Urbanism and Anthropogenic Landscapes

Arlen F. Chase[1] and Diane Z. Chase[2]

[1]Department of Anthropology, University of Nevada, Las Vegas, Nevada 89154; email: arlen.chase@unlv.edu

[2]Office of the Executive Vice President and Provost, University of Nevada, Las Vegas, Nevada 89154-1002; email: diane.chase@unlv.edu

Annu. Rev. Anthropol. 2016. 45:361–76

First published online as a Review in Advance on July 29, 2016

The *Annual Review of Anthropology* is online at anthro.annualreviews.org

This article's doi:
10.1146/annurev-anthro-102215-095852

Keywords

city, archaeology, modified environments, urban planning, remote sensing, LiDAR

Abstract

Humans consistently modify their environments—both directly and indirectly. However, the linkage between human activity and anthropogenic landscapes intensifies in urban situations. The artificial landscapes and dense concentrations of human populations encountered in urban environments create a centripetal pull for resources that results in continual and distant landscape changes, thus inextricably linking urbanism and anthropogenic landscapes. Examining past and present patterns of urban settlement and environmental impact provides context for this symbiotic relationship. Archaeological data, methodology, and technology offer insight into the similarities and variations in urban anthropogenic landscapes across time and space, suggesting that ancient practices can be compared with contemporary ones and that ancient models may have applicability for future-focused urban planning.

INTRODUCTION

Writings on urbanism and anthropogenic landscapes usually treat these two topics separately rather than together. Yet, urbanism and anthropogenic landscapes are inextricably linked. Urban settings are, by definition, anthropogenic or "human made." In addition, the services and resources that are consumed by urban occupants result in anthropogenic landscapes within and at some distance from cities. Both urbanism and anthropogenic landscapes are long-studied in the archaeological record. Urbanism can be traced some 6,000 years into the past. Anthropogenic landscapes are substantially older, having been created early in human existence but becoming pronounced with the onset of the Neolithic Revolution some 10,000 years ago (Ruddiman 2013).

Humans have a long history of modifying their environment and creating numerous human-altered landscapes. Although urban settlements themselves are a form of anthropogenic landscape, so too are the landscape modifications that are necessary for subsistence needs (Hakansson & Widgren 2014, Thurston & Fisher 2007). Humans transform the environment in both intended and unintended ways, as documented from at least as early as the first use of tools. For example, lithic production carried out over the past 500,000 years in the Central Sahara of Libya created a dense debris scatter that resulted in a massive anthropogenic landscape covering some 15,000 square kilometers (Foley & Lahr 2015, p. 4). Thus, although anthropogenic landscapes were established early in human history, the scale of anthropogenic transformation of landscapes increased in conjunction with growth in size, population density, and longevity of full-time settlement. Few landscapes are as anthropogenically transformed as urban environments.

Within this review, we focus first on defining anthropogenic landscapes and then on exploring the concept of urbanism and the variation in its past forms. Next, we consider the relationships that existed between urbanism and archaeological landscapes. Finally, we situate our discussion within the present by looking at what we can learn from past urbanism and landscape use. We argue that urban theory that has been developed for contemporary landscapes (Sorensen & Okata 2010) can also prove useful in conceptualizing and contextualizing ancient ones and, correspondingly, that ancient urbanism and anthropogenic landscapes can be of interest in contemporary contexts.

Particularly important in this consideration are the impacts that evolving forms of remote sensing (Comer & Harrower 2013, Opitz & Cowley 2013) have had in permitting the recognition and definition of ancient anthropogenic landscapes across the globe, including within Amazonia (Carson et al. 2014, Heckenberger et al. 2008), Mesoamerica (A.F. Chase et al. 2011, 2014b), and Southeast Asia (Evans et al. 2013, Fletcher 2012). The ancient landscape modification documented by remote sensing further emphasizes not only the massive scale of human landscape alteration worldwide, but also that the traditional compact city is but one outcome of the urban process.

ANTHROPOGENIC LANDSCAPES

Excluding ice-covered areas, at least 75% of the world's landscapes exhibit anthropogenic impacts, and 50% of the world's landscapes have been transformed by humans sometime between 0 and 1000 BCE (Ellis 2011, p. 1025). People and their cities were major contributors to these transitions.

In contrast with the wide-ranging and sometimes controversial definitions that exist for cities and urbanism (for summaries, see Storey 2006a, Marcus & Sabloff 2008b), landscapes are more likely to be descriptively categorized; thus, there are urban landscapes, rural landscapes, social landscapes, economic landscapes, and ritual landscapes (David & Thomas 2008, M.L. Smith 2014), as well as resilient and vulnerable landscapes (Chase & Scarborough 2014). Here, we consider landscapes to be either natural or anthropogenic; however, historical ecology demonstrates that, even in this simple dichotomy, there are gray areas (Balee 2006, Szabo et al. 2010).

Most considerations of anthropogenic landscapes focus on two factors: human settlements and subsistence activities. Thus typologies of contemporary anthropogenic landscapes additionally distinguish between urban residential landscapes; urban, nonresidential landscapes; suburban landscapes; developed villages; agricultural villages; pastoral villages; extensive industrial agriculture; plantation agriculture; shifting cultivation; extensive pastoral landscapes; and intensive nonresidential disturbance of landscapes (Ellis et al. 2006). Yet, given what we know about the past through archaeological research, most classifications are too rigid to accommodate all anthropogenic transformations. Even the simple burning of foliage that covers a landscape can cause multiple dimensions of environmental change to occur (Bowman et al. 2011). Human procurement of needed resources can also drastically alter a landscape (Hooke et al. 2012, Tilman & Lehman 2001), as happened in central Europe when mining activities resulted in a landscape of lakes where few had existed before (Jaruchiewicz 2014). In the contemporary world, China builds islands in the South China Sea for military and territorial reasons, while Dubai in the United Arab Emirates creates islands in the shape of palm trees for elaborate residential occupation. The scale of landscape change in long-occupied areas is often not fully recognized and is difficult to measure (Csorba & Szabo 2009), but it is evident that a significant volume of artificial ground has also been created in most parts of the world through both intentional and unintentional processes—in both the past and the present.

Not only are soils and stone excavated, moved, and redeposited for a variety of construction-related purposes, but industry and mining also result in by-products (such as slag) that create other landscapes or are incorporated into landscape fills. Extensive deposits of sediments may be either purposeful or incidental and result from any manner of human-caused disturbance to the landscape, including "vegetation clearance, logging, agriculture, mining, grazing, or urbanization"; the sediments produced as a result of these activities are now being referred to as "legacy sediments" (James 2013, p. 16). Many of these sediments and dense fills underlay our modern cities. Price and his colleagues (2011, p. 1064) note that 10 meters of artificial ground may be found in Manchester and Salford in northwest England and that, even in areas that were not industrial, significant artificial land occurs, noting that 8 meters of occupation fill underlays the heritage city of York in northeast England. Soils are also excavated, enriched, and then redeposited on a large scale (e.g., Certini & Scalenghe 2011, Richter 2007).

A symbiotic relationship exists between cities and anthropogenic landscapes. Cities house concentrations of people who consume food, potable water, and various resources or commodities. Archaeological studies show that as population density increases, so too does the overall productivity of the economy. As such, urbanization is correlated with heightened economic development (Glaeser 2011, p. 592), while concomitantly being responsible for "the degradation of local and regional environments, threatening basic ecosystem services and global biodiversity" (Redman & Jones 2005, p. 505). At the same time, urban populations produced various forms of waste that were recycled as construction materials, integrated into fields as fertilizers, or placed outside urban limits within the landscape (Church 2012, Enger 2004, Zimring & Rathje 2012). Thus, interdependent systems developed to facilitate the acquisition and movement of these items and to provide the necessary services to the populace (e.g., Stanley et al. 2015).

Both urbanism and anthropogenic landscapes may be considered within the constructs of historical ecology (Balee 2006). Changes to the environment that correlate with anthropogenic landscapes have long-term impacts that may or may not be recognized or expected; deforestation changes temperature (e.g., Bala et al. 2007); cultivation impacts species constitution (e.g., Hightower et al. 2014); terracing modifies water flow and retention (e.g., Chase & Weishampel 2016). Thus, urbanism and anthropogenic landscapes are closely interconnected in a symbiotic relationship. It is also useful to consider, apart from the anthropogenic landscape of the city itself, the spatial relationships between settlements and subsistence activities as well as how subsistence needs impact local ecology (Hakansson & Widgren 2014, Szabo et al. 2010). In some cases, the subsistence and urban landscapes are separated and, in other cases, they are conjoined. Perceptions of the extent to which cities and subsistence systems are or are not colocated also impact our views of the urban process and of the scale and density of urban environments.

GENERAL CONSIDERATIONS OF URBANISM

Although urbanism has been explored in a multitude of disciplines and from a wide variety of perspectives, formal definitions of urbanism are far from uniform (Marcus & Sabloff 2008a, M.L. Smith 2003, Storey 2006b, Trigger 2003), and the degree to which modern and ancient forms can or should be compared is controversial. Sjoberg (1960) identified the existence of preindustrial urbanism as somewhat distinct from later forms, but he did not fully explore variations in ancient urban adaptations that we can now identify in the archaeological record. Some researchers suggest that there are substantial parallels to be drawn between ancient and modern urban developments and note that archaeological cases may help explain contemporary situations (M.L. Smith 2003, p. 4). One area where ancient examples may provide additional contextual value is in the degree to which surrounding landscapes are integrated into the urban areas themselves. Archaeological examples, like contemporary ones, indicate that the distinctions between urban and suburban, core and periphery, or city and hinterland spaces are often not clear-cut and that these landscapes may be intertwined (Storey 2006a, p. 21). Likewise, past walking cities with integrated green spaces (Speck 2012) could provide alternative models for contemporary urban planning and development.

Identifying and characterizing cities and urbanism have long been topics of interest, considered by Greek scholars such as Aristotle and Renaissance architects such as Alberti (Kostof 1991, pp. 69–70), as well as urban planners, historians, sociologists, anthropologists, and archaeologists (e.g., Childe 1950, Jacobs 1969, Mumford 1961, Redfield 1941). Even though current research has moved beyond trait lists and simple dichotomies or evolutionary forms, there remains no absolute and universal definition of urbanism or cities. Cities have been characterized both specifically and more abstractly, as in Park's (1925, p. 1) description of cities as, among other things, "a state of mind." Although absolute metrics for urbanism are controversial, some general characteristics are widely recognized: large, dense, and heterogeneous populations. Fletcher (1995) suggests that there were three major developmental transitions in the evolution of urbanism: sedentary villages covering 1–2 hectares of land, agrarian villages at greater than 100 hectares of land, and industrial cities integrating greater than 100 square kilometers of land. Other researchers use population size to establish that urbanism exists. Storey (2006b, p. 22), for example, reviews research and suggests that populations of 5,000–10,000 or more are urban (see also Marcus & Sabloff 2008b for additional summary information). However, there is no universal agreement on the population numbers or densities that define either cities or urbanism.

In much of the world, urbanism and landscape modification were propelled and sustained by road systems that fostered both transportation and communication. There is a well-known relationship between roads and positive urban growth and development (Batten 1998, Hanson & Guiliano 2004). Roads facilitate transportation within and to urban areas. In addition to permitting people to travel more easily both to and within a city, roads also facilitate the transport of internal and external provisions and resources in and about urban areas. Roads also serve to enhance communication by easing travel time. Roads not only alter an environment through their simple construction, but also may serve as catalysts for the construction of buildings and houses along these communication routes as well as the exploitation of the immediate landscape for agriculture and resource acquisition (e.g., Verbeek et al. 2014). Thus, the areas adjacent to roads are more likely to see manipulated landscapes and resource exploitation.

Mode of transportation is also important in considering both the form and the scale of urban space. Researchers have suggested that cities, whether ancient or modern, where walking is the primary mode of transportation are more heterogeneous than nonwalking cities (Storey 2006a, pp. 9–10; see also Rothschild 2006). Describing historic cities such as New York or Rome that began as walking cities, for example, Storey noted that families with different occupations and varying wealth initially lived together in the same walking neighborhoods but that changes in transportation during the nineteenth century led to a greater separation of home and work for upper- and middle-class families and was a prime factor in reducing the heterogeneity in urban neighborhoods. Different kinds of transportation also condition urban scale and growth. For example, Garreau's (1991) modern-edge cities—in which nodes of administrative, office, and commercial space are distributed over the landscape—were defined for situations with automobile transportation and are usually established at a set distance from an initial city center (e.g., two rings for Boston, one at ~10 miles and one at ~20 miles from the city center). Such edge cities can be seen in antiquity, but at a different scale that is consistent for walking. For instance, public nodes are embedded in the landscape at an average of 3–5 kilometers from the city center and connected to a dendritic road system at the ancient city of Caracol, Belize (Chase & Chase 2014a).

A variety of typologies are used to characterize urban anthropogenic landscapes. Monica Smith identifies (2003, pp. 12–13) three types of cities: ports, cities before states, and cities between large-scale territorial expansion. Fox (1977) provides a typology of cities, defining them in relation to polity: regal-ritual, administrative, mercantile, colonial, and industrial. Cities can also take many different spatial forms: orthogonal and gridded, star-shaped, and/or concentric (Doxiadis 1968, M.E. Smith 2007). Planned symbolism for urban spaces has also been argued (e.g., Rykwert 1976). However, few cities were static. As Kostof (1991, p. 13) notes, cities change over time through what is called "urban process." Most urban places combine both "premeditated and spontaneous segments, variously interlocked or juxtaposed" (Kostof 1991, p. 47). Thus, conceptualizing cities as completely planned versus unplanned creates a false dichotomy, and assuming functional correlates of form may be ill-advised (M.E. Smith 2007). M.E. Smith (2007, p. 21) notes that while orthogonal layouts may provide an indication of central planning, nonorthogonal cities may also have had strong centralized political control—or, following Burchell et al. (1991), "governmentality." Interest in urban form and urban planning is also well established (Doxiadis 1968, M.E. Smith 2007). Some modern cities, such as Paris, France (Saalman 1971), and Washington, D.C. (Reps 1965), were highly planned landscapes. Other cities were not highly preplanned and, at least in the Mesoamerican case, have been described as "incidental urbanism" (Hirth 2008), although even in this case there is intentionality of development over time. As conceived in Western Europe, urbanism was associated with compact and densely settled cities. However, many of today's cities have engulfed the broader landscape, constituting huge settlements sometimes referred to as mega-cities (Sorensen & Okata 2010). We are now realizing that ancient cities could similarly cover large landscapes, including those located in tropical regions (A.F. Chase et al. 2011; Evans et al. 2007, 2013). Certain of these ancient cities also incorporated agricultural practices into the urban environment. Thus, the distinctions between urban and rural have become blurred, and new terminology has been developed in an attempt to describe such settlements (e.g., low-density urbanism; Fletcher 1995).

Urban landscapes profoundly impact human lifeways. However, as Gulick (1989, pp. xv–vi) points out, urban life is more varied than the dichotomous and largely negative views of the early twentieth century. Just as there is no single city type, there is no one single urban experience (Gulick 1989, pp. xv–vi). We know that ancient urban populations, like contemporary ones, moved about extensively (e.g., Price et al. 2002, 2008). From archaeology, we also can begin to assess perceptions of health within the city. Mortality rates, for example, were likely artificially high because of migrants to cities rather than because of the quality of life (Storey 2006a, p. 6). Nevertheless, lifeways were shaped by urban spaces.

Kostof (1991, p. 37) suggested that not only density but also "energized crowding" is characteristic of cities. Taking this notion of crowding one step further, research on anthropogenic landscapes can focus on the nonresidential urban locations—plazas, markets, parks—where crowding takes place (e.g., King 2015). While most researchers recognize the utility of using archaeology to contextualize urbanism, less scholarly effort has been made to archaeologically study contemporary urban landscapes (although see Carballo & Fortenberry 2015). Although it is a relatively new area of focus, the use of archaeological techniques to study the contemporary world is an area of future promise (Graves-Brown et al. 2013, Harrison & Schofield 2009). Archaeological methods clearly have much to offer in the analysis and description of contemporary near-past situations, whether dealing with studies of waste (Reno 2013), ephemeral activities (White 2013), or the significance of heritage, myth, and livability in urban environments (Wilkie 2013). Yet another area that was little explored in research is the role of human sensory engagement with the environment and the means by which the study of all five senses, and not just vision, can help shape our understanding of lived experience (e.g., Hamilakis 2013, Skeates 2008). Sometimes now called "sensual cultural studies," these efforts incorporate multiple approaches (e.g., formal, contextual, and cross-cultural), and attempts are currently under way to establish "a more clearly defined and rigorous social-science-based methodology" (Skeates 2008, p. 208). This latter kind of a sensory, phenomenological approach to the past has the potential to impact the planning of contemporary urban spaces, making them more user-friendly.

ARCHAEOLOGICAL LANDSCAPES AND URBANISM

Archaeological research on the relationship between humans and their environments was framed initially through the lens of settlement archaeology, which attempted to define and understand the patterned behaviors in past human use of a given landscape (Chang 1968, Willey 1953). Although this approach did not formally incorporate nature in an explicitly interactive or causal way, researchers assumed that the relationship existed, and the focus on settlement patterns has been referred to as perhaps the most important advance made in archaeology in the twentieth century (Sabloff & Ashmore 2001, p. 14). The subsequent formal recognition of the significance of the interplay between humans and their environments led to a reconceptualization of settlement archaeology as landscape archaeology (e.g., Ashmore 2004, Ashmore & Knapp 1999, David & Thomas 2008).

Research was slow to recognize the scale of human impact on landscapes. This underestimation may have been due in part to prevailing thought that did not fully recognize the creativity and ingenuity of past peoples within a framework of unilinear development, combined with an ingrained sense that less complex civilizations did not substantially modify their environments but rather lived in harmony with nature (Denevan 1992). There was also a sense that only limited changes to the landscape were made in support of agriculture (see discussions in Heckenberger et al. 2003 and Bush & Silman 2007). Thus, making an agricultural terrace was thought to involve only placing stones along a slope to catch soil that was eroding away (e.g., Pérez Rodríguez 2006, p. 17). However, archaeological data now document situations where entire landscapes could be stripped to bedrock in order to build these constructed features, as was the case in the Maya and Inca areas (Chase & Chase 1998, Treacy & Denevan 1994); large bodies of soil could be moved significant distances for both agricultural purposes and construction (Price et al. 2011);

and substantial bodies of soil were systematically enhanced for agricultural production (Factura et al. 2010, Glaser 2007).

Although large-scale agriculture is evident in many temperate parts of the world, such as the central plains of the United States (Tegtmeier & Duffy 2004), the scale of past landscape modification for agricultural production in the tropics has only recently been recognized (A.F. Chase et al. 2011, Chase & Chase 1998, Evans et al. 2007). For the most part, this recognition has derived from the use of remote-sensing technologies such as satellite photographic imagery, AIRSAR radar, and airborne LiDAR (Comer & Harrower 2013, Optiz & Cowley 2013, Opitz & Limp 2015). In South America, we can now recognize that much of the Amazonian basin was covered with both settlement and extensive agriculture before the advent of any Europeans (e.g., Heckenberger et al. 2007). These developments have substantial time depth and variability. Because of the extent of modern land-clearing undertaken by modern populations, the ancient landscape modifications are visible in Google Earth, allowing researchers to use this accessible satellite record to plot the ancient features that include terracing, raised fields, sunken gardens, irrigated pastures, canals, and reservoirs, as well as causeways, roads, and walls (Erickson 2008, Walker 2012). On-the-ground research has also demonstrated the correlation of the Amazonian anthropogenic landscape with improved soils (Woods 2008).

The archaeological record permits us to situate the development of cities in past settlement patterns (Cowgill 2004, M.E. Smith 2012, M.L. Smith 2014), and, with the use of remote-sensing data, we can now demonstrate that ancient cities could take different forms, to some degree being dependent on the kinds of environments and landscapes in which they developed (Chase et al. 2014a, Chase & Scarborough 2014, Wilkinson 2014, Wilkinson et al. 2010). The application of remote-sensing technologies to tropical areas has particularly highlighted the extensive nature of a form of urbanism that was originally labeled "low-density agricultural urbanism" (Fletcher 1995, 2009). Ancient low-density agricultural urbanism in some ways looks like modern-day urban sprawl with, in some cases, the same population densities as are found in modern suburban communities (D.Z. Chase et al. 2011, p. 66) but with greater focus on agricultural use of green spaces. Variations in these kinds of low-density cities are found in Southeast Asia, in Mesoamerica, in Sri Lanka, and in Africa. The Sri Lankan (Coningham et al. 2007) and African (Kusimba et al. 2006) cases are not yet as well defined as those from Angkor, Cambodia, and Caracol, Belize.

Fletcher (1995) conducted a comparative analysis of past expressions of urbanism, focusing on city size and population numbers; he was concerned with understanding both how cities came into existence and how they were integrated within the broader landscape. He argued that settlement can best be studied by considering two factors: interaction and communication. These two factors both shape and limit the size of urban settlements. All landscapes that he considers to be or have been urban had settlement densities on the order of 1,000 people per square mile (Fletcher 1995, pp. 166–73). New calculations for both the Maya and Angkor are well above these limits, with characteristic densities between 500 and 750 people per square kilometer. Angkor is now projected to have occupied an area of 1,000 square kilometers with a population of 750,000 people in CE 1100 (Lucero et al. 2015), which translates to more than 1,900 people per square mile; Caracol is projected to have occupied an area of 200 square kilometers with a population of 100,000 people in CE 650 (A.F. Chase et al. 2011) or more than 1,200 people per square mile.

In Mesoamerica, our understanding of the ancient Maya landscape has been significantly altered through the use of LiDAR, a technology that uses laser pulses to pass through gaps in enveloping foliage resulting in a record of on-the-ground features. This technology has permitted archaeologists not only to identify the sizes and distributions of settlements over a broad area (Chase et al. 2014a), but also to understand the extent of ancient Maya landscape modification as well as the urban planning and layout of these cities (A.F. Chase et al. 2011). The ancient

Maya city of Caracol, occupied from 600 BCE to CE 900, was a walking city and was characterized by heterogeneous neighborhoods, a radiating road system, disbursed market locations, extensive agricultural terracing, and over a thousand household reservoirs (Chase 2016), as well as by a city identity that extended into the surrounding area (identified archaeologically). It has parallels in both Burgess's (1925) concentric city model (with workers near the downtown) and Garreau's (1991) edge city (in terms of market placement)—albeit with walking as the mode of transportation rather than cars. It can be considered an ancient megalopolis, created through synoecism (Kostof 1991, pp. 59–62) and populated through in-migration from surrounding communities. Covering some 200 square kilometers with a population of more than 100,000 people at CE 650 (A.F. Chase et al. 2011, 2014a), Caracol is but one example of the forms of urbanism that existed in the ancient tropics.

The scale of ancient agricultural terracing at Caracol is not only impressive but also informative in the degree to which it is colocated within the urban Maya settlement and the degree to which the landscape is anthropogenic. Some 160 square kilometers of contiguous agricultural terracing is integrated with settlement, public architecture, and roads at Caracol (A.F. Chase et al. 2011, 2014a, Chase & Chase 2016). The archaeological data indicate that the development of the urban area was interlinked with the construction of agricultural terracing and that this relationship created a path-dependent situation for the inhabitants of Caracol (Chase & Chase 2014b). Thus, when conjoined with archaeological data, LiDAR has also helped archaeologists to understand how ancient Maya cities developed in tandem with agricultural practices (Chase & Chase 1998, 2014b; Fisher 2014; Hutson 2016; Isendahl & Smith 2013) and has further permitted the identification of two distinct urban forms for the ancient Maya that had different population densities and sizes, depending on whether extensive agriculture was practiced within the city (Chase & Chase 2016).

Remote-sensing technologies in the form of AirSAR and LiDAR have also played a role in helping researchers assess the nature of landscape modification in conjunction with low-density urbanism at the Cambodian site of Angkor (Evans 2016; Evans et al. 2007, 2013). Hundreds of temples, small reservoirs, and ancient rice fields can be documented as covering hundreds of square kilometers (Evans et al. 2007, Pottier 2000). Even at ground level, the massive moated temple complexes and huge reservoirs (or "barays") that exist at Angkor provide some idea about how anthropogenic the landscape there is. The built temple complex of Angkor Wat covers more than 1 square kilometer and that of Angkor Thom over 3 square kilometers. Archaeology further demonstrates that massive amounts of earth were moved in order to construct flat level surfaces that could be properly bedded for building these complexes (Fletcher et al. 2015, p. 1394). The collected LiDAR data also demonstrate the vast scale of the hydrological modifications made to the 1,000 square kilometers of landscape to both store and channel water (Hanus & Evans 2015, Lucero et al. 2015, Penny et al. 2014). Huge constructed reservoirs served to both store and channel water from the higher interior through the Angkor landscape to the Tonlé Sap Lake; the largest constructed reservoir measures 8 kilometers × 2.5 kilometers. On the basis of recovered archaeological data and on LiDAR visualizations of ancient breaches in flow channels, research has suggested that it was the failure of this hydrological system in the face of climate change that led to Angkor's abandonment (Buckley et al. 2010).

Archaeological data are also now leading to a reassessment of the developmental relationships that existed in the past among urbanism, agriculture, and sociopolitical organization. Ur (2014, pp. 17–18) has argued that urbanism needs to be disentangled from conceptions of the state and bureaucratic administration; he sees urbanism as growing out of a household-based model that focused on political and demographic centers. Mesopotamian cities seem to have been more dispersed over the landscape in their initial form, and the population became denser and more centrally concentrated over time (Ur et al. 2007, p. 1188). Thus, some of the earliest cities in

Mesopotamia were not densely occupied at all but covered more than 1 square kilometer (Ur 2014, p. 1); they integrated households with agriculture and domestic animals. As expected, the more expansive settlements were in the most fertile areas, whereas settlements in more challenging environments were smaller. Eventually, after the number of households increased and coagulated into a series of spatially proximate villages, these came together to form urban concentrations or "towns."

Fletcher's (1995) study suggested that compact settlements had longer archaeological histories and higher population densities, whereas less compact settlements had shorter trajectories and were spread over the landscape with lower population densities. This correlation deserves further testing. In much of the ancient Near East, these towns then developed into compact urban settlements with long occupation histories. Thus, populations lived in concentrated mounded cities and commuted outward to their fields during the day, returning to the more secure urban environment at night. This pattern can be seen in the roads that lead outward from these cities in dendritic fashion into the fields that surrounded the settlements (Wilkinson et al. 2010). Waste from the urban environment was used as fertilizer in fields, resulting in sherd scatters that radiate up to 6 kilometers distant from a 41-hectare city (Wilkinson 1989, p. 44). That these cities were linked into trade networks to procure additional resources from a distance can also be seen in the connectivity of their road systems (Menze & Ur 2012).

The dispersed urban form has also recently been found to underlay Iron Age cities in Central Europe. Work at the German site of Heuneburg has shown that the core of the urban settlement was surrounded by "closely spaced farmsteads" and covered some 100 hectares (Fernández-Götz & Krausse 2013, p. 474). Pompeii, Italy, is another example of a less densely occupied, ancient agricultural city in the Old World (Storey 2006a, pp. 12, 22). Thus, we suspect that smaller low-density settlements underlay the eventual development of many compact cities in both Europe and the Near East. Within the subtropical southern Maya lowlands, however, low-density agricultural urbanism remained a successful adaptation for at least 1,000 years.

MODERN URBANISM AND THE PAST

Significant debate exists in archaeology about how to interpret the past and whether models based on a modern capitalist economy can be applied to ancient societies (Feinman 2013, Garraty & Stark 2010). This same concern can be voiced in relation to whether archaeology has application for modern considerations of urbanism (Nichols 2006, p. 340) or whether modern urban theory can be applied to ancient cities (Scott & Storper 2014, M.E. Smith 2011): For example, were there ancient edge cities (Garreau 1991) and ancient megalopoli (Gottman 1961)? The answers to both questions seem to be in the affirmative (Chase et al. 2001, 2011; Evans et al. 2007). Likewise, archaeological research has suggested that a concentric city organization that mimics early-twentieth-century Chicago, with poorer workers living adjacent to the city center (Burgess 1925), more closely approximates the spatial layout of the ancient Maya city of Caracol than a more simplistic model wherein elite residences were expected to encircle downtown areas while the poor lived further afield (Chase et al. 2001, Chase & Chase 2007). Relatively recent research on archaeological urbanism has found meaningful linkages between modern and past phenomena in terms of urban planning and function (M.E. Smith 2010a). In fact, archaeological research is now focused on the role of ancient neighborhoods in past cities (M.E. Smith 2010b), on past urban sprawl (M.E. Smith 2010a; see also Breugmann 2005), and on the function and use of open spaces within urban areas (King 2015, Stanley et al. 2012). There has also been a renewed interest in incorporating agriculture into modern cities to create a collective identity in contemporary urban landscapes (Lyson 2014).

An interesting modern phenomenon has also resulted from forest reclamation of anthropogenic landscapes. Although most tropical areas include anthropogenic landscapes that are today covered by rainforest, there is also a relationship between temperate anthropogenic landscapes and the contemporary development of urban sprawl in megacities. There has been a substantial move in the past 300 years from a cleared landscape covered with self-sustaining farmers to a forested landscape in which the bulk of the population no longer farms and has moved into urban environments (Johnson & Ouimet 2014, Meyfroidt & Lambin 2011). Thus, in some cases increased urbanism and urban sprawl result in the widespread reforestation of formerly cleared and modified landscapes.

Bettencourt (2013) recently attempted to interpret ancient urban settlements by comparing them with contemporary landscapes through a scaling exercise that considers city size and urban efficiency, defined as "capturing the balance between socioeconomic outputs and infrastructural costs" (p. 1438). This research successfully modeled aspects of modern city infrastructure (using a proxy of miles of roads in metropolitan areas) and socioeconomic output (gross metropolitan product). An initial attempt to apply the modern scaling principles to the past was conducted for the ancient sites located in the Valley of Mexico; some 1,500 settlements spanning 2,000 years were viewed in terms of settlement area and population size and were argued to be consistent with the more modern data (Ortman et al. 2014). Yet, there may have been far more variation in urban form in antiquity. Although the sample size is not as large as that used for the modern and Valley of Mexico studies, it is possible to identify two separate urban patterns for the Maya Classic Period in which the population size, density, and areas settled do not scale on a single vector but rather on two distinct lines (Chase & Chase 2016); this result suggests that the attempt to fit all urban settlements into a similar scaling framework (Bettencourt 2013, Ortman et al. 2014) may be aspirational but not entirely realistic. Arcaute and her colleagues (2015) recently reached a similar conclusion; they tested the proposed scaling principles on differently sized cities in England and Wales and found that, although "most urban indicators scale linearly with city size, regardless of the definition of the urban boundaries," "population size alone does not provide us enough information to describe or predict the state of a city as previously proposed, indicating that the expected scaling laws are not corroborated" (p. 1).

CONCLUSION

Anthropogenic landscapes, though characteristic of urban environments, are not limited to cities or urban locations. Anthropogenic changes to landscape have long been prevalent in human history, beginning with hunter gatherers and early cultivation but becoming more intense with the creation of cities. The greatest extent of landscape modification and long-term ecological impacts is associated with densely occupied urban areas. However, even presumed "pristine" landscapes were changed by humans, as was the case in ancient Amazonia (Heckenberger et al. 2003, 2007). The impacts of humans going forward on earth's ecosystems are extensive (Western 2001), with urban anthropogenic landscapes being particularly relevant. More than 80% of populations live in densely settled areas with only very limited areas remaining under forest cover; current trends lead not only to a decrease in forest cover but also to concomitant biosphere changes (Ellis et al. 2013, Ellis & Ramankutty 2008). Thus, understanding the full extent and context of anthropogenic urban landscapes is important to the human future.

Examining the relationship between urbanism and anthropogenic landscapes has permitted recognition of a general underlying path to urbanization. With the transition to agriculture and settled life, individual households terraformed landscapes for agriculture and coagulated together to form communities that appear to have initially conformed with the principles of low-density urbanism. This concept is true throughout the world. In both the Near East (Ur 2014, p. 249) and Europe (Fernández-Götz & Krausse 2013, p. 478), these initial low-density agricultural settlements were approximately 1 square kilometer in size. The similarities end there, however. Although sharing a common focus on population aggregation, the development of urbanism then took different directions. In some cases, particularly in those where there was a substantial need for defense because of continued raiding, such as in Europe and in the Near East, fortifications and compact settlements became the norm, with agriculture located outside the urban boundaries. In areas that were not as volatile in terms of immediate threat, as in some of the tropics, agriculture continued to be incorporated into urban settlements, which expanded onto extensively modified landscapes. Monumental public spaces were focused on religious symbolism in both Southeast Asia and in the Maya area; however, as the populations became huge, there was an additional focus on the landscape management of water (reservoirs, barays, and channeling flow) and agriculture (terracing or rice fields), as well as on the economic well-being of the broader populace.

This brief examination of urbanism and anthropogenic landscapes has highlighted several items of value to future research on these topics: the scale and longevity of landscape modification in the past, not solely in urban situations but culminating in them; the multiple patterns of and avenues to urbanism, including ancient agricultural cities; the value of archaeological methodology in the study of both the ancient and contemporary past; the importance of study from multiple lenses whether near sensing, remote sensing, or context; and the applicability of comparisons between ancient and modern cities, as well as the potential for ancient cities to serve as models for contemporary and future planning.

It is ironic that the ancient, large low-density cities found in the tropics resemble the modern sprawl of today's megacities. Both past and current examples of these extensive cities likely faced the same issues related to infrastructure and planning. Both forms expand(ed) with growing populations and place(d) increasing pressure on their landscapes and sustainability, requiring investment in additional infrastructure (e.g., roads, service areas, and distribution systems). In the ancient cases, the managed urban landscapes were eventually abandoned, often in association with problems of contemporary concern such as sustainability, climatic stress, or potentially dysfunctionally high levels of inequality. As continued research helps us to better understand the dynamics of these past situations, we hope that the collected information will help us better frame planning and decisions with regard to our modern urban anthropogenic landscapes. Archaeology and the study of the past can indeed serve as windows to both successful and unsuccessful past social experiments.

DISCLOSURE STATEMENT

The authors are not aware of any affiliations, memberships, funding, or financial holdings that might be perceived as affecting the objectivity of this review.

ACKNOWLEDGMENTS

The authors acknowledge the input and impact of long-term discussions and meetings with members of IHOPE-Maya for contributing to the way in which we approached this treatise and to all the members of the Caracol Archaeological Project for providing hard data that can be utilized to assess urban theory. Participation in a workshop on Settlement Scaling in Pre-Modern Societies at the Santa Fe Institute in Santa Fe, New Mexico, in June 2015, also provided inspiration and background for this article.

LITERATURE CITED

Arcaute E, Hatna E, Ferguson P, Youn H, Johansson A, Batty M. 2015. Constructing cities, deconstructing scaling laws. *J. R. Soc. Interface* 12:20140745

Ashmore W. 2004. Social archaeologies of landscape. In *Companion to Social Archaeology*, ed. L Meskell, RW Preucel, pp. 255–66. Malden, MA: Blackwell

Ashmore W, Knapp AB. 1999. *Archaeologies of Landscape: Contemporary Perspectives*. Malden, MA: Blackwell

Bala G, Caldeira K, Wickett M, Phillips TJ, Lobell DB, et al. 2007. Combined climate and carbon-cycle effects of large-scale deforestation. *PNAS* 104(16):6550–55

Balee W. 2006. The research program of historical ecology. *Annu. Rev. Anthropol.* 35:75–98

Batten DC. 1998. Transport and urban growth in preindustrial Europe: implications for archaeology. *Hum. Ecol.* 26(3):489–516

Bettencourt LMA. 2013. The origins of scaling in cities. *Science* 340:1438–41

Bowman DMJS, Balch J, Artaxo P, Bond WJ, Cochrane MA, et al. 2011. The human dimension of fire regimes on Earth. *J. Biogeogr.* 38:2223–36

Breugmann R. 2005. *Sprawl: A Compact History*. Chicago: Univ. Chicago Press

Buckley BM, Anchukaitis KJ, Penny D, Fletcher R, Cook ER, et al. 2010. Climate as a contributing factor in the demise of Angkor, Cambodia. *PNAS* 107:6748–52

Burchell G, Gordon C, Miller P, eds. 1991. *The Foucault Effect: Studies in Governmentality: With Two Lectures by and an Interview with Michel Foucault*. Chicago: Univ. Chicago Press

Burgess EW. 1925. The growth of the city: an introduction to a research project. See Park et al. 1925, pp. 47–62

Bush MB, Silman MR. 2007. Amazonian exploitation revisited: ecological asymmetry and the policy pendulum. *Front. Ecol. Environ.* 5(9):457–65

Carballo DM, Fortenberry B. 2015. Bridging prehistory and history in archaeology of cities. *J. Field Archaeol.* 40(5):542–59

Carson JF, Whitney BS, Mayle FE, Iriarte J, Prumers H, et al. 2014. Environmental impact of geometric earthwork construction in pre-Columbian Amazonia. *PNAS* 111:10497–502

Certini G, Scalenghe R. 2011. Anthropogenic soils are the golden spikes for the Anthropocene. *Holocene* 21(8):1269–74

Chang K. 1968. *Settlement Archaeology*. Palo Alto, CA: Natl. Press

Chase AF, Chase DZ. 1998. Scale and intensity in Classic Period Maya agriculture: terracing and settlement at the 'garden city' of Caracol, Belize. *Cult. Agric.* 20(2):60–67

Chase AF, Chase DZ. 2007. Ancient Maya urban development: insights from the archaeology of Caracol, Belize. *J Belizean Archaeol*. 4:13–27

Chase AF, Chase DZ. 2016. The ancient Maya city: anthropogenic landscapes, settlement archaeology, and Caracol, Belize. *Res. Rep. Belizean Archaeol.* 13:3–14

Chase AF, Chase DZ, Awe JJ, Weishampel JF, Iannone G, et al. 2014a. Ancient Maya regional settlement and inter-site analysis: the 2013 West-Central Belize LiDAR survey. *Remote Sens*. 6(9):8671–95

Chase AF, Chase DZ, Awe JJ, Weishampel JF, Iannone G, et al. 2014b. The use of LiDAR in understanding the ancient Maya landscape. *Adv. Archaeol. Pract.* 3:208–21

Chase AF, Chase DZ, Weishampel JF, Drake JB, Shrestha RL, et al. 2011. Airborne LiDAR, archaeology, and the ancient Maya landscape at Caracol, Belize. *J. Archaeol. Sci.* 38:387–98

Chase AF, Chase DZ, White C. 2001. El paisaje urbano Maya: la integración de los espacios construidos y la estructura social en Caracol, Belice. In *Reconstruyendo la Ciudad Maya: El Urbanismo en las Sociedades Antiguas*, ed. A Ciudad Ruiz, MJ Iglesias Ponce de Leon, M Del Carmen Martinez, pp. 95–122. Madrid: Soc. Esp. Estud. Mayas

Chase AF, Scarborough VL, eds. 2014. *The Resilience and Vulnerability of Ancient Landscapes: Transforming Maya Archaeology through IHOPE*. APAAA No. 24. Arlington, VA: Am. Anthropol. Assoc.

Chase ASZ. 2016. Beyond elite control: residential reservoirs at Caracol, Belize. *WIRES Water* doi: 10.1002/wat2.1171

Chase ASZ, Weishampel JF. 2016. Water capture and agricultural terracing at Caracol, Belize as revealed through LiDAR and GIS. *Adv. Archaeol. Pract.* 4(3):In press

Chase DZ, Chase AF. 2014a. Ancient Maya markets and the economic integration of Caracol, Belize. *Anc. Mesoam.* 25(1):239–50
Chase DZ, Chase AF. 2014b. Path dependency in the rise and denouement of a Classic Maya city: the case of Caracol, Belize. See Chase & Scarborough 2014, pp. 142–54
Chase DZ, Chase AF, Awe JJ, Walker JH, Weishampel JF, et al. 2011. Airborne LiDAR at Caracol, Belize and the interpretation of ancient Maya society and landscapes. *Res. Rep. Belizean Archaeol.* 8:61–73
Childe VG. 1950. The urban revolution. *Town Plann. Rev.* 21:3–17
Church J. 2012. Archaeology of garbage. See Zimring & Rathje 2012, pp. 32–37
Comer DC, Harrower HC, eds. 2013. *Mapping Archaeological Landscapes from Space*. New York: Springer
Coningham RAE, Gunawardhana P, Manuel M, Adikari G, Katugampola M, et al. 2007. The state of theocracy: defining an early medieval hinterland in Sri Lanka. *Antiquity* 81:699–719
Cowgill G. 2004. Origins and development of urbanism: archaeological perspectives. *Annu. Rev. Anthropol.* 33:525–49
Csorba P, Szabo S. 2009. Degree of human transformation of landscapes: a case study from Hungary. *Hung. Geogr. Bull.* 58(2):91–99
David B, Thomas J, eds. 2008. *Handbook of Landscape Archaeology*. Walnut Creek, CA: Left Coast Press
Denevan WM. 1992. The pristine myth: the landscape of the Americas in 1492. *Ann. Assoc. Am. Geogr.* 82(3):369–85
Doxiadis CA. 1968. *Ekistics: An Introduction to the Science of Human Settlements*. New York: Norman
Ellis EC. 2011. Anthropogenic transformation of the terrestrial biosphere. *Phil. Trans. R. Soc. A* 369:1010–35
Ellis EC, Kaplan JO, Fuller DQ, Vavrus S, Goldewijk KK, Verburg PH. 2013. Used planet: a global history. *PNAS* 110(20):7978–85
Ellis EC, Ramankutty N. 2008. Putting people in the map: anthropogenic biomes of the world. *Front. Ecol. Environ.* 6(8):439–47
Ellis EC, Wang H, Xiao H, Peng K, Liu XP, et al. 2006. Measuring long-term ecological changes in densely populated landscapes using current and historical high resolution imagery. *Remote Sens. Environ.* 100(4):457–73
Enger M. 2004. *Designing America's Waste Landscapes*. Baltimore, MD: John Hopkins Univ. Press
Erickson CL. 2008. The Lake Titicaca Basin: a Precolumbian built landscape. In *Landscapes of Movement*, ed. CL Erickson, J Snead, pp. 311–56. Philadelphia: Mus. Publ.
Evans DH. 2016. Airborne laser scanning as a method for exploring long-term socio-ecological dynamics in Cambodia. *J. Archaeol. Sci.* **http://dx.doi.org/10.1016/j.jas.2016.05.009**
Evans DH, Fletcher RJ, Pottier C, Chevance J-B, Sourtif D, et al. 2013. Uncovering archaeological landscapes at Angkor using LiDAR. *PNAS* 110(31):12595–600
Evans DH, Pottier C, Fletcher R, Hensley S, Tapley I, et al. 2007. A comprehensive archaeological map of the world's largest preindustrial settlement complex at Angkor, Cambodia. *PNAS* 104(36):14277–82
Factura H, Bettendorf T, Buzie C, Pieplow H, Reckin J, Otterpohl R. 2010. Terra Preta sanitation: re-discovered from an ancient Amazonian civilization—integrating sanitation, bio-waste management and agriculture. *Water Sci. Technol.* 61(10):2673–79
Feinman GM. 2013. Crafts, specialists, and markets in Mycenaean Greece: reenvisioning ancient economies: beyond typological constructs. *Am. J. Archaeol.* 117:453–59
Fernández-Götz M, Krausse D. 2013. Rethinking Early Iron Age urbanisation in central Europe: the Heuneburg site and its archaeological environment. *Antiquity* 87:473–87
Fisher C. 2014. The role of infield agriculture in Maya cities. *J. Anthropol. Archaeol.* 36:196–210
Fletcher R. 1995. *The Limits of Settlement Growth: A Theoretical Outline*. Cambridge, UK: Cambridge Univ. Press
Fletcher R. 2009. Low-density, agrarian-based urbanism: a comparative view. *Insights* 2:2–19
Fletcher R. 2012. The dynamics of Angkor and its landscape: issues of scale, non-correspondence and outcome. In *Old Myths and New Approaches: Interpreting Ancient Religious Sites in Southeast Asia*, ed. A Haendel, pp. 42–62. Clayton, Aust.: Monash Univ. Publ.
Fletcher R, Evans D, Pottier C, Rachna C. 2015. Angkor Wat: an introduction. *Antiquity* 89(348):1388–401
Foley RA, Lahr MM. 2015. Lithic landscapes: early human impact from stone tool production on the Central Saharan environment. *PLOS ONE* 10(3):e0115482

Fox RG. 1977. *Urban Anthropology: Cities In Their Cultural Settings*. Englewood Cliffs, NJ: Prentice-Hall

Garraty CP, Stark BL, eds. 2010. *Archaeological Approaches to Market Exchange in Ancient Societies*. Boulder: Univ. Press Colo.

Garreau J. 1991. *The Edge City: Life on the New Frontier*. New York: Doubleday

Glaeser E. 2011. Cities, productivity, and quality of life. *Science* 333:592–94

Glaser B. 2007. Prehistorically modified soils of central Amazonia: a model for sustainable agriculture in the twenty-first century. *Phil. Trans. R. Soc. B* 362:187–96

Gottman J. 1961. *Megalopolis: The Urbanized Northeastern Seaboard of the United States*. New York: Twentieth Century Fund

Graves-Brown P, Harrison R, Piccini A, eds. 2013. *The Oxford Handbook of the Archaeology of the Contemporary World*. Oxford, UK: Oxford Univ. Press

Gulick J. 1989. *The Humanity of Cities: An Introduction to Urban Societies*. Granby, MA: Bergin & Garvey

Hakansson NT, Widgren M, eds. 2014. *Landesque Capital: The Historical Ecology of Enduring Landscape Modifications*. Walnut Creek, CA: Left Coast Press

Hamilakis Y. 2013. *Archaeology and the Senses: Human Experience, Memory, and Affect*. Cambridge, UK: Cambridge Univ. Press

Hanson S, Guiliano G. 2004. *The Geography of Urban Transportation*. New York: Guilford

Hanus K, Evans D. 2015. Imaging the waters of Angkor: a method for semi-automated pond extraction from LiDAR data. *Archaeol. Prospect.* 23:87–94

Harrison R, Schofield J. 2009. Archaeo-ethnography, auto-archaeology: introducing archaeologies of the contemporary past. *Archaeol.: J. World Archaeol. Congr.* 5(2):185–209

Heckenberger MJ, Kuikuro A, Kuikuro UT, Russell JC, Schmidt M, et al. 2003. Amazonia 1492: pristine forest or cultural parkland? *Science* 301:1710–14

Heckenberger MJ, Russell JC, Fausto C, Toney JR, Schmidt MJ, et al. 2008. Pre-Columbian urbanism, anthropogenic landscapes, and the future of the Amazon. *Science* 321:1214–17

Heckenberger MJ, Russell JC, Toney JR, Schmidt MJ. 2007. The legacy of cultural landscapes in the Brazilian Amazon: implications for biodiversity. *Phil. Trans. R. Soc. B* 362:197–208

Hightower JN, Butterfield AC, Weishampel JF. 2014. Quantifying ancient Maya land use legacy effects on contemporary rainforest canopy structure. *Remote Sens*. 6:10716–32

Hirth KG. 2008. Incidental urbanism: the structure of the pre-Hispanic city in central Mexico. See Marcus & Sabloff 2008a, pp. 273–97

Hooke RL, Martin-Duque JF, Pedraza J. 2012. Land transformation by humans: a review. *GSA Today* 22(12):4–10

Hutson SR. 2016. *The Ancient Urban Maya: Neighborhoods, Inequality, and Built Form*. Gainesville: Univ. Press Fla.

Isendahl C, Smith ME. 2013. Sustainable agrarian urbanism: the low-density cities of the Mayas and Aztecs. *Cities* 31:132–43

Jacobs J. 1969. *The Economy of Cities*. New York: Random House

James LA. 2013. Legacy sediment: definitions and processes of episodically produced anthropogenic sediment. *Anthropocene* 2:16–26

Jaruchiewicz E. 2014. The role of anthropogenic water reservoirs within the landscapes of mining areas—a case study from the western part of the Upper Silesian Coal Basin. *Environ. Socio.-Econ. Stud.* 2(1):16–26

Johnson KM, Ouimet WB. 2014. Rediscovering the lost archaeological landscape of southern New England using airborne light detection and ranging (LiDAR). *J. Archaeol. Sci.* 43:9–20

King E. 2015. *The Ancient Maya Marketplace: The Archaeology of Transient Space*. Tucson: Univ. Ariz. Press

Kostof S. 1991. *The City Shaped: Urban Patterns and Meanings through History*. London: Thames & Hudson

Kusimba C, Kusimba SB, Agbaje-Williams B. 2006. Precolonial African cities: size and density. See Storey 2006b, pp. 145–58

Lucero LJ, Fletcher R, Coningham R. 2015. From 'collapse' to urban diaspora: the transformation of low-density dispersed agrarian urbanism. *Antiquity* 89:1139–54

Lyson HC. 2014. Social structural location and vocabularies of participation: fostering a collective identity in urban agriculture activism. *Rural Sociol*. 79(3):310–35

Marcus J, Sabloff JA, eds. 2008a. *The Ancient City: New Perspectives on Urbanism in the Old and New World*. Santa Fe, NM: Sch. Adv. Res. Press

Marcus J, Sabloff JA. 2008b. Introduction. See Marcus & Sabloff 2008a, pp. 3–26

Menze BH, Ur JA. 2012. Mapping patterns of long-term settlement in Northern Mesopotamia at a large scale. *PNAS* 109(14):E778–87

Meyfroidt P, Lambin EF. 2011. Global forest transition: prospects for an end to deforestation. *Annu. Rev. Environ. Resour.* 36:343–71

Mumford L. 1961. *The City in History*. New York: Harcourt, Brace and World

Nichols DL. 2006. Shining stars and black holes: population and preindustrial cities. See Storey 2006b, pp. 330–40

Opitz RS, Cowley DC, eds. 2013. *Interpreting Archaeological Topography: 3D Data, Visualization, and Observation*. Oxford, UK: Oxbow Books

Opitz RS, Limp WF. 2015. Recent developments in high-density survey and measurement (HDSM) for archaeology: implications for practice and theory. *Annu. Rev. Anthropol.* 44:347–64

Ortman SG, Cabaniss AHF, Sturn JO, Bettencourt LMA. 2014. The pre-history of urban scaling. *PLOS ONE* 9(2):1–10

Park RE. 1925. The city: suggestions for the investigation of human behavior in the urban environment. See Park et al. 1925, pp. 1–46

Park RE, Burgess EW, McKenzie RD, eds. 1925. *The City*. Chicago: Univ. Chicago Press

Penny D, Chevance J-B, Tang D, De Greef S. 2014. The environmental impact of Cambodia's ancient city of Mahendraparvata (Phnom Kulen). *PLOS ONE* 9(1):1–9

Pérez Rodríguez V. 2006. States and households: the social organization of terrace agriculture in the Mixteca Alta, Oaxaca, Mexico. *Latin Am. Antiq.* 17(1):3–22

Pottier C. 2000. Some evidence of an inter-relationship between hydraulic features and rice field patterns at Angkor during ancient times. *J. Sophia Asian Stud.* 18:99–119

Price SJ, Ford JR, Cooper AH, Neal C. 2011. Humans as major geological and geomorphological agents in the Anthropocene: the significance of artificial ground in Great Britain. *Phil. Trans. R. Soc. A* 369:1056–84

Price TD, Burton JH, Bentley AR. 2002. The characterization of biologically available strontium isotope ratios for the study of prehistoric migration. *Archaeometry* 44:117–35

Price TD, Burton JH, Fullgar PD, Wright LE, Buikstra JE, Tiesler V. 2008. Strontium isotopes and human mobility in ancient Mesoamerica. *Latin Am. Antiq.* 19:167–80

Redfield R. 1941. *The Folk Culture of Yucatan*. Chicago: Univ. Chicago Press

Redman CL, Jones NS. 2005. The environmental, social, and health dimensions of urban expansion. *Popul. Environ.* 26(6):505–20

Reno J. 2013. Waste. See Graves-Brown et al. 2013, pp. 261–72

Reps JW. 1965. *The Making of Urban America*. Princeton, NJ: Princeton Univ. Press

Richter D. 2007. Humanity's transformation of earth's soil: pedology's new frontier. *Soil Sci*. 172(12):957–67

Rothschild NA. 2006. Colonial and postcolonial New York: issues of size, scale, and structure. See Storey 2006b, pp. 121–36

Ruddiman WF. 2013. The Anthropocene. *Annu. Rev. Earth Planet. Sci.* 41:45–68

Rykwert J. 1976. *The Idea of a Town: The Anthropology of Urban Form in Rome, Italy and the Ancient World*. Princeton, NJ: Princeton Univ. Press

Saalman H. 1971. *Haussmann: Paris Transformed*. New York: George Braziller

Sabloff JA, Ashmore W. 2001. An aspect of archaeology's recent past and its relevance to the new millennium. In *Archaeology at the Millennium: A Sourcebook*, ed. GM Feinman, TD Price, pp. 11–32. New York: Kluwer Acad./Plenum Press

Scott AJ, Storper M. 2014. Urban worlds: the nature of cities: the scope and limits of urban theory. *Int. J. Urban Reg. Res.* 39:1–15

Sjoberg G. 1960. *The Preindustrial City: Past and Present*. Glencoe, IL: Free Press

Skeates R. 2008. Making sense of the Maltese temple period: an archaeology of sensory experience and perception. *Time Mind: J. Archaeol. Conscious. Cult.* 1(2):207–38

Smith ME. 2007. Form and meaning in the earliest cities: a new approach to ancient urban planning. *J. Plann. Hist.* 6(1):3–47

Smith ME. 2010a. Sprawl, squatters and sustainable cities: Can archaeological data shed light on modern urban issues? *Camb. Archaeol. J.* 20(2):229–53

Smith ME. 2010b. The archaeological study of neighborhoods and districts in ancient cities. *J. Anthropol. Archaeol.* 29(2):137–54

Smith ME. 2011. Empirical urban theory for archaeologists. *J. Archaeol. Method Theory* 18:167–92

Smith ME, ed. 2012. *The Comparative Archaeology of Complex Societies*. Cambridge, UK: Cambridge Univ. Press

Smith ML. 2003. *The Social Construction of Ancient Cities*. Washington, DC: Smithson. Inst. Press

Smith ML. 2014. The archaeology of urban landscapes. *Annu. Rev. Anthropol.* 43:307–23

Sorensen A, Okata J. 2010. Introduction: megacities, urban form, and sustainability. In *Megacities: Urban Form, Governance, and Sustainability*, ed. A Sorensen, J Okata, pp. 1–14. New York: Springer

Speck J. 2012. *Walkable City: How Downtown Can Save America, One Step at a Time*. New York: Farrar, Straus and Giroux

Stanley BW, Dennehy TJ, Smith ME, Stark BL, York AM, et al. 2015. Service access in premodern cities: an exploratory comparison of spatial equity. *J. Urban Hist.* 42:121–44

Stanley BW, Stark BL, Johnston KL, Smith ME. 2012. Urban open spaces in historical perspective: a transdisciplinary typology and analysis. *Urban Geogr*. 33(8):1089–117

Storey GR. 2006a. Introduction: urban demography of the past. See Storey 2006b, pp. 1–23

Storey GR, ed. 2006b. *Urbanism in the Preindustrial World*. Tuscaloosa: Univ. Ala. Press

Szabo J, David L, Loczy D, eds. 2010. *Anthropogenic Geomorphology*. New York: Springer

Tegtmeier EM, Duffy MD. 2004. External costs of agricultural production in the United States. *Int. J. Agric. Sustain.* 2(1):1–19

Thurston TL, Fisher CT, eds. 2007. *Seeking a Richer Harvest: The Archaeology of Subsistence Intensification, Innovation, and Change*. New York: Springer

Tilman D, Lehman C. 2001. Human-caused environmental change: impacts on plant diversity and evolution. *PNAS* 98(10):5433–40

Treacy JM, Denevan W. 1994. The creation of cultivable land through terracing. In *The Archaeology of Garden and Field*, ed. N Miller, K. Gleason, pp. 91–110. Philadelphia: Univ. Pa. Press

Trigger BD. 2003. *Understanding Early Civilizations: A Comparative Study*. Cambridge, UK: Cambridge Univ. Press

Ur JA. 2014. Households and the emergence of cities in ancient Mesopotamia. *Camb. Archaeol. J.* 24(2):249–68

Ur JA, Karsgaard P, Oates J. 2007. Early urban development in the Near East. *Science* 317:1188

Verbeek T, Boussauw K, Pisman A. 2014. Presence and trends of linear sprawl: explaining ribbon development in the north of Belgium. *Landsc. Urban Plann.* 128:48–59

Walker JH. 2012. Recent landscape archaeology in South America. *J. Archaeol. Res.* 20:309–55

Western D. 2001. Human-modified ecosystems and future evolution. *PNAS* 98(10):5458–65

White CL. 2013. The Burning Man Festival and the archaeology of ephemeral and temporary gatherings. See Graves-Brown et al. 2013, pp. 595–609

Wilkie LA. 2013. Heritage and modernism in New York. See Graves-Brown et al. 2013, pp. 479–93

Wilkinson TJ. 1989. Extensive sherd scatters and land-use intensity: some recent results. *J. Field Archaeol.* 16(1):31–46

Wilkinson TJ. 2014. Comparative landscape analysis: contrasting the Middle East and Maya regions. See Chase & Scarborough 2014, pp. 183–200

Wilkinson TJ, French C, Ur JA, Semple M. 2010. The geoarchaeology of route systems in northern Syria. *Geoarchaeol.: Int. J.* 25(6):745–71

Willey GR. 1953. *Prehistoric Settlement Patterns in the Viru Valley, Peru*. BAE Bull. 155. Washington, DC: Smithson. Inst. Press

Woods WI. 2008. *Amazonian Dark Earths: Wim Sombroek's Vision*. New York: Springer

Zimring CA, Rathje WL, eds. 2012. *Encyclopedia of Consumption and Waste: The Social Science of Garbage*. Thousand Oaks, CA: SAGE

Annual Review of Anthropology

Volume 45, 2016

Contents

Anthropology of Language and Communicative Practices

Sociocultural Anthropology

Indexes

Errata

An online log of corrections to *Annual Review of Anthropology* articles may be found at http://www.annualreviews.org/errata/anthro