# SOCIOECOLOGICAL LEGACIES OF COFFEE Production in the paraíba do sul Valley in the 19th century: Shaping The Brazilian Southeastern Atlantic Rainforest Landscape

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## **INTRODUCTION**

For the fifth decade of the 19th century, while the taste for coffee spread through the growing urban areas of Europe and America, the demand for slaves and the hunger for virgin forests increased among coffee producers of the Paraíba Valley<sup>1</sup>.

Coffee production in Brazil during the 19th century left deep footprints in the landscape: social and ecological changes that are evident after almost two centuries. The current landscape is the result of an accumulation of past actions and their social and ecological consequences. The investigation of these socioecological legacies<sup>2</sup> in the landscape is an invitation for interdisciplinary research. Landscape can be understood as multidimensional in its structure and definition. In order to understand a current landscape one has to have a firm grasp of Geography, to comprehend landforms, hydrological fluxes, soil properties, climate patterns, vegetation physiognomy, and, of course, the inhabitants interacting with these physical elements. But it is through a rich

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<sup>&</sup>lt;sup>1</sup> STEIN, 1990.

<sup>&</sup>lt;sup>2</sup> Socioecological legacies consist of physical and ecological evidences imprinted on the landscape that are the direct result of a society's material and spiritual culture interacting with the environment.

dialog between Geography and History that one can delve into the past to understand how societies modified through time, especially the labour implemented in the land, and how landscape came to change<sup>3</sup>. At the same time, Historical Ecology provides a link between material culture and past societies, finding and analysing physical evidences that are hidden in the landscape<sup>4</sup>. Carol Crumley so clearly defined this field:

Historical Ecology studies the current dialectical relations between human acts and acts of nature manifested in the landscape. Practices are maintained or modified, decisions are made, and ideas take shape; the landscape retains the physical evidence of these mental activities<sup>5</sup>.

The mental and physical activities that we seek out to understand are the coffee enterprise legacies etched in the landscape of Southeastern Brazil. We seek to develop an understanding of how the process of landscape transformation occurred: (1) from the perspective of human history, investing its work in this transformative power; (2) from the cultural perspective of clarifying how much the environment provides the basic conditions for a population to interact and define different forms and functions in the landscape; (3) as well as through an ecological perspective, investigating changes in ecosystem structure and composition.

Coffee production in the Paraíba do Sul Valley in the 19th century marked a milestone in Brazilian history, becoming the nation's main export product at the time. Although it only lasted a few decades, its socioecological legacies are quite evident in the current landscape. In order to comprehend these legacies, we first have to understand the motor of change: coffee production.

#### **COFFEE PRODUCTION: PAST AND PRESENT**

Brazil is the current largest producer of coffee in the world, only the state of Minas Gerais produces the amount of Vietnam, the second biggest global producer<sup>6</sup>. In the 19th century, Brazil was already in the first place in coffee production, the difference is that at those times coffee was not produced in the entire tropical zone of the globe as it is currently. Now and then, the main consumers and importers of coffee are European nations and the United States<sup>7</sup>.

During the 19th century, coffee production of Brazil was concentrated basically in the Valley of Paraíba do Sul River (hereafter called «the Valley»). Therefore, the Valley

<sup>&</sup>lt;sup>3</sup> SOLÓRZANO et al., 2009.

<sup>&</sup>lt;sup>4</sup> SOLÓRZANO *et al.*, 2018.

<sup>&</sup>lt;sup>5</sup> CRUMLEY, 1994.

<sup>&</sup>lt;sup>6</sup> ICO, 2018a.

<sup>&</sup>lt;sup>7</sup> ICO, 2018b.

was likely to be responsible for most of the coffee world production; a popular saying was «o Império é o café, o café é o vale» (the empire is coffee, coffee is the Valley)<sup>8</sup>. Even though the European colonies in the Caribbean islands already produced coffee by the end of the 18th century<sup>9</sup>, none reached the splendid amount of Brazilian production. Table 1 shows some differences between the production of coffee in the 19th century and in the present.

|                                        | 19th century                                         | Present                                                         |
|----------------------------------------|------------------------------------------------------|-----------------------------------------------------------------|
| Main states of production in<br>Brazil | Rio de Janeiro, São Paulo (Paraíba<br>do Sul Valley) | Minas Gerais, Espírito Santo,<br>Rondônia, Bahia, São Paulo     |
| Working force                          | Slaves                                               | Workers or family agriculture                                   |
| Main internal transport                | Mule troops                                          | Trucks                                                          |
| Main destinations for export           | Europe, USA                                          | Europe, USA                                                     |
| Market competitors                     | Antilles                                             | Diverse tropical countries in Latin<br>America, Africa and Asia |
| Fertilization practices                | Organic fertilizers (rarely used)                    | Agrochemical, mineral, and organic fertilizers                  |
| Medium yield                           | 1,490 kg/ha                                          | 1,528 kg/ha                                                     |
| Export quantity                        | 2,733,900 sacks of 60 kg                             | 19,970,000 sacks of 60 kg                                       |
| Area used in coffee plantations        | not available data                                   | 1,993,926 ha                                                    |

Table 1. Differences in coffee culture in Brazil during the 19th century and nowadays

Source: Translated from OROZCO, 2018

Sugar and coffee production has been termed a system of profligate use, based on abundant resources of land, forests and labour<sup>10</sup>. With continental dimensions and an exuberant rainforest, Brazil seemed to have endless «empty» lands; though the South-eastern region was occupied by different nomadic ethnic groups which depended heavily on the forest, they were almost exterminated when coffee arrived to the Valley<sup>11</sup>.

Concerning workforce, Brazil was the main importer of slaves from the African continent since the second half of the 16th century, summing up more than five million people in a few centuries<sup>12</sup>. Slavery was so normal that the agronomic manuals contained a special chapter on slave management. Nevertheless, Frei Velloso, in his book *O Fazendeiro do Brasil*, already in 1798 criticized the colonial exploitation system,

<sup>&</sup>lt;sup>8</sup> BRITO, 2012.

<sup>&</sup>lt;sup>9</sup> LABORIE, 1797.

<sup>&</sup>lt;sup>10</sup> OLIVEIRA & WINIWARTER, 2010.

<sup>&</sup>lt;sup>11</sup> LEMOS, 2016.

<sup>&</sup>lt;sup>12</sup> CARVALHO, 2008.

warning especially about the brutality of slavery (not that he had an abolitionist position, but by recognizing the differences between rational enslaved people and irrational animals), and the fierce deforestation of the Atlantic Forest<sup>13</sup>. This intensive economic cycle brought wealth and luxury for coffee producers but poverty and degradation for slave workers and the environment. According to Dean, the coffee cycle produced the most dramatic environmental changes in the Brazilian landscape<sup>14</sup>.

#### The Valley

The Paraíba do Sul Valley is located in the southeastern portion of the Brazilian Atlantic Forest Biome, between the mountain ranges of Serra do Mar and Serra da Mantiqueira (Fig. 1). It has tropical climate, with temperatures between 16 and 23°C, and an annual precipitation of 1,400 mm<sup>15</sup>. In the 18th century, the coffee plant (*Coffea arabica L.*) was already cultivated in Rio de Janeiro and then it was introduced in the Valley. The Valley had the double advantage of having the right environmental conditions to which the coffee plant adapted fast, and of being conveniently close to the ports of Rio de Janeiro and Santos.



Fig. 1. Map showing the hydrographic basin of the Paraíba do Sul River, and the location of the main study site in Southeastern Brazil. Elaborated by Joana Stingel

<sup>&</sup>lt;sup>13</sup> ENGEMANN & OLIVEIRA, 2010.

<sup>&</sup>lt;sup>14</sup> DEAN, 1996.

<sup>&</sup>lt;sup>15</sup> NUNES & CALBETE, 2000.

The topography of the Valley was determinant for the type of production. It has a structure of hills of around 500 to 550 meters of height<sup>16</sup>, commonly known as «mar de morros» (sea of hills) (Fig. 2). They were originally covered by a mixture of dense rainforest (evergreen broadleaf forest) — associated to southern facing slopes — and seasonally dry forest (semideciduous forest) — with continental influence — both being part of the Atlantic Forest. According to the logic of the time, the best soils to plant coffee were those covered by primary (well conserved) dense rainforest because they indicated more fertile soils. Therefore, the first step to start coffee production was to cut down the best forest tracts and make use of these rich soils. For such purpose coffee was largely planted on the hill slopes. The coffee farm (*fazenda*) was a mosaic, not only coffee plantation, but also used for cultivating a variety of products, mainly for subsistence, that also included pasture lands allocated for cattle and mules.



Fig. 2. Mar de morros (sea of hills), Valença, Rio de Janeiro. Photo: Adi Lazos

Cunha recommended the cultivation of coffee in contour lines as it was done with vines in France and Portugal<sup>17</sup>. However, the prevailing plantation form was in lines perpendicular to the ground due to the need of slave work supervision<sup>18</sup>; in this way, the foreman was able to scrutinize the slaves by patrolling from the bottom of the hill (Fig. 3).

<sup>&</sup>lt;sup>16</sup> ALMEIDA & CARNEIRO, 1998.

<sup>&</sup>lt;sup>17</sup> CUNHA, 1844.

<sup>&</sup>lt;sup>18</sup> MARQUESE, 2008.



Fig. 3. Typical hill of the Paraíba Valley, with plantation in lines perpendicular to the ground so the foreman can oversee the slave work. Drawing using Marc Ferrez' photo of coffee harvesting in the study area c. 1882. Source: own elaboration

This plantation pattern and the continuous deforestation favoured intense soil erosion, producing severe geomorphological, hydrological and climatic changes in the mid and long term. A study on sedimentation in an auxiliary watershed region of the Paraíba River indicated that during the Pleistocene-Holocene transition (13,000 to 8,000 B.P.) the sedimentation rate there was approximately 300 m<sup>3</sup>/year; but during just 100 years of coffee cultivation (from 1830 to 1930) the deposition rate in the same location had more than doubled, to almost 750 m<sup>3</sup>/year<sup>19</sup>. This process of deforestation and erosion on an enormous scale created entire landscapes of barren and eroded lands virtually clear of any forest cover. The lack of erosion control in colonial coffee farming led to a regional landscape of eroded lands with severe gully and sheet erosion problems.

Around 1850, some serious problems started to show up, such as the prohibition of ultramarine slave trade (to which the agro-export economy was tied) by the Eusébio de Queirós Law<sup>20</sup>, and the first signs of declining productivity of coffee plantations, where no land reclamation techniques were adopted.

This situation reconfigured the use of hand labour provoking internal migration of slaves, from the northeastern sugarcane decadent plantations to the southeastern successful coffee plantations<sup>21</sup>. A strategy to deal with labour shortage was the illegal slave trade. On the south side of the Valley lies the sinuous coast of Angra dos Reis

<sup>&</sup>lt;sup>19</sup> DANTAS & NETTO, 1995.

<sup>&</sup>lt;sup>20</sup> JAGUARIBE & LESTON, 1968. Following the abolitionist (and capitalist) world movements lead by the English.

<sup>&</sup>lt;sup>21</sup> PRADO JUNIOR, 2006.

and Mambucaba. It is quite suitable for clandestine landing of slaves, out of sight of the English ships, allowing to hold the illegal transactions. However, the abolition of slavery in 1888 was the final blow to the collapse of the agro-exporting economy in the region.

Another determinant factor for the deep crisis was the violent fall in productivity of coffee plantations. By the end of the 19th century, the lands were completely depleted, mainly due to soil erosion and plagues. Deforestation and impoverishment of soils created the proper conditions for the prosperity of ants<sup>22</sup>, which attacked the coffee shrubs without mercy. In the past, the strategy to deal with land infertility was to open up more forest, however, by that time, there was hardly any forest cover left as the Baroness of Pati de Alferes<sup>23</sup> complained about in 1862:

The absolute lack of land has not allowed me to extend coffee plantations... Unfortunately, I must report that in all our farms, which cover an area of 21,104,000 square fathoms (10,215 ha)... we do not have two hundred square fathoms (0.01 ha) of first quality virgin forest.

As Prado Junior remarks, the statistics on coffee exports in Brazil do not reveal the decadence of the Valley (Fig. 4) because when coffee production collapsed it moved to other places, especially to the West of São Paulo<sup>24</sup>.



Exports of coffee from Brazil

Fig. 4. Exports of coffee from Brazil between 1821 and 1890. Source: PRADO JUNIOR, 2006

The golden years in the Valley lasted for less than a century. A second landscape transition occurred with the transformation of abandoned coffee plantations into pasture

<sup>&</sup>lt;sup>22</sup> CABRAL, 2015.

<sup>&</sup>lt;sup>23</sup> Baronesa de Pati de Alferes. Relatório sobre o estado da nossa casa, de 6/12/1862; testamenteiro: Francisco de Assis

e Almeida. Fazendas Monte Alegre, Manga Larga, Piedade, Sant'Anna, Palmeiras, Monte Líbano e Conceição.

<sup>&</sup>lt;sup>24</sup> PRADO JUNIOR, 2006.

lands for extensive cattle grazing. The landscape composed of thousands of coffee shrubs became a «sea of bare hills» mainly covered with an exotic grass locally known as *capimgordura* (*Melinis minutiflora* P. Beauv.). Later, in the second half of the 20th century another exotic grass, locally known as *braquiária* (*Urochloa* spp.), was introduced and became predominant in the landscape, together with some eucalyptus plantations and scattered forest fragments, occupying especially the steepest parts of the terrain.

Even though coffee is now part of the past of the Valley, it is still possible to notice signs of its previous production imprinted in the landscape. Some of these evidences are conspicuous and easy to identify, such as the multiple *fazenda* buildings in different levels of refurbishment (Fig. 5). Other vestiges are more subtle and inconspicuous, such as abandoned roads already hidden by vegetation, the composition and structure of forest fragments, and the landscape memory in terms of ecological connectivity.



**Fig. 5.** Evidences of the past of coffee production in the Paraíba Valley: a) Detail of coffee plant on the ground of the main square of São José do Barreiro. Photo: Joana Stingel; b) Remainings of the abandoned Fazenda Santa Bárbara. Photo: Adi Lazos; c) Fazenda São João da Prosperidade used for historical tours. Photo: Adi Lazos; d) Fazenda da Barra used as a hotel. Photo: Agnieszka Latawiec

## ABANDONED ROADS

Human circulation has always been challenging, considering landscape variability, climate variations, and relief. In regard to relief, mountains of the Serra da Bocaina reach around 2000 meters of height and are located exactly between the Valley and the sea, where the ports for coffee exportation were located (Fig. 6). Thus, the flow of production was rather a tortuous process. Coffee production in the 19th century could never have reached its economical extension without solving the complex transportation issues.



Fig. 6. Serra da Bocaina, located between the sea and the Paraíba Valley. Photo: Rogério Oliveira

In the colonial period, the so-called *Estrada Real* (Royal Road) was exclusively for official use, as it had strong links with the mining regions of Brazil. However, this road was far from being a single route connecting two places: a series of parallel paths, branches, and shortcuts through steep mountainous terrain filled the Brazilian south-eastern mountains with numerous routes. If in the level parts almost no traces of these routes are evident, in the Serra da Mantiqueira, as well as in the coastal mountains of Rio de Janeiro and São Paulo, many of these routes can be found. These roads are now largely buried, completely modified or entirely covered by forest vegetation. In slopes of greater declivity, the artificial ramp is evident (Fig. 7), but in more level areas it is difficult to find the original trajectory of the path.



Fig. 7. Old road bed of ox carts on the slope of Serra da Bocaina, municipality of São José do Barreiro (SP). Photo: Rogério Oliveira

Some of these roads have reduced extension (~10-15 km); others are considerably longer, like the one connecting São José do Barreiro in the Paraíba Valley to the coast of Mambucaba, crossing the Serra da Bocaina. This path (with several branches and junctions) follows through dense rainforests in advanced regeneration stages combined with abandoned pastures, and has a stone paved road, with about 80 km of extension (Fig. 8). Its average width is 2.5 m and mostly paved by rock slabs, some with about 1 m<sup>2</sup>. Considering the irregularity of the floor, it can be considered as being impossible to use ox carts. In contrast, it was adequate for mules and donkeys. There are reports of numerous mule troops transporting coffee from the Valley to the ports, until the arrival of the train in the late 19th century.



Fig. 8. Paved trail connecting Paraíba Valley to the sea through the Serra da Bocaina. Photos: Adi Lazos

These paths were not a simple passage through forests and uninhabited hills, yet they were vectors of lateral occupation, partly to provide food for both men and beasts. Albeit insipient, this occupation was responsible for changes in the structure of the remaining forests.

### FOREST FRAGMENTS

As was mentioned earlier, the establishment of vast coffee plantations in the Valley was carried at the expense of the dense rainforest and season forest cover, in a rate never seen before in Brazil. Therefore, the current landscape retains some of the forest's memory scattered in small fragments in the Valley. However, these forest fragments suffer a great deal of edge effect that possibly freezes its successional pathway into an early stage emerging ecosystem<sup>25</sup>. Most of the Valley's forest fragments are small and isolated from any large source of propagules, and many animal dispersers have disappeared.

A recent study of the vegetation structure and composition of five forest fragments in the Valley showed very low similarity between them, with only five arboreal species occurring in all fragments<sup>26</sup>. An observed pattern in these forest fragments was the dominance of a few species, with large populations, and a large number of species with few individuals. This pattern is often associated to early stage secondary succession with limited source of propagules. Although species richness and composition pattern are different from the original forest cover, tree species of Fabaceae<sup>27</sup> and Myrtaceae<sup>28</sup> botanical families are particularly well represented. In the Atlantic Forest these two families reign among the richest and abundant families of the dense rainforests and seasonal forests of Southeastern Brazil. Many species of Fabaceae fulfil an important ecological role of nitrogen fixation, enriching the soil with this nutrient and providing this benefit to the whole plant community. Also, most species of Myrtaceae present attractive fruits for the avifauna. Therefore, this richness indicates that the dispersion made by birds is, to some degree, functioning in the Valley<sup>29</sup>.

The biosphere and the atmosphere form a coupled system by which the climate influences the functioning of ecosystem and biogeographic patterns, which in turn feedback to affect climate<sup>30</sup>. Loss of forest cover decreased the amount of water in the system and precipitation rates<sup>31</sup>, leading to a gradually more seasonal climate with an

<sup>&</sup>lt;sup>25</sup> TABARELLI et al., 2010.

<sup>&</sup>lt;sup>26</sup> SALES *et al.*, 2018.

<sup>&</sup>lt;sup>27</sup> Fabaceae is also known as the legume family or the bean family. It is the richest botanical family in the neotropical region, i.e., from southern United States to Patagonia.

<sup>&</sup>lt;sup>28</sup> Myrtaceae is an important neotropical family, also known as the myrtle family. It has many important fruit trees in the tropical region such as the guava fruit (*Psidium guajava*).

<sup>&</sup>lt;sup>29</sup> SALES *et al.*, 2018.

<sup>&</sup>lt;sup>30</sup> BONAN, 2008.

<sup>&</sup>lt;sup>31</sup> LAURANCE, 2004.

increasingly marked dry season. With this, the landscape underwent changes in species composition due to the greater seasonality. At the same time, with the opening of forest vegetation and the implementation of pastoral systems, the landscape starts to present similar physiognomic characteristics to savannah formations, that is to say, a grassland vegetation, in this case represented by pastures in different degrees of use or abandonment, interspersed by forest fragments in early and intermediate successional stages. This physiognomic change in the landscape scale allowed for the entry of typical *Cerrado* species (Brazilian savannah), such as the maned wolf, locally known as *lobo guará* (*Chrysocyon brachyurus* Illiger), with sightings in different points of the Valley, accompanied by the wolf's fruit plant, locally known as *lobeira* (*Solanum lycocarpum* A.St.-Hil.)<sup>32</sup>. These species are typical of the Brazilian *Cerrado* and have had its expanded distribution towards the Atlantic Forest biome, due precisely to the process of forest fragmentation and the implementation of silvoagropastoral systems<sup>33</sup>.

## **ECOLOGICAL CONNECTIVITY**

Ecological connectivity is the capacity of landscape matrix to interfere in biological fluxes, through inter-habitat movement of organisms<sup>34</sup>. That is, because the Valley's forest fragments are connected with each other by seed and pollen dispersion and faunal locomotion, it maintains ecosystem flows and functions (i.e., biodiversity pool, water catchment, soil formation, biodiversity habitat, etc.).

Among many others, flying animals such as birds and bats play a major role in this process: they connect fragments by spreading seeds (eating fruits from one place and defecating in other) or by carrying pollen from one individual to another. Depending on the characteristics of each species, they can fly for some distance and then stop at some fragment of vegetation to rest or to hide from predators; therefore, big areas without vegetation — e.g., typical Valley pastures — are too dangerous to cross, so it is easier to lose connectivity. Trees within the pastures act as *stepping stones* in the landscape, they are nodes of connection, creating a microclimate that helps other plant species to regenerate, keeping a rich seedbank in the subsoil, increasing organic matter in the soil, and providing wildlife refuge<sup>35</sup>.

The clearcutting of forests to plant coffee during the 19th century, following the customs of the time, determined the destiny of the soils and biodiversity of the region. Coffee is naturally adapted to the understory of forests, though it can be planted either under the shade of trees or under direct sunlight. There are many examples of sustainable production of coffee as a friendly crop with forests, helping to conserve biodiversity,

 $<sup>^{\</sup>rm 32}$  This pattern was observed by the authors in different localities of the Valley.

<sup>&</sup>lt;sup>33</sup> PAULA & DEMATTEO, 2015.

<sup>&</sup>lt;sup>34</sup> METZGER, 2001.

<sup>&</sup>lt;sup>35</sup> GUEVARA *et al.*, 2005.

maintaining organic matter in the soil, and many other benefits<sup>36</sup>. Coffee planted under direct sunlight gains vigour in yield and facilitates the harvest procedures, but loses in the provision of environmental services and in the productivity time of each plant. If coffee had been planted under forest canopy in the 19th century, the story of the Valley would be entirely different. Worryingly, the work of Jha and colleagues (2014) warn about the global increase of coffee plantations under direct sunlight and the resulting diminishment of forest cover, biodiversity and connectivity.

The conditions of the landscape left after coffee shrubs were removed in the Valley — bare hills — were adequate for pastures as grasses need direct sunlight to thrive due to their photosynthetic metabolism. Although, this is not as good for livestock because they hardly have any shade to rest and ruminate. Cattle tend to squeeze under the few trees to refresh themselves (Fig. 9). The scarcity of trees in pastures limits ecological connectivity, jeopardising ecosystems' functioning.



Fig. 9. a) Isolated tree on top of the hill in the Paraíba Valley; b) Zoom in to the isolated tree in the left Photos: Adi Lazos

Planting more trees in the pastures would improve ecosystem health; while some grass would be affected, the gain in ecological connectivity would compensate in the long term. Besides, some tree species can provide benefits such as fodder (improving cattle nutrition), fruits and firewood for farmers.

## CONCLUSIONS

Coffee production in Brazil in the 19th century constituted a complex historical movement of capital growth and landscape transformation, which goes far beyond the Valley region. It expanded and modernized frontiers and was the main cause for Rio de Janeiro and São Paulo urbanization. It also filled the cups of coffee of European and American intellectuals and workers.

<sup>&</sup>lt;sup>36</sup> MOGUEL & TOLEDO, 1999.

In a few decades the landscape changed from a highly biodiverse dense rainforest into pasture lands with degraded soils. Forest cover loss, erosion, regional climate change, habitat fragmentation and biodiversity loss were the main consequences of this transformation. Roughly speaking, the socioecological legacies of coffee production in the Valley is a deforested region, composed of a matrix of low productivity pastures, with several erosive features and silted rivers. Biophysical elements and cultural traits are inexorably intertwined.

A hope for the future is to develop a more sustainable management of the landscape, taking into consideration the remaining forest fragments, maintaining ecosystem functions, and valorising the rich historical and material heritage of the coffee period in the Valley. Acknowledging the differences between now and the 19th century including the fact that environmental care was not an issue then, we should avoid the repetition of the story: wealth for a few and ecological damage for many.

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