Journal of the American Planning Association

ISSN: 0194-4363 (Print) 1939-0130 (Online) Journal homepage: http://www.tandfonline.com/loi/rjpa20

Built Landscapes of Metropolitan Regions: An International Typology

Stephen M. Wheeler

To cite this article: Stephen M. Wheeler (2015) Built Landscapes of Metropolitan Regions: An International Typology, Journal of the American Planning Association, 81:3, 167-190, DOI: 10.1080/01944363.2015.1081567

To link to this article: http://dx.doi.org/10.1080/01944363.2015.1081567

Published online: 02 Oct 2015.

Built Landscapes of Metropolitan Regions

An International Typology

Stephen M. Wheeler

Problem, research strategy, and findings: Built landscapes—patterns of streets, blocks, parcels of land, buildings, and related infrastructure at the scale of an urban neighborhood or greater—are often difficult for decision makers and the public to understand, especially within the complex "collage city" of the postmodern era. Yet understanding the variety of these forms can help stakeholders make wise choices regarding how to plan and design urban regions in the future to meet goals such as livability and sustainability. Based on aerials, maps, and images available through Google and other sources, I develop a typology of built landscape forms found within 24 metropolitan regions worldwide and use GIS to map these forms and compare regions. The analysis shows that 27 basic types of built landscape make up metropolitan regions worldwide, of which nine are very common. Traditional urban types now make up a small fraction of most metropolitan areas worldwide, while suburban and exurban forms comprise the vast majority of the land area. There are noted regional differences in the mix of built landscape types.

Takeaway for practice: Each built landscape form offers challenges and opportunities for planning objectives such as livability and sustainability. It is important for planners to a) help the public and decision makers understand built landscapes and their implications; b) include landscape-scale elements, such as street patterns and networks of green infrastructure, when framing urban development alternatives; c) ensure that local codes and design guidelines enable desired forms of built landscapes and discourage those that are problematic for sustainability; and d) encourage built landscape change that promotes sustainability.

The physical forms of 21st-century metropolitan areas are often confusing to the public. Nineteenth-century communities featured compact grids of streets or tightly knit organic patterns, but 20th-century technologies such as the motor vehicle enabled rapid growth and dispersion of development. New types of built landscapes proliferated. Postmodern culture with its diverse social and economic niches also led to different types of form. Rowe and Koetter (1978) famously termed the result "collage city."

"Built landscape" refers to an area of consistent form at a neighborhood scale, often 1 square km or greater. This is an area large enough to determine much of a resident or user's daily experience, and to have significant influence on shaping resident behavior. Five main elements determine built landscape types: street and block patterns; patterns of parcelization and land use; building form, scale, and placement on lots; street and parking design; and typical relationships between "green" and "gray" landscape components. Street, block, and parcel patterns are most important. These affect travel and other behaviors, and tend to lock in urban form for decades, if not centuries. In residential areas particularly—which comprise nearly 80% of the land area of the 24 regions studied here—once streets are built, lots are created, and land is parceled out among many owners, it becomes economically and politically difficult for societies to change these landscape types. In contrast, commercial, industrial, and institutional landscapes are more frequently retrofitted or replaced.

Built landscapes affect people every day in terms of their subjective experience of place; their ease of traveling by foot, bike, car, or public transit; their choice of housing forms, shopping, or recreational activities; their participation in civic life; and their proximity to natural features and open space. Built landscapes are also correlated with environmental performance measures such as motor vehicle use, greenhouse gas emissions, and urban heat island effects,

Keywords: metropolitan, morphology, landscapes, urban design, regional planning

About the author: Stephen M. Wheeler (smwheeler@ucdavis.edu) is a professor in the Department of Human Ecology at the University of California at Davis.

Color versions of one or more of the figures in the article can be found online at www.tandfonline.com/rjpa.

Journal of the American Planning Association,
Vol. 81, No. 3, Summer 2015
DOI 10.1080/01944363.2015.1081567

as I discuss further below. Societies face important choices about which types of built landscapes to encourage and which to discourage, retrofit, or replace. Built landscape choices are thus central to the task of creating more sustainable urban regions.

I seek to determine the types and relative quantities of built landscapes within global metro regions in the early 21st century. After a discussion of related literature and preliminary observations on the implications of these types for sustainability, I describe the process through which I develop the typology and analyze the built landscapes of 24 global urban regions. I find that 27 basic types of built landscape make up metropolitan regions worldwide, of which nine are very common. Traditional urban types now make up a small fraction of most metro areas. Suburban and exurban residential forms now exist worldwide, and comprise the vast majority of the land area within most regions. There are important differences in the mix of built landscape types between regions because of cultural, geographical, institutional, economic, and political factors.

In the final sections of this study, I consider how built landscape types relate to sustainability, suggest some planning implications, and outline further research directions. In particular, it seems important for planners to a) help the public and decision makers understand built landscapes and their implications; b) include built landscape elements, such as street patterns and green infrastructure networks, when framing urban development alternatives; c) ensure that local codes and design guidelines enable desired forms of built landscapes and discourage those that are problematic for sustainability; and d) encourage built landscape change that promotes sustainability wherever possible.

Background

Societies throughout history have developed land using particular patterns of neighborhood-scale urban form either intentionally or through expedience and tradition. Historical forms have included the tightly knit organic patterns of vernacular villages within many cultures; the grids used in ancient India, Greece, and Rome as well as Renaissance and Baroque European urban additions and 19th-century American communities; the more formal geometric patterns associated with the Renaissance as well as temple cities in India, China, and Mesoamerica; and the winding, picturesque designs popularized by European and American landscape architects and urban designers in early modern times. Scholars have provided excellent introductions to these traditions. Lewis Mumford's (1938, 1961) sweeping histories critique many of these built landscapes and urban development processes, often praising the human scale of preindustrial communities in contrast to the technology-driven forms of the spreading megalopolis (Luccarelli, 1995). Morris (1972/1994), Bacon (1967), and Kostof (1991, 1992) provide excellent analyses of preindustrial and early modern forms. Reps (1965, 1979) chronicles 19th-century North American urban forms. Jackson (1985), Fishman (1987), Vance (1977, 1990), Sorkin (1992), Ellin (1996), Dear (2000), Soja (2000), and Hayden (2003) analyze technological, political, social, economic, aesthetic, and institutional forces leading to suburbanization and the spread of postmodern landscapes. Hayden and Wark (2004), Campoli and MacLean (2007), and Campoli (2012) provide attractive pictorial guides to many current urban forms using aerial photographs. Larice and Macdonald's *Urban Design Reader* (2013) includes both classic and recent analyses of urban form traditions.

In a more normative vein, 19th-century writers such as Andrew Jackson Downing (1842), Ildefons Cerdá (1860/2002), Camillo Sitte (1889/1945), and Ebenezer Howard (1898/2003) published works promoting their preferred designs for the rapidly growing communities of that time. Downing promoted the semirural cottage neighborhood, Sitte the picturesque village, Cerdá an apartment-block form mixing urbanity with greenspaces, and Howard the garden city. The pre-eminent 20th-century theorist of urban form is Kevin Lynch, whose *A Theory of Good City Form* (1981) analyzes the values underlying spatial development traditions and endorsed principles such as legibility, vitality, accessibility, and fit. Alexander, Ishikawa, and Silverstein (1977) likewise sought to determine time-tested norms of urban form that they assemble into a "pattern language" operating from architectural to regional scales. In their view, good city form is incrementally assembled from these time-tested patterns and features tight interconnections between them.

Starting in the late 1980s, the new urbanism movement has sought to rethink urban form to meet values such as walkability and community (Calthorpe, 1993, 2011; Duany, Plater-Zyberk, & Speck, 2000). The closely related smart growth movement has promoted compact, transit-oriented forms that reduce motor vehicle use and minimize public infrastructure expenditures. New urbanism in particular is open to criticisms on a number of fronts, such as that its built projects are not truly compact and urban, its neotraditionalism lacks authenticity, and it is insensitive to gentrification issues (e.g., Southworth, 2003). Nevertheless, its form-based codes have become a leading tool that local governments can use to shape built landscapes in desired directions (Center for Applied Transect Studies, 2015). New urbanist–affiliated writers such as Duany and Talen (2002) propose a transect of urban forms—an ideal series of types ranging from downtown to rural in their built intensity—to guide city planning. These place types are smaller in scale than the built landscapes I analyze here, and represent idealized forms rather than the full range of actual extant places. Thus, the built landscape analysis I present here is likely to complement and inform this approach rather than compete with it.

Many other authors recently have proposed ideal models of urban form. Among these are Patrick Condon's (2010) vision of highly connected, grid-like, dense, mixed-use urban patterns and Douglas Farr's (2008) proposals for compact urban neighborhoods with green buildings and district energy systems. Fraker (2013) has analyzed existing ecological neighborhoods in several countries, emphasizing the importance of thinking at the neighborhood scale to meet sustainability goals.

More systematic and empirically based study of urban morphology dates to the middle of the 20th century. In her overview of "typomorphology," Moudon (1994) roots the field in three European traditions, none widely known in North America. The first stems from the work of Italian architect Saverio Muratori and his followers beginning in the 1940s, who analyzed the form of Italian communities at the building and block scale (e.g., Cataldi, Maffei, & Vaccaro, 2002). The second tradition is based on the work of British geographer M. R. G. Conzen and his colleagues, who took a deeply historical approach toward analyzing the evolution of plot patterns, building types, and urban footprint in English towns from the medieval period onward (Conzen & Conzen, 2004; Whitehand, 1981). The third tradition consists of analyses by French geographers integrating social science and literary perspectives into the development of architectural types (e.g., Panerai, Castex, & Depaule, 1997).

In North America, studies such as Sam Bass Warner's *Streetcar Suburbs* (1962) and Moudon's *Built for Change* (1986) shed light on the evolution of particular built landscape forms (gridded neighborhoods in Boston and San Francisco, respectively). Southworth and Owens (1993) analyze changing neighborhood patterns in several northern California suburbs, and Moudon (1992) describes residential forms within other selected American cities. More recently, Forsyth and Crewe (2009) analyze cultural as well as physical dimensions of comprehensively designed communities created since World War II, and Scheer (2010) presents a typology of evolving urban form focused primarily on the building and block scale. Angel (2012) uses GIS and satellite data to map urban expansion on a broader scale for a large number of cities in the developing world. In previous studies, I and my colleagues (Wheeler, 2008; Wheeler & Beebe, 2011) use GIS to map residential landscape patterns and their historical growth in seven U.S. urban regions, developing early versions of the international typology presented here.

A related research tradition coming from geography and environmental science uses quantitative satellite and aerial data—"remote sensing"—to analyze land cover. This type of effort focuses on the relative percentages of tree canopy, open ground, paved surfaces, buildings, agricultural fields, and other physical elements, often seeking to identify clustering of development at a regional scale. Wilson, Hurd, Civco, Prisioe, and Arnold (2003), for example, use Landsat data to identify "infill," "expansion," "linear branch," and "clustered branch" forms of urban development. Clark, McChesney, Munroe, and Irwin (2009) use population databases to analyze the clumping of exurban development. Irwin, Cho, and Bockstael (2007) use national land cover databases, and Sutton, Cova, and Elvidge (2006) use satellite imagery of nighttime lights for similar purposes. These types of studies have limitations due to the resolution of data, and usually cannot identify neighborhood characteristics that might be of interest to designers or planners. Finally, Song, Popkin, and Gordon-Larsen (2013) identify 27 different potential quantitative metrics useful in neighborhood-scale analysis, while Song and Knaap (2004) use parcel-level GIS data to analyze street patterns, density, land use mix, accessibility, and transportation infrastructure in several suburban Portland (OR) neighborhoods. These authors find that housing density has increased in recent years but that street connectivity and diversity of land uses have not.

Different types of built landscapes have different performance characteristics. In addition to qualitative analysis pioneered by Lynch and other environmental design researchers, quantitative researchers in recent years have correlated built form with public health and active living (e.g., Frumkin, 2002; Saelens, Sallis, & Frank, 2003), motor vehicle use (e.g., Ewing & Cervero, 2010), urban heat island effects (e.g., Stone & Rogers, 2001), energy use and greenhouse gas emissions (e.g., Ewing, Bartholomew, Winkelman, Walters, & Anderson, 2008; Ewing & Rong, 2008), and sense of community (e.g., French et al., 2014). Researchers have found statistically valid relationships for most of these effects, although performance variables for urban form are often highly multidetermined (affected by many other spatial and socioeconomic factors) and statistical analyses are difficult.

Developing a Global Typology of Built Forms

For this project I develop a comprehensive typology of built landscape forms for global urban regions through several iterative stages. In a preliminary stage I developed a typology of residential form for U.S. cities, drawing on the work of writers such as Mumford (1961), Lynch (1981), Kostof (1991, 1992), Southworth and Owens (1993), A. Jacobs (1993), Calthorpe (1993), and Hayden (2003). A main emphasis of many of these authors is the importance of street patterns, which differentiated my evolving landscape-scale typology from the work of others more focused on building form and density. As mentioned above, I emphasize a) street and block patterns; b) parcelization and land use; c) building form, scale, and placement on lots; d) street and parking design; and e) relationships between green and gray landscape elements. Following publication of this initial research, I set out to revise and expand the typology to include a greater variety of land use types for cities internationally. My assistants and I first performed a visual analysis of a convenience sample of widely distributed global metropolitan regions to expand the list of types into approximately 55 variants. We then combined similar patterns to arrive at a final typology of 27 built landscape forms. Table 1 provides a brief description of these forms, and Figure 1 gives a visual introduction. The intent throughout was to arrive at a manageable number of easily recognizable landscapes rather than hundreds of very specific variants with minor differences. To label the different forms, I sought titles that are simple, easily understandable, and, if possible, already in use. A more complete description of the types is available from the author upon request.

Any typology involves questions of judgment on the part of the researcher: what to include in each type, and what to exclude. I try here to be as transparent as possible about assumptions, and welcome further refinements in the future. The balance between landscape form and use is particularly tricky. Form is the most important consideration for typologies, but land use also matters greatly to the look and feel of a place, evolves jointly with form, and helps determine how the sustainability and livability of each type can be improved in the future. For example, a landscape type such as "commercial strips" is already well known under this label that emphasizes land use. The fact that the use is commercial bears significant implications for the future, in particular that these landscapes can be redeveloped when commercial businesses reach the end of their lifespans. So, although built landscape form is the primary consideration, use is an important secondary factor.

Many of these 27 landscape types contain distinct subtypes. For example, while "malls & boxes" landscapes all feature big parcel sizes, large building footprints, commercial uses, a significant amount of parking, and a hardscaped character (i.e., dominated by asphalt and concrete), a number of different subtypes exist. These include the shopping center (traditionally a long, low I- or L-shaped building with parking in front), the mall (a large, enclosed structure containing stores and usually surrounded by parking), and the big-box landscape (boxy standalone stores of various sizes surrounded by parking). These subtypes vary geographically: Big boxes with large parking lots are more common in North America than elsewhere, whereas European and Asian metropolitan regions tend to have commercial buildings in more vertical formats with less parking. The "malls & boxes" form of course does not include all large retail stores; many are integrated into more traditional, mixed-use urban landscape types such as the "urban grid."

To refine this typology and ensure that it is representative of a wide range of places worldwide, I map these built landscape types across two dozen urban regions. These large metropolitan regions are a convenience sample of geographically dispersed places on six continents, and are shown in Figure 2. In each case I seek to map built landscape forms from the urban core out to the limit of contiguous urbanization, which is usually well beyond the boundaries of both the central city and the regional administrative agency. Boston is the only region in which it is difficult to find a limit to urbanization (in 1961 Jean Gottmann famously proposed that the entire Boston-to-Washington region was becoming a single megalopolis). In that case, I stop mapping approximately 50 miles beyond the central city to match the scale of most other regional maps.

The mapping phase of this project relies on visual identification of built landscape types based on aerials, maps, photos, and other imagery, and then the creation of built landscape layers in ArcGIS. The process is painstaking and depends on careful specification of each type, training of student researchers, and final review by the investigator. We use Google Earth and Street View most extensively to identify landscape types, zooming in and out on one screen to identify detailed form features while digitizing at a scale of 1:30,000 on another screen. This process enables us to produce a detailed analysis while also completing the mapping of these very large metropolitan regions within a reasonable time frame. Figure 3 illustrates the mapping method. After digitizing built landscapes for each region, we then use ArcGIS to calculate the land area covered by each form type and create comparison tables

Table 1. Built landscapes of global regions.

Airports	Very large-scale landscapes for air travel, usually on the periphery of metro areas and dating to the early 20th c. or later. Similar worldwide.
Allotment gardens	Area of contiguous garden plots large enough to contain small dwelling structures. Found primarily in northern Europe and Russia. 18th c. on.
Apartment blocks	Relatively uniform landscapes of large residential buildings, often slablike. Rare in North America; common in Europe and Asia. Buildings higher and with less orientation to the outdoors than garden apartments. Common after WWII.
Campus	Large institutional sites often with formal or picturesque design of spaces. Can include universities, corporate campuses, office parks, palaces, prisons, fairgrounds, and military bases. Many eras.
Civic	Urban landscape dominated by large civic buildings and spaces, typically with formal design. Often overscaled and sterile. Larger building footprints and less mix of use than many other forms. From ancient times on.
Commercial strip	Low-density linear commercial development along highly trafficked streets. Building footprints small; streets and parking areas large. Motor vehicle oriented. 1920s on.
Country roads	Incremental, linear, small-scale development along formerly rural roads outward from a city. Creates "fingers" of urbanization. Throughout history.
Degenerate grid	Large-scale residential landscapes with rectilinear street patterns and poor connectivity. Subtypes include interrupted and warped parallels (Southworth & Owens, 1993). Mid-20th c. onward.
Garden apartments	Apartment landscapes in which low- to mid-rise buildings have a strong relationship to exterior green space and site amenities. Late 19th c. on.
Garden suburb	Detached homes along curvilinear but well-connected streets with extensive greenery. Two main subtypes: late 19th c. picturesque style created for affluent neighborhoods and post-1950 middle-class tracts (in some countries).
Heavy industry	Industrial uses on large parcels. Often includes large-footprint buildings, specialized equipment, outdoor storage of materials, fuel tanks, and rail access. 19th c. on.
Hillside	Irregular winding streets shaped by steep terrain. Often an upper-class residential retreat from the city. Many eras.
Incremental/mixed	Small-scale land subdivision and development, usually within an existing large-scale road system, resulting in a nonuniform mix of forms and moderate-to-poor street connectivity. Many eras.
Land of the dead	Large areas for burial, often with formal or picturesque design. Cairo's "City of the Dead" is inhabited by the living as well. Can serve important function as park and religious space. Common throughout history.
Long blocks	A rectilinear residential form characterized by very long block length (>1,000 feet), often due to pre-existing agricultural parcels urbanized in the 20th c.
Loops & lollipops	Term from Southworth and Owens (1993). Large-scale, mass-produced residential landscapes with regular, curvilinear street patterns and poor connectivity. After WWII.
Malls & boxes	Large commercial buildings or a single large enclosed pavilion, usually with ample parking. Asian versions have less parking. Neotraditional varieties may have pedestrian streets. After 1950.
New urbanist	A recent form promoted by the Congress for the New Urbanism combining aspects of grid and garden suburb forms. High street connectivity; mixed-use centers. After 1980.
Organic	Tightly woven street pattern with dense, fine-grained urban development, created within preindustrial cultures as well as recent informal settlements.
Quasi-grid	A variety of rectilinear, well-connected but irregular street patterns created by topography, design, or incremental development. Land uses tend to be varied. Throughout history.
Rectangular block grid	A rectangular-block grid form used for early Renaissance suburbs in Europe, late-19th c. streetcar suburbs in North America, and Latin American cities in many eras. High street connectivity. In U.S. and Europe typically before 1900.
Rural sprawl	A semirural residential landscape with very large parcels (usually 1–10 acres per dwelling unit). Rapidly growing in many countries, though at times restricted by laws to protect farmland. Generally after 1950.
Superblock	Large master-planned blocks with large residential buildings and interior circulation via small access roads. Building placement and interior design more varied than apartment blocks. Created beginning in mid-20th c. following modernist design principles.
Trailer parks	A dense enclave of mobile homes on small lots with narrow access roads. Often screened from surrounding landscapes. Exclusive to North America. Mid-20th c. on.
Upscale enclave	An affluent residential landscape master-planned or developed incrementally. Often gated. Can be similar to garden suburbs, but more insular and with lower street connectivity. Antiquity onward.
Urban grid	A grid of relatively small, squarish blocks with varied land use often found at the core of many cities. In North American cities this is usually the Central Business District. Usually platted in mid-19th c. or before.
Workplace boxes	Landscapes of boxy buildings serving industrial or commercial uses. Office park subtype has extensive, landscaped parking. Warehousing/distribution subtype features prominent loading docks and is near major roads. After 1950.

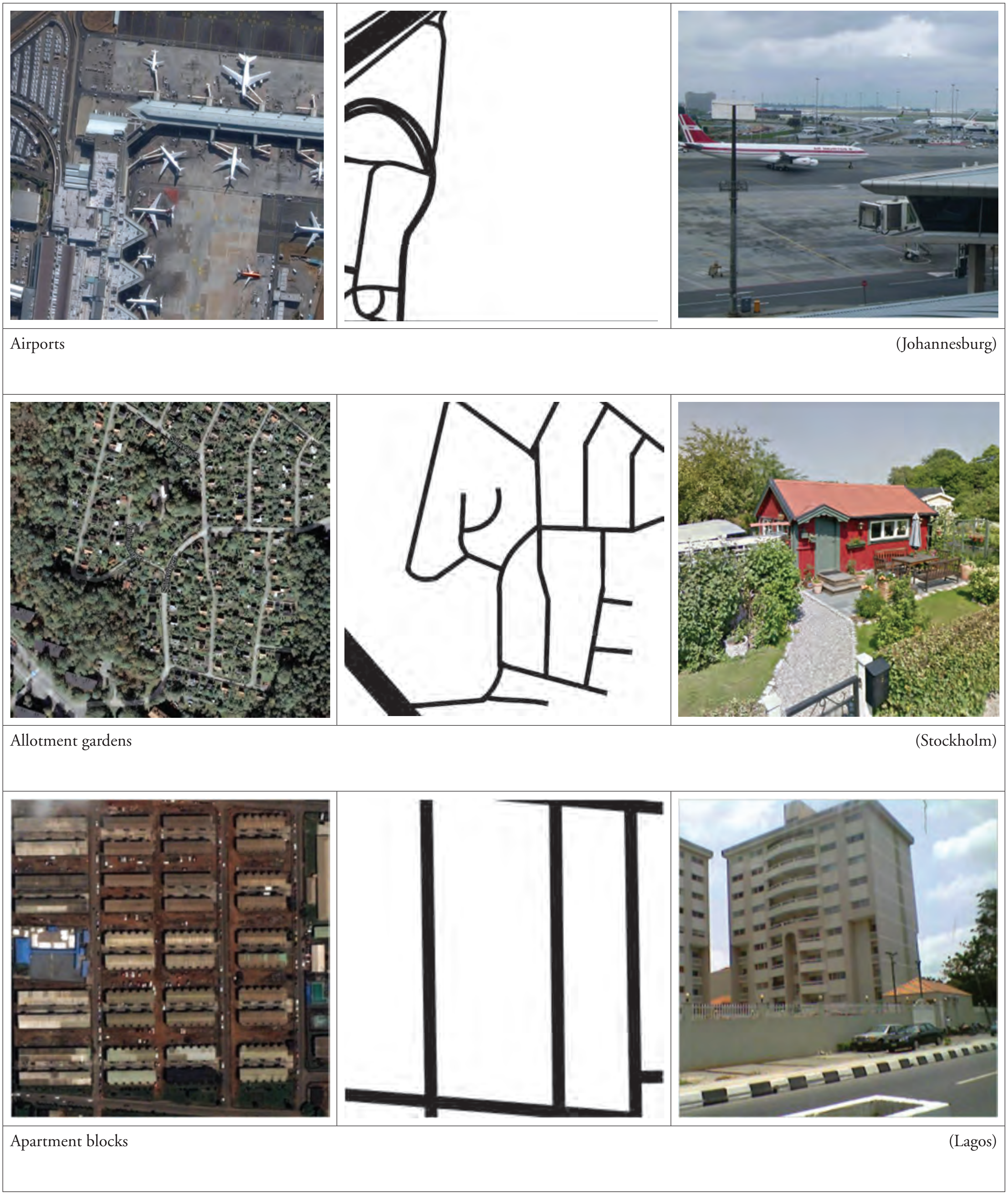


Figure 1. Examples of built landscape types.

Source: Images from Google Earth and Street View.

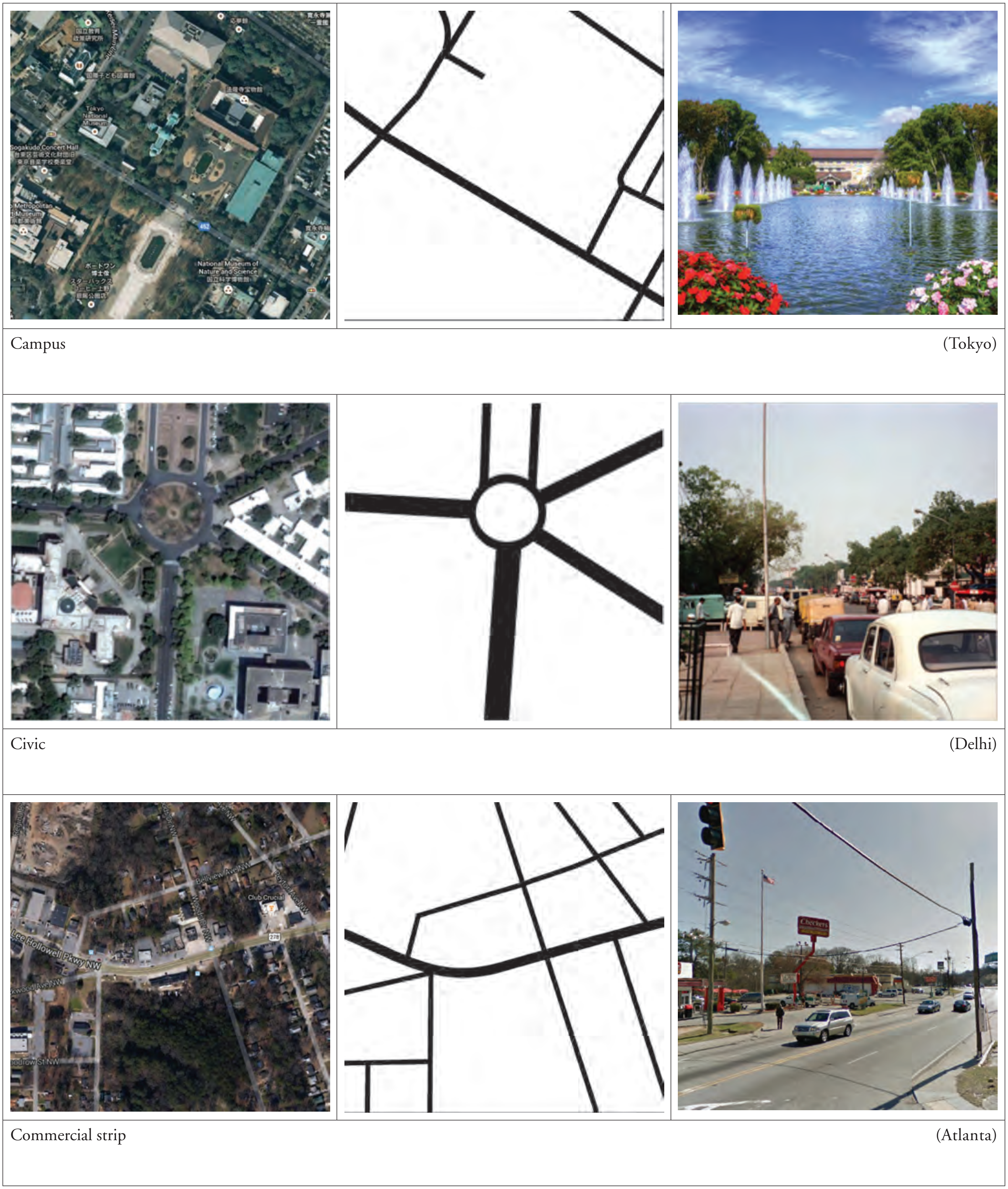


Figure 1. (*Continued*)

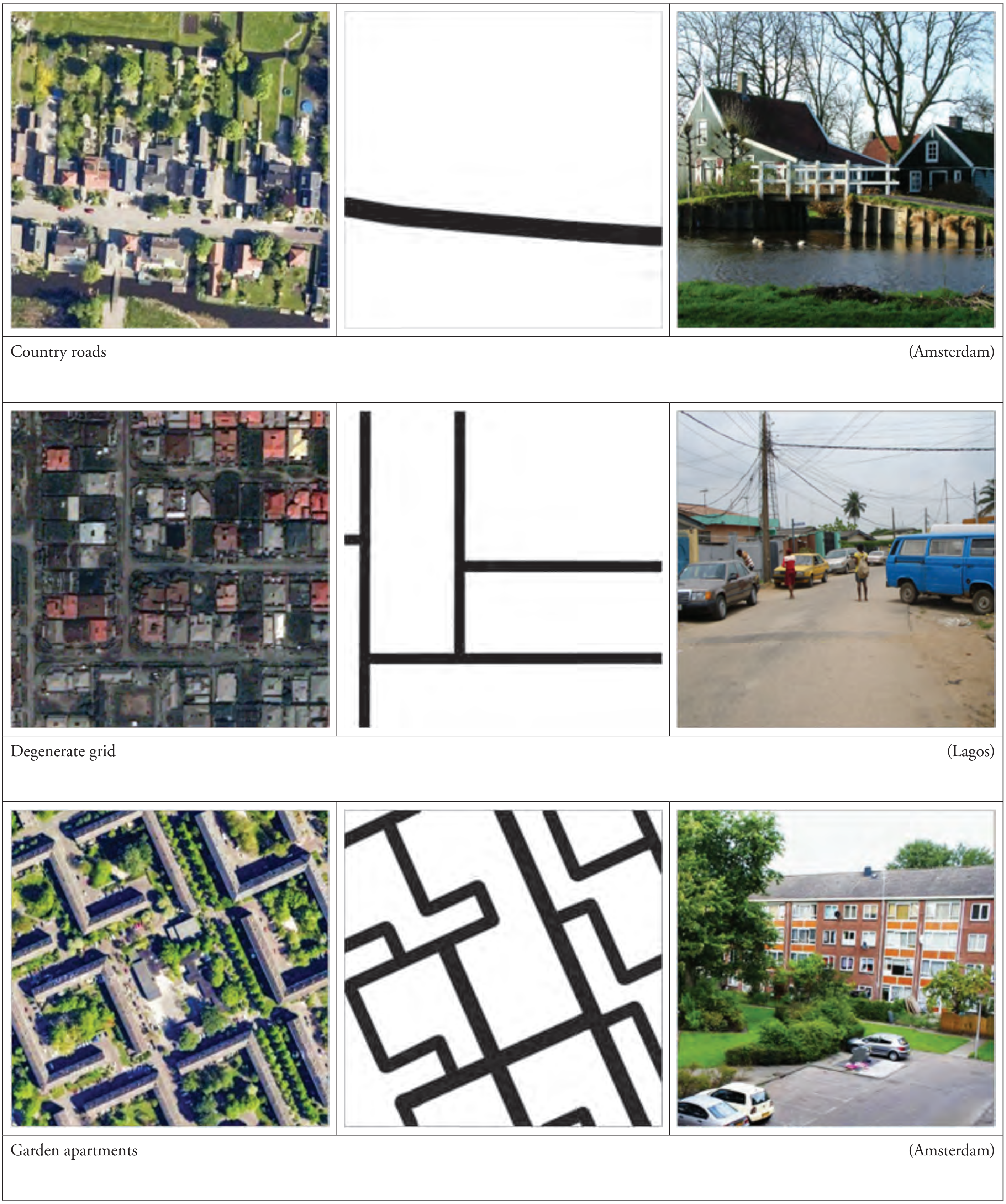
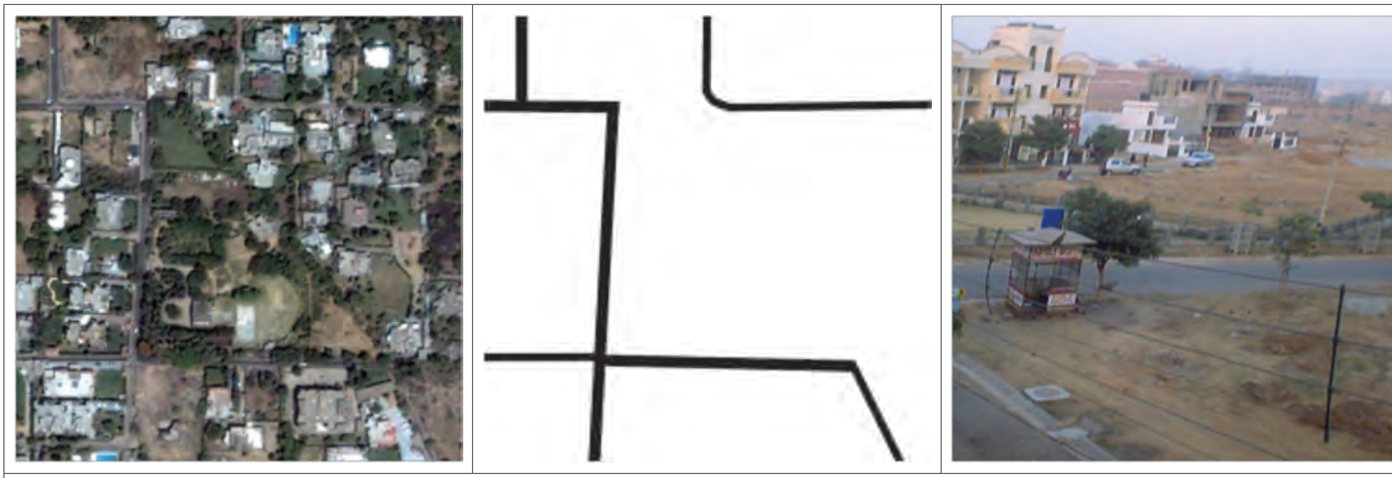
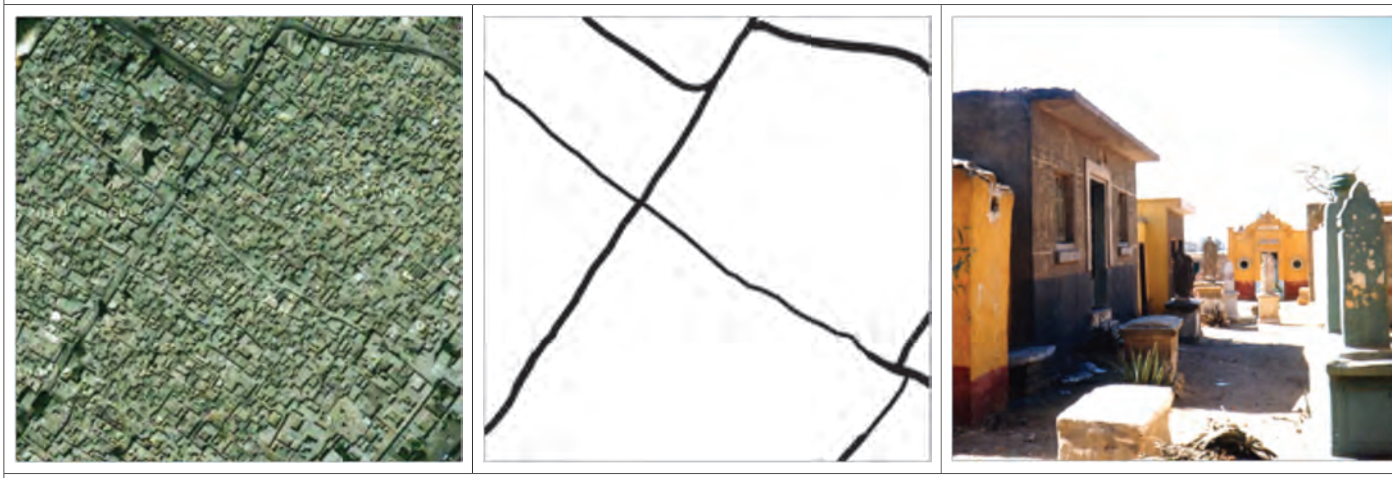


Figure 1. (*Continued*)

Figure 1. (*Continued*)



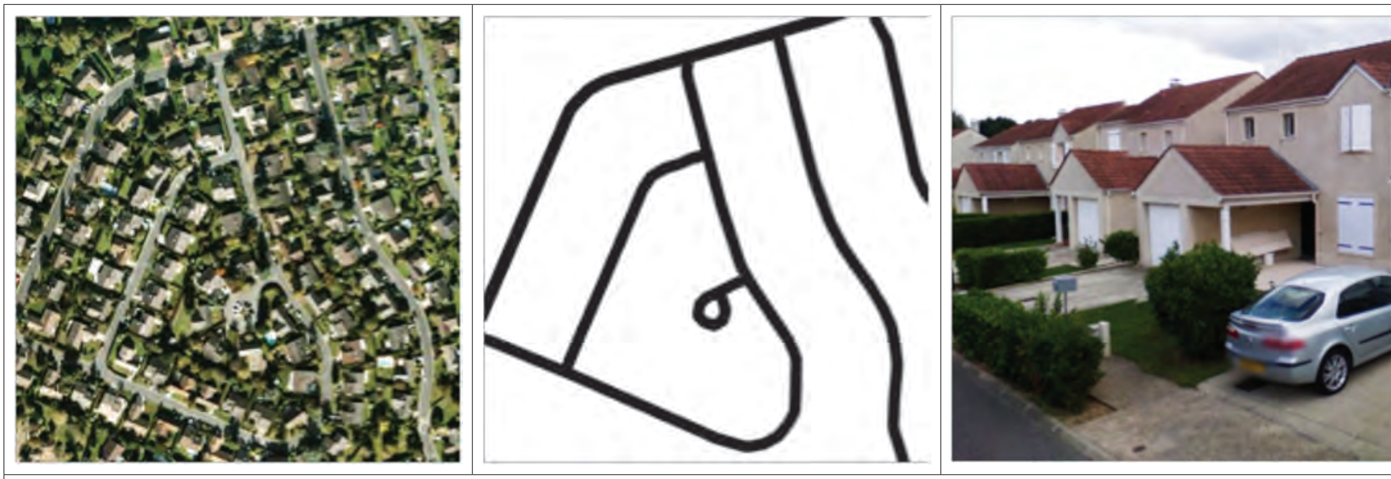
Incremental/mixed (Cairo)



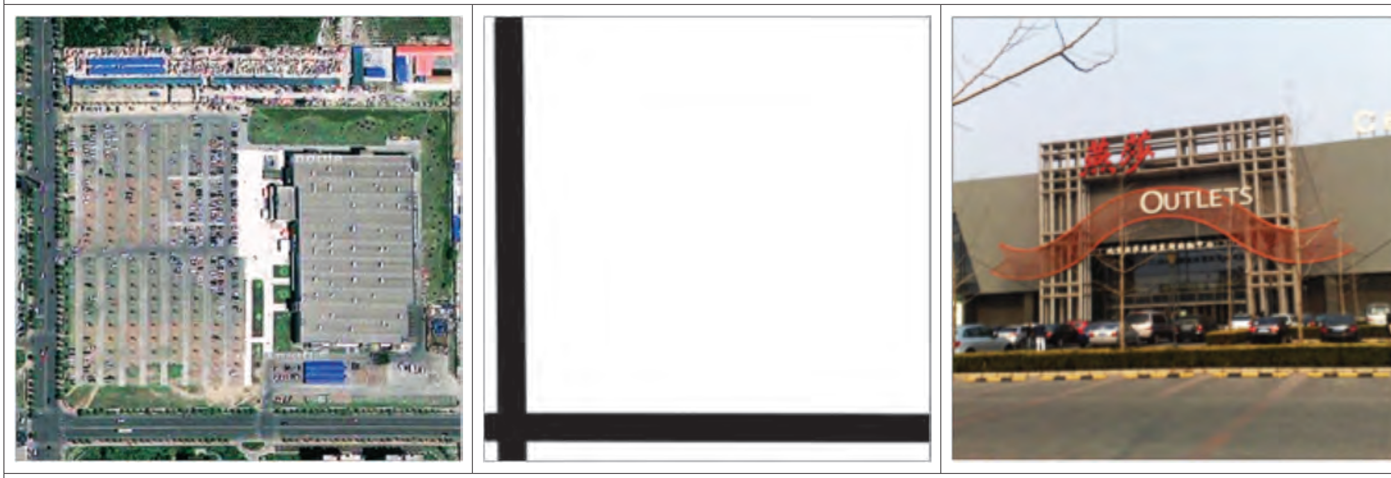
Land of the dead (Cairo)

Long blocks (Moscow)

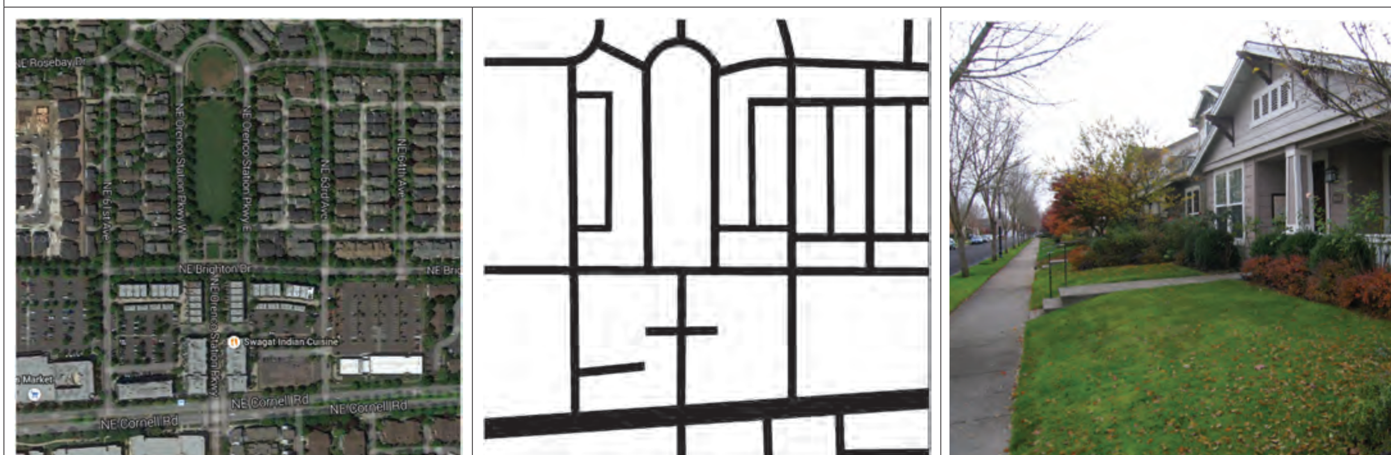
Figure 1. (*Continued*)



Loops & lollipops (Paris)



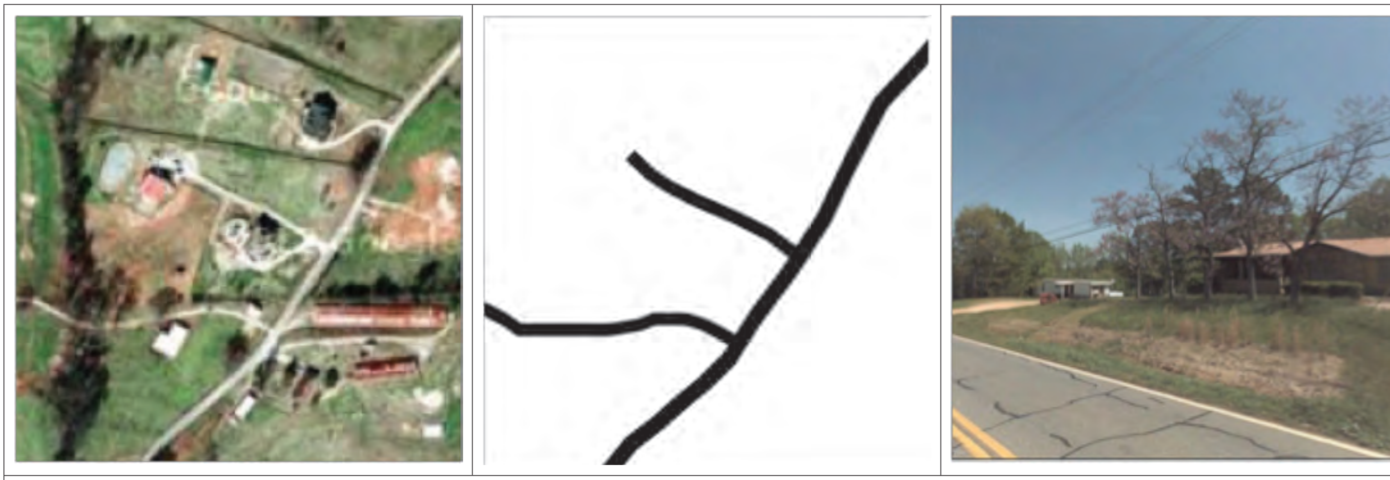
Malls & boxes (Beijing)



New urbanist (Portland)

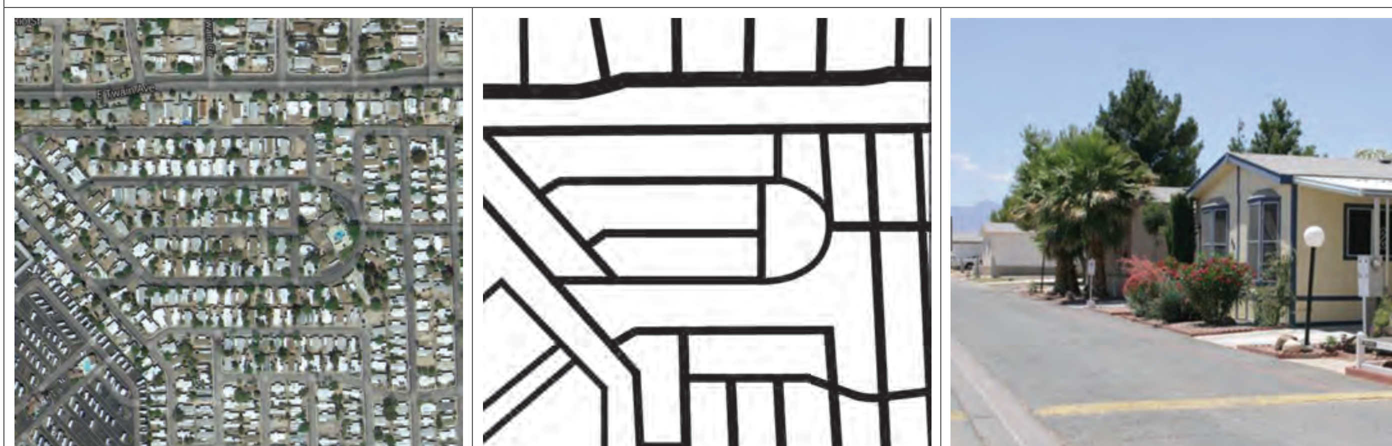
Figure 1. (*Continued*)

Figure 1. (*Continued*)



Rural sprawl (Atlanta)

Superblock (Moscow)



Trailer parks (Las Vegas)

Figure 1. (*Continued*)

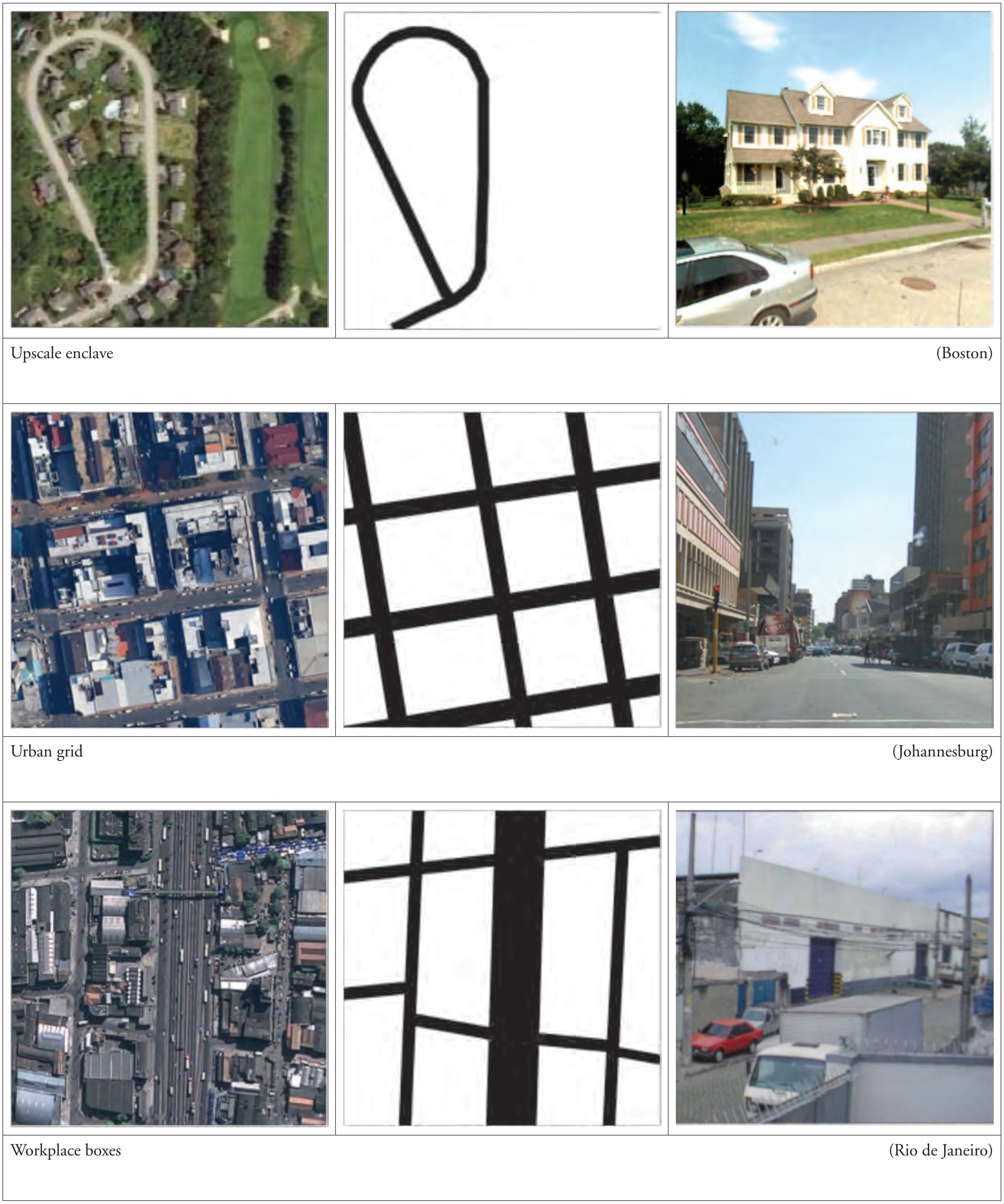


Figure 1. (*Continued*)

Figure 2. Location of mapped urban regions.

across regions. This method of visual identification of built landscape types enables us to show their relative prevalence within a region to an accuracy of a few percent, sufficient to make meaningful comparisons within and between regions. Each landscape type does vary worldwide. Streets and parcels within many types, for example, are smaller in Europe and Asia than in North America and Australia. Variations also exist within a given metro area. But the point of this typology is that even if such variations exist, enough other important features remain the same to constitute distinct types of built landscapes that present similar planning opportunities and challenges worldwide.

Built Landscape Types

I conclude that a modest number of built landscape types reoccur throughout the world (27 in this analysis, many with subtypes). Occurring in different mixtures in different places, these types combine to produce the postmodern collage of metropolitan form. The varying nature of this collage is illustrated in Figures 4 and 5, mapping built landscapes within Beijing and Atlanta. Other regional maps are available on the UC Davis Center for Regional Change website (http://regionalchange.ucdavis.edu/).

Each built landscape type has its own characteristics and history. Some have centuries-old roots and spread around the globe through colonization, economic globalization, or the diffusion of design ideals from more developed countries to less developed ones. The Spanish Laws of the Indies, dating from 1573, helped spread the urban grid form through the Americas; Renaissance design ideals helped spread formal civic spaces to many cities; and in the early 20th century, the British Empire helped popularize notions of garden suburbs, devolved in part from Ebenezer Howard's "garden city" ideal. Today, international consulting firms, schools of design education, and the global adoption of many similar regulatory standards are likely among the main influences promoting the spread of certain forms.

Other built landscape types arose through convergent evolution in which similar conditions or needs led to similar forms. Indigenous cultures in many parts of the globe developed tightly woven organic urban landscapes due to small-scale, incremental building practices and the requirements of human- and animal-powered transportation. Burial grounds (labeled "land of the dead" in this typology) are tightly packed spaces in many cultures that are separated from vehicular traffic and other worldly processes. "Country roads" are linear, incremental

Figure 3. Mapping method. This method identifies built landscape types visually using tools such as Google Earth and then digitizes ArcGIS polygons over a base map (portion of Portland, OR).

accretions of development along formerly rural thoroughfares in many countries. Such forms arise naturally from local needs and processes.

As I suggest earlier in this study, many built landscape types are relatively new, arising in the 20th century as the result of recent technologies, growing affluence, the spread of regulatory systems that separate land uses, and large-scale capitalist economics. Airport landscapes proliferated following the development and commercialization of aircraft. Apartment block landscapes spread in the 20th century following the adoption of the electric elevator and the modernist high-rise "slab" building concept. Suburban landscape types such as "loops & lollipops" and "workplace boxes" depend on motor vehicle access, an increasing scale of development, and the decision of many mid-20th-century corporations to decentralize operations from the central city, thus further catalyzing suburban development. Particular institutions including socialist governments, large-scale homebuilding corporations, and big-box retailers have also played leading roles in pioneering new forms (e.g., Fishman, 1987; Hayden, 2003).

Comparative Analysis

As Table 2 shows, only nine built landscape types can be considered common or very common among the world's metropolitan regions. In descending order of average land area covered in the regions studied here, these are "loops & lollipops," "degenerate grids," "rural sprawl," "workplace boxes," "incremental/mixed," "organic," "rectangular block grids," "heavy industry," and "apartment blocks." These types collectively account for 78% of the land area in the 24 regions studied.

Other built landscape forms are rare or unique to particular cultures. "Trailer parks" are primarily limited to North America (although there are examples in the United Kingdom and near Disneyland Paris). "Allotment gardens"—landscapes quite different from North American community gardens in which each gardener has a plot big enough to hold a small, inhabitable structure in addition to the growing area—occur primarily in northern Europe, and to the most extreme extent as "dachas" around Moscow, where such plots were one of the main perks that state-owned industries gave to workers during the Soviet period. "New urbanism" neighborhoods are the most recent type and still one of the rarest; they are directly or indirectly influenced by the recent urban design movement calling for more walkable, connected, mixed-use cities and towns.

Main findings about the prevalence of built landscape types include the following:

1. **Traditional urban landscapes account for a very small percentage of 21st-century urban regions.** Almost all of these metropolitan regions feature urban grid, quasi-grid, or rectangular block grid street patterns at their centers with large buildings, mixed uses, wide streets, and occasional parks and civic landscapes. A few cities (principally European ones dating from the Middle Ages or before) still have organic patterns at their core. The public within industrialized nations often views these five landscape types as epitomizing urbanity, and frequents these places as tourists. However, in reality they are only a small part of the current metropolitan footprint,

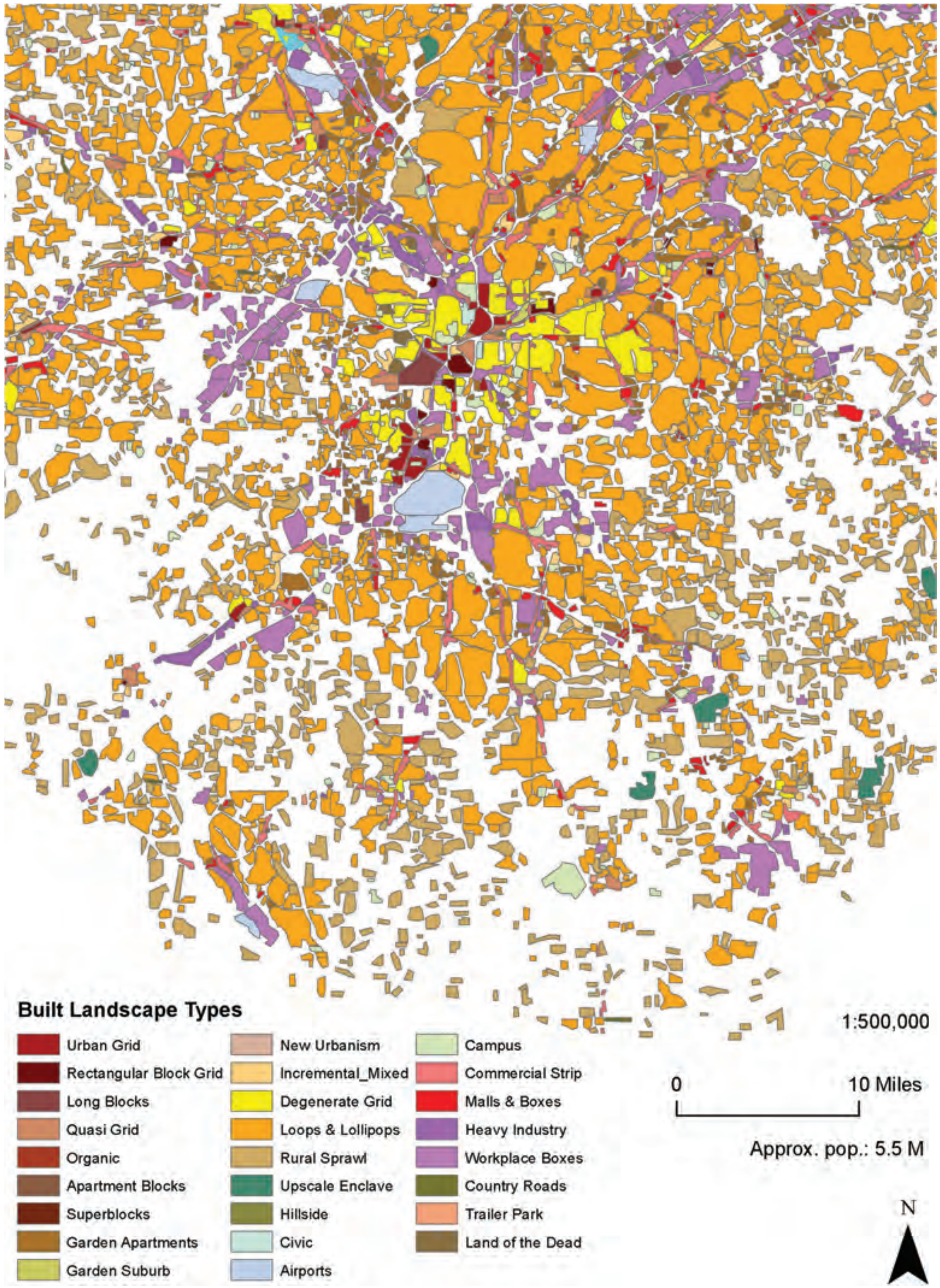


Figure 4. Sample region: Atlanta (GA). Loops & lollipops and rural sprawl landscapes surround a small, more gridded core.

comprising on average 15% of the land area of these regions, and only 1% of a recently built region such as Atlanta. More suburban landscapes constitute 66% of the land area of these regions, while exurban areas make up 13% and other categories such as "airports" and "heavy industry" the remainder. As noted elsewhere (Garreau, 1992; Wheeler, 2008), exurban landscapes are rapidly expanding, and represent a major planning challenge because of their environmental impact and transportation implications.

2. **Suburban-style development is now prevalent worldwide.** Suburban-style residential development—especially "degenerate grids," "loops & lollipops," and "upscale enclaves," all of which are often built as large subdivisions with exclusively residential land use—are found in almost every metropolitan area, although with considerable variation in design detail. In regions such as Beijing, Shanghai, and Cairo, low-density suburban forms appear to be primarily for the wealthy, while in other

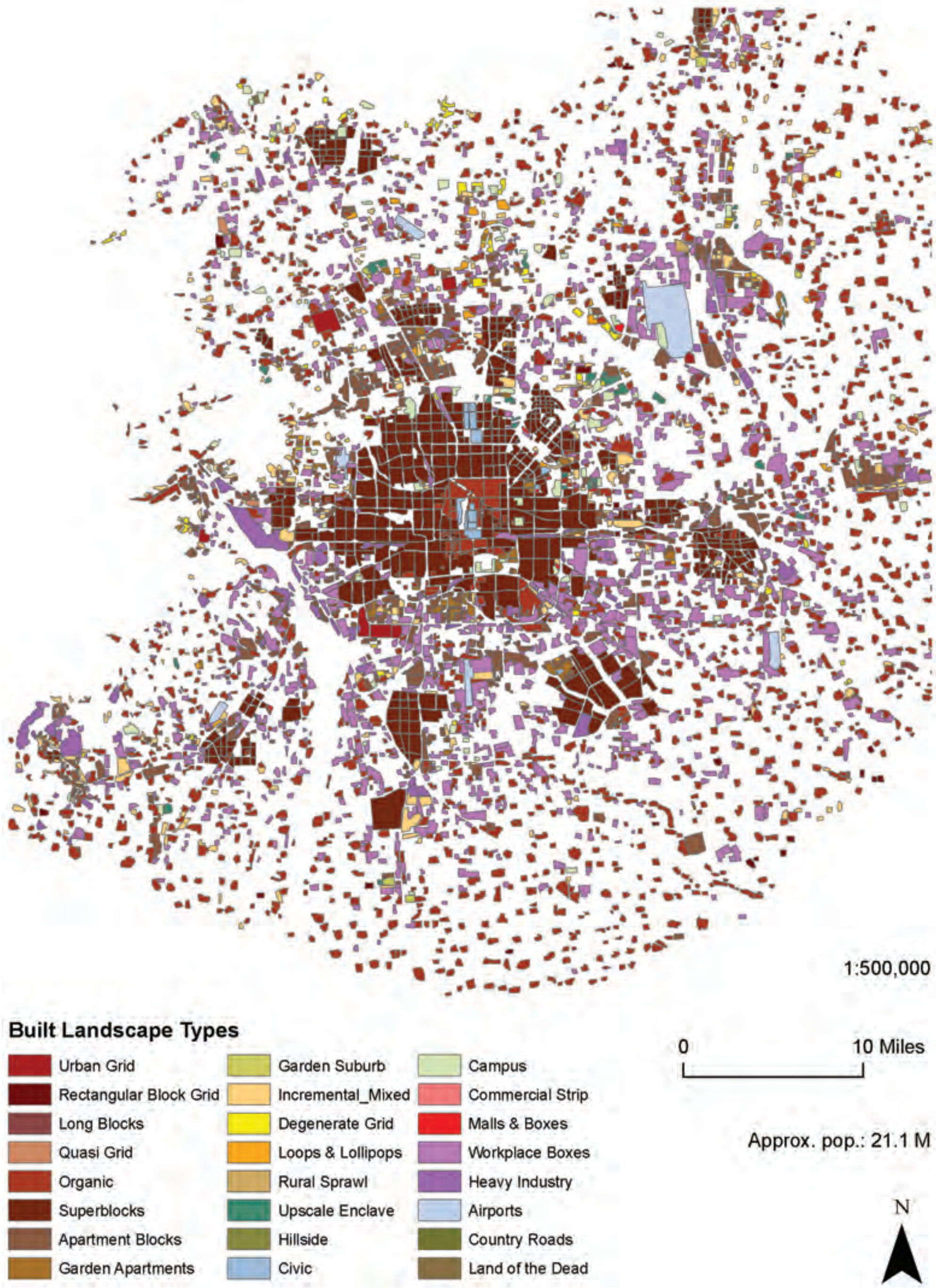


Figure 5. Sample region: Beijing (China). Superblock and apartment block landscapes surround the old organic core (the "hutongs").

places they appear to house a variety of incomes. The spread of these types is worrisome from a sustainability point of view for reasons related to density, connectivity, and diversity. The privatized character of many suburban neighborhoods also discourages the sort of mixed-use neighborhood centers and public spaces that have traditionally served as locations for community gatherings and political protests, and thus may work against social dimensions of sustainability.

3. **"Degenerate grids" is the most widely spread built landscape type.** "Degenerate grids" cover a larger proportion of space in more urban regions than any other form, accounting for more than 50 square km in 21 of 24 regions. These built landscapes come about in two ways. In some places there has been a slow, incremental, and small-scale process of subdivision in which adjacent landowners have failed to connect the streets within their subdivisions, creating quasi-regular, rectilinear street patterns with poor

Table 2. Land area covered by built landscape types within 24 metropolitan regions (square km).

	Amsterdam	Atlanta	Beijing	Bogota	Boston	Cairo	Delhi	Johannesburg	Lagos	Las Vegas	London	Mexico City	Moscow	Paris	Portland	Rio de Janeiro	Rome	Sacramento	Shanghai	Stockholm	Sydney	Tehran	Tokyo	Toronto	AVERAGE	PERCENTAGE
Airports	28	32	31	11	25	38	19	25	16	23	59	13	63	68	18	17	23	47	115	16	15	62	32	26	34	2%
Allotment gardens	4	0	0	0	0	0	0	0	0	0	6	0	30	1	0	0	1	0	0	2	0	0	0	0	2	0%
Apartment blocks	11	0	154	28	8	68	31	0	0	0	7	26	356	85	0	5	33	0	323	49	3	21	93	19	55	3%
Campus	8	64	32	13	31	43	43	13	15	17	64	31	71	45	38	20	18	55	70	13	19	49	42	32	35	2%
Civic	1	3	8	1	2	6	4	2	2	2	4	0	14	13	1	1	5	47	5	3	9	2	16	3	6	0%
Commercial strip	0	160	0	0	48	0	2	3	0	25	1	0	2	3	21	0	2	24	0	0	0	0	27	18	14	1%
Country roads	16	6	0	1	72	6	2	0	3	0	38	7	210	15	0	4	8	1	0	0	20	0	50	5	19	1%
Degenerate grid	6	107	14	97	429	180	441	429	354	66	559	573	1,058	124	182	639	88	108	24	8	529	118	496	271	287	17%
Garden apartments	69	122	0	12	30	10	36	2	1	49	40	7	3	14	26	2	65	43	109	50	3	15	3	5	30	2%
Garden suburb	0	1	1	0	84	75	1	28	0	0	195	0	70	16	4	3	3	14	0	134	6	5	0	8	27	2%
Heavy industry	26	41	51	4	17	86	20	45	14	12	59	85	234	45	74	76	15	32	198	20	29	72	209	36	62	4%
Hillside	0	0	0	0	0	0	0	3	0	0	1	17	0	0	8	31	6	4	0	0	1	0	18	2	4	0%
Incremental/mixed	9	68	71	33	148	37	69	34	180	94	170	156	189	432	27	48	57	37	236	15	10	73	284	29	104	6%
Land of the dead	1	7	0	2	22	11	0	8	0	1	11	0	14	10	4	2	3	2	3	1	5	7	6	6	5	0%
Long blocks	0	8	1	0	0	43	2	6	4	0	8	44	8	8	0	1	1	0	0	0	0	19	45	7	9	1%
Loops & lollipops	4	2,469	8	11	601	204	5	467	87	352	1,354	140	40	162	305	15	22	449	34	68	363	5	18	687	328	20%
Malls & boxes	1	65	2	2	64	4	1	9	0	48	17	11	12	12	23	5	3	38	7	4	10	2	9	33	16	1%
New urbanist	0	1	0	0	0	11	0	0	2	0	11	12	7	4	7	0	1	4	0	5	4	16	0	24	5	0%
Organic	0	0	405	13	0	171	254	21	170	0	17	2	1	49	0	63	10	0	259	0	0	76	809	0	97	6%
Quasi-grid	8	25	2	0	121	4	1	16	13	0	128	205	48	133	1	62	45	6	28	4	6	21	415	3	54	3%
Rectangular block grid	14	10	3	93	120	25	17	141	0	17	21	221	97	48	72	251	10	14	5	3	156	258	201	81	78	5%
Rural sprawl	0	943	1	11	1024	2	35	320	0	13	60	0	16	7	291	37	88	954	3	116	288	0	35	109	181	11%
Superblock	0	0	398	10	0	1	12	0	0	0	2	2	241	22	0	4	3	0	103	5	0	13	33	1	35	2%
Trailer parks	0	4	0	0	6	0	0	0	0	9	1	0	0	1	8	0	0	13	0	0	0	0	0	0	2	0%
Upscale enclave	1	32	12	8	50	81	26	31	7	46	74	4	51	9	16	14	36	135	63	0	20	10	0	22	31	2%
Urban grid	0	13	12	13	1	14	1	10	3	1	3	79	6	3	35	8	13	27	9	8	4	2	86	16	15	1%
Workplace boxes	21	299	351	23	144	54	54	132	22	51	151	51	179	129	36	5	48	102	600	28	104	85	112	308	129	8%
TOTAL	227	4,479	1,557	386	3,047	1,173	1,076	1,745	894	824	3,061	1,683	3,019	1,460	1,194	1,312	606	2,156	2,193	553	1,603	932	3,039	1,751	1,665	100%
Approx. population, millions	2.4	5.5	21.1	9.5	4.5	16.3	25.0	7.2	21.0	2.2	13.9	21.2	16.2	12.0	2.0	12.0	3.9	1.9	24.8	2.2	4.7	13.5	37.8	6.5	12	
Density (pers/sq. km)	10,591	1,228	13,549	24,643	1,477	13,900	23,241	4,126	23,485	2,669	4,541	12,597	5,365	8,222	1,675	9,147	6,440	881	11,309	3,981	2,933	14,490	12,437	3,712	7,188	

connectivity. We can label this an "incremental" subtype. But in other areas, developers have consciously created large areas of consistent, rectilinear forms using patterns such as interrupted parallels and warped parallels (Southworth & Owens, 1993). These forms represent other subtypes. In all of these variants streets remain rectilinear, but the high connectivity and diverse land uses of traditional urban grids have been lost. Traffic is funneled onto a small number of collector and arterial streets that then become congested. Travel distances increase because workplaces are located farther away from homes and residents must take more circuitous routes to reach destinations. Due to the lower street connectivity, bicycle or pedestrian travel becomes more difficult. These effects tend to increase motor vehicle dependency as well as related pollution and greenhouse gas emissions.

4. **The "apartment blocks" type is common in most urban regions except the United States.** Le Corbusier and his colleagues in the mid-20th-century modernist movement appear to have succeeded in spreading the concept of high-rise multifamily housing throughout the world, except for in the United States. Most urban regions include at least a dozen square kilometers of "apartment block" landscapes and the related "superblock" landscape type, which typically also features high-rise multifamily buildings but within a more consciously designed, interior-focused large-block format. These landscapes are particularly common within socialist or formerly socialist countries in cities such as Moscow, Beijing, and Shanghai. "Apartment blocks" offer the high residential densities often considered necessary to preserve undeveloped land outside of cities and to support public transit and local businesses. However, such landscapes also frequently contain monotonous, overscaled buildings; unattractive streetscapes; and a lack of the fine-grained, diverse, mixed-use urban forms that typically made up preindustrial cities. A main urban design question for the future is how to improve upon and/or retrofit this form.
5. **The "rural sprawl" type occupies large land areas in most regions.** Many of the urban regions in this study contain a significant quantity of "rural sprawl" landscapes: single-family housing on lots of 1 to 10 acres. This form has grown rapidly in the United States in recent decades, and works against urban sustainability by consuming large amounts of land, promoting high levels of motor vehicle use, degrading waterways through erosion, and reducing habitat quality. Today this built landscape type is found not just within Anglo-American regions such as Atlanta (GA), Boston (MA), Portland (OR), Sacramento (CA), Sydney (Australia), and Toronto (Canada), but also outside of Rome (Italy), Delhi (India), Rio de Janeiro (Argentina), and even Tokyo (Japan). Often homes in "rural sprawl" areas are large and feature pools, tennis courts, and nearby golf courses, indicating that affluent residents are choosing this form.
6. **"Malls & boxes" and "commercial strip" landscapes are limited outside of North America.** Large-scale commercial landscapes are found almost everywhere, but in small numbers since in most urban regions much retail is still located within urban, mixed-use landscape types such as "urban grids" and "quasi-grids." North America is still an outlier in terms of its great quantity of "malls & boxes" and "commercial strip" landscapes. However, these forms are beginning to appear in significant quantities in other regions such as Mexico City (Mexico), Moscow (Russia), and Paris (France), as observed by the presence of newly constructed buildings, buildings under construction, and newly graded sites. Expansion of these landscape types is likely to increase motor vehicle use and undermine existing retail businesses within more urban landscapes.
7. **Integration of natural and built landscapes is rare.** Most built landscapes are constructed with little attention to preserving "natural" landscape elements. Few intact riparian corridors or patches of habitat are visible within most landscapes I review in this study, except where steep slopes or floodplains have prevented building. There are exceptions, however. Because of its very low-density nature, the "rural sprawl" type often preserves substantial vegetation and habitat. However, it still has many negative ecological effects: Construction of fences and access roads in rural locations is likely to cut wildlife corridors, non-native species are likely to spread from landscaping around homes, and runoff from roads and construction is likely to degrade hydrology. The "upscale enclave" type also often preserves substantial amounts of open space as a visual amenity or for privacy reasons, and patches of habitat appear to exist around many golf courses in those areas.

Growing ecological consciousness worldwide may be leading to preservation and restoration of natural ecosystem features within many types of built landscapes (Beatley, 2011; Steiner, 2011). For example, in progressive planning jurisdictions such as Portland (OR), many creek corridors and greenways have been preserved within recent "loops & lollipops" subdivisions. Restored shorelines and industrial lands are also found now within many cities. Such efforts are hopeful. However, a clearly defined built landscape type that combines urban densities with a highly functional landscape ecology (well-preserved hydrological structure, a large-scale network of habitat, and ecological features such as green roofs and walls even within urban spaces) has not yet emerged to any significant extent.

Toward More Sustainable Built Landscapes

What does the existence and prevalence of these built landscape types mean for future urban planning and design? Many specific implications have already been noted, and as Lynch (1981) argues, much depends on which urban form values are considered important. Because sustainability—meaning an ecologically and socially healthy future—has become an overarching planning goal, form values such as connectivity, compactness, vitality, diversity (of form, use, and social groupings), ecological integration, and climate resilience seem important these days (Beatley, 2011; Congress for the New Urbanism [CNU], 1996).

Each built landscape type has pros and cons in terms of livability and sustainability. Although many such implications will need to be the subject of further research, previous authors have launched strong critiques against suburban and exurban forms in particular for being motor vehicle oriented, wasteful of open space, homogenous, boring, unhealthy, or associated with high levels of pollution and resource consumption (e.g., Calthorpe, 2011; CNU, 1996; Frumkin, 2002; J. Jacobs, 1961; Kunstler, 1993; Mumford, 1938; Whyte, 1968). Other authors mentioned previously have developed statistical correlations with variables such as motor vehicle use and greenhouse gas emissions. In the current era of concern about sustainability, equity, and livability, it seems clear that some types should be promoted through urban and regional planning, others should be restricted, and still others should be carefully regulated or redeveloped over time.

Planners can do four things to help bring about more sustainable built landscapes: First, they can help the public and decision makers understand built landscapes and their implications. Certainly movements such as new urbanism and smart growth already seek to do this to a large extent. But the images presented to the public through place-type menus within planning exercises often focus on building typologies, land uses, and residential densities, and show images at relatively small scales (e.g., a few buildings or a neighborhood center). Presenting images at a landscape scale is also important so that the public understands the nature and implications of different types of street patterns, different mixtures of land use throughout neighborhoods, and ways that green and gray infrastructure can be integrated across districts of a city. New methods of presenting such information simply and clearly need to be developed, but a number of existing examples can be found within Calthorpe (1993), Campoli and MacLean (2007), Hayden and Wark (2004), Scheer (2010), and Southworth and Owens (1993).

Second, planners can specifically include built landscape elements when framing large-scale development alternatives for review. What's important is not necessarily specifying the exact built landscape types identified here, but considering the elements that make up these types and creatively integrating them into new proposals, reinterpreting built landscape types for the future. For example, planners might wish to specify a level of street connectivity (measured in intersections per square mile or per linear mile of arterial street) that approximates the level within gridded forms. Or they might want to stipulate a maximum block size, characteristic building forms (as within new urbanist form-based codes), or particular mixes of green and gray infrastructure (evaluated by means of a percentage calculation or by reviewing a map of connecting green landscape elements, following principles of landscape ecology). Authorities can give built landscape elements greater attention within land subdivision processes as well, and can consider them from the beginning of any development process so that each potential built landscape can be seen as a whole and studied as such.

Third, planners can review local codes and design guidelines to ensure that they enable desired built landscape forms and discourage those that are problematic for sustainability. Existing zoning and subdivision codes as well as street standards often prevent or undermine built landscape features that might be desirable for sustainability or livability purposes (e.g., Southworth & Ben-Joseph, 1997; Talen, 2012). Conversely, code changes can promote desired built landscape features. The Portland (OR) Metro Council, for example, adopted policy in the early 2000s requiring local governments to establish 10 to 16 intersections per linear road mile as a minimum level for new development to reduce congestion, trip length, and vehicle miles of travel (Portland Metro Council, 2004). This policy will help to bring about more highly connected built landscapes within the Portland region.

Some types will need to be actively discouraged worldwide if the evidence suggests that they work against sustainability goals. "Rural sprawl" and "malls & boxes" landscapes appear particularly detrimental in this regard, the former because it consumes very large amounts of undeveloped land and has negative ecosystem impacts, the latter because it encourages high levels of motor vehicle use. Poorly connected, single-use, motor vehicle–dependent "degenerate grids" and "loops & lollipops" landscapes are likewise suspect. Last, even though they have the virtue of density, many "apartment block" and "superblock" landscapes will probably need to be redesigned to reduce the homogeneity of use, monotony of form, and excessive scale that characterized many such developments in the 20th century.

Finally, planners and elected leaders can actively encourage desirable types of built landscapes. Means to do this include providing financial assistance or streamlined permitting processes for developers of more sustainable built landscapes; differential impact fees so that developers of less sustainable types pay extra; equalizing tax rates across metro areas so that exurban residents don't pay less and certain types of commercial landscapes don't bring tax windfalls to local governments; and providing targeted infrastructure and services. Freeways and widened arterial roads have historically facilitated suburban and exurban landscape forms by providing easy and cheap motor vehicle access. In the United States, federally insured home mortgages, subsidized water and sewer systems, and other factors have also historically encouraged such development (Hayden, 2003; Jackson, 1985). Such incentives can be changed in the 21st century to favor built landscape forms more likely to meet sustainability goals.

The public sector in countries around the world, working jointly with progressive developers, institutions of civil society, and local residents, can proactively take the lead in choosing built landscape forms for the future. Comparison of built landscapes between nations with a weak, laissez-faire public sector approach to land development (e.g., the United States and Australia) and those with similar levels of development but strong public sector control (e.g., the nations of northern Europe) shows how strongly public sector planning can influence built landscape types. Many have argued that the results from Europe in particular favor sustainability (e.g., Beatley, 2000). Of course, public sector leadership has often been problematic in the past. Examples such as Moscow's social housing and the Parisian *grandes ensembles* (suburban clusters of high-rise housing) show how overly top-down planning can lead to large amounts of overscaled, sterile built form. Public sector leadership thus must be balanced with the need for public participation (Hester, 2006), nuanced governance frameworks across geographic scales, and local flexibility.

Overall, the challenge is for governments to bring about a more sophisticated era of development oversight to create more sustainable built landscapes. This may mean higher levels of government (nations, states, or regions) establishing broad standards for street connectivity, land use mix, minimum densities, affordability, and green infrastructure networks well in advance of development. Local governments might then implement such standards along with others intended to ensure that development fits with local contexts. Coordination across levels could help remove incentives for unsustainable built landscape types and encourage more sustainable ones. Such a nuanced, multifaceted approach could help bring about more sustainable built landscapes in the future.

Future Research Directions

The typology presented here is a first step toward developing a truly global understanding of built landscapes and their implications. The typology is flexible: It can be refined and additional subtypes can be identified. It may be useful, for example, to distinguish between various subtypes of "malls & boxes" landscapes to develop real or hypothetical green versions featuring extensive tree canopies over parking, green roofs, and onsite drainage. Researchers might then model or measure the environmental performance of these versions compared with the more standard varieties, for example to help with local climate adaptation.

As I suggest in this study, another step would be to further correlate built landscape forms with various sustainability performance dimensions. If greenhouse gas emissions, vehicle miles traveled, human health records, or other data could be obtained at a high level of resolution (the household, the block, or perhaps a neighborhood or census tract level), additional statistical relationships between these variables and built landscape types could potentially be developed. Socioeconomic and geographical characteristics as well as residential self-selection dynamics should be taken into account. Correlations of natural science–based variables such as tree canopy and ground temperature data with built landscape types would be somewhat simpler. Correlation of Landsat temperature data, for example, with built landscape types might help determine their relative contributions to urban heat island effects.

Yet another potential step would be to partially or completely automate the built landscape identification process. As I discuss earlier in this study, many researchers have already sought to map urban growth (though not urban form types) using remote sensing data. Resolution of those data sets historically has been limited, but is improving. Due to those limitations, my preference in this study is to rely on visual examination within Google's aerial imagery platforms. These allow us to zoom in to examine detailed imagery when necessary, and also to segue into Google Street View or user-uploaded photography within Google Earth to gain a more complete sense of the look and feel of particular landscapes. Developing computer software with similar operational flexibility is likely to be difficult. Also, the extent and quality of imagery (including aerial images, Street View, and on-the-ground photography) still varies greatly across metropolitan areas. However, both data sets and software are improving rapidly, and automation of built landscape mapping is likely possible in the future.

Building upon this typology, these additional research directions might help further develop understandings of built landscapes and their sustainability implications in the future.

Acknowledgments

I wish to acknowledge research assistance from Sara Longo, Sijia Jin, Darwin Moosavi, Jayoung Koo, Craig W. Beebe, Brigitte Driller, and Luka Ukraincczyk.

ORCID

Stephen M. Wheeler http://orcid.org/0000-0002-5293-3254

References

Alexander, C., Ishikawa, S., & Silverstein, M. (1977). *A pattern language: Towns, buildings, construction*. New York, NY: Oxford University Press.
Angel, S. (2012). *Planet of cities*. Cambridge, MA: Lincoln Institute of Land Policy.
Bacon, E. (1967). *Design of cities*. London, UK: Thames & Hudson.
Beatley, T. (2000). *Green urbanism: Learning from European cities*. Washington, DC: Island Press.
Beatley, T. (2011). *Biophilic cities: Integrating nature into urban design and planning*. Washington, DC: Island Press.
Calthorpe, P. (1993). *The next American metropolis: Ecology, community, and the American dream*. New York, NY: Princeton Architectural Press.
Calthorpe, P. (2011). *Urbanism in the age of climate change*. Washington, DC: Island Press.
Campoli, J. (2012). *Made for walking: Density and neighborhood form*. Cambridge, MA: Lincoln Institute of Land Policy.
Campoli, J., & MacLean, A. S. (2007). *Visualizing density*. Cambridge, MA: Lincoln Institute for Land Policy.
Cataldi, G., Maffei, G. L., & Vaccaro. P. (2002). Salverio Muratori and the Italian school of typomorphology. *Urban Morphology, 6*(1), 3–14. Retrieved from http://www.urbanform.org/online_unlimited/pdf2002/200261_3-14.pdf
Center for Applied Transect Studies. (2015). Smartcode 9.2. Retrieved from http://www.smartcodecentral.org/
Cerdà, I. (2002). *Cerdà urbs i territory: Planning beyond the urban*. Madrid, Spain: Electa. (Original work published 1860)
Clark, J. K., McChesney, R., Munroe, D., & Irwin, E. (2009). Spatial characteristics of exurban settlement pattern in the United States. *Landscape and Urban Planning, 90*(3–4), 178–188. doi:10.1016/j.landurbplan.2008.11.002
Condon, P. (2010). *Seven rules for sustainable communities: Design strategies for the post-carbon world*. Washington, DC: Island Press.
Congress for the New Urbanism. (2000). *Charter of the new urbanism*. New York, NY: McGraw-Hill. (Original work published 1996)
Conzen, M. R. G., & Conzen, M. P. (2004). *Thinking about urban form*. New York, NY: Peter Lang.
Dear, M. (2000). *The postmodern urban condition*. Oxford, UK: Blackwell.
Downing, A. J. (1842). *Cottage residences, or a series of designs for rural cottages and cottage villas, and their gardens and grounds*. New York, NY: Wiley and Putnam.
Duany, A., Plater-Zyberk, E., and Speck, J. (2000). *Suburban nation: The rise of sprawl and the decline of the American dream*. New York, NY: North Point Press.
Duany, A., & Talen, E. (2002). Transect planning. *Journal of the American Planning Association, 68*(3), 245–266. doi:10.1080/01944360208976271
Ellin, N. (1996). *Postmodern urbanism*. Cambridge, MA: Blackwell.
Ewing, R., Bartholomew, K., Winkelman, S., Walters, J., & Anderson, G. (2008). Urban development and climate change. *Journal of Urbanism, 1*(3), 201–216. doi:10.1080/17549170802529316
Ewing, R., & Cervero, R. (2010). Travel and the built environment: A meta-analysis. *Journal of the American Planning Association*, *76*(3), 265–294. doi:10.1080/01944361003766766
Ewing, R., & Rong, F. (2008). The impact of urban form on residential energy use. *Housing Policy Debate*, *19*(1), 1–30. doi:10.1080/10511482.2008.9521624
Farr, D. (2008). *Sustainable urbanism: Urban design with nature*. Hoboken, NJ: John Wiley & Sons.
Fishman, R. (1987). *Bourgeois utopias: The rise and fall of suburbia*. New York, NY: Basic Books.
Forsyth, A., & Crew, K. (2009). A typology of comprehensive designed communities since the Second World War. *Landscape Journal*, *28*(1), 56–78. doi:10.3368/lj.28.1.56
Fraker, H. (2013). *The hidden potential of sustainable neighborhoods: Lessons from low-carbon communities*. Washington, DC: Island Press.
French, S., Wood, L., Foster, S. A., Giles-Corti, B., Frank, L., & Learnihan, V. (2014). Sense of community and its association with the neighborhood built environment. *Environment and Behavior, 46*(6), 677–697. doi:10.1177/0013916512469098
Frumkin, H. (2002). Urban sprawl and public health. *Public Health Reports*, *117*(3), 201–217. Retrieved from http://www.publichealthreports.org/issueopen.cfm?articleID=1163
Garreau, J. (1992). *Edge city: Life on the new frontier.* New York, NY: Anchor Books.
Gottmann, J. (1961). *Megalopolis: The urbanized northeastern seaboard of the United States.* Cambridge, MA: MIT Press.
Hayden, D. (2003). *Building suburbia: Green fields and urban growth 1820–2000*. New York, NY: Pantheon.
Hayden, D., & Wark, J. (2004). *A field guide to sprawl*. New York, NY: Norton.
Hester, R. (2006). *Design for ecological democracy*. Cambridge, MA: MIT Press.
Howard, E. (2003). *To-morrow: A peaceful path to real reform*. New York, NY: Routledge. (Original work published 1898)
Irwin, E. G., Cho, H. J., & Bockstael, N. E. (2007). Measuring the amount and pattern of land development in nonurban areas. *Review of Agricultural Economics*, *29*(3), 494–501. doi:10.2307/4624855
Jacobs, A. (1993). *Great streets*. Cambridge, MA: MIT Press.

Jacobs, J. (1961). *The death and life of great American cities.* New York, NY: Random House.
Jackson, K. T. (1985). *Crabgrass frontier: The suburbanization of the United States*. New York, NY: Oxford University Press.
Kostof, S. (1991). *The city shaped: Urban patterns and meanings through history*. Boston, MA: Little, Brown.
Kostof, S. (1992). *The city assembled: The elements of urban form through history*. Boston, MA: Little, Brown.
Kunstler, J. H. (1993). *The geography of nowhere: The rise and decline of America's man-made landscape*. New York, NY: Simon & Schuster.
Larice, M., & Macdonald, E. (2013). *The urban design reader* (2nd ed.). New York, NY: Routledge.
Luccarelli, M. (1995). *Lewis Mumford and the ecological region*. New York, NY: Guilford Press.
Lynch, K. (1981). *A theory of good city form*. Cambridge, MA: MIT Press.
Morris, A. E. J. (1994). *History of urban form: Before the industrial revolutions*. New York, NY: Wiley. (Original work published 1972)
Moudon, A. V. (1986). *Built for change: Neighborhood architecture in San Francisco*. Cambridge, MA: MIT Press.
Moudon, A. V. (1992). The evolution of twentieth-century residential forms: An American case study. In J. W. R. Whitehand & P. J. Larkham (Eds.), *Urban landscapes: An international perspective* (pp. 170–206). London, UK: Routledge.
Moudon, A. V. (1994). Getting to know the built landscape: Typomorphology. In K. A. Franck & L. H. Schneekloth (Eds.), *Ordering space: Types in architecture and design* (pp. 289–308). New York, NY: Van Nostrand Reinhold.
Mumford, L. (1938). *The culture of cities*. New York, NY: Harcourt.
Mumford, L. (1961). *The city in history.* New York, NY: Harcourt.
Panerai, P., Castex, J., & Depaule, J.-C. (1997). *Formes urbaines de l'Ilot à la Barre*. Paris, France: Parenthèses.
Portland Metro Council. (2004). *Street connectivity: An evaluation of case studies in the Portland region*. Retrieved from http://library.oregonmetro.gov/files/connectivityreport.pdf
Reps, J. W. (1965). *The making of urban American: A history of city planning in the United States*. Princeton, NJ: Princeton University Press.
Reps, J. W. (1979). *Cities of the American west: A history of frontier urban planning*. Princeton, NJ: Princeton University Press.
Rowe, C., & Koetter, F. (1978). *Collage city*. Cambridge, MA: MIT Press.
Saelens, B. E., Sallis, J. F., & Frank, L. D. (2003). Environmental correlates of walking and cycling: Findings from the transportation, urban design, and planning literatures. *Annals of Behavioral Medicine*, *25*(2), 80–91. doi:10.1207/S15324796ABM2502_03
Scheer, B. C. (2010). *The evolution of urban form: Typology for planners and architects*. Chicago, IL: American Planning Association.
Sitte, C. (1945). *The art of building cities: City building according to its artistic fundamentals*. (C. T. Stewart, Trans.). New York, NY: Reinhold. (Original work published 1889)
Soja, E. (2000). *Postmetropolis: Critical studies of cities and regions*. Oxford, UK: Blackwell.
Song, Y., & Knaap, G-J. (2004). Measuring urban form: Is Portland winning the war on sprawl? *Journal of the American Planning Association, 70*(2), 210–255. doi:10.1080/01944360408976371
Song, Y., Popkin, B., & Gordon-Larsen, P. (2013). A national-level analysis of neighborhood form metrics. *Landscape and Urban Planning*, *116,* 73–85. doi:10.1016/j.landurbplan.2013.04.002
Sorkin, M. (Ed.). (1992). *Variations on a theme park: The new American city and the end of public space*. New York, NY: Farrar, Straus, and Giroux.
Southworth, M. (2003). New urbanism and the American metropolis. *Built Environment, 29*(3), 210–226. Retrieved from http://alexandrine-press.co.uk/built-environment/new-urbanism
Southworth, M., & Ben-Joseph, E. (1997). *Streets and the shaping of towns and cities*. New York, NY: McGraw-Hill.
Southworth, M., & Owens, P. (1993). The evolving metropolis: Studies of community, neighborhood, and street form at the urban edge. *Journal of the American Planning Association, 59*(3), 271–287. doi:10.1080/01944369308975880
Steiner, F. (2011). *Design for a vulnerable planet*. Austin, TX: University of Texas Press.
Stone, B. Jr., & Rogers, M. O. (2001). Urban form and thermal efficiency: How the design of cities can influence the urban heat island effect. *Journal of the American Planning Association*, *67*(2), 186–198. doi:10.1080/01944360108976228
Sutton, P. C., Cova, T. J., & Elvidge, C. D. (2006). Mapping "exurbia" in the conterminous United States using nighttime satellite imagery. *Geocarto International*, *21*(2), 39–45. doi:10.1080/10106040608542382
Talen, E. (2012). *City rules: How regulations affect urban form*. Washington, DC: Island Press.
Vance, J. E., Jr. (1977). *This scene of man: The role and structure of the city in the geography of western civilization*. New York, NY: Harper and Row.
Vance, J. E., Jr. (1990). *The continuing city: Urban morphology in western civilization*. Baltimore, MD: The Johns Hopkins University Press.
Warner, S. B. (1962). *Street car suburbs: The process of growth in Boston, 1870–1900*. Cambridge, MA: Harvard University Press.
Wheeler, S. M. (2008). The evolution of built landscapes in metropolitan regions. *Journal of Planning Education and Research, 27*(4), 400–416. doi:10.1177/0739456X08315889
Wheeler, S. M., & Beebe, C. W. (2012). The rise of the postmodern metropolis: Spatial evolution of the Sacramento metropolitan region. *Journal of Urban Design, 16*(3), 307–332. doi:10.1080/13574809.2011.572253
Whitehand, J. W. R. (Ed.). (1981). *The urban landscape: Historical development and management. Papers by M. R. G. Conzen*. London, UK: Academic Press.
Whyte, W. H. (1968). *The last landscape.* Garden City, NY: Doubleday.
Wilson, E. H., Hurd, J. D., Civco, D. L., Prisioe, M. P., & Arnold, C. (2003). Development of a geospatial model to quantify, describe, and map urban growth. *Remote Sensing of Environment, 86*(3), 275–285. doi:10.1016/S0034-4257(03)00074-9