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From the “*Terra Preta de Índio*” to the “*Terra Preta do Gringo*”: A History of Knowledge of the Amazonian Dark Earths

Klaus Hilbert and Jens Soentgen

Abstract

The anthropogenic origin of the Amazonian dark earths (*Terra Preta de Índio*) was first verified more than 70 years ago. However, the last 30 years have seen a massive wave of scientific investigation, public interest and an ever-expanding intensification of commercial activity toward all things connected to “*Terra Preta*.” Today, the dominant concept, which drives current research, is that of binding atmospheric carbon with artificially concocted dark earths. The large-scale production of *Terra Preta* is said to be an effective tool in efforts to mitigate global warming. This text attempts to provide a history of the knowledge on Amazonian dark earths. It not only focuses on scientific aspects but also considers traditional indigenous knowledge. The position is taken that without indigenous knowledge, modern *Terra Preta* research would not exist; a view, which has profound implications for the ethical evaluation of all further, applied *Terra Preta Nova* research and commercial endeavors.

Keywords: Amazonia dark earths, *Terra Preta de Índio*, traditional indigenous knowledge, biochar, history of knowledge, global warming, carbon storage

1. Introduction

Today, the term Amazonian dark earths (*Terra Preta de Índio*—Amazonian dark earths) refers to a dark soil most often found in limited zones in the lowland areas of Amazonia. These soils are, as a rule, concentrated near rivers and located on bluff zones above the floodplains (*várzea*) [1]. This unique soil has a significantly higher nutrient content, especially phosphorus and nitrogen, and a much higher pH value (around 6.7) when compared to other Amazonian soils [2, 3]. These soils are—as the name indicates—very visually dark and all of them contain some quantity of prehistoric material cultural remains. For this reason, all ancient *Terra Preta* sites are nowadays considered archeological in character and protected by Brazilian law.

According to Woods and Denevan [4], the *Terra Preta* sites cover an area of 0.1–0.3% (6000–18,000 km²) of the wooded Amazonian lowlands. As these soils are characterized by a long-term fertility, many of them are used by the local population, known as *caboclos*, in their agricultural practices [5–7].

The baseline, “non-*Terra Preta*,” primary forest soils (especially oxisols) are generally extremely nutrient-poor, unless modified significantly through the

introduction of artificial fertilizer. These primary forest soils have a low pH value, which means they are extremely alkaline and suited for long-term agricultural use. The usual agricultural workaround, known as slash-and-burn, produces ash and coal, which provide for a temporary fertility. Immediately thereafter, the areas are generally abandoned as the soil fecundity declines and much waste in biomass and land use is the overall result in this highly inefficient approach [8].

The indigenous knowledge of *Terra Preta*, their location and qualities are still invaluable to the current discussion (for a more in-depth discussion on the subject see Manuela Carneiro da Cunha [9]). Simply taking into consideration solely peer-reviewed scientific journal publications is, in our opinion, insufficient [4]. Such a limited approach creates a distorted perspective. Such a selective corpus might inspire the conclusion that only Western-based scientists and 21st century business concerns discovered and developed the fundamental benefits of the *Terra Preta de Índio*. Such a clearly simplified historically misinformed view might even be used for legitimizing claims to the economic exploitation of this important indigenous knowledge [10].

2. Dark earth as anthropogenic soil: the legacy of Curt Nimuendajú

Foreign researchers and travelers first learned about the existence of this uniquely fertile soil by local informants. Herbert Smith [11], for example, had this description to give after his visit to Santarém, "...the rich terra preta, 'black land', the best on the Amazon (...) is a fine, black loam, a foot, and often two feet thick. Strewn over it everywhere we find fragments of indian pottery, so abundant in some places that they almost cover the ground." Friederich Katzer [12], a German geologist, gave the "*Schwarze Erde*" (black earths) a natural origin and interpreted them, as they were located near the rivers, as ancient lake deposits (*igapó*). He analyzed three soil samples from *Terra Preta* and was surprised by their exceptionally high content of organic matter. He noticed a great quantity of potsherds as well of indigenous origin and concluded from this observation that these "ancient lake deposits" were once cultivated by the ancient Amazonians, when the region was much more densely populated.

Curt Unkel (1883–1945) went beyond the mere confirmation of the existence of the Amazonian dark earths and the understanding that these were places in which archeological objects could be found. Beyond a doubt, Unkel (later receiving his Indian-sanctioned moniker "Nimuendajú") is one of the most important 20th century researchers of Amerindian cultures and has done invaluable work for the investigation and protection of Brazilian indigenous populations [13].

In his research on *Terra Preta*, Nimuendajú started from the widely-understood fact, that wherever a certain earth was found (locally called *Terra Preta de Índio*), ceramic fragments of earlier indigenous cultures were always present. Following this premise, near the city of Santarém, at the confluence of the Rio Tapajos and the Amazon, Nimuendajú registered the location of 63 previously unknown *Terra Preta* sites (**Figure 1**) [14].

In 1945, in a letter to the ethnologist Herbert Baldus, Nimuendajú outlined his ideas about the origin of the *Terra Preta*. This letter, summarizing the considerations of many earlier studies, was a watershed publication in *Terra Preta* knowledge and major hallmark of Nimuendajú's personal research legacy, as it contains nearly all the keys ideas of all subsequent *Terra Preta* research [15].

His systematic analysis of the locations of the *Terra Preta* led him to reject the previously prevailing opinion that the special soil was of a natural origin and the result of flooding, the remnants of lake sediments or even volcanic ash [16]. Nimuendajú concluded, by comparing the spatial distribution of the *Terra Preta* that the soils were totally anthropogenic, did not occur naturally and clearly

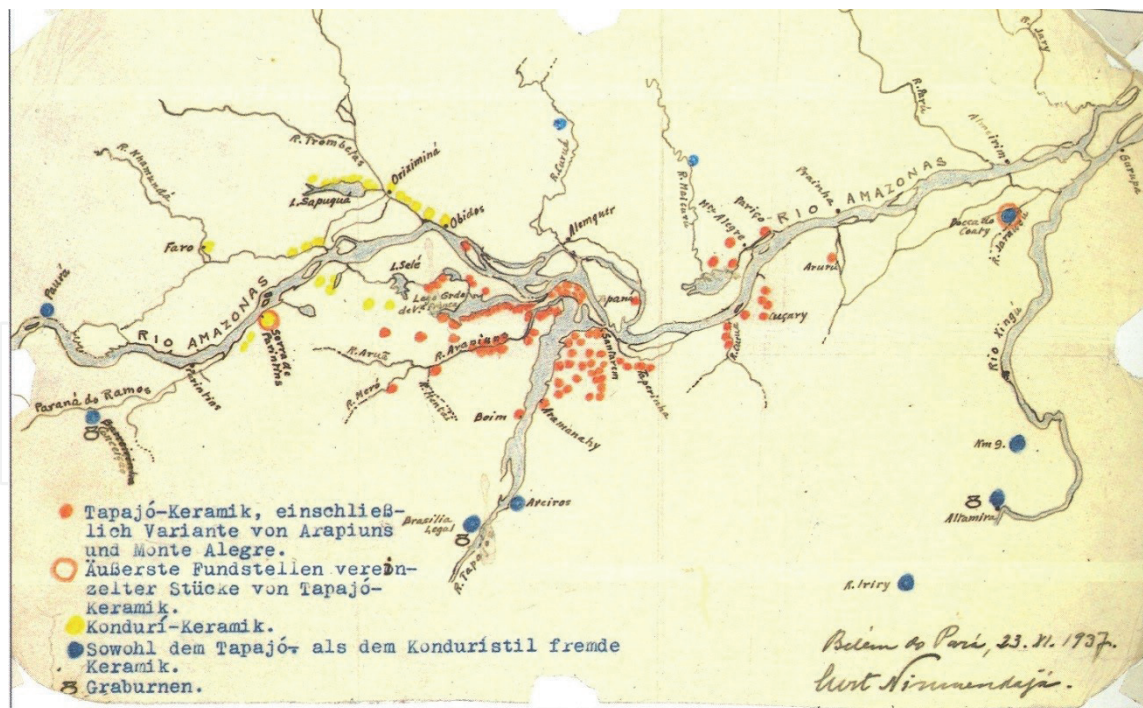


Figure 1.
Map of Terra Preta sites located in the Rio Tapajós area, drawn by Curt Nimuendajú in 1937 (property: Klaus Hilbert).

an outcome of indigenous production. Nimuendajú did not, however, mention whether he assumed this soil was created intentionally or unintentionally. What he did say with certainty and much authority was that all *Terra Preta* in Amazonia was of indigenous origin. Their formation, he explained, was due to the burning of wood in hearths and not the product of slash-and-burn techniques. He concluded that all dark earth sites were necessarily archeological sites, because of their clear association with Amazonian peoples. He was thereby squarely positioning himself in opposition to the prevailing interpretation that presumed a natural production process at work in *Terra Preta* genesis.

3. *Terra Preta* as an archeological site

Nimuendajú bequeathed, so to speak, *Terra Preta*, as a serious research topic to the archeological community. Nevertheless, the academic community was slow to ascertain the value of his contributions.

Betty Meggers and Clifford Evans [17], who eventually picked up where Nimuendajú research had left off, initially began their research inquiries following the work of Charles Hartt [18] and Orville Derby [19] by conducting their research on Marajó Island. They were more interested in the artificial mounds of the Marajoara culture, located on the eastern part of the island, than in *Terra Preta*.

Initially, the researcher to most fully grasp the gravity of Nimuendajú's conclusions regarding *Terra Preta* was Franciscan priest Protásio (Günther) Friel. He, in turn, bestowed upon fellow researcher Peter Paul Hilbert [20] the location of more than 40 *Terra Preta* archeological sites found in the vicinity of the Nhamundá and Trombetas rivers, where Friel happened to hold a parish seat. Both Hilbert and Friel associated the potsherds found in and about these sites, again following Nimuendajú's groundwork, with the Konduri natives, mentioned in the earliest European chronicles. It is likely that this was the time and place when truly systematic archeological research on *Terra Preta* first began.

During the subsequent 10 years, Peter Paul Hilbert located, sample and excavated *Terra Preta* sites along the middle Amazon River [21]. Later, archeologists associated with the Museu Paranse Emílio Goeldi in Belém, such as Mario Simões, continued Hilbert's work and even intensified the systematic approach towards treating *Terra Preta* soils as bonafide archeological sites.

Under Betty Meggers' intellectual supervision and financial support, Mário Simões and his assistants, located and pit-tested hundreds of *Terra Preta* sites, mostly along the Amazonian tributary rivers, such as Rio Negro, Rio Madeira and Rio Tocantins [22]. Recognizing these *Terra Preta* sites mainly as deposits of discarded refuse (kitchen middens), these archeologists were largely interested in the material cultural remains, such as fragmented ceramic vessels and some rare polished stone implements "thrown away" by their original, ancient owners.

Quantifying and classifying the ceramic fragments by their diagnostic features, such as decoration, style, technique and form of vessel, this group of researchers created a chronology-based model of site categorization and orientation. According to the dominant typological pattern of the ceramic fragments, four cultural traditions were pronounced: Zone-Hachured, Incised Rim, Polychrome and Incised-Punctuated [23].

As most of these habitation sites had a multi-compositional sequence of archeological remains, it was concluded that the ancient Amazonians had a semi-nomadic strategy of survival. This was necessitated, it was argued, by the poor soil conditions [24] which could not support extended agricultural use and therefore, neither a complex society nor a high population rate. Despite the extraordinarily high biodiversity of the Amazon region, it was claimed, the habitants had to change their settled areas periodically, which on one hand, explained the great number of *Terra Preta* sites and, on the other, their frequent reoccupation by varying archeologically displayed cultures. Betty Meggers elaborates on this paradoxical situation contrasting the Amazonian environment and archeological record with the idea of a "counterfeit paradise" [25].

Donald Lathrop [26], José Brochado [27] and Anna Roosevelt [28] questioned this model of environmental restraint and soil poverty, and its inherent relationship to a low level of social complexity. They defended the opposite scenario of a rich and fertile Amazonian environment, which supported a large population and complex societies, based on powerful and interrelated chiefdoms.

Eduardo Neves, observing a gradually waning academic interest in these debates and marked shift away from topics involving ancient Amazonia as important research terrain, felt impelled to develop an interdisciplinary-driven and internationally-inclusive research strategy. Initially located in the lower Rio Negro and Rio Solimões region, he united a group of scientists from soil sciences, anthropology, biology, ecology, geography, geology and sociology and set out to reinvigorate the research topic of *Terra Preta*. This wave of researchers made pivotal contributions to the knowledge of Amazonian Archeology, focusing most recently on the question of the origins of early crop domestication [29–35].

Contemporaneously, Michael Heckenberger [36], Denise Schaan [37, 38] and Denise Gomes [39] reignited discussion on the social-power relations expressed by the construction of the monumental structures of the ancient Amazonians. Their primary focus being the massive vertical constructions and their reflection of a high social and cultural complexity. Some examples include the mound builders of Marajó Island, the road builders of the Tapajos, in *Alter do Chão*, near Santarém, the village builders of the upper Rio Xingu or the geoglyph builder in Rondônia and Acre.

Despite all of these advances in the knowledge of *Terra Preta*, the subject was generally, yet again, abandoned as a serious research focus and the idea of the "dark earth" as a socio-cultural phenomenon, a massive public works project of horizontal monumentality, or as an expression of high social organization and cultural complexity, was again, relegated to the academic shadows.

4. The scientific characterization of *Terra Preta de Índio*

While archeologists, and to some extent anthropologists, were becoming more deeply involved in the discussions about the relatively high or low fertility of the Amazon region, investigations into the soil's relation to social complexity, sedentary or semi-nomadic lifestyles or population density remained secondary at best. Other scientists took up the subject of *Terra Preta* and ran with it. Soil scientists more and more gained international public interest and headlines from prestigious and highly visible publications.

In the early 1980s, research on the “natural scientific character” of the *Terras Pretas* began in earnest, with the investigations of Eije Erich Pabst and Gerhard Bechtold. They demonstrated, for the first time, that the “black earth” differed dramatically in chemical composition from the typical, reddish oxisols of Amazonia. They re-confirmed the soil's higher pH value, abundance of organic substances, and much higher nitrogen and phosphorus levels [2, 3].

How the *Terra Preta de Índio* could have come about what the leading question of Eije Erich Pabst, who not only explored the soil properties, but also ethno-pedological aspects. Pabst posited that if one could determine how the *Terra Preta* was arose from the oxisol, then one could recreate such improved soil enhancements today. As part of his strategy, Pabst visited several ethnic groups in the Amazon region. Here he found quite diverging opinions expressed, including their natural provenance by the Assurini, divine origin, as expressed by an Arawete: “the forest God threw them down from heaven,” and an anthropogenic or “man-made” origin. Finally, some Waiapi natives simply explained that they just did not know how the soil came to be [3].

Despite efforts, Pabst was not able to track down a definitive indigenous “recipe” for the manufacture of *Terra Preta* during his oral interview investigations. Pabst emphasizes, however, that this knowledge once existed, but was lost in the course of the population collapse the Amazonian people suffered during and since the European colonization. The indigenous populations were largely displaced from any favorable localities and generally forced into non-sedentary modes of survival. It is stressed that this historic and unmerited loss of cultural expertise should in no way be equated with native inventive capacity, agricultural competence or claims thereof.

Whether Amazonian black earths were intentionally produced or not, continues to fuel debate. On the one hand are the positions that exclude all intentionality and assume that the *Terra Preta* resulted to the indigenous lifestyle. This was more or less the opinion of the earliest archeologists and anthropologists conducting research in the twentieth century. On the other hand, positions exist that presume a very clever technique for the deliberate production of humus, even going so far as to suggest specific ceramics were created and then used in the process [40].

Ethnopedological research has shown that there still do indeed exist Amerindian groups whose lifestyle leads directly to the production of *Terra Preta* [41]. Even without this evidence, it would seem plausible to presume that at least some of the groups formerly living in the Amazon had consciously carried out soil improvement measures by adding a combination of plant charcoal, ceramics and organic matter [42]. Considering the many innovations of the Amazon Indians [43], it is highly unlikely that such a vital adaptive measure and its life-improving results would have totally escaped the conscious awareness of the indigenous population living in Amazonia prior to the arrival of the Europeans.

Moreover, historical studies have shown in other important cases that the ahistorical perspective, that the indigenous products are results of pure happenstance, stems from the faulty view of native peoples as “children of nature”—a perspective

no longer seriously tenable [44, 45]. On the contrary, it is almost certain that at least some central components of the *Terra Preta* required deliberate actions with the purpose of soil enhancement at play. The introduction of charcoal on fields and plantings could be one such element which is current in Amazonia even today, where hearth ashes are strewn on house gardens.

The discovery of the black earths has far-reaching significance for the history of the American continent, as it forces a total revision in estimating number of inhabitants in Amazonia prior to 1492. Because of the high and enduring fertility of *Terra Preta*, it now seems plausible that the area, before European invasion, would have had a population of several times the currently accepted approximate figure of one million people [46]. Currently a pre-colonial population of 8–10 million is considered quite plausible, based on estimates of the currently known acreage of Amazonia *Terra Preta* [29].

This also corresponds to historical accounts of the conquistador Francisco de Orellana (1511–1546), whose chronicler Gaspar de Carvajal reported sighting “numerous huge settlements,” in the first trip along the Amazon in 1542, especially above the confluence of the Rio Negro. Retrospectively Carvajal specifically praised the people of the Amazon for their extraordinary intelligence and inventiveness, demonstrated in their “wonderful works” [47].

5. The black earth as climate savior: Wim Sombroek’s vision

In 1992 the Dutch soil scientist Wim Sombroek, who had previously devoted his doctoral thesis to the soils of the Amazon [48], outlined what would prove to be a watershed conceptual breakthrough in the on-going “*Terra Preta*” story.

In contrast to previous researchers who had enjoined *Terra Preta* research to ethnological, historical and archeological data, Sombroek infused climatic sciences and concerns into the *Terra Preta* dialog [49]. Sombroek sought to manufacture *Terra Preta Nova* or “new” black soil through the introduction of plant charcoal to nutrient-poor soils.

The addition of “Biochar” (plant charcoal) into the soil, sequesters carbon, diminishes the release of carbon dioxide and methane and provides for the soils’ extended usefulness. The enhanced soils’ new fertility, it was hoped, would provide a nutritional benefit to Amazonian farmers and could also be replicated elsewhere in the tropics.

Sombroek hoped this strategy could act as a counterweight to some of the pressures created by man-made global warming on extant agricultural practices. This combination of *Terra Preta* research with “climate change” concerns proved to be very ripe recipe indeed for both academic and public consumption and interest. It brought an otherwise obscure issue, a specific soil type, into the international spotlight.

Sombroek’s new approach seemed to coincide with a new, global reckoning and awareness of the general climate change issue. In 1990 the United Nation’s first IPCC (Intergovernmental Panel on Climate Change) report was issued, followed 2 years later by the U.N.’s Rio de Janeiro Earth Summit in June of 1992.

Existing elegantly at the intersection of environmental concern and hard science *Terra Preta* research took on a new life, birthing a robust research network and garnering unsuspected mainstream media attention. At the helm of this wave of interest was always the charismatic Wim Sombroek, who was duly recognized for bringing attention and funding to the fledgling world of *Terra Preta* research, he was even honored with a poem at his posthumous memorial service. He died in December 2003 [50].



Figure 2.
A Terra Preta site used as papaya-plantation by the local population at the Rio Negro
(Photo: J. Soentgen, 2015).

At the core of Sombroek’s research initiative was the goal of providing the inhabitants of Amazonia with a means to bring greater, more reliable harvests by reinstating native soil improvement techniques (**Figure 2**) [51].

6. Terra Preta Nova

Wim Sombroek would probably be a great deal befuddled, if not downright dismayed, by the surprising direction his groundbreaking research has since taken. The *Terra Preta Nova*, as both a concept and a physical substance, has now been seized up by commercial interests and its being offered on the home improvement/horticultural market right alongside the more widely known “enhanced” home gardening soils.

The rapid and profound proliferation of the *Terra Preta* model to large-scale commercial and agricultural uses has been supported by organizations like the International Biochar Initiative (BCI). Founded in July 2006 this body aims to support research on and commercialization of biochar suitable for the manufacture of black earth (www.biochar-international.com).

By promoting the spread of Biochar's use, BCI and its proponents, hope to limit the effects of climate warming through long-term carbon sequestration and increased soil fertility. Their strategy includes political lobbying in addition to their commercial investment. One principal aim is to insert biochar, as sequestered carbon, squarely into global political climate decisions, particularly in the Kyoto protocol and its successor agreements. Further discussion in Bruges [52].

Clearly, the *Terra Preta Nova* community and its adherents have expanded well beyond the ideas Sombroek originally outlined. Carbon in the form of plant charcoal became more and more the central focus, largely because of the relation to the conversations about the climate issue.

However, it is important to take note that the climate-saving *Terra Preta Nova* is in many respects much different from the *Terra Preta de Índio*. First and foremost, it is not simply a "special soil type" that has formed over hundreds of years, but rather a substance, a stuff, that can be deliberately produced through a very specific technical process. Both the incorporation of plant charcoal, but also ceramic components (potsherds), whose porous properties act as a water retainer, were essential to the original *Terra Preta* recipe. By highlighting only certain characteristics of the *Terra Preta* properties, (those strictly relatable to climate change) and reframing the soil as a universally applicable and easily "manufacturable" substance, *Terra Preta Nova* is less an archeologically localized soil and more a commodity.

Through this change of meaning, the redefined *Terra Preta* can be industrially produced in a manner similar to what Bavarian writer Walter von Molo once imagined in his Murnau diaries as "earth factories." These factories "would produce wonderful wheat soil or whatever was desired, that then would be poured out over swamps, deserts, barren or stony areas of all types. Rains of earth would be allowed to occur with great transport aircraft, earth cloudbursts" [53].

7. Mythologizing *Terra Preta*

Another major component and catalyst for the dispersal of *Terra Preta* recognition in the public arena was the concurrent "mythologizing" of *Terra Preta* itself. Some aspects of the history told in this paper have been previously been published in: '*Terra preta de índio*': Commodification and Mythification of the Amazonian dark earths [54]. Key phrases, with very little specific meaning, like "ancient knowledge," "from the rainforest" and the like were peppered throughout the commercialization and discussion process. Thus, a "black revolution from the rainforest" was announced, showing the "way out of the world-wide climate and hunger crisis [40]. Likewise, the website of the "international Biochar Initiative reads: "Sustainable biochar is a powerfully simple tool to fight global warming. This 2000-year-old practice converts agricultural waste into a soil enhancer that can hold carbon, boost food security, and discourage deforestation." (www.biochar.org, accessed August 25, 2018).

German producer PALATERRA emphasizes the aura of mystique and arcane wisdom in their advertising slogan: "The gold of the earth—after the example of the Indians." Another commercial text reads: "More than 1,000 years old—'*Terra Preta*', the most fertile soil in the world, was produced by the advanced Indian culture of the Amazon from organic material and charcoal. This ancient form of a sustainable recycling economy enables an effective foodstuff cultivation on the infertile rainforest soils (oxisol) for an enormously large population. The production method lapsed into obscurity with the disappearance of the ancient culture years ago. Only around the end of the 20th century archaeologists discovered this 'gold of the earth'" (Figure 3) [55].



Figure 3.

Terra Preta Nova, produced by PALATERRA (BB-mbh): “The Gold from the Earth, created after the model of the Indians.” Provides healthy plants, powerful growth, healthy soil, activates the building of humus, lasting effects, active climate protection, and peat-free soil (Photo: J. Soentgen, 2015).

No doubt, one expects such an enigmatically rich dramatization to improve sales of any commercial product. Nevertheless, similarly “enchanted” language and descriptions are also found in scientific papers, usually in the abstract or introduction.

One of the most renowned *Terra Preta* researchers in Germany, Bruno Glaser, explains in a scientific article published in the *Philosophical Transactions of the Royal Society*, that *Terra Preta* could contribute simultaneously to three of the “Millennium Development Goals. These include mitigating desertification and global warming, as well as maintaining ‘biodiversity hotspots’ in tropical rainforests [56]. Large-scale use of the “black stuff” would reduce the pressure on primary forests, thereby limiting further degradation of the rainforest while also benefiting the climate.

North American soil researcher Johannes Lehmann likewise considers the introduction of biocharcoal into soils as a “win-win approach” [57] and his colleague David A. Laird goes a step further, describing it as a “win-win-win scenario” [58]. It is worth noting that biocarbon production itself is big business, especially when its manufacture and incorporation as CO₂-sequestration becomes part of the emissions certificates market.

Thus the “vision” of the soil pioneer Wim Sombroek has in some sense become a reality. Carbon storage via the production of *Terra Preta* is unique amongst strategies being implemented in the fight against climate. Whether it’s pumping CO₂ underground or the deliberate dispersal of aerosols into the environment, the *Terra Preta* strategy holds a unique persuasive power by being a modern adaptive measure from ancient pool of knowledge. Not only is a practical strategy being promulgated, but a myth and narrative is constructed that functions alongside the research-directing paradigm [45].

For such narratives and meaningful tales, it is characteristic to frame the saving agent as a return or resurrection of something ancient, prehistoric. It harkens back, painting a picture of archaic conditions, people, and gods in order to orient and motivate the act and agency of present-day protagonists [59], (on the term “myth” see also Christine Schmitz [60]). In our case, it is the ancient Amazonian indigenous population who was in possession of the secret to make fertile soil out of infertile ground. However, the ability of the traditional societies was based not only on knowledge, but also on wisdom. Therefore, it is valid to reactivate this now in order to find a way out a potential ecological crisis.

The conundrum presented by suggesting *Terra Preta*, or any other technical means, as a quick-and-easy, one-size-fits-all way solution in the combat against the steady on-set of global warming is that it relegates the role of politics and political will to the sidelines. If the political will to implement these technical solutions is not extant, then they can do very little on their own merit. Nevertheless, at the same time, the mythologizing is functional and can have real practical results. For one, it might help in convincing funding agencies. However, more importantly can spur the research community and inspire younger generations of researchers to enter the academic fray (see Jürgen Frese [61] on the function of myths in groups).

A report on a *Terra Preta* symposium, published in *Nature*, one of the most prestigious scientific journals, commented on a meeting of soil scientists researching *Terra Preta* describing how: “more than one eye in the room had a distinctly evangelical gleam” [62].

The same journal, *Nature*, is gladly supportive of spinning the *Terra Preta* mythos. In 2015, for example, an extended article was published [63] in which *Terra Preta* was praised for not only being a remedy for climate change, but also a nutrient and water reservoir and even an absorbing medium for poisons. It worth noting that *Terra Preta Nova* is now being produced in the United States and Europe (a report by the International Biochar Initiative names of 326 firms that are active in production: http://www.biochar-international.org/State_of_Industry_2015, accessed on June 22, 2019).

As an area of scientific research, *Terra Preta* is firmly established. By the end of September 2018, 1.230 scientific papers with titles containing the keywords “*Terra Preta*” and “biochar” had been published (online research in the ISI Web of Science on 24 September 2018). The academic fervor is not groundless, for it is now well documented that the introduction of biochar does indeed have soil-improving traits and does increase agricultural yields. In a limited sense, it contributes to climate protection, especially in Europe, if biocharcoal replaces compost [64]. *Terras Pretas* have also inspired research into novel methods of waste-water treatment [65].

The claim that newly-produced *Terra Preta Nova* can sequester carbon in massive amounts has not yet been sufficiently confirmed by studies. Now, there are only a few concrete field studies proving that the carbon particles really do remain in the soil for a substantial period and that the carbon bonding is not overcompensated through other processes [66]. Health is another concern when discussing the implementation of biochar, due to increased smoke levels (see a new analysis of smoke from burned plant material: Iinuma et al. [67], and products from the pyrolysis

processes can cause adverse health effects. In addition, there are other competing uses of biomass to consider [68, 69].

In addition to these aforementioned concerns there is the need to stress the enormous profit incentives many large companies inevitably take into consideration when championing the integration of *Terra Preta Nova* and, respectively, biochar-coal in the CO₂ markets [66].

However, one enormous critically concerning issues is that it is often not possible to verify that biochar production is sustainably produced and does not stem directly from sources of illegal deforestation [52]. Accordingly, the Biochar activists are criticized by other NGOs, most notably Biofuelwatch [70, 71].

From the perspective of a history of knowledge and responsible use thereof, in closing, a consideration of the ethics of knowledge is deemed appropriate.

8. Indigenous knowledge and ethics

The modern *Terra Preta* research would have never begun without indigenous knowledge. There is a clear and direct link between the *Terra Preta* archeological sites and their characteristics that inform the modern search developments. Even the specific plants most adaptable to *Terra Preta* practices is delivered to us from traditional indigenous knowledge. Although observational evidence supports the idea that the modern-day indigenous people of Amazonia produce and understand the *Terra Preta* process, the idea remains debated [41, 72]. In addition, it is highly unlikely that the technically proficient indigenous people of Amazonia would have left their soil quality and conditions, so important for their very survival, entirely to chance.

Given this state of affairs, it would justify and correct that the intellectual and financial benefit gained through the research and manufacture of *Terra Preta* goes to not only the researchers and manufacturers, but also to the local inhabitants. Although certainly individual players (in the *Terra Preta* research and commercial diaspora) have exhibited the moral responsibility and principled outlook of Wim Sombroek and have indeed contributed to the benefit and well-being of the present-day inhabitants of Amazonia, it unfortunately remains the exception in the industry.

As the locally sourced *Terra Preta de Índio* mutated into the globally distributed and produced *Terra Preta Nova*, the benefits to the local communities seems to have gone missing in the equation. Generally speaking, the present-day inhabitants of Amazonia are excluded from participating in the profit-sharing made possible by the industrialized production of *Terra Preta* and biochar. One might argue that they do indeed also benefit from the fact that climate change is being combatted. This remains a very abstract and long-term benefit however and means much less to generations living today, regardless of the efficacy the native technology does hold for negating the onset of human-caused climate changes.

Participation in both promulgation of and benefits from *Terra Preta* practices by native groups is essential. The current exploitative and non-collaborative methods used both scientifically and commercially disregard the core principles that were established for the reasonable protection of indigenous knowledge (World Intellectual Property Organization: Wipo Publication 920E). Modern suppliers and producers of *Terra Preta* products insist on emphasizing the fact that their product was produced with the insight of “traditional indigenous knowledge”. In this instance, therefore, the principle of “equitable benefit sharing” [73] (Wipo Publication 920E, p. 23) must be applied, for there are still remaining native peoples along the Amazon who continue to know and apply this knowledge [74, 75].

9. Conclusions

At present, it seems that neither the commercial manufacturers nor the science lobbyists have developed any plan of “benefit sharing” with the local populations. The situation takes on an aura of neo-colonial tendencies under the guise of protecting the world climate. In this scenario, the *Terra Preta de Índio* is today a “*Terra Preta do gringo*”; a black earth of English-speaking and publishing Northern-hemispheric researchers and for-profit companies. Incredibly, the patent process is now well underway where several companies already applying with the European Patent Office to protect “their” *Terra Preta* products (see European Patent 2188230B1). In Germany, *Terra Preta*, and *Terra Preta Mulata* are already registered words or trademarks (registered with the Terra Preta GmbH, Berlin). Clearly, these are not the product of European ingenuity, but the intellectual achievements of the people of the Amazon.

In blatant, unblushing irony, the same companies racing to register with the patent office continue to advertise the mystical “rainforest” as their products’ point of origin. Major adjustments must be in the current profit and knowledge-sharing exchanges surrounding *Terra Preta*. Although efforts against debilitating climate change is certainly necessary and noble, shorter term economic value-setting and the absolute tangible benefits of disseminating *Terra Preta* practices should not continue to only benefit a very small and well-educated citizens of North American and European industrialized countries.

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