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

Historical-Environmental Processes

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In this chapter, the historical and environmental changes in the geographical superarea of Mesoamerica are analyzed during the period between the first decade of the nineteenth century, when a reconfiguration of territory took place as a result of the independence movements in the countries of the area – with a markedly liberal orientation –, and the middle of the twentieth century, a transitional moment in the management of land and resources towards agro-industrial models. We propose an analysis based on land use and land-use change as well as vegetation substitution at local and regional scales (Turner et al. 1995; Lambin et al. 2000) through a general transnationalist proposal (Thelen 1999) to understand historical and geographical processes beyond the contexts of the different nation-states.

The historical analysis of changes in land use allows us to understand the impact resulting from the conversion of soils and land cover for different types of human productive activities. This implies recognition of the environmental impact derived from changes in the landscape as a driving force for reductions in biodiversity, water cycles, and biogeochemical cycles of geography (Guhl 2008; Montero-Mora and Viales-Hurtado 2015). When analyzing the processes of change, the conditions of land tenure must be considered, that is, the implicit or explicit forms that certify or justify a territorial appropriation for the social construction of the landscape (Urquijo 2014). In the Mesoamerican regional scheme – without considering the normative particularities of each nation – land tenure responds to three regimes: private property, collective property (communal, ejido, or cooperative), and national property.

Land use change is a central issue in the history of Latin America due to the complex processes that have occurred over the last 500 years due to agricultural development, extractive activities, forestry activities, and more recently, accelerated urban development and the exploitation of fossil fuels. The distribution of land tenure seems to indicate an apparent balance, as 33 percent of the land in Latin America is collectively owned by Indigenous and peasant groups, 33 percent by nation-states,

and 34 percent by private individuals (Larrazábal et al. 2010). However, the exercise of power and asymmetrical relations, outside the control of legislation that concerns land use, generate territorial and environmental conflicts. Globalization and the economic policies of capitalism produce demand for agricultural and natural resources that accelerate the depletion of landscapes. Contemporary agriculture, characterized by expansive monocultures, leads to the abandonment of plots of land and intensive soil erosion (Larrazábal et al. 2010). It also brings with it biodiversity losses at a variety of scales, the loss of natural resilience, and an increase of the vulnerability of communities.

"Liberal modernization" focused on the promotion of extractive and productive activities that generated transformations in ecosystems and threatened the biological and cultural diversity of the region (Goebel McDermott 2021). For these reasons, in terms of temporality, the present chapter employs a periodization based on phases of globalization from the perspective of economic history to analyze the transition to independence and the formation of nation-states (Sábato 2018) with a liberal orientation (Mahoney 2001) and, concerning the transition to agrarian-dependent capitalism (Bértola and Ocampo 2010), as contextual determinants of the Anthropocene. We propose, in this sense, four moments: 1) The colonial legacy, as a necessary contextual background; 2) 1810–1870, within the framework of nineteenth-century liberalism; 3) 1870–1930, with the construction of agrarian nationalism and the interventionism of transnational agricultural companies; and 4) 1930–1950, with the transition to the agroindustrial models of economic development and technological and scientific intervention in the countryside. Although there is focus on a regional view of these moments, any understanding would be partial without broadening the panorama to the planetary context and the contradictions of capitalism, which is why the analysis scales from the regional to the global.

Antecedents: the Colonial Legacy

The European irruption and the establishment of the colonial regime brought about abrupt environmental changes, triggering new ecological and territorial realities (Crosby 1988; Denevan 1992; Gligo 2011). In the sixteenth century, the wars of subjugation between the various Indigenous lordships and the European armies, closely related to the epidemics that arrived with the Spaniards and for which there were no biological defenses, significantly depleted native societies. The introduction of cattle ranching, an unprecedented system in the continent, and the establishment of mining as the main economic activity caused substantive changes in vegetation cover, land use, and forms of land ownership in a short period of time (Urquijo 2017).

The expansion of cattle ranching activity was fed by productive lands abandoned due to the demographic catastrophe, which were converted into pastures – although

deforestation also occurred due to the extensive nature of the activity (Melville 1994; Buzter and Buzter 1993; 1995; Sluyter 2001). Cattle ranching led to productive specialization in hot, dry regions: the plains of the Gulf of Mexico, San Luis Potosí, the province of Panama and Veragua, the Pacific lowlands of Nicaragua, San Salvador and Guatemala, and the interior valleys of Honduras. In addition to being used for food consumption, livestock farming allowed for the production of tallow (for sails and protecting the hulls of boats) or leather (for footwear, clothing, and furniture). Oxen were used as draft animals for loading. The waste of livestock was also utilized, for example, for the manure trade, especially in Costa Rica and Guatemala (Fonseca-Corrales 1983; Hall and Pérez-Brignoli 2003).

On the other hand, a slash-and-burn agricultural system, used by different Indigenous societies as an organic socioecological regime dependent on solar energy and the rainy season, was practiced throughout Mesoamerica (Sieferle 2010). The preparation of the soil involved its total or partial cleaning by slashing and burning. Then came the temporary cultivation of the food base, especially corn, and finally the cultivated area was abandoned after the harvest (fallow), where the productive period was differentiated from the non-productive period (land preparation and planting) (Ibarra 1990). The *milpa* agroecological system combined the planting of maize, beans, and cucurbits in addition to more than ninety other plants including tubers (Rojas Rabiela 1989). The practice of burning allowed soil fertilization in the tropical forest, concentrating nutrients in the biomass through phosphorus and potassium, and was carried out during the dry season, to prevent them from being dissolved by the rains (Clare-Rhoades 2017).

With respect to mining in New Spain, the structuring of the territory and the management of the landscape was articulated around the Mexico-Zacatecas axis, which crossed a series of basins of relatively flat relief, separated by small mountain ranges in the center-north of its territory. The road known as Tierra Adentro allowed connectivity between mining and ranching towns. It also allowed the ore extracted from Zacatecas to reach the capital of New Spain, and from there it was transported to the port of Veracruz, where it would be shipped to Europe. Secondary territorial networks made it possible to supply various products to the main population nodes. The corn came from various places in the province of Michoacán and the salted fish came from the western lakes of Pátzcuaro, Cuitzeo. Snook were obtained from Chamela, on the west coast. Cocoa from Maracaibo, Caracas, and Guatemala arrived by way of the Pacific coast. Wheat came from the Bajío region, as did the forest resources used in mining. Livestock supplies, both large and small, came from San Luis Potosí (Bakewell 1997).

The cattle and agricultural production of the haciendas was destined for the maintenance and consolidation of the cities and towns and the supply of mining centers. The reductions or Indigenous republics provided the labor for the large estates and mines and provided an agriculture based on pre-Hispanic management

and techniques, combined with those adapted from the Europeans. However, by the middle of the eighteenth century, haciendas faced a shortage of loans and better roads, high freight and excise costs, as well as the Crown's prohibition to export agricultural surpluses. To this last problem was added that, within the colonial territories, there were strong competitors from Indian villages, whose production was mainly destined for self-consumption, at low prices and with good harvests. To counteract this situation, many landowners built large warehouses for grain storage, which allowed them to wait for the low harvest seasons and then set their own prices (Florescano 1980).

In the eighteenth century, with the arrival of the Bourbon family to the reigning house of Spain, a new policy – the Bourbon Reforms – was established to strengthen the administration. This brought about a jurisdictional reorganization in the Spanish-American colonies in order to channel the economic benefits of the different regions more directly to the Crown. The reforms thus encouraged direct exchanges with the Iberian Peninsula, transforming the tax system to increase fiscal revenue and, in addition, intensifying military defense to contain the commercial and military activities of the English (Díaz-Arias and Viales-Hurtado 2016).

In New Spain under the Bourbons, territory was structured on the basis of the *intendencias*, which functioned as economic regions, whose main authority, the *intendente* (a mayoral figure), was appointed directly by the monarch. The New Spain territory was then reconfigured into twelve intendencias (Mexico, Puebla, Veracruz, Antequera, Merida, Guanajuato, Michoacán, Guadalajara, Zacatecas, San Luis Potosi, Durango, and Arizpe) and four governorships (New California, Old California, New Mexico, and Tlaxcala). In Central America, the Guatemalan colonial elite strengthened its power by controlling the isthmus' three most important goods towards the end of the eighteenth century: silver, indigo, and livestock. Moreover, any problems with production were laid on the producers, while economic profit was controlled by the mercantile elites (Wortman 1975). At the end of the colonial period, indigo was the most dynamic product in terms of exports, which allowed the accumulation of capital for starting up cattle raising, due to the demand for the natural dyes in Europe. These were produced in the Kingdom of Guatemala, which included the territories of the current republics of Guatemala, El Salvador, Honduras, Nicaragua, and Costa Rica, as well as the current Mexican state of Chiapas (Molina-Fernández 2003).

Economic Liberalism in the Period 1810–1870

The period between 1810–1870 saw a process oriented towards the "radical simplification" of landscapes (Worster 1990) and the social construction of the predominant agroecosystems (coffee and banana), the livestock agroecosystem, and extractivism,

in transition to a dependent agrarian capitalism. Changes in land use were not only contextually linked to the formation of nation-states in the Mesoamerican region but also entailed substantial changes in the economic aspects of the colonial legacy. Institutional and jurisdictional restructuring implemented by the Bourbon reforms was matched by a profound economic reorganization during independent liberalism (Díaz-Arias and Viales-Hurtado 2016).

In Central America, the Guatemalan colonial elite were the main beneficiary of these economic transformations, increasing their power and influence thanks to the control they exercised over the financing of silver, indigo, and livestock in the isthmus towards the end of the eighteenth century. The product that had the greatest impact on the revitalization of the Central American economy was indigo, whose profits were reinvested in highly profitable activities, such as cattle raising. The dye trade soared in the following decades, and it was not until 1799 that began to decline (Fernández 2003; Díaz-Arias and Viales-Hurtado 2016; McCreery 2017). Broadly speaking, guided by the dominant Salvadoran indigo production, the provinces of Honduras, Nicaragua, and Guatemala supplied cattle for meat to feed the workers, as well as the leather to make the *zurrones* (a small leather bag) for packaging the dye powder. Some regions of Guatemala specialized in clothing for the land, maize, and wheat, while the province of Costa Rica saw a short but relatively energetic cycle of tobacco production, which would be marketed to Nicaragua and Panama, while Honduras saw intense silver mining. This economic dynamic generated a concentration of profits in the Guatemalan commercial elite, which soon led to tensions with producers in the provinces, encouraging separatism that would be present during the process of independence (Díaz-Arias and Viales-Hurtado 2016).

After the decline of the indigo trade and the consequent disarticulation of the productive chains associated with the production and commercialization of its dye, the nascent Central American republics sought incessantly to insert themselves in a stable and constant manner in the world market (Wortman 1975). Guatemala concentrated on the exploitation of grana, surpassing Mexico as the largest exporter to the British market at mid-century – although this cycle declined by 1890. Honduras and Nicaragua, although they continued to focus on the activities that had fostered their boom in the colonial epilogue, such as cattle raising and mining, expanded their export offerings with sarsaparilla and precious woods, as well as different forest goods (Díaz-Arias and Viales-Hurtado 2016). This meant taking advantage of the marketing networks for timber and other products, but also of the new trade relations that implied the formal and definitive Central American countries' insertion in the world market as exporters of raw materials and final goods of some added value, in exchange for high-value industrial goods (Hall and Pérez-Brignoli 2003). New findings on the export cycles of natural dyes, in the case of Costa Rica, provide evidence for the continuity of the trend, albeit in smaller quantities after the expan-

sion of artificial chemical dyes, given their use for dyeing certain types of textiles (Goebel McDermott and Viales-Hurtado 2022).

In Mexico, liberal policies had important consequences in terms of land tenure. In the mid-nineteenth century, a political ideology consolidated that proposed societies of free and equal individuals. This nineteenth-century liberalism favored the figure of small landowners, among whom there could be no distinctions of class or ethnicity. This position called for the end of old privileged colonial institutions, such as the Church. But it also questioned other forms of exception, such as the legitimacy of indigenous communal property. In the case of the *pueblos de indios*, it was argued that, although these territorial figures had shown a potential for self-governance, the colonial regime had subdued them through a paternalistic control that had inhibited this capacity (Hale 1985). In terms of production, the liberal governments promoted crops that were highly valued on the foreign market, such as coffee, cocoa, vines, olives, wool, cotton, sugar cane, and valuable woods. Also in these first decades of independent life, laws were issued for the colonization of uncultivated land by interested citizens or foreigners. The overt policy of establishing colonies had displayed its inconvenience in the context of U.S. American expansionism (Urquijo 2017).

Towards the last decades of the nineteenth century, Mexican mining showed an unusual boom resulting from the increase in international demand for metals for industry – such as copper, lead, zinc, and antimony –, the need for fossil fuels – coal and oil –, as well as gold as an object of exchange. Liberal policies removed many of the fiscal obstacles from the first half of the century, and promoted foreign investment, exploration, and exploitation (U.S. American, British, German, and French). This meant, at the same time, the establishment of an extensive and complex railroad network, which linked the important mining enclaves with agricultural productive areas, big cities, and the ports (Herrera and González 2004).

In the nineteenth century, the appearance of coffee was the most groundbreaking in terms of Mesoamerican agricultural production. First, Costa Rica experienced the economic benefits of the product by successfully placing it on the international market and strengthening commercial ties with Great Britain. By the 1850s, coffee had already created an elite group of producers in the Central Valley. which consolidated the focus of the country's economy on its production (Hall 1976; Samper 1990; Acuña and Molina 1991; Gudmundson 2001). In the 1870s, Chiapas, Guatemala, El Salvador, Nicaragua, and, to a lesser extent, Honduras joined in on the production coffee (McCreery 1994; Lindo-Fuentes 2002; Charlip 2002; Santiago 2003). Towards the end of the century, bananas were linked to this economy; however, the benefits of the economic surge generated by these agricultural products were soon limited (Pérez-Brignoli 2000).

In Mesoamerica, the context of economic liberalism led to the emergence of conflicts over distribution, especially regarding land tenure and agricultural wages. Al-

though Spanish colonial institutions hindered internal trade and the Crown's resources were not earmarked for the education of local populations, as was the case in the Anglo-Saxon colonies (Engerman and Sokoloff 1997), social inequality was accentuated after the processes of independence compacted collectively owned Indigenous lands and titled public lands chaotically (Coastworth 1998). The case of Mexico is relevant here. In the mid-nineteenth century, one third of arable land was owned by the Catholic Church, which controlled a significant number of peasants through sharecropping: a contract by which a church lent its land to some peasants to work in exchange for a share of the crops. In addition, through mortgage loans, the clergy exerted a strong influence over small landowners. Then, the liberal government applied the Reform Laws that stripped the Church of the legal capacity to acquire property. The liberals sought to promote a strong and independent bourgeoisie; however, the results differed, as an exclusive landowning elite was created (Hale 1985).

At this stage, a growing international trade also began, sustained by the expansion of agricultural and livestock lands and the development of infrastructure, particularly railroads and ports. Agricultural expansion was not due to an increase of small properties as the liberal project intended but rather due to a procedure plagued with irregularities, if not fraud, with respect to large portions of land that passed into the hands of a few large landowners through alienation, demarcation, or colonization.

Agrarian Nationalism and Transnational Interventionism (1870–1930)

The agro-export model in Latin America (Bethell 1997; Bulmer-Thomas 1998; Thorp 1998; Bértola and Gerchunoff 2011), particularly in Mesoamerica, was characterized by its dependency on the international market, the concentration of capital and credit in the hands of agrarian oligarchies and transnational companies and their partners – such as the United Fruit Company (UFCo.) –, and mono-export with a tendency for monocultures (Barrantes et al. 2011), as well as increased importation and a fiscal dependence on indirect taxes of a regressive nature collected from imports and exports, to a lesser extent (Viales-Hurtado and Léon-Sáenz 2021). The demand for tropical products related to the industrial revolution and the increase in real incomes in Europe and the United States resulted in an international division of labor that forced Mesoamerica to link itself to the world market through an export-led growth style based on two star products in the case of Central America – coffee (between 1850 and 1930) and bananas (between 1880 and 1950) – with greater productive diversification in the case of Mexico.

In the last decades of the nineteenth century, societal differences and disagreements, the unsustainability of the elitist regime, and the economic crises from the hoarding of natural resources became noticeable. In this context of uncertainty, the

rural and land tenure projects that would emerge in the first decade of the twentieth century took shape. In Mexico, fifty *compañías deslindadoras* (organizations tasked with the responsibility to measure and clear land for colonists) had in their domain more than 45 million hectares, corresponding to a quarter of the nation's land mass. The vast majority of the land offered for sale was acquired by ranchers and mining and railroad companies. By the first decade of the twentieth century, 1 percent of the population owned 97 percent of Mexico's territory (Eckstein 1984).

In northern Mexico, the Yaqui peoples resisted the dispossession of communal lands by the government and compañías deslindadoras, which led to military intervention and their mass deportation to the Yucatán peninsula, where the Yaquis worked in semi-slavery on henequen haciendas. Likewise, the increase in henequen production reduced the number of lands destined for workers that were *acasillados* (servants who also lived in the haciendas), so that most of them became dependent on large landowners for their daily subsistence. This situation was complicated when the price of henequen fell in the first decade of the twentieth century. Likewise, in the face of land dispossession, many peasants in Mexico migrated to the United States or joined the mining industry. However, in the context of a recession suffered by various U.S. industries, the U.S. government announced the return of Mexican workers in 1908. The following year, in 1909, the mining industry went into crisis and many workers were laid off. At the same time, the northern corn crops were lost (Katz 1980).

By 1911, Mexico was exporting a different form of primary energy, oil, and importing the capital required to create hydroelectric projects to provide a secondary form of energy, electricity. Seen from an energy perspective, the Mexican Revolution (1910–1920) represented a period of change, as the primary base of energy shifted from biological to fossil fuels. But the transition was variable, contested, and prolonged, giving rise to contradictory phenomena. The effects of the transition are today visible and take many forms: pollution, climate change, plastic waste, among others (Soluri 2009).

The contemporary Mexican territorial organization, the restructuring of collective property and the regulation of changes in land use were a consequence of the ideological tenets of the Mexican Revolution and unprecedented agrarian reform. The post-revolutionary governments granted land to peasants in the form of an *ejido* (land parcels shared communally), as a measure for social vindication to avoid the extension of the armed struggle, despite the promotion of collective property not being part of the plan. The figures are illustrative: at the beginning of the twentieth century, less than 2,000 families owned 87 percent of the nation's land area; by the end of the 1980s, there were more than five million ejido rightsholders. There are currently now more than 29,400 agrarian nuclei, exceeding one hundred million hectares, equivalent to 50 percent of Mexican territory (Hernández 2012). The 1917 Constitution proposed a radical agrarian reform. It declared, on the one hand,

the right to restitution of communally-owned lands or the distribution among the towns; on the other hand, it declared null and void the alienation and demarcation carried out since the middle of the nineteenth century. The constitutional decree resulted in the two Mexican collective tenure figures: first, the restitution of land gave rise to the agrarian community which, in general terms, coincided with the figure of the colonial indigenous peoples; second, the endowment of land to former hacienda laborers and tenant farmers gave rise to the ejido (Garibay 2008).

In addition to harming large landowners, the distribution of land among the former peons represented a latent threat to other rural characters. These included small, but economically impoverished, private landowners with strong ties to institutional Catholicism, settled in the states of Jalisco, Guanajuato, Michoacán, and Querétaro. This type of landowner, known as a ranchero, had strong reasons to distrust agrarian reform: their land, although of poor quality, could be subject to expropriation by the government, which might prefer to take their plots over those of the landowning elites. The tension grew even greater: between 1924 and 1928, the Mexican government launched strong attacks against the Catholic Church – which had a deep-rooted moral leadership among ranching societies –, closing churches and suspending services. This provoked, in 1926, a new agrarian uprising known as the Cristero Revolution (Tutino 1990).

In 1934, Lázaro Cárdenas del Río became President of Mexico and implemented the agrarian reform from the 1917 Constitution. For Cárdenas, the ejido was the most appropriate territorial structure for satisfying the needs of rural settlements, through the establishment of strong communities that would ensure an equitable distribution of the riches of the land and natural resources. The politically neutral term *núcleo de población* (population nucleus) was created to refer to social groups receiving land, replacing the historical notions of congregation, community, civil corporation, or tribe. In addition, a distinction was made for the first time between ejido lands for common use, such as forests and pastures, and plots of land for individual agricultural work by ejido members. In summary, more than 20 million hectares were expropriated from large landowning elites, benefiting around 800,000 families (Garibay 2008).

Towards the middle of the twentieth century, the post-Cardenas Mexican government opted for two actions that had repercussions for rural areas. In the context of World War II, he proclaimed a policy of national unity, which entailing the reduction in internal conflicts generated by agrarian distribution (Salinas 1988). Thus, the bases of urban-industrial development were defined, marking the rural regions as the primary suppliers of raw materials and labor for the secondary and tertiary sectors. Agriculture was no longer a peasant industry, but a commercial agribusiness. In legislative terms, a new Agrarian Code was finally established in 1942, which granted greater guarantees to small property and created land titles for ejido rightsholders (Urquijo 2017). In this context, the process of deforestation increased. Its

environmental impact was made evident by soil erosion, changes in the composition of vegetation, and, as a consequence, changes in climatic conditions, as well as the loss of plant and animal species and the proliferation of some pests. In terms of water resources, both surface and groundwater were affected (CEPAL 1993).

Although the 1917 Constitution stipulated that the exploitation of subsoil resources corresponded to the State, in practice, the participation of foreign companies had been the norm since the nineteenth century. Oil companies, mainly U.S. and British-owned, extracted the resource from different locations in Mexican territory, mainly along the coasts of the Gulf of Mexico. In 1938, in the face of growing complaints and workers' movements, President Lázaro Cárdenas decreed the expropriation of the industry and the establishment of the parastatal company PEMEX (Boyer and Cariño 2019).

In Central America, the period of energy transition occurred before World War I – except in Nicaragua – during which coal was the main imported fossil fuel source. When the war broke out, there were different national responses. Costa Rica, El Salvador, and Guatemala reduced coal imports, but this did not happen in Honduras and Nicaragua. The latter, together with Costa Rica, Guatemala, and El Salvador increased oil imports, and by the end of the 1920s, the entire subregion was a major oil importer. The energy transition, as measured by oil imports as a percentage of total energy, was most radical in Costa Rica, from 10 percent to 90 percent; only Nicaragua remained 30 percent dependent on coal (Notten 2012: 372–376).

Regarding agricultural uses, coffee plantations in Central America took the form of polycultures following from their origins, and the cultivation systems incorporated regulated shade (Naranjo 1997; Samper 2003). This influenced a less fragmented land use, with mosaic logic and greater associated biodiversity (Viales-Hurtado and Montero-Mora 2010; Montero-Mora 2018). The expansion of the coffee plantation consolidated haciendas, as well as the agricultural colonization by small producers, in places where there was an open agricultural frontier or where Indigenous populations were confined, who produced for subsistence by growing corn, rice, beans, tubers, bananas, plantain (*Musa Balbisiana*), chayote, squash, sugar cane, tropical fruits, as well as practicing hunting and fishing (Durán Barrantes 2013). Coffee production generated a process of transformation in order to be marketed, either dry or wet (Montero-Mora and Sandí 2009), where the dry processing, as opposed to wet processing, limited water contamination and the coffee grounds could be used as natural fertilizer.

The technique of planting shade-grown coffee was somewhat positive, as it protected many lands that were previously covered with grasses or herbaceous plants from erosion and sedimentation (Ramírez Boza 2004). Wet milling produced large amounts of waste, mainly brush and *aguas mieles* (wastewater containing the unwanted residue from processing), which were thrown into rivers, leading to the development of problems with contamination. High temperatures and abundant rain-

fall led to intense bacterial activity in the soils and tropical forests, and coffee had to coexist with a variety of species. The construction of the coffee agro-ecosystem created important transformations, such as an increase in luminosity, soil temperature, and wind intensity, as well as a decrease in soil moisture and its potential for infiltration, an increase in runoff, a decrease in soil pH, and erosive processes, already detected as a concern in the 1930s. As soils became poorer, cow dung and other organic fertilizers were used, such as guano, bones, fish powders, oil cakes, lime, ground meat, and wood ashes. *Abonos verdes* (lit. green manures) were also deployed, especially through the use of leguminous plants, but then chemical inputs were used (Rojas 2000).

The process of modernizing coffee plantations took place between 1880 and 1920. In the case of Costa Rica, it entailed the generalization of regulated shade, the incorporation of coffee husks and other organic residues into the soil, as well as the importation of guano, nitrates, and other fertilizers to compensate for the loss of nutrients from the depleted soils of coffee plantations (Samper and Naranjo 2006). The government sought to systematize climatic data, especially rainfall data, given the relative dependence of Costa Rican export agriculture on soil and climatic conditions and its low levels of external energy imports, in order to increase production yields (Goebel McDermott and Viales-Hurtado 2010).

Coffee harvesting was generally practiced during the dry season, when the rivers carried little water, which resulted in the formation of pools that, combined with untreated honey, produced bad odors and the presence of bacteria, fungi, nematodes and insects, affecting aquatic life. Coffee wastes were thrown into the rivers, where they rotted, despite some attempts to minimize the impact of this by using the pulp as fertilizer and as fuel in the coffee mills. Water was used to wash the coffee and as a driving force for the coffee mill machinery; therefore, it was considered a precious and relatively scarce commodity, and permits had to be obtained from the local authorities. Water scarcity was associated with deforestation, especially along the riverbanks, so legislation was introduced to curb it and begin to reforest; fines were established and forest rangers employed, but the scope of the problem increased (Rojas 2000). The societal conflict that is recorded has been linked to the cumulative effect of river contamination from coffee waste (Román 2004).

In the case of banana plantations, in terms of the Anthropocene, the transformation of nature by human activity implied the transition from a low-input system to a capital- and labor-intensive one, where people, plants, and pathogens interacted (Soluri 2000). Under the precepts of late nineteenth century economic liberalism and its vision to modernize and transform nature, banana plantations diverted rivers, destroyed wetlands, flooded land (to combat banana diseases), and degraded soils (Soluri 2005). The forests gave way to extensive plantations of the tropical fruit, which generated genetic erosion through the cultivation of a single variety of banana, a situation that in turn enhanced the spread of diseases (Goebel McDermott

2013). The success of bananas was not only due to the availability of fertile land but also to the interconnections that could be established within and between farms. For the United Fruit Company, the choice of land depended not only on fertility but also on other elements, including roads openings and the possible risk of damage from floods or hurricanes. In the construction of roads, mainly railroad branches, UFCo. took advantage of a natural resource as an environmental service: wood.

The landscape of the initial banana plantations was rather chaotic. The forests lay on the ground and only the constant cleaning by the banana workers and the weather, which rotted the trunks, made it possible to create a new landscape: the plantation landscape. Land use was predominantly agricultural, but there were also other uses, such as forestry land, since neither the company nor the private producers razed all the forest in the region; land for construction purposes, whether for roads, bridges, docks, ports, administrative buildings, or workers' houses; or the land used for paddocks, as animal power was constantly being used as a means of loading during the first banana boom.

At first, the banana plant hardly had to compete with other species for soil nutrients, but later, a number of chemical elements became indispensable for fruit growth. Nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), and sulfur (S) are the chemical elements that a plant requires in greater proportions; these are called the major elements or macronutrients. Zinc (Zn), copper (Cu), boron (Br), iron (Fe), manganese (Mn), and molybdenum (Mo) are used in smaller proportions and are known as minor elements or micronutrients. During the early years, the strength of Caribbean soils was unquestionable. After 1910, a drop in the export of bunches began to be recognized, which was linked to a decrease in production due to depleted land. Since then, the need to use fertilizers has been insisted upon. During the first banana boom, the fungus *Fusarium oxysporium var. Cubense* caused the most damage to the industry, as it was responsible for the "Panama disease" (Viales-Hurtado 2006; Viales-Hurtado and Montero-Mora 2011).

Developmentalism and Scientific and Technological Intervention in the Countryside (1930–1950)

Despite the expansion and consolidation of cash crops, the development of livestock activities, urban expansion, and incipient industrial development during this period, there was still considerable forest area, although the rate of deforestation had accelerated: its estimated that two thirds of the area lost since the colonial period was destroyed after 1950 (PNUD 1988). Logging of primary and secondary forests continued to increase, and agroindustrialization required a wide repertoire of chemicals: herbicides, fungicides, fertilizers, pesticides, nematicides, and insecticides, swelling the presence of agrochemical-resistant pests. In addition, the latter created

residues in fruit that were consumed by humans as well as contaminating rivers and aquifers.

Most studies on pesticide crises in Mesoamerica trace their origins to World War II and the introduction of DDT; to the demands of the cotton boom of the 1950s, especially in northern Mexico; and to the spread of the agricultural technologies of the so-called Green Revolution, initiated in the Mexican countryside at the behest of the Rockefeller Foundation in the 1940s. The scientific and technological program of genetic modification of seeds – initially corn – was mainly projected from Mexico to Central America and Colombia (Picado 2008). In the early 1940s, *Fusarium* researchers continued to experiment with chemical fungicides, including formaldehyde as a bactericide (Marquardt 2001). Beginning in 1950, scientific agricultural research impacted coffee farming with the introduction of new varieties, the use of chemical fertilizers, and other industrial inputs that led to an increase in energy imports to coffee agroecosystems (López and Picado 2012). The process was gradual and the chemical change preceded the change of varieties in which coffee farming responded to international market incentives (Montero-Mora 2018; Montero-Mora et al, 2021).

In the case of Central America, the disease that had infected banana plantations since the 1930s was Sigatoka, caused by the fungus *Mycosphaerella musicola*, appearing on bananas as a parasite. This pest was controlled with techniques of fumigation. Beginning in 1935, "bordeaux mixture" (a combination of copper sulfate and lime in water) was sprayed on the leaves and in the air, beginning in the 1950s with a petroleum-based formula (Viales-Hurtado and Montero-Mora 2011).

After 1938, UFCo. used biocidal chemicals as pesticides and fungicides, today designated unfit for agricultural use because of their adverse effects on the health of people, animals, and nature. Manual spraying of these plantations was practiced between 1938 and 1962. After chemical powders spread by airplanes proved unsuccessful, they finally decided to spray it, dissolving the powder with lime in water in a blue-green soup ("bordeaux mixture" as a fungicide). To deliver the enormous quantities needed – 250 gallons per acre, twenty to thirty times a year – the UFCo. created a large-scale fungicide distribution and application infrastructure. The fumigators were nicknamed *pericos* (parakeet) because their work clothes ended up dyed greenish blue after the workday (Marquardt 2002), an activity from which they suffered *pneumoconiosis* (lung damage due to inhalation) and hepatic degeneration, in addition to gastrointestinal and eye disorders. A new stage of agroexport began in the mid-twentieth century, when the UFCo. planted palm oil to reuse land contaminated with copper sulfate during banana cultivation (Clare-Rhoades 2011). After 1950, the widespread use of Nemagon (DBCP), a nematicide with the potential to cause cancer and sterility in humans that had been developed in the 1940s, caused a strong negative health impact on people working in banana plantations in Central America and,

later, led to social movements and lawsuits against banana companies in countries such as Costa Rica and Nicaragua (Boix 2007).

In terms of vegetation cover, deforested areas in Mesoamerica increased exponentially around the middle of the twentieth century (CEPAL 1993; Heckandon-Moreno 1997). To a large extent, this process was due to changes in land use towards pastureland brought on by a new cycle of livestock exploitation to satisfy the demand for fast food, mainly in the United States market, known as the "hamburger connection" (Myers 1981). Mesoamerican deforestation was also stimulated by agricultural colonization policies in different countries, infrastructure construction, food production, and the consolidation of large agroindustrial territories (Kaimowitz 1994). This led to an increase in methane emissions, which also contributed, to some extent, to global warming.

Discussion from the Anthropocene: Strategies and Resistance to Environmental Crises

In Mesoamerica, since the beginning of the period of independence, efforts were made by the new national governments to contain the process of natural resource depletion. In Costa Rica, legal efforts were made by the state to contain accelerated land clearing and mitigate public health problems while obtaining economic benefits, aspects that, with contextual variations, were present in the nineteenth century and the first half of the twentieth century (Goebel McDermott 2005). These policies were a form of utilitarian conservationism, marked both by the scientific knowledge of the time and a set of protectionist legal measures, as well as by a rapacious economy with respect to nature's resources (Goebel Mc Dermott 2008). Costa Rica in 1849, for example, declared that authorities should ensure haciendas created no deposits of coffee husks nor of waters used in the washing process (Montero-Mora and Sandí 2009).

In Guatemala in 1885, the political leadership of Quetzaltenango intervened in the planting of trees to prevent deforestation in Coatepeque (Gallini 2009). In Mexico, the national conservation policy was consolidated in the twentieth century through the establishment of national parks in 1917 as protected areas, mainly of forests. The national parks were the antecedents of the later *Áreas Naturales Protegidas* (ANP: Natural Protected Areas). In the period between 1935 and 1940 alone, forty conservation areas were decreed, more than half of those that still exist today (Vargas 2022).

During the period under study, at the local level, several environmental conflicts occurred, especially over access to water and forests, although the focus was territorial and not necessarily conservationist. For example, in Siquirres in 1915 (part of the Caribbean region of Costa Rica), some neighbors complained because the

UFCo. kept the best timber in the region, an activity which earned it *pingües utilidades* (handsome profits) while the locals had problems even accessing firewood. The forest as a natural resource provided several services, although in the first banana boom, two were considered important: timber and firewood. Some years later, residents of Turrialba (Costa Rica) complained about the company's cutting of laurel trees, which could, in the future, affect the community's water supply (Viales-Hurtado and Montero-Mora 2011). In the case of Mexico, the relative scarcity of water and access to forests generated larger social mobilizations, conditioning local and national authorities (Tortolero 2009).

In the first half of the twentieth century, the greatest environmental impact generated by export agriculture was related to its extensive nature and the consequent simplification of rural landscapes, as well as the systematic contamination of rivers and streams to the detriment of the water supply for various populations (Goebel McDermott and Viales-Hurtado 2010; Goebel McDermott and Viales-Hurtado 2015). In Costa Rica, the utilitarian conception of resources is present in legislation after 1948, and more specifically, in the 1949 decree establishing the *Consejo Forestal* (Forestry Council), and even in the *Ley orgánica del Instituto Costarricense de Turismo de 1955* (Organic Law of the Costa Rican Tourism Institute of 1955), despite the fact that the latter contains some of the concepts that define national parks as a necessary means for environmental protection (Goebel McDermott 2005). In this country, this logic would change in the mid-1960s, with the institutionalization of laws promoted by the state and by other organizations that conflicted with the previous dynamics for production (Goebel McDermott et al. 2019), with a transition towards building a *nacionalismo conservacionista* (conservationist nationalism) and a regime for environmental protection (Goebel McDermott et al. 2020).

In summary, the history of the Anthropocene from Mesoamerica between 1810 and 1950, in terms of land use and change in land cover, directly relate to the construction and transformation of agricultural landscapes linked to activities such as extractive mining and agroexport, with a consequent loss of biodiversity. Contemporary open-pit mining has generated unprecedented environmental degradation; however, in the Mesoamerican region this has been a contextual condition of the last fifty years of the twentieth century and the new millennium, exhibited by emblematic cases in northern and central Mexico (Garibay 2011; Manríquez et al. 2018). On the other hand, the loss is related to climate change, due to the fact that a large part of the mechanisms that regulate the carbon cycle are compromised (Equihua et al. 2015). In the period studied, there was a process oriented towards the radical simplification of nature (Worster 1990) as well as the social construction of the two predominant agroecosystems (coffee and banana), accelerated cattle ranching, and extractivism (Montero-Mora and Viales-Hurtado 2014). Although some impacts come from the legacy of colonialism, the period from 1810–1950 shows dependent capitalism intensified the processes of environmental degradation, whose consequences

are palpable in the first decades of the twenty-first century, in which agricultural commodities, produced extensively or intensively, continue to put pressure on nature through the transformation of ecosystems and the fragmentation of territories (Goebel McDermott and Montero 2022), with strong socio-environmental implications that have been evidenced in this chapter throughout their historical trajectories in the Mesoamerican region.

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