Land Use in the Andes from the Mid-Nineteenth Century to 1950

Plantationocene, Extractivisms, Conservationisms, and Contested Lands

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This is a story about the complex relationship between biomass and human beings, told through their shared becoming into plantations or locations of extractivisms in the tropical Andes. Barks, trunks, resins, flowers, fruits, seabird droppings, feathers, or mammalian meat and skins are some of the actors of this narrative. Submitted through greater or lesser violence, with axes, saws, or other technologies for extraction or domestication, medicines, textile fibers, food, gums, dyes, fertilizers, stimulants, as well as museum and decorative objects were obtained from these and other non-human actors. To do so, human beings had to deal with uncertainty in the form of climate changes, pests, fluctuating markets, among other difficulties. They also built relationships of subjugation towards each other, marked by the construction of otherness and dispossession, on different scales: local, national, regional, global. And there were those who questioned servile relationships and the destruction of nature, determined to transform them through policies.

This chapter concentrates on the land use change processes in the four countries that occupy most of the tropical Andes: Bolivia, Peru, Ecuador, and Colombia. The chosen countries contain the "Tropical Andes" and "Choco/Darién" hotspots, lowlands on the coast and the Amazon, parts of the Pacific Ocean and Caribbean Sea, as well as islands (Zador et al. 2015).

Andean tropicality has received numerous descriptions, usually associated with such words as variety or megadiversity, for its cultural, biological, geological, geographical, and climatic characteristics. Colombia, Ecuador, and Peru are listed among the seventeen countries on the planet considered megadiverse (Mittermeier, Goettsch Mittermeier, and Robles Gil 1997; Josse et al. 2009), due to the combination of tropicality, mountainous topography, marine currents, and the presence of both continentality and insularity. Andean empires and chiefdoms, Amazonian and coastal, coexisted for millennia with this explosive variety. Until the twenty-first century, dense and growing Indigenous populations survive on all altitudinal

levels, preserving languages, practices, technologies, and ancestral products of agrodiversity (Sichra 2009).

This chapter refers to land use change as socioenvironmental processes of different scales, traceable in the materiality and the landscape, associated with changes in mindsets and in the economic, social, and cultural dynamics. They can occur through the transition from a forest to plantations or pastures, the change of the products sown in a territory, planting trees, the appearance of transport infrastructures, as well as urban or industrial spaces, among others. The chapter will focus mainly on changes related to plantation systems and some transformations caused by biomass extractivism. Those that led to the largest conversions have been selected for the magnitude of the productions and the investments resulting from their financial surpluses.

Other patterns of land use change have been less relevant, with the notable exception of Bolivia, where the impact of mining on the landscape was vast, both because of mines and their need for firewood, food, roads, and other infrastructure, and because of the pollution of soils, water, and air. Since the colonial period, the country's economy had been heavily anchored to mining, first for silver and then for tin. Mining was also important in Peru and generated similar environmental liabilities and land use changes.

The plantations were distributed overall under the hacienda system, which can be understood as extractivist. According to the literature consulted, there were no large plantations managed under Indigenous communal systems. As this synthesis is intended to contribute to the reflection on the processes of the Anthropocene, alluding to the deep human footprint on Earth, and as land use change in the tropical Andes had a great deal to do with the plantation system (in addition to some directly extracted products, like rubber, that also required intensive labor exploitation), this chapter ascribes these processes to the idea of "Plantacionocene" or "Plantaciocene": a devastating transformation of natural ecosystems, agricultural lands, pastures, based on work with servile relationships (Haraway 2015). This involved the domestication and geometrization of territories and populations, under rational control, to maximize production, intensively appropriating nutrients, water, and soils.

The analysis will be, above all, qualitative, although for some products, this chapter has included data on cultivated hectares, transformed areas, or volumes of exportation. It will cover the period from 1830 to 1940 (some 110 years). It begins at the breakup of the colonial period and the rise of the new Andean republics, culminating with the beginning of the intensification of the processes linked to the Great Acceleration of the Anthropocene (McNeill and Engelke 2014).

Two axes structure this chapter. The first is cross-sectional in nature, composed of the crisis elements linked to land use change. Such crises are not just "bad or difficult situations," but allude to "profound changes and important consequences in a process or a situation, or in the way they are perceived" (both meanings are recorded

in the Dictionary of the Royal Spanish Academy). This first axis includes policies, conflicts, land ownership, markets, climate, pests, deforestation and overexploitation, conservation, epidemics, and natural threats.

The second axis articulates activities and products that led to the selected land use changes. The authors focus on actors such as guano, cinchona, rubber, coca, cacao, grapevines, sugarcane, cotton, indigo, tobacco, coffee, bananas, and agriculture for local markets and livestock. This chapter does not dwell on mining (including saltpeter) or oil extraction, which are discussed in detail in other volumes. To the extent possible, items are grouped under spatial and temporal considerations.

The authors consulted secondary sources that address from big panoramas of economic or environmental history, to specific studies on commodities. Few sources give a direct and specific account of the land use change in the selected period. Explicit research on the subject alludes, with exceptions, to processes since the mid-twentieth century and contains generalities about earlier periods (for example, Killeen et al. 2008). From specific research around products such as coca, cacao, coffee, and others, it is possible to analyze the large-scale changes that had, concomitantly, greater consequences in the medium and long term.

Crises in the Tropical Andes

Political struggles and instabilities, whether international or internal, generated material impacts. The decrease in population density, herds of livestock, certain productions, and fiscal coffers corroded by the enormous debts incurred to support the military forces, were some of the repercussions. The War of the Pacific (1879–1884), which pitted Chile against Peru and Bolivia, had effects on port access, labor, production, and exports. Similar consequences brought about other international belligerences: between Peru and Ecuador (1858–1860), Colombia and Ecuador (1863), Bolivia and Brazil (1899–1903), Colombia and Peru (1932–1933), or the Chaco War between Bolivia and Paraguay (1932–1935). The very destructive War of the Thousand Days in Colombia (1899–1902) had considerable implications, including the separation of Panama as an independent republic. There were also consequences after civil strife in Bolivia, the Liberal Revolution in Ecuador in 1895, or resistance processes, including radical social movements that ended with massacres, in Guayaquil, Ecuador (1922), Uncía, Bolivia (1923), and Santa Marta, Colombia (1928). As far as the authors know, Indigenous uprisings were not as frequent.

The dynamics of global mercantilism, particularly those related to the British empire, gave rise to crises. Regardless of the dominant ideology in each moment, the republics sought to connect to the world to promote their economic growth and pay their debts. They did so at the cost of converting natural heritage (fertility, water,

land) into financial capital. Exports, investment, and material prosperity increased for certain groups. But these external markets changed because of the emergence of competition (cotton, rubber, cinchona, or coca) or the collapse of prices due to global financial crises, as in 1873 and 1929.

Deforestation, overexploitation, and biological invasions were indicators of crisis, booms, and busts. The introduction of two Australian species – *Eucalyptus globulus* (as wood and firewood) and *E. citriodora* (as an aromatic) – attempted to counteract, from the second half of the nineteenth century, the loss of forest mass in the highlands, a process that began with the Spanish conquest. In a Colombian law of 1884, a bonus was offered for every 10,000 eucalyptus trees planted in the Bogotá savanna (Palacio 2006: 55–56); cultivation in that area declined at the beginning of the 20th century (Molina 2021). In Ecuador, eucalyptus trees were called "the timber salvation of the Sierra", for their contribution as firewood and timber for construction (Acosta Solis 1945). There were also resistances: in Quito, when President Gabriel García Moreno planted them in the dusty Plaza Mayor, "was ridiculed and even threatened" (Orton 1870: 76–77). In the twentieth century, some peasant women argued that these trees should be taken from food crop plots, because "they were not going to feed their children with eucalyptus leaves" (Mayer and Fonseca 1988, quoted in Martínez Alier 1990).

Since colonial times, the woods around Guayaquil were reserved, destined exclusively for the construction of ships. In 1829, other measures were issued to protect the forest wealth of this region. Willow trees were introduced around Lima to alleviate the shortage of materials (Buenaño Olivo 2000). There were policies to stop the destruction of cinchona stands in the Loja province of Ecuador from the eighteenth century, condemned by Eugenio Espejo (1993). In Bolivia, the government banned in 1837 the cutting of cinchona bark for five years and regulated the form of exploitation of these plants. In Colombia, it was said, in relation to cinchona, that when a medicinal plant was completely extracted, its reproduction had to be ensured, under penalty of having the product confiscated (Palacio 2006: 58). In 1903, the prohibition of the felling of trees of rubber, cinchona, cacao, and other products, under threat of a fine, was insisted on, and in 1905, the free exploitation of national forests was prohibited.

Bolivia passed in 1832 a law to protect overexploited chinchillas (*Chinchilla chinchilla*). There were other laws at the beginning of the twentieth century to prohibit the hunting and export of such rodents as well as vicuñas (Ibisch 2005; Marconi 1991). Both species were hunted for the quality of their fur. Those rules, however, could be left on forgotten on the page, due to poor controllability. The twentieth century witnessed the emergence of forestry institutions throughout the area, along with the adoption of new regulations on forests, soils, waters, fauna, and fisheries.

In the highlands, mineral extraction caused deforestation by road openings, establishing populations and infrastructures, obtaining firewood and other materials,

consumption of food, among other things. In the lowlands, the destruction of mangroves on the Ecuadorian coast was reported and condemned in literary records, such as the novels *Don Goyo* (Demetrio Aguilera Malta 1933) or *Los Sangurimas* (José de la Cuadra 1934). In the Galapagos archipelago, there was no state control until the impacts of fledgling tourism began to be visible and the declaration of the first protected area of the entire region was made, in 1936 (Bustamante 2016). The decline of resources such as guano prompted conservationist thinking in Peru (Cushman 2005). Sajama National Park in Bolivia was declared in 1939 to protect firewood, as well as an area in Nor Lípez (Potosí), to protect chinchillas (Marconi 1991; Ibisch 2005). Decades later, the declaration of protected areas became widespread.

Crop pests were decisive in productions such as cacao. They also affected rubber, bananas, and other cultivars; possibly the only major export crop that did not suffer from a devastating epidemic was coffee (McCook 2019). Between 1860 and 1873 alone, Peru reported the orange blight, rambutan mortality, apple disease, maladies and mortality of peaches, bean disease, poor cassava production, epidemics in willows and other trees, potato disease and loss of barley sowing, aphids in many plants (especially cherimoyas and guavas), epidemics of tomato, cucumber and other nightshades, malaise in alfalfa, corn disease, maladies in banana crops, maladies of cottonwoods, vineyard disease, sweet potato disease, cattle, horses, and donkeys decimated by pests, cattle attacked by *Typhus carbuncosa*, rams attacked by liver fluke or moths, pigs attacked by pests (Garcia and Merino 1876, cited in Díaz Palacios et al. 2016).

Climate threats were decisive, particularly when it came to heavy rainfall, sometimes associated with El Niño events (Huertas Vallejos 2001; Grove and Adamson 2018). The overflow of rivers, alluvions, and floodings occurred along with the destruction of populations, crops, and infrastructure, as well as the emergence of epidemics and impacts to fisheries. Between 1800 and 1987, there were 32 moderate or close to moderate El Niño events; the 1925 event was the strongest of the first half of the 20th century (Takahashi and Martínez 2019; Grove and Adamson 2018; Quinn, Neal, and Antunez de Mayolo 1987; Díaz Palacios et al. 2016). Among other effects, increased temperature and precipitation brought forward the maturation of vines, sugarcane, and cotton, also facilitating the arrival of pests.

Excessive water prompted pleas for "the rains to stop," while its absence also generated losses. Variations in harvests were audited in the records of tithes and scores paid by the Indigenous communities, and it has been suggested that the long period between 1720–1860 was characterized in the Andes by a maximum degree of drought (Tandeter 2001: 232). The impact of climate change, particularly temperature rise, caused the elevation of vegetation and altitude of crops (Morueta-Holme et al. 2015; Moret et al. 2019; González-Orozco and Porcel 2021). The agricultural frontier expanded up and down, due to the interplay of the search for new fertile and

pest-free land, route openings, the introduction of new varietals, and climatic issues such as droughts or rains.

A study on the distribution of eight crops concluded that, over 224 years, there occurred a 740.1 meters change in their elevation range (González-Orozco and Porcel 2021). The crop with the most expanded range was sugarcane, adding 1,426 meters. Also important was the extended range of barley, potatoes, cassava, maize, and wheat.

Epidemics, whether or not associated with climatic aspects, were more decisive in human settlements than in productive enclaves. Bubonic plague, cholera, and malaria were all present. Likewise, some earthquakes, tsunamis, and volcanic activity played crucial roles.

Lack of labor caused crises for productions of scale, in the context of little or no mechanization. In the nineteenth century the population increased, despite the impact of the wars. Slavery had been abolished (Colombia and Ecuador in 1851, Bolivia in 1852, Peru in 1854), but systems such as *yanaconaje*, *huasipungo* and *pongueaje*, among others were maintained. The Ecuadorian writer Jorge Icaza narrated in 1934 this precariousness of work in his novel *Huasipungo*; this system, like *pongueaje,* consisted of the patron giving a piece of land to the Indigenous for agriculture or pastoralism, in exchange for working for the benefit of the former. From the rubber regions of the Amazon to the sugarcane plantations of the Galapagos, there were relationships that maintained characteristics of slavery. Alphons Stübel, a German geologist who travelled the Andes in the 1870s, noted that the abolition of slavery dented productions, so other systems of servitude were attempted (Brockman 1996). With an absence of labor, migrations from the highlands to the lowlands were promoted, as well as that of foreigners like the Chinese "coolies," to extract guano (Cushman 2013). European immigration did not reach the scale of the austral countries, although German populations did reach places like the Galapagos Islands and the Oxapampa colony in the Peruvian Amazon, where other Europeans gathered (Marcone 1992).

Crucial in the transformation of space was the structure of land ownership, particularly since circa 1850. The change from communal to private, and the liberation of many estates, including those of the Catholic church, spawned land grabbing and monocultures of scale (Dollfus 1981; Bethell 1992). The establishment of the plantation system had a strong basis in these processes of land changing hands. In Bolivia, the *Ley de Exvinculación* of 1874 exacerbated the gradual narrowing of the territory of Indigenous communities, the increase in the number of haciendas, along with the resurgence of the *pongueaje*. In Colombia, both liberals and conservatives hoarded land that had been owned by Indigenous peoples and the church (Palacio 2006: 41). The idea of the existence of large tracts of "wastelands" (*baldíos*), "uncultivated" and depopulated lands, was instrumental in fostering colonization and human settlements, as well as sustaining national territorial claims. The idea of emptiness was

maintained in the absence of a particular type of agriculture and land usage, considered an indicator of non-settlement.

Urbanization caused no major changes in land use. Although it intensified at the beginning of the twentieth century, cities barely overflowed uncontrolled until the middle of that century. However, urban landscapes did see important changes linked to the prosperity of exports. The Great Fire of Guayaquil of 1896, together with the immense capitals of cacao, allowed profound reforms. Bogotá, La Paz, and Quito extended from their historic centers to gardened neighborhoods with avenues, parks, and residences away from the agglomeration (Palacio 2008; Guerrero Farías 2012; Gallini and Castro Osorio 2015; Sánchez Calderón 2021; Cuvi 2022). These processes hidden or domesticated rivers and streams, sometimes as part of sanitation and hygienic works (Lossio 2003; Sánchez Calderón 2021). Port, rail, and road infrastructures associated with exports, and industries, were created, as in Medellín.

The intricate topography and poor means of communication limited production. To alleviate this, states undertook their construction with foreign and local capitals. Railways were built between productive sites and ports, but also to communicate highlands and lowlands, such as the train that linked the port of Guayaquil with the high Andean cities of Quito and Cuenca in Ecuador. The first Colombian railway line, completed in 1871, linked the Caribbean city of Barranquilla with the mouth of the Magdalena River, to allow sea access for the entry and exit of products. In Bolivia, the construction of railways to move minerals to ports began in the 1870s and was rapid. The *abrazo de hierro* (embrace of iron) as the alternative to impassable roads much of the year, strengthened the locations through which it passed, giving rise to regional competitions (Clark 2004; Bulmer-Thomas et al. 2006; Contreras and Cueto 2007). These works impacted forests, using wood for railroad ties, infrastructure, or firewood to fuel locomotives. Steamboats, such as those along the Magdalena River, also demanded biomass for fuel. These works proved crucial in enhancing the social metabolism associated with the plantation system and other forms of extractivisms, by facilitating exports, as well as investments and expenditures in urban centers where the revenues were concentrated.

The completion of the Panama Canal improved the connection between the Pacific and Atlantic Oceans. The railway that linked the city of Cali with the Pacific Ocean through the port of Buenaventura in 1915, as well as the land roads to that port (Figure 1), significantly expanded the output of products from the Cauca Valley. Buenaventura eventually became the main point of departure for Colombian coffee. The roads caused substantive changes: note in Figure 1 the magnitude of the movements of mass and materials, and the marks of the explosives used to engineer the route. These routes generated extensive transformations due to the demand for materials to sustain their construction, and the possibility they brought to increase the transport of production.

Fig. 1: Overview of the Road Cali-Buenaventura (1930)

Source: Foto Escarria (1930).

Environmental sciences, particularly botany, agriculture, geography, geology, and cartography, were promoted for the exploration and exploitation of raw materials (McCook 2018). Led by the Italian Agustin Codazzi from 1850 to 1859, the Chorographic Commission fulfilled this role in Colombia (Appelbaum 2016). In Ecuador, this role was carried out by Jesuit scientists brought to the National Polytechnic School in the 1870s, such as the German Teodoro Wolf and the Italian Luis Sodiro (Miranda Ribadeneira 1972). In Peru, the Italian Antonio Raimondi made important and decisive explorations (Seiner Lizárraga 2003). Gradually, national scientists, such as the Peruvian Mariano Rivero, the Ecuadorian Augusto Martínez, or the Colombian Joaquín Acosta, joined these activities and work. The expeditions also had impacts on biodiversity, extracting huge quantities of specimens; for example, the Webster-Harris expedition of 1897 to the Galapagos collected in four months, among other things, 3,000 bird skins, 150 iguanas and sixty-five turtles, many of them living (Hennessy 2019).

Land Use Change

Natural ecosystems were pressured and altered. Some processes came from the sixteenth century, such as the deforestation of the highlands. In the inter-Andean valleys of Ecuador, during the nineteenth century, landscapes more desertic than Palestine were mentioned (Orton 1870) and confronted by intellectuals such as Juan Montalvo (1999), who wrote about the need to take care of the few remaining trees. In Peru, *taquia* (manure of llama – *Lama glama*) and tola (the shrubs of *Parastrephia* spp.)

were used as sources of energy; only from the second half of the nineteenth century did the development of stone coal, gas, and oil began (Díaz Palacios et al. 2016). Deforestation occurred in sites of agriculture, forestry, livestock, mining, urban development, and industry. Isolated cases such as the extraction of fruits from tagua nut or vegetable ivory (*Phytelephas* spp.) were associated with the establishment of populations of Afro-descendants in the Colombian and Ecuadorian Pacific (Leal and Van Ausdal 2014). Similar processes occurred around extractivist practices related to the balsa trees, rubber, cinchona, among others. The capture of birds for the feather trade had local effects (Quintero Toro 2012).

Tab. 1: Estimated Annual Rates of Change for Transformed Area of Forest Ecosystem Types

	1800–1850		1850–1920		1920–1970	
Ecosystem	ha	%	ha	%	ha	%
Tropical dry forests	-5,024	-0.35	-4,206	-0.43	-5,670	-0.75
Tropical subhumid forests	-582	-0.06	-265	-0.03	-11,853	-2.16
Andean Forests	-19,910.	-0.1	-25,888.	-0.21	-40,742	-0.41
Tropical Humid Forests	-7,910	-0.01	-6,994	-0.03	-11,450	-0.03
Total	-33,427	-0.04	-39,753	-0.08	-69,716	-0.12
Low Andean forests (<1,000 m)	-5,779		-2,939		-11,174	-66,453
Mid-Andean forests (1,000-2,000 m)	-12,390		-12,014		-18,925	-55,520
High Andean forests (<2,000 m)	-1,741		-6,935		-10,643	-49,216

Source: Etter, McAlpine, and Possingham (2008:13).

Quantitative information on the processes of land use change is lacking except for Colombia, where overall annual rates of natural ecosystem transformation have been reconstructed (Etter, McAlpine, and Possingham 2008: 13, Table 1). The table shows that the Andean forests located between 1,000 and 2,000 meters above sea level were particularly affected. Much destruction was justified under the idea that these sites were "wastelands" or underutilized. This imaginary also fell on the *páramos*, natural formations where shrubs and grasses, many endemics, predominate; they are located at high altitudes and have suffered the introduction of plant and livestock species since the colonial period; these landscapes were converted to agricultural lands mainly through burning (Kessler and Driesch 1993). In Colom-

bia, Indigenous high-altitude populations were moved from 1821 to reservations (*resguardos*) above 3,000 meters altitude, initiating processes of soil overexploitation and intensified biomass extraction. As in other interventions, there was a geometrization of the territory, alteration of the hydrological cycles, erosion and reduction of the productive capacity of the soils, loss of biodiversity, and alteration of regional and local climate. A second wave of occupation came from the haciendas, which expanded their crops to high altitudes, burning the shrubs to obtain coal and provide land for potato cultivation (Hofstede, Segarra, and Mena Vásconez 2003).

"Wastelands" were state property as they were "uncultivated." With this mindset, the uses of these land by Indigenous peoples were made invisible. In Colombia, their transfer or sale came to be considered as an alternative to cover foreign debt; a project caused great controversy in 1855, as it planned to sell approximately 30 million hectares, almost one third of the national territory, to a French company (Zárate Botía 2001: 138). A few years later, territories of tens of thousands of hectares were granted to national companies. Only a few years later, after the decline in the export of cinchona, the term *baldíos* was replaced by *bosques nacionales* (national forests), which also failed to recognize their millenary Indigenous occupation. Imaginaries about these spaces with potential riches, re-enlivened myths such as those of the Country of Cinnamon, El Dorado, Gran Paitite, Gran Mojo, among others (Cuvi, Guiteras-Mombiola, and Lehm 2021). Literary interpretations in this regard appeared in novels such as *La Serpiente de Oro (The Golden Serpent)*, by the Peruvian writer Ciro Alegría in 1935, which gave an account of the civilizing spirit and criticism of it. There were also insights from travelers, some scientists, adventurers, who left perceptions around such environments.

Biomass Plantations and Extractivisms

Among the activities that modified land use, production to supply domestic markets has been less studied compared with those associated with exports. There were hundreds of species and varieties of crops, livestock, and forestry, both for subsistence and to sustain populations in productive sites. Many changes happened due to the slash and burn system.

The Indigenous populations, particularly in the mountains, used to manage the environment through systems such as multicrop *chacras*, in a microvertical scheme, using ancestral domesticated species, along with others that arrived as part of the Columbian exchange. Certain technologies never fell into disuse, such as crop terraces, or water catchments and reservoirs, called *amunas* or *qochas* (Dollfus 1981; Murra 2002; Cuvi 2018). Until the twenty-first century, food supply in these countries has continued to be supported by the production of smallholders and Indigenous peoples.

There were and still are pastoral groups, some nomads, dedicated to the care of Andean camelids such as alpacas and llamas (Del Pozo-Vergnes 2004; Sendón 2009). Cattle ranching, which has received several historical approaches (Flórez-Malagón et al. 2008), caused intensive and extensive land use changes. In the entirety of the Andes, the size of the cattle herd went from about 350,000 in 1850, to 1,700,000 in 1920, and then up to 6,000,000 around 1970 (Etter, McAlpine, and Possingham 2008). The herds supported the extraction processes of cinchona, rubber, coca, minerals, as well as the construction of railways and other activities. The breeding of cattle for meat, milk, or both purposes, led to the introduction of pastures, which became dominant to the detriment of natural formations. In the highlands of Colombia, Ecuador, and Peru, kikuyu grass (*Pennisetum clandestinum*) has displaced native herbs. In subtropical and tropical lands, forest and pasture conversion led to rapid productivity losses and major difficulties in recovering vegetation cover.

Two export products, connected with Peru and somewhat less with Bolivia, were guano and saltpeter. The extraction boom of guano, a substance that is produced by the accumulation of seabird droppings, occurred between circa 1850 and 1875 (Cushman 2013; Bonilla 1984). Although it did not cause substantial changes in land use, because it was removed from small islands, the capital obtained was used for improvements in Lima or as investment in railways associated with sugarcane and cotton plantations (Deustua 2011). Overexploitation, together with the Great Depression of 1873, the War of the Pacific, and the emergence of synthetics and other types of substitutes, brought about guano's fall as the main export product. Part of the decline had to do with the lack of knowledge about the relationship between the quantity extracted and its replenishment by bird populations, since mistaken observations by the Prussian Alexander von Humboldt were used as a baseline. Only in 1890, with the exploitation in crisis and the decline of bird populations, measures were taken (Cushman 2005; Díaz Palacios et al. 2016). The exploitation of guano overlapped, to some extent, with saltpeter, a type of salt that has several uses, particularly as a fertilizer. Thus, the European agricultural revolution was sustained by the fertility of South America. The saltpeter fields were in the Atacama Desert, near the coast, in territories of Peru and Bolivia, until the Pacific War, when they were taken by Chile. Its extraction required more machinery, supplies, and labor, and involved deforestation in areas that had some vegetation.

In the Amazonian-Andean region, three products dominated the participation in exports and land use change: quinine, rubber, and coca. Cinchona trees (*Cinchona* spp.) were exploited since the sixteenth century to obtain their medicinal barks, often by cutting down the tree or, less frequently, debarking it *in situ*. From the eighteenth century, the destruction of cinchona stands was evident in Loja and its surrounding region, south of Ecuador, from where the so-called fine bark had been extracted. It has been estimated that, to gather 20,000 *arrobas* (a bit more than 225 metric tons), it was necessary to cut down 34,000 large trees and that, when using

only the parts where the bark was thin (which was sometimes the only bark received), it was necessary to fell around 100,000 trees (Moya Torres 1994: 54). The extractive frontier increased from 1820, when chemical analyses were developed to determine the quinine content in each species and British demand increased. Cinchona was exploited on both sides of the Andes from about 2,500 meters above sea level, and into the inter-Andean valleys. Plantations were encouraged in Bolivia; 473,180 plants were purchased in Soratas alone, in the foothills north of La Paz, between 1877 and 1882. In Bolivia, just like in previous centuries in the Loja region, there were declinations in overexploited areas (Zárate Botía 2001). In Colombia, cinchona was integrated into the most dynamic export sector, along with gold, coffee, and tobacco; between 1881 and 1883, it became the primary export (Palacio 2006).

As in other exploitations, immigration occurred to extractive sites, with the subsequent displacement of native populations and the emergence of new activities of production, social relations, and spatial organization. The packaging of the bark required leathers, wood, nails, and bitumen. Moreover, the operation required mules for transportation; food, cattle, and crops to feed populations; and fuel for steamboats. Hunting was frequent, partly for the control and extermination of species considered "pests," such as felines. Thus, weapons and tools were introduced into local populations. This dynamic prevailed until various actors succeeded in smuggling cinchona seeds in the 1860s (Brockway 1979), after which Dutch production in Southeast Asia monopolized markets, the British became self-sufficient by their plantations in India and Ceylon, leading to the decline of Andean extractivism, except for a short-lived boom (like rubber) during World War II (Cuvi 2011).

After the decline of cinchona extractivism, capital moved on to rubber, which took advantage of the preexisting structures. The discovery of vulcanization in 1839 led to new industrial applications and increased demand. Overall, species of the genus *Hevea* were exploited, especially *H. brasiliensis*, which provided the highest yield of the top-quality latex. In many places, trees were cut down. For example, in 1903, within a strip approximately 200 km wide, all black and white rubber trees were destroyed from the Ariari River in Colombia to Ecuador (Larrea-Alcázar et al. 2021). Its extraction was associated with exploitative practices such as a bait and switches with the aim to create a debt, or *habilito*, exposed by the Colombian writer José Eustasio Rivera in his novel *La Vorágine* (*The Vortex*) published in 1924, or by the English-speaking authors Roger Casement (1988) or Walter Ernest Hardenburg (1913). Demographic debacles occurred in these and other areas of rubber production, contrasting with the population growth near to coffee and tobacco plantations.

The Peruvian rubber lord Julio Cesar Arana came to control extraction on more than 3 million hectares. Iquitos became a key hub, like Manaus in Brazil. Rubber exports grew until 1911, when international prices declined. In Bolivia, exploitation of rubber began around 1860 with capital from cinchona harvesting, although the

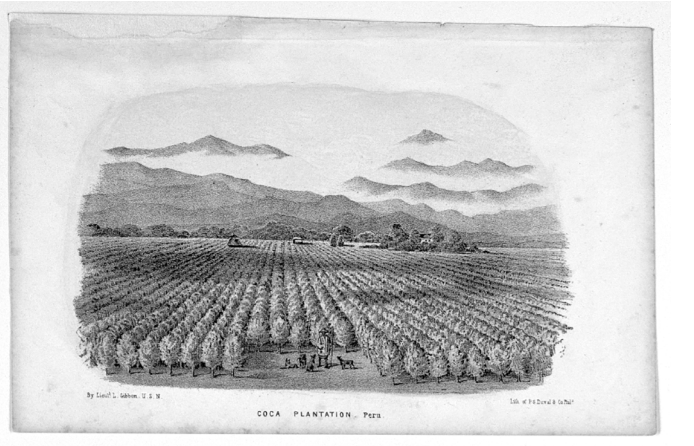
boom only occurred between 1898 and 1919, thanks to high prices attracting foreign capital and benefits for the state in the form of taxes. The Casa Suárez controlled production, transport, food and other aspects associated to the extractive chain (Larrea-Alcázar et al. 2021)

Another product of the Amazon foothills was coca (*Erythroxylum coca*), a ritual and medicinal plant that provides greater resistance to fatigue, hunger, thirst, and improves adaptation to altitude. Ancestral cultivation continued during the colonial period, particularly to supply mine workers. The compact valleys and eastern zones between 600- and 2,000-meters altitude were the active areas of cultivation in Peru and Bolivia (Gootenberg 2008). There was a strong trade of lands, and settlers arrived to take advantage of the "wastelands." The population of Huánuco, transformed into an agro-industrial site, doubled by 1896.

Coca boomed after 1850 as medicine, food, and narcotic. In 1859, cocaine was discovered and promoted primarily as a surgical anesthetic, but also as food, elixir, and tonic (Gootenberg 2008). There was demand from Europe, Bolivia, Peru, Chile, the United States (for Coca-Cola syrup), among other places. Over time, the economic roles of coca and cocaine reversed: between 1904–1908, cocaine revenues were about twice those of coca, but by 1929–1933, profits from the coca leaf were twice that of cocaine. Plantations encouraged the radical removal of wild vegetation, replacing it with a geometric order that gave rise to tight control of the territory. Such an ordered arrangement is seen in Fig. 2: a plantation in a valley appears in the foreground, along with the minor remnants of tree vegetation, while the densest forest masses consist of those in the mountains in the background. In addition, there appears an armed man and some dogs. During peak exportation, between 1900 and 1905, Peruvian businessman and politician Alejandro Garland reported ownership of at least twenty-one cocaine factories. In Bolivia, from independence until 1952, coca farmers around the Yungas were among the elites who ruled in alliance with the military; from 1829 on, they gained the authority to impose taxes on the roads and the sale of coca.

Markets declined in the face of international prohibitions, such as the one imposed by the United States Food and Drug Administration in 1906. In addition, as with cinchona, the Dutch displaced Peru from many markets since the beginning of the twentieth century: in 1904, only twenty-six tons of coca leaf were exported from the island of Java, but this increased to 800 tons in 1912, and 1,700 tons in 1920. These new players built a particularly productive industrial cocaine regime, which was followed by a Japanese network in the 1920s and 1930s (Gootenberg 2008).

Fig. 2: Coca Plantation in Peru



Source: Gibbon (n.d.).

In the lowland and coastal areas, a product that emerged in the late nineteenth century was cacao, a food whose ancestral origins reside in the Amazonian-Andean rainforests (Zarrillo et al. 2018). A base ingredient of chocolate, cacao boomed in Ecuador beginning in the nineteenth century; it was also sown on a smaller scale in other countries. Exported since the colonial period, its exploitation paused during the wars for independence but later recovered (Contreras 1994; Maiguashca 1996). Ecuador accounted for 20–25 percent of world exports between 1895 and 1914, representing 70 percent of domestic exports. With the *pepa de oro* (golden seed), great fortunes were forged, and Guayaquil became the richest and largest city in the country. The cacao district known as *Arriba* (Above) had better quality and priced fruits, navigable rivers, cheap and easy transportation, and "wastelands" available at low prices. Little technology was used, although some ranchers tried to introduce machinery and new farming systems. Since labor was scarce, due to low population density and competition with other crops, peoples from the highlands migrated to the plantations, seeking higher wages and relative freedom from taxes; this was recounted by the Ecuadorian writer Luis A. Martinez in his 1904 novel *A la costa (To the Coast)*. The population of the coastal provinces increased sevenfold between 1873 and 1926 (Pineo 1994).

The increase in cacao production was sustained by the advance of the agricultural frontier through clearing, mainly towards higher regions, humid all year round. Between 1885 and 1910, more than 47 million trees were planted, and by 1923, plantations occupied 85,500 hectares (McCook 2002). Big haciendas appeared that began to displace small and medium landowners; vast properties came to control

most of the land (Deler, Portais, and Gómez 1983). The forest was converted into permanent crops and pastures, causing erosion. The location of farms in higher areas of very heavy rainfall all year round and problematic drainage favored the appearance of pests. First came the *Monilia* fungus, which incited the abandonment of plantations beginning in 1919. Then, in 1923, it was the turn of the "witch's broom" fungus, which affected nearly all plantations. Attempts were made to increase tree density, occasionally on foreign advice, with no results. Production collapsed 60 percent, leading to a national crisis (McCook 2002).

Three other plantation goods stood out in the coastal plains: grapevines, sugarcane, and cotton. The acclimatization of the grapevine occurred mainly in Peru around the sixteenth century. Vineyards were scattered along the coast, although by the eighteenth century, they concentrated in the south, due to the dry and warm climate, taking advantage of Indigenous irrigation systems. Distilleries for grape spirits and pisco appeared. Wines had a boom but declined after 1850 because of the expansion of cotton and sugarcane plantations, and the end of the old prohibition on the production of sugarcane spirits (Huertas Vallejos 2004; Lacoste 2004). Cultivation was also affected by wars, rains, earthquakes, and pests (Díaz Palacios et al. 2016).

Sugarcane, also introduced with early transatlantic travels, caused land use change since colonial times. Its plantations triggered deforestation both in the generation of planting area and the production of firewood to process the cut cane and obtain raw sugarcane (*panela* or *chancaca*), spirits (*aguardiente*), or refined sugar (Díaz Palacios et al. 2016). It played a very important role in the north of Peru, near Trujillo and the surrounding areas, all the way to warm inland valleys, including territories belonging to Cusco, central areas of the country, and the foothills to the Amazonia. The rubber boom promoted markets for sugarcane derivatives such as spirits and *panela*. Plantations were also promoted in dry inter-Andean valleys, such as Chota in Ecuador, where it caused transformations since the nineteenth century. Its cultivation reached the Galapagos archipelago, where a sugar mill was established on San Cristóbal Island in the second half of the 19th century, with very harsh working conditions (Hennessy 2019); sugar was exported to Panama. It was important in the Cauca Valley, Colombia, in the twentieth century, whose sugarcane flowed through the port of Buenaventura (Armas Asín 2020; Tucker 2000).

Finally, in warm coastal plains, there were numerous plantations of cotton, a product obtained from various species of the genus *Gossypium*. These native plants were sown by the Indigenous, and the Spanish tried to replace them, at times successfully, with wool from sheep, as occurred in present-day Ecuador, where large textile manufractures (*obrajes*) were built (Tyrer 1988). Colombia experienced a short-lived boom in cotton fiber exports from the 1850s on (Safford and Palacios 2002); cultivation was mainly carried out in the lowlands of the Caribbean slope, and artisanal mills supplied the country with quality fabrics at affordable costs. Peru, where plan-

tations were larger, took advantage of the gap in the world market when production fell due to the Civil War in the United States (Armas Asín 2020). Later, external demand continued, and cultivated areas expanded and consolidated, sometimes to the detriment of vineyards (Lacoste 2004: 7–8). At the time, entrepreneurs were looking for land, and Peru caught "the white gold rush," becoming one of the main producers: between 1909 and 1914 production reached 260,000 quintals, which ranked the country seventh in the world and second in Latin America. Production continued to rise to 852,000 quintals in 1935–1936 (Armas Asín 2020). Notable in this country was the generation, after enormous efforts, of a local variety, achieved by the Puerto Rican Fermín Tangüis around 1912. Named after him, this variety was advantageous for its softer and shorter fiber. Its cultivation quickly spread throughout the country (Armas Asín 2020).

In Colombia, cotton ceased to be important around the 1870s. In its place, the indigo bush (*Indigofera suffruticosa*), from which a blue ink can be obtained, emerged. This biomass was, for a short time, the main export. Such a turn was the result of unrest in the producing regions of India, the main supplier for the world. Indigo was planted in several locations and, by 1880, accounted for almost 7 percent of exports (Bushnell 1994). Local producers, however, never considered it necessary to invest in systems of irrigation and fertilization, or a more permanent establishment. As with cotton, indigo collapsed in the country after the development of artificial dyes in the chemical industry in Europe in the final third of the nineteenth century.

Tobacco, coffee, and banana were the other three most relevant plantation products, particularly in Colombia. Tobacco (*Nicotiana tabacum*), domesticated in the Americas, was produced since colonial times in the four tropical Andean countries to meet domestic demand. It experienced a major boom in Colombia between 1845 and 1870 (Kalmanovitz 2015), when the government ended its monopoly in 1850 and liberated its production and trade. The Ambalema region, in the Magdalena River valley, was one of the most important areas (Ceballos Gómez 2011). The main destination was Germany, and the earnings from exports allowed the installation of the telegraph throughout the country (Uribe Celis 2011: 230). By the 1850s, it accounted for 28 percent of total exports (Ocampo Gaviria 2017: 244), peaking around 1860, when it reached 40 percent of the value of exports, surpassing Antioquia's gold (Kalmanovitz 2015). By 1875, its key role dropped sharply (Ocampo Gaviria 2017: 228), languishing in a gradual process to never recover. Part of the lack of continuity would have involved problems in presentation and quality (Palacio 2006; Bushnell 1994). In Peru, production was basically for domestic demand, with only a few exports through the Amazon (Armas Asín 2020: 123).

Important attention is paid to coffee (*Coffea* spp.), introduced to the region in the late eighteenth century. Over time it gained global importance, and Latin America became its main producer (Topik and Samper 2006: 126–127). Demand did not fall, and its production has been correlated to that of sugarcane, often used to counter-

act the bitterness of the drink. In Colombia, coffee left its mark on land use from the end of the nineteenth century in a decisive and uninterrupted way. The country became the second-largest world producer, behind Brazil, in 1920s (Uribe Celis 2011); plantations became widespread in the haciendas of central and eastern Colombia and on small properties. In Cundinamarca and Tolima, in the center-west, the haciendas established a subservient and sharecropping system, while in Santander, and mainly in Antioquia, north of the departments named above, there was a free production regime, with a more adequate distribution of land and more equal relations (Kalmanovitz 2015). Coffee brought transcendental changes, such as internal migrations, interventions on "virgin" lands, and population movements to borderlands. Part of this great migration has been described as the Antioquian colonization. The Antioquia and Pacific railroads, as well as the completion of the Panama Canal, consolidated the shift of plantations to the Coffee Axis in western Colombia (Bushnell 1994). It has been the only export product that was almost entirely in Colombian hands, although, since 1920, foreign companies have entered the market (Murillo Posada 2011).

Another product that incited changes in land use through the plantation system was banana (*Musa* x *paradisiaca*); early introduced to be grown in humid, warm lowlying areas. In the late nineteenth century, it was extensively planted in Colombia, for export purposes, particularly in the Atlantic area of Santa Marta, resulting in destruction of primary forest (Soluri 2013: 355). This boom was due to a crisis: epidemics caused by the Panama disease (the fungus *Fusarium oxysporum)* in Central America. A major player was United Fruit Company (UFC), which constructed the plantations in an enclave model, isolated from the local population, with sharp differences in treatment of native and foreign personnel. It controlled irrigation, rail transfer, ships' loading, and sale. The company had 25,000 workers, which weakened the labor supply in other areas. Banana accounted for 8–10 percent of total Colombian exports between 1905 and 1925 (Kalmanovitz 2015). In the face of poor working conditions, there were two major strikes. The second culminated in a massacre in the town of Ciénaga in 1928 (Safford and Palacios 2002: 281), whose infamy was enhanced by an exaggerated story, typical of magical realism, from the Colombian writer Gabriel García Márquez, in his novel *Cien años de soledad* (*One Hundred Years of Solitude)*, published in 1967. The banana boom in Santa Marta lasted until 1943, when the sigatoka appeared. The UFC chose to avoid the cost of fighting the pest and withdrew from the region.

Final Discussion

Land use change analysis usually includes information on the number of hectares transformed. For the territory and time addressed, however, these data, when avail-

able, are approximations on which agreement does not always exist. Instead, there are frequent assertions about the volume or income from exportation, as well as qualitative assessments of systems of plantation and biomass extractivisms.

Over the 110 years considered, nineteenth century liberal ideology gained prominence in both political and economic matters in all four countries. The republics began to participate in the global economy in a way that was in sharp contrast to the colonial situation, when a Spanish monopoly was imposed on production and trade, although contraband existed. In any case, the Republican production of commodities was forged in a framework of inequality that replicated structures of the ancient regime. These were, almost always, stories about elites who concentrated capital, land, and profits, usually with the participation of foreign investment, which ran alongside stories about large masses of people, native or immigrant, who worked under usually exploitative systems, in the context of labor shortages and competition. There were also stories of frontier colonization, of bottom-up ventures, such as in nations that were really beginning to build themselves, with opportunities of different kinds, like in certain coffee or coca growing sites (although there were regional monopolies in those products as well).

Several state policies segregated the Indigenous populations, at times pushing them up into the highlands (like the *páramos*), at others because the aggressive colonization of the frontiers and its "wastelands" pushed them deeper into the jungles. Many Indigenous lands, as well as the properties of the Catholic church, were considered "wastelands" to enable these acts of colonization.

National and international variables and conditions played a role, as commodities formed part of global markets. Wars, price fluctuations, the emergence of competition and substitutes, pests, and social revolts in different production sites, among others, exerted their impact. In the case of competition, much of it originated in the smuggling of Amazonian-Andean species, such as cinchona, rubber, or coca, into Southeast Asia. Something similar happened with cotton. Pests, or the events of El Niño/La Niña, also played a decisive role.

Some crises were not resolved either in the short or medium term, such as the cacao crisis in Ecuador – caused by pests, poor plantation management, and expansion of cultivation into unsuitable areas. In that country, and in other areas, there was a notorious lack of local research and innovation, expressed in the development or improvement of varieties, pest management, and betterment or introduction of machinery. In very few cases did creative and constructive interventions occur, responding to specific needs, such as Tangüis cotton in Peru. The attitude of the elites towards improvements in production conditions was overly comfortable and accommodative, marked by conformism and immobility. Confident ruling classes, waiting for the prodigal nature to provide the answers or solutions, or waiting for technological improvements and renovations to come from outside. Low production costs and relatively low regional competition, as well as resistance to change, could

have had an impact. In extractive systems such as cinchona, rubber, and guano, there were local depredations and extirpations, but little restoration with simple technologies like reforestation.

Ideas and practices appeared, which today one could call conservationist and utilitarian, that challenged hegemonic processes. There were often reforestation regulations, although they were not always fulfilled. In the 1930s, the first protected area initiatives appeared.

Various products were described in this period with metaphors of wealth: golden seed for cacao, green gold for banana, white gold for cotton, bitter gold for cinchona. Several products ended up associated with the psychoactive revolution of commodities, with stimulants such as tobacco, coffee, chocolate, alcohol, coca, and sugar (Gootenberg 2008).

Although there were star products, usually more identified within national dynamics (coffee in Colombia, cacao in Ecuador, guano in Peru, tin in Bolivia), in this chapter, just a glimpse of a connected look, illustrates a more complex and dynamic picture. In several cases the capital of one product was moved to another, either through the emergence of competition, as in the shift from cinchona to rubber, or more favorable prices on international markets, as in the move from grapevines to cotton and sugarcane. Unprocessed biomass was mainly exported; industrialization occurred only in some cases around quinine, cocaine, wines, and refined sugar.

The dynamics analyzed here fit into the broad denomination of the Plantationocene, which includes not only monocultures, but the socioenvironmental processes associated with them (Haraway 2015), where colonial relations and construction of otherness predominate. Part of these processes was an intense geometrization of the territory: just as colonial cities tried to establish the idea of a checkerboard, far from the winding layout of Andean cities and European medieval cities, plantations-imposed symmetry, repetition, rational planning, efficiency, engineering for nature control, and, what Scott (1999) has called, a simplification in agricultural landscapes. They were premature signs of the advent of scientific agriculture, epitomized by the long Green Revolution.

In the period under study there was also a systematic introduction of technologies in the form of domestic animals, plant varieties, tools, means of transport, which intensified social metabolism. There were no major and decisive technological improvements driven by necessity as the mother of invention. There was no intentional search to solve problems *in situ*, but rather improvements came from somewhere outside, if you will, in the face of the passivity of local stakeholders.

The recipients of most of the biomass were in distant spaces. At the same time, the Andean space in transformation was inhabited by groups that accumulated financial capital and masses of workers in desperate situations. Such circumstances triggered conflicts of all kinds over land tenure and the distribution of income from production.

The changes in land use in the tropical Andes were unique because of the geographical space and plants cultivated, but also similar, in several respects, to other Latin American territories. Vast landscapes were transformed to extract minerals or biomass, causing social, economic, political, and cultural changes, including: intensive migrations, alterations of local dynamics (wild, rural, and urban), appearance of elites and subaltern groups, occurrence of wars and conflicts, boom and bust of markets, promotion of knowledge of the territory (particularly scientific), among others. The traces of these processes continued to be imprinted on the landscape during the twentieth century to the present day, some with more intensity than others.

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