 59.

70 Gleick et al. 2011, Data Table 2, p. 225.

71 The Urban Land Institute and Ernst & Young, *Infrastructure 2010: Investment Imperative* (Washington, DC: the Urban Land Institute, 2010), p. 48.

72 According to comparative urban data compiled by the Economist Intelligence Unit. See the Economist Intelligence Unit and Siemens AG, *US and Canada Green City Index* (Munich: Siemens AG, 2011), p. 19.

73 Economist Intelligence Unit and Siemens AG, *European Green City Index: Assessing the environmental impact of Europe's major cities* (Munich: Siemens AG, 2009), pp. 30-1.

a portion (as is true in most cities globally), thus inducing conservation.[74] In an attempt to cut its water deficit, Beijing's government has undertaken significant water conservation efforts aimed at residential, industrial, and commercial water users. It now recycles and reuses some 65% of its gray water, amounting to nearly 1 billion cubic meters per year, owing to a combination of water conservation measures and grey water infrastructural investments (recycling plants). Beijing's total water consumption has been stable for well over a decade, although the enormous gap between consumption and supply remains.[75]

As is true of other types of services (electrical power, etc.), water is unevenly distributed within cities of the developing world. The pace of urbanization in Asia, Africa, and elsewhere often outstrips the provision of new fresh water infrastructure in terms of both water supply and sewerage. The burden falls mostly on poor residents who reside in informal settlements; wealthier residents are able to locate in areas serviced by such infrastructure or can purchase potable water on the open market. Water demand, therefore, is often highest in the wealthiest parts of the city, where people not only have the means to afford more consumptive lifestyles but also enjoy more complete municipal water service provision. Conversely, municipal water supply and consumption are lowest in the poorest parts of cities, where people often are forced to either steal municipal water or purchase water on the private market.[76]

In addition, municipal water supply, especially for the poorest and least politically influential urban residents, can be a source of corruption when public officials see an opportunity to make illicit profits off their control over this vital resource. In Karachi, an illegal but nonetheless pervasive system exists, wherein private actors siphon water from the public supply and resell it at exorbitant prices to poor residents.[77] This system creates widespread resentment among the city's poor because the high cost of potable water is another hindrance to escaping the poverty in which they are trapped.

B. Cities and climate security

In 1995, Marc Levy penned an essay outlining why global environmental challenges such as ozone layer depletion and climate change are national security challenges. Echoing arguments made by other thinkers, Levy argued that ozone depletion and climate change are national security problems because they threaten "highly important national values [stemming] from global, not merely domestic, sources." Environmental security is relevant to national security when it has a demonstrable connection to core national interests. In Levy's mind, "the only significant environmental problems [posing] a direct physical harm to US

74 ULI and Ernst & Young 2010, pp. 50-1.

75 Ivanova 2011.

76 For Indian examples, see Rajendra Sagane, "Water management in mega-cities in India: Mumbai, Delhi, Calcutta, and Chennai," in Juha I. Uitto and Asit K. Biswas, eds., *Water for Urban Areas: Challenges and Perspectives* (New York: United Nations University Press, 2000), pp. 85-96.

77 Alex Rodriguez, "Karachi 'water mafia' leaves Pakistanis parched and broke," *Los Angeles Times*, March 16, 2010. http://articles.latimes.com/2010/mar/16/world/la-fg-pakistan-water-mafia16-2010mar16.

interests" are ozone depletion and climate change because they have the potential for direct physical harm to Americans' public health and physical well-being.[78]

Cities are the main causes of climate change, its primary victims, and the locus of the most hopeful solutions to the climate security problem. Cities consume most of the world's energy and generate the bulk of the world's greenhouse gases (GHGs). The consensus is that cities account for some 60-80% of the world's primary energy consumption and about the same share of the world's CO2 emissions. Beyond energy conversion, cities also produce direct GHG emissions through landfills (methane releases), waste treatment and incineration, and refrigerant emissions. Cities are powerful indirect drivers of climate change in that they alter land use patterns in areas well outside their boundaries. Urban sprawl consumes forested and agricultural landscapes, for instance, while urban consumption patterns contribute to deforestation and other land use changes at both regional and global scales. Both processes remove carbon sinks. Finally, urban expansion has a range of atmospheric effects that are independent of these other processes, including reductions in the earth's surface albedo (cities have large amounts of dark surfaces such as pavement that absorb heat).[79]

At the same time, cities and their populations are highly vulnerable to the effects of climate change. These effects will be both broad in scope—affecting nearly every aspect of urban life—and significant in impact. Effects include sea level rise, storms and other types of extreme weather events, public health effects, increased energy use, alterations to fresh water supply, local air pollution effects, urban biodiversity changes, and multiple indirect but significant economic effects.[80] Each of these categories can be broken down into a range of sub-effects (Table 6). Extreme weather events, for example, include flooding, drought, extended heat waves, wind storms and storm surges. Altered rainfall, snowmelt, and storm patterns will mean that cities can expect either more damage from river flooding or more frequent and intense droughts—and, in the case of some cities, both, depending on seasonal factors. Increased frequency and severity of drought will have myriad effects on cities. It will stress fresh water resources, affecting both the quantity and quality of fresh water, and reduce the amount of water in upstream reservoirs (thereby reducing hydroelectric power generation), and decrease agricultural yields (thus raising the price of food that is sent to cities.)[81]

Climate change also will act as a chronic background stressor, worsening existing challenges, in particular heat-related problems from the urban heat island (UHI) effect. Cities have large amounts of heat-soaking surfaces (pavement, etc.) and

78 Marc A. Levy, "Is the Environment a National Security Issue?" *International Security* 20, 2 (1995), pp. 48-9, 61.

79 United Nations Human Settlements Programme, *Cities and Climate Change: Global Report on Human Settlements 2011* (London: UN-Habitat, 2011), pp. 36-44; Lamia Kamal-Chaoui and Alexis Robert, eds., "Competitive Cities and Climate Change," OECD Regional Development Working Papers N° 2, (Paris: OECD publishing, 2009), p. 35.

80 This list is adapted from Alistair Hunt and Paul Watkiss, "Climate change impacts and adaptation in cities: a review of the literature," *Climatic Change* 104 (2011), p. 15.

81 The International Bank for Reconstruction and Development/The World Bank, *Guide to Climate Change Adaptation in Cities* (Washington, DC: The International Bank for Reconstruction and Development/The World Bank, 2011), Table 2.1, p. 12.

Table 5: Climate change effects on urban systems and residents

Effects on urban systems	Effects on urban residents
Built environment › Increased freshwater demand › Increased energy demand › Changing disease vectors › Public utilities disruption (storm water, sewage, water treatment, and electrical grid systems) › Shipping and port disruption › Increased road surface damage and washouts › Stress on building foundations Natural environment › Coastal erosion & ecosystem disruption › Groundwater salinization and depletion › Surface freshwater depletion and disruption › Increased mudslides from heavier rainfall › Disruption of food growing conditions › Changes in fish populations › Increased runoff contamination › Increased heat island effect › Increased air pollution	› Increased illnesses: heat stress, stroke, malnutrition, water borne disease, asthma, physical and mental disability › Disruption of basic service provision and access (e.g., electricity disruptions) › Housing instability from increased erosion and other climate-related effects › Property loss and relocation (e.g., from coastal losses) › Loss of livelihoods from climate-related economic stresses › Exposure to flood-related toxins and wastes › Disruption in availability of potable water, food, and other supplies › Water shortages; higher water prices › Food shortages; higher food prices

Source: adapted from The International Bank for Reconstruction and Development / The World Bank 2011a, Table 1, p. 4.

contain many sources of heat emission (factories, power plants, and motor vehicle engines release heat into the local atmosphere). As a result, temperatures can be several degrees Celsius warmer in cities than in surrounding rural areas. Data from the American context indicate that the temperature gap between urban and rural areas is rising over time, meaning that urban areas are heating up faster than rural ones.[82]

Finally, climate change is also likely to impact rural-to-urban migration patterns. This is based on the premise that 'climate refugees' who are displaced from rural areas through increased drought, sea-level rise and storm-related damage will flee to cities. Dhaka is the most obvious example of a city likely to face the climate refugee problem on a mass scale. Sea-level rise and more frequent cyclones may create up to 20 million displaced Bangladeshis by 2050. While not all of them will head to Dhaka, it is reasonable to assume that many will, as the city already is the destination for Bangladeshis who have been forced to move due to deteriorating environmental conditions. Cyclones Sidr (2007) and Aila (2009) made hundreds of thousands of rural people homeless, many of whom migrated to Dhaka. The great majority of newcomers live in the city's slums (Dhaka has a slum population of about 3.5 million). As will be true in other places, climate refugees will add to

82 For a short but technical discussion of the UHI / climate change relationship, see Brian Stone, "Land use as climate change mitigation," *Environmental Science and Technology* 43, 24 (2009), pp. 9052-6. http://pubs.acs.org/doi/pdf/10.1021/es902150g.

Dhaka's climate-induced problems that will include increased heat stress and more flooding from excessive rainfall and altered Himalayan glacier melt.[83]

Resiliency and risk

Urban resiliency refers to how cities can withstand and recover from external shocks such as storms, earthquakes, and other natural and non-natural events. It also refers to how cities must build diverse, multi-faceted, inclusive and well-conceived plans for adapting to environmental changes. Farsighted planning (assessing climate- and storm-related risk levels, building adaptive considerations into building and zoning codes, accounting for the loss of ecosystem services in cost-benefit analyses, etc.), emergency preparedness, ecosystem protection, infrastructural protection, and the inclusion of broad social groups in anticipating climate change are all part of an urban resiliency strategy.[84] "In a resilient city," Peter Newman, Timothy Beatle and Heather Boyer write, "every step of development and redevelopment of the city will make it more sustainable: it will reduce its ecological footprint (consumption of land, water, materials and energy, especially the oil so critical to their economies, and the output of waste and emissions) while simultaneously improving its quality of life (environment, health, housing, employment, community) so that it can better fit within the capacities of local, regional and global ecosystems." In this formulation, resiliency is defined as reducing a city's exposure to external risks. The security of a city is ensured when it has successfully managed this process in inclusive fashion, when all of its citizens enjoy the benefits from reduced risk exposure.[85]

One of the great resiliency problems involves how to protect cities located in low-lying coastal areas. Low-elevation coastal zones (areas less than 10 meters above sea level) are now home to a disproportionate share of the world's population. In 2000, such zones accounted for only 2 percent of the world's land area but contained 10 percent of its population. As urbanization continues, the population in these zones will increase. As shown in Table 6, Asia has by far the highest number of people living in low-elevation coastal zones, followed by Africa and Europe. On every continent, cities are home to at least half of all people living in these zones; for Australia/New Zealand, Latin America, North America and Europe, the share is around 80 percent or higher. Asia's extremely large number of people living in low-elevation zones is a function of the continent's massive total population, long coastlines and unusual amount of low-elevation topography. In 2000, China had the most people in the world living in low-elevation zones (144 million), followed by India (63 million) and Bangladesh

83 Joanna Kakissis, "Environmental Refugees Unable to Return Home," *The New York Times*, January 4, 2010. http://www.nytimes.com/2010/01/04/world/asia/04migrants.html?pagewanted=all. On Dhaka and climate change generally, see Mozaharul Alam and MD Golam Rabbani. "Vulnerabilities and responses to climate change for Dhaka," in Jane Bicknell, David Dodman, and David Satterthwaite, eds., *Adapting Cities to Climate Change: Understanding and Addressing the Development Challenges* (London: Earthscan, 2009), pp. 93-110.

84 Hoornweg et al. 2010, pp. 10-11.

85 Peter Newman, Timothy Beatley, and Heather Boyer, *Resilient Cities: Responding to Peak Oil and Climate Change* (Washington, DC: Island Press, 2009), chapters 1, 3 (quotation on p. 7).

Table 6: Population in low-elevation coastal zones (LECZ), by region, 2000

Region	Total population in LECZ (millions)	Urban population in LECZ (millions)	Urban population in LECZ as % of total population in LECZ
Asia	466	238	51%
Africa	56	31	55%
Australia / New Zealand	3	3	100%
Latin America	29	23	79%
North America	24	21	83%
Europe	50	40	80%
Small island states	6	4	67%

Source: adapted from McGranahan, Balk, and Anderson 2009, Table 2.1, p. 58.

(63 million; 46 percent of the country's population).[86] A good fraction of Asia's largest and most important cities lie in these zones, including all or significant parts of Dhaka, Shanghai, Guangzhou, Mumbai, Kolkata, Ho Chi Minh City, and Bangkok. Asia also has about 40 percent of the world's largest port cities. Six of the 10 most vulnerable port cities (defined as the number of people living in low-lying urban areas) are in Asia – Mumbai, Guangzhou, Shanghai, Ho Chi Minh City, Kolkata and Osaka-Kobe.[87]

As climate change is expected to increase the frequency and severity of oceanic storms, those cities that sit either directly on the coast or on large river floodplains will suffer increased damage from more frequent and violent storms and storm surges. Southern and Southeastern Asian cities are particularly vulnerable because of the region's frequent tropical storms (cyclones, monsoons, typhoons). In addition, long-term sea-level rise will threaten to inundate low-lying urban areas and further degrade groundwater supplies.

The loss of wetlands and mangroves due to urban growth and other land use changes will compound the storm vulnerability problem for cities lying on or near coastlines. These local ecosystems act as buffers for storm surges and provide a host of other ecological benefits (fish habitat, erosion control and water purification, etc.). Human activities have degraded or removed such ecosystems over the course of the modern period, especially in recent decades. River alteration and fresh water diversion schemes, for example, have greatly reduced river deltas around the world. Climate change is itself taking an additional toll

86 Gordon McGranahan, Deborah Balk, and Bridget Anderson, "The Rising Tide: Assessing the Risks of Climate Change and Human Settlements in Low-Elevation Coastal Zones," in Jane Bicknell, David Dodman and David Satterthwaite, eds., *Adapting Cities to Climate Change: Understanding and Addressing the Development Challenges* (London: Earthscan, 2009), p. 51-62.

87 R.J. Nicholls et al., "Ranking Port Cities with High Exposure and Vulnerability to Climate Extremes: Exposure Estimates", OECD Environment Working Papers, No. 1, (Paris: OECD Publishing, 2008), p. 7.

on such ecosystems through drought (by further reducing the flow of river water reaching deltas), sea level rise and other effects.[88]

Storm-related threats are in no way limited to emerging economies, as illustrated by Hurricane Sandy, which struck the American east coast in 2012, and Hurricane Katrina, which struck the US Gulf Coast in 2005. The destruction that Katrina wrought on New Orleans was likely made much worse by the loss of southern Louisiana's coastal wetlands. From 1932 to 2000, southern Louisiana lost 1,900 square miles of wetlands and marshes (an area more than 25 times the size of the District of Columbia) to the Gulf of Mexico. During these decades, public authorities built extensive levee systems along the Mississippi River and its tributaries in order to enhance navigation along the river and to protect New Orleans and other settlements from river flooding, while private interests (oil and gas companies, primarily) cut canals through the marshes for their own purposes. The levee system robbed the southern Louisiana delta of the river-borne silt it needed to fight soil subsidence and sea level rise. Rather than sending the silt through the delta's intricate lattice structure, the levee system either sent it straight down the river's main channel or held the silt back from the delta altogether. Meanwhile, the artificial canals further degraded these ecosystems. Despite some federal efforts to counteract these trends, scientists fear further large-scale marsh and wetland losses in the delta, in turn worsening the exposure of New Orleans and other communities to storm surges. [89]

For coastal cities, infrastructural questions are key. Rising sea levels and increased storm surges and damage pose significant threats to the viability of existing infrastructure. Much critical infrastructure sits at low elevation. Power plants and wastewater treatment plants need large amounts of water to operate and are typically sited on the edges of coastlines or rivers. Their intake and outflow piping systems are highly sensitive to flooding. Gravity-fed sewage systems are likewise vulnerable, as flooding can cause sewage backups in low-lying areas. Other exposed systems include transportation infrastructure (roads, railroad and transit lines, underground tunnels, waterfront airports), port facilities, landfills and the electrical grid (relay hubs, for instance), to name only a few.[90]

Coastal cities therefore will be forced to adapt. Cities have five policy options. They can (1) invest in protection infrastructure, (2) manage subsidence, (3) move new development away from floodplains, (4) relocate existing infrastructure, residents, etc., and (5) create better warning and evacuation systems.[91] These options have widely different cost structures (e.g., option five is far less expensive than option one)

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88 A brief discussion of these issues can be found in Nirmalie Pallewatta, "Impacts of Climate Change on Coastal Ecosystems in the Indian Ocean Region," in David Michel and Amit Pandya, eds., *Coastal Zones and Climate Change* (Washington, DC: The Stimson Center, 2010), pp. 11-12.

89 John Tibbetts, "Louisiana's wetlands: a lesson in nature appreciation," *Environmental Health Perspectives* 114, 1 (January 2006), pp. A40-3. On federal restoration, see generally Louisiana Coastal Wetlands Conservation and Restoration Task Force, The 2009 *Evaluation Report to the U.S. Congress on the Effectiveness of Coastal Wetlands Planning, Protection and Restoration Act Projects* (2010). http://lacoast.gov/reports/rtc/2009RTC.pdf.

90 For a review and discussion of climate change impacts on existing infrastructure, see Mark Dorfman and Michelle Mehta, *Thirsty for Answers: Preparing for the Water-related Impacts of Climate Change in American Cities* (Washington, DC: Natural Resources Defense Council, August 2011), pp. 1-16.

91 This analysis from Nicholls et al. 2008, pp. 7-10.

and feasibility. On political and economic grounds, it may prove highly difficult to relocate existing development away from flood-prone areas. Given the enormous sunk costs in existing infrastructure and real estate development, low-lying cities likely will need to provide extensive new protective infrastructure. The planning and construction of such infrastructure often requires 30 years or more to complete, and hence requires long-term forecasting. As these investments will be expensive, poorer cities will have a more difficult time shielding themselves. Asian coastal cities likely will face the largest amount of exposure to climate-associated risk. An OECD study of 136 global port cities showed that cities concentrated in South, Southeast and East Asia will be the most exposed in the coming decades. China, India, Bangladesh, and Vietnam are predicted to have the most exposed populations, followed by the United States. China will have the most asset exposure, followed by the United States, India and Japan.[92]

Climate change risk to cities, including coastal cities, has become a cottage industry. For earthquakes, tsunamis, or hurricanes to be defined as 'disasters' rather than just geological or meteorological events, they must impact people and/or economic assets. Many of the largest disasters are defined as disasters precisely because they strike cities—New Orleans in 2005, Port-au-Prince in 2010, New York City in 2012, and so forth. The disaster/urbanization connection is complicated, however, by the fact that people living in cities might have the means to flee from disaster-threatened or –stricken areas more easily, live in sturdier structures or can evacuate to same, or have better access to post-disaster emergency services and supplies.[93]

The insurance industry has become a major force in this field. Recognizing that climate change has the potential to dramatically alter the economics of the insurance industry, global insurance firms seek to understand the implications of climate change for the industry and price climate risk to property insurance accordingly. To mitigate financial losses from expected climate impacts on coastal-zone cities and other areas, the insurance industry is expected to increase premiums for certain types of property development, demand mitigation strategies for new construction before insuring (building codes, etc.), and refuse to insure some types of development altogether (e.g., in areas prone to storm-surge flooding). Moreover, the insurance industry has a vested interest in preventing catastrophic climate change—its business model, perhaps more than any other on earth save for agriculture, depends on a stable climate. As one observer has hopefully written, the industry "may also become more proactive in formalizing social solidarity to prevent and, when necessary, endure and adapt to extreme events that individuals cannot manage independently, keeping the commons livable and sustainable and the insurance business viable. This is the highest form of insurance, with roots in its centuries-old tradition of loss prevention."[94]

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92 Nicholls et al. 2008, pp. 20-2.

93 For an outstanding discussion of this topic, see Denis McClean, ed., *World Disasters Report 2010: Focus on Urban Risk* (Geneva: International Federation of Red Cross and Red Crescent Societies, 2010), esp. chapter 2.

94 Evan Mills, "Insurance in a Climate of Change," *Science* 309 (August 12, 2005), pp. 1040-4 (quotation on pp. 1042-3).

C. Cities and global public health

The modern discipline of city planning arose from concerns about poor sanitation in European and North American cities during the 19th century. City planning's focus on a wide range of public goods—sewage and drinking water systems, street sweeping and public parks—all arose from similar worries about how to contain disease outbreaks and otherwise improve public health in cities. Edwin Chadwick, the great English social reformer, developed his interest in sanitation from contagious disease epidemics that swept through London in the 1830s. Chadwick's epidemiological studies of disease transmission undergirded his argument that diseases could be controlled through sanitation systems—clean water supply and effluent control, essentially. Over the next half-century, the efforts by Chadwick and other sanitation reformers helped usher in the age of municipal waterworks. Likewise, Baron Georges-Eugène von Haussmann's famous reconstruction of Paris during the 1850s stressed the extension and upgrading of the city's sewage system in order to contain and control disease outbreaks.[95]

There are multiple linkages between public health and urbanization.[96] Water pollution in cities remains a major problem in many parts of the world. Waterborne diseases such as cholera largely have been eliminated in the rich world, but remain problematic in poor cities, where chronic water quality problems are typical in slums and other informal settlements. Urban air pollution creates respiratory diseases of all sorts. Urban air pollution continues to plague many wealthier cities, but in contrast to poorer cities such pollution tends to be driven more by automobile exhaust (oil-based pollution) and less by industry (coal-based pollution). Poor residents of poor cities, moreover, often face significant indoor air pollution resulting from the burning of biomass and other 'dirty' fuels for cooking and other purposes. Finally, climate change will exacerbate these and other public health problems, putting greater pressure upon urban systems and public health providers. Heat wave mortality in cities, for example, is likely to be compounded through worsening of the urban heat island effect.

In every case, the urban poor have the most difficulty avoiding exposure to these health hazards. Their surroundings often create multiple health threats simultaneously (e.g., dangerous drinking water, absence of sanitation systems, and indoor air pollution) that act as threat multipliers. Up to half or even more of slum dwellers globally have low or no access to potable water and sewage systems. Informal solid waste dumping is also a chronic problem in and around slums because there is often no solid waste disposal service. Slum conditions thus tend to breed pathogens, contain disease-carrying 'vectors' such as rats, and introduce several other types of health dangers, including sharp objects and hazardous materials. In addition, slum residents are often forced to live on unsuitable land,

95 Martin Melosi, *The Sanitary City: Urban Infrastructure in America from Colonial Times to the Present* (Baltimore: Johns Hopkins University Press, 2000), chapters 2-4.

96 The following discussion is adapted from Fischer and Katz 2011.

for example on steep hillsides, marshes and swampland, and flood plains.[97] Despite these problems, most analysts consider cities better suited for public health service provision compared with rural areas. Because cities concentrate people, they can be efficient spaces for social, sanitation and medical service provision. Service providers typically find it easier and cheaper to reach and service more people quickly in cities versus rural areas, assuming such services exist in the first place.

Cities can act as originators of diseases, as transmission belts for spreading such diseases throughout the global system, and as recipients of diseases from elsewhere. Much concern centers on the potential for communicable disease pathogens to arise in poor cities—specifically in informal settlements—and then be transmitted abroad to form a global pandemic. Poor sanitary conditions and other factors in such settlements might allow communicable diseases to originate and spread quickly to nearby dense urban areas as well as abroad. Moreover, because residents of developing-world cities frequently cycle between cities and to nearby villages where they have familial ties, there is a higher risk that diseases found in rural areas will be reintroduced into urban ones. In 2007/2008, yellow fever struck cities in Brazil, Argentina, and Paraguay in part because some residents had been circulating between their homes and nearby rural areas, where deforestation and other land-use changes had created good breeding conditions for the Aedes aegypti mosquito, the disease vector. Once established in a city, a disease can be transmitted elsewhere quickly and easily through air travel. These transmission processes can be swift enough to overwhelm international disease detection, response and containment systems. Cities therefore act as hubs for the spread of pandemic outbreaks to the global community.[98]

The public health consequences of rapid urbanization do not stop at communicable diseases involving the poor. As Julie Fischer (formerly at the Stimson Center) and Rebecca Katz have written, "populations in developing regions are increasingly susceptible to a dual burden of the diseases of poverty and wealth."[99] Here, the phrase "dual burden" means not only that poor people in poor cities face poverty-driven health problems, but also that they increasingly face rich-world health problems related to diet and lifestyle (smoking, physical inactivity, and high-fat and high-sugar diets). The public health and planning communities in the rich world, it should be noted, have been focused on the latter set of issues for years and in some cases decades. One such is a sub-field focusing on the connections between urban form, physical inactivity, and poor public health outcomes such as obesity.[100]

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97 David Satterthwaite, "In pursuit of a healthy urban environment in low- and middle-income nations," in Peter J. Marcotullio and Gordon McGranahan, eds., *Scaling Environmental Challenges: From Local to Global and Back* (London: Earthscan, 2007), pp. 79-82.

98 Fischer and Katz 2011, pp. 8-9.

99 Fischer and Katz 2011, p. 1.

100 See Lawrence Frank, Peter Engelke, and Thomas Schmid, *Health and Community Design: The Impact of the Built Environment on Physical Activity* (Washington, DC: Island Press, 2003).

D. Cities and human security

Human security is a broad concept that extends the security logic to individual people. As articulated in a key 1994 report from the UN Development Programme (UNDP), human security focuses on the "legitimate concerns of ordinary people" across seven security domains: food, health, environment, personal, community, economic and political forms of security. Critics seized upon this list of threats as being overly broad (in 2001, the scholar Roland Paris wrote that "if human security means almost anything, then it effectively means nothing").[101] Yet despite this critique, human security also contains the useful insight that security ultimately depends on human well-being, which in turn is a function of multiple cross-cutting elements ranging from nourishment to personal safety to economic opportunity to a clean environment.

One of the more advanced areas of research inquiry concerning the urbanization-security nexus centers on the relationships between rapid urbanization, mass poverty and the potential for violence. Here, the focus is on how the speed of informal settlement growth in some developing-world cities has overwhelmed the capacity of local and state governments to guide physical development (adequate streets and street paving, sewage and drinking water systems, electrical supply systems, etc.) and provide necessary social services such as health care. The resulting insecurity can take many different forms, as with inadequate food and water provision. These problems are chronic in that residents face them daily, but they nevertheless may fuel acute violent reactions, as when global commodities prices spike and cause food riots in the world's poorest cities (the poorest households can spend up to 80 percent of their income on food).[102] Moreover, as articulated in a highly influential essay published in 1994 by Robert Kaplan and since echoed by others,[103] slum conditions create fertile environments in which conflict and violence can breed. These conditions not only lead to more ad hoc crimes against people and property but more fundamentally create conducive conditions for the proliferation of organized crime and terror networks. Analysts working in this field worry about two types of related problems: first, that personal insecurity within both slums and affluent neighborhoods hinders current human well-being and inhibits future social and economic development; second, that the scale of the slum problem threatens to undermine both national governments and international order.

Urban insecurity takes many different forms in informal settlements, ranging from random crime and violence to highly organized crime and terror networks. Slums create these conditions due to a toxic mixture of high unemployment levels, large numbers of unemployed and unschooled youths (especially young males), and the absence or under-provision of state- and municipally-provided services. Ad hoc crime—especially violence to persons and property—is the most basic type of human insecurity. Municipal policing is often absent from such

101 Roland Paris, "Human Security: Paradigm Shift or Hot Air?" *International Security* 26, 2 (Fall 2001), p. 93.

102 Graeme Thomas and Guilio Sansonetti, *Growing Greener Cities* (Rome: Food and Agricultural Organization of the United Nations, 2010), p. 5. http://www.fao.org/ag/agp/greenercities/pdf/GGC-en.pdf.

103 Robert Kaplan, "The Coming Anarchy," *Atlantic Monthly* 273, 2 (February 1994).

settlements, is otherwise chronically ineffective, and/or tends toward heavy-handed tactics that serve to alienate residents. Such conditions also create gang-based community violence, similarly focused on economic ends (theft) but also on notions of justice (vigilantism) and defense of ethnically-based communities. Such groups ratchet up levels of violence and organizational sophistication, but tend to remain local in orientation and organizational capacity. The most sophisticated organizations are the crime and terror networks that have developed in megacity slums and that aim to control larger territories. These are the cartels, smugglers and traffickers of guns, drugs, and humans that have become infamous for their organizational networks, brutal and effective violence, and ability to resist police and state security forces. These use violence and intimidation to enforce their agendas, including extortion, assassination, terror, kidnapping, systematic sex crimes and enslavement. Like the gangs, they also recruit children into their ranks for use as quasi soldiers.[104]

Insecurity, violence, and illegal trafficking create fear both inside and outside the slums, which in turn creates a popular backlash against crime amongst non-slum dwelling residents. This reaction can be severe enough to induce repressive crime control strategies. "Cities [in the developing world] have become dominated by a fear-of-crime rhetoric that enables and demands repressive policing strategies," Josjah Kunkeler and Krijn Peters have argued. "Combined with the impact of the opportunities created by the shadow economy, urban violence in many cities of the South generates well over one thousand deaths per year per city, and draws in organized violent and armed actors ranging from youth gangs, police officers, militia groups composed of former military men, vigilantes, violence brokers, up to the level of politicians. Cities are becoming increasingly segregated into social and spatial archipelagos as fear of the 'other' informs mutually interpretative frames of their inhabitants."[105]

Much concern focuses on the fear of violence originating in and emanating outward from megacity slums. Although urban growth is now faster in small and medium sized cities than in megacities, the megacities of Latin America, Asia, and Africa are considered to be much greater security risks because of their size, social and environmental problems, strategic location (often political capitals, e.g., Cairo, Nairobi, Dhaka), and critical importance to the global economy (e.g., Mumbai).[106] As Peter Liotta has written, "cities in this condition will pose a particularly serious security threat because they will have substantial pockets of insecurity within their municipal boundaries and extensive commercial, communications and transportation links to the rest of the world…. Anarchy, governmental collapse, ethnic rivalry, cultural grievances, religious-ideological extremism, environmental degradation, natural resource depletion, competition

104 Humansecurity.org, *Human security for an urban century: local challenges, global perspectives* (2007), Figure 1.3, p. 16. Available at http://www.eukn.org/E_library/Security_Crime_Prevention/Security_Crime_Prevention/Human_security_for_an_urban_century_local_challenges_global_perspectives.

105 Josjah Kunkeler and Krijn Peters, "'The Boys are Coming to Town': Youth, Armed Conflict and Urban Violence in Developing Countries," *International Journal of Conflict and Violence* 5, 2 (2011), p. 289.

106 P.H. Liotta and James F. Miskel, *The Real Population Bomb: Megacities, Global Security and the Map of the Future* (Washington, DC: Potomac Books, 2012), p. 9.

for economic resources, drug trafficking, alliances between narco-traffickers and terrorists, the proliferation of 'inhuman weapons' and the spread of infectious diseases threaten everyone" on earth.[107]

Local and state governments often cannot deal with slum problems effectively. Governments' inability to create secure conditions in turn externalizes the problems of violence and insecurity originating within the slums, allowing such problems to emanate outward to other parts of the city and country and even abroad. Ongoing population growth in these megacities, moreover, will stress conditions even further, perhaps beyond the point of social, political and ecological carrying capacity. The biggest security fear is that the "municipal failures" of megacity governance will lead to "contagion effects" elsewhere, wherein slum-based political violence threatens to collapse national governments and slum-based crime syndicates threaten international order through sophisticated arms, drugs, human and terror trafficking networks.[108]

The security literature in this area focuses on a handful of megacities in Latin America, Asia, and Africa that have been epicenters of urban violence. While Latin American cities have had significant problems associated with slum violence and/or crime (São Paulo, Rio de Janeiro, Medellin), many of these cities have begun finding solutions. African urbanization, on the other hand, tends to worry observers. African states frequently lack the economic resources and often the political will to alleviate these conditions. The potential for political violence is made more significant in Africa because megacities are often capital cities—Cairo, Kinshasa and Nairobi, for instance. Such violence can threaten national stability. As occurred after the December 2007 Kenyan elections, large-scale slum-centered violence emerged when the chronic conditions of daily life met frustration with the national political process (widespread government corruption and preferences for some ethnic groups over others).[109]

The security discussion centering on slums often focuses on governance failure. Across Asia and Africa, cities tend to be governed by complex and poorly coordinated governmental authorities at all levels (national, state, local), thereby creating confusion, bureaucratic infighting and turf wars, and the shifting of responsibility from one authority to another. Moreover, local governments often lack both the financial resources and the technical capabilities to deal with the enormous problems created by rapid urbanization. Competent governance is the fundamental key to solving these problems. Good governance can provide the array of services, infrastructure, and amenities that make cities safe, sustainable and habitable, create a positive environment for economic development, and enable broad public and civil society participation in democratic decision-making processes. The trouble is how to provide these things given the scale

107 P.H. Liotta, "Human security for an urban century: local challenges, global perspectives," in Humansecurity.org 2007, pp. 12-13.

108 Liotta and Miskel 2012, pp. 9-10.

109 Stephen Commins, "Urban fragility and security in Africa," *Africa Security Brief* 12 (April 2011), pp. 1-7; Liotta and Miskel 2012, pp. 32-40.

and speed of urbanization and the lack of resources that national and local governments are willing and able to invest.

International organizations, national foreign aid programs, and NGOs have been active in the field of urban violence and insecurity for some time. USAID, for example, has built a small but focused program on the topic.[110] According to USAID, "the goal of urban security is to improve basic development needs in urban and peri-urban areas: food, shelter, water, services, employment and livelihoods."[111] UN-Habitat has a longstanding program, Safer Cities, focusing on urban violence in developing countries. Safer Cities supports local governments through "good governance and appropriate urban planning and management to prevent and reduce the incidents and impacts of crime and violence in developing and transition countries."[112] Safety is a condition for other forms of development, including poverty reduction.

V. Conclusion

The scale and speed of global urban change during the 21st century is unprecedented in human history, but neither the world nor the environmental security community have yet to come to grips with this reality. To paraphrase the Stimson Center's David Michel, "urbanization is going to have to force itself into the environmental security discussion. We are going to have to come to grips with the rate and scale of urbanization, of the size of the urban environmental footprint, of cities' resource needs with respect to food, water, energy and materials. If environmental security is to mean anything, it must mean security where most people live, and most people now live in cities."[113]

Cities are complex, even contradictory phenomena. The problems that beset developing-world cities are proof of this proposition. On the one hand, the mass poverty and squalor found in the developing world's megacities create a set of intense security-related problems. Urbanization is beset by a very large shadow side wherein the marginalized face grinding poverty, squalor and despair. This shadow side is non-trivial, explosive, and potentially catastrophic well beyond local urban boundaries. One billion people already live in the developing world's slums, with another billion or even more on the way over the next few decades. A world with mass urban poverty is one in which organized, transboundary crime and terror networks engage in illicit trafficking in drugs, human beings, small arms, and possibly even sophisticated instruments of terror. Further, such conditions allow communicable diseases to form, reform, and spread quickly throughout the international system, with the potential to become global pandemics. And, of course, having billions of human beings consigned to lives in the most extreme forms of wretchedness is a recipe for humanitarian and

110 http://www.usaid.gov/our_work/cross-cutting_programs/urban_programs/.

111 http://www.makingcitieswork.org/urban-theme/introduction-0.

112 United Nations Human Settlements Programme (UN-Habitat), *Strategic Plan for Safer Cities 2008-2013. Summary Document* (October 2007), p. 4. http://www.unhabitat.org/content.asp?cid=5524&catid=375&typeid=34&subMenuId=0.

113 Personal communication to author, June 2013.

political disaster. If circumstances are right—if, say, a spike in global food prices adds to chronic urban poverty in capital cities—such conditions ultimately could undermine national and even international governance.

On the other hand, urbanization simultaneously is the key to national and global economic prosperity. The McKinsey Global Institute (MGI) is one of several private-sector firms that have built comprehensive datasets focusing on global urbanization and wealth accumulation trends.

It projects that ongoing urbanization in developing-world cities will lift hundreds of millions of people out of lower-income status and into the ranks of developed-world consumerism over the next few decades—as MGI puts it, the "new armies of higher-end middle-classes" that can be targeted for marketing purposes.[114] The subtext to the work that is done by MGI and other organizations is that the urbanization story is basically a happy one: urbanization raises incomes and, with it, consumption, in the large swathes of the world that have been trapped in poverty.

Indeed, it is fair to say that at least since the Industrial Revolution, few if any countries have gotten rich without urbanizing.

Yet, as this study has asserted, the urbanization/wealth nexus is not entirely positive. If history is any guide, we ought to be concerned. One could say that the great 20th-century model that was perfected in the United States, the low-density model that includes the house-yard-car embodiment of the American dream, addressed the local ecological problems that had beset industrial America through spreading dense urban populations over wide-ranging metropolitan areas. This model arose during a period of empty-world economics,[115] when the world appeared to be blessed with enormous, or at least sufficient, resources to supply the model's needs—plenty of arable land, fresh water and fossil fuels (oil, mostly, for transportation)—as well as the sinks that were necessary to absorb the model's wastes—especially the atmosphere and oceans, where we have dumped the carbon that our cities have produced.

America's mid-20th century model has become a core symbol of modernity and consumerism for the rest of the world. China's urbanization experience during that country's boom decades, for instance, has features that parallel its American predecessor. Widespread suburbanization and massive road- and highway-building have turned China's consumers into the world's most prolific car buyers. As Chinese suburban development over the last few decades has been "fundamentally and unapologetically oriented toward the motor vehicle,"[116] China's consumers have purchased cars in staggering quantity. During the 2000s, the consumption rate outstripped even the most robust forecasts, rising from four million privately-owned automobiles in 2000 to 85 million in 2010—a 2025

114 Richard Dobbs et al., *Urban world: Mapping the economic power of cities* (McKinsey Global Institute, 2011), p. 25.

115 For a discussion of 'empty' versus 'full' world economics, see Herman Daly, "Economics in a full world," *Scientific American* (September 2005), pp. 100-07.

116 Campanella 2008, p. 227.

percent increase over a single decade. China could have 250 million cars and trucks by 2020, equal to the number the United States has now. If all vehicles are counted (e.g., including scooters and motorcycles), China is forecast to have between 600 million and one billion vehicles by 2030.[117] The scale of the Chinese experience has enormous global implications, among the most important of which is the increasing pressure on global oil supplies. The energy security consequences will be felt globally, as China and other emerging economies compete for access to oil supplies, and domestically as well. Ironically, Chinese demand is affecting the United States, which is among the most oil-dependent societies on earth thanks to its century-long commitment to the automobile.

The problem is that neither the planet's sources nor its sinks are big enough for a 21st century redo—on a much larger scale—of the 20th-century experience. How, then, do we figure out a way to reduce the billions of urbanites who live in abject poverty, enable billions more to enjoy lives as middle-class consumers, and still have enough nature left over for the world to be habitable? Cities concentrate many diverse things into small spaces—people, housing, office towers, streets, airports, sewers, drinking water systems, energy transmission hubs and lines, industry, governments, firms, universities, and on and on. Nearly everything that matters to humans occurs in cities or as a result of urban processes, ranging from economic exchange to technological innovation to political conflict to disease formation and transmission to the use and transformation of nature and natural resources. Consequently, if we get cities wrong, we will get much else wrong. Conversely, if we get cities right, we will get much else right.

The way out is to adopt a model that—per the resiliency model outlined above—adopts technologies that dramatically improve resource and energy efficiencies and that can be scaled easily, implements public policies that lower the resource and energy intensities of urban living, invests in infrastructure that reduces the risk exposure to external resource- and climate-related shocks, and that aims for inclusive and participatory forms of governance. Such a model would aim to reduce the urban ecological footprint while at the same time improving the quality of life for all inhabitants. The challenge for the 21st century is not whether such a model can be created, as there are examples of cities around the world that are doing all of these things. It is, rather, whether or not real, substantive, and lasting gains in all of these areas can be replicated thousands of times over, in the great majority of the world's cities.

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117 Deborah Gordon and Yuhan Zhang, "Driving Force: Energy and Climate Strategies for China's Motorization," *Policy Outlook* (Washington, DC: Carnegie Endowment for International Peace, March 14, 2011), pp. 4-8. Stacy C. Davis, Susan W. Diegel, and Robert G. Boundy, *Transportation Energy Data Book: Edition 30* (Oak Ridge: Oak Ridge National Laboratory, June 2011), Table 3.3, p. 3-5.

Bibliography

2030 Water Resources Group, *Charting Our Water Future: Economic frameworks to inform decision-making* (2009).

Alam, Mozaharul and MD Golam Rabbani. "Vulnerabilities and responses to climate change for Dhaka," in Jane Bicknell, David Dodman and David Satterthwaite, eds., *Adapting Cities to Climate Change: Understanding and Addressing the Development Challenges* (London: Earthscan, 2009), pp. 93-110.

Angel, Shlomo. *Making Room for a Planet of Cities* (Cambridge, Mass.: Lincoln Institute of Land Policy, 2011). http://www.lincolninst.edu/pubs/1880_Making-Room-for-a-Planet-of-Cities-urban-expansion.

Averyt, K., J. Fisher, A. Huber-Lee, A. Lewis, J. Macknick, N. Madden, J. Rogers, and S. Tellinghuisen. *Freshwater use by U.S. power plants: Electricity's thirst for a precious resource. A report of the Energy and Water in a Warming World initiative* (Cambridge, Mass.: Union of Concerned Scientists, November 2011). http://www.ucsusa.org/clean_energy/our-energy-choices/energy-and-water-use/freshwater-use-by-us-power-plants.html.

Bernauer, Thomas, Tobias Böhmelt and Vally Koubi. "Environmental Changes and Violent Conflict," *Environmental Research Letters* 7 (2012), pp. 1-9.

Booz & Company Inc. *A Report on Intelligent Urbanization: Roadmap for India* (New Delhi: Confederation of Indian Industry, 2010). http://www.booz.com/global/home/what_we_think/reports_and_white_papers/icdisplay/47958191?gko=44786.

Brand, Stewart. *Whole Earth Discipline* (New York: Penguin, 2009).

Campanella, Thomas. J. *The Concrete Dragon: China's Urban Revolution and What it Means for the World* (New York: Princeton Architectural Press).

Commins, Stephen. "Urban fragility and security in Africa," *Africa Security Brief* 12 (April 2011), pp. 1-7. http://africacenter.org/2011/04/urban-fragility-and-security-in-africa/.

Cronon, William. *Nature's Metropolis: Chicago and the Great West* (New York: W.W. Norton, 1991).

Dabelko, Geoffrey D. "An Uncommon Peace: Environment, Development and the Global Security Agenda," *Environment: Science and Policy for International Development* (May/June 2008). http://www.environmentmagazine.org/Archives/Back%20Issues/May-June%202008/Dabelko-full.html.

Daly, Herman. "Economics in a full world," *Scientific American* (September 2005), pp. 100-07.

Davis, Stacy C., Susan W. Diegel, and Robert G. Boundy. *Transportation Energy Data Book: Edition 30* (Oak Ridge: Oak Ridge National Laboratory, June 2011). http://cta.ornl.gov/data.

Deudney, Daniel. "The case against linking environmental degradation and national security," *Millennium – Journal of International Studies* 19, 3 (1990), pp. 461-76.

Dhakal, Shobhakar. "Climate change and cities: the making of a climate friendly future," in Peter Droege, ed., *Urban Energy Transition: From Fossil Fuels to Renewable Power* (Oxford: Elsevier, 2008), pp. 173-92.

Dobbs, Richard, Sven Smit, Jaana Remes, James Manyika, Charles Roxburgh and Alejandra Restrepo. *Urban World: Mapping the Economic Power of Cities* (McKinsey Global Institute, 2011). http://www.mckinsey.com/Insights/MGI/Research/Urbanization/Urban_world.

Dorfman, Mark and Michelle Mehta. *Thirsty for Answers: Preparing for the Water-related Impacts of Climate Change in American Cities* (Washington, DC: Natural Resources Defense Council, August 2011). http://www.nrdc.org/water/thirstyforanswers.asp.

Droege, Peter. "Urban energy transition: an introduction," in Peter Droege, ed., *Urban Energy Transition: From Fossil Fuels to Renewable Power* (Oxford: Elsevier, 2008), pp. 1-14.

-----. *The Renewable City: A Comprehensive Guide to an Urban Revolution* (West Sussex: Wiley-Academy, 2006).

Economist Intelligence Unit and Siemens AG: *African Green City Index* (Munich: Siemens AG, 2011a). [All EIU/Siemens publications available at http://www.siemens.com/press/en/index.php.]

-----. *Asian Green City Index* (Munich: Siemens AG, 2011b).

-----. *European Green City Index* (Munich: Siemens AG, 2009).

-----. *German Green City Index* (Munich: Siemens AG, 2011c).

-----. *Latin American Green City Index* (Munich: Siemens AG, 2010).

-----. *US and Canada Green City Index* (Munich: Siemens AG, 2011d).

Fischer, Julie E., and Rebecca Katz. "The International Flow of Risk: The Governance of Health in an Urbanizing World," *Global Health Governance*, 4, 2 (spring 2011), pp. 1-17.

Frank, Lawrence, Peter Engelke and Thomas Schmid. Health and Community Design: *The Impact of the Built Environment on Physical Activity* (Washington, DC: Island Press, 2003).

Gagnon, Luc. "Greenhouse Gas Emissions from Transportation Options" (Montreal: Hydro-Québec, Direction – Environnement, September 2006). http://www.hydroquebec.com/sustainable-development/documentation/pdf/options_energetiques/transport_en_2006.pdf.

Giraud, Pierre-Noël, Michel Benard, Benoit Lefevre, Vincent Renard, Ian Cochran, Paula Restrepo Cadavid and Mathieu Saujot. *Energy and Urban Innovation* (London: World Energy Council, 2010). http://www.worldenergy.org/publications/2842.asp.

Gleick, Peter H., et al., The World's Water: *The Biennial Report on Freshwater Resources*. Volume 7 (Washington, DC: Island Press, 2011).

Goldstone, Jack A. "The new population bomb: the four megatrends that will change the world," *Foreign Affairs*, January/February 2010,

Grimm, Nancy B., Stanley H. Faeth, Nancy E. Golubiewski, Charles L. Redman, Jianguo Wu, Xuemei Bai and John M. Briggs. "Global change and the ecology of cities," *Science* 319 (Feb. 6, 2008), pp. 756-60.

Hanley, Susan B. "Urban sanitation in preindustrial Japan," *Journal of Interdisciplinary History* 18, 1 (summer 1987), pp. 1-26.

Heitzman, James. *The City in South Asia* (New York: Routledge, 2008).

Holmes, Tisha and Stephanie Pincetl. *Urban Metabolism Literature Review* (Los Angeles: Center for Sustainable Urban Systems, UCLA Institute of the Environment, winter 2012). http://www.environment.ucla.edu/media/files/Urban-Metabolism-Literature-Review2012-44-fea.pdf.

Homer-Dixon, Thomas F. "Environmental scarcities and violent conflict: evidence from cases," *International Security* 19, 1 (summer 1994), pp. 5-40.

-----. "On the threshold: environmental changes as causes of acute conflict," *International Security* 16, 2 (Fall 1991), pp. 76-116.

Hoornweg, Daniel, et al., *Cities and Climate Change: An Urgent Agenda* (Washington, DC: The International Bank for Reconstruction and Development/The World Bank, December 2010). http://climatechange.worldbank.org/content/new-report-sees-cities-central-climate-action.

Huang, Shu-Li, Chia-Tsung Yeh and Li-Fang Chang, "The transition to an urbanizing world and the demand for natural resources," *Current Opinion in Environmental Sustainability* 2010, 2.

Humansecurity.org. *Human security for an urban century: local challenges, global perspectives* (2007).

Hunt, Alistair and Paul Watkiss, "Climate change impacts and adaptation in cities: a review of the literature," *Climatic Change* 104 (2011).

The International Bank for Reconstruction and Development / The World Bank, *Climate Change, Disaster Risk and the Urban Poor: Cities Building Resilience for a Changing World* (Washington, DC: The International Bank for Reconstruction and Development/The World Bank, 2011a). http://wbi.worldbank.org/wbi/stories/new-studyclimate-change-disaster-risk-and-urban-poor.

-----. *Guide to Climate Change Adaptation in Cities* (Washington, DC: The International Bank for Reconstruction and Development/The World Bank, 2011b).

-----. *World Development Report 2009: Reshaping Economic Geography* (Washington, DC: The International Bank for Reconstruction and Development/The World Bank, 2009).

Ivanova, Nadya. "Off the Deep End — Beijing's Water Demand Outpaces Supply Despite Conservation, Recycling and Imports," May 3, 2011. http://www.circleofblue.org/waternews/2011/world/off-the-deep-end-beijings-water-demand-outnumbers-supply-despite-conservation-recycling-and-imports/.

Jackson, Kenneth T. "Cities," in Richard W. Bulliet, ed., *The Columbia History of the 20th Century* (New York: Columbia University Press), pp. 528-42.

Jenerette, G. Darrel, and Larissa Larsen, "A global perspective on changing sustainable urban water supplies," *Global and Planetary Change* 50 (2006), pp. 202-11.

Jerrett, Michael, Richard T. Burnett, C. Arden Pope, III, Kazuhiko Ito, George Thurston, Daniel Krewski, Yuanli Shi, Eugenia Calle and Michael Thun. "Long-term ozone exposure and mortality," *The New England Journal of Medicine* 360 (March 12, 2009), pp. 1085-95. http://www.nejm.org/doi/full/10.1056/NEJMoa0803894#t=article.

Kakissis, Joanna. "Environmental Refugees Unable to Return Home," *The New York Times*, Jan. 4, 2010. http://www.nytimes.com/2010/01/04/world/asia/04migrants.html?pagewanted=all.

Kamal-Chaoui, Lamia and Alexis Robert (eds.), "Competitive Cities and Climate Change," OECD Regional Development Working Papers N° 2, (Paris: OECD publishing, 2009).

Kaplan, Robert. "The Coming Anarchy," *Atlantic Monthly* 273, 2 (February 1994).

Kats, Greg, with Jon Braman and Michael James. *Greening our Built World: Costs, Benefits and Strategies* (Washington: Island Press, 2010).

Kenworthy, Jeffrey. "Energy use and CO2 production in the urban passenger transport systems of 84 international cities: findings and policy implications," in Peter Droege, ed., *Urban Energy Transition: From Fossil Fuels to Renewable Power* (Oxford: Elsevier, 2008), pp. 211-36.

Khagram, Sanjeev and Saleem Ali. "Environment and Security," *Annual Review of Environment and Resources* 31, 14 (November 2006), pp. 14.1-14.7.

Kunkeler, Josjah and Krijn Peters. "'The Boys are Coming to Town': Youth, Armed Conflict and Urban Violence in Developing Countries," *International Journal of Conflict and Violence* 5, 2 (2011), pp. 277-91. http://ijcv.org/index.php/ijcv/article/viewFile/155/pdf_33.

Levy, Marc A. "Is the Environment a National Security Issue?" *International Security* 20, 2 (1995), pp. 35-62.

Ling, Ooi Giok and Kenson Kwok. "Introduction: Planning Singapore," in Ooi Giok Ling and Kenson Kwok, eds., *City & the State: Singapore's Built Environment Revisited* (Singapore: Oxford University Press, 1997), pp. 1-12.

Liotta, P.H., and James F. Miskel. *The Real Population Bomb: Megacities, Global Security and the Map of the Future* (Washington, DC: Potomac Books, 2012).

Louisiana Coastal Wetlands Conservation and Restoration Task Force, *The 2009 Evaluation Report to the U.S. Congress on the Effectiveness of Coastal Wetlands Planning, Protection and Restoration Act Projects* (2010). http://lacoast.gov/reports/rtc/2009RTC.pdf.

Marcotullio, Peter J., and Niels B. Schulz. "Urbanization, increasing wealth and energy transitions: comparing experiences between the USA, Japan and rapidly developing Asia-Pacific economies," in Peter Droege, ed., *Urban Energy Transition: From Fossil Fuels to Renewable Power* (Oxford: Elsevier, 2008), pp. 55-89.

McClean, Denis, ed., *World Disasters Report 2010: Focus on Urban Risk* (Geneva: International Federation of Red Cross and Red Crescent Societies, 2010). http://www.citiesalliance.org/node/2176.

McGranahan, Gordon, Deborah Balk and Bridget Anderson, "The Rising Tide: Assessing the Risks of Climate Change and Human Settlements in Low-Elevation Coastal Zones," in Jane Bicknell, David Dodman and David Satterthwaite, eds., *Adapting Cities to Climate Change: Understanding and Addressing the Development Challenges* (London: Earthscan, 2009), pp. 51-62.

McGranahan, Gordon, Peter Marcotullio, Xuemei Bai, Deborah Balk, Tania Braga, Ian Douglas, Thomas Elmqvist, William Rees, David Satterthwaite, Jacob Songsore and Hania Zlotnik, "Urban Systems," in Rashid Hassan, Robert Scholes and Neville Ash, eds., *Ecosystems and Human Well-being: Current State and Trends. Findings of the Condition and Trends Working Group of the Millennium Ecosystem Assessment* (Washington, DC: Island Press, 2005), pp. 795-825.

McKibben, Bill. *Hope, Human and Wild. True Stories of Living Lightly on the Earth* (Minneapolis: Milkweed Editions, 2007).

McNeish, John-Andrew. *Rethinking Resource Conflict*. World Development Report 2011 *Background Paper*. (Washington, DC: World Bank Group, Sept. 17, 2010). http://wdr2011.worldbank.org/resources.

Mehaffy, Michael, Stuart Cowan and Diana Urge-Vorsatz. "The factors of urban morphology in greenhouse gas emissions: a research overview." Draft paper presented at the IARU Scientific Congress, Copenhagen, 10-12 March 2009. http://www.tectics.com/IARU.htm.

Melosi, Martin. *The Sanitary City: Urban Infrastructure in America from Colonial Times to the Present* (Baltimore: Johns Hopkins University Press, 2000).

Mills, Evan. "Insurance in a Climate of Change," *Science* 309 (August 12, 2005), pp. 1040-4.

Montgomery, M.R., R. Stren, B. Cohen, and H.E. Reed, Eds. *Cities Transformed: Demographic Change and its Implications in the Developing World* (Washington, DC: National Research Council, 2003).

Newman, Peter and Jeffrey Kenworthy. *Sustainability and Cities: Overcoming Automobile Dependence* (Washington, DC: Island Press, 1999).

Newman, Peter, Timothy Beatley and Heather Boyer. *Resilient Cities: Responding to Peak Oil and Climate Change* (Washington, DC: Island Press, 2009).

Nicholls, R.J., et al. "Ranking Port Cities with High Exposure and Vulnerability to Climate Extremes: Exposure Estimates," OECD Environment Working Papers, No. 1, (Paris: OECD Publishing, 2008). http://www.oecd-ilibrary.org/environment/ranking-port-cities-with-high-exposure-and-vulnerability-to-climate-extremes_011766488208.

OECD Development Assistance Committee. *Overview of the Links Between the Environment, Conflict and Peace*. (Paris: OECD, 2005).

Orum, Anthony M., and Xiangming Chen. *The World of Cities: Places in Comparative and Historical Perspective* (Malden, Mass.: Blackwell, 2003).

Pallewatta, Nirmalie. "Impacts of Climate Change on Coastal Ecosystems in the Indian Ocean Region," in David Michel and Amit Pandya, eds., *Coastal Zones and Climate Change* (Washington, DC: The Stimson Center, 2010), pp. 3-16.

Paris, Roland. "Human Security: Paradigm Shift or Hot Air?," *International Security* 26, 2 (Fall 2001), pp. 87-102.

Parthemore, Christine, with Will Rogers. *Sustaining Security: How Natural Resources Influence National Security* (Washington, DC: Center for a New American Security, June 2010).

Peirce, Neal R., and Curtis W. Johnson with Farley M. Peters. *Century of the City: No Time to Lose* (New York: The Rockefeller Foundation, 2008).

Pick, James B., and Edgar W. Butler. *Mexico Megacity* (Boulder: Westview Press, 2000).

Rabinovitch, Jonas. "Curitiba: towards sustainable urban development," *Environment and Urbanization* 4, 2 (October 1992), pp. 62-73.

Rodriguez, Alex. "Karachi 'water mafia' leaves Pakistanis parched and broke," *Los Angeles Times*, March 16, 2010. http://articles.latimes.com/2010/mar/16/world/la-fg-pakistan-water-mafia16-2010mar16.

Sagane, Rajendra. "Water management in mega-cities in India: Mumbai, Delhi, Calcutta and Chennai," in Juha I. Uitto and Asit K. Biswas, eds., *Water for Urban Areas: Challenges and Perspectives* (New York: United Nations University Press, 2000), pp. 85-96.

Satterthwaite, David. "In pursuit of a healthy urban environment in low- and middle-income nations," in Peter J. Marcotullio and Gordon McGranahan, eds., *Scaling Environmental Challenges: From Local to Global and Back* (London: Earthscan, 2007), pp. 69-105.

Shlomo, Angel, with Jason Parent, Daniel L. Civco, and Alejandro M. Blei. *Making Room for a Planet of Cities* (Cambridge, Mass.: Lincoln Institute of Land Policy, 2011). http://www.lincolninst.edu/pubs/1880_Making-Roomfor-a-Planet-of-Cities-urban-expansion.

Stone, Brian. "Land use as climate change mitigation," *Environmental Science and Technology* 43, 24 (2009), pp. 9052-6.

Thomas, Graeme and Giulio Sansonetti. *Growing Greener Cities* (Rome: Food and Agricultural Organization of the United Nations, 2010).

Tibbetts, John. "Louisiana's wetlands: a lesson in nature appreciation," *Environmental Health Perspectives* 114, 1 (January 2006), pp. A40-3. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1332684/.

Turnbull, C.M. *A History of Modern Singapore, 1819-2005* (Singapore: NUS Press, 2009).

Ullman, Richard H. "Redefining Security," *International Security* 8, 1 (summer 1983), pp. 129-53.

UNESCO / World Water Assessment Programme, *Water for People, Water for Life - UN World Water Development Report (WWDR). Executive Summary* (Paris: UNESCO/WWAP, 2003). http://www.unesco.org/new/en/naturalsciences/environment/water/wwap/wwdr/wwdr1-2003/downloads/.

United Nations Human Settlements Programme (UN-Habitat). *The Challenge of Slums: Global Report on Human Settlements 2003* (London: Earthscan, 2003), pp. 9-12. http://www.unhabitat.org/downloads/docs/GRHS.2003.0.pdf.

-----. *Cities and Climate Change: Global Report on Human Settlements 2011* (London: UN-Habitat, 2011). http://www.unhabitat.org/content.asp?typeid=19&catid=555&cid=9272.

-----. *The State of Asian Cities 2010/11* (Fukuoka: UN-Habitat, Regional Office for Asia and the Pacific, 2010a). http://www.unhabitat.org/pmss/listItemDetails.aspx?publicationID=3078.

-----. *State of the World's Cities 2010/2011: Bridging the Urban Divide. Overview and Key Findings* (Nairobi: UN-Habitat, 2010b). http://www.unhabitat.org/pmss/listItemDetails.aspx?publicationID=2917.

-----. *State of the World's Cities 2008/2009: Harmonious Cities* (London: Earthscan, 2008). http://www.unhabitat.org/pmss/listItemDetails.aspx?publicationID=2562.

-----. *Strategic Plan for Safer Cities 2008-2013. Summary Document* (October 2007). http://www.unhabitat.org/content.asp?cid=5524&catid=375&typeid=34&subMenuId=0

Urban Land Institute. *Land Use and Driving: The Role Compact Development Can Play in Reducing Greenhouse Gas Emissions* (Washington, DC: Urban Land Institute, 2010).

Urban Land Institute and Ernst & Young, *Infrastructure 2010: Investment Imperative* (Washington, DC: the Urban Land Institute, 2010).

White, Peter. "Transport Communications Cities," in Seetharam Kallidaikurichi and Belinda Yuen, eds., *Developing Livable Cities: From Analysis to Action* (Singapore: World Scientific Publishing, 2010), pp. 107-25.

Wong, Tai-Chee, and Charles Goldblum. "Sustainability Planning and its Theory and Practice: An Introduction," in Tai-Chee Wong, Charles Goldblum, and Belinda Yuen, eds., *Spatial Planning for a Sustainable Singapore* (Singapore: Springer Science + Business Media B.V., 2008), pp. 1-13.

World Business Council for Sustainable Development, *Water: Facts and Trends* (Geneva: WBCSD, August 2005).

World Commission on Environment and Development [Brundtland Commission]. *Our Common Future* (Oxford: Oxford University Press, 1987).

Ying, Tian. "China Ends U.S.'s Reign as Largest Auto Market (Update2)," *Bloomberg News*, January 11, 2010. http://www.bloomberg.com/apps/news?pid=newsarchive&sid=aE.x_r_l9NZE.

Atlantic Council
1030 15th Street NW, 12th Floor
Washington, DC 20005
p 202.778.4952 | f 202.463.7241
www.atlanticcouncil.org

STIMSON
1111 19th Street NW, 12th Floor
Washington, DC 20036
p 202.223.5956 | f 202.238.9604
www.stimson.org

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