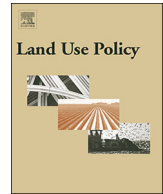




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Land Use Policy

journal homepage: www.elsevier.com/locate/landusepol

From “Green Hell” to “Amazonia Legal”: Land use models and the re-imagination of the rainforest as a new development frontier

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ARTICLE INFO

Keywords:

Amazon
Land use models
Military developmentalism
FAO
TVA
SPVEA
Science and technology studies

ABSTRACT

Critical scholars have addressed land use models and related technologies by pointing to their epistemological underpinnings and the social consequences of visibilities and invisibilities induced by these instruments to different forms of governance. More recently, in addition to reaffirming the old dictum that the map is not the territory, some scholars have analyzed how land use models can shape perceptions, narratives and policy, and in this way “make” the territory and the state. In this study, we adopt the notion of sociotechnical imaginaries to highlight the role of land use models and basin-wide development schemes in the emergence of military developmentalism in the Brazilian Amazon. We show that earlier surveys of the Amazon were created in order to substantiate territorial claims and to guide the exploitation of natural rubber and other extractive resources. Mapping of the rivers as arteries with limited upland assessment implied a view of the Amazon as an immutable and invincible nature where resources were given as elements of natural landscapes. The approach of economic sectorial mapping that had dominated earlier surveys began to shift during and especially after World War II in an effort to imagine Amazonia as a separate and identifiable policy space which transformation would be possible with the application of development frameworks, such as the one derived from Tennessee Valley Authority (TVA). Likewise, experts from the United Nations Food and Agriculture Organization played a key role in providing land use models and assessment that “proved” the economic viability of large-scale colonization projects. This article points out that the extensive occupation and ongoing destruction of the Amazon rainforest was also informed by US large-scale planning regimes infused with technoscientific approaches derived mostly from Global North scientific institutions. Those concepts underpinned imaginaries of an integrated region whose “planning surface” would be oriented by the idea of the “Legal Amazon”, subject to a technocratic, centralized and authoritarian style of developmentalism. In this way this paper shows how land use models are not mere representations of the territory but also carriers of sociotechnical imaginaries that coproduce radical changes in social and natural landscapes.

1. Introduction: maps, imaginaries and places

Scientific representation of space through maps has been central to the exercise of power over place since antiquity by specifying certain regimes of possession, geographic features and forms of occupation (Harley, 1988; Scott, 1998; Pickles, 2004). These technologies acquired an even wider reach during the 20th century thanks to the emergence of geographic information systems, remote sensing, and other tools related to the quantitative revolution in geography. These new instruments enabled the creation of land use models via the extension and combination of a wide set of disciplines, such as soil science, forestry, agronomy, cartography and economics and the management regimes

associated with these. While land use models and maps are based upon the same cartographic medium, the word “model” implies the representation of not only what the landscape is but also what it *should* or *could* be. As such, land use models contain a strong imaginative dimension by providing a basis for comparing ideal or dystopian futures with present realities. In this way, land use models became a central element in planning or controlling territorial transformations (Soares-Filho et al., 2004; Briassoulis, 2008; Jasanoff, 2015).

The creation of land use models has often been framed as a positivist and neutral enterprise able to provide transparent windows onto past, present and future socio-economic and ecological spatial configurations. But since the 1990s, the strongly promotional character of the

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<https://doi.org/10.1016/j.landusepol.2019.02.030>

Received 3 January 2018; Received in revised form 4 February 2019; Accepted 19 February 2019

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mainstream literature has been challenged by critical scholars who analyze the social implications of the technologies that provide the epistemic foundations for land use models. These studies have suggested, for instance, that the introduction of geographic information systems (GIS) and remote sensing furthers the digital divide (Pickles, 1995), provides opportunities for surveillance (Rose-Redwood, 2006), manipulates public opinion in relation to natural resources and environmental disasters (Jarosz, 1996; Harwell, 2000) and leads to the neglect of non-Western/scientific epistemologies (Warren et al., 1995; Posey and Balick, 2006; Sletto, 2008; Rival, 2014; Iwamura et al., 2016; Mackenzie et al., 2017). Most importantly, this critical literature posits a political and epistemological critique of land use models by re-emphasizing the famous dictum that “the map is not the territory”.

More recently an emerging body of literature went beyond the critique of the epistemological limitations of models to emphasize instead the ways in which models *make* the territory (Scott, 1998; Herlihy and Knapp, 2003; Smith et al., 2003; Pickles, 2004; Kitchin and Dodge, 2007; Leuenberger and Schnell, 2010; Almeida, 2011; Peluso and Vandergeest, 2011; Rajão and Vurdubakis, 2013; Olson et al., 2016; Delgado-Aguilar et al., 2017; Hunt and Stevenson, 2017). These studies have shown the central role of mapping in the constitution of empires and managerial practices of modern states, but also in the redefinition of environmental and indigenous/traditional spaces through processes of counter-mapping using GIS, remote sensing technologies and social mapping (Edney, 1997; Smith et al., 2003; Perkins, 2008; Almeida, 2011; Olivero et al., 2016; Olson et al., 2016; Asner et al., 2017; Hunt and Stevenson, 2017; McDonough, 2017; Smith et al., 2017; Bebbington and Bury, 2013).

The repositioning of land use models from faulty mirrors of reality into “makers” of the territory poses important theoretical challenges. Amongst the different approaches that have emerged in recent years to study the role of science in policy-making the notion of coproduction proposed by Jasanoff seems particularly useful given the focus of this study (Jasanoff, 2004). In line with the critical GIS literature, she deconstructs the idea that science merely provides a neutral window into reality, and instead puts forward a theoretical framework that explicitly foregrounds the process of coproduction of science and society and how states use science as a rationalizing element of practice (see also Peluso and Vandergeest, 2011; Rajão and Vurdubakis, 2013; Hecht et al., 2014). That is, rather than considering that science determines society (or vice versa) she emphasizes that “knowledge and its material embodiments are at once products of social work and constitutive of forms of social life” (Jasanoff, 2004: 2). At the same time, the coproduction idiom also goes beyond some of the pitfalls of other approaches such as actor-network theory and structuralism, by enabling a finer analysis of the discourses and power relations in the science-policy interface. Along similar lines, different authors have highlighted the role of ideologies, imaginaries and myths in the co-construction of science, technology and society (Latour, 1990; Edney, 1997; Neumann, 1998; Burnett, 2001; Benton, 2010; McDonough, 2017; Smith et al., 2017; Rajão and Duque, 2014). Based on this tradition, Jasanoff (2004) has argued that, in a similar way to fiction novels, scientific knowledge and artifacts reflect current societal anxieties and desires, on the one hand, but also point towards specific futures, rendering them in “a staging ground for action” (Appadurai, 1996, p 7). Thus, sociotechnical imaginaries “link past and future times, enable or restrict actions in space, and naturalize ways of thinking about possible worlds” (Jasanoff, 2004, 2015). They integrate the mental with the material, and are a key element and central practice in forms of engaging “development” processes and in structuring and creating new regimes.

This paper aims to advance our understanding of how land use models both represent and “make” the territory in specific ways. For this purpose, we analyze how the sociotechnical imaginaries embedded in a set of land use models deployed in Amazonia from the end of the nineteenth century until the 1950s played a key role in the transformation of the region. In particular, we explore how the notion of

Amazon as an impenetrable and immutable “Green Hell” gave way to the establishment in 1953 of the “Legal Amazon” as a discrete planning and socio-environmental space that could be developed by an authoritarian and technocratic regime. This article is organized in chronological order with three empirical sections that start by describing the role of mapping in promoting colonial imaginaries and end in the 1950s, showing how maps became not only representations of territorial possession but also models embedding an imaginary of the Amazon as a “planning surface” envisioned through specific geopolitical, spatial and land transformational actions in post-WWII nation building. The final section concludes the paper and points to the importance of studying the role of land use models in shaping present and future territorial policies.

2. From possession to planned resource exploitation

Surveys have an illustrious place within the histories of cartography, development and resources sciences (Cortésão, 1935; Harley and Woodward, 1987; Harley, 1992; Burnett, 1999; Harley et al., 2002; Zimmerer, 2006; Safier, 2009; Baker et al., 2013). Historically, tropical cartographies in particular presented challenges because of the problems of scale, physical mobility, accuracy, technological limits, observer positioning, western unfamiliarity with the tropics and the famously political and colonial usage of maps (Lestringant, 1994; Varela Marcos and Vernet Ginés, 1994; Perkins, 2008; Hecht, 2013). Further, while there were certainly indigenous cartographies in the new world, they were mostly illegible to the Europeans who tried to decipher them (Cortésão, 1935; Lestringant, 1994; Mundy, 1996, 1998; Smith et al., 2003; Safier, 2009; Asner et al., 2017). The “grey literature” of the tropics, especially Amazonia, is thus awash mainly with navigational information such as riverbanks, river bottom soundings, their tributaries and depths. These were often coupled with far less quantitative digressions on inhabitants, obvious resources, a few handy vocabulary words and phrases of local languages; this input was part of the more general practical colonial archive and thus a key instrument of conquest. Following the establishment of *Uti possidetis* as a diplomatic concept for land claiming and national sovereignty in mid-nineteenth-century Latin America (according to which the presence of nationals in the territory permitted new boundaries and formal claiming), actualized maps and documented settlement became essential to diplomatic and military contestations. Surveys showing specific national settlement did work as national claiming devices by stabilizing a common imaginary of possession of remote lands between competing powers. These maps maintained a highly “nautical” stamp with “overland” *terra firme* lands left blank or to the aesthetics of cartographers (Reis, 1949; Farage, 1991; Rivière, 1995; Burnett, 2000; Hecht, 2013), where bottom soundings, place names and settlement density comprise the information about a region that was dominated by rubber to be found inland (see Fig. 1).

What was required ultimately was a shift from the “traveling gaze” to one more embedded in the concerns of regional identity and the sciences to create newer sociotechnical imaginaries and establish the Amazon not just as stories about commodity rivers or natural marvels, but as distinctive, colonizable, governable places. The mapping exercises, and the communities of survey practice developed in places like the Royal Geographical Society and the Military training schools of Brazil, were able to handle the first outlines of state involvement for largely geopolitical reasons, but they were too flimsy and narrow for the next round of state making which required different forms of intervention.

The mapping surveys of the late nineteenth and early twentieth centuries represent the beginning of a departure from a focus on navigation and boundary possession, a kind of imaginary state mainly materialized in military posts and customs houses, to the planning of rational resource exploitation. One of the pioneering examples was provided by the Brazilian engineer, explorer, surveyor and writer

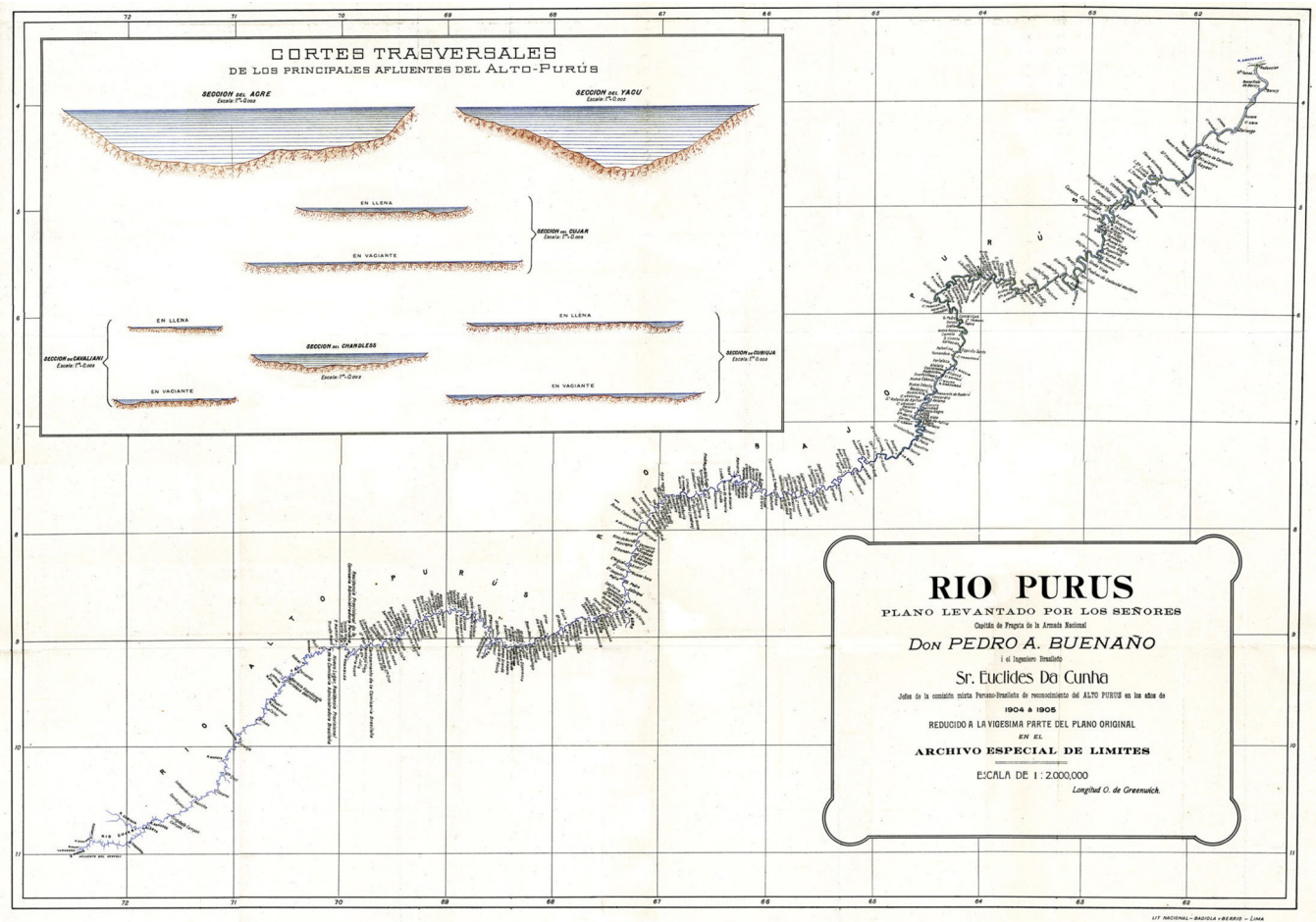


Fig. 1. Benaño/Da Cunha map from a section of River Purus in the Amazon.

Euclides da Cunha. While mapping the Purus river in the context of a territorial contest between Brazil and Peru, Cunha also represented the differences in latex extraction economies of the sparser *Castilla* and the denser rubber trees. He also strived to represent not only the natural infrastructure provided by rivers but also the manmade forest tracks used to link waterways for the transport of goods and people, and the political ecologies and social relations of production (Hecht, 2013). He further elaborated a set of new discourses meant to tie this outback to deep Brazilian history, folklore and lifeways as a means of consolidating Brazilian identity in a different discursive form of claiming that went with the maps, and not just simple survey and demographics, which were the usual order of the day. In this way, memory and identity as well as spatial practices were deployed in the construction of the ideas of new nation and tropical civilization in boundary adjudications. Finally, he invoked a normative question about “deserving colonizers,” comparing Peruvians who were “schooled in plunder” to Brazilian yeomen who practiced careful land husbandry.

These surveys were part of a broader imperial remit that was enhanced by new scientific methods and technologies: 1) the comparative biogeographic analytics and models of von Humboldt that informed pan-tropical comparisons (Humboldt et al., 1821; Kohlhepp, 2005; Arnold, 2006; Zimmerer, 2006; Walls, 2009); 2) the expansion of intermediating institutions such as botanical and acclimatization gardens and tropical agronomic training in the global North as well as in tropical colonial centers (Brockway, 1979; Spary, 2004; Schiebinger and Swan, 2005); and 3) technologies such as steam boats and Wardian cases that permitted the transport of live plants.

Biotic interests allied to the deployment of these new technologies began to transform the content of surveys and collections from nautical

and simple “census” exercises useful for conquest to studies in economic botany with commercial biopiracy as an animating logic (Brockway, 1979; Spary, 2004; Schiebinger and Swan, 2005). For this reason these surveys often employed different forms of state espionage focusing on assessment of *in situ* resources, the efficiencies of their exploration, and their potential for future finance, investment and, potentially, theft. These became elements of colonial knowledge systems, imperial archives and training inputs for evolving imperial institutions such as the Royal Geographical Society and colonial agronomists (Church, 1907; Driver, 2001; Flandreau, 2016) as well as North American Expeditions (Herndon, 1853; Dozer, 1948). It was thanks to this new form of survey and related technologies that, after some failed attempts, officials from the British Empire were able to steal and successfully germinate seedlings of Brazilian rubber trees (*Hevea brasiliensis*) in the Royal Botanic Gardens in Kew. These were then sent to Ceylon (modern day Sri Lanka) and Singapore, and propagated in the British colonies and later in the Dutch colonies (Plane, 1903; Dean, 1987; Hecht and Cockburn, 1989). The animating idea of these exercises however, remained rooted in the exploitation and at best, the improvement of native lands with the introduction of new species brought from other countries in the same biogeographic region.

2.1. Resources assessments and economic futurism

The problems of the Amazon rubber economy, North America’s covert imperialism, and the expanding demand for rubber for tires and other transport and industrial uses stimulated a new kind of natural resource survey. During the early 1920s, the US Secretary of Commerce (and later US president) Herbert Hoover financed a series of scientific

expeditions to the Amazon. To accomplish the work he invited the head of the US soil service Curtis Marbut (Brevik and Hartemink, 2010), tropical botanist Carl La Rue and US trade attaché in Brazil William Schurz (Schurz, 1925; Marbut and Manifold, 1926; Marbut, 1934; Dawson, 1952).

In the Amazon, this analytic survey team deployed modern soil and resource mapping techniques and quantitative land evaluations that had already been operationalized in the US, China, Russia and India as part of the scientific apparatus for territorial expansion into their remoter national hinterlands. In the US, such surveys were part of the early “progressive era” strategies for scientific management and forestry assessment as a central resource tool mandated by Gifford Pinchot, head of the newly founded US Forest Service, for scientific forest management, and advocated by John Muir for conservation and ethical and spiritual uplift (Hays, 1969). Both “wild lands” and production landscapes in the US involved creating federal bureaucracies and new kinds of institutions to claim large areas with uncertain (or indigenous) land tenure, involving an array of property regimes, cultural histories and economic forms. The effort was to remove such lands from simple pillage by expropriating them and claiming them *institutionally* for the nation state and deploying a narrative about their national role in both the present and the future. The state then would mediate access rights and use, capturing royalties, while consolidating frontiers within a capitalist but not entirely privatized property framework

In Amazonia at the time, such survey enterprises had a highly sectorial emphasis—mainly on rubber—and an interest in moving the economy from its loose mercantile into more ordered capitalist and scientific forms of organization through changing the relations of production of specific commodities, a theme reproduced in dozens of major Amazon assessments at the time (Pearson, 1911; Akers, 1914; Lecointe, 1922; Schurz, 1925; Rue, 1926; Santos, 1980; Weinstein, 1983) and later advanced through the engagement of Henry Ford’s Fordlandia plantation. The failure of Amazon rubber in the face of more productive Asian plantations required rethinking local efficiencies as a political economic response to: 1) the emerging colonial Dutch and British cartels of rubber in south Asia (Dean, 1987); 2) the desire for enhancing US control over the burgeoning demand for latex for car and bicycle tires (Schurz, 1925; Marbut, 1931, 1934); 3) the efforts of US business concerns and interests to expand vertical production control of the supply chain along what would later be known as “Fordist” lines (Grandin, 2009); and 4) the aim to animate “better” forms of labor management and mobilization (Pearson, 1911), in part because of the human rights issues that had begun to compromise Amazon rubber (sometimes campaigners called it “Blood rubber”) that emerged after the Roger Casement’s denunciations of the rubber economy of the Putumayo river (Great Britain Foreign Office and Michell, 1913; Singleton-Gates and Girodias, 1959; Santos, 1980; Weinstein, 1983). Finally, racial dimensions of Amazonian character were often invoked with the idea of importing more hardworking Asians in lieu of indolent Amazonians (Pearson, 1911), since labor assessment was deeply informed by the “scientific anthropology” of the time and its derogatory views of the darker races and racial blending (Pearson, 1911; Schurz, 1925; Rue, 1926; Stocking, 1982; Schwarcz, 1999).

For the first time, Amazonian surveys not only mapped river landscapes but also emphasized the possibility of transforming, albeit discretely, its social reality in order to improve the efficiency of extracting natural resources. Rather than the limitations and intractability of nature, science and social engineering offered remedies for problems that were viewed previously as environmentally constraining. In this way, an increasingly modernist framing (wages, free labor, efficiency, restructuring of the production system) were part of a discursive repertoire about capitalist modernism and especially the role of the sciences in tropical development that superseded previous arguments such as civilizational, plunder or evangelical conquest. In this way, the Schurz survey represented a modernist agenda *avant la lettre*.

The set of surveys described above were different in their essence from the maps of early colonial enterprise. The mapping of the natural and social infrastructure of latex extraction indicated pragmatic ways in which the region could be managed through new forms of state rentier practices and modern entrepreneurialism. In this way, these surveys resulted in not only maps but also land use ideas with a sociotechnical imaginary that would transform intractable “wild resources” into tropical commodities that could be reliably provided to the growing global industrial complex (Coomes and Barham, 1994; Barham and Coomes, 1996; Hecht, 2013; Flandreau, 2016).

3. Reimagining alternative Amazonian realities: from “Green Hell” and intractable nature to scientific projections and speculations

Despite the success of the Amazonian rubber economy at the end of the 19th century and beginning of the 20th, the region carried the tinge of failure after the collapse of the rubber boom, emerging again as a pointless development arena and a locus of ultimately doomed enterprises (Dean, 1987; Coomes and Barham, 1994; Barham and Coomes, 1996). It should be recalled that the region had been a graveyard of large infrastructure and rural development projects. The eighteenth-century Marquis of Pombal failed to change the basis of the Amazonian economy from nomad extractivism (less subject to government control) to settled agriculture and managed extraction by creating “Directories”, urban centers under direct colonial control. Pombal subsidized the purchase of slaves, cracked down on independent traders and built a defensive fort system (Mendonça, 1963; Sommer, 2006), and was seen as the first “entrance of the state” into Amazonian, the state” into Amazonian. Other efforts met a similar fate in the late nineteenth and early twentieth centuries when different attempts to build a railroad connecting the Mamoré and Madeira rivers failed amidst tropical diseases, wild animals and construction accidents that took the lives of tens of thousands of workers (Ferreira, 1981; Hecht and Cockburn, 1989; Da Silva, 1991). Even the great tropical tycoon and port developer, the American Percival Farquhar, saw his wealth evaporate with the collapse of Brazil’s rubber. Thus, it is not surprising that alongside the overheated Edenic visions supplied by naturalists, the Amazon ranked much more solidly as a “Green Hell”, a place as hostile to colonial domination as the Greek warrior women who inspired the region’s name. Based on this perspective, these early conceptual land use models limited themselves to mapping and rationalizing exploitation through social reorganization and minor technological interventions (like better rubber tapping knives) without trying to transform the physical landscape of the region. This would soon change.

Land use models developed from the early 1920s played a key role in challenging the imaginary of the Amazon as an intractable “Green Hell”. One of the pioneers in this direction was Paul Le Cointe (1922), a Frenchman who moved to the Amazon in 1892 to help establish the telegraphic lines between Manaus and Belem and later decided to live there as a farmer. Le Cointe published an early comprehensive economic geography of the eastern Amazon and wrote reports for the Pará government describing economic potential of not only timber and rubber but also crops and livestock (LeCointe, 1922). In this way, LeCointe (1922) was one of the first authors to explicitly imagine the Amazon rainforest as a barrier that had to be sacrificed to create a viable agricultural frontier rather than as an immutable tropical nature:

Currently the *sertanejo* [the poor immigrant from the Northeast] considers the forest his main adversary in the fight for life; only with the help of fire he is able to clear a small area to grow manioc [...] the [big] farmer goes further: his objective is the complete destruction of the forest in order to create large tracts of pasturelands indispensable for raising cattle. [...] It is evident that the colonization of the countryside can only be done by sacrificing most of its forests (LeCointe, 1922).

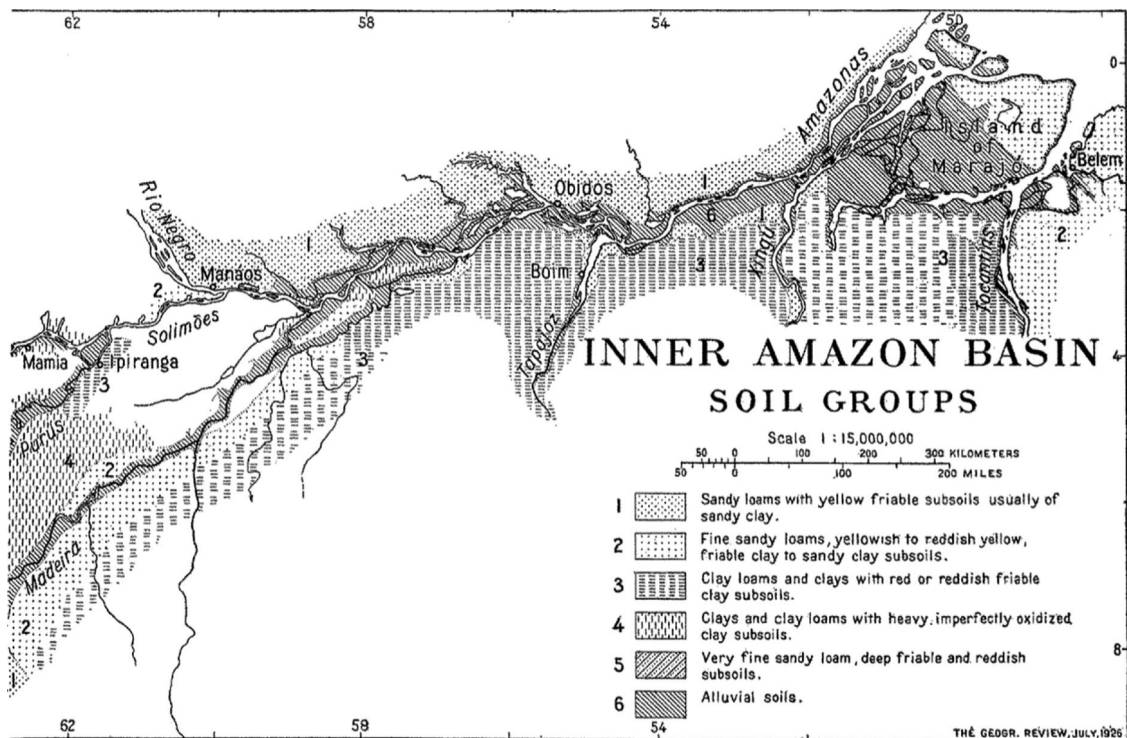


Fig. 2. Map for location and treatment of the soil samples collected by Marbut and Manifold (1926).

The US-led surveys during this period also assessed the transformation of the Amazon from a biophysical perspective. These studies aimed to identify the types of soil vegetation that would be ideal for the creation not only of rubber plantations but also the suitability of the region for growing sugar, cotton, corn, rice and livestock (Hecht, 2013). With this purpose Curtis Marbut and Manifold (1926) produced the first soil map of the inner Amazon basin stretching from Belém to Manaus, including also a substantial portion of the Madeira and Tapajós rivers (Fig. 2). William Schurz, Carl La Rue, CB Manifold and Curtis Marbut generated rigorous, systematic mapping exercises and regional diagnostics that would remain the durable foundation for Amazonian biogeographies (La Rue, 1925; Marbut, 1925; Marbut and Manifold, 1925; Schurz, 1925; Marbut and Manifold, 1926; Marbut, 1931; Prance and Elias, 1978).

The land use models advanced by Le Cointe, Schurz and Marbut did not translate into any major regional policy during this early period, but they did inform the idea of transforming the region for capitalism by: 1) importing capitalists who presumably knew what regional elites did not about organizing production and changing the relations of production; 2) hiring scientists to focus on the problems in the regional scientific institutions like the Goeldi Museum, including internationally renowned scientists such as Jacques Huber, Alfredo Ducke, Emilia Snelthelage and Kurt Nimuendaju (Simões et al., 1973; Faulhaber and Toledo, 2001); and 3) bringing in other specialists employed by the USDA and US Department of Commerce like Marbut and Schurz, and later, specialists in bioprospecting like Richard Schultes, to use modern science to pivot from an extractive “wild forest past” into modern rubber plantations informed by empirical evidence, social science models and economic rationalization that inhered in the translocation of the natural resource ideas of the US progressive movement as it engaged “frontier” areas. From this perspective, it was easy to see why a scientifically oriented tycoon like Henry Ford choose the region for transformational capitalist development, with the powerful techno-imaginary of a tropical Detroit with suburban bungalows and a disciplined labor force.

The surveys supplied another element: information for speculators,

which would become a durable feature of Amazonian enterprises up to the present (Hecht, 2013; Flandreau, 2016). Speculation is of course the imaginary of a future value. William Schurz, the US commercial attaché in Rio, who spent most of his time in the Amazon, was well placed to see the commercial possibilities of speculations in the desire to revive the collapsed latex industry during the 1920s. Along with Pará state governor Dionysio Bentes and São Paulo entrepreneur and speculator Jorge Dumont Villares, Schurz took a free land option on 2.5 million hectares of forest on the Tapajós, the river from whence Henry Wickham had taken the seeds that became the production foundation of Asian rubber. Not by coincidence this area was identified by the early surveys as suitable for agriculture for having the type of “friable reddish clay subsoils” where “the highest grade of wild rubber and the largest quantity per unit area” occur (Marbut and Manifold, 1926: 416; see Fig. 2). In addition, the Tapajós area had been part of various earlier settlements, native Munduruku rubber tapping, and US confederate colonization and agricultural enterprises—it thus had a more readily available labor force and diversified economy (Weinstein, 1983; Nugent, 1993; Anderson, 1999; Whitehead, 2003; Harris and Nugent, 2004).

Based on this detailed survey information, Villares would later sell the land to Henry Ford for the establishment of Fordlândia, his tropical enterprise where millions of *Hevea* trees were supposed to be planted to secure a source of cultivated rubber for the automobile industry, along the lines of what was unfolding in Firestone’s Liberia (Church, 1969). Villares and his partners, taking advantage of the post-rubber desperation of local states and their insolvent elites, managed to take the land offered by the Para State for free and sell it to Ford for over \$125,000, or almost 2 million in today’s dollars (Grandin, 2009). Later on, the surveys would be proven incorrect since Acre territory had much higher rubber tree densities than the area chosen for Fordlândia. Furthermore, the varieties of *Hevea* that were ultimately planted and the limitations on plantation development caused by plant disease led to the failure of the enterprise. Schurz’s presence in the land deal, given his role in large-scale Amazon surveys and the imprimatur of American resource science, gave it authority when he went to the bankers and

investors, reprising a long history of scientific investigation and financial speculation (Hecht, 2013; Flandreau, 2016). Most importantly, by indicating the suitability of the soil for growing a specific crop, these surveys also worked as land use models, providing the seeds of a sociotechnical imaginary that portrayed the Amazon as an agricultural and plantation frontier—a realm of modernizing futures—for the first time.

4. Wartime surveys and the military planning of Amazonia

While Amazonian rural elites felt the impact of the Wall Street crash of 1929 with the loss of their markets, the attention of the newly established Getúlio Vargas government (1930–1945) turned towards the industrialization of the southern parts of the country at the expense of the countryside as a central element of the modernization program for the military regime of the Estado Novo (Vargas, 1940; Monteiro, 2016; Welch, 2016; Bellintani, 2017; Graham, 2018). Mirroring the US frontier's ideology of manifest destiny, Vargas launched the “March to the West” program in 1938 to incentivize the colonization of the countryside. Settlement efforts at that time did not go beyond the center-west and western frontiers of the southern Brazilian regions, but they established a new sociotechnical and social imaginary of waged labor in a modern economy (Skidmore 1986). With Vargas' military dictatorship, the ideologies of national “interiorization” emerged to stimulate a national project of physical territorial occupation based on science, an issue that held immense interest for the military theorists at the War College of Brazil in the face of a long history of border uncertainty (Reis, 1942, 1947; Silva, 1957; Mattos, 1960; Reis, 1965; Birkner, 2002; Hecht, 2013). In a famous speech on the Amazon, Vargas dreams of a place apt for science-based agriculture and reflects the influence of the earlier land use models pioneered by Le Coite and Marbut:

The commonplace idea, now outdated, was that the equatorial lands are improper for civilization. The facts and technical achievements prove the opposite and show, with our own example, how it is possible to implement a rich and prosperous civilization at the margins of the great river. [...] It is time to take care in a permanent sense, of the colonization of the Amazon [...] because you are the land of the future, the promised land of the Brazilian life of tomorrow (Vargas, 1940: 78–79).

This discursive shift was to be coupled to colonization programs for the interior, and the outbreak of the second World War offered an important opportunity for that. During WWII, US and allied rubber supplies were limited by Axis occupation in Asia since more than 90% of the US supply was Asian in origin. This brought US resource vulnerability sharply into focus and highlighted the urgent problems of supply of strategic materials. Even though Brazil remained neutral during the first three years of the conflict, the US government via its Department of Agriculture (USDA) renewed its survey efforts in the region, conducting an Amazon-wide study in 1941 that estimated that there might be 200 million wild *Hevea* trees in the region, with a potential yield of 667,000 tons a year. However, the same study also acknowledged that in order to realistically tap 100,000 tons a year it would be necessary to have at least the same number of tappers (Dean, 1987).

4.1. The Washington accords and new deal internationalists

In Brazil's coastal waters, Nazi boats blew up supply and passenger ships, forcing President Vargas, though his administration hardly lacked fascist sentiments, to take the US side in the war. This led to the signing in 1942 of the Brazil-United States Political-Military Agreement, also known as the Washington Accords, whereby Brazil would provide rubber, iron, cotton and other commodities crucial to the war effort, and allow the US to establish a military presence in the Northeast and the Amazon, while the US would supply Brazil with

weaponry, capital and technical cooperation to ensure the provision of commodities (Moura, 1980; Hecht and Cockburn, 1989). This was, at the time, the largest US foreign assistance package ever offered (Garfield, 2013).

The surge in war demand coupled with the loss of Asian supplies produced the second rubber boom in the Amazon. In contrast to previous economic cycles, this time both Brazilian and US officials were keen to expand and deploy the land use models derived from progressive era institutional “claiming” models as well as capitalist models of rural development. As such, these models aimed to foster integration of large areas through reconceptualizing land uses and supporting land use changes, new forms of labor deployment (wages) coupled to social engineering (health and education) that was to accompany such changes. Here governmental officials and businessman attempted a comprehensive transformation of the rubber sector following the logics of efficiency and scientific management elaborated in theory as part of “Fordist” labor and supply chain management. Using propaganda and the war effort to mobilize workers, and updating the older surveys (Dean, 1987) with new techniques of aerial photogrammetry as part of mapping resources and orienting transportation, these military-style intercessions would meld into a new sociotechnical imaginary about the Amazon. This imaginary was based on the rational and centralized spatial planning of the rubber economy and scientific inputs on the rubber itself combined with international capital flows from large enterprises, such as Goodyear and Firestone, as well as from private scientific philanthropic entities such as the Rockefeller Foundation. In this way the development paradigm prefigured what would become the dominant modernist form: state funding, international capital and NGOs for an international commodity.

This was, as historian Seth Garfield (2013) notes, part of a “New Deal Internationalism” and anticipates the extension of this model throughout the tropics (and elsewhere into Brazil like the Brazilian Northeast). Henry Wallace, Roosevelt's vice president, was given complete control over the procurement of raw materials from abroad through the Wartime Bureau of Economic Welfare (BEW), and was the directorial planner, intellectual guide and key authority in the Amazon Rubber Project. Wallace's approach was profoundly influenced by the Tennessee Valley Authority (TVA). During the 1930s, the Dust Bowl and rampant poverty in Appalachia testing the ability of US democratic capitalism to respond to severe social and ecological crises. Wallace, then US Secretary of Agriculture, assisted in the creation of the TVA, a unified river basin development program that transformed the area into an agricultural and industrial hub along what had been seen as an intractable waterway and backward region plagued with high levels of poverty. US planners intended to replicate abroad the model provided by the TVA, using basin development as the organizing framework for their interventions (Bishop, 1936; Ekbladh, 2002). The TVA model buttressed much of the “deep logic” of modernization as a global strategy and as an “alternative planning model” to Soviet-style and fascist central planning on offer during the same period.

The TVA became a more general guiding model for river basin development through the vast suite of infrastructure development and public works guided by centralized rational planning. The Brazilian military and its engineers envisioned an integrated and essentially *dirigiste* development approach based on detailed survey, energy, resources and economic planning experts (Denieke, 2011). By the 1950s, the TVA model began to be proposed as a solution to other large rivers, such as the Nile, Congo, Paraná, the Mekong and Brazil's São Francisco River, and of course, the Amazon (White, 1957; Ekbladh, 2002). Wallace was keen to frame the Amazon Rubber Project as a basin wide development project based on a sociotechnical imaginary derived from advanced land use models as the basis for promoting not only better rubber supply but also social development but also fomenting industrialization and thus aligning with the Vargas industrial ambitions (Liggio and Martin, 1976). This discursive dynamic, however, was at odds with the resuscitation of the old oligarchic extractive system

which could deliver the product at once through its traditional regimes. The US government and resource surveyors were sent to collect cultivars and plan the supply chains and production systems. Yet the most challenging aspect of the expansion of rubber production was the lack of labor. The local workforce of the Amazon was not only scarce and dispersed, but also considered undisciplined and unresponsive to traditional economic and disciplinary mechanisms following the definitive abandonment of Fordlândia in 1934 (Grandin, 2009; Nugent, 1993; Harris and Nugent, 2004).

4.2. The labor question

Planners quickly realized that to have a workforce of 100,000 tappers in the region they would need to systematically train and recruit workers from other parts of the country. In order to implement the complex social engineering necessary to revamp the rubber industry, the Rubber Development Corporation (RDC) financed the Specialized Service for the Mobilization of Workers for the Amazon (SEMTA), an agency created within the Brazilian Department of National Integration (which was under the aegis of the military) to recruit and deliver labor to the Amazon. In this context, technological changes in *Hevea* cultivation, health and welfare were touted as the elements of a New Deal for the common man in Amazonia (Garfield, 2013).

Even though the Brazilian army was not directly involved with the management of SEMTA, the new organization was keen to mobilize military-like language and practices for the recruitment process. In some of the new production areas the rubber soldiers were settled in carefully planned barracks that contained an infirmary and areas for entertainment and meetings. Every tapper was given a “kit” with a standardized uniform, tapping tools, hammocks, knife and other “essentials” for life in the forest. New tappers were not hired as regular workers but instead recruited in rallies in the main cities of the northeast of Brazil as “rubber soldiers” (Miranda, 2013). For that, the government propaganda depicted Brazil as a country under siege. A famous SEMTA poster trenchantly represented this vision: Army soldiers with rifles look towards Europe to defend the shores against the Nazi threat, while the rubber soldiers in standardized uniform and tapping tools defend the country by producing an essential material for

the war effort. The message is further emphasized by a message in bold letters: “Everyone in their place! Towards VICTORY” (Fig. 3). For the workers recruited to be rubber tappers, state propaganda presented this task being as important and as masculine as military service (Garfield, 2006). Furthermore, the occupation of the Amazon was depicted as not only a way to prosper individually but also a nationalistic way to contribute to the country’s civilizational project, a theme of national projection with private gain that would be reiterated throughout the later military period 1964–1985.

While figures are contested, some authors point out that around 50,000 people were recruited from the northeast into pre-established rubber posts in the Amazon by the SEMTA. A severe El Niño drought during the war period certainly contributed to the success of the recruiting effort by creating masses of people eager to find a way out of poverty. This movement was the largest territorial and social engineering project in Brazil’s modern history up to that point (Dean, 1987; Garfield, 2013), laying the groundwork for the military colonization programs of the 1970s and 1980s. In the end, US and Brazilian planners would not transform labor relations or turn tappers into model citizens, as rubber barons still centralized knowledge about where the rubber was, controlled access to the forests and the technologies of tapping, and reduced the labor costs of extraction by reverting to their earlier practices of debt bondage and barter. Nevertheless, the experience of SEMTA and the land use models behind it promoted for the first time a regional imaginary that would be decisive for colonization in the following decades: basin-wide land use models, international capital, militaristic central planning and patriotic propaganda.

5. The invention of the Legal Amazon

While geopolitical concerns always played a role in the Amazon, after WWII the writings of military theorists and Brazil’s Amazon intellectuals indicated an increasing concern with the international interference in the region, in part reflecting the growing US presence there (Stepan, 1973, 1974; Mattos, 1980). Writings about the Amazon economy from the late 1930s to the early 1950s were awash in laments about the relapsed state of Amazon economies and their vulnerabilities (Reis, 1949; Bonfim, 1953; Reis, 1965). Influenced by the notion of



Fig. 3. Propaganda piece from SEMTA by Jean Pierre Chabloz, 1943 (Miranda, 2013).

Lebensraum (living space) from the German geographer Friederich Ratzel, important sectors of the Brazilian civil and military elite argued that if the Amazon was not quickly integrated into the body of the nation it would be lost to foreign powers (Ratzel, 1897; Barroso, 1935; Mattos, 1960; Peixoto, 1977; Mattos, 1980; Bassin, 1987; Silva, 1957; Beattie, 2001; Castro and Araújo, 2001). In this new context, politically influential thinkers realized that in order to safeguard the region in Brazilian hands a sectorial approach based on the decadent Oligarchic rubber economy would not be enough (Silva, 1957). Instead, the definitive integration of the Amazon into Brazil would require the involvement of all key economic sectors, including large-scale farming, mining and forestry. Here again it is possible to see both the influence and reinforcement of a modernist imaginary embedded in basin-wide land use models and large-scale development plans, such as the TVA, linked to emergent national security concerns and Brazilian Amazonian development fantasies.

5.1. Postwar politics and the new Amazonia

The late 1940s, 1950s and early 1960s saw radical changes in the political landscape of the country, including civil and military governments with both populist and technocratic stamps. Despite these radical political swings, it is possible to observe the continuing influence of Vargas' "March to the West" and the growing influence of land use models and related basin-wide development schemes. President Elio Gaspar Dutra, elected to replace Vargas' authoritarian regime in 1945, continued the expansionistic plans of his military predecessor and stipulated in the 1946 constitution the investment of 3% of national receipts in Amazon development. There was still little by way of a coherent mechanism for spending these funds other than showering them on the rubber barons, and as the Cold War began to heat up, geopolitical and geospatial concerns became more prominent. Dutra had also used the TVA model as the organizing frame for the Commission for the São Francisco Valley (CVSF), which aimed at developing the region surrounding the large river that crosses some of the poorest areas of the country (Buckley, 2017). Indeed, continuing the TVA theme in river basin modernization, Stephan Roback, the lead economist for the TVA was placed in charge of the development agencies of the Northeast.

In 1953, during the second authoritarian (but elected) government of Getulio Vargas (1950–1954), the national integration of the Amazon moved to the foreground and became a central geopolitical and ideological goal in national and especially in military consciousness (Silva, 1957; Martins and Zirker, 2000). With the militarized central planning experience acquired during wartime, and the government's experiment with the Vale do São Francisco "TVA", the regime embarked on a centralizing development agency in 1953. Superintendência do Plano de Valorização Econômica da Amazônia (SPVEA) would direct and coordinate the substantial resources granted to the region by the 1946 constitution. The same law that brought SPVEA into being also defined the Legal Amazon "for the purpose of economic planning and implementation of the Plan defined in this law" (Art. 2, Law 1806/1953). The creation of both the Legal Amazon and SPVEA are strong testimonies to the influence of the sociotechnical imaginary, with TVA's DNA embedded in basin-wide land use models and related development schemes.

While previous basin-wide development schemes and land use models were delimited based on political (i.e. state boundaries) or hydrological definitions (Benchimol, 1966), the Legal Amazon transgressed traditional definitions in order to match a new conceptualization of the region as a novel economic space. Less determined by biogeography but rather as an area of influence, The Legal Amazonia encompassed the rainforest as well as the swampy Pantanal, portions of the Cerrado, and the "pre-Amazonic" palm forests of Maranhão. The denomination also subverted existing political boundaries since only part of the state of northern Mato Grosso and eastern Maranhão, and the related northeast and central-west regions, were included (see

Fig. 4). These relatively arbitrary boundaries allowed the creation of a new kind of development space which could then be redefined as a land of emptiness—"a land without people for a people without land," as the military slogan had it, fulfilling at one and the same time the social function of land as well as geopolitical ambition and also advancing a means of diffusing ever more intransigent rural labor demands for agrarian reform. In this way, the definition of Legal Amazonia was the first step in creating a "unified planning space" for national integration policies, a new spatial representation of the Legal Amazon as a unified and authorized site of state planning intervention. Not chunks of states or a watershed with diverse institutional and political structures but a place coordinated by state investments through large-scale state management institutions. In short, Legal Amazonia and SPVEA signaled the arrival of the modern state in "Green Hell".

SPVEA, a centralized technocratic structure that would be in charge of planning and developing the Legal Amazon, marked a definitive break with previous policies towards the region. Brazilian planners realized after WWII that earlier sectorial development approaches that focused only a specific commodity (e.g. rubber) or issue (e.g. droughts in the northeast) had clearly failed as drivers of modernization. At the same time, the government also understood that approaches designed for the industrial south would be irrelevant in this highly tropical rural context. SPVEA's main purpose thus was to transform the Amazonian landscape by developing new agricultural and livestock production, building defenses against flooding and fostering mass migration to the region as part of its labor and national security doctrines, and to reduce pressure for land reform in already developed or poor and over populated regions (Bonfim, 1953; Cavalcanti, 1967; Pereira, 1997).

Transforming Amazonia into a new agricultural frontier required understanding Amazonia as an integrated policy intervention space ripe for "modernist" technologies that could function throughout the extended basin, but contextualized through land use models and spatial and ecological conceptual practices indicating the potential futures of the region. SPVEA explicit aim was to develop energy and transportation plans, "select areas for human occupation," foster "geographic, natural, technological and social research" and "prepare, recruit and settle teams of technicians and scientists in the region" (Bonfim, 1953: 37–38). SPVEA was also innovative in placing land use models at the core of its efforts from its onset and supplanting building up the agronomic institutions that would both train agronomists and develop technologies. SPVEA would be engaged in centralized planning, with its echoes of scientific development doctrines, it would also mobilize the animal spirits of emergent tropical capitalism through state- and science-led development. Rather than rule via local states with their ineffective oligarchs, a more technocratic set of federal functionaries would advise and also manage the reconfigured regional development bank, Banco da Amazonia.

The Brazilian government was convinced of the necessity of continuing to deploy the latest scientific methods and technologies developed in Europe and the US with the creation of institutes and exchange programs. With this purpose, in 1948 a group of scientists and diplomats from Italy, France, Netherlands, the US and the Amazonian countries created the International Institute of the Hylea Amazon based in Manaus. However, the internationalist focus of the institute and its interest in basic scientific infrastructure was at odds with both the nationalist and applied ambitions of development projects, which led to its demise. The Brazilian government made a second and successful attempt to establish an international scientific program for the Amazon, this time with the Food and Agriculture Organization (FAO) of the United Nations. In contrast to the earlier institute, the FAO "Mission to the Amazon Valley" was placed directly under SPVEA management and funding and thus had a direct link to the country's development agenda.

The internal memos from US and European experts reveal that the FAO program was not immune to suspicion from Brazilian politicians. The funding to FAO also suffered from severe cuts and delays in payments from SPVEA at different moments. Nevertheless, FAO experts in



Fig. 4. Brazilian biomes and the Legal Amazon (hatched area).

collaboration with Brazilian scientists and the continuing support of the military managed to conduct a series of large-scale surveys and implement demonstration units. These included studies that showed the potential of different livestock systems for the Amazonian wet lands and the adoption of mixed farming with soybeans to feed cattle during the dry and flood periods (Jacob, 1958; Duraud, 1959). FAO forestry experts also finalized a forest inventory covering 18 Mha, realized a study on timber marketing and distribution and implemented two experimental and training stations around Santarem at the mouth of the Tapajós in the state of Pará (Heinsdijk, 1957, 1958). Finally, FAO experts collaborated with Brazilian and foreign academics conducting soil surveys in different parts of the Amazon to identify agricultural potential and mineral resources (Day and Santos, 1958; Sombroek, 1966).

While SPVEA derived from the transposition of development schemes from the US and land use models developed to a large degree

by foreigners, it functioned as a nationalist development program. It was necessary to ideologically identify the region as fundamentally Brazilian, in part by inventing a new language for speaking about Amazonia as the future, “as ours” (*Amazonia é nossa*); Brazil had to “integrate it or lose it” (*integrar para não entregar*)—deeply nationalist slogans that would later mark the history of the region. The nationalist discourse was complemented by a modernist scientific emphasis on “new” forms of development rather than its played out extractivism, which was consistently described as decadent, inefficient and exploitive with revanchist labor relations, in contrast to a new modern engagement with a much broader suite of economic activities. This echoed the modernist discourses flowing around the mid-century authoritarian modernism of Brasília.

The development of new institutions like SPVEA at the level of the federal state as a feature of its military history and an institution with

significant autonomy over an area of more than 60% of the nation helped to establish an imaginary of the possibility of a massive transformation from oligarchic rule into authoritarianism modernism with the rapid creation of and support for new scientific institutions and completely new communities of practice focused on modern agronomic practices (improved varieties of annual crops) while largely neglecting its woodland resources. These played out as part of the development of a scientific infrastructure conflicted in its desire for international knowledge and its paranoia about international presence, the very deep roots of its national security agenda.

With the exception of a few demonstration units created by SPVEA and the arrival of the “rubber soldiers” promoted by SEMTA, the Amazon rainforest remained largely untouched. It would be only in 1958, with the construction of the Belém-Brasília highway, and again ten years later with the implementation of large development projects under military rule, that the modernist project would begin leaving its physical mark. The apparent stability of the present Amazonian landscape hides a deep transformation of expectations about the future of the region. The creation of land use models indicating the social and biophysical potential for different crops, livestock, mineral and timber products, and the parallel establishment of basin-wide development schemes from the 1920s onwards co-produced a new sociotechnical imaginary for the Amazon. Instead of conceiving the region as an immutable “Green Hell” occupied by primitive Indians and resistant to the development enterprise, it was possible to imagine the Legal Amazon as a new, totally planned modernist development frontier. Without the radical transformation of the sociotechnical imaginary for the Amazon it is likely that the region would have remained largely untouched up to the present.

6. Conclusion

In this article, we have argued that the rapid transformation of the Amazonian landscape from the 1970s onwards cannot be understood without making reference to the increasingly scientized basin-wide land use models and development schemes that emerged from the 1920s. This approach became a hallmark of Brazilian military development interventions and fit well with the ideologies of the professional military as a technocratic, non-partisan, disinterested actor in the development arena (Stepan, 1974; McCann, 1982; De Moraes et al., 1987; Oliveira, 1987; Kraay, 1995; Smallman, 2002). With it, a *dirigiste* and heavily “scientific” modernization would be applied to the national integration of the Amazon, leaving behind, as Euclides da Cunha would put it in another context, “the laps of the rivers”. While survey and land models changed over time, the importance of the TVA as a regional framing for the planning and the economy developed strongly during the WWII period and in the following decades, with additional layers of technocratic planning.

The emergence of basin-wide planning schemes and interventionist land use models took place neither suddenly nor in a social vacuum. There is a clear genealogy of land use models, starting with expeditions by the US government in the 1920s, that not only mapped the existing Amazonian social and physical realities but also pointed to its development potential both as *lebensraum*, future living space, and as technocratic land use utopia. These land use models expanded in both technical sophistication and territorial breadth as some of the same experts involved in earlier models, such as Le Cointe, La Rue, Marbut, Manifold, and Schurz, contributed to the next generation of surveys and policies, and as new technologies transformed the technical underpinnings of regional planning enterprises.

The same could be said about the “mobility” of the basin-wide development schemes, whereby senior officials such as Henry Wallace would be involved in both in the implementation of TVA in the US and planning for Amazon rubber supply as part of WWII efforts, and where other TVA regional economists would also take part in other regions of basin development in the Brazilian Northeast. The growing influence of

basin-wide schema was also made possible with the institutionalization of technical assistance via the FAO and the construction of Legal Amazon as a new planning space and of SPVEA as the technocratic agency responsible for implementing the regions’ development visions and materializing these plans. These were essential for Amazonia to become “legible”, and this required scientific description to organize and direct regional modernization and the new forms of state building evolving around centralization, techno-scientific institutions and political visions that would both build worlds and also project them into the future

Critics have tended to attack the quantification of nature as an instrument of expert power and as a conscious misrepresentation of reality designed to obfuscate local perspectives (Harley, 1989; Scott, 1998). Their critique discounts the degree to which the perceived neutrality of land use models provided an important ideological as well as practical framework through which the Brazilian government could orient and legitimate its Amazonian activities while framing the occupation as part of a “rational,” rather than political, enterprise. What is also less evident in these epistemological critiques is how land use models also had politically as well as substantively advantageous effects. Ordering the forests, land and related agricultural potentials in terms of quantitative natures rendered the forest available to new forms of governmental power in part by supporting a sociotechnical imaginary that represented the region as an empty *tabula rasa* available for new forms of development, thus moving it out of its believed stasis—the Green Hell—into deterministic futures of nation building based on technified knowledge systems. The land use models and Amazonian conceptualizations created between the 1920s and the late 1950s played a key role in providing the imaginaries and the staging ground for the occupation of the region in the decades that followed. In that sense, the representation of the Amazon found in these land use models coproduced the Amazon also in its material sense. It transformed Amazonia, an “unknown and invincible jungle,” empty and isolated from civilization, into Legal Amazon, a space for transformation and rural development in a predictable, calculable and legible way. It is possible to argue that these land use models both preceded and pre-configured the large-scale process of colonization of the Amazon initiated with the construction of the highway Belém-Brasília in 1958 and consolidated the very explicit Amazon agenda following the military *coup d'état* of 1964. As such, land use models should not be understood only through their ability to represent worlds, but also as co-creators of radical changes in social and natural landscapes. For this reason, it is all the more important for modelers to learn about past successes and mistakes and take responsibility for the worlds they help to imagine and materialize.

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