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A Focus on Cities Takes Us Beyond Existing Governance Frameworks

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Introduction

Incorporating the urban scale into global-level environmental governance framings can take us beyond the limitations and distortions of a carbon trading regime. This in turn takes us beyond the kinds of nationalisms that carbon trading brings into negotiations. Among the key properties that distinguish cities as a site for environmental policymaking, and thereby as a source of policy innovations, are their multiple scales and diverse socio-physical ecologies. I want to argue that these two features should be conceived of as urban capabilities for addressing the environmental challenge. A key obstacle to this potential is that cities tend to be excluded from current practice and environmental governance discourse: Cities are flattened into one scale—the "local," the bottom of the institutional hierarchy that runs through the national state.

Mobilizing these scalar and ecological urban capabilities would enable more complex applications of mixes of policy and scientific knowledge. Further, recognizing the city as a multiscalar and multiecological system is critical for developing more sophisticated types of policies and anchors for policy implementation. The biosphere shows us that what might be negative at one scale, can become positive at another scale: When we flatten

the city into the "local" level we miss these possibilities. Finally, making the application of scientific knowledge more central to the governance discussion counteracts the excessive weight of markets (i.e., carbon trading) as a means to address the environmental crisis. This counteracting matters because misplaced protectionisms of the "right" of countries to pollute is not going to help much in addressing the larger environmental crisis.

The articulation between cities and international regimes can generate a novel type of governance vector: a global regime centered in cities that promotes the development of new kinds of urban capacities regardless of (sovereign) country. Cities are de facto components of the global environmental governance regime, though they are not so de jure. Neither their weight in environmental damage production nor their specific capacities to reduce this damage have been factored into the formal regime. Incorporating this dual role of cities into the global regime would make a major difference in the reduction of environmental damage. Further, the mechanisms for achieving this difference would be drastically different from those of carbon trading, though they could coexist with the latter: The focus here is particularly on the potential use of scientific knowledge to detect biospheric capabilities we should use to replace chemicals we now make in factories.

This chapter is an exploration of these possibilities.

The Multiple Articulations of Cities and the Biosphere

The massive processes of urbanization under way today are inevitably at the center of the environmental future. It is through cities and vast urban agglomerations that mankind is increasingly present in the planet and through which it mediates its relationship to the various stocks and flows of the environment. The urban hinterland, once primarily a confined geographic zone, is today a global hinterland. With the expansion of the global economy, a growing number of countries and firms have raised our collective capacity to annex growing portions of the world to support a limited number of industries, places, and people.

A key starting point in the larger project (Sassen, 2009, in process[Ben1]; Sassen and Dotan 2011) on which this chapter is based has to do with recognizing the multiple articulations cities have with the biosphere. Today these articulations are mostly negative—they damage the environment and produce ruptures in biospheric cycles that are meant to be continuous. The

challenge is how to make these articulations positive. In contrast, today's more common policy approach is to focus on the damage and on what are basically minor mitigations of that damage; this is fine but not enough. Particular systemic properties of cities can enable a switch in the valence of those articulations, from negative to positive.

The substantive rationale for this project is that we need a better understanding of the role of cities because existing theories about environmental sustainability and global environmental governance do not accommodate cities in a productive way. Cities are reduced to the local level and to a source of damage. My effort goes in the opposite direction: to work with what is there at its most variable and complex. This also means going beyond the notion that the only way for cities to contribute to sustainability is mitigation and adaptation or to start from scratch. Mitigation and adaptation are not enough to address environmental damage. And most cities cannot start from scratch. Thus for most countries, Abu Dhabi's Masdar project of a fully self-sustained city is not a model because it is far too expensive and accommodates only a small population; it should be seen as a laboratory experiment that shows us what is possible, even if realistically it cannot be the solution for most of our existing cities. Thus it becomes urgent to recognize that one path into making cities part of the solution is to work from what is there but with the aim of changing the negative valence of current articulations with the biosphere.

The larger project has focused especially on the multiscalar and ecological properties of cities; these mimic those of the biosphere thereby enabling a notion of bridging between these two parallel worlds. But once cities reach a certain size (i.e. very large cities), cities become "unbiological" consumers of the biosphere (Bettencourt et al. 2007; Bettencourt and West 2010; Environment and Urbanization 2007; Sonnenfeld and Moll 2011) and thus need to be conceived of as representing a diverse logic from that of the biosphere. In other words, the social, legal, and economic characteristics of cities need to be factored into this bridging with the biosphere. Scientific and technological types of knowledge are critical to this bridging, especially for amplifying the capacities of the biosphere so as to compensate for the "unbiological" consuming of the biosphere. But implementation of that scientific and technological knowledge will, in turn, require significant changes in the social, legal, and economic modus operandi of cities.

One assumption in the larger project is that the scale of the city can enable these transformations in more direct ways than can the scale of nation-states. This is partly because cities can avoid the nationalisms so present in

the interstate debates about environmental sustainability. The fact is that cities across the world are learning from each other and implementing a range of similar innovations. This points to an emergent de facto cross-border. intercity geography for addressing environmental sustainability that can bypass much of the, often fruitless, debate around international carbon trading. Cities have implemented far more innovations than national governments, partly enabled by global urban networks for cross-border collaboration (Toly 2008). These types of interventions are beginning to reorient at least some of the articulations between cities and the biosphere. It is critical to avoid flattening the city into one singular scale and system, as is typical today and to develop and bring to the fore the multiscalar and ecological properties of cities.

A major obstacle to this type of intervention is the absence of recognition of the urban level in most international agreements and documents aimed at protecting the environment.

The Gaping Hole in the Current Climate Change Governance Framework

Neither the Kyoto Protocol (KP) nor the United Nations Framework Convention on Climate Change (UNFCCC) contain specific references to local government or city level actions to meet the Protocol commitments. There are just a few references to local level involvement; for example, Article 10 in the KP recognizes 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 in some of the debates and briefings.

Even though neither the KP nor UNFCCC consider any role for cities or local governments, they have established and built up financial and fiscal incentives, local knowledge and education, and other municipal frameworks for action through the 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 go beyond national and state jurisdictional obligations.[1] 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 onwards. 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 as to a specific urban structural condition, some of these local initiatives go back to the 1980s and 1990s when major cities, notably Los Angeles and Tokyo, implemented clean air ordinances, not because their leaderships were particularly enlightened but because they had to for public health reasons. The global initiative "Cities for Climate Protection" developed by the International Council for Local Environmental Initiative's (ICLEI) Local Governments for Sustainability network has been active as far back as 1993; these were mostly result-based, quantified, and concrete local climate actions, launched long before the Convention and KP came into force.[2] Local governments held Municipal Leadership Summits in 1993, 1995, 1997, and 2005, parallel to the official Conference of Parties (COP) meetings of national governments. Thereby the Local Government and Municipal Authority Constituency (LGMA) have built upon their role as one of the first NGO constituencies acting as an observer to the official international climate negotiations process (UNFCCC).[3]

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 (REDD) and on the Nairobi work program (REDD Web Platform; UNFCCC) on adaptation within the new and emerging concepts of the international climate negotiations. There is by now a rather extensive set of studies showing that cities and metro regions can make a large difference in reducing global environmental damage, focused mostly on greenhouse gas emissions (GHG). But the international level, 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 (Arikan 2009). The discourse on mitigation and adaptation needs to be localized, including in its international financing options. This would involve both a bottom-up—information from local level—and a top-down understanding of how existing protocols and post-2012 agreements integrate cities.

But ultimately, I will argue, there is a need, and cities make this need visible and urgent, to go well beyond these governance frameworks. We cannot simply redistribute carbon emissions, nor are mitigation and adaptation directives enough. We need to bring in the knowledge that diverse

natural sciences have accumulated, including practical applications, to address the major environmental challenges.

At the level of the city, using this knowledge is a far more specific and domain-interactive effort than at the level of national policy. Further, it will entail an internationalism derived from the many different countries that are leaders in these scientific discoveries and innovations. But this will be an internationalism that runs through thick local spaces, each with their own political and social cultures for implementing change. Finally, as I will argue, capturing the complexity of cities in their multiscalar and multiecological composition will allow for many more vectors for implementation than just about any other level, whether national, international, or suburban, such as the neighborhood. This should, in turn, allow us to go well beyond adaptation and mitigation as currently understood.

The Urbanizing of Global Governance Challenges

Many of today's major global governance challenges become tangible, urgent, and practical in cities worldwide. Urban leaders and activists have had to deal with many issues long before national governments and interstate treaties addressed them. Cities are sites where these challenges can be studied empirically and where policy design and implementation often is more feasible than at the national level. Among these global governance challenges are those concerning the environment; human insecurity, including the spread of violence against people of all ages and a proliferation of racisms; and the sharp rise in economic forms of violence. Cities also constitute a frontier space for new types of environmentally sustainable energy sources, construction processes, and infrastructures. Finally, cities are critical for emerging intercity networks that involve a broad range of actors (NGOs, formal urban governments, informal activists, global firms, and immigrants) that potentially could function as a political infrastructure with which to address some of these global governance challenges.

Cities also enter the global governance picture as sites for the enactment of new forms of violence resulting from various crises. In the dense and conflictive spaces of cities, we foresee a variety of forms of violence that are likely to escape the macrolevel norms of good governance. For instance, drug gang violence in São Paulo and Rio de Janeiro point to a much larger challenge than inadequate local policing. So do the failures of the powerful U.S. forces in Baghdad to institute order. To explain this away as acute

anarchy is inadequate and too facile. It will take much effort to maintain somewhat civilized environments in cities. In discussing global governance questions, one challenge is to push macrolevel frames to account for, and factor in, the types of stress that arise from violence and insecurity in dense spaces in everyday life—the type of issue that global governance discourse and its norms do not quite capture. Yet it is critical that such everyday conditions be incorporated in the global governance framing, because some of these may eventually feed into micro- and macrostyle armed conflicts, which will not solve the matter but make it worse.

More than nation-states, cities will be forced into the frontlines by global warming, energy and water insecurity, and other environmental challenges (Reuveny 2008; Dietz, Rosa, and York 2009; Warner et al. 2009). The new kinds of crises and, possibly, ensuing violence will be felt particularly in cities because of the often extreme dependence of cities on complex systems. City life depends on massive infrastructures (electricity for elevators and abundant public transport) and institutional support (e.g., hospitals, water purifying plants)—apartment buildings, hospitals, vast sewage systems, vast underground transport systems, entire electric grids dependent on computerized management that are vulnerable to breakdown. In a major simulation by NASA of a breakdown in the computerized systems that manage the electrical grid of a major city, it was discovered that the population would be in a fairly desperate situation by the fifth day. We already know that a rise in water levels will flood some of the densest areas in the world. When these realities hit cities, they will hit hard and preparedness will be critical. These realities are overtaking the abstract norm-oriented arguments of global governance debates that consist largely of future-oriented "oughts"—what we ought to do.

These challenges are emergent, but before we know it they will become tangible and threatening in cities. This contrasts with possibly slower trajectories at the national level. In this sense, cities are in the frontline and will have to react to global warming, whether or not national states sign on to international treaties. The leadership of cities is quite aware of this.

Can We Bridge the Ecologies of Cities and the Biosphere?

The enormously distinctive presence that is urbanization is changing a growing range of nature's ecologies, from the climate to species diversity and ocean purity. It is creating new environmental conditions—heat

islands, ozone holes, desertification, and water pollution. We have entered a new phase. For the first time, mankind is the major consumer in all the significant ecosystems, and urbanization has been a major instrument. There is now a set of global ecological conditions that have never been seen before. Major cities have become distinct socioecological systems with a planetary reach. Cities have a pronounced effect on traditional rural economies and their long-standing cultural adaptation to biological diversity. Rural populations have become consumers of products produced in the industrial economy, which is much less sensitive to biological diversity. The rural condition has evolved into a new system of social relationships, one that does not work with biodiversity. These developments signal that the urban condition is a major factor in any environmental future. It all amounts to a radical transformation in the relationship between mankind and the rest of the planet.

But is it urbanization per se or the particular types of urban systems and industrial processes that we have instituted? That is to say, is it the urban format marked by agglomeration and density dynamics or what we have historically and collectively produced partly through processes of path-dependence that kept eliminating options as we proceeded? Are these global ecological conditions the results of urban agglomeration and density or are they the results of the specific types of urban systems that we have developed to handle transport, waste disposal, building, heating and cooling, food provision, and the industrial processes by which we extract, grow, make, package, distribute, and dispose of the foods, services, and materials that we use?

It is, doubtless, the latter—the specific urban systems that we have made. Among the outstanding features that are evident when one examines a range of today's major cities are the pronounced differences in environmental sustainability. These differences result from diverse government policies, economic bases, patterns of daily life, and so on. In addition to these differences, there are a few foundational elements that now increasingly dominate our way of doing things. One of them is the fact that the entire energy and material flux coursing through the human economy returns in altered form as pollution and waste to the ecosphere. The rupture at the heart of this set of flows is *made* and can, thus, be unmade—and some cities are working on it. This rupture is present in just about all economic sectors, from urban to nonurban. However, it is in cities where it has its most complex interactions and cumulative effects. This makes cities a source of most of the environmental damage, and of some of the most

intractable conditions that feed the damage. Nevertheless, it is also the complexity of cities that is part of the solution.[4]

It is now imperative to make cities and urbanization part of the solution. We need to use and build upon those features of cities that can reorient the material and organizational ecologies of cities to positive interactions with nature's ecologies. These interactions, and the diversity of domains that they cover, are themselves an emergent socioecological system that bridges the city's and nature's ecologies. Part of the effort is needed to maximize the probability of positive environmental outcomes. Specific features of cities that help in this effort are economies of scale, density, and the associated potential for greater efficiency in resource use as well as important but often neglected dense communication networks that can serve as facilitators to institute environmentally sound practices in cities. More theoretically, one can say that insofar as cities are constituted through various processes that produce space, time, place, and nature, they also contain the transformative possibilities embedded in these same processes. For example, the temporal dimension becomes critical in environmentally sound initiatives. Thus, ecological economics enables us to recognize that what is inefficient or value-losing, according to market criteria with short temporal evaluation frames, can be positive and value-adding, using environment-driven criteria.[5]

The Complexity and Global Projection of Cities

As has been well-documented, cities have long been sites for innovation and for developing and instituting complex physical and organizational systems. It is within the complexity of the city that we must find the solutions to much environmental damage and the formulas for reconfiguring the socioecological system that constitute urbanization. Cities contain the networks and information loops that may facilitate communicating, informing, and persuading households, governments, and firms to support and participate in environmentally sensitive programs and in radically transformative institution building.

Urban systems also entail systems of social relationships that support the current configuration.[6] Aside from adoption of practices, such as waste recycling, it will take a change in these systems of social relationships themselves to achieve greater environmental sensitivity and efficiency. For instance, a crucial issue is the massive investment around the world

promoting large projects that damage the environment. Deforestation and construction of large dams are perhaps among the best known problems. The scale and the increasingly global and private character of these investments suggest that citizens, governments, and NGOs lack the power to alter these investment patterns. However, there are structural platforms for acting and for contesting these powerful corporate actors (Sassen 2005). The geography of economic globalization is strategic rather than all encompassing, and this is especially true in the managing, coordinating, servicing, and financing of global economic operations. The fact that it is strategic is significant for a discussion of the possibilities of regulating and governing the global economy. There are sites in this strategic geography, such as the network of global cities, where the density of economic transactions and top-level management functions come together to form a strategic geography of decision-making. We can see this also as a strategic geography for demanding accountability for environmental damage. It is precisely because the global economic system is characterized by an enormous concentration of power in a finite number of large, multinational corporations and global financial markets that makes for concentrated (rather than widely dispersed) sites for accountability and changing investment criteria. Engaging the headquarters is a very different type of action than engaging the thousands of mines and factories and the millions of service outlets of such global firms. This engagement is facilitated today by the recognition of an environmental crisis by consumers, politicians, and the media. Certainly, it leaves out millions of small, local firms that are responsible for much of the environmental damage. However, they are more likely to be controllable by means of national regulations and local activism.

A crucial issue raised by the foregoing is the question of the scale at which damage is produced and intervention or change should occur. This may, in turn, differ from the levels and sites for responsibility and for accountability. The city is, in this regard, an enormously complex entity. Cities are multiscalar systems where many of the environmental dynamics that concern us are constituted and which, in turn, constitute what we call the city. It is in the cities where different policy levels, from the supra- to the subnational, are implemented. Further, specific networks of mostly global cities also constitute a key component of the global scale and, hence, can be thought of as a network of sites for accountability of global economic actors.

Urban complexity and diversity are further augmented by the fact that urban sustainability requires engaging the legal systems and profit logics

that underlie and enable many of the environmentally damaging aspects of our societies (Sassen 2008, chapters 4 and 5). The question of urban sustainability cannot be reduced to modest interventions that leave these major systems untouched. The actual features of these systems vary across countries and across the North–South divide. Although in some of the other environmental domains it is possible to confine the discussion of the subject to scientific knowledge, this is not the case when dealing with cities. Nonscientific elements are a crucial part of the picture. Questions of power, poverty and inequality, and of ideology and cultural preferences 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.

Toward a Multiscalar Ecological Urban Analysis

City-related ecological conditions operate on a diversity of geographic scales. Importantly 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 multiscalar properties of ecological systems present and recognizable to its residents. This urban capacity to make visible should be developed and strengthened as it will become increasingly critical for policy matters not only of 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 (see, for example, 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 2000;). This is also a long-standing position in general, nonurban, analyses of the economy and the environment (Etsy and Ivanova 2005).

Beyond regulation, 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 (Satterthwaite et al. 2007; Van Veenhuizen and Danso 2007; Redclift 2009). Air, noise, and water pollution can all be partly addressed inside the city, even

when the policies involved may originate at the national or regional level. Indeed, thousands of cities worldwide have initiated their own de facto environmental policies to the point of contravening national law, not because of idealism but because they have been compelled to, as national governments are far more removed from the immediate catastrophic potentials of poisoned air and floods and have been slow to act.

The acuteness of environmental challenges at the urban level has been further sharpened by the current phase of economic globalization, which puts direct pressures on cities. One example of these pressures is the global corporate demand for the extreme type of built environment epitomized by Dubai. The other side of this 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 that the current global corporate economy has brought is the World Trade Organization's subordination of environmental standards to what are presented as "requisites" for "free" global trade and proprietary "rights" (Gupta 2004; Mgbeogi 2006). Finally, privatization and deregulation reduce the role of government, especially at the national level, and hence weaken its mandatory powers over environmental standards.

The city becomes a strategic space for the direct and brutal confrontation between forces that are enormously destructive *to* the environment and increasingly acute needs *for* environmental viability.[7] Much of what we keep describing as global environmental challenges becomes tangible and urgent in cities. It is likely that international and national standards will need to be implemented and enforced at the urban scale.[8] There are limits to the urban scale, especially in the Global South where local governments have limited funds. However, it is one of the scales at which many specific goals can be achieved. Local authorities are in a strong position to pursue the goals of sustainable development as direct or indirect providers of services, as regulators, leaders, and partners and as mobilizers of community resources.[9] Each urban combination of elements is unique, as is its mode of insertion within local and regional ecosystems. From this specificity comes place-based knowledge that can be scaled-up and that can contribute to the understanding of global conditions. The case of ozone holes illustrates this scale-up. The damage is produced at the microlevel of cars, households, factories, and buildings, but its full impact becomes visible and measurable only over the poles, where there are no cars and buildings.

A debate that gathered heat, beginning in the 1990s and remaining unresolved, pits the global against the local or vice versa as the most strategic

scale for action. Redclift (1996) argued that we cannot manage the environment at the global level. Global problems are caused by the aggregation of production and consumption, much of which is concentrated within the world's urban centers. For Redclift, we first need to achieve sustainability at the local level. He argues that the flurry of international agreements and agencies are international structures for managing the environment that bear little or no relationship to the processes through which the environment is being transformed. Not everyone agrees. Thus Satterthwaite has long argued that we need global responsibilities but cannot have such without international agreements (Satterthwaite 1999). Low (2000; see also Low and Gleeson 2001) adds that we have a global system of corporate relationships in which city administrations are increasingly taking part. This complex cross-border system is increasingly responsible for the health and destruction of the planet. Today's processes of development bring into focus the question of environmental justice at the global level, a question that, if asked, would have been heard at the national level in the early industrial era.

I make two observations here. One is that what we refer to or think of as the local level may actually entail more than one scale. For instance, the operations of a mining or manufacturing multinational corporation involve multiple localities scattered around the globe. Yet these localities are integrated at some higher organizational level into what then reemerges as a global scale of operations. Each locally produced set of damages will require much clean up and the establishment of preventive measures. However, the global organizational structure of the corporation involved also needs to be engaged. Along these same lines, the focus on individual cities promoted by notions of intercity competition in a global corporate economy has kept analysts and political leaders from understanding the extent to which the global economy needs networks of cities, rather than just one perfect global city. Hence, specific networks of cities are natural platforms for cross-border city-alliances that can confront the demands of global firms. One key benefit of international agreements for cities is in preventing some countries and cities from taking advantage of others that are instituting environmentally sound policies. Implementing such policies is likely to raise costs, at least for the short term, thereby possibly reducing the "competitiveness" of such cities and countries, even if it is likely to enhance their competitiveness in the long term. Cities that succeed in instituting such policies should not bear the expense incurred by the lack of such policies in other cities, whether at the national or international level. This will,

at times, require policies that restrain the transfer of environmental costs to other locations.[10]

The second observation is that an enormous share of the attention devoted to urban sustainability in the literature has been on how people as consumers and household-level actors damage the environment. When measuring cities, inevitably individuals and households are by far the most numerous units of analysis. Yet, there clearly are shortcomings in this focus. In matters of policy, it leads to an emphasis on household recycling activities without addressing the fundamental issue of how an economic system prices modes of production that are not environmentally sound. An "urban" focus limited to individuals and households is problematic in that it can easily leave out global economic and ecological systems that are deeply involved, yet cannot be addressed at the level of households or many individual firms. For instance, those who insist that greenhouse gas emissions will have to be controlled at the local level are, in many ways, right. However, these emissions will also have to be addressed at the broader macro levels of our economic systems. Further, some recent innovations suggest the possibility of planetary interventions though multiple local initiatives.

One matter that I have researched is a range of discoveries in biological laboratories that would allow us to use biospheric capacities to do what we now do with chemicals made in factories (Sassen and Dotan 2011; Sassen, 2013). For instance, a newly developed "paint" that has been mixed with bacteria that can live in concrete and deposit a kind of calcium helps seal the surfaces of buildings. This diminishes green gas emissions and purifies the air around the building.[11] This simple technology may be used for all concrete buildings, whether they are located in modest neighborhoods or the business districts of global cities. It is just one example of how a global scale can be constituted through a vast number of local sites, all of which are using the same mix of scientific knowledge and technology.

These diverse questions can be analytically conceived of as questions of scale. Scaling is one way of handling what are now often seen as either/or conditions: local versus global, markets versus nonmarket mechanisms, green versus brown environmentalism. I have found some of the analytic work on scaling conducted by ecologists helpful for conceptualizing the city in the context of environmental sustainability, particularly the question of bridging between the biosphere and the city. Of particular relevance is the notion that complex systems are multiscalar systems, as opposed to multilevel systems, and that the complexity resides precisely in the relationships among scales. Understanding how tensions among scales

might be operating in the context of the city can strengthen the analysis of environmental damages associated with urbanization and the ways in which cities as complex systems also contain the elements for solutions. One of the reasons this may be helpful is that we are still struggling to understand and situate various types of environmental dynamics in the context of cities; current environmental policy may be missing the best scale at which to use the city for a range of policy implementation. There is greater understanding of what needs to be done when it comes to remedial policy and clean-up.

Research has raised a set of specific issues concerning ecological systems that point to possibly fruitful analytic strategies to understand cities and urbanization processes with regard to environmental conditions and policy.

However, understanding the city as a broader system poses enormous difficulties precisely because of the multiple scales that comprise the city—as a system of distributed capabilities and as a political-economic and jurisdictional-administrative system. For instance, the individual household, firm, or government office can recycle waste but cannot address effectively the broader issue of excess consumption of scarce resources. An international agreement can call for global level measures to reduce greenhouse emissions but depends on individual countries, individual cities, and individual households and firms to implement many of the necessary steps. A national government can mandate environmental standards, but the specifics of implementation may depend partly on the character of a country's systems of economic power and of wealth production. A key analytic step is to decide which of the many scales of ecological, social, and economic processes is appropriate for addressing a specific environmental condition, whether negative or positive, and to design a specific action or response. Another analytic step is to factor in the temporal scales or frames of various urban conditions and dynamics; for instance, the cycles of the built environment are not the same as those of the economy, nor does the life of infrastructures correspond to the time frames of more and more investment instruments. The combination of these two analytic steps helps to deconstruct a given concrete urban situation and locate it in a broader grid of spatial, temporal, and administrative scales.

The connection between spatial and temporal scales evident in the biosphere may prove useful analytically to approach some of these questions in the case of cities. In the biosphere, it is clear that what may be negative in a small spatial scale or a short time frame can become positive in a larger

scale or longer time frame. For a given set of environmental disturbances in a city, diverse spatiotemporal scales may produce (or make visible) different responses. Using an illustration from ecology, we can say that individual forest plots may come and go, but the forest cover of a region can remain relatively constant overall. This raises a question as to whether a city needs to be conceived as a multiscalar system (rather than a collection of buildings, infrastructures, and population groups) in order to ensure a proper understanding of the character of the risk and how to address it; conceivably what is experienced as negative and hence deserving of an all-out deployment of resources to solve it, may turn out to be the equivalent of the forest plot, and in the long run have the effect of strengthening the overall forest (i.e., the city's overall capacity to deal with environmental damage). One research finding of ecologists in this domain is that movement across scales brings about change, which is the dominant process. It is not only a question of larger or smaller but rather that the phenomenon itself changes. Unstable systems come to be seen as stable, bottom-up control can turn into top-down control, and competition becomes less important. This mobile valence invites us to think of cities as containing solutions to types of environmental damage we now reduce to an "absolute" (i.e., absolute evil, absolutely destructive—with the city as a whole often seen as one such instance). What are the scales at which we can understand the city as contributing solutions to the environmental crisis?

An important issue raised by scaling in ecological research is the frequent confusion between levels and scales. What is sometimes described as a change of scales may merely be a change of level. A change of scale results in new interactions and relationships, often a different organization. Level, on the other hand, is a relative position in a hierarchically organized system. Thus, a change in levels entails a change in a quantity or size rather than the formation of a different entity. A level of organization is not a scale, even if it can have scale or be at a scale. Scale and level are two different dimensions.

Thus thinking of the city as multiscalar entails recovering, for instance, that an urban feature such as density actually alters the nature of an event or condition—it is not more of the same. The individual occurrence is distinct from the aggregate outcome. It is not merely a sum of individual occurrences (i.e., a greater quantity of occurrences). It is a different event. The city contains both and, in that regard, can be understood as instigating a broad range of environmental damage that may involve very different scales and origins. CO_2 emissions produced by the microscale of vehicles

and coal burning by individual households can scale up and become massive air pollution covering the entire city with effects that transcend CO_2 emission per se. Air- and waterborne microbes materialize as diseases at the scale of the household and the individual body. But they become epidemics that thrive on the multiplier effects of urban density and are capable of destabilizing the operations of firms whose machines have no intrinsic susceptibility to the disease. A second way in which the city is multiscalar is in the geography of the environmental damages it produces. Some of the damage is atmospheric and becomes planetary, therewith transcending the city. And some of it is internal to the built environment of the city; this might be the case with sewage or disease, whereas some of it, such as deforestation, is in distant locations around the globe.

A third way in which the city can be seen as multiscalar is that its demand for resources can entail a geography of extraction and processing that spans the globe, although it does so in the form of a collection of confined individual sites distributed worldwide. This worldwide geography of extraction materializes in particular and specific forms (e.g., furniture, jewelry, machinery, and fuel) inside the city. The city is one moment—a strategic moment—in this global geography of extraction, and it differs from that geography itself. A fourth way in which the city is multiscalar is that it houses a variety of policy levels. It is one of the key sites where a very broad range of policies—supranational, national, regional, and local—materialize in specific procedures, regulations, penalties, forms of compliance, and types of violations. These specific outcomes differ from the actual policies—in terms of the design of these policies and the specifics of implementation at other scales of government.

Conclusion

Bringing the city level into larger governance regimes is not without its complications. Among the subjects examined in this chapter, let me emphasize two I consider strategic. One is the use of science and technology in ways that would mobilize urban capabilities to transform what are now negative articulations between cities and the biosphere into positive ones. This means making full use of the complexity of cities, notably their multiscalar and ecological features. I do not think we are close to such a full use, but there is the beginning of a mobilizing in this direction. This should enable urban experts and scientists to connect on far more processes than they do now.

The second strategic element concerns the city as a social and power system—with laws, extreme inequalities, and vast concentrations of power. 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 is necessarily implicated in these systems and logics. To this we need to add that the actual features of these systems vary across countries and across the North–South divide. Although in some domains concerned with the environmental question, such as national states, it might be possible to confine the analysis to scientific knowledge this is not the case when dealing with cities.

And yet we must try. A focus on cities makes visible the limitations of existing climate governance framings. It would make every major city, regardless of country, a complex space for the implementation of processes that actually cut environmental damage rather than shifting it around as is the case with the carbon trading proposals. Using science and technology to reverse the negative articulations of cities with the biosphere would help make cities a strategic ground for active reductions of environmental damage. These types of efforts might well, and partly already do, bypass the intergovernmental debate on carbon trading and the protectionism of a country's "right" to pollute more than is allowed by the carbon trading regime.

Making "urban ground" a key component of a multisited global regime would operate on a practical rather than formal vector: The fact that cities tend to be ahead of their national governments in addressing environmental issues, and the fact that this is not the result of "good politics" but rather of practical and often urgent needs.

Notes

1. See for instance the *Global Status Report on Local Renewable Energy Policies*, Institute for Sustainable Energy Policies. Tokyo. (http://www.ren21.net/Portals/97/documents/Publications/REN21_Local_Renewables_Policies_2011.pdf), accessed 13 October 2012.

2. See, for instance, the ICLEI Climate Program at www.iclei.org/index.

3. The UNFCCC is focussed on a successor to the climate protection agreement following 2012, also known as the post-Kyoto or post-2012 agreement.

4. That it is not urbanization per se that is damaging, but the mode of urbanization also is signaled by the adoption of environmentally harmful production

processes by pre-modern rural societies. Until recently, these had environmentally sustainable economic practices, such as crop rotation and foregoing the use of chemicals to fertilize and control insects. Further, our extreme capitalism has made the rural poor, especially in the Global South, so poor that for the first time, many now are also engaging in environmentally destructive practices, notably practices that lead to desertification.

5. One key component here is ecological economics. For some of the foundational concepts and logics of ecological economics, see Daly (1977), Daly and Farley (2003), Gund Institute (2009), Rees (2006), Schulze (1994), and Porter et al. (2009).

6. See for instance Sassen (2001, 2005), Satterthwaite et al. (2007), Girardet (2008), Beddoe et al. (2009), and Morello-Frosch et al. (2009).

7. This is a broad subject. For studies that engage a range of aspects, see Rees (1992), Sassen (2001, 2005, 2009), Satterthwaite et al. (2007), Girardet (2008), Mol and Sonnenfeld (2000; 2011), Beddoe et al. (2009), and Morello-Frosch et al. (2009).

8. Some kinds of international agreements are crucial. Examples include agreements that set enforceable limits on each national society's consumption of scarce resources and their use of the rest of the world as a global sink for their wastes. Other agreements I find to be problematic, notably that concerning the market for carbon trading. The latter contain negative incentives. Firms need not change their practices insofar as they can pay others to take on their pollution. Overall there is a good chance of no absolute reduction in pollution.

9. For instance, instituting a sustainable consumption logic can be aided by zoning and subdivision regulations, building codes, planning for transport, water and waste, recreation and urban expansion, local revenue raising (environmental taxes, charges, levies) and by introducing environmental considerations when preparing budgets, purchasing contracting, and bidding (see Satterthwaite's and other researchers' work on the International Institute for Environment and Development (IIED) Web site (http://www.iiep.unesco.org/) for one of the most detailed and global data sets on these issues).

10. For instance, the vast fires to clear large tracts of the Indonesian forests in order to develop commercial agriculture (in this case, palm oil plantations geared to the world market) have regularly produced thick smoke carpets over Singapore, a city-state that has implemented very stringent air pollution controls often at high taxation expense to its inhabitants and firms.

11. Bacteria residing within concrete structures seal cracks and reduce the permeability of concrete surfaces by depositing dense layers of calcium carbonate and other minerals. Our buildings would thus more closely model the self-sustaining homeostatic physical structures found in nature (Jonkers 2007). This is particularly significant in the current period because (a) buildings are the largest single source of green gas emissions and (b) it would create employment, mobilize citizens in their neighborhoods, and allow local governments to get involved by initial small subsidies, especially in modest neighborhoods. An experimental technology with a similar capacity to be deployed "globally at the local level" is the so-called carbon negative cement (see www.novacem.com/docs/novacem_press_release_6_aug_2009.pdf). There are many other such uses of nature's capacity to address the environmental challenge in cities, although none as

globally present as the challenge of greening buildings. Some of these were developed a decade ago. For instance, bioreactors (essentially, controlled ponds) that combine bacteria and algae can clean nitrate-contaminated water as gaseous nitrogen (N_2) can be recycled into the atmosphere (Garcia et al. 2000).

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