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Land and the City

Edited by George W. McCarthy, Gregory K. Ingram, and Samuel A. Moody

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PREFACE

The majority of the world's population now lives in urban areas and depends on urban systems for housing and social and economic goods and services. This number will only increase as cities blossom and expand to accommodate new residents, particularly in developing nations. What remains unchanged, however, is the key role of cities as engines of economic growth, social activity, and cultural exchange. In an effort to support the success and sustainability of cities, this volume explores how policies regarding land use and taxation affect issues as diverse as the sustainability of local government revenues, the impacts of the foreclosure crisis, and urban resilience to climate change.

This collection, based on the Lincoln Institute of Land Policy's 2014 annual land policy conference, addresses the policies that underlie the organization, financing, and development of the world's cities. It is the final volume in the Institute's land policy conference series. Over the years, these meetings have addressed land policy as it relates to a range of topics, including local education, property rights, municipal revenues, climate change, and infrastructure.

We thank Armando Carbonell, Martim Smolka, and Joan Youngman for their advice on the selection of topics and on program design. The conference was organized by our exceptional event team, comprising Brooke Burgess, Sharon Novick, and Melissa Abraham. Our special thanks go to Emily McKeigue for her exemplary management of the production of this volume, to Peter Blaiwas for the cover design, to Nancy Benjamin for maintaining the publication schedule, and to Barbara Jatkola for her tireless and reliable copyediting.

George W. McCarthy
Gregory K. Ingram
Samuel A. Moody

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Monitoring the Share of Land in Streets: Public Works and the Quality of Global Urban Expansion

Shlomo Angel

Securing an Adequate Share of Land in Streets

As cities expand, the land necessary for public streets, infrastructure networks, and open spaces must be firmly secured, preferably in advance of development. For cities to be efficient, equitable, and sustainable, there must be a balance between the shares of public and private land.

When too much land is in public ownership and public use, as was the case in Moscow between 1917 and 1989, decisions about what to build on a given plot are often made without reference to competing demands that seek to realize the full potential of the land—or to use the language of urban economics, to put the land to its "highest and best use." Land was typically allocated with the objective of minimizing the bureaucratic costs plus the out-of-pocket costs to develop it. As a result, there was little incentive to recycle unused or underused land in city centers—often costly in both bureaucratic and financial terms—and a preference

The author wishes to acknowledge colleagues who have contributed ideas to earlier versions of this chapter and who have helped articulate the methodologies underlying this research initiative: Claudio Acioly, Alain Bertaud, Alejandro Blei, Daniel Civco, Joan Clos, Alex de Sherbinin, Brandon Fuller, Nicolas Galarza, Patrick Gerland, Gregory Ingram, Patrick Lamson-Hall, Rob Lemmens, Gora M'Boup, Ana Moreno, Eduardo Moreno, Jason Parent, Paul Romer, Richard Sluizas, Kevin Thom, and Jaime Vasconez. Special thanks are due to Manuel Madrid, who prepared the sample street maps and their associated metrics for 30 cities.

for greenfield projects on the urban fringe instead. Over time, residential densities in Moscow increased rather than decreased with distance from the city center, reducing overall access in the city. This unnecessarily raised the average length of trips, with the concomitant energy loss and increased pollution (Bertaud and Renaud 1995).

Similar distortions occur when municipalities do not own all the land but exercise strong powers over its designated use, as is currently the case in Israel. Israeli planning law mandates that as much as 40 percent of any land to be converted to urban use be transferred to the municipality for public use, free of charge. This percentage is now a baseline to which municipalities and other government ministries, such as the Education or Interior Ministry, add land requirements for schools, parks, and the like, with the result that the share of land claimed to be necessary for public use is much higher. The Israel Land Authority, which owns many large parcels of land required for urban expansion, now refuses to allow the share of land for public use to exceed 65 percent. Strange as it may seem, were it not for the authority's ability to force the hands of municipalities, public authorities would seize more than 70 percent of the land for public use, often holding it in reserve for future use (and possibly for sale or lease to private enterprises as well).[1] This practice is no doubt excessive, reflecting a rather bureaucratic approach to city planning that is out of touch with the way successful cities develop and thrive. There must be ample land in private use—available for production, commerce, civic activities, and residences—for the city to develop and thrive. And it is in the public interest to make that possible, at the very least to generate the resources needed to invest in and operate a full complement of public services.

Bangkok in the 1980s, in sharp contrast to Moscow during the same period, was an unfettered, laissez-faire land market that ensured an ample supply of land for urban expansion and an adequate supply of affordable housing. That being said, Bangkok failed miserably when it came to allocating enough land for roads. More specifically, it failed to provide adequate land for its arterial road network—the network that typically carries public transport as well as the city's primary infrastructure grid (water, sewer, and storm drainage lines)—as well as for its local street networks. This failure has resulted in large losses in productivity and efficiency, as well as massive shortages of essential infrastructure services, which have greatly compromised the city's quality of life.

The road network in every country typically forms a three-tier hierarchy of primary, secondary, and tertiary roads. Central or state governments usually plan, acquire land for, finance, construct, and maintain the primary intercity road network of the entire country. Municipalities typically plan, acquire land for,

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1. This information comes from a conversation in January 2012 with the architects Amir Kolker and Ofer Kolker, who recently completed the master plan for the expansion of the Israeli city Rishon LeZion.

finance, construct, and maintain the secondary, or arterial, road network within their jurisdictions. It is this network that connects all parts of the city, allowing it to function as one large and integrated market for labor, goods, and services, rather than as a mosaic of fragmented communities. In a minority of cases, as in the 1811 Commissioners' Plan (figure 3.1), the municipality plans and builds the tertiary road network as well. This allows for the homogenization of the urban territory, in the spirit of transforming disparate strangers into citizens, creating a large public sphere for bringing people together, removing the differentiations between rich and poor and between formal and informal, and equalizing the efficient distribution of public services.

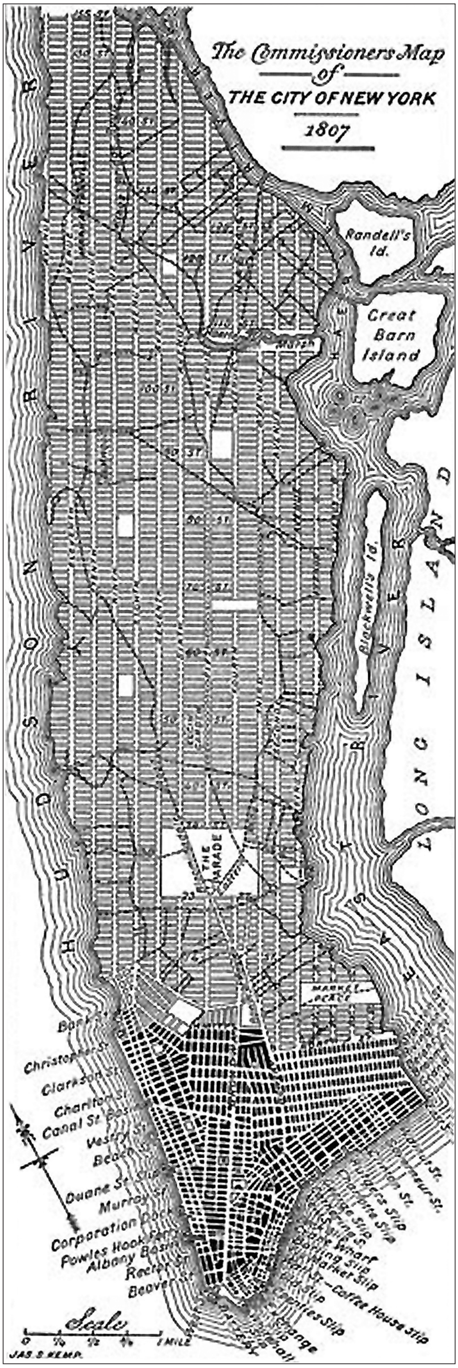
In most cases, private developers of residential neighborhoods or of commercial, office, and industrial projects plan, acquire land for, finance, and construct the tertiary roads that connect individual buildings within their projects to the rest of the city. In some instances, private developers must abide by regulations requiring that adequate land be allocated for streets in a planned fashion in advance of any construction. In many other cases, especially on the rapidly expanding fringes of cities in developing countries, regulations are not enforced. Buildings sprout on the urban periphery in a disorderly fashion, with narrow lanes and sometimes only walkways connecting them to the rest of the city. In yet other cases, "informal" private developers subdivide land into plots for sale, allocating the absolute minimum amount of land for roads and lanes to provide access to these plots. Atomistic households, informal developers, or professional "squatters" who subdivide and sell unserviced plots, and even formal developers who assemble and transform large tracts of land into residential subdivisions, can all urbanize areas on the periphery of cities while allocating a share of the land for local streets. But such actions on the part of market agents typically fall short of providing for an adequate network of arterial roads.

ARTERIAL ROADS

In 1924, Los Angeles planner Gordon Whitnall wrote, "When we faced the matter of subdivisions in the County of Los Angeles . . . we reached the conclusion that it would be absolutely necessary to go out and try to beat the subdividers to it by laying out adequate systems of primary and secondary highways at least, thus obtaining the necessary areas for highways and boulevards" (cited in Foster 1980, 470).

Arterial roads are classic public goods (i.e., users cannot be effectively excluded from using them). Since they are public goods, there is no market mechanism that can ensure they are in adequate supply in appropriate locations. In other words, a shortage of arterial roads is a form of market failure. Arterial roads need to be financed by municipal budgets rather than from tolls or revenues from the sale of plots abutting them because the market typically fails to supply them in adequate quantities. Given the strained budgets of municipalities, especially in developing countries, and their limited ability to borrow funds, it is no wonder that the arterial road network in urban areas is typically undersupplied.

Figure 3.1
The 1811 Commissioners' Plan for Manhattan, New York



Source: Bridges (1811).

Similarly, in larger metropolitan areas with a multiplicity of municipalities, there are inherent difficulties in planning and building arterial roads that link the metropolitan area together to form a single labor market, the key productive advantage of larger cities over smaller ones. Such artificial shortages cannot be remedied through the interaction of supply and demand in land markets on the urban periphery. And they will not likely be remedied correctly through the actions of dysfunctional or myopic public authorities either. It is important that people understand why.

In recent decades, frustrations with public authorities—often rife with inefficiency and corruption, beholden to powerful private interests, and perceived by the general public as no longer acting in its interest—has led intellectuals, opinion leaders, and political movements to champion the free market as the only workable system for modern postindustrial societies. There have been repeated calls for privatizing public services such as water, sewer, transportation, and power; for lessening the regulation of businesses to make them more efficient and more creative; and for lowering local tax rates (and sometimes national tax rates as well), which would compromise the ability of local governments to invest in and maintain public facilities and essential services. There have even been calls for weakening the ability of public authorities to acquire private property for public use through eminent domain, a power that is essential for laying out both primary intercity roads and secondary arterial roads.

Some of these calls resonate with many people. There is no question that the private sector has played a very useful role in building cities and in extending them into the urban periphery. Similarly, there is no question that the public sector has, for example, utterly failed to supply affordable housing, or even affordable sites and services, on the required scale. The private sector—through the actions of formal and informal developers, through the building activities of firms and households, and through harnessing the financial resources of international capital as well as those of neighborhoods and families—has managed to build millions of houses in thousands of cities, with the surprising result that only a very small share of households in any city (less than three per thousand) remain homeless (Angel 2010).

Unfortunately, when it comes to preparing cities for expansion, people's fervent hopes that the private sector, relying entirely on free-market transactions, can ensure efficient—let alone equitable or sustainable—development of the metropolitan fringe are entirely misplaced. For the urban periphery to become an integral part of the metropolis as a whole, it must contain a wide network of well-connected arterial roads. Yet there is simply no market mechanism that can create such a network. If a private entrepreneur wanted to build a long road from A to B, for example, she would be right to want to make that road as straight as possible. Doing so would reduce the cost of its right-of-way and construction, as well as the time users would need to traverse it. But once the entrepreneur decides on the alignment of the road, she loses any leverage she might have had to bargain with the owners of the land for the road. Each owner now has a monopoly on his or her land and can set a price that is many times that of the value of nearby properties.

Only public authorities can plan roads that traverse the land of multiple owners, and only public authorities can acquire such land using eminent domain, which allows them to pay a price equal to the prevailing value of adjacent properties outside the right-of-way. Eminent domain is necessary whenever the public needs to assemble land for public use from a large number of landowners, each of whom can refuse to sell. That power must remain in the public realm; it cannot be privatized. And because it cannot be privatized, the market cannot be counted on to plan and prepare for urban expansion in an efficient manner.

Urban expansion in the real world comes about through the merging of two spheres: one embodies the essential public actions that make cities habitable, and the other encompasses the necessary private actions that make cities productive and livable. Neither the public nor the private sphere can survive or thrive on its own. For public goods such as arterial roads to be constructed in a planned and timely fashion, citizens must come together as a public rather than remain as private individuals. To be of any use to individuals, private goods, such as serviced plots of land for homes and businesses, need these underlying public goods to be in place.

The absence or near absence of an arterial road grid in areas of expansion has a number of negative consequences. For one, the city expands in a starlike fashion along the primary road network—the main roads that connect it to other cities in the country or to minor roads that run to towns and villages on its periphery. This design renders the city less compact—that is, less like a circle—resulting in longer infrastructure lines and longer commute distances than those in more-compact cities. In addition, the main transportation routes remain radial in nature, linking the city center to the outlying suburbs but failing to link the suburbs to one another. This layout benefits workplaces in central city locations, increasing congestion at the core but not necessarily slowing down the movement of workplaces out to the suburbs. In most cities today, the great majority of jobs are outside the city center—in the United States, for example, only one-eighth of the jobs were located in central business districts in 2000 (Angel and Blei 2015)—but commuting to these jobs is difficult due to street layouts, which generally have an overabundance of radial roads to the city center and a shortage of suburb-to-suburb arterial links. Finally, the absence of an arterial road grid within walking distance of homes makes the provision of public transport less viable and the provision of trunk infrastructure more difficult, if not impossible. This problem is clearly illustrated in the city of Bangkok.

The hands-off, laissez-faire, market-led approach to urban development that has characterized Bangkok illustrates how the absence of arterial roads creates large losses in efficiency and stymies organized urban expansion. It underscores one of the drawbacks of this type of expansion, which ignores the substantial land needs for public works. Arterial roads are spaced no less than eight kilometers apart, and the local roads are not connected to one another to facilitate through traffic. As longer intracity trips are crowded onto a small number of main roads, congestion increases, which results in more air pollution, heightened energy use, and decreased labor productivity.

The absence of an arterial road grid in Bangkok makes it very difficult to extend key infrastructure services. Indeed, most Bangkok districts do not have a piped water supply and must continue to rely on water pumped from increasingly deeper wells. Because well drilling leads to land subsidence, large areas of Bangkok are now below sea level. The absence of an arterial road network also makes it much more difficult for the city to collect its storm water and pump it out, or for it to collect its sewer water and treat it properly before pumping it out or recycling it. Indeed, Bangkok does not have piped drainage or sewer systems. Most modern homes are built on a meter or more of landfill (rather than on stilts as in the past) so as to stay above flood level. They are fitted with septic tanks that are too close together and rarely emptied, meaning that sewage simply seeps into the wet ground around it, polluting deeper and deeper levels of groundwater.

In short, for Bangkok, one of the world's largest and fastest-growing cities, the absence of adequate land for public works has been devastating. The city is expanding rapidly without an arterial road network; a primary infrastructure network that can carry water, sewage, or storm water; a system of dikes to manage its storm water; and a hierarchy of public open spaces large and small. As a result, it suffers from acute traffic congestion, air and water pollution, and flooding caused by land subsidence. It also has a dire lack of parks and playgrounds.

The solutions to its self-inflicted environmental crisis would require massive investments in public works. But in the absence of the rights-of-way for an arterial road network, investment in public works would be exorbitant and quite possibly unaffordable now or any time soon. Necessary as they may be, the solutions would require massive destruction of private property, which would make them nearly impossible to implement. Land for these public works should have been acquired or reserved before the city's expansion took place or, at the very least, at the time of the earlier phases of urban development and expansion. In fact, a 30-meter-wide arterial road grid, with roads spaced one kilometer apart, would have taken up only 6 percent of the land in areas of expansion had this land been purchased then.

STREETS

Prior to the transportation revolution that took place around 1800, all cities were walking cities. Passageways only a meter or so wide were needed to connect to private realms. In the old sectors of many cities, such as the casbah of Algiers, private property is still connected by narrow lanes (figure 3.2). This is also true of the contemporary high-density informal settlements of many cities, from Dharavi in Mumbai to Khlong Thoy in Bangkok and Rocinha in Rio de Janeiro. What is more, many of these networks are hierarchical and treelike, rather than gridlike. In a treelike structure of passageways, there is only one route connecting each

Figure 3.2
The Casbah of Algiers, 1938

Source: Map data from Google, DigitalGlobe (2015).

private realm to the rest, and the total length of the passageways is minimal. The route between any two realms can be quite circuitous. Some links in the network may be central and heavily used, while others may be peripheral dead ends that are rarely, if ever, used. As new private realms are added, each one is connected to the existing network with a narrow passageway, and the overall network continues to retain its hierarchical properties. This type of network is the earliest stage in the evolution of street networks. It has three important properties: its total length is minimized; its width, and therefore its total area, is minimized; and it can develop gradually through the atomistic actions of private individuals or groupings.

The second stage in the evolution of street networks is still hierarchical, but it provides for wider roads that can carry cars, passenger vans, small trucks, and emergency vehicles, though rarely buses. Roads must be around six meters wide in order to carry two-way traffic. They are often unpaved and rarely have sidewalks. This type of road network still minimizes total road length, but it does not minimize road width or total road area. Like the earlier network, it can be developed gradually through the atomistic actions of individuals. The road network of the section of Bangkok mentioned above is an example of this later stage of street evolution. The roads there are typically six meters wide. The rights-of-way are negotiated by village headmen, who approach abutting property owners and ask them each to contribute a three-meter-wide right-of-way for a road into the interior of the area. Over time, they are able to construct zigzag-shaped roads into all private properties by way of these small, unplanned actions, each building on an earlier one. This road network is not on a grid. Many road segments are cul-de-sacs, and most intersections are three-way, rather than four-way, as in a typical grid. This type of network creates a hierarchy of plots in terms of their accessibility: some are at the far edge of a cul-de-sac and are less accessible than others that are located where many roads meet before joining a wider city street or avenue. All properties have access to one another, but the routes connecting them are quite circuitous. The advantage of this type of network over the earlier one is that it provides road access to plots and, more important, it provides road access for emergency vehicles.

The third stage in the evolution of street networks employs the street grid, which has been in existence for thousands of years. The best-known grids are rectangular, like those in the 1811 Commissioners' Plan for Manhattan, New York, or the 1898 plan for Buenos Aires, the capital of Argentina. At this stage, all the streets are wide enough to carry vehicular traffic, as well as pedestrian, bicycle, and bus traffic, and they often provide for on-street parking as well. Blocks are relatively small, and the great majority of intersections are four-way. As a result, there are many alternative routes from location to location. There is no hierarchy of road segments, as all roads are of equal importance. Adrian Gorelik, in his book *La Grilla y el Parque* (Gorelik 2010), equates the 1898 street grid in Buenos Aires—the grid shown in its 1904 plan as covering the entire city—with the homogenization of its territory in the spirit of social reform, removing any differentiation between rich and poor or formal and informal, and equalizing the distribution of public services, essentially streets and public open spaces. Street grids are less prone to congestion because there are many alternative routes from place to place and no particular street is a bottleneck, a typical limitation of hierarchical road networks. Street grids with short blocks are also more walkable than hierarchical networks, because people can walk in relatively straight paths to their destinations. At this stage, the overall length of streets, as well as their width, increases. As a result, a larger share of the land needs to be devoted to streets. The street network of Manhattan, New York, for example, takes up as much as 36 percent of its built-up area.

The key feature that differentiates this stage in the evolution of street networks from earlier ones is that it requires that streets be laid out over the entire area in advance of settlement and construction. Urban development can no longer be undertaken solely through the atomistic actions of individual landowners. Surely, an individual can subdivide his or her land into plots and organize the street pattern within the land as he or she sees fit or in accordance with the prevailing land subdivision regulations. But for a dense street grid to emerge,

Figure 3.3
The El Carmen Squatter Settlement in Comas, a Suburb of Lima, Peru

Source: Map data from Google, DigitalGlobe (2015).

planning control over a large area—sometimes the entire area of urban expansion—is of central importance.

Planning and securing this land requires organization. While Bangkok's suburbs were built up with little organization to speak of, the creation of new squatter settlements on the desert outskirts of Lima, the capital of Peru, required serious organization. The Comas district, for example, was formed by a series of organized "invasions" in the 1960s. Each invading family occupied one building site, which was surveyed and selected in advance. The sites were relatively large, measuring 10 by 20 meters. There were 20 sites to a block and 10-meter-wide roads between blocks (figure 3.3). Some blocks were intentionally left open for markets, schools, and public open spaces. Comas is now a fully built urban neighborhood, indistinguishable from any other neighborhood in the city. Squatters were eventually awarded titles to the land, and houses in the district are now part of Lima's formal housing market. In Comas, given its small blocks and wide streets, no less than 27 percent of the land area is devoted to local streets.

The advance planning and reservation of rights-of-way for street grids at the block level are essential for the orderly development of the urban periphery. It stands to reason that the Comas street grid and its open spaces accelerated its incorporation into metropolitan Lima as a district among equals. By making all plots similar to one another and facing a broad street, the Comas plan also reduced the difference in real estate values among houses in the community and increased the overall value of real estate in the metropolitan area as a whole. This important lesson has not been lost on others, and in several countries developers of minimally serviced, informal land subdivisions catering to the urban poor lay out streets and plots with an eye to creating neighborhoods that will be indistinguishable from higher-income ones (Baross and van der Linden 1990). The basic street grid, with its myriad variations at the neighborhood level, thus has an important social and economic value for neighborhood residents, and it is usually—but not always—in the interest of landowners, developers, and local people to cooperate in making it happen.

At one end of the spectrum, where informal developers subdivide land for sale to low-income families, street networks may still retain their hierarchical nature, and only a small share of land may be devoted to streets. At the other end of the spectrum, developers of upper-income communities may choose to insulate their projects from the rest of the city by creating walls around them, essentially privatizing all the "public" space within them by preventing strangers from passing through. In upper-income outer suburbs where large plots are accessible only by car and no one walks, a smaller share of the area may be devoted to streets, and a hierarchical system of streets, abounding with cul-de-sacs and three-way intersections, may be reintroduced (figure 3.4). In yet other neighborhoods on the urban periphery, large apartment-block projects may be accessible only to residents, with public areas separated from the rest of the city. These are only a few examples of street networks that do not fall neatly into the three stages of evolution outlined here. Some people may view them as either more or less advanced than other networks. That is a value judgment, however, and not pertinent to this discussion.

ASSESSING THE EVIDENCE

Assessing the current state of the evolution of street patterns in urban expansion areas throughout the world is an important step in understanding what can and should be done to improve them. Public officials, professionals, and interested citizens should have the ability and the information to judge the quality of their street networks so that they can then act together to guide the development of their cities in a manner that will promote the most beneficial growth. The attributes of street networks outlined earlier can serve as guidelines for understanding and analyzing urban street patterns.

Efficient, equitable, sustainable, and orderly urban expansion requires that an adequate amount of land on the urban fringe—where expansion is likely to take place—be allocated for streets before urban development takes place. A share

Figure 3.4
A Large-Lot, Car-Oriented Subdivision in Franklin Township, New Jersey

Source: Map data from Google (2015).

of that land, on the order of 5 percent, should consist of the rights-of-way for a grid of arterial roads—preferably spaced approximately one kilometer apart, or within walking distance of homes and workplaces—a grid that can carry public transport and trunk infrastructure as well as facilitate drainage. Another share of land should be reserved for streets, also preferably in advance of development. The requirements of this share will depend to a large extent on current norms and practices. Standards that can be expected to be met, let alone enforced, in one city cannot be simply transplanted to another.

There is disparate evidence on the share of land dedicated to streets in various cities. For a review, see UN-Habitat (2013). Two recent studies merit attention. The first reported on the decline in the share of land devoted to streets in U.S. cities (Peponis et al. 2007). It compared street density, measured in kilometers of streets per square kilometer, in urban districts developed before and after 1950 and found that the share of land declined significantly between the two periods. Using the data from this study, I determined with a 99 percent level of confidence that street density declined from 15.4 ± 1.6 km/km^2 to 8.6 ± 1.1 km/km^2 between the two periods. Assuming that streets did not vary greatly in width between the two periods, urban districts in U.S. metropolitan areas during the later period devoted significantly less area to streets than those in the earlier period.

The second study compared the share of land in streets in city cores and suburban areas in a representative set of cities worldwide (UN-Habitat 2013). Using the data for 52 cities in this study, I determined with a 99 percent level of confidence that the average area in streets in these cities was 19.7 ± 2.8 percent in core areas, compared with 8.6 ± 1.3 percent in suburban areas. Since core areas have higher residential densities than suburban ones, it is safe to assume that higher densities go hand in hand with a larger share of land devoted to streets. I also determined with a 99 percent level of confidence that cities in more-developed countries had a higher share of their land in streets in core areas than those in developing countries: 26.9 ± 3.8 percent versus 16.5 ± 2.7 percent. They also had a higher share of land in streets in suburban areas: 11.7 ± 1.8 percent versus 7.2 ± 1.3 percent. In other words, streets in peripheral areas of cities today occupy significantly less land than streets in more-central areas. And streets in cities in more-developed countries, which typically have lower residential densities than cities in developing countries, now occupy significantly more land than streets in cities in less-developed ones. These results are preliminary and may be unreliable. For example, there were issues of definition in the United Nations Human Settlements Programme study (UN-Habitat 2013) that reduced the reliability of estimates. To be estimated correctly, the share of land in streets must be its share of the built-up area of cities and not its share in the administrative area of cities, an area that may contain large amounts of vacant land. And street maps must be complete for data to be truly comparable. It is not clear that these conditions were met in all the cities studied. I revisited the data for 30 cities in this study with the aim of mapping one square kilometer in the city core and one square kilometer in the suburbs to illustrate the great variety of urban street patterns across the world.[2] The maps for these cities, arranged in alphabetical order, are shown in figure 3.5. They illustrate that, in general, the streets in the core area occupy a larger share of the total area than streets in the suburbs; they are also wider and intersect one another more frequently. In some cities, such as Bangui, Central African Republic, there are very few streets in the suburbs, as homes are built in a haphazard fashion, connected by meandering walkways.

The share of the land in streets in areas of recent urban expansion is only one dimension (though a central one) of the quality of expansion. More and better data are needed on this dimension for cities throughout the world and, more important, for their fringes, where urban expansion is taking place. Although more information about the *quantitative* aspects of global urban expansion is available now than ever before, much less information is available about the *qualitative* attributes, especially in regard to the patterns of streets. The proposed initiative outlined in the rest of this chapter aims to generate comparative data pertaining to these attributes in a representative global sample of cities.

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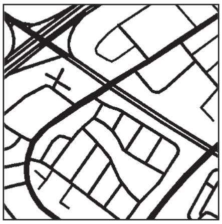
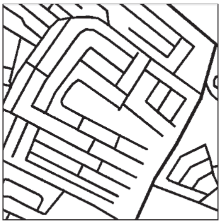
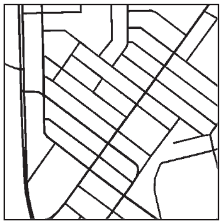
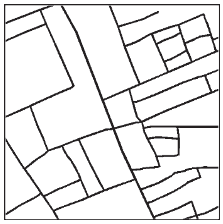
2. Manuel Madrid provided maps and calculations for these cities based on the maps and street categories at *www.openstreetmap.org*.

Figure 3.5
One-Square-Kilometer Street Maps in the Core and Suburban Areas of Selected Cities


Abuja core (25.3%)

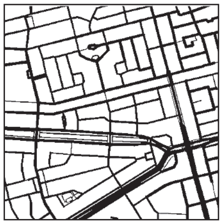

Abuja suburb (19.2%)


Accra core (14.7%)


Accra suburb (10.8%)

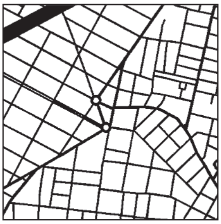

Addis Ababa core (19.8%)

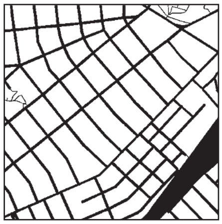

Addis Ababa suburb (14.6%)


Amsterdam core (28.2%)


Amsterdam suburb (23.2%)

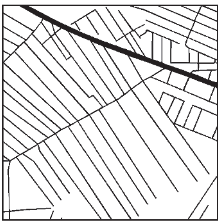

Athens core (25.8%)


Athens suburb (23.8%)

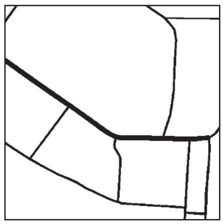

Auckland core (25.3%)

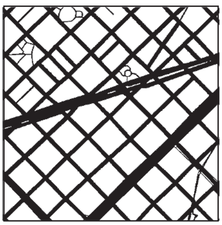

Auckland suburb (16.7%)


Bangkok core (23.2%)


Bangkok suburb (13.5%)

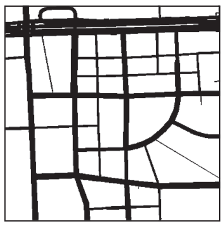

Bangui core (20.2%)


Bangui suburb (13.5%)


Barcelona core (36.4%)


Barcelona suburb (22.7%)

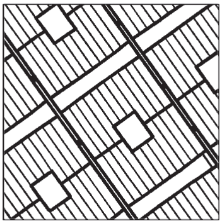

Beijing core (26.9%)


Beijing suburb (26.0%)

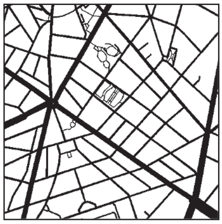
(continued)

Figure 3.5 ***(continued)***

Brasilia core (35.3%)



Brasilia suburb (28.4%)



Brussels core (24.8%)

Brussels suburb (20.8%)

Chandigarh core (22.3%)

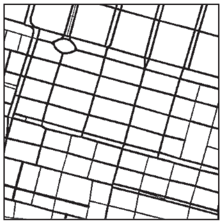
Chandigarh suburb (22.6%)

Copenhagen core (28.0%)

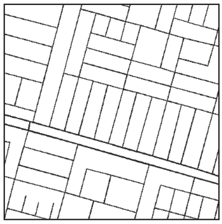
Copenhagen suburb (21.4%)

Dakar core (20.9%)

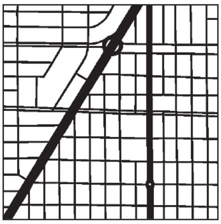
Dakar suburb (18.3%)



Georgetown core (18.4%)



Georgetown suburb (7.3%)



Guadalajara core (27.4%)

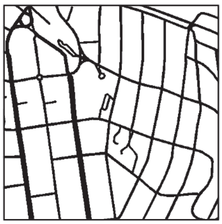
Guadalajara suburb (23.5%)

Helsinki core (31.6%)

Helsinki suburb (24.6%)

Hong Kong core (35.2%)

Hong Kong suburb (14.6%)



Kigali core (19.2%)

Kigali suburb (5.4%)

(continued)

Figure 3.5 ***(continued)***

Monitoring Global Urban Expansion

There are currently no metrics for measuring the global performance of the world's cities, which are now home to more than half of the world's population. The United Nations Population Division publishes a biannual report called *World Urbanization Prospects*, which contains important information about global urbanization, including data on the past, present, and future urban population in every country, as well as in major urban agglomerations (UN Population Division 2011). This information, regularly improved and updated, is quite useful, but it does not address many of the issues that are most critical to monitoring the performance of cities on a global scale.

The United Nations monitors the state of the world and guides global development through its Millennium Development Goals. Other than the share of the urban population in slums, however, there is no goal that pertains to the performance of cities and no metric that could measure progress in the attainment of that goal if it should exist. The purpose of the initiative proposed here is to monitor global urban expansion and provide a set of metrics for measuring both the quantity of land converted to urban use and the quality of the resulting environment in areas of urban expansion. The key objective is to provide policy makers—in local governments, central governments, and international agencies—with a reality check in setting goals, preparing plans, and investing public resources in helping cities to accommodate their expected population growth in the coming decades.

The world's urban population is expected to double between 2010 and 2050, from 2.6 billion to 5.2 billion. The urban population of developed countries is expected to increase by a mere 160 million during this period and stabilize at 1 billion by 2050. By that time, the urban population of developing countries will have increased by 2.4 billion, or 15 times that of developed countries (Angel 2012). It has been shown that putting limits on city population growth is ineffective. Attempts to prevent people from migrating to cities or from moving from one city to another have utterly failed and are prohibited by the United Nations' Universal Declaration of Human Rights (UN 1948). But cities do occupy land, and the conversion of land to urban use is guided and influenced by public policies and actions.

As cities grow in population and wealth, they expand, and as they expand, they need to convert and prepare more land for urban use. Stated as a broad public policy goal, cities need *adequate land* to accommodate their growing populations, and this land must be *properly serviced* and yet *affordable* to be of optimum use to their inhabitants. Cities that can consistently meet this goal become more efficient, productive, equitable, sustainable, and resilient. To do so, however, they need concerted public action that must precede and guide the operation of the free market on the urban fringe. More particularly, in the absence of concerted public action that can secure adequate land for public works (arterial roads and streets, public utilities, public open spaces, and public facilities) *in* *advance of development*, land and housing markets, efficient as they may be in theory, will fail to perform efficiently in practice.

The *Atlas of Urban Expansion* (Angel et al. 2012) contains systematic and comparable data on a number of metrics of key quantitative attributes of urban expansion (urban extent, built-up area density, fragmentation, and compactness, as well as the changes in them over time) in a global sample of 120 cities from 1990 to 2000. It offers the beginnings of a scientific understanding of the quantitative aspect of global urban expansion—namely, how much land will need to be converted to urban use, in the absence of revolutionary changes in current practices and norms, to accommodate the expected population growth in the coming decades. That being said, there is only anecdotal evidence available regarding the quality of global urban expansion.

The initiative outlined in this section would help cities the world over become proactive in making adequate preparations for expansion. Cities can be expected to expand whether advance preparations are made or not. Yet preparations can prevent disorderly urban expansion, which can result in problems that are difficult and costly to correct after cities are built and populated. Building an essential arterial road in a densely built-up area of Bangkok, for example, is now next to impossible. Upgrading basic infrastructure in some of the dense favelas in Brazil costs three to six times as much now as it would have in advance of their occupation (Abiko et al. 2007). In general, it is safe to conclude that not all urban expansion has the same quality and that some forms are clearly preferable to others.

UN-Habitat has formed a partnership with the Urbanization Project at the Stern School of Business of New York University to monitor global urban expansion in a new stratified sample of 200 cities (a 5 percent sample of the universe of 4,043 cities and metropolitan areas that had 100,000 people or more in 2010) in preparation for Habitat III, the United Nations Conference on Housing and Sustainable Urban Development, scheduled for the summer of 2016. The monitoring effort will be divided into three distinct phases.

In the first phase, the *Atlas of Urban Expansion: The 2015 Edition* will produce the same metrics as the previous *Atlas* for three years—1990, 2000, and 2010—for the new sample of cities, thus greatly improving understanding of the quantitative dimensions of global urban expansion. The 2015 edition of the *Atlas* is a joint project of UN-Habitat, the Lincoln Institute of Land Policy, and the NYU Stern Urbanization Project. Its focus, as before, is on the quantitative aspects of urban expansion.

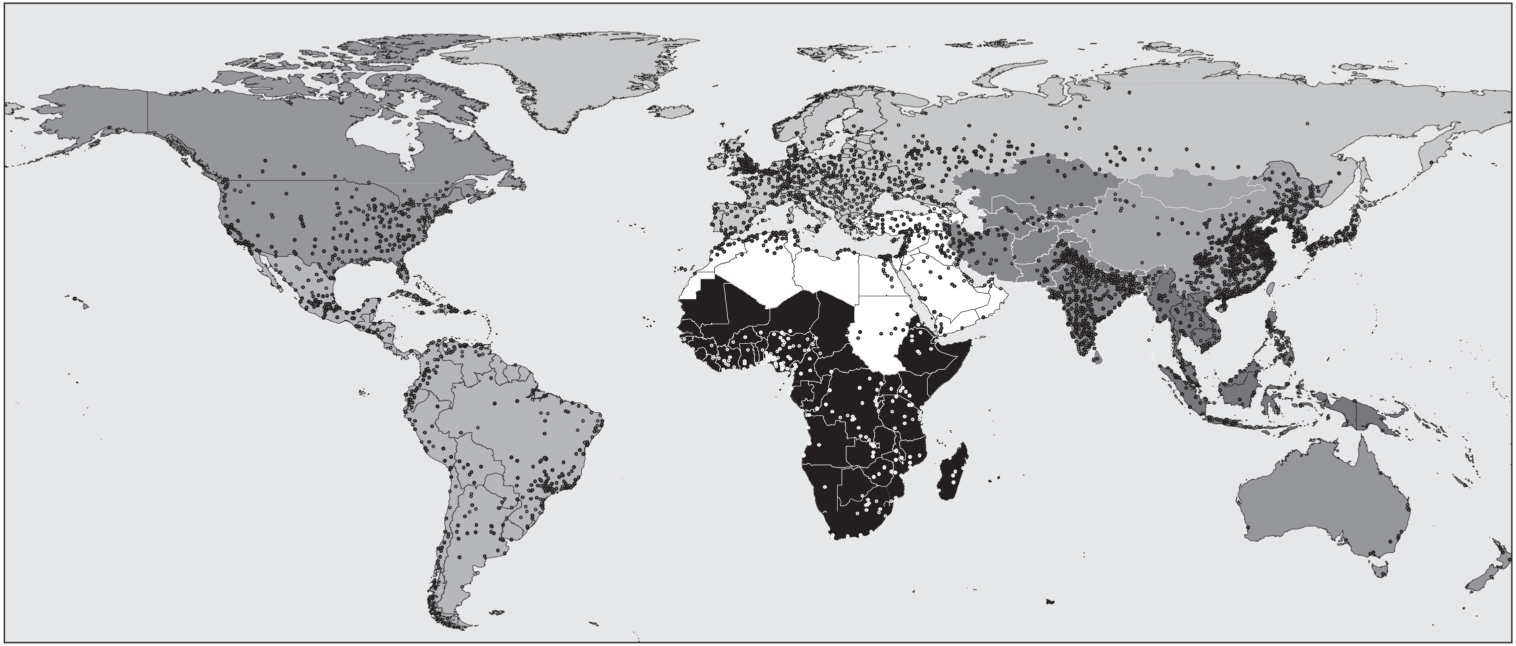
The second and third phases of the monitoring initiative focus on the quality of the emerging urban fabric in expansion areas and are the subject of this section. The second phase involves the analysis of high-resolution satellite imagery of the expansion areas. The third phase involves engaging people on the ground in each city in the global sample. The second and third phases are now in the pilot stage. They are being tested in four cities: Addis Ababa and Mekele in Ethiopia, and Bogotá and Valledupar in Colombia. The analysis of satellite imagery in the second phase focuses on the years 1990–2000 and 2000–2013. Maps prepared from medium-resolution satellite imagery in phase 1 are used to identify these expansion areas in images from two open-source collections of high-resolution satellite imagery, Google Earth and OpenStreetMap. The maps are then analyzed with the purpose of obtaining a set of metrics that can address different quality attributes directly from the high-resolution satellite images. Data on additional attributes and metrics that cannot be directly observed in the satellite imagery will be collected on the ground in phase 3. The purpose of the rest of this chapter is to articulate these attributes and to propose simple metrics that can measure them in a consistent and rigorous manner.

THE NEW GLOBAL SAMPLE OF CITIES

The new global sample of cities is described in detail in an unpublished research note (Angel et al. 2014) and is summarized here. Using a number of data sources, my colleagues and I identified a universe of 4,043 cities, metropolitan areas, or urban agglomerations that had at least 100,000 people in 2010 (figure 3.6). The only data currently available on the cities in this universe are their names, their populations at one or more recent points in time, and their geographic coordinates. The unit of analysis is the urban agglomeration, here referred to by the more general term *city* or *large city* to denote a city with 100,000 people or more. This unit of analysis is a contiguous built-up area extending out of a traditional city center that can be identified on a map, associated with a name, and given map coordinates. Thus, there is only one name associated with each city, even though it may comprise a large number of municipalities. For example, Tokyo, an urban agglomeration that had 36.7 million people in 2010, is considered to be one city with a single name. For each city in this universe, we obtained population data for the latest two census periods, one circa 2000 and one circa 2010. The population data are associated only with the city name. In general, maps of the enumeration areas corresponding to those numbers are not readily available. The total population in this universe comprised some 70 percent of the total world urban population in 2010. The remaining 30 percent was in a very large number of cities and towns with populations below 100,000.

It is not necessary to study the entire universe of cities in order to monitor global urban expansion. A carefully designed sample of cities can be studied instead. Using appropriate statistical tools, the results from the sample can then be generalized to provide insights into the patterns and characteristics of urban expansion in the entire universe of cities. We selected a stratified sample of 200 cities with a view to drawing useful conclusions about the universe. There are three strata: eight world regions, four city population size categories, and three groups of countries with different numbers of cities. In general, the sample was drawn with the urban population in mind, focusing on urban dwellers rather than on cities. For example, the number of cities sampled in each world region is roughly proportional to the urban population in that region; the number of cities in each population size category is roughly proportional to the total population

Figure 3.6
The Universe of 4,043 Cities with 100,000 People or More in Eight World Regions, 2010



Source: City location data from Angel et al. (2012 online).

in each category; and the number of cities sampled in each of the three groups of countries with different numbers of cities is proportional to the number of people in each group. Figure 3.7 is a map of the sampled cities.

The only data on the universe of cities not used in the construction of the sample were the annual population growth rates between the two census dates. The growth rates were used to test the representativeness of the sample. It was found that when cities in the sample were weighted by the number of cities in the universe they represent, or by the urban population in the universe they represent, the average population growth rates in the universe and the sample were not statistically different from each other at the 95 percent confidence level. Thus, the sample is indeed representative of the universe of cities.

QUANTITATIVE ATTRIBUTES OF URBAN EXPANSION OBTAINED FROM MEDIUM-RESOLUTION SATELLITE IMAGERY

The quantitative attributes of urban expansion are defined and described in detail in the *Atlas of Urban Expansion* (Angel et al. 2012), and the findings concerning these attributes are analyzed in detail in *Planet of Cities* (Angel 2012). They are reviewed here only for the purpose of presenting the monitoring initiative in its complete form.

Urban Extent Urban extent is the shape of the built-up area a city occupies in geographic space at a given point in time. The map describing that shape is the result of the classification of Landsat satellite imagery with a pixel resolution of 30 by 30 meters into three classes: (1) built-up; (2) not built-up; and (3) water. The measure of interest in characterizing urban extent is the total *built-up area* of the city. The built-up area is measured at different points in time, as shown in figure 3.8, so that its growth rate can be estimated and it can be projected realistically into the future. Maps of urban extent will be drawn and the built-up areas will be calculated for all 200 cities in the new global sample for three years, 1990, 2000, and 2013.

City Population The population of a city or metropolitan area is not well defined unless it is associated with a specific administrative district whose geographic boundaries are known. Administrative districts of cities do not necessarily correspond to their built-up areas. Sometimes they encompass only part of the built-up area, and sometimes they are much larger than the built-up area. For example, the administrative area of Beijing was 11 times its built-up area in 1999 (figure 3.9). For the study of urban expansion, it is of critical importance to obtain population data at a given point in time for all the administrative districts that together encompass and contain the built-up area of the city at that time but exclude, to the extent possible, built-up areas that are not part of the city. These data have only recently become available in digital form from national census bureaus, and they are often proprietary. The measure of interest in

Figure 3.7
The Sample of 200 Cities in Eight World Regions

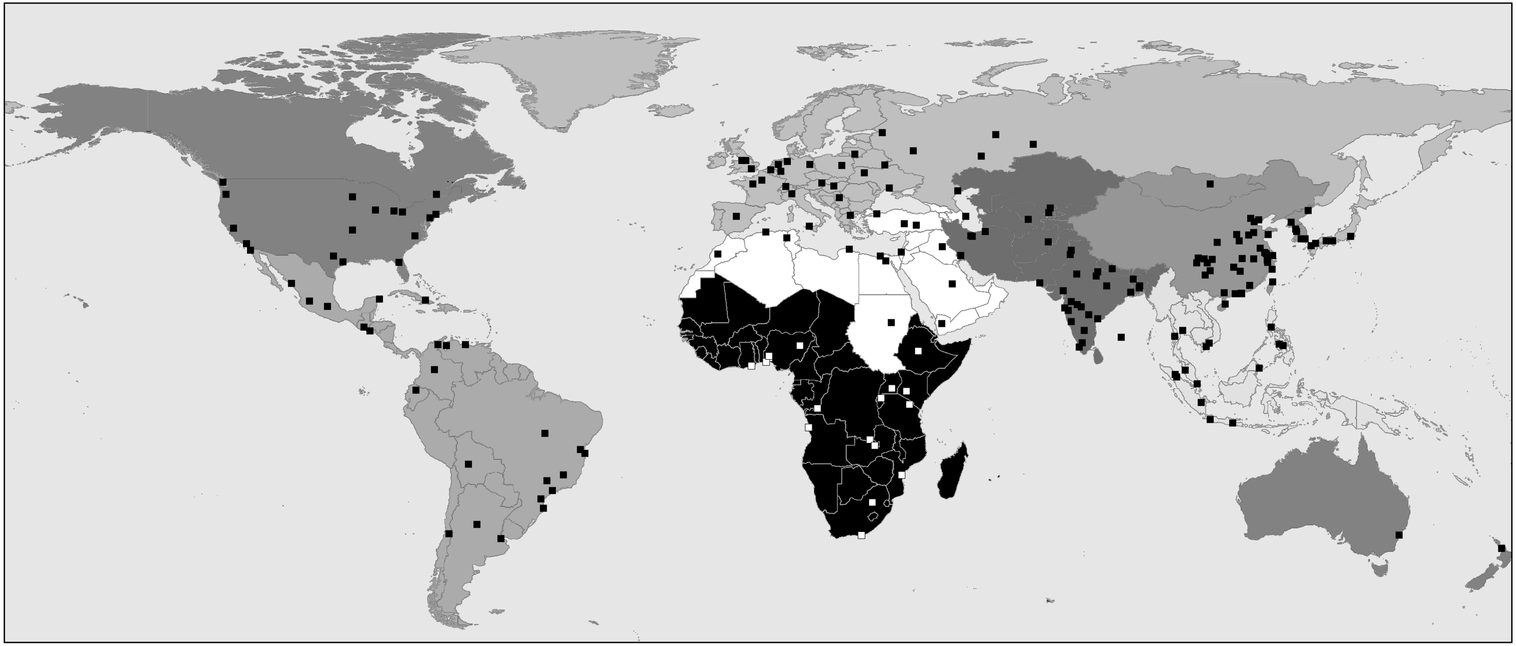
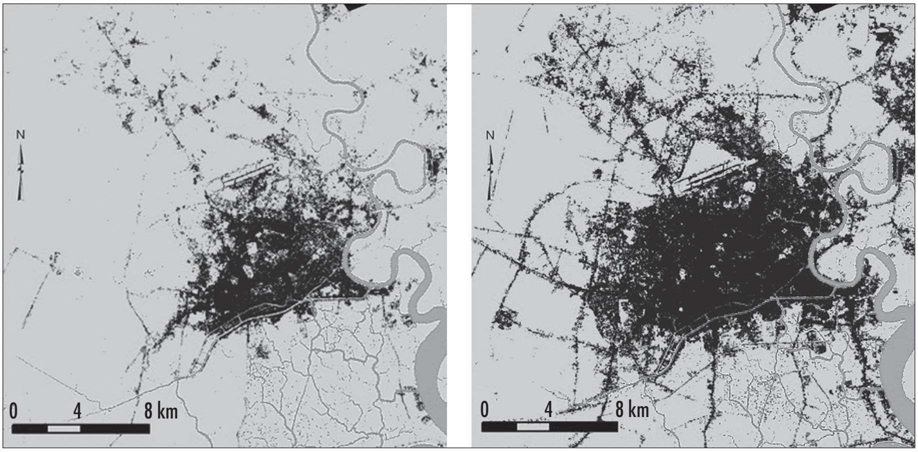
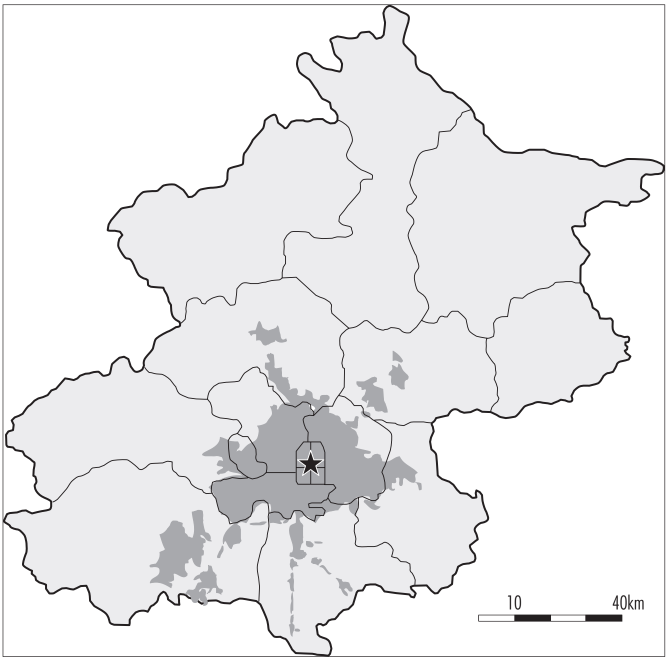


Figure 3.8
The Urban Extent of Ho Chi Minh City, Vietnam, 1989–1999



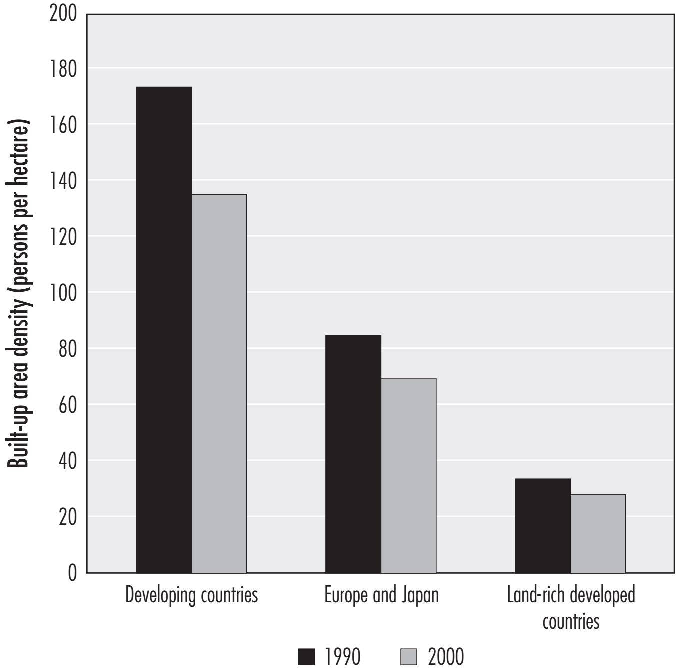
Source: Redrawn from Angel et al. (2012, 92).

Figure 3.9
The Administrative Area of Beijing, 1999



Source: Built-up area adapted from Angel et al. (2012, 48).

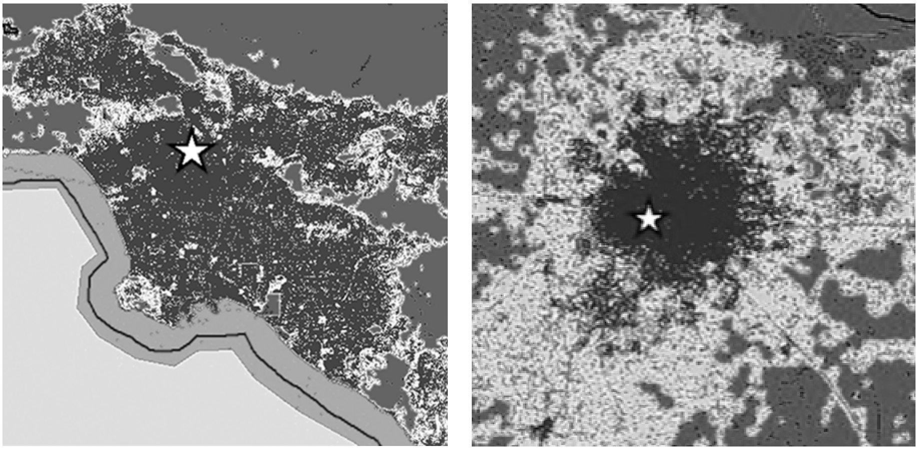
Figure 3.10
Average Built-Up Area Densities, 1990 and 2000



characterizing population is the total *city population* residing within these administrative districts at different points in time, so that its growth rate can be estimated and it can be projected realistically into the future. Maps of administrative districts and their corresponding populations will be obtained and drawn for all 200 cities in the new global sample for three years, 1990, 2000, and 2010.

Density The average density of the built-up area of a city—that is, its total population divided by its total built-up area—is the measure of interest in calculating the area that a city will occupy when its population reaches a given size. The average *built-up area density* of the city can be calculated at different points in time so that its growth rate can be estimated and then projected realistically into the future. Values for the average built-up area density will be calculated for all 200 cities in the new global sample for three years, 1990, 2000, and 2010. In a sample of 120 cities, variations in average built-up area density ranged from 550 persons per hectare in Hong Kong to 20 persons per hectare in Minneapolis. On average, densities in the sample declined in all world regions at an average rate of 2 percent per year between 1990 and 2000 (figure 3.10).

Figure 3.11
Urbanized Open Space (light gray) in Los Angeles, 2001 (left), and Zhengzhou, China, 2000 (right)



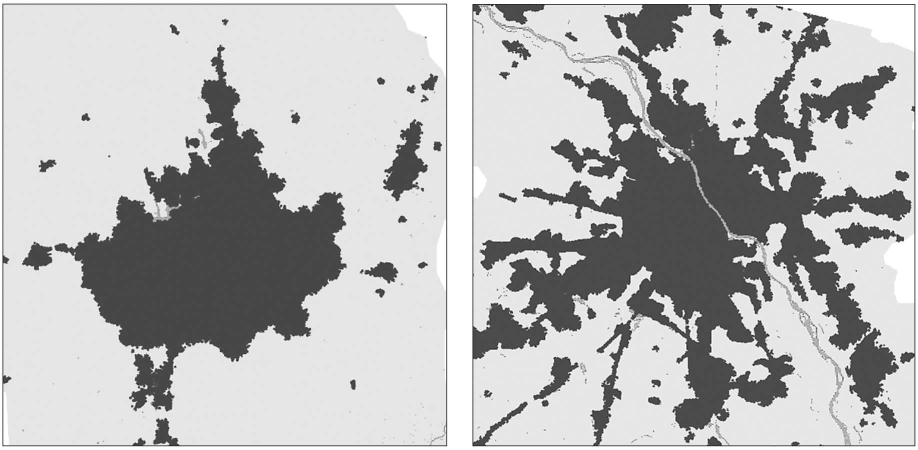
Source: Angel et al. (2012, 138; 252).

Fragmentation Urban extent underestimates the total amount of land a city occupies because it ignores the open spaces in and around the built-up areas. Open spaces fragment the built-up areas of cities, and built-up areas fragment the open spaces in and around them. The degree of fragmentation can be measured with the *city footprint ratio*, which is equal to the sum of the total built-up area plus the total area of urbanized open space, divided by the total built-up area. On average, this ratio was about 2.0 in a global sample of 120 cities in 2000. In other words, cities occupied areas that were, on average, twice as large as their built-up areas. The city footprint ratio varied from 1.4 in Los Angeles to 2.8 in Zhengzhou, China (figure 3.11).

Compactness The degree to which the city footprint approximates a circle at different points in time can be measured and projected realistically into the future. The metric of interest is the *cohesion index*, which is equal to the average distance between random points in a circle with the same area as that of the city footprint, divided by the average distance between random points in the city footprint at different points in time. Ibadan, Nigeria, for example, had a higher cohesion index than Warsaw, Poland, in 2000 (figure 3.12).

These five attributes of urban expansion are useful in understanding how much land has been converted to urban use in recent years in different cities, offering some indication of how much land will be converted in the coming decades, bar-

Figure 3.12
The City Footprints of Ibadan, Nigeria (left), and Warsaw, Poland (right), 2000



Source: City footprint maps redrawn from Angel et al. (2012, 100; 242).

ring a radical change in the urbanization patterns that have been in place for a century or more. But these attributes provide little information about the *quality* of urban expansion. We do not know, for example, whether arterial roads, local streets, or public open spaces in expansion areas are in adequate supply; whether expansion areas are squatted on or occupied before they are laid out properly in proper land subdivisions; whether homes in expansion areas have a full complement of basic services, such as piped water and sewage; whether expansion areas are accessible to jobs; or whether land and housing in expansion areas are affordable. Without this evidence, which can establish a relationship between public action in advance of urban expansion and the quality of the built environment in expansion areas, urban policy makers will continue to act without an empirical basis for their decisions.

QUALITATIVE ATTRIBUTES OF URBAN EXPANSION OBTAINED FROM HIGH-RESOLUTION SATELLITE IMAGERY

Current knowledge of the qualitative attributes of present-day urban expansion in different cities in different countries is meager and unsatisfactory. At best, it is anecdotal and unsystematic. Where more-rigorous studies have been carried out, they have usually focused on cities in developed countries, particularly those in the United States, where the sheer quantity of urban expansion and suburbanization in recent decades has typically been characterized by the derogatory term *sprawl*, implying that it is to be lamented and should be resisted, contained, tamed, guided, and regulated. That being said, many cities in developing countries that are growing rapidly in population, especially those in countries experiencing rapid economic growth as well, are also expanding rapidly in area and can be expected to expand manyfold in the coming decades. *Sprawl*, however defined, may or may not be an apt term for characterizing their expansion, because by and large, nothing is really known about the quality attributes of this expansion.

It is imperative that planners gain some understanding of whether such expansion is orderly or disorderly, whether it is accompanied by the full complement of public works, whether residential land supply in expansion areas is adequate or constricted, and whether housing in expansion areas is decent and affordable, to cite a few examples. If expansion is of sufficient quality, planners need not be especially concerned about it. But if it is not, there may be effective ways to improve it. The purpose of monitoring the quality of urban expansion is to gain an initial understanding, in a rigorous and systematic manner, of its quality attributes, of variations in these attributes among cities, of the reasons for such variations, and of effective, pragmatic, and realistic ways to address poor-quality expansion.

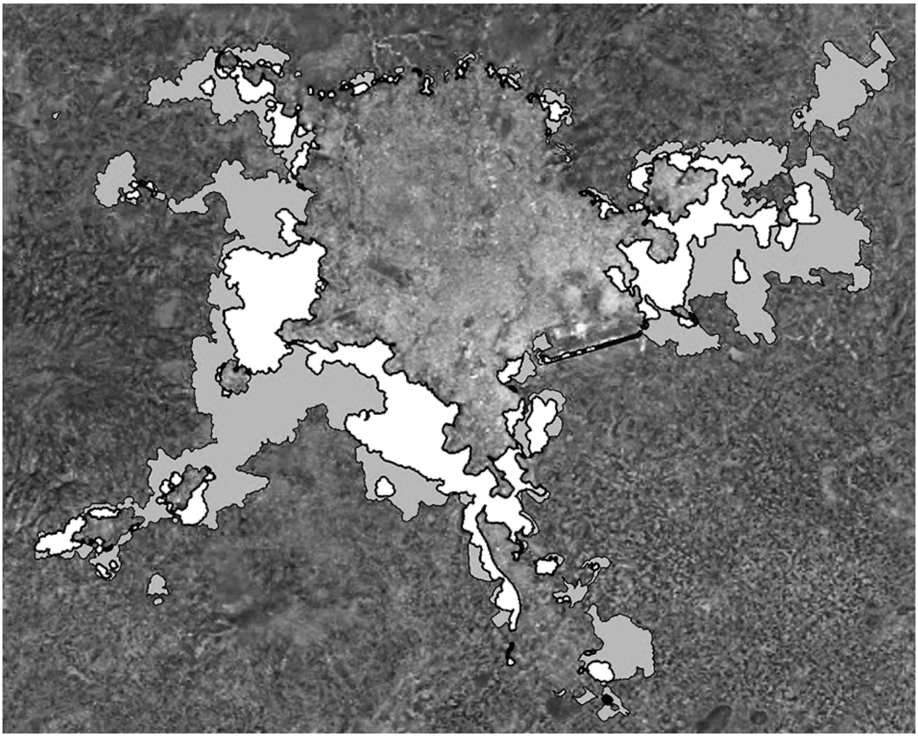
The challenge of studying the quality of global urban expansion is in the identification, assembly, analysis, and interpretation of available data and, more specifically, in reducing the vast quantities of data to a set of simple metrics that can usefully represent them. Such metrics may then allow for monitoring of global urban expansion over time, as well as for the comparative analysis and statistical modeling of that expansion—its attributes, causes, and consequences—in cities and regions.

Global high-resolution satellite imagery is now publicly available at no cost on Google Earth and OpenStreetMap, and it can yield important information on the qualitative dimensions of urban expansion—information that can later be supplemented by informants on the ground who can collect representative data. This satellite imagery is the focus of phase 2 of the proposed monitoring initiative. My colleagues and I, as well as our colleagues at the UN Human Settlements Programme (UN-Habitat) who are partners in this research, have chosen to study the expansion areas of cities first, before expanding the effort to cities as a whole. While there are clear advantages of studying expansion areas side by side with cities as a whole, this approach does increase the demand for data collection. In addition, we believe that the areas most recently settled are the least understood, often remaining invisible for most people, including scholars, who are more familiar with central cities and rarely venture out to the fringes.

In our pilot study of four cities—Addis Ababa and Mekele in Ethiopia, and Bogotá and Valledupar in Colombia—we divided the expansion into two periods, circa 1990 to circa 2000 and circa 2000 to circa 2013. The two expansion areas in Addis Ababa are shown in figure 3.13.

Between 1985 and 2000, the city expanded by 6,676 hectares (67 km^2), and between 2000 and 2010 it expanded by 10,892 hectares (109 km^2). These ar-

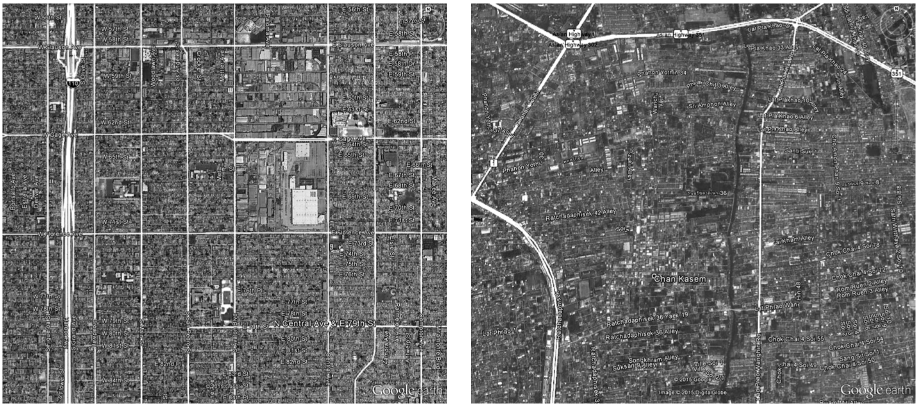
Figure 3.13
The Expansion Areas of Addis Ababa, 1985–2000 (light gray) and 2000–2010 (darker gray)



eas are still quite large and difficult to study in detail. We have, therefore, decided to study a representative sample of locales within the expansion areas, each 10 hectares in size. The statistical platform for selecting these locales and preparing them for analysis has now been finalized and is not described here. The number of locales to be analyzed in each city will depend on the variance in the city's development patterns. In cities with uniform patterns of development, only a few locales will be studied; in cities with diverse and varied development patterns, more locales will be analyzed.

Numerous aspects of the quality of urban expansion can be identified by analyzing high-resolution satellite imagery. In the pilot study of four cities, we chose to focus on five of them in a primary module for data collection: arterial roads, housing sector evolution, street space, block size, and rooftop density.

Figure 3.14
Arterial Roads in Los Angeles (left) and Bangkok (right)



Cities are shown at the same scale.
Source: Map data from Google, DigitalGlobe (2015).

Arterial Roads The arterial road grid pertains only to the network of *major arterial roads*, the urban roads that typically carry intracity traffic, public transport, and trunk infrastructure, especially water and sewer lines. It does not pertain either to the primary network of freeways that may connect cities to one another or to the tertiary network of local streets that provide access to individual properties. To accommodate and support efficient, equitable, and sustainable urban expansion, an arterial road grid on the urban fringe should have four essential properties: (1) it must cover the entire area designated for expansion and not just a segment of that area; (2) it must be a network of long, continuous roads that crisscross the expansion area and are connected to the existing road network; (3) the roads should be spaced no more than one kilometer apart to ensure that public transportation is within a 10-minute walk; and (4) the width of the roads should be 25–30 meters, so that they can include designated bus lanes, bike paths, a median, and several lanes to carry intracity traffic, but still not be too wide for pedestrians to cross safely and comfortably. Los Angeles, for example, has a relatively dense grid of arterial roads (figure 3.14, left). In contrast, large areas in suburban Bangkok have no arterial roads at all (figure 3.14, right).

An arterial road grid takes up a very small share of the built-up area. Thirty-meter-wide roads spaced one kilometer apart will take up only 6 percent of the land. It is, therefore, impossible to expect that the share of the land dedicated to arterial roads can be identified by inspecting a small sample of locales. In the proposed study, we will seek to identify arterial roads—wide roads that are identified as major roads in OpenStreetMap—in the entire expansion area. We will then determine their width and calculate (1) the share of the expansion area in arterial roads and (2) the density of arterial roads, measured in kilometers per square kilometer of built-up area. As noted earlier, an efficient arterial road grid with 25–30-meter-wide roads will require 5–6 percent of the land and provide two kilometers of arterial road per square kilometer of built-up area.

Housing Sector Evolution The evolution of the housing sector on the urban fringe can be characterized by its level of organization—that is, the degree to which houses are located and built in an integrated and coordinated fashion. At one end of the spectrum, houses are located and built one by one over time in a haphazard but organic process through the atomistic actions of individual households. The orientation of the house and its distance from those built before it are determined by the household, with minimal attention paid to the efficient organization of public space, access roads, and residential infrastructure, such as water, sewer, and drainage lines. At the other end of the spectrum, complete projects with houses or apartment buildings of similar design are built to completion during a short period in large, legally approved subdivisions located on land that is assembled, planned, financed, and provided with a full complement of residential infrastructure and services before it is occupied (figure 3.15).

There is no question that public intervention aimed at improving the quality of urban expansion differs markedly depending on the stage in the evolution of the housing sector. At the present time, there is no information available on a global scale about the proportion of each type of residential environment. Some researchers assume that the bulk of the housing is either haphazard or arranged informally in so-called slums, but there is no solid basis for making such claims. One of the primary aims of the monitoring effort will be to assess the share of new development on the urban fringe that is indeed informal.

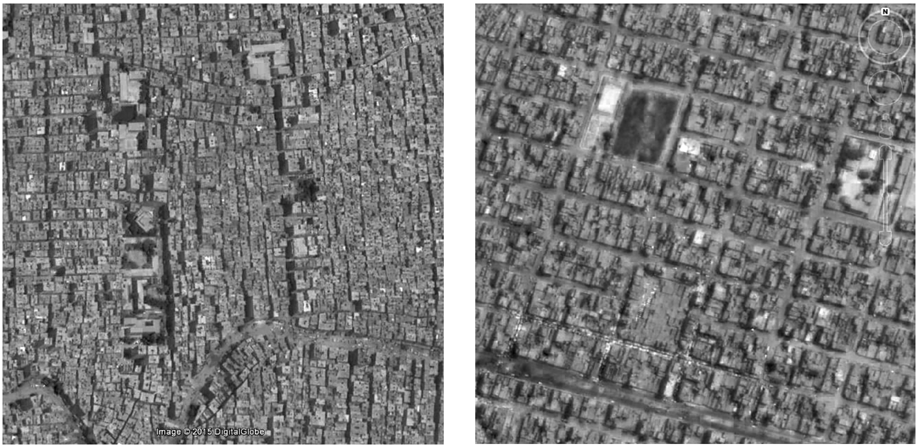
The stage in the evolution of the housing sector will be determined by first dividing the land in each selected 10-hectare locale in the expansion area into three discrete and nonoverlapping land use zones (each extending to the middle of roads or paths separating them): (1) residential; (2) nonresidential; and (3) open or vacant space. The residential zone within the locale will then be classified into four housing types based on the level of evolution, where *evolution* refers to the degree of planning, the availability of construction and mortgage finance, and the quality of public services: (1) informal settlements (irregularly shaped and irregularly arranged houses along meandering narrow paths); (2) informal land subdivisions (irregularly shaped houses arranged along narrow roads that were laid out in advance of occupation); (3) formal land subdivisions (proper street layouts and paved roads with a single house on each plot; (4) housing projects (similar or identical houses or apartment complexes in formal land subdivisions). The share of the residential land in the expansion area in each of these four residential categories will then be determined.

Figure 3.15
Building Without Prior Land Subdivision in Bangui, Central African Republic (top left); Informal Subdivisions in Accra, Ghana (top right); Formal Land Subdivision in Mexico City (bottom left); and Formal Land Subdivision with Identical Housing Designs in Ahmedabad, India (bottom right)

Source: Map data from Google, DigitalGlobe (2015).

Street Space Well-functioning urban neighborhoods require a substantial amount of area for streets. At the minimum, buildings have to be within a short distance (not more than, say, 50 meters) from fire lanes—streets that are wide enough to accommodate firefighting vehicles (at least three meters wide). Streets are also needed for vehicular traffic, to park cars, to walk or cycle, and to allow all residents and visitors to the city to share a common public realm. Municipal

Figure 3.16
Street Space in an Informal Settlement in Cairo, Egypt (left), and in a Squatter Settlement in Comas, a Suburb of Lima, Peru (right)



Note: Cities are shown at the same scale.
Source: Map data from Google, DigitalGlobe (2015).

street grids, to paraphrase Adrian Gorelik (2003), also function to homogenize the area of expansion, eliminating the differences between the formal and informal and the legal and illegal. Finally, a regular pattern of streets is needed to facilitate the provision of public works, especially water, sewer, and drainage lines. It has been reported that the cost of providing the full range of public works in informal settlements after they have been built ranges from three to six times that of providing them earlier, before residential areas are occupied (Abiko et al. 2007).

The share of the land in public streets is thus an important dimension of the quality of areas of urban expansion. That being said, it is often the result of the interplay of market forces rather than the successful application of local regulations. In the informal residential areas expanding into the high-value agricultural land on the periphery of Cairo, Egypt (figure 3.16, left), street space is meager, while in the informal residential areas formed by organized squatter invasions on low-value unoccupied land on the desert fringe of Lima, Peru (figure 3.16, right), street space is in ample supply. The monitoring initiative will seek to calculate (1) the share of the land devoted to streets in each of the four residential zones defined earlier and (2) the average width of the streets in each of these zones. These values will be used to determine the overall average share of the land devoted to streets in expansion areas, as well as the average width of streets.

Figure 3.17
Block Size in Beijing (left) and Manhattan (right)

Note: Cities are shown at the same scale.
Source: Map data from Google, DigitalGlobe (2015).

Block Size Streets are made for walking, and urban areas function best when people can walk freely from one place to another. Walking is facilitated when city blocks are short, when there are few cul-de-sacs, and when pedestrians are not blocked from entering restricted areas such as gated communities or large institutional grounds. It is quite evident, for example, that the streets in suburban Beijing (figure 3.17, left) are less accommodating of pedestrians than the short blocks of Manhattan (figure 3.17, right). The monitoring initiative will seek to measure the average area of blocks, and by measuring the density of street intersections—that is, the number of intersections per square kilometer in the expansion area.

Plot Area Regulations mandating a minimum area for residential plots, such as the large plot zoning requirements of many suburban municipalities in the United States (figure 3.18, left), function to exclude the poor from living in suburban locations that may provide them with better access to jobs and schools. Alternatively, when regulations that do not permit the provision of affordable plots can be ignored, the informal market will provide plots that are smaller and thus more affordable. In a way, the informal market may be sending a message to regulators that plot sizes may be too large, given what people can afford. At the same time, when residential plots are found to be exceedingly small (figure 3.18, right), the informal market may be signaling that residential land is in short supply and that the city cannot expand at a rate that might allow the

Figure 3.18
Large Plots in Franklin Township, New Jersey (left), and Small Plots in the Matinha Favela in Rio de Janeiro (right)

Sources: Image courtesy of Anton Nelessen (left); image courtesy of Alvaro Uribe (right).

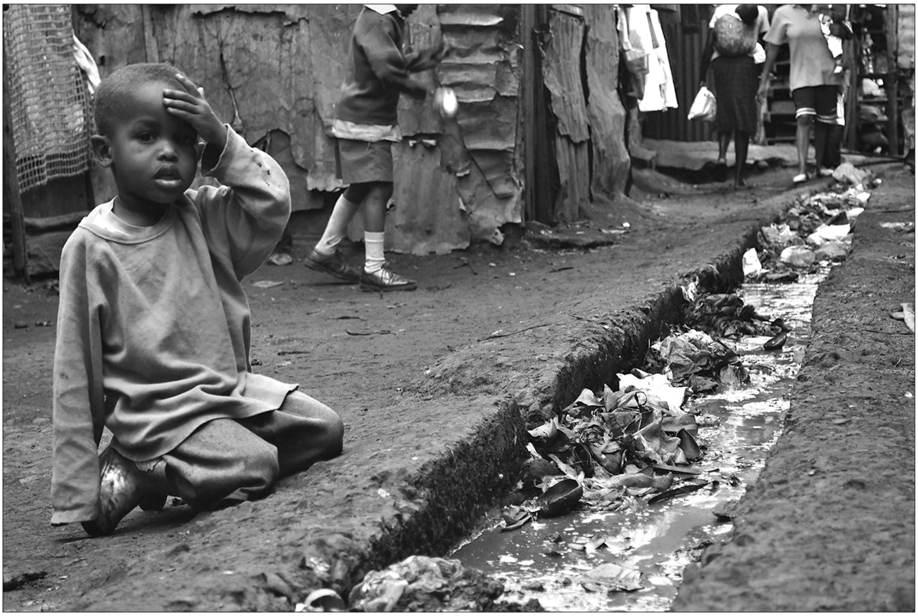
provision of plots of adequate size. The monitoring initiative will seek to measure the average size of plots in residential subdivisions with the aim of providing these signals both to regulators and to the formal residential land market.

It is clear that these five metrics are not independent of one another. More-advanced stages in housing sector evolution may require larger shares of land for streets. Similarly, larger plots and lower rooftop densities may require smaller shares of land for streets. Thus, the five metrics taken together provide both a description of the quality of the built environment in areas of expansion and a deeper understanding of the possible causal relationships among them. Data on these metrics applied to a global sample of cities will allow the estimation of global and regional norms, as well as provide more-robust explanations of commonalities and differences in norms among various cities and regions.

QUALITATIVE ATTRIBUTES OF URBAN EXPANSION OBTAINED FROM INFORMANTS ON THE GROUND

As noted earlier, the monitoring initiative will focus on urban areas of expansion in two time periods, circa 1990 to circa 2000 and circa 2000 to circa 2010. In each area of expansion, a set of 10-hectare locales will be examined. The number of locales in each area of expansion will depend on the overall variance in the city's metrics. It may be on the order of 20 locales in each area of expansion, or

Figure 3.19
An Open Sewer in the Kibera Slum of Nairobi



Source: © Trocaire/Creative Commons.

40 locales per city. In each city, informants who can visit each of the locales will need to be recruited to collect data from local residents, using a short questionnaire. The number of households interviewed may vary but should be about 10 households per subarea. In addition, informants may need to obtain information from local planning officials or from local real estate agents or other people familiar with the value of land and housing in the area.

The study of the quality of global urban expansion on the ground will focus on five key attributes: basic services, affordable plots and homes, squatters, access to jobs, and public open space.

Basic Services When cities are expanding rapidly, essential public services such as water supply and sewers may lag behind, leading to the imposition of high costs for the provision of such essentials or to the creation of neighborhoods with unsanitary living conditions (figure 3.19). The monitoring initiative will seek to determine the share of homes in expansion areas where water and sewers are in adequate supply. Informants on the ground will survey households in selected locales to determine the share of homes with a regular piped water supply and a functioning piped sewer system.

Figure 3.20
Squatter Settlements in Cape Town, South Africa (left), and Davao City, Philippines (right)

Sources: © Patrick Neckman/Creative Commons (left); © Carrie Kellenberger/Creative Commons (right).

Affordable Plots and Homes Expansion areas may be well supplied with a full complement of services and an adequate share of land in streets and arterial roads, but the plots and houses there may be out of reach financially for a substantial share of the households seeking shelter in the city. In cities where land with good access to the job market is in short supply—either because of artificial limits imposed on expansion or because of the absence of adequate access roads into the city—plots and homes on the fringe may no longer be affordable, for rent or for purchase, by those on the lowest rung of the city's income distribution. In other cities, however, plots and dwelling units on the urban fringe are highly affordable. The monitoring initiative will seek to determine the affordability of plots and homes in each expansion area, a key dimension of the quality of urban expansion. This may be done by surveying households in locales and inquiring as to the value of their homes or the rent they pay compared with their monthly household income. It may also be done by obtaining data from local real estate agents on the cheapest plots available for sale in the expansion area. After obtaining information on the median household income in the city, we will seek to calculate the ratio of the plot price to median income of the cheapest plots available in substantial quantities, the ratio of the dwelling unit price to income of the cheapest new dwelling units available in substantial quantities, and the ratio of rent to median income of the cheapest new dwelling units available in substantial quantities.

Squatters Much of the literature on housing in cities in developing countries still refers to squatter settlements as a major form of housing for the urban poor who are excluded from the land market (figure 3.20). But it is not at all clear

Figure 3.21
Singapore Mass Rapid Transit (left) and Jeepney Informal Transport in the Philippines (right)

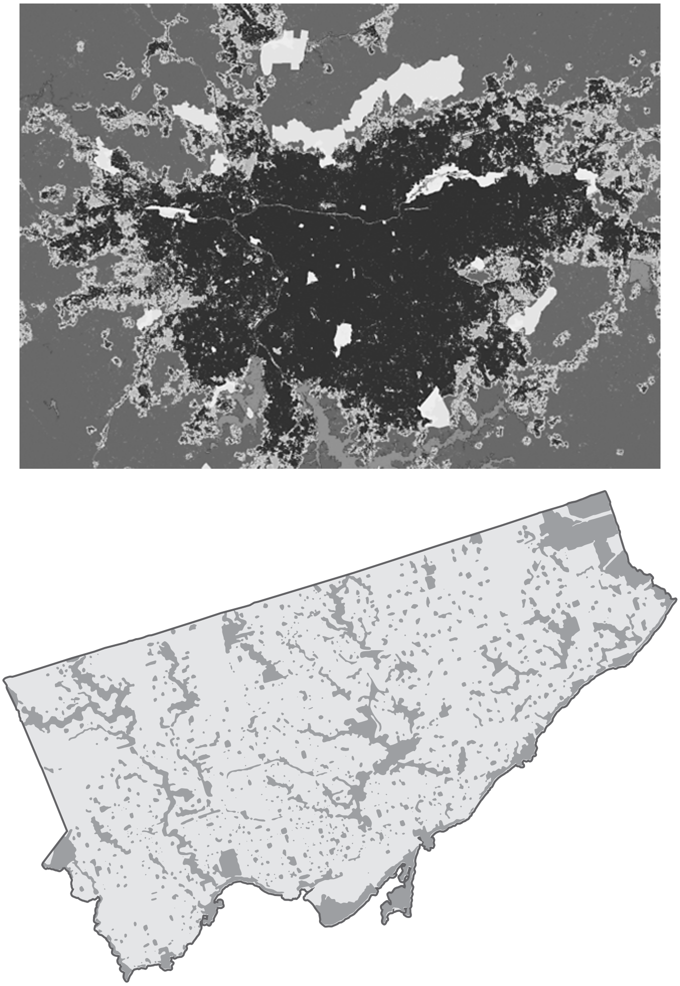
Sources: © Alantankenghoe/Creative Commons (left); © Ken Marshall/Creative Commons (right).

to what extent squatting remains a prevalent form of housing on the urban fringe and whether it is on the increase or the decrease. It is, therefore, not clear to what extent public action on housing the poor needs to address the squatter problem. The monitoring initiative will seek to determine the share of informal settlements in expansion areas that are squatter settlements by interviewing households in those areas.

Access to Jobs In some cases, areas on the urban fringe may be provided with a full complement of services and plots that are affordable to all. Yet these areas may be so far away from the central business district or from the metropolitan job market as a whole that getting to work may be too costly and time-consuming, reducing the benefit of living in a decent home located in a good residential neighborhood. It is important to know, therefore, how accessible expansion areas are to jobs and, more specifically, how accessible they are to jobs via public transport (figure 3.21). The monitoring initiative will seek to determine to what extent expansion areas are accessible to the metropolitan job market by public transport—be it formal or informal—by surveying selected households in locales as to (1) the longest time it takes any member of the household to get to work by any means of transport as well as by public transport and (2) the estimated time it takes to reach the central business district using public transport.

Public Open Space Public open space—parks, playgrounds, sports fields, and plazas—is an essential feature of well-endowed urban neighborhoods. But when development on the urban fringe is entirely at the mercy of market forces, very little, if any, open space is left for public use (figure 3.22, top). In cities with generous provisions of public open space, such as Toronto (figure 3.22, bottom),

Figure 3.22
The Absence of Public Parks in São Paulo (top) and the Public Park System in Toronto (bottom)



as much as 11 percent of the land is devoted to this purpose. The monitoring initiative will seek to determine (1) the share of the land in expansion areas in use as public open space; and (2) the average distance of homes from any such space. Both will be determined by household interviews in locales of the expansion areas.

Conclusions

While planners are beginning to acquire a good understanding of the amount of land required by cities to accommodate their burgeoning populations and of the rate at which cities the world over are now expanding, they know next to nothing about the qualitative attributes of urban expansion—namely, whether cities are expanding in a satisfactory manner or, alternatively, whether planners need to intervene to render it more satisfactory. And while we cannot and do not advocate a global set of standards, we do believe it is important to determine the present global and regional norms regarding urban expansion. Measuring these norms on a global scale may provide planners with the information they need to meet the challenge of managing future urban expansion in a more realistic and pragmatic way.

This chapter proposes a possible platform for undertaking this effort in the coming years that will focus on the expansion areas of a representative global sample of 200 cities during two time periods (circa 1990 to circa 2000 and circa 2000 to circa 2010). The monitoring initiative will entail analyzing high-resolution satellite imagery of a representative set of small locales within the expansion areas; administering a simple questionnaire to a small number of households in each subarea; obtaining information from experts on the regulatory environment and the real estate regime in the areas; assembling this global data set using a rigorous and consistent platform; using these data to obtain a set of comparable metrics for all cities in the sample; analyzing these metrics to obtain a set of global and regional norms of contemporary urban expansion practices and outcomes; and proposing a set of pragmatic and evidence-based action programs that can assist cities in improving their ability to accommodate their burgeoning populations in the decades to come.

Financing is already in place, and work on the first phase of the initiative, the *Atlas of Urban Expansion: The 2015 Edition*, is expected to be completed in the summer of 2015. Work on testing the primary and secondary modules of phases 1 and 2 is now in its initial stages and should be completed during the summer of 2015. Collecting the data for the primary modules of phases 1 and 2 in the global sample of cities started in late 2014, and financing of this work has been secured. UN-Habitat is firmly committed to making sure that the work is completed in time for Habitat III, scheduled to take place in October 2016. At the time of writing, plans for obtaining data from informants in the 200 cities in the global sample—albeit on a much more limited scale than that envisioned in this chapter—are in place, but budgets for these surveys have not yet been secured. There is good reason to believe that if adequate funds can be secured in time, the work on all three phases of monitoring global urban expansion can indeed be finished in time for the conference, providing planners for the first time with a new global data set that could be of great use to cities now confronting rapid population growth and the concomitant urban expansion.

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