

A history of perceiving the soil in the Amazon Basin

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Abstract

The soil resource is a natural resource in the Amazon that has had sustained attention given its importance for potential agriculture in the region. The objective of this paper is to review the history of thinking about and perceiving the soil resource in the Amazon Basin over the last few hundred years. Views of the soil have varied considerably over time and were linked to the scientific 'lens' used to analyze them.

During the Victorian era numerous European scientists documented much about the flora, fauna, and the people of the region. With this documentation came the perception that the Amazon region held great agronomic potential due to the European sensibility of associating vigorous forest growth with fertile soils.

The view of the soil during much of the modern period, especially after the initial opening up of the region for agricultural occupancy, shifted significantly. After numerous failed attempts at agricultural colonization, the soils of the Amazon were deemed a large homogenous area of highly leached and acidic Oxisols and Ultisols, rendered useful only with massive inputs of artificial fertilizer. This view persists in the popular press and within industry and the academy.

Today there is increasing evidence of a great deal more heterogeneity of the soils resource in the region. As more ecologic and agronomic research is conducted in the region it is becoming clear that areas of different types of soils exist in the Basin. Research on indigenous soil knowledge and management techniques is demonstrating that it is possible to learn from local people about ways of managing inherently poor soils in ways that make them productive. It is also becoming clear that there are areas of anthropogenic soils in the region (*Terra Preta do Índio*) that clearly demonstrate that soils of higher fertility status do exist, and that these persist over time.

The materials and methods used for this research consist of text analysis of secondary sources. A wide range of documents (e.g. historical accounts, academic texts, soil manuals, agronomic policy papers, soil maps, etc.) is being consulted in order to gain an appreciation of the changing perceptions of the soil resource over time. These changing perceptions are linked with changing views of science and the way it is practiced.

The findings discussed in this paper are relevant in two ways. The first is that from a soil science history perspective there is an interest in documenting how perceptions of the soil resource in the area have changed. The second is that soils have been used as an explanatory variable for the development of civilizations in the region, a topic that is undergoing a transformation yet persists in the broad literature. 'Placing' the history of soil perception will help inform new theories on civilization in the Amazon.

Keywords: Amazon, soil resource, soil perception, history of soil science

Introduction

Soils are a resource of critical importance to the maintenance of human populations since they provide the substrate for primary production. As such, soils are a key variable in assessing agricultural potential of a region. What is important to realize however is that the way that soils are perceived may be quite different during different historical time periods, which may then result in very different ideas, albeit for the same resource. This paper looks at the history of soil perception in the Amazon Basin, a much contested space in regard to land use and soil management. My objective is to illustrate this history and to evoke an awareness that the 'lens' placed over the object of study is of critical importance when considering the outcomes of the research (LaTour, 1999).

Materials and Methods

The materials used for this paper consist of publications, primarily in English and Portuguese, of articles, books, and reports on the soils of the Amazon Basin (see References). A relatively long historical time frame has been used to include literature from the Victorian Era up until the present, essentially the entire period in which the Amazon Basin has been known to the world as a region. Authors range from naturalists to anthropologists to geographers to soil scientists as well as people from the more applied disciplines.

The findings presented in this paper are the result of 'text analysis.' This is a method by which texts are analyzed directly for their content, the way the content is presented, and the societal framework and institutional context within which content is constituted. These frameworks and contexts can be seen as lenses through which the object of study is viewed, and can differ significantly during different time periods.

Results and Discussion

Publications on soils in the Amazon Basin are numerous, although there has been a habit of perpetuating certain myths about the soils of the region (e.g. Lal and Sanchez, 1992) which has led to a certain repetitive nature of many publications. My selection of readings includes general and specific academic works, those that pertain particularly to the development of the Amazon Basin, and more broad readings such as textbook and publications for the lay public.

My analysis of the literature reveals that there are three broad categories of writings, and hence ways of perceiving Amazonian soils. These fall into chronological order and parallel eras in the social sciences and humanities. I call them the 'Victorian Bounty,' the 'Period of Modernist Thinking,' and the 'Post-Modern Interpretations.'

The victorian bounty

The Victorian Era is perhaps best exemplified by the writings of Henry Walter Bates, the intrepid naturalist/ explorer of the mid 1800s. He initiated a much-perpetuated myth about the perceived fertility of the soils of the Amazon rainforest, including floodplain areas (Bates, 1864). His description of the verdant and lush tropical rainforest launched the idea that the soils of the Amazon rainforest must be very fertile and possess great potential for agricultural exploitation. His ideas were founded in the European context where forests were associated with fertile agricultural land once cleared. As Bates saw it, the land-use 'problem' of the region was the lazy ways of the

local populace who the need to use more civilized agricultural methods. Herbert Smith offers similar interpretations from his travels in the Lower Amazon (Smith, 1879).

Even-though acknowledgment of tropical forest soils not being as fertile as first assumed came as early as the late 1920s (e.g. Marbut and Manifold, 1926), the idea of good soils for agriculture under lush tropical forest has persisted well into the latter half of the twentieth century. This myth of lushness is in part responsible for the massive development efforts on the part of the Brazilian government to occupy the Amazon Basin with landless peasants displaced from southern agricultural areas (Hecht and Cockburn, 1989).

Another part of the impetus to settle the Basin starting in the 1960s stemmed from geopolitical reasons to occupy the border areas (e.g. Hecht and Cockburn, 1989). Overall, however, much of the push came from the perceived need to modernize and tame the 'uncivilized' forested areas of the country, paralleling Bates's assessments. Similarly founded on European ideals of what constitutes a civilized society, road building and colonization schemes were initiated, all with the misguided view that the 'rich' forest soil would sustain high crop yields as well. Brazil's love affair with modernist development schemes were based on the 'Victorian Bounty' and forged ahead of its modernist soil interpretations (Scott, 1998).

Modernist thinking

The harsh reality of the false myth of lush forests resulted in failed colonist farms, the consequences of which the region is still grappling with. It also resulted in directed and detailed research on soils in the Amazon Basin. Wim Sombroek's dissertation on soils in the Amazon (1966) is still the benchmark of detailed soil survey for the Brazilian Amazon region. The large Tropsoils project launched by North Carolina State University in Yurimaguas, Peru demonstrated that presumed rainforest lushness is not due to fertile soils, but that the soils are in fact quite depleted in nutrients (e.g. North Carolina State University, 1976 [one of numerous annual reports]). Brazil's own RADAM project (Ministério das Minas e Energia, 1976) also demonstrated and documented the poor fertility of tropical forest soils.

Other works have summarized these findings as well (e.g. Falesi, 1974; Wambeke, 1978; Sombroek, 1984; Ministério de Economia, Fazenda, e Planejamento, 1991). Most of these are descriptive in nature, detailing the morphology and genesis of soil types found within the Amazon Basin usually presented together with their 'agricultural potential'. Descriptions of the tropical forest nutrient cycle are frequently included wherein nutrients are cycled in the forest biomass and by-pass or only briefly reside in the soil. Hence soils nutrients are export rapidly upon removal of the forest for agricultural purposes (Jordan, 1982). A flush of fertility is felt for the first few years as the nutrients in the ashes from burned forest are taken up, but then year upon year of low yields follow (Hecht, 1984). It is the long tail of the low yields after the initial flush that caused the colonization disasters and continued deforestation. Since the new 'flush' of nutrients is what is needed, colonists continued to deforest new land after 3-4 years of extracting a living from a previously cleared plot.

To overcome the perception that the uplands of the Basin contained only poor soils that constrained agricultural potential, technological solutions were suggested. Researchers demonstrated that with adequate levels of fertilizers and other artificial inputs, soils could remain continuously productive over extended periods of time

(Sanchez *et al.*, 1982). Oxisol and Ultisol soil structure is not poor, and can be quite productive under mechanized farming, and the Tropsoils program clearly demonstrated that continuous cropping was possible on 'tropical soils.' These studies were conducted at the Yurimaguas research station in the Peruvian Amazon. Unfortunately the conclusions drawn from those findings were thought to be applicable basin-wide. Both the ideas that high input systems could be implemented basin-wide and be sustained have now been proven unfeasible (e.g. Fearnside, 1987). Unfortunately most of the necessary artificial inputs were, and continue to be, beyond the financial means of the peasants that live and have settled in the region. Additionally, modernist agricultural schemes require mechanization that was/ is equally inaccessible to the peasant farmer in the region for financial and structural reasons.

With the initial phases of the settlement and colonization schemes proving to be disastrous, a spate of researchers demonstrated the superior alluvial soils and thereby invoked the higher agricultural potential of the floodplain areas of the Amazon (e.g. Petrick, 1978; Denevan, 1984; Barrow, 1985). Arguments were made that floodplains should preferentially be used for agriculture and upland areas be used for other purposes (Alvim, 1978; Camargo, 1958). This schism between floodplain and upland persists to this day and goes far beyond the obvious environmental differences.

Post-modern investigations

The third 'group' of writings on soils is the post-modern investigations. Post-modernism arose in reaction to modernism and is skeptical of previous theories and ideas. It stresses open interpretations and plural views. This is clearly the case with writings on Amazonian soils in the last few decades. Specifically, post-modernism seeks to 'deconstruct' modern constructions. The modern construction regarding soils in the Amazon Basin was that the majority of soils are highly leached Oxisols and Ultisols, and that these can only be used once they are rectified by modern inputs such as artificial fertilizer and mechanized agricultural techniques.

Recent research has shown that within the Amazon Basin there is much greater diversity of soils (Moran, 1995). Most soils orders are represented, including those often associated with temperate zones such as Spodosols and Histosols (e.g. Bravard and Righi, 1990; Dubroeuq and Volkoff, 1998). Future research will more than likely continue to demonstrate a vast range of soils types.

More research is being done as well on the vast areas of very dark and often very fertile soils, known locally as *terra preta* soils (Smith, 1980; Woods, 1995). These soils have been described before (Sombroek, 1966; Falesi, 1974), but the extent of their existence and the way in which they are currently used are just coming to be understood (Woods and McCann, 1999).

The focus on pluralistic perspectives that is a characteristic of post-modern research is demonstrated by the increased attention to indigenous systems of soils knowledge in the Amazon. Work with the Kayapó Indians has introduced the idea that some cultural groups improve their soils over time (Hecht, 1989; Hecht and Posey, 1989). The Kayapó manage their soil resource carefully by creating patches of higher fertility within a pattern of 'concentric ring' agriculture. They also create forest islands in a predominantly savannah environment (Posey, 1985). Making the islands of trees first requires the active creation of a soil that will help support a small forest. This is done through active and long term burning and composting. These activities demonstrate

clearly that Amerindians were/ are not constrained by their soil environment, but were/ are able to modify it to suit their needs (Denevan, 2001). Parallel findings have been documented amongst the Wola highlanders of Papua New Guinea who maintain and improve soil fertility in a tropical region by careful soil management strategies (Sillitoe, 1996; 1998). Elsewhere in the Amazon I have documented the use of an anthropogenic soil in raised beds. This soil was created by mixing organic material such as rotting bark and leaves harvested in the forest with household compost (WinklerPrins, 1994; Hiraoka, 1995). Similarly, in the Lower Amazon local Caboclos are active managers of their soil resource (WinklerPrins, 2001).

Conclusions

As a result of the modernist view of the soil, reports of the types and qualities of soils found in the Amazon are often grossly over-generalized. This generalized view reflects limited studies in the region, and a sweeping belief that all tropical and especially Amazonian soils are poor and acid on the uplands, and rich and fertile in the floodplains (e.g. Clawson, 2000: 71-72 and Wilson, 1999: 51 for textbook examples). This simplistic view does not address the heterogeneity of soils found in the basin (Moran, 1995), which the modernists did not have the ability to 'see' since they were occupied with finding ways of 'fixing' the soil problem through modernist ideals of industrial agriculture.

This modernist view is in stark contrast to Victorian beliefs of the richness of Amazonian soils as exemplified by Bates's comments. It is also in contrast to the more post-modern strategies that embrace detailed and local level work. This more detailed work is increasingly being done and is slowly demonstrating that land utilization will be more successful when it is adapted to local soil conditions and that land use solutions cannot be generalized and will need site-specific realizations (Furley, 1990: 344).

There is also the increased incorporation of the idea that people are not limited by their soil environment. Many studies exist on the adaptation of people to 'poor' conditions on the uplands. Only recently has the ingenuity of people managing these soils been exposed (e.g. Hecht and Posey, 1989). This forces a reconsideration of the 'soil limitation theory' prevalent in Amazonian studies (Meggers, 1996 [1971]). It appears that people living with poor soils are able to make them produce remarkably well despite the inherent properties of the soils, and this is perhaps the greatest contribution to the changing perceptions of the soils resource in the Amazon Basin.

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