Mesología de la terra preta
Mesology of the Terra preta

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Figure 1. Terra preta deposit in Santaré, Pará, on December 12, 2009. Photograph by Eric Royer Stoner.

Abstract

The text presents mesological research about *terra preta*, a type of soil that, due to its chemical, mineral, and nutritional composition, harbours a higher degree of fertility than the adjacent soils in the Amazon region. This cosmo-geographic phenomenon is of anthropic origin since the studies of its composition indicate the continuous deposition of organic matter from human waste. We consider this modulation of organic matter as a cosmotechnic, one that appeared independently of the technological development of the modern-classical Western paradigm since it presents an alternative technical approach that sits between the moral and the cosmic. *Terra preta* began to form in the Amazon from the middle of the Holocene and continues to regenerate, behaving as a kind of "super organism". The present work outlines this eco-social framework, reviewing the available literature on its pedogenesis and the anthropic activity that intervened in it.

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1. Introduction

In his chronicle about the discovery of the Amazon River, the missionary Gaspar de Carvajal describes his impressions of the exploration commanded by Francisco de Orellana, that in 1542 crossed the Amazon River encountering large and complex populations.[1] It is estimated that the population of the Amazon at that time was between 5 million and 10 million inhabitants.[2] By 1900, the total population of native inhabitants in the area had been reduced to around 500,000; a reduction caused by the diseases that Europeans had brought to the region, ethnocides, wars, slavery and expropriation of resources.[3] This modest number of inhabitants feed the notion of an environmental determinism,[4] a notion which postulates that the development of a complex society in the Amazon territory was impossible due to the limitations that were presented and to which the native inhabitants could not have adapted: the low fertility of the soils, the lack of technical tools, the supposed lack of protein sources[5] and the frequent floods.

> In the Amazon region, often depicted as a "Counterfeit Paradise" or "Green Hell"; the highly weathered, very acidic soils of the *terrafirme* (upland settings) are thought of as extremely forbidding. With few available nutrients and having extremely high aluminium concentrations, one could not imagine a worse regime for productive agriculture, particularly when associated with nucleation of population. Indeed, even in the *varzea* (floodplains) with somewhat better soils, crop production has been seen as a risky endeavour because of the unpredictability of the flood regime.[6]

Today, few researchers hold this position since multiple archaeological, historical ecological and biochemical research shows that much of Amazonia was transformed by burning, settlement, roads,

1 Gaspar De Carvajal, *Descubrimiento del río de las Amazonas*, (Consejo de la Hispanidad, 1942): These texts contributed to the beginning of the El Dorado legend.

2 William M. Denevan, "Estimating Amazonian Indian Numbers in 1492," *Journal of Latin American Geography* 13, no. 2 (2014): 207–21, doi https://doi.org/10.1353/lag.2014.0036.

3 Clark L. Erickson, "Amazonia: The Historical Ecology of a Domesticated Landscape," in *The Handbook of South American Archaeology*, eds. Silverman H., Isbell W.H. (New York: Springer, 2008), 157–183.

4 Betty J. Meggers, "Environmental Limitation on the Development of Culture," *American Anthropologist, New Series* 56, no. 5 (1954): 801–24.

5 Erickson, "Amazonia: The Historical Ecology of a Domesticated Landscape," 164: Erickson mentions that the pre-Columbian inhabitants of the Amazon consumed various sources of protein such as fish, corn, nuts, fruits and insects.

6 William Woods and Bruno Glaser, "Towards an Understanding of Amazonian Dark Earths," in *Amazonian Dark Earths: Explorations in Space and Time*, eds. Glaser B., Woods W.I. (Berlin, Heidelberg: Springer, 2004), 1–8. https://doi.org/10.1007/978-3-662-05683-7_1

agriculture, and agroforestry into forest clearings, savannas, parkland, countryside, and forest islands. It is now argued that much of the tropical rainforest as it exists today, is the result of a "rebound effect" created by the reduction of population. Amazonia had fewer trees five hundred years ago, and the existing forests resembled gardens, orchards, and game preserves more than "wilderness." [7] It is likely that Carvajal was referring to these areas when he wrote: "we saw very large provinces and towns, and these were in the most cheerful and colourful land that we saw and discovered in the entire river, because it was high land with heavily populated hills and valleys."[8] In these described locations underlie the "Amazonian Dark Earths,"[9] a kind of soil of "biocultural origin that would not have existed without past human interference,"[10] and which has a fertility superior to the adjacent soils. These soils functioned as a tool for the pre-Columbian inhabitants to domesticate and propel the biodiversity of their territory.[11] The Amazonian Dark Earths are usually divided into two categories: *terra preta* and *terra mulata. Terra preta*, associated with village dwelling and socializing sites, is very dark in colour, and contains pieces of pottery, bones, and other cultural remains.[12] While *terra mulata* is more extensive and usually surrounds the *terra preta* areas; it contains fewer human remains, and it is thought that semi-intensive agriculture took place in it.[13] For this article, we have decided to use *terra preta* to refer to both variations. Since this is the term used by urban and rural inhabitants of the Amazon region to refer to both on a daily basis,[14] and because between these there is usually a gradual pedological transition.[15]

To investigate how human agency intervened in the formation of the *terra preta*, we propose to carry out a *mesological* study of this phenomenon. Mesology is a discipline that was re-discovered by geographer Agustin Berque in 1985, through his effort to translate the *fudogaku* neologism developed by the Japanese philosopher Tetsuro Watsuji:

7 Erickson, "Amazonia: The Historical Ecology of a Domesticated Landscape," 162.

8 Gaspar De Carvajal, *Descubrimiento del río de las Amazonas.*

9 William Woods and Bruno Glaser, "Towards an Understanding of Amazonian Dark Earths", 1–8.

10 William Balée, "Native Views of the Environment in Amazonia," in *Science Across Cultures: The History of Non-Western Science*, (Netherlands: Springer 2003), 277–88.

11 Erickson, "Amazonia: The Historical Ecology of a Domesticated Landscape," 171.

12 Anna Roosevelt, "The Amazon and the Anthropocene: 13,000 Years of Human Influence in a Tropical Rainforest," *Anthropocene* 4, (2014): 69–87, doi:10.1016/j.ancene.2014.05.001.

13 William Denevan and William Woods, "Discovery and awareness of anthropogenic Amazonian dark earths (terra preta)," *Energy and agricultural carbon utilization: sustainable alternatives to sequestration* (2004): 2.

14 Laura German, "Ethnoscientific Understandings of Amazonian Dark Earths" in *Amazonian Dark Earths* (Amsterdam: Kluwer Academic Publishers, 2003), 179–201.

15 Laura German, "A Geographical Method for Anthrosol Characterization in Amazonia: Contributions to Method and Human Ecological Theory," in *Amazonian Dark Earths: Explorations in Space and Time*, eds. Glaser B., Woods W.I. (Berlin, Heidelberg: Springer, 2004), 29–51.

> As I had eventually decided to translate fûdo with 'milieu', and given the lexical sterility of this term in French [...] I searched around the roots of the notion of milieu in Latin (med-) and in Greek (meso-). This work made me discover [...] the existence of a discipline, by now dead and gone, mesology (mésologie), which had been founded as the science of human milieux.[16]

Landscape thinking is the way in which each being translates its *mediance* from his flesh to his actions.[17] By mediance, Berque means "the co-implication of milieu and Being,"[18] that is, the "medium character between the physical and the phenomenal, the natural and the cultural, the collective and the individual."[19] In our mesological study of *terra preta*, mediance refers to "all intentional and non-intentional practices and activities of humans that transform the environment into a productive landscape for humans and other species."[20] In this *productive landscape,* constituted through the dynamical coupling between human and milieu, *terra preta* can be understood as a *techno-geographic medium* in which a multiplicity of *functional circles* develop, and that belong to the great variety of species that interact with—and are part of—the environment of the region: "...in [the] same environment, different species or cultures will have different milieux..."[21]

With *functional circle*, we refer to the sphere of perception–action of an agent in relation to its environment. This concept was coined by Jakob von Uexkull to understand the ways in which animals execute their actions from the perception (or internalization) of their environment. "Jakob von Uexküll introduced a founding distinction between *environment* (Umgebung) and *milieu* (Umwelt). Environment is a raw and universal datum, considered in abstracto by the look from nowhere of modern science, [...] whereas milieu is a concrete and singular reality, [...] dynamically coupled with the constitution"[22] of the being which experiences it. As Berque writes, "what the animal encounters is the 'as' by which he perceives things: *as* food, *as* obstacles, *as* shelter, *as* housing, etc. In other words, in a functional circle, this 'as' is the medial handle that an object offers the animal..."[23]

16 Augustin Berque, "Offspring of Watsuji's theory of milieu (Fudo)", *GeoJournal* 60, (2004): 389–396, https://doi.org/10.1023/B:GEJO.0000042975.55513.f1

17 Augustin Berque, *Thinking through Landscape*, trans. Anne-Marie Feenberg-Dibon (London: Routledge, 2013), 59.

18 Augustin Berque, "Mésologiques: Can we recosmize architecture ?," *Mésologiques*, (2014). https://ecoumene.blogspot.com/2014/12/can-we-recosmize-architecture-berque.html.

19 Berque, "Offspring of Watsuji's theory of milieu (Fudo)", 389.

20 Erickson, "Amazonia: The Historical Ecology of a Domesticated Landscape," 158.

21 Augustin Berque, "An Enquiry into the Ontological and Logical Foundations of Sustainability: Toward a Conceptual Integration of the Interface 'Nature/Humanity'," *Global Sustainability* 2, (2019): e13; 4. doi:10.1017/sus.2019.9.

22 Berque, "An Enquiry into the Ontological and Logical Foundations of Sustainability: Toward a Conceptual Integration of the Interface 'Nature/Humanity'," 2.

23 Augustin Berque, "The Perception of Space or a Perceptive Milieu?," *L'Espace géographique* 45, no. 2 (2016): 168–181. https://doi.org/10.3917/eg.452.0168

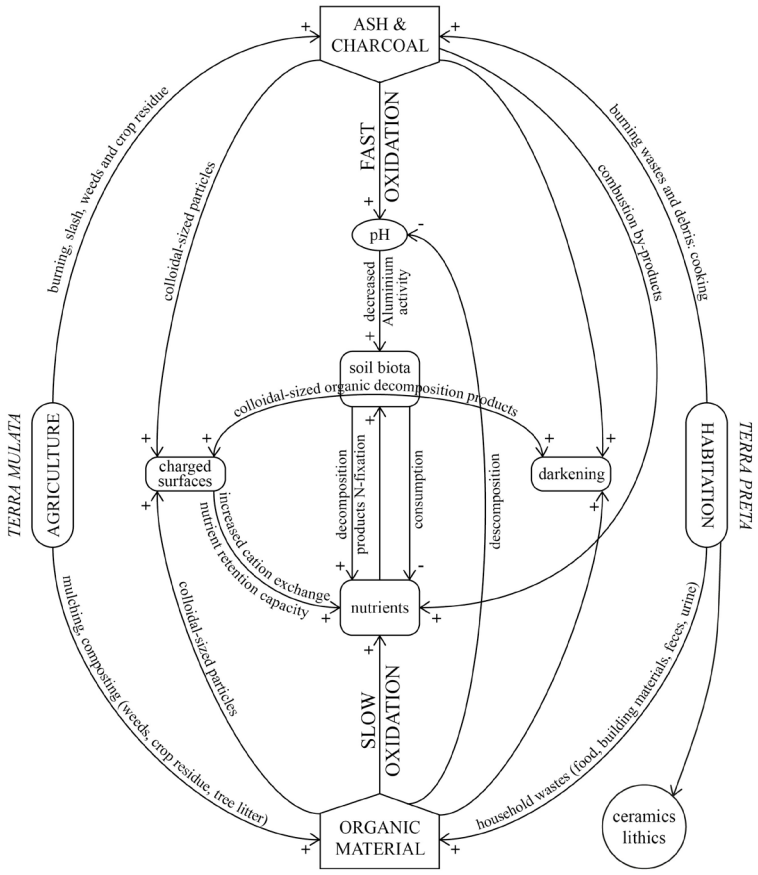

Figure 2. Conceptual model for the formation and persistence of Terra Preta and Terra Mulata.[24]

Yuk Hui coined the concept *cosmotechnics* in reference to "the unification of the cosmic order and moral order through technical activities."[25] Human activities, by being accompanied by technical objects such as tools, are always cosmotechnics.

> Instead of a universal history describing one technology with various stages of development, we can step back for a moment and instead describe technological development as involving different cosmotechnics.[26]

24 William I Woods and Joseph M. McCann, "The Anthropogenic Origin and Persistence of Amazonian Dark Earths", *Yearbook. Conference of Latin Americanist Geographers* 25, (1999): 7–14. http://www.jstor.org/stable/25765871. Re-traced by Alice Pontiggia.

25 Yuk Hui, "On Cosmotechnics" *Techné: Research in Philosophy and Technology* 21, no. 2 (2017): 319–41. https://doi.org/10.5840/techne201711876.

26 Yuk Hui, "Machine and Ecology," *Angelaki* 25, no.4 (2020): 54–66, doi: 10.1080/0969725X.2020.1790835

We consider that the concrescence that exists between "the moral, the cosmic and the technical,"[27] embedded in the management of resources which generates the *terra preta*, presents dynamics that diverge from the onto-epistemic configurations that exist within the modern-classical Western paradigm.[28] Following the thought of Gilbert Simondon, we understand *terra preta* as a techno-geographic constitution, namely, a milieu that appears between the forest and the human, in which each modification is self-conditioned by the result of its functioning.[29] According to Simondon, "invention is the emergence of the extrinsic compatibility between the environment and the organism and of the intrinsic compatibility between the subsets of action."[30] But what is a subset of action? Simondon describes the subsets of action as the relatively independent perceptive images within a living being. Could we then consider that the concretization of the *terra preta* happens through the encounter of the extrinsic compatibility between the forest and the human, and the encounter of the intrinsic compatibility between the perceptive images of the forest and the human? If we take into consideration that the "forest" and the "human" are constituted through a multiscale interspecies cooperation, it becomes clear that both can be described as "environment" and "organism," depending on the scale of the analysis. Therefore, to approach the emergence of a techno-geographic constitution such as the *terra preta*, we require a model of invention that happens through interactive enaction. The *terra preta* is the effect of a multitude of concordant and parallel inventions that emerged in multiple locations of the region, through the modulation of concrete relations and elements. Thus, we could frame it as what Simondon calls "the simplest invention,"[31] since its axiomatics do not need to be constructed, because it is the organism itself "who delivers them." In this case "organism" refers to the forest, which, as we will discuss later, goes through a process of phenotypic diversification based on human technicity.

The mesological study of *terra preta* elaborated in this work is enabled through the existent historical ecological research, a field that "focuses on landscape as the medium created by human agents through

27 Yuk Hui, "Machine and Ecology", 54–66.

28 Berque, "An Enquiry into the Ontological and Logical Foundations of Sustainability: Toward a Conceptual Integration of the Interface 'Nature/Humanity.'" 1: the *modern-classical Western paradigm* "ontologically founded on dualism and logically on the law of excluded middle, has entailed modernity and industrialization The MCWP is ontologically and logically founded on the principle of decosmization, by means of abstracting our Being from its milieu: (1) ontologically with dualism; and (2) logic- ally with the law of excluded middle, both entailing the reign of Binarity (as exemplarily instanced, nowadays, by the binary 'language' of our electronic devices)."

29 Gilbert Simondon, *On the Mode of Existence of Technical Objects*, trans. Cecile Malaspina and John Rogove (Minnesota: Univocal, 2016), 58.

30 Gilbert Simondon, *Imaginación e invención*, trans. Pablo Ires (Buenos Aires: Editorial Cactus, 2013), 158.

31 Simondon, *Imaginación e invención*, 170.

their interaction with the environment."[32] Historical ecologists argue that "disturbance caused by human activities is a key factor in shaping biodiversity and environmental health."[33] Through radiocarbon dating of the physical signals of human activity embedded in the landscape, it has been possible to build a historical perspective of up to 11,000 years of the interaction between human and environment in the Amazon. In his text *History, Ecology and Alterity* (2006), Heckenberger presents a research recollection on the possible modes of social and political organization in the area, exposing a complex and changing heterogeneity over time. The different ethnic groups that have developed in the area have been both nomadic and sedentary, and have had hierarchical and heterarchical organizations, hosting around 300 languages belonging to 170 different families.[34] It has been confirmed that the formation of *terra preta* is not exclusive to a single cultural group, since different ceramic traditions have been identified in its deposits.[35] We believe that reflecting about this phenomena and the possible ways it can be extrapolated, can contribute towards the resolution of several socio-ecological problems of late modernity.

2. Pedogenesis

> Approaching soil as infrastructure makes it appear as a highly lively entity. Not only living memories of the discarded and of past organisational settings are archived and processed in it, but labours invisible to most humans: of earthworms, fungi, microorganisms etc.[36]

The soils of the Amazon region are usually unfertile, due to the high decomposition rate of organic carbon (C), rapid losses of nitrogen (N) and potassium (K) through leaching, and rapid phosphorus (P) fixation to (hydr-) oxides of iron (Fe) and aluminium (Al).[37] As described above, this data on the Amazon region informed the positions of environmental determinism. But the *terra preta* deposits usually occupy limited areas, and they are even not usually shown on soil maps of the Amazon,[38] therefore regional

32 Erickson, "Amazonia: The Historical Ecology of a Domesticated Landscape,." 158.

33 Erickson, "Amazonia: The Historical Ecology of a Domesticated Landscape," 158.

34 Balée, "Native Views of the Environment in Amazonia," 277–288.

35 Michael J. Eden *et al*, "Terra Preta Soils and Their Archaeological Context in the Caqueta Basin of Southeast Colombia," *American Antiquity* 49, no. 1 (1984): 125–40, doi:10.2307/280517.

36 María Puig de la Bellacasa, "Encountering Bioinfrastructure: Ecological Struggles and the Sciences of Soil," *Social Epistemology* 28, no.1 (2014): 26–40, doi: 10.1080/02691728.2013.862879.

37 G Van Hofwegen *et al*, "Opening the Black Box: Deciphering Carbon and Nutrient Flows in Terra Preta," in *Amazonian Dark Earths: Wim Sombroek's Vision* (Netherlands: Springer2009), 393–409.

38 Benedito Nelson Silva et al, "Solos da ärea de Cacau Pirera-Manacapuru," *Inst Pesqui Exp Agropec Norte* 2, no 1 (1970): 198.

or continental depictions are not appropriate, "one needs to look at the microscale and here one finds great variety in and enormous pre-Columbian modifications to the soil landscape."[39]

In *pedology,* the soil is understood as a "natural–historical body, resulting from the collective influence of (a) subsoils, (b) climate, (c) flora and fauna, (d) geological age, and (e) relief of the locality."[40] In this discipline, the relationships between organisms are manifested as digestive mutualisms, which occur between agents of different scales. These types of mutualistic relationships are called *anisosymbiotic* (*aniso* means unequal) due to the difference in size of the related organisms, to the transitory or temporal character of these associations, and to their exhabitational character, meaning that their contact is physical rather than organismic.[41] Although in the study of soil formation, "macro-organisms" refers to worms or to the roots of a tree, in the case of *terra preta*, humans also fall into this category. Anisosymbiotic mutualism between organisms is a key factor in the function of soils. Decomposition and turnover of organic matter, and maintenance of the soil structure, are determined by the nature and effectiveness of these mutualistic relationships,[42] allowing organisms to make use of resources that they could not digest with their own body.

Figure 3. Comparison between latosol and terra preta. Photograph by Daniel Markewitz, Univ of Georgia.

39 Woods and Glaser, "Towards an Understanding of Amazonian Dark Earths,"1–8.

40 Catherine Evtuhov, "The roots of Dokuchaev's scientific contributions: cadastral soil mapping and agro-environmental issues," in *Footprints in the Soil. People and Ideas in Soil History*, eds. Warkentin, B.P. (Amsterdam: Elsevier, 2006), 125–148.

41 Patrick Lavelle *et al*, "Mutualism and biodiversity in soils," *Plant Soil* 170, (1995): 23–33. https://doi.org/10.1007/BF02183052.

42 Lavelle *et al*, "Mutualism and biodiversity in soils," 23–33.

Ecosystem engineering refers to the process in which organisms "directly or indirectly modulate the availability of resources to other species by causing state changes in biotic or abiotic materials. In doing so, they modify, maintain and/or create habitats."[43] Worms, for example, collaborate in soil engineering by ingesting organic matter and minerals, adding them chemically through their digestion, and causing aeration through their movements, creating structures that allow the growth of other organisms.[44] The organisms as *ecosystem engineers* are divided into two main categories: (1) *autogenic engineers*, organisms that change their environment through their own physical structure (e.g. digestion), and (2) *allogeneic engineers,* organisms that alter matter through processes external to their body (e.g. use of tools). "The boundaries between types of engineering are occasionally fuzzy,"[45] as in the case of the type of *engineering* that humans undertake in relation to the *terra preta*.

The garbage of the people who lived in the Amazon region was very important for the increase in organic matter in the soil and also for its calcium (Ca), magnesium (Mg), zinc (Zn), manganese (Mn), phosphorous (P), and carbon (C) enrichment.[46] Herbert Baldus mentions that the Kayapó "do not fear much the dirt, nor on their bodies nor in their houses nor their belongings. The major part of the trash, for this reason, is left where it falls, if it does not happen to be of interest to dogs and other animals that roam around and inside the houses".[47] Trash is randomly discarded around the habitations, in some cases forming mounds.[48] Funeral practices also increase certain chemical elements in the soil, mainly calcium (Ca) and phosphorus (P). "At present, various tribal groups bury their dead inside their own houses or in the village center" (Kern et al. 2004). Some groups cremate their dead, and leave the ashes at the place of cremation, others simply abandon the house or the village, leaving the dead in the hammock, or put fire to the house.[49] Simões mentions that some pre-Columbian groups "dislocated and buried many times their dead in funeral urns which were deposited inside the village",[50] and in her study of the Krahó, Carneiro da Cunha mentions burials in rectangular tombs covered with organic matter such as leaves and

43 Clive G Jones *et al*, "Organisms as Ecosystem Engineers," *Oikos* 69, no. 3 (1994): 373–86, doi:10.2307/3545850.

44 Filippo Bertoni, "Soil and Worm: On Eating as Relating", *Science as Culture* 22, no.1 (2013): 61–85, doi: 10.1080/09505431.2013.776365.

45 Jones *et al*, "Organisms as Ecosystem Engineers," 373–86.

46 Dirse Clara Kern *et al*, "Evolution of the Scientific Knowledge Regarding Archaeological Black Earths of Amazonia," in *Amazonian Dark Earths: Explorations in Space and Time* (Berlin Heidelberg: Springer, 2004) 19–28, https://doi.org/10.1007/978-3-662-05683-7_3.

47 Herbert Baldus, "Aldeia, casa, móveis e utensílios entre os índios do Brasil," *Sociológica* 4, (1942): 157–172.

48 Kern *et al*, "Evolution of the Scientific Knowledge Regarding Archaeological Black Earths of Amazonia" 19–28.

49 Kern *et al*, "Evolution of the Scientific Knowledge Regarding Archaeological Black Earths of Amazonia" 19–28.

50 Mario F. Simões, "O Museu Goeldi e a Arqueologia da Bacia Amazônica" in *Antologia da Cultura Amazônica*, eds. Roque Carlos (São Paulo: Amazônia Edições Culturais 1972), 172–180.

sticks, allowing the integration of decomposing bodies into the processes of soil generation.[51]

Traditional conservation tends to think that "nature must be protected from disturbances", however, the multidisciplinary studies conducted in the Amazon region reveal that disturbances in nature are not only common, but integral to the health of an ecosystem and its biodiversity.[52] The instability, non-equilibrium, and at times chaos created by disturbance encourage environmental heterogeneity through the creation of patches, mosaics, and edges of distinct habitats where diverse species can thrive.[53] The disturbances humans cause (or caused) in the Amazon, have created synanthropic relationships with animals that "do not show regular irruption cycles, but have a propensity for dramatic population increase under favourable anthropogenic conditions associated with agricultural production or storage."[54] In some cases, these species become dispersers of plant seeds that are useful to them and to humans.[55] "Several Amazonian Indigenous peoples credit agoutis for cultivating Brazil nuts" and in the Jamamadi universe, there are no such things as wild plants, everything is cultivated by some "other" cultivator.[56]

Terra preta occurs in soil patches whose size varies between one hectare and several hundred hectares. [57] Archaeological research has confirmed that it occupies at least between 0.1% to 0.3% of the area in question, that is, 6,000 to 18,000 km2,[58] and it has been speculated that it could occupy up to 3.2%, that is, 154,063 km^2 using predictive algorithms.[59] Geographer William I. Woods considers that the *terra preta*

51 Manuela Carneiro da Cunha, *Os mortos os Outros* (Sao Paulo: Hucitec 1978), 53.

52 Erickson, "Amazonia: The Historical Ecology of a Domesticated Landscape," 160.

53 Erickson, "Amazonia: The Historical Ecology of a Domesticated Landscape," 160.

54 Peter Stahl, "Microvertebrate Synecology and Anthropogenic Footprints in the Forested Neotropics: Studies in the Neotropical Lowlands" in *Time and Complexity in Historical Ecology: Studies in the Neotropical Lowlands*, eds. William Balée and Clark L. Erickson (New York: Columbia University Press, 2006), 127–150.

55 Carolina Levis *et al*, "How People Domesticated Amazonian Forests," *Frontiers in Ecology and Evolution* 5, (2018): doi: 10.3389/fevo.2017.00171

56 Manuela Carneiro da Cunha, "Antidomestication in the Amazon: Swidden and Its Foes," *HAU: Journal of Ethnographic Theory* 9, no. 1 (March 2019): 126–36. https://doi.org/10.1086/703870.

57 Dirse Kern *et al*, "Distribution of Amazonian Dark Earths in the Brazilian Amazon," in *Amazonian Dark Earths* eds. Glaser B., Wodos W.I. (Dordrecht: Springer, 2003), 51–75, doi: https://doi.org/10.1007/1-4020-2597-1_4.

58 William I Woods and William Denevan, "Amazonian Dark Earths: The First Century of Reports" in *Amazonian Dark Earths: Wim Sombroek's Vision*, eds. Woods W.I., Teixeira W.G., Lehmann J., Steiner C., Winkler Prins A., Rebellato L. (Dordrecht: Springer, 2009), 1–14. https://doi.org/10.1007/978-1-4020-9031-8_1.

59 Crystal McMichael *et al*, "Predicting pre-Columbian anthropogenic soils in Amazonia" *Proc. R. Soc* 281, Issue 1777 (2014): 5, http://doi.org/10.1098/rspb.2013.2475.

could even occupy up to 10% of the forest of the Amazon.[60] Compared to adjacent soils, *terra preta* contains 2 to 8 times more total nitrogen, and up to ten times more total phosphorus.[61] The *terra preta* layer extends 40–60 cm deep on average, but in certain cases it can reach up to 2m. lt contains human occupation remains (ceramic fragments, lithic artefacts, bones, and charcoal) through all of its thickness. Generally, *terra preta* is located on non-floodable ground or *terra firme*. These soils are well drained, often near rivers, creeks, or lakes, and almost always in a topographic position that permits a good view of the area as a whole.[62] There is evidence of the presence of *terra preta* from around 7,000 years ago, but archaeological research indicates that there was a great increase in its development during the middle of the first millennium AD.[63] Terra preta not only contain higher concentrations of nutrients such as nitrogen (N), phosphorus (P), potassium (K) and calcium (Ca), but also greater amounts of stable soil organic matter.[64] The organic matter occurs as freshly added plant, animal, and insect remains, which gradually transform into stabilised nutrient-rich humus material.[65]

Frequent findings of charcoal and highly aromatic humic substances suggest that residues of incomplete combustion of organic material (black carbon) are a key factor in the persistence of organic soil matter in these soils. *Terra preta* contains up to 70 times more black carbon than adjacent soils.[66] Black carbon is chemically and microbially stable due to its polycyclic aromatic structure and persists for centuries.[67] Oxidation during this time produces carboxylic groups[68] on the edges of the aromatic backbone,

60 Charles C. Mann, "AGRICULTURE: The Real Dirt on Rainforest Fertility," *Science* 297, no. 5583 (2002): 920–23. https://doi.org/10.1126/science.297.5583.920.

61 Santiago Mora, "Archaeobotanical Methods for the Study of Amazonian Dark Earths," in *Amazonian Dark Earths*, (Dordrecht: Kluwer Academic Publishers, 2003), 205–25, doi: https://doi.org/10.1007/1-4020-2597-1_11.

62 Kern *et al*, "Evolution of the Scientific Knowledge Regarding Archaeological Black Earths of Amazonia," 19–28.

63 Morgan J. Schmidt *et al*, "Dark Earths and the Human Built Landscape in Amazonia: a Widespread Pattern of Anthrosol Formation" *Journal of Archaeological Science* 42, (2014): 152–65, doi:10.1016/J.JAS.2013.11.002.

64 Bruno Glaser *et al*, "The 'Terra Preta' Phenomenon: A Model for Sustainable Agriculture in the Humid Tropics," *Naturwissenschaften* 88, no. 1 (January 2001): 37–41. https://doi.org/10.1007/s001140000193.

65 Maria de Lourdes Pinheiro Ruivo *et al*, "Microbial Population and Biodiversity in Amazonian Dark Earth Soils," in *Amazonian Dark Earths: Wim Sombroek's Vision* (Netherlands: Springer, 2009): 351–362, https://doi.org/10.1007/978-1-4020-9031-8_19.

66 Glaser *et al*, "The 'Terra Preta' Phenomenon: A Model for Sustainable Agriculture in the Humid Tropics" 37-41.

67 Glaser *et al*, "History, Current Knowledge and Future Perspectives of Geoecological Research Concerning the Origin of Amazonian Anthropogenic Dark Earths (Terra Preta)," in *Amazonian Dark Earths: Explorations in Space and Time*, (Berlin Heidelberg: Springer2004), 9–17.

68 In chemistry, the carboxyl group is an organic, functional group consisting of a carbon atom that's double-bonded to an oxygen atom and singly bonded to a hydroxyl group. Another way to view it is as a

and increases cation exchange capacity[69] as well as its nutrient-holding capacity.[70] The high presence of black carbon increases the soil's capacity to sequester CO2 present in the atmosphere[71] and generates favourable conditions for mycorrhizal and microbial abundance since the carbon pores become habitats for these organisms, protecting them from predators and, as such, allowing them to thrive.[72] Compared to adjacent soils, the *terra preta* bacterial community has a richness of approximately 25% more species.[73] This great microfloral diversity appears to be directly related to their superior fertility.[74]

> Apparently, at some threshold level of biotic activity and soil nutrient retention status, *terra preta* attains the capacity to perpetuate—even regenerate itself—thus behaving more like a living "super" organism than an inert mineral.[75]

Figure 4. Terra preta profile. Photograph by Newton P.S. Falcao.

carbonyl group (C=O) that has a hydroxyl group (O-H) attached to the carbon atom. Consulted in https://www.thoughtco.com/definition-of-carboxyl-group-and-examples-604879#:~:text=In%20chemistry%2C%20the%20carboxyl%20group,attached%20to%20the%20carbon%20atom.

69 The cation exchange capacity (CEC) is the ability of a soil to retain and release positive ions, thanks to its content in clays and organic matter. Clays are negatively charged, so soils with higher clay concentrations exhibit higher cation exchange capacities. A higher content of organic matter in a soil increases its CEC. Consulted in https://en.wikipedia.org/wiki/Cation-exchange_capacity.

70 Glaser *et al*, "The 'Terra Preta' Phenomenon: A Model for Sustainable Agriculture in the Humid Tropics," 37–41.

71 Kern *et al*, "Distribution of Amazonian Dark Earths in the Brazilian Amazon," 51–57.

72 Daniel D. Warnock *et al*, "Mycorrhizal Responses to Biochar in Soil – Concepts and Mechanisms," *Plant and Soil* 300, no. 1–2 (September 19, 2007): 9–20, doi:10.1007/s11104-007-9391-5.

73 Jong-Shik Kim *et al*, "Bacterial Diversity of Terra Preta and Pristine Forest Soil from the Western Amazon," *Soil Biology and Biochemistry* 39, no. 2 (February 2007): 684–90, doi:10.1016/j.soilbio.2006.08.010.

74 Maria de Lourdes Pinheiro Ruivo *et al*, "Microbial Population and Biodiversity in Amazonian Dark Earth Soils," 351–362.

75 Woods and McCann, "The Anthropogenic Origin and Persistence of Amazonian Dark Earths," 7–14.

3. Human Functional Circle

In 2009, Guido van Hofwegen *et al*. conducted a research project for "identifying and quantifying the carbon and nutrient fluxes as well as gaining insight into the processes that make the fertility of these soils so persistent."[76] In their first diagram,[77] dedicated to the human transportation of matter to the villages, the authors divided the main entries into three categories: atmospheric, aquatic, and terrestrial. Carbon and nitrogen are introduced from the atmosphere, while the aquatic and terrestrial represent flows of carbon, nitrogen, and phosphorus.

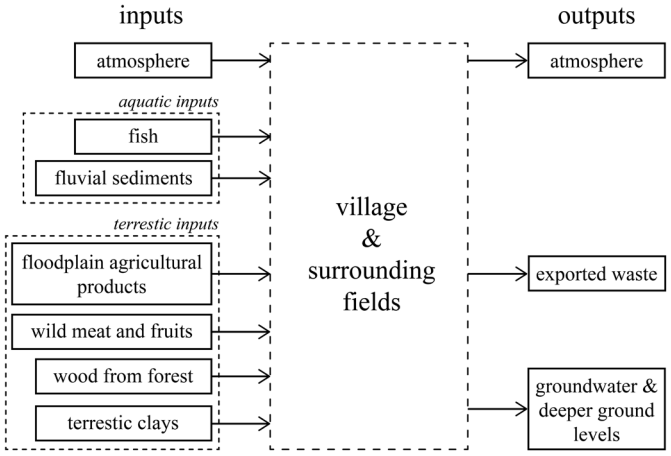

Figure 5. Diagram of material inputs and outputs to the village and surrounding fields.

The second diagram[78] by van Hofwegen *et al*. shows the material flows internal to the village. In it, all arrows represent flows of carbon, nitrogen, and phosphorus in the form of (a) harvested products, (b) absorption of nutrients by flows, (c) nutrients from crop residues, (d) household waste and (e) charcoal from cooking fires.

76 van Hofwegen *et al*, "Opening the Black Box: Deciphering Carbon and Nutrient Flows in Terra Preta," in *Amazonian Dark Earths: Wim Sombroek's Vision*, (Netherlands: Springer 2009), 393–409.

77 van Hofwegen *et al*, "Opening the Black Box", 393–409. Re-traced by Alice Pontiggia.

78 van Hofwegen *et al*, "Opening the Black Box", 393–409. Re-traced by Alice Pontiggia.

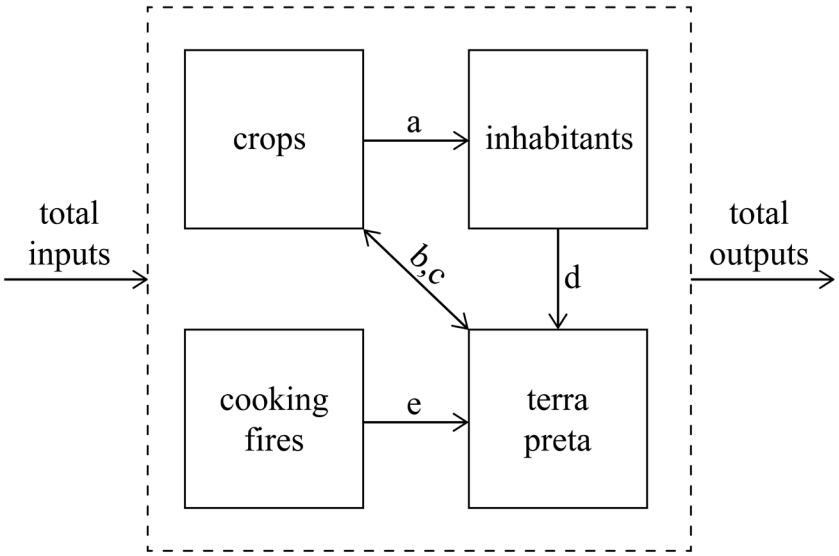

Figure 6. Diagram of internal material flows to the village and surrounding fields.

When analysing the behaviour of the people that led to the formation of the *terra preta*, it is necessary to consider that most of the basic decisions happened at the personal or family level, and therefore, there are enormous complications in relation to the heterogeneity of types, quantities, and distribution of inputs and withdrawals over time.[79] In addition to this, most contemporary residents do not know that the *terra preta* is anthropogenic, although many recognize the benefits of cultivating in it, they do not understand how it was formed.[80] The lack of local understanding of these processes could be due to the historical disjunction in the patterns of settlement and land use,[81] or because the formation of the *terra preta* requires several decades.[82] The Kayapó are known to intentionally modify soils to optimise their crops[83] through composting, mulching, burning, and direct application of fertilisers in the form of specially formulated ashes, organic material from offsite and termite and ant mounds, modifying soil characteristics in the short and long term.[84] But it cannot be known with certainty whether or not the

79 Woods and Glaser, "Towards an Understanding of Amazonian Dark Earths," 1–8.

80 Laura German, "Ethnoscientific Understandings of Amazonian Dark Earths," in *Amazonian Dark Earths*, (Dordrecht: Kluwer Academic Publishers, 2003), 179–201.

81 Anna Roosevelt, "Ancient and modern hunter-gatherers of lowland South America: An evolutionary problem", in *Advances in Historical Ecology*, ed. W. Balée (New York: Columbia University Press, 1998), 190–212.

82 William M. Denevan, "Comments on Prehistoric Agriculture in Amazonia," *Culture Agriculture* 20, no. 2–3 (June 1998): 54–59. https://doi.org/10.1525/cag.1998.20.2-3.54

83 Susanna Hecht and Darrell Posey, "Preliminary Results on Soil Management Techniques of the Kayapó Indians", *Advances in Economic Botany* 7, (1989): 174–188.

84 Woods and McCann, "The Anthropogenic Origin and Persistence of Amazonian Dark Earths," 7–14.

pre-Columbian inhabitants had the intention of generating *terra preta*. At the level of human perception–action, the *engineering* of *terra preta*, happens as an inherent effect of localized resource management as well as due to the search to achieve short-term objectives such as: the elimination of non-useful plants, the protection of useful plants, or the selection of phenotypes[85] useful for humans.[86] Processes that, in addition to contributing to the pedogenesis of the *terra preta*, also resulted in the domestication of the forest.

The human functional circle enacted in the Amazon modifies the composition of the soil through the management of organic matter that is presented to humans *as* food, building material, or any other object necessary for survival, meaning that a same object will exist differently according to the species concerned. In the case of humans, "the physical data of the environment exist as four main categories or predicates: resources, constraints, risks and amenities."[87] The anthropogenic management of the Amazon forest was defined by William Balée as "the human manipulation of inorganic and organic components of the environment that brings about a net environmental diversity greater than that of so-called pristine conditions, with no human presence."[88] This form of multigenerational indigenous knowledge more closely resembles a mode of conscious exploitation than an innate ethic of preservation, and subsequent generations benefit from the work and knowledge that their ancestors inscribed in the landscape, which could be understood as a good that is transferred from generation to generation.[89] Anthony Seegers *et al*. conducted a study on the corporeality of the Gê, the Xinguan and the Tukano, and identified that in these heterogeneous cultures the human body is "a matrix of symbols and an object of thought" that functions "as an instrument, an activity, that articulates social and cosmological meanings."[90]

The fabrication, decoration, transformation, and destruction of bodies are themes around

85 In biology and specifically in genetics, the expression of the genotype in function of a certain environment is called phenotype. Phenotypes have both physical and behavioural traits. Importantly, the phenotype cannot be defined exclusively as the "visible manifestation" of the genotype. Consulted in https://en.wikipedia.org/wiki/Phenotype.

86 Levis *et al*, "How People Domesticated Amazonian Forests".

87 Berque. "An Enquiry into the Ontological and Logical Foundations of Sustainability: Toward a Conceptual Integration of the Interface 'Nature/Humanity,'" 5.

88 William Balée, "Indigenous Transformation of Amazonian Forests: An Example from Maranhão, Brazil," *L'Homme*, "La remontée de l'Amazone" 33, no. 126–128 (1993): 231–254, https://doi.org/10.3406/hom.1993.369639

89 Erickson, "Amazonia: The Historical Ecology of a Domesticated Landscape," 157–183.

90 Anthony Seeger *et al*, "The Construction of the Person in Indigenous Brazilian Societies," *HAU: Journal of Ethnographic Theory* 9, no. 3 (December 2019): 694–703. https://doi.org/10.1086/706805.

> which mythologies, ceremonial life, and social organization revolve. A physiology of body fluids—blood, semen, and the processes of communication between the body and the world (food, sexuality, speech, and other senses)—seems to underlie the considerable variations that exist among South American societies.[91]

In his article *Cosmology as Ecological Analysis* (1977), Reichel-Dolmatoff mentions that for the Tukanos with whom he worked, the sun's energy forms a circuit that "flows continuously between man and animal, between society and nature". The Tukano individual "is conscious that he forms part of a complex network of interactions which include not only society but the entire universe."[92]

> The rules the individual has to follow refer, above all, to cooperative behaviour aimed at the conservation of ecological balance as the ultimately desirable quality. Thus, the relationship between man and his environment is being formulated not only on a cognitive level, but clearly it also constitutes an affective personal relationship in which individual animals and plants are treated with respect and caution.[93]

Reichel-Dolmatoff continues his text by mentioning the precision with which the Tukans understand seasonal climatic variation, and the behaviours of the other zoological and botanical species that inhabit the same locality. For example, when a human harvests a vegetal species or hunts an animal, the "borrowed" energy must be converted "into an essence that can be reincorporated into the circuit"[94] by its consumption as a nourishment. However, it does not explain how this energy is reintegrated beyond human consumption. Following his analysis, it could well be understood as being reintegrated into the soil as feces, urine and the decomposition of bodies. What is mentioned, however, is the use and significance of other bodily fluids such as semen, menstruation, vomit and saliva, which are inscribed in this circuit of sexual energy that flows through their localized cosmos. In the Tukano worldview the human is not positioned in nature, neither as being dominant of it, nor in harmony with it. Nature "is not a physical entity apart from man and, therefore, he cannot confront it or oppose it or harmonise with it as a separate entity."[95] This is reminiscent of the notion of magical unity hypothesized by Simondon as "the relation of the vital connection between man and the world, defining a universe that

91 Seeger *et al*, "The Construction of the Person in Indigenous Brazilian Societies," 694–703.

92 Gerardo Reichel-Dolmatoff, "Cosmology as Ecological Analysis: A View from the Rain Forest," *Man* 11, no. 3 (September 1976): 307. https://doi.org/10.2307/2800273.

93 Reichel-Dolmatoff, "Cosmology as Ecological Analysis: A View from the Rain Forest," 307.

94 Reichel-Dolmatoff, "Cosmology as Ecological Analysis: A View from the Rain Forest," 307.

95 Reichel-Dolmatoff, "Cosmology as Ecological Analysis: A View from the Rain Forest," 307.

is at once subjective and objective prior to any distinction between the object and the subject."[96] For Reichel-Dolmatoff, the emergence of technicity is the result of a "phase shift" away from this way of being in the world, however it seems that in the Amazon region, technicity appeared without a "phase shift" from the ""magical.".

> The long-term human presence in Amazonia has had impacts on floristic and faunal diversity in locales and regions, and these impacts are reflected in traditional knowledge. Amazonian traditional knowledge is reflected in lexical richness of vocabulary referencing biota intrinsic to anthropic landscapes.[97]

The diversity hosted by the Amazon region "is, or was, contingent on human-mediated disturbance, which is another way of saying human history and agency."[98] Agriculture in the Amazon is a technical activity that presupposes social skills capable of establishing an extensive network of relationships between humans and non-humans, and therefore cultural and technological repertoires, such as politics, art and cosmology represent social skills that were transposed to the landscape.[99] The pre-Columbian inhabitants of the Amazon did not perceive their influence on the ecosystem in terms of genetic modifications, but in terms of phenotypic variations[100] that were inscribed in various languages spoken in the region. Contemporary natives of the Amazon often encounter multiple species in cases where scientific classifications see only one, this phenomenon is known as *over-differentiation*:

> Although manioc is recognized as constituting but one species scientifically, it is typically subdivided into between 15 and 137 folk species in diverse Amazonian cultures, with the average number of named folk species per language being 22.[101]

"Traditional practices imply not only selection of naturally occurring new varieties, but they actually favour the creation of such varieties and their conservation."[102] However, in these practices the conservation of diversity is not the main goal, plant breeders usually opt for the most desirable varieties in

96 Gilbert Simondon, *On the Mode of Existence of Technical Objects,* 177.

97 William Balée, "Contingent Diversity on Anthropic Landscapes," *Diversity* 2, no. 2 (February 2010): 163–181. https://doi.org/10.3390/d2020163.

98 Balée, "Contingent Diversity on Anthropic Landscapes," 163–181.

99 Balée, "Contingent Diversity on Anthropic Landscapes," 163–181.

100 Balée, "Contingent Diversity on Anthropic Landscapes," 163–181.

101 Balée, "Native Views of the Environment in Amazonia," 163–181.

102 Manuela Carneiro da Cunha, "Traditional People, Collectors of Diversity," in *The Anthropology of Sustainability*, eds. Marc Brightman y Jerome Lewis (New York: Palgrave Macmillan, 2017), 257–272.

terms of flavour, size, productivity, resistance, etc., allowing many other varieties to become extinct.[103] "It is now clear that agrarian technology arose independently in Amazonia" as a form of resource management "within the framework of spatialization in traditional knowledge, which tends to be limited to the immediacy of known and historic landscapes."—[104] Anthropogenic disturbance—that is, the modulation and distribution of resources—that gave rise to the *terra preta* in the Amazon, is one of the various techniques for cultivating the land that existed "prior to the employment of pesticide as a universal solution;"[105] a *technodiversity* enacted by humans who, unable to conceive themselves as "external to", or as "part of" nature, maintain an inherent bodily proximity with the forest, in a process that is more like a "familiarization with" rather than a "domestication of" non-human species.[106]

> Amerindians refrain from making their organization of the land into the "primary organizing principle" of the forest. In short, one could say that they do not submit the forest to human generalized domestication. They no doubt made the forest more favorable to human life but did not colonize the forest.[107]

Agriculture in the Amazonian region involves the itinerant swidden method, which has resulted in an abundance of forest types in the regrowths that follow after a few years of burning. In some cases, after the initial plantation of a swidden field and its respective burning, a forest is regenerated with a tendency to high diversity, containing a species richness that is divergent from the species present in surrounding areas.[108] "Fallows will eventually result in a biodiverse and high biomass forest. Swidden is not only a cultivation system in the forest, it is as well and very importantly a procedure for high forest regeneration."[109] Harris conducted a long-term cycle study—5 to 10 years—of the swidden polycultural agriculture of the Waika. These crops contained species such as banana (*musa paradisiaca*), yucca (*manihot esculenta*), papaya (car*ica papaya*), cotton (*gossypium barbadense*), cocoyam (*xanthosoma sagittifolium*), yam (d*ioscorea trifida*), arrowroot (*maranta arundinacea*), pumpkin (*lagenaria siceraria*), sugar cane (*saccharum officinarum*), arrow cane (*gynerium sagittatum*), and tobacco (*nicotiana tabacum*). The positioning of the plants in these plots did not follow any regular plan but was guided by the need to avoid tree

103 Carneiro da Cunha, "Traditional People, Collectors of Diversity,"

104 Balée, "Contingent Diversity on Anthropic Landscapes," 257–272.

105 Hui, "Machine and Ecology," 54-66.

106 Carlos Fausto and Eduardo G. Neves,"Was There Ever a Neolithic in the Neotropics? Plant Familiarisation and Biodiversity in the Amazon," *Antiquity* 92, no. 366 (December 2018): 1604–18, doi: https://doi.org/10.15184/aqy.2018.157.

107 Manuela Carneiro da Cunha, "Antidomestication in the Amazon: Swidden and Its Foes," *HAU: Journal of Ethnographic Theory* 9, no. 1 (March 2019): 126–36. https://doi.org/10.1086/703870.

108 Balée, "Native Views of the Environment in Amazonia," 277–88.

109 Manuela Carneiro da Cunha, "Antidomestication in the Amazon: Swidden and Its Foes," 126–36.

stumps, felled logs and other forest debris that remained after slash and burn.

> The effect of this apparently haphazard pattern of cultivation was to leave little bare soil exposed to the direct effects of insolation and raindrop impact [...] The interplanting of species with different growth habits and root systems, trees, shrubs, and herbs, climbing and sprawling plants, root and fruit crops also ensures effective vertical and lateral exploitation of available light, warmth, moisture, and nutrients.[110]

Carneiro da Cunha mentions that in the Amazon, itinerant swidden agriculture seems to resist the supposed progress, that is, the "irreversible evolution" that is usually assumed as universal. According to da Cunha, it seems that at times the inhabitants of the region can transform their ways of life. Nomad-gatherers can become farmers, and farmers can become gatherers. "Their science, as much as their messy gardens that mimic the forest, contradicts what we thought we knew about agriculture: that once one has it, there is no turning back."[111]

4. Conclusion

> climate change science has well demonstrated current human influence on species' plenitude and on the biosphere generally to be greater than at any time in history [...] the term (anthropocene) perhaps obscures the fact that humans have had a variety of quantitatively distinct impacts.[112]

In this brief investigation, we have outlined the foundations of a mesological understanding of anthropic activity related to the formation and maintenance of the *terra preta*. This anthropogenic soil located in the Amazon region is similar to other dark soils of high fertility, such as the Russian *chernozem*, or the Egyptian *khemit*, to name a few. It seems clear that there is a multiplicity of cases in which human disturbance of ecosystems has resulted in an increase of their biodiversity, and not only their atrophiation and decrease. We consider that the techniques of the contemporary intensive agroindustry can be understood within what Hui names the global export of "homogeneous technologies embedded within a very narrow and predefined epistemology", which conform the process of modernization that "driven

110 David R Harris, "The Ecology of Swidden Cultivation in the Upper Orinoco Rain Forest, Venezuela," *Ekistics* 34, no. 202 (1972): 150–54, doi: http://www.jstor.org/stable/43618019.

111 Manuela Carneiro da Cunha, "Antidomestication in the Amazon: Swidden and Its Foes," 126–36.

112 William Balée, "Historical Ecology and the Explanation of Diversity: Amazonian Case Studies," in *Applied Ecology and Human Dimensions in Biological Conservation* (Berlin, Heidelberg: Springer, 2014), 19–33, doi: https://doi.org/10.1007/978-3-642-54751-5_2.

by economic and military competition has blinded us of seeing the multiplicity of cosmotechnics".[113] It seems to us that the infrastructure of the *terra preta* offers us a key to overcome problems such as water pollution from the use of agrochemicals and the sewage system, soil degradation from intensive monocultural agroindustry and the damaging effects on the health of humans and other biological species caused by these mono-technological approaches.

At present there are two main currents trying to extrapolate some of the elements of the composition and generation of *terra preta* to the contemporary world:

(a) Terra Preta Nova

This name was coined by William Sombrek during his panel at the Latin American Geographers conference in 2001. It is considered that the addition of biochar can be an effective replacement for the application of agrochemicals to fertilize soils.[114] Biochar is a carbon-rich product that is produced by the slow thermochemical pyrolysis of biomass materials. Organic residues such as livestock manure, sewage sludge, crop residues, and compost are converted to biochar, and then applied to soils.[115] As mentioned above, the carbon structure increases nutrient retention and allows for the emergence of a larger fungal and microbial population. The positive effect of the use of charcoal for crop improvement has been documented in science since the beginning of the last century, however the nutrient retention capacity of the recently produced biochar is low, as it increases with the passing of time.[116] At present there are several agents, both commercial and scientific, that—inspired by the phenomenon of *terra preta*—produce and promote biochar to improve degraded soils without using agrochemicals and increase its capacities for the sequestration of C present in the atmosphere.

(b) Terra Preta Sanitation

Terra Preta Sanitation is proposed as an alternative to the contemporary management of human waste and the application of chemicals for the fertilization of soils used by intensive agribusiness: locally closing the material cycles of these flows through the reuse and recycling of nutrients. Terra Preta

113 Hui, "On Cosmotechnics," 319–41.

114 Johannes Lehmann, "Terra Preta Nova – Where to from Here?" in *Amazonian Dark Earths: Wim Sombroek's Vision* (Netherlands Springer, (2009), 473–486.

115 Shih-Hao Jien and Chien-Sheng Wang, "Effects of Biochar on Soil Properties and Erosion Potential in a Highly Weathered Soil," *CATENA* 110, (November 2013): 225–33, doi:10.1016/j.catena.2013.06.021.

116 Johannes Lehmann, "Terra Preta Nova – Where to from Here?", 473–486.

Sanitation proposes a paradigm shift that "must recognize human excreta and household water not as waste, but as a resource that must be available for reuse."[117] This transforms organic kitchen waste, urine and human feces using lacto-fermentation and vermicomposting in a two-stage process.[118] Lacto-fermentation is an anaerobic biological process that generates a pre-stabilization of the mixture. Its main advantage is that it does not produce gases or strong odours. The mixture of microorganisms needed for lacto-fermentation is commercially available, but it can be expensive and spoils after a few weeks. Therefore, one of the easiest ways to obtain an effective microbial mixture is by taking an inoculum from Sauerkraut (pickled sour cabbage).[119] Lacto-fermentation causes an inhibition of pathogens such as escherichia coli and salmonella, which allows its application to the production of food without risks to human health.[120] Vermicomposting is a process of aerobic decomposition of pre-digested materials by the combined action of worms and microorganisms. Following these processes, it is possible to "hygienically and sustainably convert biological waste and faecal matter into highly fertile humus-like material."[121]

Although the idea of personally manipulating our own excretions instead of letting them go down the toilet may seem like an unpleasant activity for those of us who have grown up coupled to the sociogeny[122] of late modernity, when we leave this frame of subjectivation, even only in theoretical terms, the necessity of closing the cycles of material flows becomes obvious. Taking into account the mesology of the *terra preta*—we know that we can easily take advantage of the nutrients present in our own waste to produce our food—but it is also important to consider that the regenerative agroforestry infrastructure that intersects in it represents an adaptable and plural prototype, for the constitution of food autonomies that could allow a global and sustainable abundance, activated from localized human agency. The localized ecological disturbance through which the *terra preta* was engineered as a techno-geographic

117 Sabino De Gisi *et al*, "History and Technology of Terra Preta Sanitation," *Sustainability* 6, no. 3 (March, 2014): 1328–45, doi:10.3390/su6031328.

118 H. Factura *et al*, "Terra Preta Sanitation: Re-Discovered from an Ancient Amazonian Civilisation – Integrating Sanitation, Bio-Waste Management and Agriculture," *Water Science and Technology* 61, no. 10 (May 2010): 2673–79. https://doi.org/10.2166/wst.2010.201.

119 Factura *et al*, "Terra Preta Sanitation", 2673–79.

120 Stephanie Estrella Ubau-Piedra, *Saneamiento tipo Terra Preta de biosólidos obtenidos a partir de sanitarios ecológicos secos*. (Tecnológico de Costa Rica, 2019). https://repositoriotec.tec.ac.cr/handle/2238/10591.

121 H Factura, "Terra Preta Sanitation," 2673–79.

122 Sylvia Wynter, "Towards the Sociogenic Principle: Fanon, Identity, the Puzzle of Conscious Experience, and What It Is Like to be 'Black", in *National Identities and Socio-Political Changes in Latin America*, ed. Mercedes F. Durán-Cogan and Antonio Gómez-Moriana, (New York: Routledge, 2001), 30-66: For Sylvia Wynter, the sociogenic principle is the "organizing principle that encodes information of the criterion of being / not-being of each culture ..."

object—with a high capacity to capture carbon from the atmosphere—allowed its inhabitants the constitution of multiplicities of polycultural and agro-diverse environments, that through self-preservation, generated an abundance accessible to the large pre-Columbian populations of the region: leaving a biocultural heritage of useful plant species for subsequent human and non-human generations.

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