

THE ANGKORIAN WORLD

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Since the first accounts of 19th-century explorers, structures like Angkor Wat have been considered the focal point of ‘temple-cities,’ but the size, structure, and population of those cities have, until recently, been topics of debate and disagreement. The core problem is that urban complexes of the Angkorian World were made almost entirely of perishable materials that disappeared centuries ago, leaving behind the religious monuments of stone and brick that have engaged most of the public and scholarly attention.

Nonetheless, archaeologists have been taking to the skies over Angkor for nearly a century to document the traces of urban and agricultural elements that remain inscribed into the surface of the landscape. In the last ten years, lidar technology has helped to fill in the remaining lacunae in our cartography of these landscapes, and after a century and a half of survey and mapping, we have arrived at a series of archaeological maps of Angkorian settlement complexes that are unlikely to change substantially in the future. Very extensive and systematic ground-based surveys have complemented aerial perspectives to document time-diagnostic material such as ceramics, and all of this information has been federated within massive geospatial databases. Our newly comprehensive spatial awareness of places like Angkor has been used to more effectively target excavations and other research initiatives on the ground, adding time depth and granular detail in key locations.

For perhaps the first time, therefore, archaeologists are well positioned to trace the development of Khmer settlement complexes across time and space, from prehistory through the Angkor Period and into the contemporary world. In this chapter, we re-evaluate conventional theories of urban development in the Khmer milieu, which typically define a neat transition between moated prehistoric sites and well-planned, rectilinear, and cardinally oriented settlements and gridded ‘hydraulic cities’ that define the Angkor Period. Instead, we identify multiple pathways to urban and agricultural complexity that produced a diverse range of settlement patterns across the Khmer Empire. Moated prehistoric sites are, in fact, exceedingly rare in north-west Cambodia; furthermore, the early urban complexes of the Angkor Period are, in many cases, not rigidly planned or enclosed spaces and are better characterised as ‘open cities.’ At the height of the Angkor Period, it is possible to identify formally planned and gridded urban areas which accord with long-standing views about ‘temple-cities’; however, these typically turn out to be the epicentres of extended, lower-density urban landscapes that were patchworks of open spaces, agricultural systems, and residential areas (see Hawken and Klassen 2023, this volume).

In this chapter, we trace the history of archaeological approaches to Khmer urbanism and assess the current state of knowledge about the development of Khmer urbanism over the past two millennia. We then use spatial analytics to offer preliminary assessments of the area, population, and density of settlements and how those changed over time and space. We argue that the new data provide important insights into the historical trajectory of the Khmer Empire and that, more broadly, the scale and structure of Angkorian settlement patterns challenge us to think differently about the nature of early urbanism in tropical environments Worldwide.

Evolving Perspectives From the 19th to 21st Centuries

Epigraphy

As detailed elsewhere in this volume (see e.g. contributions by Soutif, Estève, Goodall, and Lustig), the inscriptional record of the Angkorian World has been the focus of intensive study since the very beginning of scholarship in the 19th century and has long been the cornerstone for our understanding of the Angkorian World. The corpus of inscriptions offers us a wide array of toponyms describing lived-in spaces at various scales (see Table 11.1 in Hawken and Klassen 2023, this volume). However, the nature and size of settlements described by categories in the Sanskrit and Old Khmer languages such as *pura* (typically translated as ‘cities’) are open to interpretation and debate (Lewitz 1967), with each category likely encompassing habitation areas that varied widely in terms of population, morphology, and spatial extent. It is also likely that these categories had considerable overlap between them and that their meanings were not fixed or standardised but varied significantly over space and time.

It is, therefore, very difficult to infer or reconstruct indigenous conceptions of ‘urban’ and ‘non-urban’ space from the inscriptional record, and linguists have tended to rely on apparent links between words in Old Khmer and their present-day equivalents. An example of the ambiguity that arises from this is seen in the Ta Prohm inscription (Cœdès 1906), which refers to donations to the temple from 3140 ‘*grama*’, a word almost universally interpreted in the literature on Angkor as a ‘village’ (see e.g. Higham 2001, 271), implying some kind of discrete urban settlement which, presumably, ought to be identifiable in the archaeological record.

However, a closer review of the literature reveals that the word *grama* is, in fact, rather ambiguous and has no precise correlate in Khmer (Lewitz 1967, 404). The simple working assumption is that it is equivalent to the Khmer word *sruk*, meaning village, although here, too, there is some uncertainty about the meaning of that word in the ancient context (Lewitz 1967, 404–46). Suppose we adopt Mabbett’s (1978, 23) interpretation that *sruk* defines a division of territory where a religious foundation is set up and a community grows. In that case, we may expect—as in present-day Cambodia—an extremely broad spectrum of real-world correlates in the geography of Angkorian urbanism, from multiple overlapping *sruk* in dense urban areas on the one hand to remote and isolated village outposts on the other. Therefore, it is difficult to reliably reconstruct urban geography or demography using inscriptions, and, as Maxwell (2007, 67) has noted in relation to the Preah Khan inscription, attempts to do so can result in confusing, improbable outcomes.

Given the uncertainty and imprecision within the contemporary historical record of the Angkorian World, researchers have relied instead on material remains for evidence of habitation, but this too presents a series of problems, above all the fact that houses of stone were reserved by and large for divinities and that the vast majority of the material used for other kinds of dwellings was non-durable and has not survived to the present day (Coe and Evans 2018). This is true across essentially all of Southeast Asia (Higham 2014), and therefore domestic

contexts are very rarely discovered in the region, including in the Angkorian World (see Carter et al. 2023, this volume). Nonetheless, recent work has emphasised that traces of neighbourhoods stretching between and beyond the temples do remain (Fletcher and Pottier 2002). It is worth briefly surveying how urban form at Angkor and beyond has ‘emerged’ from scholarship over the last 150 years as theoretical perspectives have changed and as innovations in flight and imaging technologies have gradually enabled more detailed views of urban form.

The Earliest Work: Temples and Enclosures

Among the defining features of colonialism was a competition between great powers for possession of exceptional historical monuments, and present-day territorial claims were strengthened through systematic inventorisation and study of heritage sites across the widest possible range of time and space. In Southeast Asia, as elsewhere, an explicitly ‘scientific’ approach to the study of monuments, artefacts, and inscriptions had emerged and become institutionalised by the beginning of the 20th century (Edwards 2005, 2008; Evans 2007; Falser 2019; Pottier 2006). This work was also essential for establishing the basic framework of Khmer society, including the chronology of its kings and temples, the periodisation of architectural and art historical styles, and the broad contours of its religious and political history within a regional and global context. As Carter et al. (2018) note, there is an assumption throughout this scholarship that the areas within enclosure walls comprise ‘temple-cities’, despite an absence of compelling evidence.

This focus on the more durable remains of elites continues to predominate in the study of Angkor today, but in early 20th-century scholarship, it was the lens through which almost all new information on Angkor was considered. With the advent of flight, for example, the discipline of aerial archaeology emerged after World War I, and scholars began to trace the subtle traces of human activity inscribed into the surface of the landscape that could only be clearly seen from above (Barber 2017). By the 1930s, scholars associated with the EFEO were regularly flying over Angkor and noting previously undocumented traces of habitation between and beyond the temples, such as depressions and mounds, which were mapped in significant detail (Evans 2007). Ultimately, however, work in this era remained relentlessly focused on defining the footprints of temples and their associated enclosures. The maps that were produced were not published until more than half a century later (Pottier 2006; Pottier and Dumarçay 1993), and an emerging tradition of aerial archaeology in Southeast Asia failed to gain traction or achieve the recognition of kindred traditions in Europe and the Middle East (Evans 2007, 66–67).

The Mid-20th Century: Subsistence, Environment, and Landscape

By the mid-20th century, new perspectives in anthropology—in particular the rise of environmental and landscape archaeology, in which long-term human–environment interactions became a core focus of research—began to impact Angkorian studies with the work of Malleret, Groslier, and others at the EFEO. In addition to ad hoc collections of aerial images collected by Williams–Hunt and others (Moore 2009), researchers for the first time had access to comprehensive and systematic aerial coverage of the landscape thanks to missions undertaken by the French *Institut géographique national* (IGN). Alongside these technical innovations, in the newly emerging discipline of ‘settlement archaeology’, they had the rudiments of a theoretical agenda in which the study of residential and agricultural activity within and beyond the temples not only made sense but was critically important. On the ground, this work was pioneered by Bernard-Philippe Groslier, who explicitly acknowledged the need to refocus on networks of habitation, assisted by aerial remote sensing (1952).

Groslier set in motion an ambitious program of archaeological research to fulfil this potential but was forced to abandon the project in the early 1970s with the rise of civil war in Cambodia. Although he had very clearly identified what we now recognise as the building blocks of Angkorian urbanism—occupation mounds, communal ponds, linear traces such as roads and canals, community temple foundations—his work on this subject remained mostly unpublished until long after his death (Groslier 1998). Having fled Cambodia for France, he focused his later work on the development of a theoretical approach that continues to resonate in present-day studies of Khmer urbanism and has attracted much controversy: the ‘hydraulic city’ hypothesis (Groslier 1979).

Urban Infrastructure: Functional or Symbolic?

Although the ‘hydraulic city’ thesis is most closely associated with a definitive 1979 paper on the subject, its origins can be traced back to work by Goloubew (1941), and Groslier spent nearly three decades elaborating the theory over a series of publications (Evans 2007). Ironically, despite the name, the theory has relatively little to say about the nature of Angkorian urbanism, focusing instead on the role of irrigated rice agriculture and multi-cropping as the source of Angkor’s wealth and, thanks to its environmental impacts, a factor in the weakening of the Khmer state and its capitulation to a Siamese invasion in the 15th century. Other chapters deal sufficiently with the ‘hydraulic city’ thesis and its discontents (see Lustig et al. 2023 and Hawken and Castillo 2023, this volume), but in terms of the development of ideas about urbanism, it embodies two major developments. The first was the idea that Angkor is more than just a ritual-ceremonial landscape consisting of monuments and enclosures—the ‘temple-cities’ that have remained a staple of the literature on Angkor since the 1800s—but includes an extended network of infrastructure that remained deeply embedded in the urban fabric for many centuries (Groslier 1956, 1958).

The second point that both Goloubew and Groslier were keen to reinforce was that the hydraulic infrastructure had a ‘double aspect’. Although it was clearly part of a sacred geography that embodied specific magico-religious ideals, it also served practical and utilitarian purposes, such as providing arteries for movement and communication and ameliorating the sharp seasonality of water supply in the urban context (Evans 2007). This nuance has often been lost in subsequent scholarship, much of which seeks to discredit the ‘hydraulic city’ hypothesis on the grounds that the water network was ritual and symbolic in nature and therefore not functional (see Evans 2007 for a summary of this debate). Such criticisms present us with a false dichotomy and can be dismissed *a priori* on logical grounds, but it is nonetheless worthwhile considering the ways in which Angkor’s urban space may be ordered according to ‘ritual’ imperatives.

For the last two decades, Gaucher (2002, 2003a, 2004, 2017) has been a leading proponent of the idea that the urban layout of Angkor is structured according to ideals and principles derived from Indian traditions of urban planning, in much the same way as the temples of Angkor themselves represent a specific vision of the Hindu-Buddhist cosmos rendered in earth, water, and stone. Following many years of painstaking ground survey in the central walled enclosure of Angkor Thom beginning in 2000, Gaucher’s team was able to identify elements of an urban grid, and cartographic work by his team filled out earlier, schematic maps by Groslier and others (Groslier 1956, 1958) with extraordinary detail.

According to Gaucher (2004, 83), the grid network of the Angkor Thom enclosure (Figure 10.1) conforms sufficiently to ideal models of urban planning laid out in Indian literature such as the *Śāstra* that we may consider it as a ‘genuine city’, elaborated according to a master plan based on ancient principles. In that respect, Gaucher’s approach echoes ideas presented

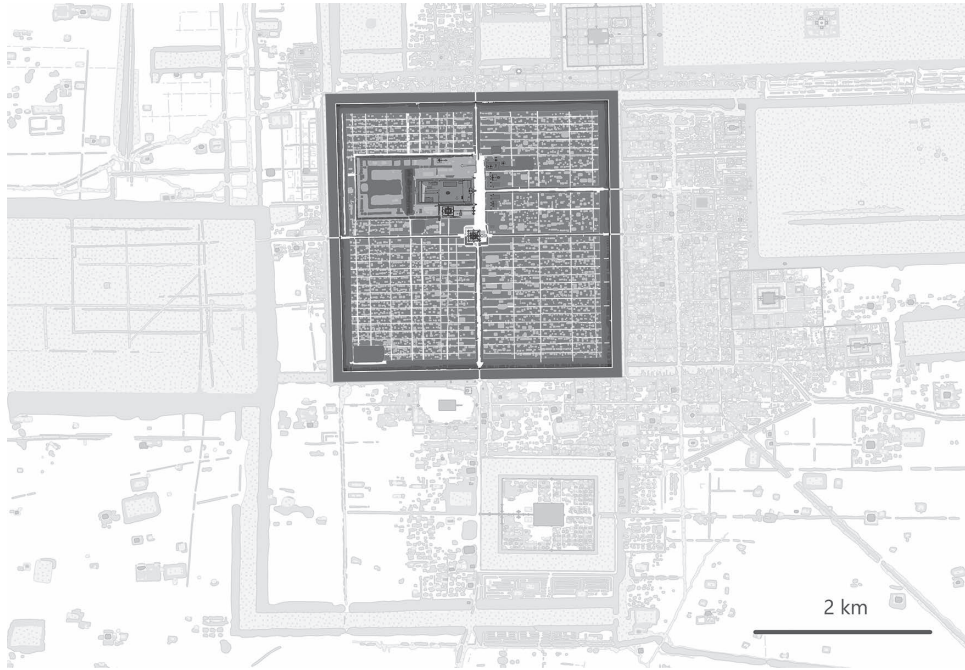


Figure 10.1 Archaeological map of the intramural area of Angkor Thom.

Source: (Based on Gaucher and Husi 2013).

decades earlier by Wheatley (1983), who argued that urban planning in Southeast Asia was based on idealised models described in Indian and Chinese treatises—a theory that, perhaps surprisingly, has not been particularly influential on studies of Khmer urban form. It is also a natural evolution of the original idea of ‘temple-cities’ since, in this vision of Angkor, the Bayon temple remains the focus of an extended enclosure which neatly delimits and defines the true urban space: Angkor Thom, in this view, is essentially a temple-city writ large.

There are a number of potential problems with this, some of which Gaucher anticipates and deals with in his text (2004). To begin with, models of Indian urban form found in ancient treatises were rarely, if ever, achieved in physical reality; rather, the ideals form an abstract model of urban space in which ‘the city is an experiential shape only loosely associated with the physical shape’ (Srinivasan 1993). On the other hand, the grid is also highly evocative of the ideal layout of Chinese cities, as Gaucher and others have pointed out (Evans and Fletcher 2015; Gaucher 2004). Historically in China, these geometric plans *were* frequently fully realised in physical space, and more obvious elements of Indian tradition frequently overshadow the influence of Chinese cultural traditions in Angkorian society. There also remains the obvious point that grids are a natural and fundamental layout of urban designs everywhere throughout history and that since the inscriptional corpus of Cambodia is silent on such questions of urban planning, there is no particular way of testing or refuting the theory of Indian inspiration one way or the other. Finally, Gaucher’s work excluded the broader grid that had already been identified by Groslier and others (Pottier 2006) and took as its starting point the notion that the walls of Angkor Thom enclosed more or less the totality of the grid pattern of central Angkor—an assumption that was later challenged by the advent of airborne lidar mapping, as we will see.

Landscape Approaches and the Advent of Lidar

With the re-opening of Cambodia to archaeological work in the early 1990s, Pottier (1993, 1999) resumed mapping the urban fabric of Angkor (see Hawken and Klassen 2023, this volume), a process that had been set in motion on a piecemeal basis in the 1930s and which later formed a core component of Groslier's unfinished research agenda. The inventory of temples at Angkor was expanded by several hundred sites in Pottier's work, which consolidated archival material and maps produced over the course of a century and a half as a basis for the new cartography (Pottier 2006). Many thousands of community ponds or *trapeang*, occupation mounds, and other features were identified in the new maps, which were systematically verified on the ground over the course of the 1990s. Connecting these features was a vast and intricate web of infrastructure consisting of embankments, canals, and a network of field systems. Pottier and colleagues began to use the spatial logic of the network to address long-standing issues about the development of Angkor and its urban and agricultural systems (Pottier 2000a, 2000b; Pottier and Bolle 2009).

The new maps of the central and southern areas of Angkor (Figure 10.2) finally allowed researchers to move beyond schematic maps of lines and point locations towards richly detailed depictions and interpretations of archaeological topography. The mapping, survey, and interpretive work completed in the 1990s also established a template for numerous projects that followed at Angkor and beyond. In 1999 and 2000, Pottier's maps were digitised into a geographic information system (GIS). Within the framework of the Greater Angkor Project (GAP), the cartography was then extended into the further northern, eastern, and western reaches of Angkor that were inaccessible to researchers in the 1990s due to conflict (Evans et al. 2007). By

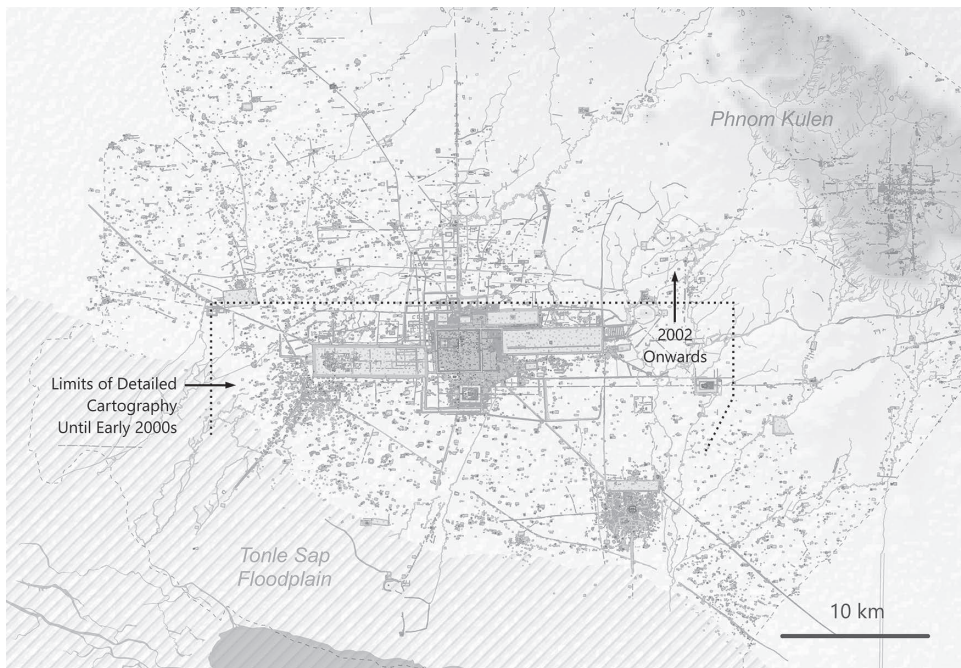


Figure 10.2 Archaeological map of the Greater Angkor region.

Source: (Map by the authors, with contributions from N. Hofer and J.-B. Chevance).

2007, researchers were confident that a more or less comprehensive overview of the Greater Angkor archaeological landscape had been achieved, even if lacunae remained in some areas and ground verification had not yet been completed (Evans et al. 2007).

Elsewhere in Cambodia, other archaeological mapping projects developed in parallel and added similar detail for other urban areas. A project led by Shimoda at the Pre-Angkorian capital of Sambor Prei Kuk used aerial photographs and satellite imagery to document a similar pattern of pond- and mound-based, temple-centric habitation dating from the 5th to the 9th centuries CE (Shimoda 2010), while the LOMAP program led by Stark and colleagues was able to identify even earlier antecedents for this form of settlement organisation dating from the early first millennium CE in the Mekong Delta (Stark 2006; Stark et al. 2015). Other teams across Cambodia were able to replicate these findings and identify patterns of residence and urbanism at places such as Banteay Chhmar and Koh Ker (Evans and Moylan 2013; Evans and Traviglia 2012) and also Preah Khan of Kompong Svay (Hendrickson and Evans 2015), where previously there had existed only schematic maps consisting of points and lines delineating the largest infrastructural elements. Unlike in neighbouring countries, Cambodia had decades of conflict that preserved the heritage landscape from processes of urbanisation and mechanised agriculture. As a result, we can trace the topographic legacy of centuries of urban development in detail on the Earth's surface.

This work, however, suffered from one major shortcoming: in many areas, vegetation cover obscured the subtle topographic traces that researchers were identifying in aerial imagery and using to map elements of Angkorian urban form. A solution to this problem arrived in 2012 with the first deployment of airborne lidar in the Angkor region, and at Koh Ker (Evans et al. 2013), as part of the Khmer Archaeology LiDAR Consortium. Researchers were able to leverage the unique capability to map fine-grained topographic relief even under dense forest canopy to fill in important lacunae in the maps of Angkor and Koh Ker (Evans 2010; Evans et al. 2013; Evans and Fletcher 2015), as well as reproducing and validating the mapping work already completed by Gaucher in Angkor Thom. Within the framework of the Cambodian Archaeological Lidar Initiative in 2015, the 2012 lidar work at Angkor was extended to include most other major temple complexes within the borders of present-day Cambodia, including Banteay Chhmar, Preah Khan of Kompong Svay, the Pre-Angkorian capital of Sambor Prei Kuk, and the Post-Angkorian capital region of Longvek and Oudong (Evans 2016). Since then, these acquisitions of aerial data have been complemented by years-long projects of survey, mapping, and excavation, usually within the framework of broad multi-disciplinary projects involving multiple international teams working in concert with Cambodian researchers. In some areas, ground verification work continues, and analysis of the results will preoccupy researchers for many years to come. Nonetheless, we have recently arrived at what may be considered definitive, final archaeological maps of all of these places, including Angkor, which allows us to make some basic observations about the development of urban form over space and time in the Angkorian World.

Khmer Urban Patterns Over Time

The paradigm of settlement and landscape archaeology continues to inform most of the archaeological work done in Cambodia outside of temple contexts, and this is reflected in many of the contributions to this volume, some of which go into considerable detail on elements of Khmer urbanism in different areas and in different periods (see Heng 2023; Chevance and Pottier 2023; Hawken and Klassen 2023; Hawken and Castillo 2023; Carter et al. 2023; Polkinghorne and Sato 2023). Therefore, the purpose of this section is to offer a broad synthesis

of this work to trace the contours of urban development from prehistory to the present day, incorporating the latest results from lidar-derived mapping work.

Early Capitals Beyond Angkor

There are at least four major centres beyond Angkor for which we have sufficient amounts of archaeological data to make assessments of early urbanism.

At Óc Eo, a major trading port of the polity known from Chinese sources as *Funan* (Malleret 1959; Manguin and Khôi 2000; Manguin and Tingley 2009; Manguin and Vallerin 1997), we find perhaps the first example of an urban centre in mainland Southeast Asia organised according to an orthogonal plan, with occupation areas and temple remains organised over an area of more than 400 ha. Located on a floodplain without the presence of large, elevated mounds, Óc Eo was structured along either side of the main axis and was home perhaps to several thousand people. Dating from the first few centuries BCE to the first few centuries CE, it represents a very early integration of monumental architecture and residential occupation within a coherent urban design apparently elaborated according to an overall plan (Bourdonneau 2007) (Figure 10.3).

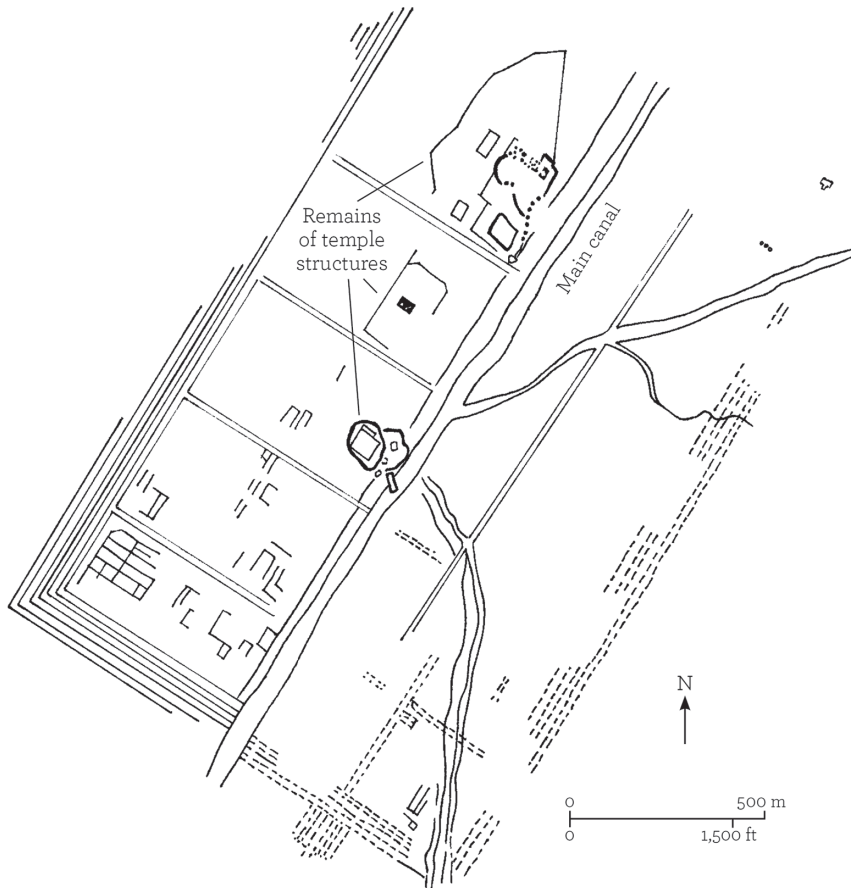


Figure 10.3 Map of Óc Eo.

Source: (Based on Coe and Evans (2018, 91).

Further inland, legacy forms of occupation on large irregular mounds persisted. The site of Angkor Borei in southern Cambodia, perhaps the capital of Funan and linked to Óc Eo by a great canal, has evidence for occupation dating from at least the 4th century CE scattered across 35 km² (Stark 2006; Stark et al. 2015). Some of this occupation is located on very large and irregular mounds containing scatters of ponds and temple sites, while other ponds, temples, and smaller occupation mounds are distributed across the surrounding landscape, reflecting a diversity of settlement forms that do not adhere to any obvious grid or plan.

At the site of Sambor Prei Kuk, new maps created from lidar imaging in 2015 (Figure 10.4) add considerable detail to the enclosed Pre-Angkorian city mapped in detail by Shimoda (2010), which includes a vast array of ponds and numerous small shrines in its intramural and extramural spaces, much of it apparently reflecting a rather chaotic and disordered development. Most of the development at Sambor Prei Kuk, including its main group of shrines, appears to coincide with the apparent lifespan of the ‘*Chenla*’ polity from the 6th to 8th centuries, but here, too, there is evidence for occupation dating back to Prehistoric Period (Shimoda et al. 2015).

A defining feature of Sambor Prei Kuk has always been its imposing earthen enclosure, stretching 2 km on three sides, with the other side bordered by the river. In addition to this piece of infrastructure, we can now add an internal system of water management, consisting of a series of canals around the main temple sites. Another network of intramural canals revealed by lidar appears to be the remnants of an interior grid, which seems to conform to the orientation of the exterior wall and is connected to it. Sambor Prei Kuk may therefore represent the earliest evidence of a city grid enclosed within an outer wall.

The nature of occupation at Sambor Prei Kuk partly evokes that of Angkor Borei, with massive mounds dotted with temple sites and ponds but a much greater density of smaller ponds and



Figure 10.4 Archaeological map of Sambor Prei Kuk.

Source: (Map by the authors, with contributions from Kong L. and A. Loyless).

mounds scattered across the landscape, and with a network of large-scale infrastructure imposed upon it. Importantly, the many thousands of occupation mounds and ponds at Sambor Prei Kuk, along with many of its temple sites, stretch far into the extra-mural spaces; the ‘enclosure’ encloses little aside from the principal shrines.

The fourth Pre-Angkorian urban complex for which we have detailed mapping is the ancient city associated with Wat Phou, in present-day Laos (Santoni et al. 1997; Santoni and Hawixbrock 1998; Santoni and Souksavatdy 1996), dating from around the 5th to 8th centuries. Like Sambor Prei Kuk, it sits on the floodplain astride a major river—the Mekong, in this case—with three walls of approximately 2 km on the other three sides forming an enclosure. Evidence for occupation is relatively sparse with a light scatter of occupation mounds, ponds, and temples, and although there is no evidence of a formally planned grid interior, there seem to have been multiple phases of wall construction, with three concentric wall systems radiating out from the river’s edge. Later phases of occupation from the Pre-Angkor and Angkor Periods consisting of a scattering of temples, ponds, and mounds lay further inland from the river and seem to reflect growing confidence in the construction of settlements further away from major water sources, in tandem with the development of more sophisticated techniques for water management (Lorrillard 2010).

Urbanism at Angkor

As detailed by Chevance and Pottier (2023, this volume), urban development in the early centuries of the Angkor Period also experimented—perhaps not always successfully—with major centres located in highland areas further away from the flooded lowland areas that were traditionally the locus of Khmer settlements, in a trend that we can also identify in other parts of the Angkorian World (see Heng 2023, this volume). The Angkor plain is dotted with well over a thousand local temple sites from the Pre-Angkor and Angkor Period consisting of moated temple-mounds surrounded by ponds and occupation mounds (Evans et al. 2007), and Pottier (2017) makes a convincing case that one cluster, in particular, centred on the temple-mountain of Ak Yum, emerged as the first major capital of the area during the Pre-Angkor Period (see Chevance and Pottier 2023, this volume). Alongside this, Pottier proposes that this city, named Bhavapura, emerged in the 6th century and was characterised by a cardinal aligned grid system, as well as a prototype of the giant reservoir or *baray* that would come to characterise later stages of Angkor’s development. Both of these would represent major innovations in urban planning, predating by centuries the development of analogous infrastructure on Phnom Kulen in the 8th to 9th centuries (Chevance et al. 2019). This view directly challenges the conventional view that large-scale urbanism and ‘capital cities’ developed in areas distant from Angkor and instead traces the origins of Angkorian urbanism back several centuries within Angkor itself. However, the precise structure of Bhavapura is partly obscured and confused by subsequent urban developments, and further work will be required to fully disentangle the palimpsest in this area.

With the establishment of Mahendraparvata as capital on the Phnom Kulen massif at the turn of the 8th to 9th centuries CE, we see the earliest and clearest example of the disengagement of Khmer habitation from flooded lowlands, as part of a project of city-building that seems to have been planned and executed by the Angkorian state within a relatively brief period of time (Chevance et al. 2019). Apparently drawing on previous elements from Bhavapura, the king, Jayavarman II, unsuccessfully attempted the construction of a *baray*—which were typically fashioned of earth—by quarrying deep into raw stone atop the plateau. Although there is evidence of residential enclosures and habitation on the plateau, there are few or no occupation mounds,

since there is no need to keep residence above the floodwaters; no evidence for flooded rice field systems; and, instead of excavated ponds, usually small earthen dams. Like Bhavapura, it lacks the enclosures that were characteristic of Khmer cities outside of Angkor from the 6th to 8th centuries. Mahendraparvata thus represents a sharp departure from classical forms of Khmer urbanism. The experiment was short lived, with the capital returning within a few decades to the plains of Angkor, where it would stay for most of the next five or six centuries (Chevance et al. 2019).

The capital of Hariharālaya, built atop several thousand years of continuous occupation, marks a return to a more organic urban form that took advantage of the legacy of the previous habitation on mounds at the edge of the floodplain of the great lake, the Tonle Sap. Although partly formalised and structured into a kind of sacred geography in some areas and containing some infrastructural elements that offer axes in the urban space, Hariharālaya has no grid system, and it also has no overall enclosure. It consists of a central nucleus of monuments, comprising a well-organised space out of which radiates a sprawl of ponds, mounds, and community temples. It is, therefore, characteristic of the ‘open cities’ that we see in Angkor for the first several centuries of its existence as the capital of the Khmer Empire (Pottier 2012). This pattern was repeated in the initial stages of Yaśodharapura at Angkor from the 9th to 11th centuries and also in the city of the East Baray built by king Rajendravarman in the 10th century.

A brief exception to this model of lowland capital cities comes in the form of Koh Ker, some 100 km to the east of Angkor, in which we can identify an attempt to take the defining elements of the open, unstructured urban layouts of the Angkor floodplain and reproduce them in the gently rolling hills of present-day Preah Vihear province (Evans 2010). As with Mahendraparvata, there are few occupation mounds here, most of the monumental remains date from a single period, and ill-conceived infrastructural projects may have contributed to its ephemeral tenure as the capital of the Khmer Empire (Lustig et al. 2018).

Urban Development in the 11th to 13th Centuries

By the 11th century, the open city model at Angkor had developed to the point where densely inhabited nuclei—in particular forming around current and former capital city locations—punctuated a broad, landscape-scale fabric of community temples, ponds, and occupation areas, which began to expand and become tied together with the urban core at Yaśodharapura by significant amounts of infrastructure (Carter et al. 2018; Evans 2016; Evans et al. 2007, 2013; Gaucher 2017; Klassen et al. 2021). By the 11th to 12th centuries, the open cities of Angkor came to be replaced, at least in part, by the development of the colossal walls of Angkor Thom (Gaucher 2017). Angkor Thom had reached more or less its final (and current) form by the 13th century, but it was elaborated in stages over centuries. Around the time of the reign of Jayavarman VII, Angkor achieved more or less the morphology that we see depicted on maps of the Greater Angkor region today. It consisted of a densely inhabited, formally planned urban core of around 40 km² with many thousands of ponds organised along an urban grid that extended far into extramural areas beyond Angkor Thom. This civic-ceremonial core was surrounded by a vast, low-density network of mixed residential and agricultural space, punctuated here and there by nodes of high-density occupation such as at Beng Mealea and tied together into a coherent system by a pervasive network of canal and embankment infrastructure (Carter et al. 2021; Klassen et al. 2021).

Meanwhile, at a smaller scale than that of the settlement complex, the development of true ‘temple-cities’ from the 11th to 13th centuries can be defined using lidar data, as the increasing amount of space between ever-larger monuments and their enclosure walls becomes organised

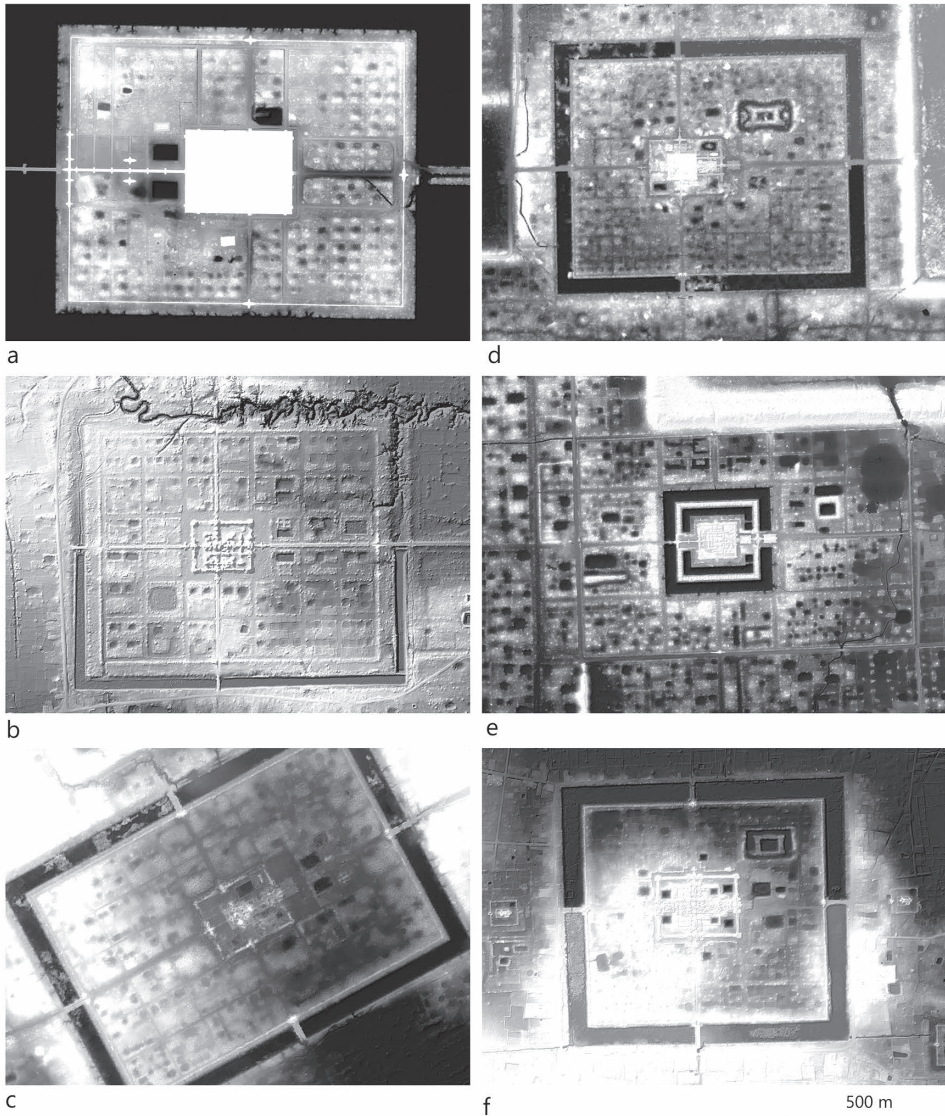


Figure 10.5 Lidar renderings of gridded urban areas of the Angkor Period: a) Angkor Wat; b) Beng Mealea; c) Preah Khan of Kompong Svay; d) Preah Khan of Angkor; e) Ta Prohm; f) Banteay Chhmar. Data from KALC 2012 and CALI 2015. All images are the same scale.

into systematic grid patterns of mounds and ponds (Figure 10.5) (Evans 2016). Sometimes, as with Beng Mealea, these ‘temple-cities’ form nodes within the extended agro-urban complex; in other cases, as with Ta Prohm, for example, they are firmly embedded in the occupational matrix of the urban core. Recent excavations have provided proof of habitation within these temple precincts, including at Ta Prohm and Angkor Wat (Carter et al. 2018; Stark et al. 2015). Overall, at its height in the 13th century, the region of Greater Angkor was likely home to around 700,000 people (Klassen et al. 2021).

Angkorian Urbanism Beyond Angkor

In 2015, airborne lidar data were acquired over the 11th- to 13th-century temple complex of Preah Khan of Kompong Svay, a provincial industrial centre located 100 km to the east of Angkor, where many years of study using conventional sensors and ground survey had led to the conclusion that the area inside its enclosure wall—at 5 km on each side, the largest in Southeast Asia—was very sparsely inhabited (Hendrickson and Evans 2015), presenting us with something of an anomaly in the history of Khmer urbanism until that point. However, the lidar data clearly revealed an urban layout within the central moat of the site that is analogous to the early 12th-century grids of Angkor Wat and Beng Mealea—complete with the enigmatic ‘coiled’ embankments. Surrounding the main temple moat is an extended, less-organised urban grid that resembles the late-Angkorian urban centres of Jayavarman VII. Excavations completed at Preah Khan in 2016 led by Mitch Hendrickson and colleagues confirm the accuracy of interpretations of archaeological topography visible within the lidar data. While it remains true that Preah Khan’s enclosure seems less densely populated than large enclosures such as Angkor Thom, the evidence for occupation is nonetheless rich and unequivocal, with spatial patterning that fits neatly within schemes of urban development in the Angkorian World.

The same cannot be said of Banteay Chhmar, a provincial centre of the 12th to 13th centuries, located in an arid zone that shows evidence of an extensive water management system (Evans et al. 2011). The new lidar data essentially confirm previous mapping work and do not significantly change the overall interpretation of the archaeological topography. Among all the 11th- to 13th century CE temples of the Khmer, Banteay Chhmar is the only one so far mapped with lidar that shows almost no evidence of a formal urban grid extending throughout any of its successive enclosures and represents a (so far) unique exception to the model of urban development we propose here for the Angkor Period, in which ‘open cities’ gradually evolve into urban complexes with formally planned urban cores by the 12th to 13th centuries CE. The reasons for this are unclear: was Banteay Chhmar a ‘city’, or was it a ‘garrison-temple’ on the fringes of the empire that was inhabited ephemerally or episodically (Sharrock 2015)?

After Angkor

In order to arrive at a relatively complete and consistent view of the development of Khmer urbanism over the course of two millennia or more, airborne lidar data were also acquired over the Post-Angkorian capital regions of Longvek and Oudong, far to the south of Angkor near present-day Phnom Penh (Evans 2016). From the 15th century onwards, this region was the location of the Cambodian capitals of the Early Modern Period. The issue of settlement size and structure in the capitals that came after Angkor is also relevant to the study of the demise of Angkor as the capital of the Khmer Empire and its gradual depopulation up until the 19th century: the tempo of Angkor’s decline is a matter of ongoing research interest (Carter et al. 2019; Hall et al. 2021; Lucero et al. 2015; Penny et al. 2019), and understanding Early Modern settlement patterns may offer important insight into patterns of migration from Angkor (Evans 2016). Our understanding of this area has been considerably enhanced by further remote sensing, survey, and excavation work that is described elsewhere in this collection (see Polkinghorne and Sato 2023, this volume), so only a brief summary is warranted here.

Essentially, the mapping work at Middle Period capitals reveals only sparse evidence for occupation in the form of subtle topographic traces within spaces that are either bounded (as in the case of Longvek) or open (as in the case of all other capitals). Traces that we associate with ‘classic’ Khmer urbanism from the middle of the first millennium CE onward, such as the

remains of ponds, occupation mounds, and moated-mound community temples, are poorly represented in this landscape. Polkinghorne et al. (2018) nonetheless argue for substantial populations in these areas, even if the configuration of the built environment differed substantially from that of the Angkor Period and has less visibility in the archaeological record—a conclusion that would be consistent with other important shifts in material culture in the Early Modern Period.

Discussion

Our survey of the literature on Angkorian settlement patterns reveals the extraordinary progress that has been made since the 1990s, when Cambodia began to emerge from decades of conflict, setting the stage for systematic exploration and analysis of archaeological landscapes at scale using aerial photography in concert with innovative and emerging technologies such as GPS, GIS, airborne radar and lidar, and very-high-resolution satellite imagery. Before this work began, maps of Angkorian settlement complexes were largely schematic in nature, consisting of a scatter of points around large infrastructural elements and the major temple complexes. Twenty years ago, arguments that Angkor was an ‘orthogenetic’ ceremonial centre that was sparsely populated and dedicated largely to ritual and administrative functions (Miksic 2000), or that the walls of Angkor Thom in the 12th to 13th centuries fully enclosed the only ‘true’ urban context at Angkor (Gaucher 2002, 2003b), were reasonable and tenable positions held by widely respected scholars. Today, it is difficult to see how these perspectives might survive the evidence.

Nonetheless, there are a number of broad lacunae in our understanding of the lived-in spaces of the Angkorian World and some significant issues with definitions and terminology that hinder our ability to draw broad and meaningful conclusions from the data, alongside a range of other methodological and theoretical problems that must be acknowledged to allow a full and fair appraisal of the results and set the stage for future research directions. Some of these issues are by now well known, and researchers have begun to address them in detail. For example, it is relatively difficult to draw chronological information from remotely sensed data, and systematic efforts are being made to link map datasets to related datasets from art history, architecture, and epigraphy that offer finer-grained chronological data and set the stage for mapping the development of urban spaces over space and time (Klassen et al. 2018, 2021). Others are more obscure and are worth discussing here.

Low-Density Urbanism and Cities: Scale and Definitions

Probably the most significant and far-reaching consequence of the last three decades of landscape archaeology in the Angkorian World has been to inspire a broad re-appraisal of lived-in spaces in early Southeast Asia, which in turn has informed emerging perspectives on diverse trajectories of urbanism Worldwide, especially in the tropics (Graham and Isendahl 2018). In particular, we now recognise that the conventional definitions of ‘cities’ that derive from other archaeological traditions—such as studies of the Classical World and the Near East, in which ‘urban’ spaces are clearly delineated and differentiated from the ‘non-urban’ or ‘rural’ spaces that lay beyond—are entirely inadequate for describing Khmer residential patterning (Fletcher 2020). The survey of the state of the art that we have provided shows that, although enclosures bound parts of Khmer settlements, the formally planned urban spaces in these intra-mural spaces frequently spill beyond the ‘enclosing’ walls and go on to merge gradually and imperceptibly into low-density residential landscapes incorporating fields and gardens.

Research work produced by the Greater Angkor Project has generally avoided using the term ‘cities’ to describe this patterning of lived-in space since the word ‘city’ conjures up images of the walled cities of classical antiquity. Instead, scholarship in recent years typically defines Khmer habitation zones as ‘settlement complexes’ characterised by ‘low-density agrarian-based urbanism,’ in which a central, densely populated civic-ceremonial centre is surrounded by an extended hinterland of diffuse urban and agricultural spaces containing occasional nodes of high-density occupation (Fletcher 2009, 2012). In general, a system of infrastructure such as roads and canals radiates out from the centre, permeating the low-density sprawl and lending functional and material coherence to the settlement complex as a whole (Evans et al. 2007).

Although this approach to categorisation neatly elides the problematic category of a ‘city’, there remains a good deal of confusion and imprecision about the distinction between ‘urban’ and ‘rural’ in the archaeological literature, which has given rise to an extensive body of work discussing whether the kind of diffuse residential patterning we see in the homelands of the Maya and Khmer is ‘urban’ or ‘rural’ by definition (Michelet and Nondédéo 2019), where and when ‘hinterland’ (Klassen et al. 2021) or ‘peri-urban’ (Evans et al. 2013) areas begin, and whether we should describe those in terms of ‘low-density urbanism’ or ‘high-density ruralism’ (Scarborough et al. 2012); whether labels such as ‘garden cities’ or even ‘forest gardens’ may be more appropriate (Isendahl 2012); whether terms such as ‘agro-urban landscapes’ should be adopted to accommodate new perspectives on residential patterning in the tropical world (Graham and Isendahl 2018); or whether we may simply settle on ‘low-density cities’ for some places while divorcing the concept of ‘density’ from ‘urbanism’ altogether (Graham and Isendahl 2018).

Notable throughout much of this literature is the absence of precise and uniform criteria against which we may reliably define a given part of the landscape as belonging to one category or another. Michelet and Nondédéo (2019) characterise much of this work as ‘fake feuds’ about urbanism deriving from confusion and imprecision in the definitions of ‘urban’ and ‘rural’, and, as Fletcher (2020) has observed, ‘it is now clear that definitions of urbanism are regionally specific and that global definitions have become tenuous and increasingly decoupled from material actuality’. In rare cases, authors have attempted to systematise their classification using quantitative approaches drawn from material culture (e.g. Canuto et al. 2018), but these are based on criteria specific to the local archaeological record (stucco remains in the case of the Maya World) and may not be broadly applicable to other archaeological contexts such as the Angkorian World. Many archaeologists make a compelling case that studies of urbanism from the deep past to the present day are important for understanding the resilience and vulnerability of the sprawling low-density cities which increasingly define present-day urbanism (Hawken and Fletcher 2021; Ortman et al. 2020; Smith et al. 2021), but the categories upon which archaeologists have long relied for classifying lived-in spaces clearly provide us with a poor foundation for this kind of work.

Instead, research on urbanism in the Angkorian World brings into sharp relief some of the challenges and opportunities with this broader comparative project. The first major challenge is that the comparative frameworks proposed by Smith and others still require arbitrary and specific definitions of lived-in spaces at various scales of space and time, in order, for example, to define ‘a settlement’ or ‘a neighbourhood’ and its trajectory of growth and decline (Smith et al. 2021; Smith 2020). The ‘messy’ archaeological landscapes of the Khmer, frequently lacking distinct boundaries between different types of spaces, underscore the need to move beyond these kinds of arbitrary categories and focus instead on continuous fields of density of occupation across the landscape, moving seamlessly through multiple spatial scales without pre-supposing an ‘appropriate’ or ‘natural’ scale for the study of lived-in spaces of one category or another (Hawken and Fletcher 2021). This kind of approach offers the possibility of undertaking truly

global comparative studies and segues neatly into new perspectives offered by settlement scaling theory (Ortman et al. 2020), which has already begun to make an impact on the study of Khmer urbanism by offering insights into how population densities at different scales contributed to specific kinds of social, political and agricultural organisation (Klassen et al. 2021).

Missing Pieces of the Puzzle

These kinds of quantitative studies of population density across time and space underpin many of the most recent studies of Angkor and inform our latest perspectives on the overall demography and morphology of the agro-urban landscape (Carter et al. 2018, 2019, 2021; Klassen et al. 2018, 2021). The calculation of population density, however, rests on a number of assumptions drawn from household archaeology (see Carter et al. 2023, this volume) and from the study of traces that remain on the surface in the present day. It is important to acknowledge these assumptions here, since it will help us to appraise the precision of the work that has been published and point to a number of useful future directions for research.

One of the core assumptions in this recent work is that the existence of a religious shrine, relatively modest in size in comparison to the better-known temples of Angkor and characterised as ‘local temples’ or ‘community temples’ (Carter et al. 2021), lay at the centre of substantial communities of sedentary agriculturalists during the Angkor Period and that the size of those communities can be inferred from the spatial coverage of occupation mounds and ponds associated with that particular temple foundation (Klassen et al. 2018, 2021). For now, this is a working assumption, and although it is a reasonable assumption given the range of epigraphic and archaeological evidence for habitation around *some* of those temples (Bâty 2005; Klassen et al. 2021), it should be acknowledged that we so far have an extremely limited number of excavations to draw from in inferring population densities outside of the urban core of Angkor and that much of our thinking about the role of ‘community temples’ in the Angkorian World draws from ethnographic analogy with the role of Theravada Buddhist pagodas in contemporary village contexts across mainland Southeast Asia.

Beyond the pioneering work done by Bâty and colleagues, the nature of occupation around community temple sites is a question that will need to be solved by wide-area archaeological excavations across a wide selection of sites, in much the same way as Stark, Carter, and colleagues have pioneered household archaeology in the urban centres of Angkor (Carter et al. 2018, 2019; Stark et al. 2015). The lack of sustained archaeological investigation into the nature of residence alongside roads and canals, and atop other elements of infrastructure in the Angkorian World such as the banks of reservoirs and ponds, is also a matter of concern: by and large, for the time being, habitation in those areas is simply assumed. Moving forward, the study of occupation density based on ceramic material and other durable remains such as macrobotanicals may be complemented by other techniques for estimating population density, such as seeking biochemical markers like faecal stanols, as has been done, for example, in the Maya World (Keenan et al. 2021).

Another major concern derives from our use of durable components of the archaeological record—patterned mounds and depressions that remain inscribed on the landscape—as a proxy for certain kinds of residential and agricultural activity. As pointed out by Hawken in this volume (Hawken and Castillo 2023), based on many years of observations on the ground working alongside rice farmers, a substantial amount of Angkor’s population was likely seasonally mobile, living among rice fields during periods of intensive agricultural activity. It is certain that tens of thousands of people would have migrated on a seasonal basis to the urban core for work on infrastructural projects. To what extent, then, may our estimates of Angkor’s

population be inflated by ‘double-counting’ residential infrastructure that was used seasonally by the same population? In a similar vein, the lack of obvious surface evidence for certain kinds of rice agriculture (e.g., swidden cultivation and retreating flood rice agriculture) may also be further muddying our perception of the complex mosaic of habitation and agricultural spaces in the Angkorian World. Methods from biogeochemistry—analysing soil chemistry and sampling environmental DNA, for example—may help to elucidate certain patterns of activity that have been obscured by a focus on macro remains (and offer perhaps our only pathway to solving the perennial debate about irrigation and multi-cropping in the ‘hydraulic city’ of Angkor).

A further issue related to transience and visibility in the archaeological record relates to those living on the margins and peripheries of Angkorian settlement complexes and of the Angkorian World as a whole. Mainland Southeast Asia during the time of Angkor, as today, contains a great deal of ethnolinguistic variation and diverse material cultures, many of which are likely to be poorly represented in the surface archaeological record. The work of Hendrickson et al., for example, shows that the Kuay people played an outsized role in the industry of Angkor, well represented in terms of material remains—and yet their patterns of habitation are poorly understood in the archaeological record, which has likely contributed to some long-standing confusion about the nature of occupation at Preah Khan of Kompong Svay and beyond (Hendrickson and Evans 2015; Pryce et al. 2014). Zhou Dagan mentions highland people on the forested periphery of Angkor who were engaged in the provision of valued goods for the city centre (Zhou 2007[1297]). We know that the ‘urban’ and ‘agricultural’ areas of Angkor sprawled into those areas, that increasing contact took place during the Angkor Period (see Heng 2023, this volume), and that major centres such as Mahendraparvata were located in highland regions (Chevance et al. 2019). How might these populations, otherwise largely absent from the discourse on Angkor, be identified and incorporated into our models of socio-ecological dynamics?

Conclusion

Our survey highlights the tremendous progress that has been made in recent years in understanding the diverse trajectories of urbanism in the early Khmer world while underscoring specific areas of work where further research is required. The pattern that emerges is of gradual and continuous development and experimentation with different forms of urbanism over time, for example, as the enclosed cities of the Pre-Angkor Period gave way to the open cities of the early Angkor Period, followed by a time of extremely intense infrastructural development and innovation in the 11th to 13th centuries characterised by rigidly formalised city grids and the imposition of giant walled enclosures in pre-existing urban spaces. Urban agglomerations located in the traditional homeland of the Khmer—seasonally inundated floodplains—persisted for several centuries, supported by elaborate and successful hydraulic works, while urban complexes that emerged in highland areas such as Koh Ker and Mahendraparvata, on the other hand, were short lived and beset by engineering problems. Between and beyond these centres, a vast, diffuse mosaic of community temples and walled rice fields permeated the flooded lowlands of the Angkorian World.

It is difficult, for now, to draw definitive conclusions about the implications for Khmer society from the spatial patterns of these layouts. It is clear that anthropological approaches used in similar contexts Worldwide, such as the use of Gini coefficients to explore wealth inequality, are not applicable in the Angkorian World, since we lack the granular data on residential patterning that are necessary for such approaches. On the other hand, new approaches such as settlement scaling theory offer us promising opportunities for exploring the articulation between urban

morphologies and socio-economic developments. These kinds of theoretical approaches provide an overarching rationale for the kind of comparative approaches between ‘tropical forest civilisations’ proposed by Michael D. Coe more than half a century ago (1957, 1961). Furthermore, the arrival of consistent and comparable datasets in the form of lidar has set the stage for rigorous, systematic, and quantitative studies that move beyond anecdotal observations about the similarities of settlement complexes in different parts of the world and between cities past and present.

Eventually, this work may live up to the promise that the archaeological record of urban environments in the Angkorian World has important insights to offer us in terms of contemporary urbanism and urban futures. So far, efforts to draw relevance have landed on some fairly straightforward observations that reflect core principles in the design of sustainable urban systems: that we ought to have green space and biodiversity, that infrastructural systems should have multiple points of redundancy, and that massive infrastructural works are inertial and impose unforeseen costs and consequences on future generations. What we can see for the time being, therefore, is not so much the study of archaeology informing urban futures but rather contemporary urban studies providing a window through which we can understand the successes and failures of past urban models. However, as the study of urbanism in the Angkorian World moves past old debates about ‘hydraulic cities’; better acknowledges its current shortcomings; and adopts more rigorous, systematic, and quantitative approaches to the data now available, we should expect that research on Khmer settlement patterns will be more broadly impactful in terms of understanding trajectories of urbanism from the deep past to the present.

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