Harvesting the winds, harvesting the rain: an introduction to the issue on *Inhabiting the Tropical Worlds*

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Introduction

The tropics occupy one third of the earth's landmass and are home to more than 40% of the global population. They were destinations of many voyages that changed modern human history and the location of many of the greatest scientific discoveries and observations that have profoundly shaped the direction and advancement of scientific research (e.g. Charles Darwin's Galapagos experiences). They continue to stimulate great public interest—Sir David Attenborough's popular tropical television documentaries are a great manifestation of this—and shift the boundaries of our scientific quest into the planet's natural history. The latter includes recent scientific recognition of the importance of carbon storage and sequestration in Africa's tropical forests and wetlands and how these processes might contribute to further our understanding of global carbon cycles and ecological changes (Lewis et al. 2009).

Despite these great scientific achievements, the tropics remain largely remote and often exotic imaginaries in mainstream academic discourse and our understanding of the deep histories of tropical inhabitation and human adaptation is particularly sparse (although see Mercader 2003), compared to that of the global temperate zones. The gaps in our knowledge of tropical human pasts have also commonly led to the isolation of tropical societies from consideration in broader syntheses, with the lowland American tropics being perhaps best served (e.g. Clasby and Nesbitt 2021; Lippi 2004; Stahl 1995). Although some recent archaeological discoveries have brought the tropics into the spotlight in efforts to establish an inclusive global history (e.g. Bulliet et al. 2014), the archaeology of the tropics is still underrepresented despite the recent attempts to highlight the importance of tropical rainforests to understanding both the 'deep history' of our species (Scerri et al. 2022) and 'the Anthropocene' (Roberts, Hamilton and Piperno 2021). In academic debates on the fundamental archaeological questions such as the origins of modern humans, agriculture and early states, the voice of tropical archaeology in all their ecological complexity remains limited. One of the technical challenges in the archaeology of tropical inhabitation, as acknowledged by many researchers, is the generally poor preservation of not only palaeo-ecological evidence but also perishable architectural remains of past lives due to the common (although by no means universal) acid soil conditions and other taphonomic issues (but note also that earthen and stone architecture can be well preserved in some tropical settings). Although the growing application of scientific techniques has started to overturn wholly negative pictures of what the tropics can offer us to disentangle their complicated histories, the macroscopic perspectives and microscopic observations that are increasingly adopted by scholars remain to be robustly integrated to create more holistic reconstructions of how ancient populations interacted with their environments. Indeed, our appreciation of the exceptional

diversity of tropical inhabitation is only in its infancy, as is recognition of the significantly varied historical processes that underpin such an intrinsic diversity. Hence, one of the main objectives of this issue of *World Archaeology* is to bridge the analytical divide between 'household archaeology' and 'landscape archaeology' through integrating multi-faceted and multi-scalar evidence on domestic lives and land-use histories in diverse tropical environments. The contributing syntheses and case studies here meet this intention but also touch upon several old and new trends in the archaeology of tropical inhabitation, which we explore here in this editorial introduction.

What defines the tropics: tropical climates, environments, and biodiversity

Climate across the continents and numerous islands and archipelagos of the tropics is primarily influenced by rainforest-, monsoon-, and savanna- climate systems. As the most representative of these, tropical rainforest climate zones receive ample rainfall throughout the year without marked seasonal variations. Comparatively, whilst the other two tropical climates are distinctively comprised of wet and dry seasons, the variation in annual precipitation in those regions that are controlled by savanna climates is exceptionally high, resulting in frequent droughts and floods in many tropical regions, for example in parts of Madagascar. These have been experienced with escalating severity in recent years. The spatial distribution of rainfall in tropical Africa is especially uneven (Balek 1977, 26), with some areas receiving as little as 250mm annual precipitation compared to 3000mm in others. Some of the countries in mainland Southeast Asia, too, have an extremely prolonged dry winter. Managing such an extreme seasonality is both a great challenge as well as an opportunity for the societies living and prospering here (e.g. Marengo and Espinoza 2015). Compared to the temperate zones, tropical regions are also more frequently fraught with medium-term climate change (e.g. the El Niño phenomenon) and extreme weather events such as hurricanes and typhoons that can have devastating consequences for local communities.

Tropical climate and environments evolve in tandem, and indeed in some tropical regions the change in Holocene tropical climates and environments has been dramatic. Archaeologists have long been aware of the significant implications of the marked changes in climate seasonality and environmental conditions for tropical civilizations. For example, Halin (2nd century BC to 9th century AD), as one of the ancient cities of the Pyu Kingdom, was situated in an especially dry zone in central Myanmar and saw the development and expansion of an enormous urban and rural hydraulic network that sustained the fluorescence of the Pyu Kingdom even as its population grew and water stress escalated. Iannone et al.'s contribution to this issue, based on their multi-season survey, has focused on the 'classical' Bagan period's peri-urban development, but it is important to note that the interaction between this climate and environmental seasonality and social development extends much earlier in time in Central Myanmar and many other similar environments in the tropics such as Angkor Wat (e.g. Buckley et al. 2010).

Adapted to these volatile climate systems, tropical environments are characterized by their unparalleled biodiversity. Whilst much research attention has been given to illustrating tropical biodiversity, it is the diverse environmental conditions such as hydrology, soil, vegetation, and landforms (these overlap largely with the so-called geodiversity) that directly shape the incredibly rich and varied subsistence strategies that support tropical inhabitation (some of these strategies are unfortunately rapidly disappearing). These environmental parameters change at multiple scales, ranging from small hillslopes and valleys, offshore islands, and large alluvial plains, to the continents of the tropical worlds. Simplistic generalizations such as the common assertion that the poor soil conditions in the tropics restrict agricultural intensification and long-term sustainable, socioeconomic developments are no longer justified. As has been demonstrated by many recent studies and briefly discussed below, whilst soils in some regions are sterile, in many other places, tropical soil systems contain abundant nutrients and organic matter. Amazon Dark Earths (ADEs) (Arroyo-Kalin 2017) are a good example of this, although their genesis as anthropogenically created soils and their sources of nutrients continue to be debated (e.g. Lombardo et al. in press; Silva et al. 2021). Additionally, some tropical ecosystems also possess a unique ability to self-replenish, holding great potential for sustainable farming and other economic practices. Farr's contribution to this issue provides a well-presented case on the critical role termite mounds and reworked soil play in increasing soil fertility across the tropical worlds.

In addition to the large-or-medium scale hydrological fluctuations between different environmental zones that are controlled by various tropical climate systems, small-scale hydrological change is equally complicated even within a limited geographical area. In an erosion valley, which is a widespread landform in tropical regions, for instance, hydrological situations can vary dramatically between different parts of the valley. In such a system, water flows as surface runoff, through various channels and creeks at different points along the valley, and as groundwater (Dykes and Thornes 2000). Combined with the often highly heterogeneous soil conditions, the hydrological regimes in the upper, middle, and lower catchments and on the two flanks of the small valley respond to erosion, surface clearance, logging, and other forms of disturbances or seasonal changes differently. Such hydrological and soil conditions have a profound impact in shaping some characteristic land uses in the tropics, as has been explored, for instance, in the vicinity of Kuk Swamp, highland Papua New Guinea (Denham and Grono 2017).

Similar to this heterogeneity in soil and hydrology, landforms in many tropical regions are also highly variable. Apart from alluvial processes, hillslope erosion is one of the most common geomorphological processes especially on tropical highlands in Africa (e.g. Ethiopia, Uganda, Kenya, and Madagascar) and elsewhere. Such processes occur naturally, but it can often be accelerated by agriculture and other land-use activities (e.g. Ciampalini et al. 2012; Heckmann 2014), creating some of the most characteristic hillslope-valley systems in the tropics. These valley systems were also places where

early settlements appeared (partly because the colluvial deposits that accumulate following erosion can offer considerable agricultural potential), and have therefore become a focal point in academic debate on the relationship between early tropical inhabitation and the formation of such unique landforms (e.g. in Madagascar, Wright 2007). Related to these issues of hillslope dynamics, albeit at larger geographical scale, are the historical and political ecologies of tropical mountains. James Scott's (2009) seminal contribution has drawn scholarly attention to the importance of tropical mountains, in parallel to valleys and other landforms, to our reconsideration of the evolution of tropical societies. The Ryukyu archipelago to the southwest of Kyushyu shares similarities with many tropical islands in terms of climate and vegetation. A recent study has further demonstrated a 'unique Ryukyu trajectory of Neolithization' in that mountains, along with lowland coasts, were vital to the maintenance of a wide spectrum of subsistence practices (Ito 2014). Coastal seascapes are another type of characteristic tropic landform. While not unique to tropical regions, coastal landforms constitute a key component of tropical environments and their incredibly rich resources have long attracted ancient and more recent communities for fishing and other economic activities (Fitzpatrick and Giovas 2021), and also spiritual significance and resonances (e.g. McNiven 2004).

To sum up, there are unique environmental characteristics in the tropics that contributed to the shaping of diverse land-use activities, subsistence strategies and forms of tropical inhabitation in the past and continue to do so in the present. First, few, if any, tropical zones such as forests are pristine or untouched, nor are they 'humid desert' (Rostain 2013), only being connected to the outside world in later historic times. Rather, several scholars (e.g. Meracder 2003; Roberts et al. 2018; Roosevelt 2013; Scerri et al. 2022) have convincingly demonstrated, early human engagements with the tropical forests and other ecological zones have now been traced back to the Pleistocene confirming that the tropics constituted an integral part of our collective deep, global human pasts. Second, parallel with the remarkable biodiversity in the tropics is the patchiness of natural resources such as soils and landforms that are subject to multi-scalar changes within even micro-or-medium habitats. These are inherent constrains that affect patterns of tropical inhabitation. In the ongoing academic debate on the spread of Malayo-Polynesian languages and farming across Southeast Asia, recent reconstructions of palaeo-landscapes have shed new light and further unpacked this complicated historical process. For example, Carson and Hung (2018) have revealed that the coastal landscape in Taiwan and the northern Philippines was dominated by accelerating hill erosion and sedimentary aggradation in the lowland as well as active tectonic activities. The 'limited suitable landforms' in this unstable coastal setting significantly restrict development of certain economic modes such as large-scale rice farming, which consequently did not support large population growth (Carson and Hung 2018), although the causal relationship should be tested more rigorously in future investigations. Third, some tropical ecosystems such as wetlands are fragile and extremely sensitive to climate change and external disturbances. It is not news that African and Amazonian wetlands are disappearing at

an alarming rate (Dixon et al. 2016; Hu et al. 2017). Many great tropical civilizations saw an unprecedented scale of wetland alteration and epitomize the relationship between tropical inhabitation and the 'Early Anthropocene' hypothesis (Krause et al. 2021).

What feeds the tropics: knowledge, risk management and development of tropical inhabitation

As in other regions, the archaeology of tropical food production is concerned with two major issues: the beginning of plant food production and animal husbandry, and the intensification processes that underpinned subsequent demographic growth and social and political developments. As mentioned, scientific archaeology has revolutionized our understanding of tropical plant domestication. It has revealed that tropical India, for instance, was home to independent domestication events of a wide variety of plants, both vegetable and cereal crops. More prominent examples include the domestication of maize, a more significant crop in terms of its influence on recent human history, in tropical Mesoamerica (see Roberts 2019, chapter 5 for a good summary). Knowledge on the environment, plants and soils plays a crucial role in the long and close engagements with the tropical ecosystems for food production. The accumulation of knowledge and its transmission between different genders and generations are important to sustaining food production and social developments, especially in circumstances when 'equitable access' to natural resources is important for supporting gender relations (Beinart 2009; Douglass et al. 2019; Robin 2006). For modern BaYaka hunter-gatherers of Congo, anthropological observations reveal that girls start engaging in foraging and similar activities as early as age six when joining adult women on 'foraging trips'. They learn knowledge and skills through 'imitation, observation and practice' (Salali et al. 2019). The early participation of girls in plant food gathering can also be seen in Borneo (Barker and Janowski 2011) and many other tropical places. Other similar studies have also shown that women played a more central role in plant gathering and the transmission of knowledge about these practices and the plant world. Comparatively, it is more common for boys or adult men to participate in games and/or hunting activities, although such a gender division on specific food production activities is not absolute and there are many exceptions.

Forest management and the knowledge accumulated from close interactions with the forests have long been considered a vital strategy for hunters and gatherers or groups practicing mixed subsistence economies. Notable examples include the Jomon culture in Japan (albeit not in a tropical area) and many past and present Island Southeast populations (e.g. Hunt and Rabett 2014; Janowski et al. 2014). A recently emerging paradigm in the history of tropical food production is the so-called 'Forest Gardens' model which highlights the continuous importance of forests and their diverse resources to tropical inhabitation (Ford and Nigh 2015). The model was first proposed for tropical forests in Mesoamerica with 'eight millennia of sustainable cultivation of the tropical woodlands', as the title indicated. Engagements with such a distinctive tropical habitat can be seen in many other tropical regions in light of recent

archaeobotanical evidence (e.g. Castillo et al. 2020), and also in some contemporary societies (Roberts et al. 2017). On the other hand, even with the advent of agriculture, hunting-gathering continued to play an important role in local subsistence economies in areas such as northwest Thailand (Conrad et al. 2021) and in many tropical forests across the globe (Mercader 2003). Indeed, long after the introduction of cultivation, the intimate management of forests 'belies a rapid, destructive agricultural expansion' (Roberts 2019, 144). As Barker and colleagues clearly showed in their studies on why Island Southeast Asia adopted farming, mainly 'agricultural' peoples such as Penan and Chewong, as did their 'foraging' neighbours', heavily exploited forest- and other wild resources as a supplement to crop cultivation and for trade. Barker and colleagues proposed that foraging and farming are two components of a deeply entangled landscape that requires rich knowledge to manage (Barker and Janowski 2011). The unparalleled biodiversity and patchiness in sources discussed above creates both significant challenges to and opportunities for managing these entangled landscapes. Some habitats are also incredibly fluid and dynamic, with different habitats 'interspersing' with each other (e.g. Roberts 2019, 133), which would have also influenced tropical food production systems.

In managing tropical seascapes, whether for fishing or seafaring, understanding wind direction, currents and marine resource seasonality are all of paramount importance, without which early tropical migrants would not have been able to travel and colonize different parts of the tropics (Kirch 1985). Additionally, as Carson and Hung demonstrate in their contribution to this issue, knowledge or knowhow of tool making and other technological aspects would have also been instrumental in enabling early coastal or island occupants in the Marianas to explore the rich marine resources in the vast tropical seascape. They describe the development of a special device used for catching octopus. Their work greatly complements the existing ethnographic and historical records on marine food exploitation that can be traced back beyond 1000 BCE in possibly a much wider range of tropical regions.

For tropical farming, central to the debate on the mode of tropical plant food production is whether or not tropical soils can sustain long-term cultivation and if soil amendment is required to secure soil fertility. Knowledge on soil and ecological conditions and how they can be best manoeuvred is indispensable to food production and sustainable development. In his synthetic contribution to this issue, Farr uses examples to illustrate the role of termite mounds in local farming practices that led to the formation of the Amazonian Dark Earths (*terra preta*). He also discusses the detailed knowledge held by many indigenous groups about termite mounds: some groups, for example, deliberately move termite nests and/or mounds to new locations to foster plants and for soil improvement and other ecological modifications. Termite mounds are nonetheless just one of the many sources in the tropical farmers' inventory for soil improvement. As already noted, routine and repeated deliberate discard of food waste and compound sweepings in household gardens and nearby fields have proved an effective means of enriching tropical soils in high rainfall areas

where leaching of nutrients is a significant challenge to farmers. The routine nature of such practices and their deep histories have transformed local soils, creating humic-rich dark earths in Amazonia (Lehman et al. 2003) and areas of West Africa (Fraser et al. 2014; Solomon et al. 2016). Planting strategies are another common means of enabling soil improvement (Wiersum 2004) and for providing protection against soil erosion and excessive leaching of nutrients, as especially well illustrated by Chagga banana forests and home-gardens on Mount Kilimanjaro, Tanzania (Hemp 2006). Elsewhere, rice farmers in Madagascar and other African regions still use abundant eco-fertilizers (Becker et al. 2003), including plants available in different seasons. Knowledge on the seasonality and physiological properties of the plants is required to use these fertilizers effectively (personal communication, Ramilson, Madagascar; see also Virtanen 2002 for the related role of Traditional Ecological Knowledge in managing sacred forests). Not just soil amendment but water management and many other technologies that have been invented for tropical farming and land-use management require sophisticated knowledge to operate and develop (Carson 2017; Davies 2009; Rostain 2013).

These diverse soil and plant regimes, as well as fields deliberately constructed for crop cultivation whether with stone terracing, such as the examples now identified in both forested and grassland areas of eastern NW Argentina (Zuccarelli Freire et al., this issue), or less elaborate mounding and soil bunds (e.g. Sillitoe 1998), might all be considered 'ecosystem engineers' that individually and as distinct 'assemblages' contribute to 'self-organizing' processes critical to the ecological resilience of tropical habitats (McKey et al. 2010). For many tropical farmers, knowledge is indeed about managing risk for achieving better adaptations and societal resilience. As also noted by other scholars, local knowledge is vital for 'small stakeholders' to withstand environmental stress (e.g. Roberts 2019, 185). Davies and Moore (2016, 67–68) revealed the 'hidden cultural resilience' in northern Kenya facing continuous external interventions and challenges. Farmers in Pokot and Marakwet communities have been practicing 'a complex system of both semi-permanent and shifting cultivation' with flexible managerial structures in an environment with diverse landforms and benefiting from an extensive irrigation network predating the colonial era. Davies and Moore argue that such 'smaller-scale' innovations and management bear great significance for understanding socio-ecological resilience. It has also been suggested that the mobile and small-scale farming in the Maya regions that concentrated on fertile soils continued to exist even after the 'decline' of the major political system (Lucero 2006; also see Wilk 1997 on agriculture and land organization in Maya culture). It is also clear that long-term histories of human inhabitation of the tropics, whether in high rainfall zones (Barker et al. 2017), or drier areas such as found in upland NW Argentina (Zuccarelli Freire et al., this issue) can create distinctive multi-species patchworks of biogeographical diversity that provide multiple socio-ecological affordances and risk-buffering opportunities. In the agropastoral landscapes of the El Alto-Ancasti mountain range, for example, the fruit from the 'Cebil' tree (*Anadenanthera colubrine* var. Cebil) was accorded particular cultural significance,

featuring in various ritual practices and in regional rock art, but was also traded more widely to establish ties and reciprocal relations that helped these communities 'weather' ecological and socio-political change.

As some of the recent syntheses have started to show, such small-scale farming and associated inhabitation patterns profoundly defined patterns of social agglomeration and urbanization in the tropics. The key to unpack such a complex relationship lies in understanding the wider environmental contexts and their implications to shaping land use histories of the region. Iannone et al.'s contribution to this issue touches upon the task of managing the peri-urban environment in Classical Bagan using their ethnoarchaeological data from ten traditional villages and excavation data. In an arid environment like Central Myanmar, the support population and their economic activities in the villages would have been essential to urban success. A particular challenge for archaeologists, however, has been identifying these village sites from often ephemeral and ambiguous material traces and reconstructing their spatial layout from surviving structural features. In this regard, Iannone et al.'s detailed ethnoarchaeological observations, informed by local knowledge and close observation of process of house construction, use, decay and collapse provide an excellent model that could help resolve this challenge, and so encourage greater archaeological consideration of *rural* dwelling practices in debates over local *urban* dynamics.

Heng (this issue) also explores the contributions of rural farming settlements to urban dynamics and their prosperity in some depth. Following the recent trend for landscape-oriented approaches to examining the trajectory of pre-Angkorian urban development on the Mekong River, Heng's multiple data show the upland and lowland dynamics before the rise of the Angkor Centre. Whilst the lowlands favoured expansion of rice agriculture and other subsistence practices, settlements in the uplands practiced swidden rice agriculture and exploited forest products. The role of the latter in early urban expansion was more important than previously thought. Guerin (2001 cited in Heng, this issue) pointed out that both lowland and upland cultivation offered 'a risk-management' strategy for populations across the entire region especially when the lowland and/or highland areas encountered environmental disasters. Similarly, Davies and others have noted the 'economic specialisation' in Eastern Africa due to great variations in environmental conditions and resources not only stimulated development of 'intensive agriculture' (Davies 2015, 1) but also offered 'alternative sources of livelihood and subsistence' to local communities at times of environmental crises in the region (on these, see Lane 2015, 9; Petek and Lane 2017; van der Plas et al. 2019).

A further set of issues that require consideration are those related to tropical environmental and economic intensification. Kirch and colleagues' (Kirch et al. 2004) several studies on precontact Polynesian landscapes demonstrate the decisive and dynamic role of soil and landform conditions to the formation of diverse farming practices in different parts of Polynesia. They first found that soils were considerably

richer in phosphorus at the base of hill slopes than in other zones, and 'predated the establishment of intensive agriculture' (Hartshorn et al. 2006; Vitousek et al. 2004). On upland surfaces, rapid depletion of soil nutrients fundamentally precluded the 'development of large-scale intensive dryland agricultural systems', especially on older islands. The establishment of irrigated agriculture might have mitigated adverse soil conditions, however. On marginal landscapes, Kirch and colleagues (2004) suggest that large-scale agriculture was possible on 'older, tephra-blanketed lava flows'. Additionally, precontact farming was concentrated on the cultivation of taro and sweet potato, which was able to support a large population, although the trajectories to social development and population expansion varied between different ecological zones. Vitousek et al. (2004) have pointed out that cultivation on dryland demands more labour while still producing smaller harvest or surpluses compared to irrigated agriculture, and they suggest was related, therefore, to the formation of the 'aggressive and expansive' chiefdoms that emerged on the younger islands of the Hawaiian archipelago.

Also known as home to pioneering manioc and sweet potato, recent studies in the Amazon Basin have similarly offered new material to change research perspectives. Manioc has a long cultivation history in the Amazon, with the date of its domestication now seeming to have been in the early Holocene (Olsen and Schall 2006). Debate surrounds whether manioc cultivation followed a mobile 'slash and burn' mode of farming or was practiced in 'gardens' as part of early development of 'polyculture agroforestry' (Iriarte et al. 2020; Lambardo et al. 2020; McMichael et al. 2012; Watling et al. 2018). There is also a suggestion that raised fields were built in some regions for cultivation, indicating a more permanent and larger-scale modification of the landscape, which was accompanied by earthwork construction and other more substantial labour investment in the landscape (Schann et al. 2013) sometimes also described as 'landesque capital' (see Arroyo-Kalin 2019 for clarifying definitions), that also had long-lasting benefits for local and regional biodiversity (Heckenberger et al. 2007).

Roland Fletcher and colleagues (Fletcher 2012; Lucero et al. 2015) famously proposed a model for 'low-density, agrarian-based urbanism' in Southeast Asia, where settlements were scattered around farming fields, irrigated infrastructures and other facilities. The model has received favourable responses and is considered to have been a 'common' strategy deeply entrenched in the seasonal and regional variations of the tropical environments (see Roberts 2019, 156 and chapter 6 for a comprehensive review and evaluation). The model highlights the extensive spatial distribution of urban infrastructures and supportive economic activities centred around the small temples, ponds, and residential mounds found across the Angkorian landscape, in parallel with the 'centripetal' pattern of ritual/religious and political organisations (Fletcher 2012; Lucero et al. 2015). Carter et al.'s (2018) recent studies further investigate some other aspects of urban inhabitation in the Greater Angkor region and how they were linked to urbanisation, drawing on excavation data from a few temple

sites. Because of the lack of evidence for craft production and other typical urban phenomena, they propose calling these spaces 'civic-ceremonial zones'. They emphasize that it is the agro-urban combination that defined Angkor Wat and some other Southeast Asia urbanism (Carter et al. 2018). The 'higher-density' zones were integrated with 'dispersed rural areas' that 'allowed for access to diverse ecological resources' to improve the viability of urban development (Carter et al. 2021, 12). Their studies of Greater Angkor agro-urbanism have been on the 'most granular and fundamental level', and are supplemented by Heng's regional data (Heng, this issue). These show how distinctive lowland and upland economic structures were developed, long pre-dating the Khmer Empire and that these systems became interdependent on each other, further stimulating intra-regional trade and economic prosperity along the Mekong River. These data therefore offer a new perspective, as Heng also elaborated, on James Scott's (2009) theory of 'not being governed'. Essentially, the interactions between rural, peri-urban or precinct regions and the urban centres in early Southeast urban systems were much more dynamic than previously thought. This echoes what Morrison, Junker and many other scholars have long suggested, namely, that the ecological and environmental diversity in the tropics might have caused greater economic specialization which in turn stimulated intra- and inter-regional exchange between different ethnic and economic groups (Morrison and Junker 2009; also see Roberts 2019, 201).

We do not have space to discuss urbanism in other key tropical regions such as Mesoamerica, the Indian subcontinent (e.g. in the Indus basin) and Africa (e.g., cities in the ancient Middle Niger). Yet, it is worth noting that urbanism in these regions shared similarities with the low-density urbanism in Southeast Asia but displayed significantly different patterns too that were related to the intrinsic biodiversity and environmental characteristics of these regions (Graham 1999; Graham and Isendahl 2018; McIntosh 2005; Green and Petrie 2018; Monroe 2018; Scarborough and Isendahl 2020).

Tropical Anthropocene and sustainable growth?

The importance of tropical rainforest, wetlands and other ecozones to regional and global-scale climate change has been emphasized by many recent studies (e.g. Boysen et al. 2014; Kume et al. 2011; Sjögersten et al. 2014). Tropical environments, especially tropical islands, have long been considered microcosms of global change (Kirch 1997). Understanding tropical inhabitation is crucial to disentangling discourses on the Anthropocene and in identifying and evaluating routes to future sustainability, both being heated (excuse the pun!) topics. Human interactions with the environment are extensive as well as increasingly intensive in the tropical worlds, with the emergence of some of the largest urban enterprises occurring first in the tropics, such as around Angkor Wat and Maya centres on the Yucatan peninsula. The scale of landscape modification such as deforestation, intensified farming, and channelization for irrigation and water transportation was enormous in both localities, and their impacts were far-reaching. These are clear indicators of an early Anthropocene, in its classic

sense, and might be relatively easier to trace and quantify than various kinds of stratigraphic marker. There are challenges, nonetheless, to disentangling multi-faceted interactions between different anthropogenic and environmental agents in the tropics, which are inherently related to diverse patterns of tropical inhabitation, some of which have been noted above. As Barker and colleagues have noted (see above) tropical forest environments managed by farmers and foragers are deeply entangled entities in which the boundaries between 'natural' and 'cultural' domains are interspersed (McKey et al. 2010). This renders it hard to differentiate the 'natural' from the 'cultural', let alone to quantify and assess the impact of 'cultural' interventions on the formation of tropical environments.

The effort to make such a distinction often lies in a 'tacit epistemological commitment' to such binary thinking accompanied by *a priori* belief in pre-disturbance baselines (Lane 2015, 490). An inherent danger associated with such thinking is that it leads to the reproduction of 'the Enlightenment idea that human action inherently acts against nature and so degrades it' (*idem*.). The unparalleled ecological biodiversity and the unique processes of economic intensification and social development in the tropics, some of which are briefly dealt with above and by the contributing articles in this issue, can also help determine the thresholds of environmental capacity and the bottlenecks of ecological responses (cf. Malhi et al. 2014) to increasing anthropogenic interventions, which further complicate the definition of a tropical Anthropocene. The close intimacy between environments and lifeways that is still extensively exercised by many tropical communities might also prove an innovative way for ensuring sustainable development. In their recent synthesis on soils and their long-neglected significance for understanding socio-political development, Tironi et al. (2020) offer numerous examples that show how 'Indigenous conceptualizations of soil' opens not only new avenues for epistemological diversity but also new terrains for political actions, particularly in the face of climate change' (page 8 in online version).

Generally, academic inquiry into sustainable growth in the tropics has followed a rather different scholarly discourse. A more recent focus on the food-energy-water nexus (e.g. Wallington and Cai 2017), coupled with the great enthusiasm to achieve sustainable farming in the tropics using traditional ecological knowledge and involving multiple agents and stakeholders (as in other climate regions of the world), offers greater scope for integrating archaeological insights and knowledge enacting these processes. Despite the increasing awareness of what archaeology can and cannot realistically achieve in improving wellbeing and sustainability in less-developed regions (Chirikure 2021; Richer et al. 2019; Morrison 2021), archaeology at least helps to identify 'the key components that moderated climate change vulnerability and sustained food production' and the interactions between them as well as why such 'integrations' were disrupted (Lane 2015, 495-6). The potential of understanding archaeological history and genesis of Amazon soils to shape new ontologies of and for the Anthropocene and sustainability in Amazonia (and in other tropical regions) can never be overstated (cf. Kawa 2016). As Kirch puts it, 'the more modern humanity

understands how its predecessors fashioned the earth we have inherited, the better … to achieve a sustainable relationship with our planet, our own little microcosm within the cosmos' (Kirch 1997, 39). The burgeoning application of archaeology in community-based sustainability projects has provided practical and beneficial lessons (Glaser 2007; Logan 2016; Isendahl and Smith 2013; Isendhal and Stump 2019). This realization also helps to highlight the importance of integrating ethnographic records within both the archaeology and sustainable development in the tropics (e.g. Walters et al. 2019). It will also help to challenge the 'hegemonic environmental policies and epistemologies' in the tropics (Farr, this issue). The integration of ethnography, physical and environmental science, and social science subjects is common to many of the articles in this issue, and these kinds of interdisciplinary studies for sustainable development in tropical regions have fostered new research horizons and perspectives. For example, anthropologists have started to explore the possibility of a degrowth in the sustainable development of the Amazon (Brightman and Lewis 2017). Recognition of the importance of embedding issues of environmental justice that draw on epistemologies of the South in the promotion of such strategies is growing (Singh 2019), and biocultural approaches to sustainability that seek to transcend conventional nature:culture binaries are also becoming more widespread (Hanspach et al. 2020; Velasco-Herrejón et al. 2022).

Conclusion

Through the characteristics that define what the tropical environments are and why they are distinctively different from those in other parts of the world, the archaeology of tropical inhabitation is faced with both challenges and opportunities. Tackling these issues requires rigorous examination of multi-disciplinary data and methodological and theoretical innovations. Contributors to this issue apply a suite of analytical methods and illustrate how such data could help to further define meanings and functions of 'domestic space' and 'land use' in the wider frameworks of social complexity, economic intensification, and environmental diversity in tropical worlds. Some venture into promising new domains of research on the archaeology of tropical inhabitation (e.g. Farr's contribution on ecology and fertility, this issue). Others make fruitful attempts to reconstruct and simulate diverse elements of the living landscape of tropical communities (e.g. Schroder et al.'s contribution), and have expanded research on processes of landscape domestication to previously under-studied ecological niches, such as semi-deciduous tropical forests and montane grasslands (see Zuccarelli Fiere et al.'s contribution). Some explore the potential of novel and more established approaches to overcoming some of the challenges posed by tropical environments that can often render traces of their inhabitation harder to recognize than in more temperate settings (e.g. Iannone et al.'s contribution). As Zuccarelli Freire et al.'s paper also makes clear, such problems are not restricted to the high rainfall areas of the tropics but can also be found in semi-arid and arid zones as well. Here they can be further compounded by the high mobility of communities that typically forms a critical adaptive response to the uneven distribution of water in both space

and time—which has been noted elsewhere, including different parts of sub-Saharan Africa. In such circumstances, botanical and other ecological evidence on the landscape may often provide more effective means for detecting former settlements than material remains (for an additional example, see Marshall et al. 2018).

By exploring these diverse issues, our contributors offer not only data that are comparable to the archaeology of other tropical regions (e.g. the Maya data compiled by Schroder et al. will be informative for future cross-regional comparison with similar kinds of data from Angkor Wat, see Evans et al. 2013), but also solutions to address some of the critical issues facing the subject. Some contributions (e.g. Heng) distill examples from their rich archaeological datasets from regional surveys and either significantly substantiate some long-held speculations on tropical inhabitation such as upland and lowland interactions, or offer alternative models that can advance understanding of older conceptualisations of such interactions (e.g. Zuccarelli Freire et al.'s contribution). Others, with their 'old-fashioned' yet clear examples (e.g. Carson and Hung's contribution on the rare material evidence on fishing), remind us of the need to reconsider some of the taken for granted issues in technological innovations for tropical living. Our effort to address all the problems discussed above is just beginning and is as yet far from satisfactory and the possible solutions we can offer in this issue are limited. Nonetheless, we hope the contributions presented here will collectively stimulate multi-disciplinary dialogue in the archaeology of tropical inhabitation.

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