Cities and the Biosphere

Cities are a type of socio-ecological system that has an expanding range of connections with nature's ecologies. As of 2012, most of these connections produce environmental damage: to mention just two cases, greenhouse gases pollute the atmosphere and felled trees contribute to desertification. The carbon footprint of urbanites, therefore, is enormous. Can we begin to use these connections to produce positive outcomes—outcomes that allow cities to contribute to environmental sustainability? The complex systemic and multi-scalar capacities of cities have massive potential for a broad range of positive connections with nature's ecologies.

The city is a key scale for implementing a broad range of environmentally sound policies and a site for struggles over the environmental quality of life for different socioeconomic classes (e.g., Satterthwaite et al. 2007; Redclift 2009; Van Veenhuizen and Danso 2007). Cities can help address air, noise, and water pollution, even when the policies involved may originate at the national or regional level. Thousands of cities worldwide, in fact, have initiated their own de facto environmental policies to the point of violating national law, not because of idealism, but because they have been compelled to do so. In contrast, national governments are far more removed from the immediate catastrophic potentials of poisoned air and floods and have been slow to act.

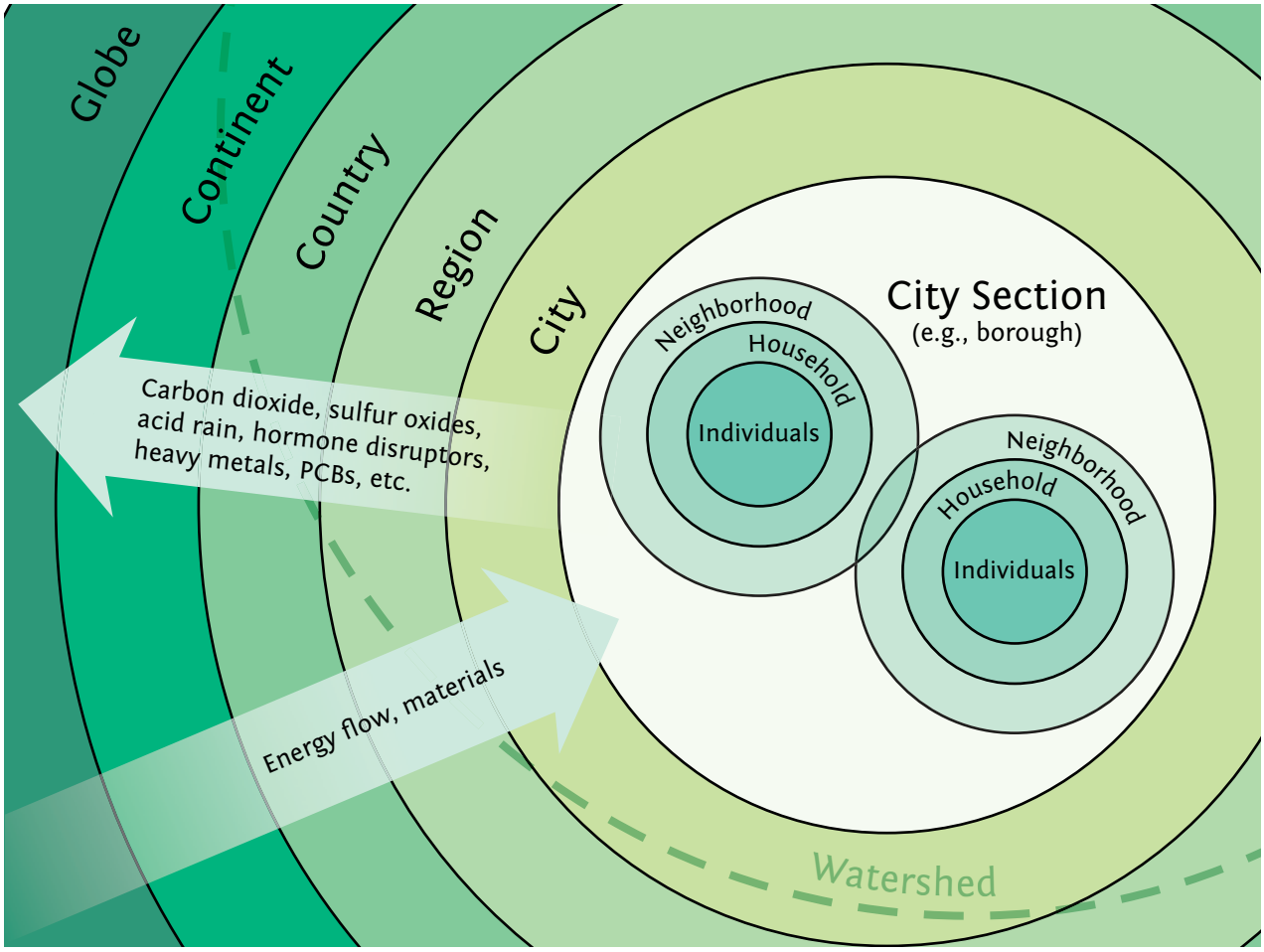
The current phase of economic globalization, which puts direct pressures onto cities, has sharpened further the acuteness of environmental challenges at the urban level. One example of these pressures is the global corporate demand for the extreme type of built environment Dubai epitomizes. The other side of this situation is the sharply increased demand for inputs, transport, and infrastructure for mobility—the enormous demand for wood, cement, nonrenewable energy, air transport, trucking, shipping, and so on. A second element influenced by the current global corporate economy is the World Trade Organization's subordination of environmental standards to what are presented as "requisites" for "free" global trade and proprietary "rights" (e.g., Gupta 2004; Mgbeogi 2006). Finally, privatization and deregulation reduce the government's role, especially at the national level, and hence weaken its mandatory powers over environmental standards.

These urban conditions, some negative, some positive, will become increasingly critical for policy matters not only for cities, but also at regional, national, and global levels. The city is one of the strategic sites where most of the questions about environmental sustainability become visible and concrete.

A Multi-scalar Ecological Urban Analysis

The city is a strategic space for the direct and brutal confrontation between enormously destructive forces that harm the environment and increasingly acute needs that support environmental viability. Much of what we keep describing as global environmental challenges becomes tangible and urgent in cities. Cities likely will need to implement and enforce international and national standards at the urban scale. The urban scale has limits, however, especially in the Global South, where local governments have limited funds. This scale is one at which societies can achieve many specific goals, however. (See figure 1 on page 37.) Local authorities are in a strong position to pursue the goals of sustainable development in their roles as direct or indirect providers of services; regulators, leaders, and partners; and mobilizers of community resources. Each urban

Figure 1. The Nested Scales of Urban Impacts on the Biosphere



Source: Berkshire Publishing.

Figure 1 shows the interconnectivity of the world from the largest scale to the scale of the individual, with watersheds showing across regions. Energy and materials—which release carbon dioxide, sulfur oxides, acid rain, hormone disruptors, heavy metals, PCBs, and other poisons that are often shipped from developed countries to developing countries—flow into the city. Each urban combination of elements is unique, as is the way it fits within local and regional ecosystems.

combination of elements is unique, as is the way it fits within local and regional ecosystems. From this specificity comes place-based knowledge that can be scaled up and contribute to the understanding of global conditions. The case of ozone holes illustrates this scale-up. The damage occurs at the microlevel of cars, households, factories, and buildings, but its full impact becomes visible and measurable only over the North and South poles, where there are no cars and buildings.

City-related ecological conditions operate on a diversity of geographic scales. Cities incorporate a range of scales on which a given ecological condition functions, and in that sense, cities make visible the fact itself of scaling. Further, cities make the multi-scalar properties of ecological systems present and recognizable to their residents. Developing and strengthening this urban capacity to make these properties visible will become increasingly critical for policy matters, not only for cities, but also at regional, national, and global levels. For the majority of those who write about environmental regulation in, and of, cities, the strategic scale is the local one (Habitat II, Local Agenda 21). Others have long argued that the ecological regulation of cities can no longer be separated from wider questions of global governance (Low and Gleeson, 2001). This is also a long-standing position in general, nonurban analyses of the "economy and the environment" (e.g., Etsy and Ivanova 2005).

A debate gathering heat, beginning in the 1990s and remaining unresolved as of 2012, pits the global against the local, or vice versa, as the most strategic scale for action. The British sociologist Michael Redclift (1996) argued that society cannot manage the environment at the global level. Global problems result from the aggregation of production and consumption, much of which is concentrated within the world's urban centers. Redclift

maintains that achieving sustainability at the local level must come first. He argues that the flurry of international agreements and agencies are international structures for managing the environment, and they bear little or no relationship to the processes transforming the environment. Not everyone agrees. The British environmental expert David Satterthwaite (1999) thus has long argued that we need global responsibilities, but these require international agreements. Nicholas Low, professor of Environmental Planning at the University of Melbourne (2000), adds that a global system of corporate relationships exists in which city administrations are increasingly a part. This complex cross-border system increasingly is responsible for the health and destruction of the planet. Today's development processes bring into focus the question of environmental justice at the global level, a question that, if asked in the early industrial era, would have been heard at the national level.

One key aspect of such an effort is to understand the biosphere's capacities to provide "nature's services," or "ecosystem services," which factory-made chemicals provide today: for instance, instead of controlling pests with pesticides, we would diversify the species in the cultivated land to ensure a balance. We have forgotten the knowledge about how a mix of species can ensure a balance that handles predators. Rotating crops according to the season is a long-standing example worldwide. We must relearn by using particular forms of scientific knowledge that help us understand what the biosphere can do. This replacement in itself would reduce the role and power of major corporate actors, such as pesticide manufacturers; each farm and each garden would be a center for managing a balanced distribution of species.

Greening our cities would mean that all households, neighborhoods, and firms would need to be part of the effort, thereby making of each of these an active contributor to environmental sustainability. Cities are complex systems and can wire this decentralizing of greening efforts into the urban fabric itself. This integration could balance the growth of inequality that became wired into the urban fabric when certain types of economic growth took off in the 1980s. Greening our cities, the necessity of confronting the environmental catastrophe, can force growing participation by all and push toward developing a new politics.

Environmental Inequalities

The possibility that greening might have distributive social effects adds to its importance, because environmental destruction is likely to add sharply to the inequality between poor and rich. Low-income settlements absorb more of the environmental damage than wealthy settlements do, even when the latter are far more destructive of the environment (Satterthwaite et al. 2007). The evidence shows that the decline of health because of global environmental change (including climate change) is predicted to be far greater in poor African populations than in European populations. Several factors are at work, from regional variations in the impact and types of climate change, to differences in existing levels of heat and food stress.

This trend also cuts across the high-income/low-income country divide. For instance, data on Los Angeles, California (United States), which is in many ways a rich city, show a sharp climate gap (Morello-Frosch et al. 2009). African Americans in Los Angeles are twice as likely as other city residents to die during heat waves, and families living below the poverty line are less likely to have access to air conditioning or cars to escape the heat. Five of the smoggiest cities in California have the highest concentrations of people of color and low-income residents; these communities are projected to have the largest increases in smog associated with climate change. Low-income and minority families spend more of their income than most others in the United States do on food, electricity, and water—as much as 25 percent of total family income.

This unequal distribution of the costs of environmental damage is also evident in studies about who will be the environmental refugees of the near future, when rising water levels and desertification worsen. Estimates of the numbers of migrants and projections of future numbers vary, but clearly, there will be many, and mostly the poor will have to flee for refuge. The estimates range

from 25 to 50 million by the year 2010 to almost 700 million by 2050; the International Organization for Migration (IOM) takes the middle road with an estimate of 200 million environmentally induced migrants by 2050 (IIED 2007, 17–25). A sea-level rise of 1 meter could affect 23.5 million people and reduce agricultural lands by 1.5 million hectares in the Ganges, Mekong, and Nile river deltas; a sea-level rise of 2 meters would impact an additional 10.8 million people and reduce agricultural lands by an additional 969,000 hectares.

These numbers point to a disturbing landscape of massive threats and sharp inequalities in the intensity of these threats for different areas and income groups.

Cities at the Heart of Our Environmental Future

The massive processes of urbanization under way in the early twenty-first century are inevitably at the center of the environmental future. Humankind increasingly is present in the planet through cities and vast urban agglomerations; it mediates its relation to the various stocks and flows of environmental capital through its urban presence. The urban hinterland—the surrounding area or region from which a city draws much of the resources it needs—is today a global hinterland. As the global economy expands, we have raised our capacity to annex growing portions of the world to support a limited number of industries and places.

Major cities have become distinct socio-ecological systems with planetary reach, going well beyond urban space. Massive population growth in cities and the consumption patterns of rich countries have combined with the sharpening of profit seeking by agribusiness to disrupt older, balanced ways of producing food. Traditional rural economies and their long-standing cultural adaptation to biological diversity ensured that the biosphere could replenish the land with needed nutrients. Humankind no longer allows the land to do so and, in fact, kills some of its nutrients with excess pesticides. In addition, rural populations increasingly are forced to consume goods, including food, the industrial economy produces, and this economy is much less sensitive to biological diversity. Food has become a commodity not to satisfy a basic need but designed to make a profit. The rural condition has evolved into a new system of social relations, one that supports monocrops rather than biodiversity and embraces the pecuniary nexus (financial connections) rather than community and meaningful interpersonal relationships. These developments all signal that the urban condition is a major factor in rural areas as well. It all amounts to a radical transformation in the relation between humankind and the rest of the planet.

Urbanization, an enormously distinctive presence, is changing, directly and indirectly, a growing range of nature's ecosystems, from the climate to species diversity. Urbanization is leading to the formation of new environmental conditions—heat islands, ozone holes, desertification, and water pollution. Urbanization and industrialization have made humankind the major consumer of all significant ecosystems. A set of global ecological conditions never seen before is the result.

Are these global ecological conditions, however, the result of urban agglomeration and density? Or are they the result of the specific subtypes of urban systems humankind has developed to handle transport, waste disposal, building, heating and cooling, food provision, and the industrial process through which we extract, grow, make, package, distribute, and dispose of all the foods, services, and materials we use?

It is, doubtless, the latter—the specific urban systems humankind has made. One of the outstanding features among a range of major cities in the early twenty-first century is their sharp differences in environmental sustainability. These differences result from diverse government policies, economic bases, cultures of daily life, and so on. European cities generally are far more engaged with environmental sustainability than are US cities, and the poor megacities of both the poor and rich worlds face a particularly big challenge.

Urbanization is inevitably going to alter the biosphere—cement covering land and water is just one simple element. But it need not be as damaging as it is now. Beyond the city itself, rural areas have adopted environmentally harmful production processes largely oriented to the urban demand for food. Until fifty years ago, or a hundred years in some regions, rural areas primarily had environmentally sustainable economic practices, such as crop rotation, and did not use chemicals to fertilize soil and control insects. Further, extreme capitalism has made the rural poor, especially in the Global South, so poor as of the early twenty-first century that, for the first time, many are also engaging in environmentally destructive practices, notably practices leading to desertification; thus very poor rural settlements are often pushed to live at the edge of inhospitable lands, such as deserts, where gathering wood for cooking means taking the few frail trees that prevent further desertification.

Delegating to the Biosphere

Beyond the differences among cities are a few foundational elements that dominate how we do things and are at the heart of what we need to address. One of these is the rupture in the energy and material flux through the human economy—in other words, what we use and need

returns in altered form as pollution and waste to the ecosphere. Humans disrupt the biosphere's ongoing cycle whereby, for example, rain or an animal's death replenishes the Earth with needed nutrients. This disrupting of continuous cycles occurs in nearly all economic sectors, from urban to rural. The cities, however, are where it takes on its most complex interactions and cumulative effects. This situation makes cities a source of most of the environmental damage and some of the most intractable conditions feeding the damage. The complexity of cities, however, also is part of the solution. Some cities are doing a great deal to maximize the flow through—with waste recycling the most familiar case.

An important concept to heal the rupture in how energy and material flow through the human economy is to use humankind's inventive skill and technology to redesign the manufacture processes. Users would return products, such as computers, lawn mowers, automobiles, and appliances, to the manufacturer when they no longer function. Manufacturers who saw the same parts returning to the input stream likely would find new solutions to make the objects work in the same way, but with different parts and processes. Another foundational element is that human-made chemicals have replaced far too many of nature's balancing processes, thereby further disrupting nature's cycles. Delegating back to nature would encourage ecologically sound practices. A familiar case that illustrates this dynamic is biodiversity in agriculture—crop rotation is one way of achieving what destructive chemical fertilizers and pest-killing poisons now do.

Multiple ways are possible to use nature for what destructive industrial goods do (see Sassen and Dotan 2011). It has taken science, however, to reconnect us to this knowledge. Industrialized societies buried these practices, along with the knowledge. For instance, we now know that certain bacteria that can live in cement can neutralize the carbon dioxide emissions of buildings—extremely important because buildings account for well over half of all such emissions worldwide (Jonkers 2007). One dramatic technology being developed is self-healing bacterial concrete. In this technology, bacteria living within concrete structures seal cracks and reduce the permeability of concrete surfaces by depositing dense layers of calcium carbonate and other minerals. Several groups have demonstrated the feasibility of this approach. This technology is still under development, but it promises to reduce energy and materials needed to maintain human infrastructures. Buildings thus would more closely model the self-sustaining, homeostatic (having balance among elements) physical structures found in nature. Furthermore, this technology is not expensive, except for high-rise buildings. Residents in most residential areas, notably low-income ones, could implement this change themselves, thereby contributing to employment and civic engagement. In major office districts, the matter changes, because major firms would need to handle the height.

Another example is using certain types of algae to clean up chemically contaminated water and ground. The problems of concentrated contaminants are a major issue in cities due to extremely high population densities. Landfill waste that human activity generates becomes a dangerous pollutant, a source of greenhouse emissions, and a terminal break in many natural cycles. The development of landfill bioreactors (devices using living organisms to synthesize useful substances or break down harmful ones) is one way of using nature for the cleanup. Landfill bioreactors accelerate waste decomposition by improving conditions for aerobic or anaerobic biological processes. This result is paired with the capture of by-products, such as carbon dioxide and methane, released in these processes, which produce a fuel known as "landfill gas" (LFG). This process both reduces the uncontrolled diffusion of greenhouse gases and provides a concentrated fuel source; it also makes possible the use of carbon dioxide for carbon sequestration (carbon dioxide removal) and fuel generation. These are just two examples. There are many more.

There is, however, a second course of action: fighting the power and profit logics that have organized environmentally destructive economies and societies.

The Complexity and Global Projection of Cities

Humankind cannot reduce the question of urban sustainability to modest interventions that leave the major economic systems untouched. Although in some environmental domains (e.g., protecting the habitat of an endangered species), simply acting on scientific knowledge can produce considerable advances, this is not the case when dealing with cities, multinationals, or society at large. Nonscientific elements, such as political will, are a crucial part of the picture: questions of power, poverty and inequality, ideology, and cultural preferences must be addressed. Policy and proactive engagement are critical dimensions for environmental sustainability, whether they involve asking people to recycle garbage or demanding accountability from major global corporations known to have environmentally damaging production processes.

The spaces where damage occurs often differ from the sites where responsibility for the damage lies (such as the headquarters of mining corporations) and where society should demand accountability. A crucial issue is the massive investment around the world promoting large

projects that damage the environment. Deforestation, mining, and construction of massive dams are perhaps among the best-known cases. The scale and the increasingly global and private character of these investments suggest that citizens, governments, and nongovernmental organizations (NGOs) all lack the power to alter these investment patterns. Tactics are available, however, most notably in global cities, which should be seen as structural platforms for acting and contesting these powerful corporate actors (Sassen 2005). A firm may have hundreds of mines across the world, but its headquarters are likely to be in one or a few major cities, where it is far easier to confront the firm than in hundreds of often isolated production sites.

The geography of economic globalization is strategic rather than all-encompassing, especially when it comes to the managing, coordinating, servicing, and financing of global economic operations. About seventy-five cities worldwide contain just about all the headquarters of globally operating firms. The strategic nature is significant for regulating and governing the global economy. The network of global cities is a strategic geography where the density of economic transactions and top-level management functions come together and constitute a concentrated space of global decision making.

This strategic geography also is available for demanding accountability from major corporate headquarters about the environmental damage they have produced. It is precisely because the global economic system is characterized by enormous concentration of power in a limited number of large multinational corporations (about 300,000 MNCs compared to millions and millions of small firms) and global financial markets that makes for concentrated rather than widely dispersed sites for accountability and for demanding changes in investment criteria. Engaging the headquarters actually is easier than engaging the thousands of mines and factories in often remote and militarized sites or the millions of worldwide service outlets of such global firms. Direct engagement with the headquarters of global firms benefits from the recognition, among consumers, politicians, and the media, of an environmental crisis. Because the global economy needs a growing number of global cities, not just one perfect imperial capital, these cities are a key space for countries around the world to engage global firms. The common though erroneous idea that cities compete with each other, however, has kept urban leaderships from collaborating to contest the claims of powerful global firms.

Specific networks of cities are natural platforms for cross-border city alliances that can confront the demands of global firms. Dealing with the headquarters of large firms, of course, leaves out millions of independent small local firms responsible for considerable environmental damage, but national regulations and local activism are more likely to control these.

One major obstacle in much of the effort to promote environmental sustainability is the absence of a strong recognition of the local level in interstate policy discussions and negotiations. Important here is that attaining major or minor recognition in global governance framings brings the focus on a level—cities—that helps make visible the limitations of existing climate governance framings. Every major city, regardless of country, would become a complex space for the implementation of processes that actually cut environmental damage rather than shift it around as is the case in carbon trading, still the preferred way for national governments.

Shortcomings in the Climate Change Governance Framework

Neither the Kyoto Protocol (KP; protocol aimed at fighting global warming) nor the United Nations Framework Convention on Climate Change (UNFCCC, or the Convention) contains specific references to local government or city-level actions to meet the Protocol commitments. A few references allude to local-level involvement, with Article 10 in the Kyoto Protocol recognizing that regional programs may be relevant to improve the quality of local emission factors. The latest UN Climate Conference (COP15) did not advance matters much, even though the addition of a Local Government Climate Change initiative did introduce some local issues into some of the debates and briefings.

Although neither the KP nor UNFCCC considers any role for cities or local governments, local governments have, in fact, established and built up financial and fiscal incentives, local knowledge and education, and other municipal frameworks for action through the actual practical obligations and opportunities that municipal-level governments encounter. Based on their legal responsibility and jurisdiction, local governments have developed targets and regulations; in this work, they have tended to exceed national and state jurisdictional obligations. In view of the failure to recognize cities at the international climate negotiations, the Local Government Climate Roadmap (a consortium of global municipal partnerships) has focused on this failure from 2007 onward. One basic premise in this effort is that including the local government level would ensure that the full chain of governance, from national to local, would be involved in the implementation of a climate agreement.

Further, and very illuminating about a specific urban structural condition, some of these local initiatives go back to the 1980s and 1990s, when major cities, notably Los Angeles, California, and Tokyo, implemented

clean-air ordinances, not because their leaderships were particularly enlightened, but because public-health reasons compelled them. The global initiative Cities for Climate Protection, developed by the ICLEI Local Governments for Sustainability network (founded in 1990 as the International Council for Local Environmental Initiatives), has been active as far back as 1993; the initiative included mostly results-based, quantified, and concrete local climate actions, launched long before the Convention and KP for national governments came into force (see ICLEI's Climate Program). Local governments have held Municipal Leadership Summits in 1993, 1995, 1997, 2005, and 2012, parallel to the official Conference of Parties (COP) meetings of national governments. As a result, the Local Government and Municipal Authority Constituency (LGMA) has built upon its role as one of the first NGO constituencies acting as observer to the official international climate negotiations process (or UNFCCC).

These interactions have led to an increasing recognition of a role for local governments and authorities, particularly regarding discussions on reducing emissions from deforestation and forest degradation in developing countries and the Nairobi work program on adaptation within the new and emerging concepts of the international climate negotiations. An extensive set of studies shows that cities and metro regions can make a large difference in reducing global environmental damage; it focuses mostly on greenhouse gas emissions (GHG). The international level, however, whether the Kyoto Protocol or the post-2012 UNFCCC negotiations, fails formally when it comes to recognizing this potential, nor is this potential built into draft agreements. Localizing the discourse on mitigation and adaptation, including in its international financing options, would involve both a bottom-up—information from local level—and a top-down understanding of how existing protocols and post-2012 agreements could integrate cities.

Ultimately, however, there is a need to go well beyond these governance frameworks, and cities make this need visible and urgent. Simply redistributing carbon emissions is not enough, nor are mitigation and adaptation directives enough. The process needs to bring in the knowledge that diverse natural sciences have accumulated, including practical applications, to address the major environmental challenges.

At the city level, using this knowledge is a far more specific and interactive effort than the more top-down modes of national policy. Further, it will entail an internationalism derived from the many different countries that are leaders in these scientific discoveries and innovations. This internationalism, however, will run through localities, each locality having its own political and social cultures for implementing change. Finally, capturing the complexity of cities in their multi-scalar and multi-ecological composition will permit many more implementation channels than just about any other level, whether national, international, or suburban. These additional channels should, in turn, allow us to go well beyond adaptation and mitigation as currently understood.

Outlook

Two issues stand out as strategic. One is the use of science and technology in ways that could lead to multiplying the positive articulations between cities and the biosphere. This step is merely one in a trajectory that should aim at fully using the complexity of cities—their multi-scalar and ecological features. We may not be close to such a full use, but a mobilization is beginning in that direction. Urban experts and scientists should succeed at connecting far more, which might enable us to move much faster on this potential.

A second strategic element concerns the city as a social and power system—with laws, extreme inequalities, and vast concentrations of power. Urban complexity and diversity are further augmented by the fact that implementing environmental measures that go beyond current modest mitigation and adaptation efforts will require engaging the legal systems and profit logics that underlie and enable many of the environmentally damaging aspects of our societies. Any advance toward environmental sustainability necessarily is implicated in these systems and logics. The actual features of these systems vary across countries and across the North-South divide. In some of the other environmental domains, it is possible to confine the discussion to scientific knowledge, but this is not the case when dealing with cities.

Nonscientific elements are a crucial part of the picture. Questions of power, political will, values, beliefs, poverty and inequality, ideology and cultural preferences, and

impact of purchasing power are all part of the question and the answer. One major dynamic of the current era is globalization and the spread of markets to more and more institutional realms. Questions of policy and proactive engagement possibilities have become a critical dimension of treatments of urban sustainability, whether they involve asking people to support garbage recycling or demanding accountability from major global corporations that are known to have environmentally damaging production processes.

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See also Buildings and Infrastructure; Climate Change and Big History; Collective Thinking; Community; Design and Architecture; Local Solutions to Global Problems; Migration; Mobility; Population; Waste—Engineering Aspects; Waste—Social Aspects

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