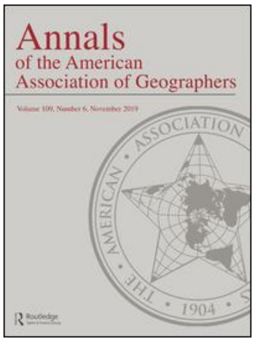

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Reframing Pre-European Amazonia through an Anthropocene Lens

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Reframing Pre-European Amazonia through an Anthropocene Lens

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This article examines three intertwined forms of human transformation of Amazonia's landscapes: (1) anthrosols, (2) cultural or domesticated forests, and (3) anthropogenic earthworks. By acknowledging the extent to which landscapes are humanized, an Anthropocene lens provides an opportunity to examine Amazonia as an Anthropogenic space (anthrome), providing a more realistic approach to understanding the region's past and for guiding its conservation. *Key Words: Amazonia, anthrosols, domesticated forests, earthworks, landesque capital.*

> The significance of the Anthropocene resides in its role as a new lens through which age-old narratives and philosophical questions are being revisited and rewritten.
>
> —Ellis (2018, 4)

The popular imagery of Amazonia continues to conjure up two extreme views: rampant deforestation and environmental destruction on the one hand and intact or pristine wilderness on the other. Neither is a correct representation of the region, yet the persistence of these imageries hinders a more realistic approach to understanding and conserving the region. The Anthropocene lens, which acknowledges that the Earth has long been significantly transformed by the actions of humans, permits a redress of this popular imagery (Ellis and Ramankutty 2008; Ellis and Ramankutty 2008; Ellis 2015, 2018). Earlier reframing of the Neotropics, including Amazonia, as anthropogenic spaces came through the historical ecology research program, which is concerned with the interactions through time between human societies, environments, plants, and animals and the consequences of these interactions for understanding the formation of current landscapes (Balée 2006; Balée et al. 2020). For Amazonia specifically, historical ecologists take the perspective that indigenous people "did not adapt to nature but rather they created what they wanted through human creativity, technology and engineering, and cultural institutions," which resulted in a widespread distribution of domesticated landscapes across the region (Erickson 2003, 456). This perspective contrasts with still persistent ideas of environmental determinism (Meggers [1971] 1996) and also with traditional ecological and land use change research that treats Amazonia ahistorically and visualizes it as a demographic void. These approaches typically do not acknowledge or discuss past human action or treat it as inconsequential for conservation planning (e.g., Barlow et al. 2012).

This article considers Amazonia through an Anthropocene lens by examining three intertwined human transformations of Amazonian landscapes: (1) anthrosols (2) cultural or domesticated forests, and (3) anthropogenic earthworks. The first two are legacies of long-term and cumulative activities of Native Amazonians (Denevan 2007; Clement et al. 2015a; Levis et al. 2018), and the third is a form of landesque capital, because earthworks were intentionally produced and their creation involves permanent changes to the landscape in accordance with economic, social, and ritual purposes (Håkansson and Widgren 2014; Arroyo-Kalin 2016). The interactions of these three types of domesticated landscapes result in feedback mechanisms that are not yet fully understood but are the topic of ongoing research regarding their persistence through time (Levis et al. 2020). Anthropogenic earthworks were identified before anthrosols, but research on anthrosols in turn contributed to the further identification of earthworks. Both influenced forest composition in the region long before the arrival of Europeans. Some of these domes-

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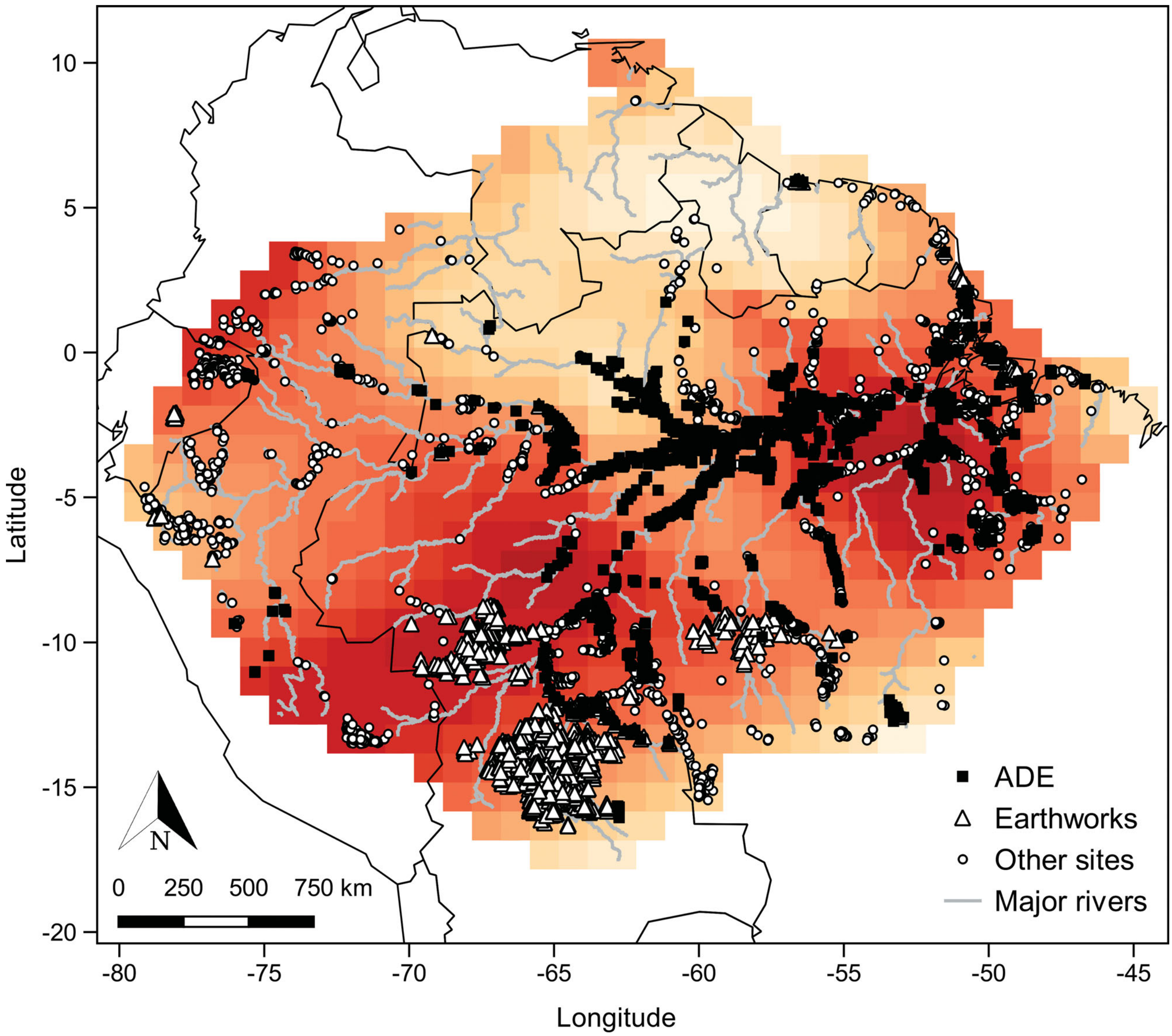

Figure 1. Spatial distribution of pre-European human transformations of Amazonian landscapes. Black squares show the spatial extent of known locations of anthrosols (Amazonian Dark Earth [ADE]), white triangles show the spatial extent of known locations of earthworks, and white circles indicate other archaeological sites. *Note:* There are likely many more archaeological sites; this is not meant to be a comprehensive map. Archaeological data were obtained from the Amazon Archaeological Sites Network (2020), Instituto do Patrimônio Histórico e Artístico Nacional (http://portal.iphan.gov.br/pagina/detalhes/1701/), Lombardo et al. (2020), and the second author's own research. The white-red background shows the interpolation of the observed values of the total number of domesticated species (richness) in each Amazon Tree Diversity Network (http://atdn.myspecies.info/) forest plot modeled as a function of latitude and longitude on a 1° grid cell scale by use of loess spatial interpolation (modified after Levis et al. 2017). The major river network was obtained from the HydroSHEDS data set (http://hydrosheds.cr.usgs.gov). Map was created in QGIS 2.18.25 by Carolina Levis. ADE = Amazonian Dark Earth.

ticated forests, such as forest islands, have been dated to as early as 10,850 calibrated years before present (cal. yr BP) in the Bolivian Amazonia (Lombardo et al. 2020). Pre-European transformations persist in hyperdiverse Amazonian forests and their resources are maintained and re-created by indigenous and traditional peoples (Roberts et al. 2017; Levis et al. 2018). These landscape transformations are widespread across the region (Figure 1).

Anthrosols

Anthrosols are the most visible legacy of widespread pre-European human settlements in Amazonia. They are a continuum of fertile soils found in patches (1 to 300 ha) throughout the Amazon basin (Kern et al. 2003; WinklerPrins 2014). The most consistently used and inclusive term for these soils is Amazonian Dark Earths (ADEs) (Woods and

McCann 1999). *Terra Preta* (shorthand for the Portuguese *Terra Preta do Índio*, black earth of the Indians) is also used (Lehmann et al. 2003; Glaser and Woods 2004; Teixeira et al. 2009; Woods et al. 2009). The anthrosol continuum ranges from "true" black *Terra Preta* (TP), with embedded ceramics to *Terra Marrom* (TM),[1] which has shades of brown and covers a much larger area than TP (Denevan 2004). TM usually does not contain ceramics, yet carries charcoal and chemical signatures that indicate human origin (Fraser et al. 2011).

The dark color of Amazonian anthrosols contrasts with the lighter colored, usually yellow and red, dominant tropical soils of the region. The dark color is due to high levels of soil organic matter (SOM) and charcoal, particularly pyrogenic carbon (Glaser and Birk 2012). The dark color and associated SOM persist over time, challenging traditional understanding of tropical soils wherein organic matter is thought to be rapidly degraded and leached out of the system. The persistence of SOM and soil nutrients (e.g., phosphorus and calcium) is because much of the carbon is pyrogenic, which is highly recalcitrant and resists weathering in the high temperatures and precipitation regimes typical of Amazonia (Glaser, Lehmann, and Zech 2002). This pyrogenic carbon is formed during slow, cool burns with smoldering, a process identified as variations on "slash and char" in contrast to "slash and burn" (Steiner, Teixeira, and Zech 2004; WinklerPrins 2009; Arroyo-Kalin 2012). Soils with pyrogenic carbon absorb and retain nutrients and moisture better, and yield more plant-available nutrients over the long term, a combination that contributes to their fertility.

The texture and mineralogy of these anthrosols are generally similar to those of surrounding not-anthrosols, which confirms that they were formed in situ via additions from above but in the same parent material (Glaser and Birk 2012). Current thinking about anthrosol formation is that TP was formed as a result of refuse accumulation from long-term habitation; hence the accumulation of ceramics (Glaser and Birk 2012; Schmidt et al. 2014). Although debated, TM was likely created as a result of semi-intensive active soil management, including the addition of organic inputs and charcoal (Woods and McCann 1999; Denevan 2004, 2006). These forms of management, light in-field burning and smoldering, have been noted in the ethnographic record and can be observed today among indigenous and traditional Amazonian villages (Hecht 2003; Heckenberger et al. 2003; Heckenberger et al. 2007; Heckenberger et al. 2008; WinklerPrins 2009; WinklerPrins and Falcão 2010; Schmidt et al. 2014). Thus, Amazonian anthrosols formed as a result of long-term human occupancy and active land management.

It is becoming increasingly evident that these anthrosols are deeply intertwined with vegetation patterns in Amazonia and illustrate the degree to which forests are domesticated. Changes in soil properties due to past human activities lead to differentiation in vegetation patterns of contemporary home gardens, swiddens, secondary, and old-growth forests (Junqueira, Shepard, and Clement 2010; Junqueira et al. 2011; Lins et al. 2015; Quintero-Vallejo et al. 2015; Junqueira et al. 2016; Junqueira et al. 2017; Maezumi et al. 2018; Levis et al. 2020). For example, Junqueira, Shepard, and Clement (2010; Junqueira et al. 2017) demonstrated that secondary forest growth on anthrosols conserves agrobiodiversity and that old-growth forests on anthrosols concentrate plant species domesticated to some degree. Lins et al. (2015) found greater plant diversity of native species in home gardens where there is evidence of multiple occupancies in pre-European times. Maezumi et al. (2018) demonstrated evidence of 4,500 years of polycultural agroforestry in the lower Tapajós basin and documented enrichment of fruit-bearing forest species. Levis et al. (2020) demonstrated that forest enrichment with such species is associated with pre-European soil fertilization and this legacy might extend far beyond localized former occupation sites as evidenced by TM.

Most ADEs identified thus far are located along or near bluffs or close to a source of perennial water reflecting past Amerindian settlement patterns that were predominantly on bluffs (Denevan 1996; see Figure 1). Recent mapping efforts and modeling, however, have revealed that these soils are increasingly common along minor perennial and temporary rivers that are very abundant across the region (see maps in Levis et al. [2014] and Palace et al. [2017]). Their predominance along bluffs might also reflect modern-day accessibility. The extent to which ADEs are found in interfluves, away from major perennial water sources (e.g., McMichael et al. 2012; Bush et al. 2015; Piperno, McMichael, and Bush 2015), is still debated, but the increasing evidence is that they are found in the interfluves and throughout the region (Franco-Moraes et al. 2019; AmazonArch

2020; Levis et al. 2020). Although the spatial extent of TP has been intensively studied and is estimated to cover from 0.1 percent up to 3 percent of the Amazon basin (Madari et al. 2004; McMichael et al. 2014), the spatial extent of TM has not yet been evaluated.

Domesticated Forests

A widespread and common legacy of human transformation of Amazonian landscapes is the forests themselves. Although long thought to be the result of ecological and evolutionary processes with limited influence by humans (Meggers [1971] 1996; Barlow et al. 2012; McMichael et al. 2012; Bush et al. 2015; Piperno, McMichael, and Bush 2015), substantial research since 2000, building on earlier scholarship (e.g., Sauer 1963; Denevan and Padoch 1987; Balée 1989; Denevan 1992; Neves 1998) and undertaken from a variety of disciplinary perspectives (Balée 2006), demonstrates that Native Amazonians were active managers of those forests, intentionally or not, and to varying degrees (Heckenberger et al. 2007; Clement et al. 2015a; Piperno, McMichael, and Bush 2015; Roberts et al. 2017; Levis et al. 2018; McKey 2019). Peters (2000) argued that "managed forest systems are subtle, but they can produce lasting changes" (213) and that "what is overlooked in t[he] historical treatment of tropical silviculture is the fact that the indigenous population … [has] been using, manipulating, and managing tropical forests for several thousand years" (203). Researchers demonstrate that various forms and combinations of incidental and active forest management and arboriculture (forest, garden, and swidden mosaics, as well as longer term forest management combined with semi-intensive agroforestry) were practiced for millennia in Amazonia before European arrival and sustained substantial and increasing populations (e.g., Denevan 1992, 2007, 2014; Heckenberger et al. 2003; Erickson 2006; Heckenberger et al. 2007; Heckenberger et al. 2008; Neves 2013; Roosevelt 2013; Clement et al. 2015a; Levis et al. 2017; Levis et al. 2018; Clement et al. 2020; Iriarte, Elliott, et al. 2020). Today, "domesticated forests are recognizable by the presence of forest patches dominated by one or a few useful species favored by long-term human activities" (Levis et al. 2018, 1).

Forests on and around anthrosols were initially described as "cultural" or "anthropogenic" forests (Balée 1989, 2013; Denevan 1992; Peters 2000; Shepard et al. 2020), in which "species … [were] manipulated, often without a reduction in natural diversity" (Denevan 1992, 374). Recent research by interdisciplinary teams of archaeologists, ecologists, geographers and others revealed that Amazonian forests are not just cultural forests but domesticated ones (e.g., Erickson 2006; Clement et al. 2015a; Hecht 2016; Levis et al. 2017; de Souza et al. 2018; Levis et al. 2018; Franco-Moraes et al. 2019; McKey 2019; Clement et al. 2020). There is significant evidence of human management on species distribution and abundance: "many present Amazonian forests, while seemingly natural, are domesticated to varying degrees in terms of altered plant distributions and densities" (Clement et al. 2015a, 2). Plant species with utility and domesticated to some extent by Native Amazonians occur in high densities in and around archaeological sites across Amazonia (Levis et al. 2017).

Domesticated forests demonstrate the degree to which Amazonians worked with ecological processes to make their landscapes more productive than the natural endowment provided them (Levis et al. 2018). Through subtle intentional and unintentional actions, including managing, cultivating, fishing, and hunting, Amazonian forests and other ecosystems were to some degree transformed by the activities of indigenous and traditional peoples. Shepard et al. (2020) recently urged a turn away from the term *agriculture* and the concept of *farming*, because these carry cultural history and baggage with them and this bias hinders the ability to see the entirety of what is really a food production system that has been practiced in the region for millennia. A food production system is more appropriate because it encompasses the broad continuum of the varied activities that Native Amazonians engaged with to produce food. The continued attempt to fit what Amazonian people did in the past into the agriculture and farming mold does not do justice to their landscape management (Neves 2013).

Although the full scale and degree of Amazonian domestication remains a topic of debate (e.g., Clement et al. 2015b; McMichael et al. 2015; Junqueira et al. 2017; McMichael et al. 2017; Piperno, McMichael, and Bush 2017; Watling et al. 2017b) and requires more attention, what is clear from research to date is that Amazonia, long thought to be an intact, pristine rainforest, the epitome of wilderness and untrammeled nature, is actually an anthrome. Active landscape management and transformation by pre-European peoples resulted in changes to varying degrees in forest structure and composition that are still discernable today across the region, especially where archaeological sites are found (Levis et al. 2017; Levis et al. 2018; AmazonArch 2020).

Earthworks

The most intentionally produced forms of human transformation of Amazonian landscapes are anthropogenic earthworks. These earthworks can be regarded as landesque capital, because the permanent changes to the landscape generated by humans are the result of intentional actions produced to endure economic, social, and ritual organizations (Håkansson and Widgren 2014; Arroyo-Kalin 2016). Although numerous anthropogenic earthworks in Amazonia were identified more than fifty years ago in the Llanos de Mojos of Bolivia (Denevan 1966), their variety and ubiquity are becoming increasingly apparent through greater visibility due to land clearing and the advances of remote sensing techniques such as LiDAR (e.g., de Souza et al. 2018; Stenborg, Schaan, and Figueiredo 2018; Iriarte, Robinson, et al. 2020; Lombardo et al. 2020). Although earthworks have been identified throughout Amazonia, most sites are in the periphery of the region, and it is likely that there are many more (Figure 1). These include raised fields, mounds, ditches, fish weirs, causeways, canals, moats, embankments, forest islands, and geoglyphs/ring ditches (e.g., Roosevelt 1991, 2013; Heckenberger, Petersen, and Neves 1999; Erickson 2000, 2006; Heckenberger et al. 2003; Heckenberger et al. 2008; Pärssinen, Schaan, and Ranzi 2009; McKey et al. 2010; Schmidt et al. 2014; Schaan 2016; Watling et al. 2017a; de Souza et al. 2018; Iriarte, Robinson, et al. 2020; Lombardo et al. 2020). These earthworks had many functions, although these are not yet well understood, but most concentrated or provided access to food resources, eased transportation and communication between communities, and were likely used for ceremonial functions. Across southern Amazonia, earthworks are organized in to complex networks of villages, suggesting that this part of the region sustained a high population density in the late Holocene (de Souza et al. 2018). In southwestern Amazonia, thousands of anthropic forest islands were constructed within a seasonally flooded savannah starting in the early Holocene (about 10,850 cal. yr BP) and continuing up to 2,300 cal. yr BP, indicating significant human transformation of landscapes much earlier than previously thought (Iriarte, Elliott, et al. 2020; Lombardo et al. 2020). Since the early Holocene and throughout this epoch, forest builders cultivated domesticated plant species, such as squash, manioc, and many palms. Today, anthropogenic forest islands concentrate edible plants that feed not only local communities (Balée and Erickson 2006) but also critically endangered bird species (Lombardo et al. 2020).

The construction of earthworks, along with anthrosols and domesticated forests, is a result of societal development and ecosystem engineering techniques that increased habitat heterogeneity and the productivity of Amazonian landscapes. According to Ellis's framing of anthroecological change, a general causal theory that "explain[s] why human societies gained the capacity to globally alter the patterns, processes, and dynamics of ecology" (Ellis 2015, 287), these domesticated landscapes contribute to an understanding of the origin of anthromes. Recent work by Ellis, Beusen, and Klein Goldewijk (2020) acknowledges human transformations in pre-European Amazonia, although their study continues to treat the region homogenously. Recognizing the heterogeneity of the region's domesticated landscapes is key to understanding how extensive and intense these transformations were and will better inform conservation efforts.

Conservation of Amazonia through an Anthropocene Lens

Widespread anthrosols, domesticated forests, and earthworks reveal significant human transformations, an anthrome, in contrast to a perceived "intact" or "pristine" Amazonian forest. Understanding Amazonia through this Anthropocene lens challenges the definition of what is cultural and what is natural as "the separation between the human and the non-human … has grown increasingly fuzzy, to the point that it is rendered almost meaningless" (Kawa 2016, 19).

Developers continue to see the region as tabula rasa, a vast storehouse of riches for exploitation: soybean production, cattle ranching, lumbering, mining, and other natural resource extraction. Technocrats and large land owners tend to see indigenous and traditional people and their activities as getting in the way of progress and with little value besides the labor they provide. Conservationists consider the region essential for global ecosystem services (e.g., climate regulation), a vast storehouse of yet undiscovered biodiversity, and one of the last wildernesses on Earth. They urge maximum conservation of the forest, ideally without people, to conserve intact ecosystems (Watson et al. 2018). Both perspectives perpetuate the belief that "wilderness areas are … the only places that contain mixes of species at near-natural levels of abundance" (Watson et al. 2018, 28). This goes along with the persistent and pernicious myth of environmental constraints on forest people that together with a still perpetuated textbook trope of demographic emptiness of Amazonia needs to be moved beyond (Neves 1998). The Anthropocene lens has the potential to deconstruct this old model and open the way to a new framework for how conservation is approached in the region.

When significant findings by Heckenberger, Petersen, and Neves (1999) about Kuikuru landscape transformations were first published, Meggers (2001) wrote a rebuttal in which she stated that "uncritical acceptance of the conclusions of [revisionist assessments] not only conflicts with ecological and archaeological evidence, *but provides support for the unconstrained deforestation of the region*" (304, italics added). Meggers was upset that her theory regarding limited cultural potential in the region was being challenged (Woods 2013), but she also raised concerns that breaking the belief of Amazonia as a wilderness with humans as minimalist interlopers would open up the region to unprecedented development. Essentially, she and many others do not want to acknowledge that humans were significant landscape agents in Amazonia because that runs counter to the conservationist approach to conserving the forest (Denevan 2011). There are few who want to see the wholesale destruction of the forest, but by ignoring the *longue durée* of sustainable human use of the region, as evidenced by the existing intertwined landscape transformations, scientists are missing an engagement with the instructive ways in which Amazonians have managed and transformed ecosystems (Clement et al. 2020).

Ziegler (2019) observed that conservation in the Anthropocene is "wrought with tension" (274), because it forces an acceptance that there is not a nature–culture divide and that there are no intact, unhumanized places on Earth. What needs to become accepted—and this is what makes the Anthropocene lens a constructive framing—is that domesticated landscapes are just as worthy of conservation as apparently "pristine" intact ones, because biodiversity exists in a domesticated forest just as it does in a less domesticated forest (Balée 2013). In fact, beta diversity of some life forms, such as the spatial turnover of plant species, increases in Amazonian landscapes with different types and degrees of pre-European human transformations (Lins et al. 2015; Odonne et al. 2019). Similarly, the provisioning of ecosystem services increases in domesticated forests because these forests concentrate agrobiodiversity and food resources highly valued by modern societies and wildlife (Junqueira, Shepard, and Clement 2010; Levis et al. 2020). Such concentrations form an essential component of participatory conservation and community-based management approaches, because they can promote socioeconomic benefit to local communities from the sustainable management of nontimber forest products such as Brazil nuts (Guariguata et al. 2017). It is increasingly understood that the best conservation policy in a region such as Amazonia is a participatory conservation approach, working with local people, because people-less "set-aside" spaces efface the rich history of the region (Katz 2005; Cámara-Leret, Fortuna, and Bascompte 2019; Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) 2019; Clement et al. 2020). Research also demonstrates that indigenous territories protect better against rampant development than other forms of protection such as national parks (Nepstad et al. 2006; R. Walker et al. 2009; Garnett et al. 2018; Balée et al. 2020; W. S. Walker et al. 2020).

The landscape legacies and landesque capital evident today in Amazonia demonstrate that indigenous peoples, since before European conquest, practiced landscape transformations that enhanced the physical environment for humans while maintaining ecosystem functioning and its ecological integrity, in ways that current industrial-scale land use does not (e.g., McKey et al. 2010; Watling et al. 2017a). The local knowledge to transform soils, forest assemblages, and the land itself to improve its utility for human use, while sustaining, even improving, ecosystems services, represents a promising alternative to ensure the conservation of Amazonian ecosystems and to promote the rights and livelihoods of indigenous and traditional peoples.

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Note

1. *Terra Marrom* was formerly known as *Terra Mulata* and is now called Amazonian Brown Earth (Iriarte, Elliott, et al. 2020).

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