

An Urbanizing World

Kai N. Lee

In 2007, engineers and construction workers are to begin transforming rural Chongming Island, in the Yangtze River near Shanghai, into a city. Arup, the firm preparing the master plan for this new development, called Dongtan, touts it as “the world’s first sustainable city.” Plans call for a city of 50,000 by 2010, with the population expected to reach 500,000 by 2040. The development will cover 4,600 hectares, less than a fifth of the entire island. Windmills will dominate the skyline, and turf, vegetation, and solar panels will cover the roofs. Some 80 percent of solid waste will be recycled, while organic waste will be composted or burned to supply heat and power. The only motorized vehicles allowed on the streets will be powered by electricity or fuel cells.¹

In theory, Dongtan will be self-sufficient in energy, food, and water, with close to zero carbon emissions from transportation. If this

is accomplished, each person living in Dongtan will exert much less pressure on nature than a New Yorker does today. Although New York City’s density of settlement is similar to that envisioned for Dongtan, the American city relies on electricity that is virtually all generated by fossil fuels and nuclear fission, and its wastes are carried by truck to landfills up to 650 kilometers away. New York’s recycling rate is less than 20 percent.²

The Dongtan eco-city project is one of the latest attempts to design an urban form that brings the needs of people into line with the needs of the environment. A century ago, Ebenezer Howard, a British reformer, advocated “garden cities,” self-contained towns of roughly 30,000 people living on 1,000 acres (405 hectares) surrounded by greenbelts. Within these new towns, zoning was to separate houses and gardens from factories and farms. The first garden city, Letchworth, was

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founded some 60 kilometers from London in 1902, and the idea spread to other countries, including the Netherlands and Japan. But the new towns did not create their own workplaces, as planned, and were instead absorbed into the regional growth of the cities they surrounded.³

Dongtan has yet to be built and tested. Like utopian projects before it, there are sure to be negative consequences. Some may be expected, such as the possible displacement of farmers now living on the island or the potential disruption of the protected wetlands that house a bird sanctuary, while others have yet to surface. Nonetheless, this project comes at a time when humanity needs new models for urban development.⁴

The Global Challenge of Urbanization

Thanks to rapid urban growth not only in China but elsewhere in Asia and Africa, some time in the coming year the population of the world will become mostly urban. By 2005, the world's urban population of 3.18 billion people constituted 49 percent of the total population of 6.46 billion. Very soon, and for the first time in the history of our species, more humans will live in urban areas than rural places.⁵

This is a significant milestone on the long road of civilization. Ten thousand years ago, humans were hunter-gatherers who moved with their food sources. With the discovery of agriculture came permanent settlements and, in time, the imperial cities of the ancient world. More than two centuries ago, improvements in agriculture in northwest Europe made it possible for a smaller fraction of the population to feed everyone. In 1740 about two thirds of the labor force in England and Wales worked in agriculture. By 1840 this had dropped to less than a quarter, even though

the English exported food throughout that century. On the heels of this increase in agricultural productivity came the invention of machines that could transform the heat of burning coal or wood into useful work. The Industrial Revolution spread from Europe to North America and then Japan, and cities grew to house and serve the new factory workers, many of whom had left farms where their labor was no longer needed. By 1900 humanity stood on the threshold of modernity: a new way of life anchored in cities that would rewrite the conditions of human life. (See Box 1–1.)⁶

In parallel, human activity has emerged as an environmental force of planetary proportions: replumbing watercourses, exterminating species, and altering the global climate. These changes have brought unprecedented material gains to our species, particularly in the high-income nations. Whether these gains can be shared with all of humanity, and whether they can be sustained, are questions that now seem increasingly urgent, as the impact of humans on the natural world can no longer be considered negligible. These are also matters that will be decided by urban inhabitants, because although human population growth may well cease in this century, cities and their environmental pressures are continuing to expand through economic growth, migration, natural increase, and the transformation of rural areas into urban settlements.⁷

U.N. projections suggest that nearly all of the world's population growth in the coming generation will be in cities in low- and medium-income nations. Asia and Africa, the most rural continents today, are expected to double their urban populations to about 3.4 billion in 2030. Already, about 1 billion urban dwellers live in "slums" or informal settlements—areas where people live without one or more of life's basic necessities: clean water,

Box 1–1. Transitions of Modernity

The cities made possible and necessary by industrialization have incubated a mutually reinforcing set of transitions that have redrawn the outlines of material existence. What we now think of as globalization is the latest phase in a set of linked transitions in population, health, economy, politics, social relations, and environment.

Families have grown smaller all over the world, led by the high-income countries and by China's surprisingly successful one-child policy. This demographic transition seems likely to result in the end of human population growth before the end of the twenty-first century. Stabilization of population has not been imposed by disease, famine, or war. With the exception of African countries hard hit by AIDS, health has improved almost everywhere over the past century, with declines in child mortality, decreases in infectious illness, and longer life spans, especially in high-income countries. This epidemiological transition had an important consequence for cities: just over a century ago, cities had so much disease that urban populations declined unless people moved into them. That urban penalty was erased by improvements in sanitation and clean water—although the poor public health conditions of slums still sicken and kill on a large scale.

Industrialization has brought an unprecedented economic transition, one still unfolding in the process of globalization. Average per

capita income has grown, with interruptions, since the early nineteenth century. But wealth and the indirect benefits of prosperity have been shared unequally, even as the output of the world economy has grown enormously. Economic power has been rooted in cities; the purchases of urban people, who cannot live off the land, form the foundation of national economies. Technological changes allowed cities to become larger and to spread further; steel-framed buildings made skyscrapers possible, while faster transportation brought people to and from jobs in high-density downtowns even as they came to live in distant, low-density suburbs.

As dramatic as the economic transformations of the past two centuries has been the uneven but unmistakable rise of democracy. The fraction of the world's people ruled by democratic governments rose from about 4 percent in 1840 to about 12 percent in 1900, and crossed 50 percent around 2000. This remarkable transition reflects the end of colonialism, which added India and many other medium- and low-income countries to the list of democracies. The widening reach of competitive elections has given city dwellers a chance to demand accountability for the conditions of urban life, and governments are now considered responsible for matters ranging from education to parks to women's rights that were simply not on the agenda of feudal societies.

SOURCE: See endnote 6.

sanitation, sufficient living space, durable housing, or secure tenure, which includes freedom from forced eviction.⁸

Urbanization thus presents a global challenge of human development and human rights. The shift in where we live brings to the fore the question of how we live—the challenge of sustainable development, defined in a widely quoted form 20 years ago as meeting the needs of the present without com-

promising the ability of future generations to meet their own needs.⁹

Many scientists agree that the global economy is not on a path toward sustainable development. More than a decade ago, the Intergovernmental Panel on Climate Change found that the burning of fossil fuels was altering the composition and heat balance of the atmosphere; the group has since documented signs of a changing climate, from

shrinking glaciers to the decline of some plant and animal populations. An international analysis of the world's ecosystems, written by more than 1,300 scientists, found that 60 percent of the services of nature—including those provided by farmlands, fisheries, and forests—are being degraded or used unsustainably. This Millennium Ecosystem Assessment warned in 2005 that “these problems, unless addressed, will substantially diminish the benefits that future generations obtain from ecosystems.”¹⁰

This chapter reviews the state of the world's urban areas, highlighting the way in which urbanization and sustainable development are linked. At first sight, cities seem to be the problem rather than the solution: the number of people living in slums has steadily increased, and industrial pollution in rapidly growing economies fouls water and air. Yet the flow of people toward cities seems unlikely to stop or even slow, in part because life chances and economic opportunities are often better in cities, even for many of the poor.¹¹

From that perspective, urbanization provides a crucial opportunity: to create living patterns harmonized with nature's rhythms as people continue to create urban habitat. Cities offer economies of scale for recycling water and materials, for instance, and for using energy efficiently. Yet today's high-income cities use resources unsustainably, and the high-consumption approach is plainly unaffordable for slum dwellers. Finding ways to create better urban settlements in all societies is central to sustainable development.

A city may be thought of as a physical and social mechanism to acquire and deliver essential natural services, such as clean water, to a concentrated human population. The physical part of this mechanism is often called infrastructure, while the social part includes markets, government, and community organizations. Cities vary tremendously, but

thinking of urban areas as linked to nature reveals an important pattern: the environmental problems of low-income cities are different in kind and in scale from the problems facing industrializing, medium-income cities. And the challenges brought by rapid industrialization in Guangzhou, China, or by poverty in Cochabamba, Bolivia, differ from those found in high-income cities like Phoenix or Turin.

Cities are tied to nature through markets and technology. Virtually all cities rely on food, fuels, and materials from elsewhere, and all cities are marketplaces. Thus, “sustainable” does not mean self-sufficient. Rather, a city moving toward sustainability improves public health and well-being, lowers its environmental impacts, increasingly recycles its materials, and uses energy with growing efficiency. Note the word “toward”: it is unrealistic for a human economy to have no impacts on the natural world, but clearly it is necessary for the human economy to share its wealth more equitably and in ways that enable our species to endure on a finite planet.

Urban Areas Today

While the trend of urbanization is clear, the measurement of what is urban is not. When the United Nations projects that the world's population will become predominantly urban in 2008, it is drawing upon information provided by member nations, who define “urban” differently. More than two dozen nations do not document their definitions at all. Urban populations can be identified using at least three different ideas: the number of people living within the jurisdictional boundaries of a city; those living in areas with a high density of residential structures (urban agglomeration); and those linked by direct economic ties to a city center (metropolitan area).

These definitions yield quite different pictures of the “city.” The U.S. National Research Council remarked in 2003 that “cities such as Buenos Aires, Mexico City, London, and Tokyo can correctly be said to be declining or expanding in population, depending on how their boundaries are defined.” Moreover, about two dozen low-income countries have not had a census in more than a decade, and the populations attributed to them are projections. Then there is the matter of how large a settlement must be to count as urban. India, for example, would change from being mostly rural to being mostly urban if it adopted the definition of urban area used in Sweden. Despite these weaknesses, the data published by the United Nations are widely used (as they are throughout this book) for lack of better estimates.¹²

In the second half of the twentieth century, according to the United Nations, the urban population of the world increased nearly fourfold, from 732 million in 1950 to 2.8 billion in 2000 and to more than 3.2 billion in 2006. As shown in Table 1–1, growth has been rapid in Africa, Asia, and Latin America, but much slower in Europe and North America, where more than half the population already lived in urban areas by 1950. Only 40 percent of the urban population lived in low- and middle-income nations in 1950, but that fraction will reach three quarters shortly after 2010.¹³

Since 1975, more than 200 urban agglomerations in low- and medium-income nations have grown past 1 million inhabitants. Their local governments are faced with the sanitation, housing, transportation, water, energy, and health needs of more than a million constituents—a striking new challenge that arose in a single

generation. Many municipal governments trying to cope with these matters lack trained workers, the budgets to pay them, and traditions of civic governance on a mass scale.¹⁴

The trends of the past generation are projected to continue into the coming one. More important, as noted earlier, the overwhelming majority of net additions to the human population—88 percent of the growth from 2000 to 2030—will be urban dwellers in low- and medium-income countries. Already, Africa has 350 million urban dwellers, more than the populations of Canada and the United States combined. In terms of absolute numbers of inhabitants, urban growth is unprecedented and will continue to be so. But in percentage terms, the rate at which national populations are becoming urban lies within the historical range experienced by the high-income countries.¹⁵

The rapid swelling of urban populations is due to both migration into cities and natural increase of the people already there. Although policymakers tend to emphasize the role of migration, which is high compared with historical levels in the places where rapid growth is taking place, natural increase actually accounts for over half of

Table 1–1. Urban Populations by Region, 1950–2000, with Projection for 2010

Region	1950	1970	1990	2000	2010
	(million inhabitants)				
Africa	33	85	203	294	408
Asia	234	485	1,011	1,363	1,755
Latin America and the Caribbean	70	163	315	394	474
Europe	277	411	509	522	529
North America	110	171	214	249	284
Oceania	8	14	19	22	25
World	732	1,329	2,271	2,845	3,475

Note: Columns may not add up to world total due to rounding.
SOURCE: See endnote 13.

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the rise in urban population.¹⁶

Perhaps the most visible aspect of global urbanization has been the rise of megacities, large urban agglomerations with more than 10 million inhabitants. (See Figure 1–1.) These cities only account, however, for about 9 percent of total urban population. Just over half of the world’s city dwellers live in settlements with fewer than 500,000 inhabitants. (See Figure 1–2.)¹⁷

The rapid urbanization of the world’s population is unfolding in distinctive ways in different parts of the world. Latin America, at 77 percent urban, has already gone through an urban demographic transition like those of North America and Europe, with national population growth rates declining since the 1960s. Growth in the region’s megacities has slowed considerably, as the costs of congestion have made smaller urban areas more attractive. Yet thanks to the world’s highest levels of economic and social inequality, Latin American cities have large slum populations that continue to grow.¹⁸

In Africa, where some 38 percent of the population lives in urban areas, urbanization is more recent and more rapid in proportional terms because of higher population growth rates, rural poverty due to low agricultural productivity, and wars that drive people into cities. The spatial and economic structure of African cities reflects choices made by Europeans in the colonial era, when trading centers for agricultural products and natural resources produced for international export replaced an older network of market settlements serving an agrarian population. The colonial cities were designed by Europeans with small enclaves for themselves; adjoining indigenous districts were built with little attention to water and sanitation, roads, transportation, or energy supply. The lack of infrastructure for the poor, followed by rapid urban growth, has produced large slum populations living at high levels of risk from disease and environmental hazards like flooding.¹⁹

Poor macroeconomic performance in sub-

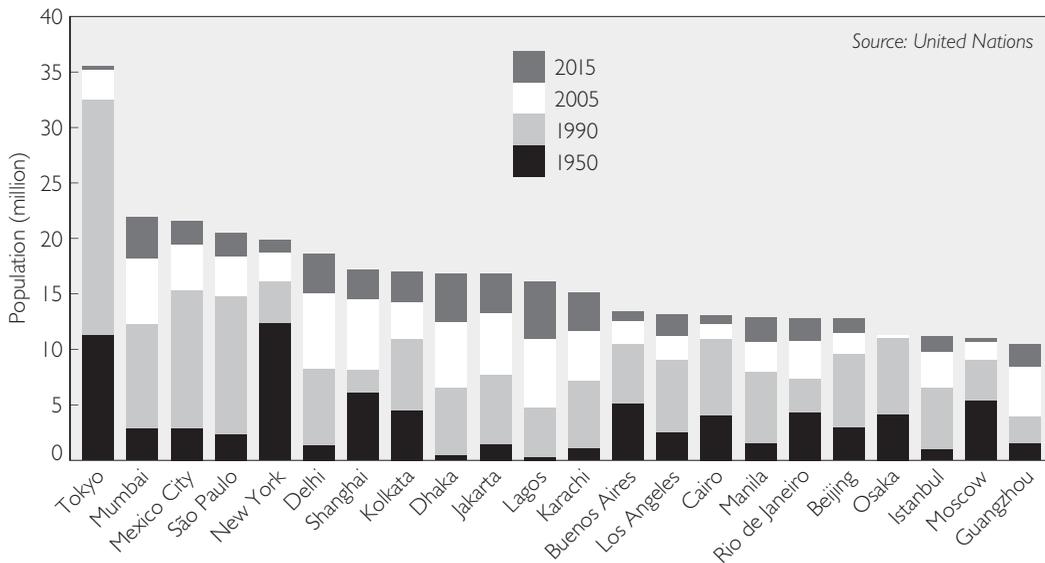


Figure 1–1. Urban Agglomerations Projected to Exceed 10 Million Population by 2015

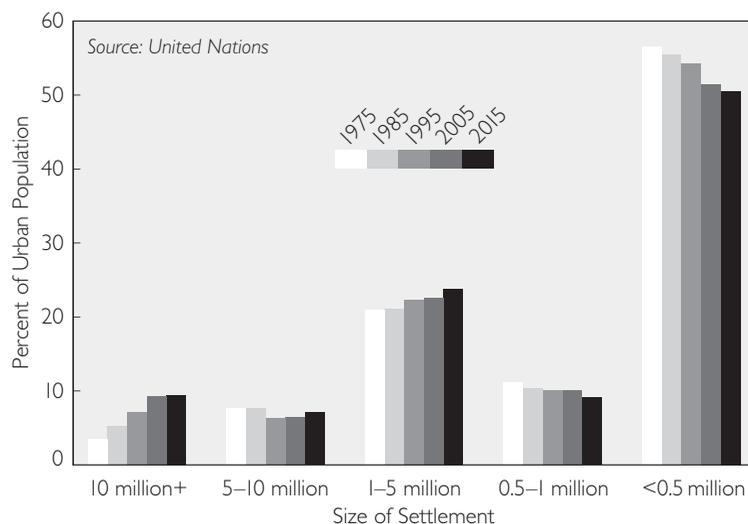


Figure I-2. Urban Population by Size Class of Settlement

Saharan Africa since independence, nearly half a century ago, has led to urban economies dominated by informal work such as food hawking and small-scale commerce, but little industrial employment. More than three quarters of nonagricultural employment is in the informal sector, yet it accounts for only 41 percent of economic output, because nearly all its jobs are in low-wage and low-profit activities. African economies are little integrated into the global economy, and they still depend on exports of natural resources and agricultural products in order to import manufactured products—as in colonial times.²⁰

Asia, the world's most populous region, is roughly 40 percent urban, with a varied urban landscape. Pacific Asia—the coastal regions from Japan to Southeast Asia—has undergone a remarkable economic transformation over the past generation as China and the newly industrializing countries of East Asia have rapidly increased incomes and levels of urbanization. China is now home to 16 of the world's 20 most polluted cities, as rapid eco-

omic changes have pressed the ability of governments to protect and improve public health. In western China, South Asia, and interior Asia, urbanization is also rapid, but economic growth has not been so meteoric, and poverty burdens nearly a third of India's urban population. Population growth rates remain high in Bangladesh and Pakistan, although they are declining. Urban populations shrank or grew

slowly in Central Asia in the severe economic and political disruptions that followed the collapse of the Soviet Union.²¹

Beyond these regional generalizations, each city has a history and a population that will lead the city in its own direction. Cities attract settlers and retain residents because they offer opportunities for employment, for meeting and being with people, for becoming someone different. As migrants to every slum will affirm, they are there because they want to be. Seizing the opportunities and taking the risks of city life, some will fail and others succeed. Often, people will do things they could not have done in rural settings, and sometimes they will push the urban community and economy in a new direction altogether, whether this involves opening up a new kind of business like an organic food market, or making new links to distant communities by sending earnings back home, or disrupting the community by committing a crime or contracting a previously unknown disease like avian flu.

The dynamism of cities makes each urban

area a place, a distinctive social and environmental setting around which loyalties and antipathies can form.

Dark Alleys

That each city is different has an important implication for policy: sensible support of or investment in an urban area requires knowledge of its relevant characteristics. Yet our understanding of cities is strikingly limited, and this constrains the ability of international institutions, governments, and nongovernmental organizations to act intelligently. One result is that there is no simple model of how to spur economic growth—not to mention sustainability—in cities. By comparison, it is an axiom of rural development that raising agricultural productivity is an ingredient of economic growth.

A basic limitation lies in the paucity of information collected on cities. Urban population is tabulated by the United Nations, but the variables that provide a picture of sustainability—human well-being, environmental conditions, and economic data—are measured mostly at the national level, with scant coverage in the cities of the developing world, where the most rapid urbanization is occurring.²²

As noted earlier, the delineation of cities varies from country to country. Drawing a boundary between rural and urban spaces implies a sharp separation between countryside and built-up area that simply does not exist in most places. Many families depend on both urban and rural settings to make a living. Cecilia Tacoli of the International Institute for Environment and Development points to studies that estimate the share of rural households' incomes from nonfarm sources, including migrants' remittances, at 40 percent in Latin America, 60 percent in South Asia, and 30–50 percent in sub-Saharan

Africa, reaching as much as 80–90 percent in Southern Africa. In addition, the changes in land use at the fuzzy edges of urban agglomerations are complicated, rapid in comparison to the reaction time of local government, and often difficult to control. Municipal governments do not often take responsibility for slums outside their boundaries.²³

Another challenge for policy is our unclear view of population growth. The urban population projections of the United Nations are not quite what they seem: they are purely demographic projections, showing the population trajectories if parameters observed and estimated now were to unfold in future years. They do not include the effect of economic, social, or environmental factors that might alter, for instance, birth or migration rates. Although the assumptions behind them are spelled out in U.N. documents, these projections are commonly taken to be predictions incorporating the best understanding of all the forces at play. Yet, studies of demographic projections have shown that U.N. estimates have tended to overestimate urban growth in developing countries by about 19 percent for estimates made 20 years earlier. Thus the projections of rapid urbanization in sub-Saharan Africa may prove to be high in the future if the economies in those countries remain weak.²⁴

A further limitation arises from the lack of data about variations within cities. Wealthy districts and slums occupy areas well known to a city's residents, but little information is available to analysts about how housing or employment conditions vary between them. Even accurate maps—essential for planning, building, and maintaining streets or sewers—are missing in many developing countries, especially for informal settlements that were occupied without authorization or recorded land transactions. This lack of knowledge compounds the difficulties arising from mul-

tiple, conflicting sets of property rights. In Ghana, as in many other former colonies, one system of property is rooted in precolonial family claims while another is inherited from the colonial legal system. Sorting these out, without maps or records of the traditional property claims, clogs courts and hinders the development of housing and businesses to accommodate rising urban populations.²⁵

Geographic information systems (GIS) that use computers to assemble data from different sources and to overlay them on maps are beginning to make a substantial contribution. Building on studies of specific cities that find that slum dwellers may have worse health conditions than people in rural areas, GIS analyses of conditions in Accra in Ghana and Tijuana in Mexico, among other places, are showing how poverty is much more than a lack of money. It includes higher prevalence of disease, exposure to flooding, and other adversities.²⁶

Why do these limitations of understanding matter? There is about \$150 billion spent each year on physical infrastructure in developing countries. The United Nations Millennium Project estimates that meeting the Millennium Development Goal of improving the lives of 100 million slum dwellers would cost \$830 billion over the next 17 years. These expenditures could help move poor people toward sustainable living and decent lives, but only if the donor agencies and governments allocating these substantial sums are able to target spending sensibly. Most development assistance has been aimed at rural poverty on the assumption that urban poverty is a transitory phenomenon for those migrating into cities. Yet with more than half of urban growth due to natural increase, it is far from clear when slum dwellers will escape or be able to improve their dwellings and neighborhoods. Development that moves people toward sustainable patterns will surely

need investments based on understanding who lives where in growing cities and how they earn their living.²⁷

Development that moves people toward sustainable patterns will need investments based on understanding who lives where in growing cities and how they earn their living.

Research and learning are accordingly practical necessities. UN-HABITAT has been collecting a large set of indicators in its Global Urban Observatory, and the important 2003 study *Cities Transformed* undertook analyses of the international Demographic and Health Survey in order to illuminate urban health and social conditions. Another noteworthy effort is led by economist Stephen Sheppard and urban planner Shlomo Angel. They chose 120 cities of various sizes from all regions of the inhabited world and developed a fast-track protocol to assess a wide range of variables in each city, ranging from housing prices to air pollution to urban planning policies. The protocol is designed so that a student who is a native speaker of the language can collect information on several hundred indicators in about a week. The project includes remote-sensing analyses of the 120 cities, using satellite images from 1990 and 2000. This study, supported by the World Bank and the U.S. National Science Foundation, is building a database for analysts worldwide in order to investigate social, environmental, and economic changes over a decade for a large sample of cities.²⁸

As important as research is learning from experience, translating failures and surprises into better choices going forward. This has proved to be a challenge in both development and environmental management. Although

surprises happen so often in social interventions that they should be expected, it is rare for those implementing a plan even to consider unexpected results. Merely stating goals clearly enough that failures can be identified is risky for politicians. Systematic methods for learning from policy implementation have been developed and tried out at a small scale, but uneven learning hangs like fog over the path to urban sustainability.²⁹

Wealth and Environment

The environmental challenges of cities vary with their level of economic activity. To oversimplify, poor city dwellers face direct, everyday environmental problems, while the wealthiest urban residents cause environ-

mental problems that they do not experience in their daily lives. A child in Soweto, South Africa, risks dying from waterborne illnesses that his distant cousin in Birmingham, England, will not be exposed to. A factory worker in Wuhan, China, may suffer from asthma triggered by air pollution, while her counterpart in Nagoya, Japan, is less likely to encounter pollutants in the air she breathes. The college student in Denver, Colorado, contributes more to global warming as he drives to the campus each day than does someone riding a bus to classes at the Universidad de los Andes in Bogotá, Colombia.

These stories of individual experiences correspond to statistical differences among low-, medium-, and high-income cities. Table 1–2 compares indicators for three cities drawn from these three categories,

Table 1–2. Sustainability Indicators for Ghana, Mexico, Singapore, Accra, and Tijuana

Indicator	Ghana	Mexico	Singapore
Population	21.2 million (2003)	104.3 million (2003)	4.37 million (2005)
Share of population urban, 2003	45.4 percent	75.5 percent	100 percent
GDP per capita (in purchasing power parity), 2003	\$2,238	\$9,168	\$24,481
Human Development Index rank, out of 177, in 2005	138	53	25
Life expectancy at birth, 2003	56.8 years	75.1 years	78.7 years
Probability of dying before age 5 (male/female) per 1,000 population, 2001	107/100	31/25	4/3
Health expenditure per capita (in purchasing power parity), 2002	\$73	\$550	\$1,105
Energy use (oil equivalent per capita), 2003	400 kg per year	1,564 kg per year	5,359 kg per year
	Accra	Tijuana	Singapore
Population (2005)	1.97 million	1.57 million	4.37 million
Share of population without access to “improved” sanitation	48 percent (1991–92)	17 percent (2000)	0 percent (2002)
Share of population without access to an “improved” water source	46 percent (1991–92)	29 percent (2000)	0 percent (2002)

SOURCE: See endnote 30.

showing economic and health indicators at the national level together with indicators of the cities' environmental conditions; energy use, a national statistic, is used as an indicator of carbon emissions. National statistics do not accurately represent conditions in cities, and variations within cities can also be large. The economic and health indicators are included here to show the divergence in the national contexts of low-, medium-, and high-income cities.³⁰

These numbers illustrate a pattern of spatial, environmental, and economic variation. A low-income city like Accra faces direct threats to health: water contaminated with human waste, housing infested with insect and rodent pests, streets and neighborhoods that flood in the rainy season. Each person and family must cope with these environmental problems in daily life. An industrializing city like Tijuana may face additional environmental problems from polluting factories and toxins from manufacturing processes. The rapid rise of energy use during industrialization, often in inefficient foundries and furnaces, imposes a large burden of air pollution on workers and residents, with substantial public health consequences. But industrialization also generates earnings that can be invested in environmental controls and public health measures, as the data on Tijuana and Singapore indicate.³¹

With the transition to economies dominated by service industries, high-income cities competed with one another on quality of life, seeking to attract the professional talent to staff service firms such as software engineering or finance. Good environmental conditions and amenities help create the clean, interesting places that draw and keep highly mobile people in cities like Singapore. The rising economies of wealthy cities also powered increasing energy consumption and exploitation of forests, oceans, and other natural

resources—with effects that were often far removed from the comfortable offices and homes of those living there.

High- and medium-income cities today are caught in the paradox of losing sight of nature just as they become more dependent on it through increasing consumption and the globalization of production. The paradox itself is a gift of markets of ever greater reach: if a coffee crop fails in Indonesia, the supply from Guatemala or Kenya will smoothly fill the cup in Rouen or Buenos Aires. A disaster for rural growers is an unnoticed blip for the urban coffee drinker. But there is another paradox of planetary-scale markets. Cities are places. Yet as cities become wealthier, their residents buy goods from around the world and invest in global companies. The widening spatial range of urban economies has frequently eroded a city's distinctiveness. This process is accelerating. Industrialization took more than a century to unfold in Europe, the United States, and Japan. The spread of industrial production to the once-poor lands of Asia has transformed economies in a few decades. And the rise of the information-intensive service economy brings change measured in years.³²

The variations among low-, medium-, and high-income cities have been discussed in terms of a curious empirical pattern known as the environmental Kuznets curve, named for American Nobel laureate in economics Simon Kuznets. (See Figure 1–3.) Drawing together a wide array of data, analysts have framed a generalized scenario of urban environmental development: local environmental problems that pose an immediate threat, such as lack of sanitation, tend to improve with increasing wealth, while global ones such as carbon emissions worsen, slowly undermining large-scale life-support systems such as climate. And as a city industrializes, environmental problems at the scale of the city and metro-

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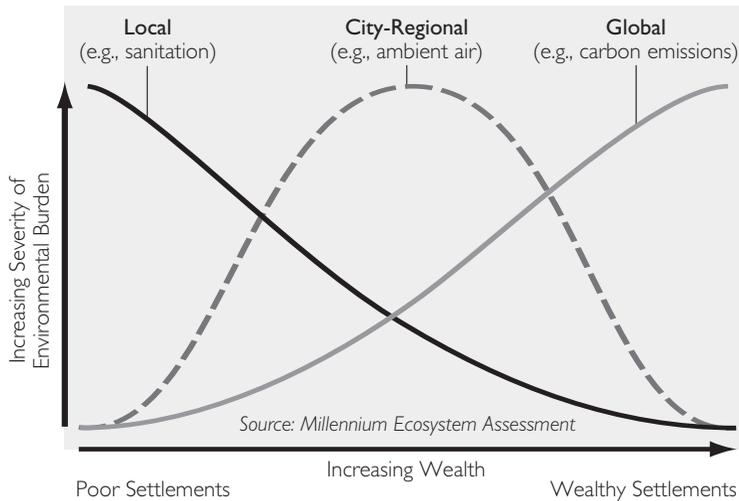


Figure I-3. Challenges to Urban Sustainability in Relation to Wealth

politan region first worsen, as pollution increases, and then improve, as resources for engineered controls and regulation became available. In some cases, those regulations, combined with economic changes, force polluting activities to other locations.³³

This pattern does not mean that environmental problems automatically improve with greater wealth, as has sometimes been suggested. Yet the fact that there are different types of environmental challenges at different income levels does have significant implications for sustainable development. The idea of meeting the needs of the present has a sharply different meaning for someone living in a slum than for someone with a high-income lifestyle. Similarly, the obligation not to compromise the ability of future generations to meet their own needs has a different resonance for the poor and the rich.

Sorting cities by income alone is a drastic oversimplification, of course. A key difference is the range of inequality in different cities, something that is missed by focusing only on average income. The poorest residents of

Tijuana or Accra face more difficult environmental conditions than those at the high end of the income scale in these cities, while the exposure to health and environmental risk varies less in Singapore. Poverty does not necessarily translate into high risks to health and poor environmental conditions, however, as has been demonstrated by the success of community-level organizations within a small number of slums. (See

Chapter 8.) And transportation patterns vary widely among high-income cities, with large effects on energy use, air quality, and land use. (See Chapter 4.)³⁴

Despite the complex circumstances of individual cities, however, it is useful to understand overall trends. The rapidly growing cities of India, China, and other industrializing nations need to organize and pay for their environmental cleanups. In rich nations' cities, reducing consumption of fossil fuels and other finite resources and redirecting investment toward sustainably managed industries—from renewable energy to sustainably harvested wood to well-managed fisheries—are critical to managing global threats to biodiversity, climate, and renewable resources. Poor cities whose populations are also growing rapidly must deal with worsening environmental and health conditions, in many cases without comparable increases in locally generated income. They might not be able to afford high-cost, long-term solutions such as expensive drinking-water purification plants and citywide pipelines.

Nature: Still Essential to Human Well-being

All humans rely on the natural world: water comes from wells and streams; food from farms and fisheries; and wastes are returned to nature. Some ancient civilizations may have been weakened by degrading the natural resources they needed to keep their cities operating. Archaeological evidence suggests that although Sumerians had figured out by 3500 BC how to draw water from the Tigris and Euphrates Rivers to their fields to grow wheat and barley, their irrigation systems did not drain well, so salts built up in the soil and caused wheat production to cease by 1700 BC. Overuse of resources is also implicated in the fall of the Mayan cities of Central America.³⁵

Today, we still need trees and wetlands to protect us from floods and storms, and we rely on nature for the raw materials of everyday life. These ecosystem services are essential to life and well-being. Securing necessary ecosystem services is a daily preoccupation of hunter-gatherer societies and a seasonal reality to farmers and fishers today. But it is barely glimpsed amid the hustle and cacophony of city life, at least until disaster strikes in the form of supply disruptions, skyrocketing prices, or a “natural” disaster for which engineering proves inadequate. As noted earlier, a city can be thought of as a mechanism to provide its inhabitants with ecosystem services; this is a large task, performed imperfectly for many urban dwellers around the world.

In the early 1990s, William Rees and Mathis Wackernagel devised the ecological footprint to measure human communities’ reliance on nature. The footprint is an estimate of “how much land and water area a human population requires to produce the resources it consumes and to absorb its wastes under prevailing technology.” The appealing notion of a footprint evokes the picture of a prein-

dustrial city, drawing its sustenance from the farmlands around it. The ecological footprint attempts to adapt this picture to cities and nations deeply enmeshed in a global economy. Using this approach, the per capita footprint of high-income countries is eight times as large as that of low-income countries.³⁶

Perhaps as important as the magnitude of humans’ reliance on nature is how people take care of the ecosystems that supply services. There are pastures in the Alps and irrigation systems in Bali that have been used for centuries with no diminution of their productive capability. In many other cases, ecosystems have been overused with disastrous economic and social consequences, particularly when the social institutions to govern use were absent or ineffective. Many ocean fisheries are now suffering this fate. Or consider litter: no one owns it, and few want to pick it up—so government refuse collectors have to be hired. There is a broader pattern here: when human responsibility does not match the cycles and patterns of nature, irresponsibility is likely to flourish. This is a problem of human institutions, including markets, governments, and concepts of property. These mismatches between nature’s logic and the rules and incentives that shape human behavior are called problems of the commons.³⁷

In cities, the high intensity of human activities leads often to problems where individual interests are at odds with the common good. The central task of urban sustainability is effectively managing commons problems in the ecosystems that sustain cities.

During the Industrial Revolution, pollution in cities of North America and Western Europe spurred a renegotiation of the relationship between humans and the environment as more people came to live at much higher densities than in rural areas. As industrialization drew workers to cities, water from wells was supplanted by piped water. The

availability of large quantities of relatively inexpensive water, in turn, spurred rapid growth in use. Between 1856 and 1882, for example, water consumption in Chicago rose from 125 to 545 liters per day per person.³⁸

For poor people in low-income cities today, nature's services are both expensive and arduous to obtain, as illustrated by the cost of water. Water free of disease-causing germs is available to a small and sinking share of residents of low-income cities. An assessment of 116 cities by the World Health Organization in 2000 estimated that only 43 percent of urban dwellers in Africa had access to piped water. The fraction is declining as more people settle in urbanizing areas without water service and as the existing delivery systems falter from inadequate maintenance, corruption, and the exhaustion of their sources from growing demand. Yet people still require water for drinking, cooking, washing, and bathing.³⁹

Where water is not available by pipe, the costs can be steep. (See Table 1–3.) In two informal settlements in Accra, Ghana, a bucket of water from a standpipe costs about 5¢, a price that seems modest to someone from Houston who readily pays more than \$1 for 500 milliliters of bottled “spring” water. But water can command more than 10 percent of a poor family's budget. In Addis Ababa, Ethiopia, the poorest fifth of the

population spends roughly a sixth of its household income on water. Moreover, water sold by private vendors in small quantities is far more expensive than water from a pipe: 37 times more expensive in Accra, nearly twice as high in a study done in East Africa. Water that is costly is used sparingly: usually, hygiene suffers and disease is more prevalent. These problems have become so widespread that they affect families that are not poor. One scientist in an Accra research institute rises before dawn each day to fetch water for his family to bathe, carrying buckets up four flights of stairs. He lives in the tony district among diplomatic compounds in his nation's capital.⁴⁰

Infrastructure and Governance

The economies of scale possible with high-density settlement in urban areas may offer the best chance to bring decent conditions to all of the world's poor and to conserve the resources on which we all depend. Health, education, and other measures of human development are highest in countries with mostly urban populations. Our need to build at least as much urban habitat as exists today, with its attendant infrastructure and governance systems, is the central hope for sustainable development—if we can learn the lessons of the world we are

Table 1–3. Cost of 100 Liters of Water in Accra and East Africa from Different Sources

Water Source	Accra, 2006	East Africa, 1997	Users
Sachet (500 milliliters)	\$8.01		General public for street drinking
30-pack (sachets)	\$4.45		General public for household drinking
Bucket from kiosk	\$1.87	18¢	Households relying on shared standpipe
Community shower	\$1.33 (bathing only)		Informal settlement dwellers
Vendor	27¢	45¢	Mixed-income neighborhood without piped water
Water pipe	5¢	10¢	Households with pipe connection

SOURCE: See endnote 40.

now modifying apace.⁴¹

Human life in cities is structured by infrastructure: water and food supply, sewers, transportation and communications networks, technologies to improve air quality, and buildings to house people and production. Physical infrastructure is largely inflexible. Streets and water pipes are expensive, long-term commitments, shaping urban form for decades to come. A decision against mass transit locks in a commitment to buses and autos. If a power plant is built to burn coal, that implies a stream of greenhouse gases for two generations.

A good deal of the infrastructure in high-income nations, built in response to the health threats in industrializing cities of the nineteenth century, spawned new problems. Engineers built dams and aqueducts to boost urban water supplies, but the environment has suffered. A study of 292 large river systems in the United States, Canada, Europe, and the former Soviet Union concluded that 42 percent of the ecosystems drained by these streams were strongly affected by impoundments and diversions, putting at risk habitats for a wide range of plant and animal species in the rivers and their watersheds.⁴²

Systems designed to channel waste away from people as quickly as possible have also improved human health while damaging the environment in other ways. When rainwater runs off pavement and into drains and sewers, the rivers at the end of the pipes flood more often and more severely than would be the case if plants, soil, and wetlands soaked up some of the deluge. Much as storm drains short-circuit the water cycle, urban waste disposal systems disrupt the nutrient cycle. Roughly half of the food brought into New York City is transformed into human energy; the other half is shunted to sewers or trucked to increasingly remote landfills. Yet organic waste is a valuable resource if composted into

a product that invigorates agricultural soils. (See Chapter 3.)⁴³

Twentieth-century transportation infrastructure has allowed urban food and energy supply lines to stretch to new lengths, as production has become ever larger and more centralized. Although large farms and power plants excel at producing more food and electricity with fewer employees, they generate pollution and require complex distribution routes, with use occurring far from the site of production. And despite gains in productivity, some 852 million people remain hungry, and roughly 1.6 billion lack electricity.⁴⁴

Infrastructure is largely invisible—pipes are usually underground and water, sewer, electricity, and telecommunications services are widely taken for granted. But it is not inexpensive. When it is financed and maintained from the public purse, governments take on debt that usually can be repaid only if there is economic growth. In the decades ahead, access to capital to build infrastructure will play a central role in the quality of life in cities, particularly for poor people.

As the large costs of physical infrastructure suggest, the social institutions needed to build, maintain, and pay for cities' connections to nature are also complex and varied. Foremost among them is the market, which affords access to ecosystem services to those who pay. The magnitude of poverty in rapidly growing low-income cities thus poses a stark dilemma. People who cannot afford reliable access to vital ecosystem services suffer risks to health and well-being. Yet many governments are so poor and so overwhelmed by the pace of urban settlement that they cannot afford to build the infrastructure that would, in many cases, bring down the cost of water, sanitation, and other services. The problem of creating a business model that can bring affordable and clean water to residents of low-income cities has beset corporations

and governments experimenting with privatization of water supply over the past 20 years. (See Chapter 2.)⁴⁵

In short, markets are not a complete solution for provision of nature's services to urban inhabitants, especially where there are common problems. The institutions that complement and substitute for markets range from bureaucracies to assure control of ecosystem interactions, such as public health and environmental protection agencies, to traditions such as informal harvest limitations in some fishing communities. Many of these social arrangements can be costly, requiring educated workers and durable organizations. As with physical infrastructure, sustaining formal organizations requires steady revenues and effective management.

The concepts of development and investment in infrastructure implicitly assume arrangements found in rich nations: public institutions that are largely free of corruption, economic activity that takes place in a formal economy, and per capita incomes high enough that water, food, shelter, and transportation become settled matters for most people rather than persistent crises of daily living.

In low-income cities, however, these conditions are not present for many people, particularly those living in slums and in an informal economy. Yet people cope and mostly survive. Safe drinking water, secure claim to a dwelling, protection from criminals, and much else may not come from government at all. In these circumstances, community-level organizations have sometimes been able to supply some social and public services. (See Chapter 8.) Urban initiatives such as the Orangi Pilot Project in Karachi have demonstrated that very poor people need not live without sanitation or clean water. (See Chapter 2.)⁴⁶

Recognizing that potential and linking it

to development assistance have risen higher on the agenda of international donors over the past decade. Major efforts to decentralize government have been instituted from Mexico to Mali to Thailand with notable success. Decentralization has channeled more resources to municipal governments, and innovations such as participatory budgeting have in turn given poor communities a voice in allocating public funds. There is still a long way to go, however, in realizing the self-help potential of slum dwellers and other poor people in meeting their needs for nature's services. (See Chapter 9.)⁴⁷

Circular Metabolism

Giving the poor a voice in solving local environmental problems would be a big step toward meeting the needs of the present, one of the two criteria of sustainable development. But for sustainability in the long term, more is needed: to move institutions and infrastructure toward forms that also protect the ability of future generations to meet their own needs. In this arena there are ideas that cut across income groups. While there have been some promising beginnings, particularly in high-income nations, here too there is much work to do.

A key conceptual step is to reconsider infrastructure. In theory, much of the waste from the water, food, fuels, and materials that course into cities could be reused or recycled. Herbert Girardet called for substituting a "circular metabolism," in which wastes are reused, for the linear metabolism of a city that simply converts resources into wastes. The notion of closing nutrient loops in a way parallel to the operation of natural ecosystems can be pursued at different scales, ranging from an individual building to the design of a metropolitan area. (See Box 1–2.)⁴⁸

"Green architecture" is the name of an

Box 1–2. Circular Urban Metabolism in Stockholm

Stockholm's new urban ecological district Hammarby Sjöstad is the best demonstration to date of putting circular urban metabolism into practice through creative design and building in a new, dense neighborhood. From the outset, planners tried to think holistically—to understand the resources that would be required by residents and the wastes that would result and could be used productively. For instance, about 1,000 apartments are equipped with stoves that use biogas extracted from the community's wastewater. Biogas also provides fuel for buses that serve the area.

People in the neighborhood put their solid waste into a vacuum-based underground collection system, which allows efficient separation of recyclables and organic and other wastes. Combustible waste is burned and returned to the neighborhood in the form of electricity and hot water, with the latter deliv-

ered through a district heating grid.

Stormwater from streets is directed into a purification and filtration system, and stormwater from buildings is guided to greenroofs and wetlands. Both streams of water are kept apart from wastewater, which is treated separately.

Carbon emissions from residents' transportation are minimized, as the neighborhood is close to central Stockholm, with a high-frequency light rail system, the Tvärbanan, and an extensive pedestrian and bicycle network. There are also 30 car-sharing cars distributed throughout the neighborhood.

While not a perfect example, Hammarby represents a new and valuable way of seeing city buildings, and it requires a degree of interdisciplinary and intersectoral collaboration that is unusual in most cities.

—Timothy Beatley, *University of Virginia*

SOURCE: See endnote 48.

approach to building design that moves toward circular metabolism by using technologies that reuse water and generate electricity. (See Chapter 5.) Vegetation planted on a building's exterior captures water that would otherwise be wasted, for instance, while reducing the energy needed for cooling. The 15-story IBM headquarters in Kuala Lumpur designed by Ken Yeang is a good example of this. In New York City, photovoltaic cells embedded in the south and east facades of the Condé Nast building in Times Square, combined with two fuel cells, provide enough electricity to operate the building at night.⁴⁹

A well-known example of a circular design on a larger scale is the eco-industrial park in Kalundborg, Denmark, where waste gases from an oil refinery are burned by a power plant, waste heat from the plant warms commercial fish ponds, and other companies use

byproducts of combustion to make wallboard and concrete.⁵⁰

The concept of green infrastructure is gaining adherents in Europe and America. This is a planning idea for a whole metropolitan region, applicable also to rural areas facing strong development pressures. By thinking at a regional level, planners identify natural areas and corridors that can sustain the ecological fabric of the area, allowing plants and wildlife to continue ecological functions such as migration and seed dispersal, even as land is converted to urban uses. The network of green spaces also provides flood control, clean air and water, and recreational services to the urban residents.⁵¹

Cities in low-income countries could, in theory, leapfrog directly to twenty-first-century technologies, and many ideas are being tried in industrializing economies, such as

the large-scale adoption of solar energy in Rizhao, China. Already, many cities have skipped directly to wireless phone systems, and a number of projects are under way to test the viability of water recycling and decentralized renewable energy in medium-income countries. A key element of leapfrog innovation is making it possible for municipal governments to benefit politically from solving problems in new ways. One effort to do this in the rapidly urbanizing landscapes of Asia is described in Box 1–3.⁵²

Which Urbanizing World?

As most humans come to call an urban environment home in this century, we are learning from the determined inhabitants of cities like Accra. In the long-established slum of Nima, a member of the municipal assembly has organized his neighbors to manage the mountain of refuse that emerges each day from Nima's numerous small businesses and markets, helping an overtaxed city deal with the garbage that clogs drains and worsens

Box 1–3. The Mayors' Asia-Pacific Environmental Summit

In May 2006, mayors and other local government officials from 49 cities in 17 countries around the Pacific Rim gathered in Melbourne, Australia, at the fourth Mayors' Asia-Pacific Environmental Summit (MAPES), a conference first held in 1999. Of 47 municipal leaders at the 2003 meeting who pledged to meet specific environmental goals within two years, 7 received awards for doing so in 2006. Their achievements ranged from building new composting plants for municipal wastes in Nonthaburi, Thailand, to extending water pipes to 4,000 poor households in Phnom Penh, Cambodia, and installing a new sewage-disposal system in Male, the capital of the Maldives.

Once a mayor makes a commitment, the summit organizers provide technical support and help line up funding. In 2006, each city that received a MAPES award also won a scholarship for a resident of the city to study at the Royal Institute of Technology in Stockholm in a program leading to a master's degree in urban sustainable technology. The American software publisher ESRI also offered assistance to cities that wanted to adopt geographic information systems in municipal management.

The brainchild of Jeremy Harris, former mayor of Honolulu, and Karl Hausker, an economist who worked at the U.S. Environmental

Protection Agency, MAPES is funded by the Asia Development Bank and the U.S. Agency for International Development.

"We know how to build sustainable cities," Harris says, "but it is still hard to marshal the political will to do so." With an eye on Asia's rapidly growing cities, he and Hausker devised MAPES to give mayors political rewards for moving toward sustainability, together with technical resources and the chance to learn from one another.

Other attempts to transfer sustainable development projects from one city to another have shown that lasting change is difficult to achieve. Even within a city, environmental reforms can be started and stopped with the changing of administrations. In Honolulu, energy-efficient lightbulbs in City Hall and a water recycling facility seem likely to last beyond Harris's tenure. However, his successor has ripped out some street trees, arguing that Harris was fiscally irresponsible and that the city could not afford the cost of maintaining the trees. Whether MAPES, with its focus on political leaders, will be able to facilitate environmentally responsible development that is also sustainable in a governmental sense is an important question.

SOURCE: See endnote 52.

flooding in the rainy season.⁵³

We are seeing cities with rapidly growing economies like Tijuana experiment with reforms that have streamlined municipal finance, enabling the city to support residents' self-initiated upgrading of their housing.⁵⁴

We have seen the transformation of Singapore in only one generation from a struggling, newly independent city-state to a modern postindustrial city prospering in a global economy through financial services, manufacturing, and a major port. Singapore's slums were replaced with modern housing, most of it built by a competent, incorruptible government. With its mass transit system and compact urban design, Singapore also enjoys a high standard of living with lower energy use per person than in the United States.⁵⁵

None of these cities is sustainable yet. Low-income cities stagger under their growing populations' unmet needs. Industrializing cities' demands for energy and materials

compound the demands already placed on nature by high-income urban and suburban consumers. All cities depend on many ecosystems. There are few cases now in which that dependence would be durable over the long run, even if population and consumption were to stabilize.

The urbanizing world must coexist with the natural world if both are to endure. The extraordinary diversity of human experience and human enterprise provides ample evidence of the threat of wider irreversible damage to ecosystems but also promising paths toward a sustainable future. Urbanization, perhaps surprisingly, is leading us to rediscover nature and the ecosystem services on which all humans rely. Creating urban habitats that deliver the bounty of nature in a sustainable fashion to the inhabitants of cities in all societies is an opportunity within our reach, as well as a cardinal test of our humanity.

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