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Forest flickers of history. Early modern woodland restoration and how it shapes postmodern options

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2.1 Introduction

Forest restoration, here understood as bringing back forests where once they stood, has gained major attention in multiple international forums (Erbaugh et al. 2020). The area of restored forests has increased dramatically since the mid-20th century. For instance, the global area of planted forests has increased from 65 Mha around the early 1960s to close to 300 Mha in 2020 (de Jong et al. 2021; FAO 2020).

Forest restoration has been taking place in many countries for much longer. Well-known examples are from European countries, many of which were able to reverse a progressive decline in their national forest cover into a sustained forest cover increase (Mather 2001), much of which continues today (FAO 2020). Other, less well-known cases are of forest restoration undertaken by European colonial powers in countries like India, Indonesia, Myanmar, and the Philippines. Poorly researched cases include Japan, mainland southeast Asia, and China. Historical forest restoration has left little long-lasting imprints in most of these examples.

Given the prominence of forest restoration on the global policy agenda, looking back at past forest restoration experiences, such as those listed above, is relevant. For several countries, forest restoration in the early modern period and the first half of the 20th century resulted in significant contributions to their national forest estates which, in the Global Forest Resource Assessment statistics, qualify as planted forests (de Jong et al. 2021). Past forest restoration experiences can provide insights into the drivers that resulted in forest restoration and into how knowledge, interests, and politics shape forest restoration trajectories and outcomes. Understanding these past experiences might also provide insights into the environmental and social impacts of forest restoration. We argue that these past experiences might inform modern-day forest restoration decision-making and implementation.

In this chapter we understand forest restoration to be efforts to restore a tree cover that by prevalent definitions can be qualified as a forest. The return of a tree cover in a certain area of land can be the result of planting or seeding tree species but can also result from natural regeneration. The tree-planting efforts of interest are those in which a substantial, contiguous area of land is planted with trees with the intention to create a tree cover that meets a definition of forest—either the Food and Agriculture

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Organization of the United Nations (FAO) definition or a national definition. Natural regeneration can be the result of active avoidance or abandonment of activities that inhibit spontaneous tree growth. This might be because land use interests have changed or because land protecting measures have been introduced.

Our chapter reviews historical cases of forest restoration to answer the following questions: 1. How common and widespread was forest restoration in the past? 2. How was forest restoration undertaken and implemented, by whom, and for what purpose? 3. What were the environmental consequences? 4. Who benefitted and who suffered from forest restoration and in which sense? 5. What can be recognized as a historical forest restoration legacy? 6. What lessons can be drawn from past experiences that are relevant for modern-day forest restoration?

The chapter is structured as follows. Section 2.2 develops an analytical frame, including an outline of a protocol to collect information and data from the selected cases of early modern forest restoration. Section 2.3 provides the results of the research on those cases. Section 2.4 discusses the evidence presented in Section 2.3 and provides answers to the formulated questions of the previous paragraph. Section 2.5 concludes.

2.2 Analytical framework, cases, and research protocol

We limit the historical scope of our analysis of forest restoration up to the mid-20th century. We consider later forest restoration efforts to be part of modern-day forest restoration practices (de Jong et al. 2021). Such later practices took place in markedly different settings. By the mid-20th century many former territories held as colonies had become independent countries. This ended forest restoration implemented by colonial governments in the now-independent countries. The end of World War II (WWII) saw the foundation of FAO, which has been an important facilitator of the modern global forest restoration trajectory. It also marked the beginning of international development cooperation in which forest restoration efforts play an important role.

The lower historical boundary of the analysis is harder to define. Ancient structured and organized efforts to restore forests are known from India and China, among others (Evans 2009; Rahman 1993). These have, to our knowledge, left no significant imprint on contemporary forests estates anywhere. In Section 2.3, we briefly review references in the literature to ancient forest restoration but do not examine these examples in-depth. For cases of early modern forest restoration, however, not having much imprint on contemporary forest landscapes does not necessarily exclude them from the analysis. Examples from Asia, including mainland Southeast Asia (Peluso 1994), and China (Saito 2009) represent serious forest restoration efforts that resulted in restored forests; forests that were subsequently converted back to agricultural land. These cases constitute remarkable forest restoration efforts, and their analyses contribute to providing answers to the research questions formulated in Section 2.1.

We selected relevant cases to be included in this study. We formulated a list of questions to be posed for each of the cases researched for this chapter (Table 2.1). These include the magnitude of early modern forest restoration (question 1), which suggests the relative importance that was assigned to the problem of disappearing forests and the need to bring them back. Past forest restoration, as is today, was undertaken

Table 2.1 Questions for cases of early modern forest restoration

Questions paper tries to answer	Questions posed to the cases
1. How common and widespread was forest restoration in the past?	When did forest restoration begin?
	When did the forest restoration end? How large was the targeted area?
2. How was forest restoration undertaken and implemented, by whom, and for what purpose?	How was forest restoration undertaken?
	Who implemented forest restoration?
	What were the arrangements, including policies and legislation, incentives and agreements, and compensations?
	For what reasons was restoration considered necessary?
3. Who benefitted and who suffered from forest restoration and in what sense?	Who benefitted from restoration, in the short term and long term, and what were those benefits?
	Who was disadvantaged because of forest restoration and what were the losses?
4. What were the environmental consequences of forest restoration?	What were the short-term and long-term positive and negative outcomes for regulating ecosystem services and biodiversity?
	Who were the beneficiaries of positive outcomes for regulating ecosystem services and biodiversity?
	Who was negatively affected by restoration resulting in ecosystem disservices or biodiversity loss?
5. What can be recognized as a historical forest restoration legacy?	Based on analysis of answers to questions 1–4
6. What lessons can be drawn from past experiences that are relevant for modern-day forest restoration?	Based on analysis of answers to questions 1–4

for various reasons, by different actors, under different arrangements, and with the support of variable policies and legislation (question 2). These are important dimensions, not least because it is a relevant question to what extent they influenced forest restoration in subsequent time periods. The same point can be made for questions 3 and 4, which inquire about the political economic reality of forest restoration. Forest restoration is intended to generate benefits, provisioning and regulating ecosystem services; but restoration choices likely limit the benefits for some while enhancing the benefits for others. Questions about biodiversity gains and losses, and the risk the latter might pose for humanity, adds a contemporary evaluation criterion. These considerations might or might not have been relevant at the time a given forest restoration was initiated.

We relied on our own knowledge to identify relevant past forest restoration events (e.g., de Jong et al. 2021), but also undertook a literature search for cases of which we were unaware. Once we had identified cases of interest to be included in our analysis,

we expanded the literature search to find answers to the questions in the second column of Table 2.1. We used Scopus and Google Scholar as the main databases to find information. We also undertook less structured searches in Google to identify references or documents not found in the academic databases.

2.3 Cases of early modern forest restoration

2.3.1 Japan: From the Shogunate era into westernization

Early modern period (1603–1867)

Since the beginning of the Edo Shogunate in 1603, Japan was ruled by a Shogun and major feudal lords. Each of the 250 independent domains was governed by a feudal lord, but the Shogun did hold power over them (Totman 1998). Society was dependent on agriculture and gradually developed countrywide commercial activities. The population almost doubled during the 17th century and then stagnated until the mid-19th century (Kito 2000). In the 16th and 17th centuries the rampant use of high-quality timber for constructing castles, other large buildings, and castle towns led to the wide-scale depletion of forests.

The Shogunate and many major feudal lords established Lords' Forests (*ohayashi*), which they used to secure timber, especially for construction. These were in the form of reserved mountains (*tomeyama*) and reserved trees (*tomeki*), which could not be harvested even when they were growing on farmers' housing sites. For example, in the middle of the 17th century, two farmers in the Owari domain were executed because they peeled off the bark of some of those reserved trees (TIHF 2012). Starting in the late 17th century, rotation management was practiced in some of the Lords' Forests to ensure sustainable harvesting (TIHF 2012). As these regulations alone could not sustain resources, more active afforestation measures were undertaken since the 18th century. Several feudal lords launched profit-sharing and afforestation schemes with farmers (TIHF 2012).

As the Shogunate and feudal lords were dependent on rice tributes as land taxes from farmers, they were eager to protect rice crop farming. Due to the expansion of agricultural lands and population growth, forest lands were heavily exploited for extracting fodder, fertilizer, and fuel during the 16th and 17th centuries. This caused erosion, flooding, and landslides, which negatively affected rice crops. The Shogunate issued several ordinances to prevent this, for instance, the Ordinance for the Mountains and Rivers in Several Countries (*shokoku sansen okite*), which stipulated that farmers plant seedlings on denuded sites along rivers to stop erosion (TIHF 2012; Totman 1998). The Shogunate dispatched inspectors to check whether farmers observed these ordinances. Additionally, the Shogunate and major feudal lords designated protection forests to protect water sources (TIHF 2015). The protection forests were also set up to protect agricultural lands on seashores from sand, sea wind, or high tide (TIHF 2015).

In the 17th century, entrepreneurial plantation forestry was practiced by Japanese farmers and merchants in farmers' forests, for instance, in Yoshino, Yamaguni, Owase, Ohme, and Nishikawa (TIHF 2012). In the early modern era, as the transportation of

harvested timber was very costly, only areas with transportation opportunities, that is, proximity to waterways or to large cities, could afford to establish entrepreneurial forestry. Agricultural books (*nohsho*) that included technical knowledge on forest plantations were published in large numbers.

In summary, during this period, despite the doubling of the population and little reliance on fossil fuels, Japan sustained its forests. Saito (2009) estimates that while the population doubled during the 17th century, the total area of woodlands decreased from 27 to 25.5 Mha in the same period. Political regime policies and entrepreneurial plantation forestry are believed to have played important roles. The benefits of planted forests were accrued to the Shogunate, major feudal lords, and residents in general. Shogunate and feudal lords secured timber resources to meet their own needs, while planted forests helped protect agricultural production, from which common people benefitted. Nevertheless, residents had to endure restrictions on the use of forests. The Edo period political regime continued until the Meiji Restoration in 1868, the beginning of a national state and the modernization of Japan. Proto-industrial activities were also observed during the later Edo period and developed further during the Meiji period. The knowledge about forests gained during the Edo period was transferred to the next era. In 1879, the succeeding government began collecting documents about policies during this era to consult with them when drafting forest legislation (Totman 1998). During the late 19th century, many forest owners and the government referred to technological and institutional knowledge about entrepreneurial forestry in Yoshino (Fujita 1995).

The Meiji and later years (1867–1920)

The period between the Meiji Restoration in 1868 and the 1920s saw the introduction of Western science, technology, and institutions. A capitalistic economy was established in Japan at the turn of the century, yet traditional and agricultural components of society were still prominent in the 1920s. The Meiji government established national forests and imperial forests, which were transformed mainly from Lords' Forests (Handa 1990). The differentiation between national forests and imperial forests, and nonnational forests owned by local residents created many disputes because forest lands assigned to both categories had been used by the same forest users during previous periods (Totman 2007). Newly introduced knowledge, mainly from Germany, was applied to the management of national and imperial forests. Responding to the nationwide flooding in previous years, the government prepared its first Forest Act in 1897, which designated protection forests in national and nonnational forests (Handa 1990).

The new government abolished forest regulations enacted by the Shogunate and feudal lords, and this was followed by an intensification of forest use by farmers, which again led to erosion and floods (Takahashi 1888). Local leaders, farmers, merchants, and local bureaucrats responded to this by organizing residents and regulating forest use and also by planting trees. Local branches of the Meiji government, the prefectures, supported such efforts by providing knowledge and materials. Prefectural forest councils, the members of which were appointed by governors who were appointed by the central government, designated protection forests (Furuido 2018; Shiga Prefectural Local Forest Council 1898–1938).

An increase in Japan's population from 32.3 million in 1850 to 43.8 million in 1900 accompanying the growth of capitalistic industries did not lead to a drastic decrease in Japan's forests. The total area of woodland was 25.5 Mha in 1850 and 24.3 Mha in 1900 (Saito 2009). The benefits from forests accrued mainly to elite groups of the Meiji society, including aristocrats, bureaucrats, and the owners of agricultural and forest lands. Farmers, who made up a majority in society and many of whom owned land, gained from forest regulating services.

As these examples show, throughout the early modern to modern era, efforts to restore Japan's forest and to assure a stable forest cover were linked to agricultural production and disaster prevention and other major societal interests. Despite fluctuations in forest cover as a result of periods of increased deforestation, the evidence suggests that Japan never experienced drastic and long-term deforestation (Saito 2009). The country counteracted deforestation trends with policies and forestry activities, maintaining about 70% of its land area under forest cover until today (Totman 1998).

2.3.2 Germany: From resolving the "Holznot" to multifunctional forests

The history of German forest restoration starts at the beginning of the 19th century. Connected to the establishment of forest science, "modern" forest laws, and forestry administrations, these restoration efforts transformed large parts of the German landscape. Impacts went well beyond the German border: a core part of "German forestry" influenced many other countries' forest management, ideologically and technically (Scott 1998).

The turn of the 19th century was a decisive period in German history. The expansion of post-revolutionary France led to the French occupation of the politically fragmented German states. Political restoration followed the defeat of Napoleon, which consolidated particularly Prussian state power in Germany. It reduced the power of the church and other religious institutions, and of local noble families, who previously ruled much of the fragmented territory. The political restoration also served as the catalyst for the advancement of a centralized "modern" nation-state in Germany, established in 1871, and for economic liberalism, resulting in the expansion of an industrial sector in the country.

Around 1800, the German countryside was dominated by small-scale agriculture. Pre-historic forests that once covered most of the country had long been pushed back to less fertile soils, nonproductive mountains, wetlands, and a few aristocratic hunting grounds. The remaining forest area, around 20% of the country, was used by the agrarian society as woodland pasture, for shifting cultivation especially in mountainous regions, the feeding of pigs in oak forests, and the use of the upper organic soils for fertilization and feed. Large areas of the territory, especially on sandy soils in the north and east of the country, were used for fuel wood production using coppicing. Small numbers of trees were cut to be used for construction where mature forests remained near settlements. The landscape was intensively used to supply food and feed for an increasing population and domestic animals, resulting in integrated forest and agricultural uses on poor soils.

At the dawn of German industrialization and urbanization, wood was a critical resource for energy and construction materials. This resulted in intense expert debates during the 18th century of a perceived or expected wood shortage (Holznot) that might constrain industrial and urban development. This debate paved the way for forest policy change in the 19th century (Radkau 1986; Schott 1997).

During the first half of the 19th century, the socioeconomic land-use situation began to change. Increasing agricultural productivity and trade decreased the importance and profitability of extensive agroforestry land use on marginal sites. This resulted in rural impoverishment and strong migration to industrializing urban centers, including overseas, such as the United States and Brazil. Immigration occurred particularly from rural areas with high proportions of marginal lands. The combination of these socioeconomic changes, the establishment of forest science as a discipline, and the new state-centered planning of the economic transition toward industrialization lay the ground of the new forest restoration projects by the German states and, after 1871, the German Empire.

Forest restoration followed two closely interrelated approaches. First, on heathlands and other marginal agricultural lands, large-scale reforestation occurred. In many cases, fast-growing conifer trees, such as European spruce (*Picea abies*) and Scotch pine (*Pinus sylvestris*) were planted in pure stands. These species were seen as advantageous, as they can produce industrial and construction wood in a short time and are well adapted to poor soils and open lands. Second, the transformation of already extant forests into high forests for timber production began. Silvicultural practices changed drastically, for instance from different types of coppice forestry or shifting cultivation to high-production forests. This resulted in a separation between agriculture and forestry. Forestry shifted to primarily wood production, and agriculture was pushed out of forest areas.

The new forest restoration project was accompanied by changes in forest legislation as new forest laws were enacted. This new forestry regime came up against resistance from the rural population. For example, in the Western German High Eifel (Hocheifel) region around 1800 about 45% of the land area was heathland where sheep pasturing and extensive shifting cultivation were practiced. When the Prussian state began large-scale afforestation in this region, local farmers objected to the conversion of heathlands into coniferous forests. In some cases, the military was called upon to protect the newly planted trees. Forest restoration that was started in the early 19th century continued throughout the 20th century. Less than 1% of the heathland was left in the Hocheifel by the end of the 20th century. Today these remnant heathlands are under nature conservation status for their exceptional biodiversity and scenic and recreational value.

In 1800, Germany's forests made up 20% of the country's land area, while today it is 31%. The expansion concentrated in the country's mountainous areas, but also in the north and northeast in regions with poor, sandy soils. The forest restoration project drastically altered the tree-species composition of the forests: from forests with largely native broadleaf trees to a high proportion of coniferous forests with trees native to the country but often planted outside of their natural habitats (e.g., in low elevations instead of mountain areas).

German forest restoration concurred with a major transition from an agrarian to an industrial society. Economic life changed from local markets to national and international commodity markets; a ruling of scattered territories by the church, noble families, and free cities was replaced by a centralized state with a professional bureaucracy; and a reliance on local knowledge was replaced by a turning to science and technology for answers and solutions. Strong debates over a shortage of wood as energy for a growing society were decisive for legitimizing forest restoration (Radkau 1986). Afforestation (*Waldvermehrung*), sustainable timber management (*forstliche Nachhaltigkeit*) and protection of the forest area from conversion into other land uses (*Walderhaltung*) became the three central goals of German forestry and were institutionalized in forest laws. Also key was the institutionalization and development of autonomous, hierarchically organized state forest services that had the mandate to implement the three goals (Winkel 2007). Ambitious natural science research programs began during this time, aimed at demonstrating the positive effects of forests for society (Pistorius et al. 2012). Biodiversity impacts and carbon storage were yet to be of concern. However, the soil and water protection functions of forests were emphasized in expert and policy debates, and they served to legitimize forest protection and restoration.

Retrospectively, the pre-restored forest landscape, with a huge variety of often small-scale agricultural and agroforestry uses, is now perceived to be higher in biodiversity than the large-scale forest areas planted with a handful of species. The German forest restoration project and the abolition of forestry in agriculture led to an improvement in soil productivity, increased forest growth, and boosted carbon storage. It appears that the synergy and trade-off patterns of the 19th century German forest restoration project are similar to those now debated for forest restoration in the tropics.

2.3.3 Poland: Restoring forests for restoring the nation

Between 1795 and 1918, the north and west of Poland was part of the Prussian Kingdom, the south was part of the Austrian Habsburg Monarchy, and the east was part of the Russian Empire. During these years, forest restoration on Polish lands took place under the influence of legislation according to the forestry model of the state that controlled the respective area (Broda 2006a). In the Austrian and Prussian partitions, liberal economic theory and land and forest ownership in private hands provided the state with greater income. Large-scale sale of state property and forests had taken place early during this time. In the middle of the 19th century, a reverse process began in the Prussian partition. Centralization, nationalization, and strengthening of the role of the Prussian state led to the enlargement of state forests (Scott 1998). In the Austrian Polish territory afforestation took place on wasteland and land unsuitable for agriculture. Agricultural land was purchased from local landowners and subjected to afforestation.

Afforestation in the north and west of Poland, part of the Prussian Kingdom, was mostly pine monocultures managed according to the prevailing German forest

science principles (Scott 1998). Clear-cutting and the removal of valuable trees from mature forests, as well as ongoing deforestation, took place in the Austrian partition, while restoration in private forests was rare (Broda 2006a). Forest restoration began in the Russian partition after 1852, but despite these efforts, forest cover declined until 1907 (Figure 2.1).

In 1919, just after World War I (WWI), about 240,000 ha of deforested land previously held by the partitioning states became Polish state forests. Clear-cutting during the war amounted to 213,615 ha, and burned forests, destroyed young stands, and areas with depleted soils amounted to 26,500 ha (Jaworski 2006). During the 1919–1922 period, the forest area in the Polish territory continued to decline despite restoration efforts, as a result of policies to hand out land to smallholders and landless peasants. During the later interwar period, however, the total Polish forest area increased from 19.6% in 1922 to 22.2% in 1937 (Broda 2006b).

Between 1918 and 1939 the share of state-owned forests increased by 7% because of afforestation by the State Forests Service of some 700 000 ha. The State Forest Service implemented afforestation on privately owned land that was exchanged for arable land or purchased. In September 1936, a new Presidential Decree stipulated that the total forest area owned and managed by the State Forests Service could not decrease. Consequently, the decree required the State Forests Service to acquire privately owned forests, as well as non-forest land whose restoration was in the interest of the Polish state (Broda 2006b). Despite these regulations, during the interwar period private forest owners, who owned and managed 66% of the total forest area, reforested 180 000 ha of land (Broda 2006b).

Restoration efforts by the State Forest Service were hindered by lack of access to seeds and seedlings. In the 1920s the negative effects of nonlocal provenances were already visible in Polish forests. The policy then became the use of forest seeds harvested in Polish forests only (Maciejowski 1935) and establishing forest nurseries

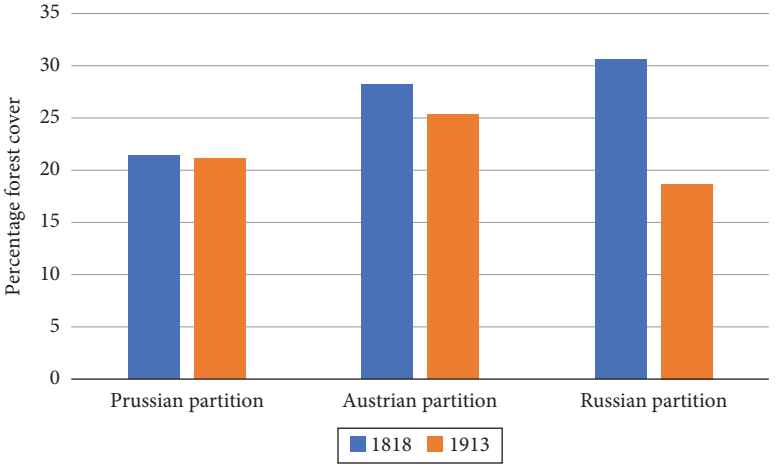

Figure 2.1 Forest cover change in Poland between 1815 and 1913 in the different partitions (Source: Miklaszewski 1928)

(Jaworski 2006). Between 1919 and 1929, 90–95% of reforestation was done with pine (Broda 2000). In 1925 an outbreak of pine beauty (*Panolis flammea*) destroyed significant areas of forest stands in northern Poland and led to salvage logging of stands of mostly nonlocal provenances, called Bavarian pine. These were replanted with domestic provenances. Between 1919 and 1939 in the area managed by the State Forest Service, more forest was restored than was clear-cut.

The necessity for forest restoration stimulated the development of forest science in Poland. The topics of restoration and regeneration were vividly debated among forest scientists during the entire interwar period. The possibility of natural and seminatural regeneration was explored and, when possible, recommended, e.g., to allow for the natural regeneration of fir and beech (Jaworski 2006). As a result, restoration shifted focus to improving the health and quality of existing stands. The Polish State Forests Service prioritized changing stands' species composition to species suitable for habitats in which they were planted with the use of local provenances. The principles of forestry copied from the German model and German foresters, following the German-Austrian forestry traditions, were reconsidered by recognizing the unique Polish forest context, for instance, in newly opened forestry technical and high schools. Polish forestry and the need for forest restoration became deeply linked with the "reborn Polish nation" ideology. Knowledge about Polish forests and their specificity was tightly linked with love for the country (Konczal 2020).

2.3.4 United States: Eastern reforestation following westward expansion

Widespread deforestation occurred throughout the Eastern United States from 1750 through to the later part of the 19th century. Of the estimated 340 Mha of forest land east of the Great Plains prior to European settlement, only 190 Mha remained by 1920, with 56 Mha estimated to be original forest not degraded by grazing, logging, burning, or other human disturbance (Williams 1989). As the population grew, eastern forests were cleared for settlement and agriculture, including crops and grazing. As the country industrialized, it had a voracious appetite for timber and fuelwood for wood products and energy. Fuelwood and charcoal demand for cooking and heating grew to include fuel for furnaces, boilers, steam engines, and eventually electric power generation. Wood demand grew rapidly for structural lumber and building materials, shipbuilding, railroad ties, mining trusses, and many other uses, including wood and resin-derived chemicals like methyl alcohol, tannic acid, and turpentine. By the late 1800s, paper made industrially from wood pulp was common; and by 1900, large paper companies were active in the northeast (Irland 1999).

Patterns of deforestation during this period were not uniform but varied across the region in time and space according to a variety of forest characteristics and socioeconomic drivers. Near the densely populated northeast coastal cities and adjacent countryside, settled and agricultural lands dominated. For example, agricultural land use peaked in the state of Massachusetts between 1830 and 1885 when tilled land, hay, and pasture were the dominant land cover; forest was reduced to 20–40% of land cover, depending on the subregion (Hall et al. 2002). Farther north, in the

more sparsely populated forests of interior Maine, timber harvesting was widespread without concurrent land clearing for agriculture. The coastal and settled areas of the south followed similar patterns as the northeast, but commercial harvesting in the interior southern states intensified later, around the turn of the 20th century, following deforestation in the northeast and north-central states near the Great Lakes (Walker 1999). This industry was often characterized by temporary boom–bust operations, leaving abandoned mills and infrastructure in their wake. Much of the industrial logging in both the north and south was done without consideration of regeneration. By the late 19th century, many of the states that are now covered in relatively well-stocked forests had larger proportions of poorly stocked timberlands and agricultural land than mature forest.

It was not always clear to landowners at the time that cut-over timberlands would be able to regrow merchantable trees again (Walker 1991); but thanks to favorable soils and climate, much of the clear-cut industrial timberland regenerated naturally through seed and sprouting, though the stocking, composition, and condition of the forest was often different from the original forest. For example, forests in the Allegheny region of Pennsylvania, heavily dominated by hemlock, birch, beech, and maple in 1800, came to be dominated by cherry, maple, and oak by the mid-20th century (Irland 1999). In the northeast, agricultural production fell dramatically after 1890, and much of the farmland that had been in crops and pasture was no longer used for agriculture. After peaking around 1880, a long period of agricultural "abandonment" followed (Hart 1968). Reforestation of abandoned farmland often occurred through natural regeneration in the absence of tilling, grazing and burning, with some establishment of plantation forests, especially after 1900. A similar trend occurred later but was less pronounced in the southeast, where farmland area peaked in 1920 and then declined sharply when croplands were abandoned, following the disintegration of the prevailing sharecropping system (Waisanen and Bliss 2002). In the southeast, reforestation was aided by the conversion of some abandoned agricultural lands to plantation pine forests and by the recognition that degraded, cut-over industrial timberlands could be rehabilitated to pine forest through good management that included seeding, planting, fire exclusion, and protection from wild boars (Hart 1968; Williams 1989).

The reforestation of the eastern United States occurred primarily on private land under generally well-established individual property rights for the time. Currently, of the estimated 134 Mha of forest land across all northeast and southern states, approximately 84% is privately owned by individuals, families, and corporations. However, this does not mean that public policies at the national, state, and local levels did not play a role in reforestation.

A national forest agency was established in 1876, which became known as the United States Forest Service in 1905. This designated a federal agency specifically devoted to the conservation, management, and use of the nation's forests for the public good. The rise of scientific forestry in the United States was further codified by the proliferation of university forestry programs devoted to training professional foresters, including early programs in North Carolina, New York, Connecticut, and Georgia that were established around the turn of the 20th century. The Smith-Lever Act (1914) established partnerships between agricultural colleges and the United

States Development Agency to support agricultural extension work, including farmer and landowner education in forestry. In the south, the establishment and expansion of the National Forest System and the rehabilitation of cut-over pine land by professional foresters was instrumental in their recovery (Walker 1999).

Among the robust forest policy activity of the time, several policies are of note. The Weeks Act (1911) authorized the federal government to purchase private land to protect watersheds and their streams and waterways from sedimentation and other effects of deforestation and degradation. This act was instrumental in expanding the National Forest System in the east. It was subsequently updated by the Clarke–McNary Act (1924), which expanded land buying authority and allowed the Department of Agriculture to work cooperatively with the states to improve forest protection, especially to protect water supplies and control wildfire, as well as to secure the continuous production of timber. Legislation also played a critical role in establishing nurseries to produce seedlings, developing state forest agencies, and assisting private landowners in reforestation, especially by providing seedlings and direct technical assistance through agricultural extension and other means. In some cases, the government provided direct incentives to convert farmland to conservation use, such as in the Soil Bank Act (1956). Some eastern private lands continue to be harvested in exploitative ways that degrade their condition, especially when subdivided and fragmented for real estate development (Germain et al. 2007).

Early 20th century US forest restoration is widely hailed as a success story. However, land clearing, logging practices, and diseases significantly altered the composition of eastern forests, as did the intentional and unintentional introduction of non-native invasive species. Most notable are the near extermination of mature American chestnut (*Castanea dentata*), which was once widespread and commercially valuable, due to introduced chestnut blight (*Cryphonectria parasitica*), and the severe loss of longleaf pine (*Pinus palustris*) habitat in the south, where cutover stands transitioned to other species, often to low-grade, poor-quality deciduous forests (Walker 1999). The loss of biodiversity in the case of longleaf pine was severe. Furthermore, it is disputed that reforestation in the east necessarily resulted in net gain in forest cover nationally (Ramankutty et al. 2010). As western forests opened to harvesting, many associated environmental problems were exported from east to west. More recently, a reversal of forest transition appears to be occurring in some eastern states from deforestation associated with residential and commercial development (Jeon et al. 2014).

The eastern transition from agricultural land use and exploitative harvesting back to forest was facilitated by a combination of broad socioeconomic forces and societal changes occurring at a time when the government and society more broadly were beginning to perceive and understand the importance of forests, not just for wood supply but also for water and other values (Godfrey 2012). Scientific forestry was emerging in the United States as a professional discipline, and universities were implementing vigorous agricultural extension in cooperation with state and federal government agencies to guide the transition. Certainly, farmers and agricultural producers in the east were hit hard by these changes. However, the benefits of reforestation that accrued proximately to private landowners were ultimately shared more widely among a population that was increasingly concerned with forest conservation for water, recreation, wildlife, aesthetics, and a broader pallet of ecosystem services.

2.3.5 Colonial forest restoration

An important contribution of early modern forest restoration can be attributed to efforts by colonial regimes. The countries that held colonies changed in the course of history. Prominent colonial regimes included Belgium, Germany, Great Britain, France, Italy, Japan, Netherlands, Spain, Portugal, and the United States. Territories held under colonial control changed equally over time. A recognized phenomenon is what Siiskonen (2015) refers to as the scramble for colonial territories toward the end of the 19th century, a period when European countries competed for the control of ever-larger areas of the southern hemisphere, especially in Africa and Asia.

Colonial governments had much interest in forests in their colonial territories. Not only were forests an important natural resource that could be exploited for profit, which colonial powers expected to obtain from their colonies, but also because it was widely believed among colonial land specialists and related academic circles that deforestation contributed to climate change, which negatively affected other land use sectors. This "desiccation debate" was held among British, Dutch, German, and French colonial land specialists alike. Desiccation is a decrease in rainfall, a lowering of the water table, and a drying up of surface waters. Deforestation caused by local agricultural extension, grazing, and fires was held to be a main cause of desiccation (Siiskonen 2015). The appropriation of customary lands, however, was also shaped by the articulation of national timber (or wood fuel) and global environmental crisis narratives. Locals were persistently framed as profligate land and resource users. They encountered forestry arguments unfolding in different places and at different times (Barton 2002), comprising three main elements: the appropriation of lands to create national networks of forest reserves, the establishment of forestry departments to oversee the introduction of "scientific forestry" principles and multifaceted efforts to regulate and control bushfires, and the production and marketing of wood fuels and other forest products.

Several commentators hold that the desiccation discourse served to restrain forest and land use of the indigenous population in some colonial territories (e.g., Endfield and Nash 2002). It was rejected by the famous forester Dietrich Brandis in 1911, following his experience in British India (Potter 2003). But the belief in the validity of desiccation theory greatly influenced conservation policies in some colonial territories and left its imprint on forest restoration plans (Grove 1995; 1997).

Colonial commercial plantations

The largest area of planted forests in colonial territories was in commercial plantations. Only a handful of species were planted. The timber species most in demand internationally was teak, used for shipbuilding. It was already being produced in Java by local rulers at the time when first Portuguese and later Dutch administrations took control of much of what is now Indonesia. The Dutch colonial government engaged German foresters, as did several other colonial governments in India and African countries (Siiskonen 2015), to take care of the teak forests in the early 19th century. British colonial authorities also engaged French foresters trained in the French Royal Forestry School established in Nancy in 1824, preceding the British equivalent by a century.

All teak forests in Java were planted forests, and much of it was planted following a "taungya" arrangement. Under this arrangement, which was implemented variously across regions in Asia, local farmers were engaged to plant teak and were allowed to interplant food crops until the growing trees inhibited food production. Taungya was also applied with other commercial species. An estimated 300,000 ha of teak forest existed in Java in 1950, 5 years after the country gained independence. Great Britain continued to exploit natural teak forests, especially in Burma, until the mid-20th century.

Teak was planted by the British Forest Service in India starting in 1842 and in Burma in 1856 (Evans 2009). It is estimated that, at the beginning of the 20th century, India had some 50,000 ha of planted teak (Bennet 2014). Commercial tree planting in India was not limited to teak. Eucalyptus and acacia species were planted in the Nilgiri plateau, and eucalyptus species in the Mysore region. These plantations were intended to meet regional firewood and other wood demands (Bennet 2014) and to yield Mysore gum (Evans 2009). The total area of planted forests on the Nilgiri plateau, however, appears to have been not much more than 500 ha (Bennet 2014).

The planting of teak, eucalyptus, and acacia was followed by tree planting in other areas of southern India, Australia, and the Cape Colony. Teak began to be planted outside Asia, for instance, in what is now Nigeria (Horne 1966) and Ghana (Kadambi 1972). British foresters also turned to pine species, which began to be extensively planted in South Africa, Australia, and New Zealand. Evans (2009), for instance, reports that 180,000 ha of plantations of various pine species existed in South Africa and 9,800 ha of planted pine forests in Queensland, Australia.

Forest restoration and the desiccation conundrum

Colonial administrations were also interested in other forest commodities, such as shea nuts in West Africa (Wardell et al. 2021). As seen above, forest restoration was also considered necessary to address the perceived negative environmental impacts of local land use. Davis (2016) undertakes an extensive review of the prominence of the desiccation discourse. It was debated extensively among foresters and related professionals with responsibilities or interest in colonial territories. The discourse led to calls for policies to implement reforestation in many instances, including the planting of two protective tree belts across West Africa following the Anglo-French Forestry Mission between December 1936 and February 1937. These plans were abandoned due to WWII but have since become the focus of the contemporary Great Green Wall program (Wardell 2020).

How much the desiccation debate resulted in forest restoration is difficult to know. Multiple authors point to the limited impact of the desiccation debate on forests and land use (Davis 2016; Fairhead and Leach 2000a; Siiskonen 2015). This limitation resulted from the difficulties in implementing policies that restricted land use practices perceived to degrade forests and in implementing other conservation measures and forest restoration activities. (Fairhead and Leach 2000a). Siiskonen (2015), for instance, mentions plans by the German administration to establish thousands of hectares of date palm (*Phoenix dactylifera*) along the Swakop River in the Namibia desert; but only 50 ha were planted. Similarly in 1934, the French colonial administration of Guinea planned to "rewood the degraded Niger upstream catchment areas,"

but these plans "foundered in the face of limited budget allocation" (Fairhead and Leach 2000a) and the greater interest in developing the (agricultural) Office du Niger. In French Algeria, a League for the Reforestation of Algeria was established in 1882, which gained broad membership among French and a few Algerian settlers. In 1912, a dedicated reforestation service was founded. Much of the efforts to achieve lofty objectives to restore, or rather to transform, Algerian rural areas to an ideal imagined forested landscape (Ford 2008) focused, as elsewhere, on restraining the land use practices of local land users. During the second half of the 19th century evidence is available of the planting of only 5,400 ha (Merdas et al. 2017), when the country had 3.2 Mha of forestland at that time (Ford 2008).

In Namibia, there are reports of forest restoration by local farmers under the colonial regime. Settlers extensively planted fruit trees near the Angola-Namibian border, on land they had occupied since the 1920s. Kreike (2009) refers to this as a "fruit tree frontier." The tree vegetation included planted fruit trees but also spontaneous regenerating fruit trees and other tree species. Similar cases of forest restoration among rural communities in remote regions who engaged in low technology, low-input land use are reported for South America, Africa, and Asia (Fairhead and Leach 2000b; Padoch and Peters 1993; Posey 1985). Commercial interest in trees resulted in their protection and reproduction in swidden fallows, but also more actively tended forest gardens. These are practices that predate the modern forest restoration era. There is some evidence that these practices were influenced by the land use administrations of colonial powers. The example given by Kreike (2009) suggests that colonial land administration influenced land occupation, vegetation conversion, and the subsequent fruit tree frontier formation. Another example is the adaptation of swidden fallow restoration among rural farmers in Southeast Asia. Rubber trees introduced into the region by British and Dutch colonial officials began to be planted by local farmers in swidden fallow fields. This increased the proportion of managed fallows in swidden fallow agriculture landscapes (de Jong 2001; Dove 2011).

In summary, the colonial administrations had much interest in forests in the foreign territories they controlled. In several colonial territories, particularly after budget restrictions were introduced in the early 1900s, timber was a key commodity that helped pay for colonial administration. This is one of the reasons that the colonial forestry ideas were exported from India and Burma to many other anglophone colonies. Forests constituted a valuable economic resource but were also recognized for regulating ecosystem services. It was argued that deforestation would cause wide-scale desiccation problems that would negatively affect agricultural commodity production, one of the primary incomes derived by colonial regimes. Actual planting of forests, however, was primarily done with species that had commercial value, such as teak, pine, acacia, and eucalyptus, and a few less common species. This also happened in rural areas outside the view of colonial governments. It appears that forest restoration to address the desiccation problem happened only occasionally. The benefits of planted forests accrued primarily to the colonial regimes. Both the land grabbing for the planting of commercial trees and the desiccation narrative concurred with policies and measures meant to constrain local land use practices that resulted in the removal of tree vegetation—land use practices that were largely evaluated negatively by colonial (and also some postcolonial) professionals (e.g., Whittlesey 1939).

One can draw parallels between colonial forest restoration discourse and practice and its contemporary counterpart (Davis and Robbins 2018). Colonial regimes were widely concerned about the negative impacts of deforestation and hailed forest restoration as an important measure to remediate those impacts. Not enough actual restoration appears to have taken place, however, to achieve environmental benefits. Most forest restoration in colonial territories pursued by colonial administrations was commercial tree planting. Such commercial tree planting, the limited efforts to restore forests for environmental benefits, and the prevailing narratives to justify both were used to condemn and constrain local land use practices. Meanwhile, local land use and sometimes forest restoration was adapted to the colonial forestry regimes.

2.4 Discussion

We structure the discussion of the evidence provided in Section 2.3 by returning to the questions posed in Section 2.1. Responding to question one, how common and widespread was forest restoration in the past, the evidence indicates that forest restoration did happen in early modern times and even before. The determination of how widespread such pre or early modern restoration was, or to extract learning from any other relevant characteristics of these initiatives, would require an in-depth research of historical sources, which is beyond the scope of this chapter.

The examples reviewed in this chapter, and other cases reported in the literature, illustrate that forest restoration happened in multiple locations around the world. In Japan early modern forest restoration began in the 17th century, both to grow timber and to combat erosion that negatively affected rice production. Through its restoration efforts, Japan managed to prevent a serious decline of its forest area and maintain a relatively stable forest cover since the 17th century. In Europe, forest restoration varied considerably by country. Several European countries experienced a first wave of forest recovery during the 14th century as a result of a decline in population, caused by bubonic plague epidemics. However, in many cases this recovery was not long-lasting. Early restoration took place in India and Egypt, for instance, and evidence exists of pre-modern tree planting in Roman Italy, and by cloisters in lands they controlled (Farrell et al. 2000). Mather and Needle (1998), Rudel et al. (2005), and Meyfroidt and Lambin (2011) suggest historical moments when European countries experienced their forest transition inflection point, after which forest restoration took place. While forest restoration did occur before these moments, it did not exceed deforestation, especially when considered over a longer period.

Meyfroidt and Lambin (2011) place the beginning of "modern" forest recovery in European countries in the 17th century for Scotland and the UK, in the early 19th century for Czechia, Denmark, France, and Hungary, and in the second half of the 19th century for Austria, Germany, Poland, Portugal, Slovenia, Sweden, and Switzerland. In Bulgaria, European Russia, Ireland, Italy, Ukraine, and the United Kingdom, forest cover began to increase only in the early 20th century (Meyfroidt and Lambin 2011). Of the countries outside Europe, only Japan, the United States, and New Zealand are listed as having experienced forest cover increase before the 1950s.

The countries listed above are the only ones that experienced forest transition before the mid-20th century. This indicates that forest transition is by no means equivalent to forest restoration taking place, as the cases of colonial forest restoration discussed in the previous section show. Forest restoration did take place before the mid-20th century in multiple countries in Europe as well as in tropical regions (de Jong 2010; Meyfroidt and Lambin 2011). But the evidence suggests that, at a global scale, forest restoration practices accelerated in the second half of the 19th century, and even more so since the first half of the 20th century.

The second question, how was forest restoration undertaken and implemented, by whom, and for what purpose, also requires nuanced answers. The evidence in this chapter and from other cases (Chokkalingam et al. 2005; Songster 2003; Wardell 2020) indicates that forest restoration was pursued to generate a range of ecosystem services. The primary purpose of tree planting was often wood or timber production; in fewer cases, it was for other products that qualify as provisioning ecosystem services. However, the purpose of some of the early forest restoration was also to generate environmental benefits rather than producing consumables or commodities. Or, in terms of the ecosystem services classification, an important part of pre-1950s forest restoration was aimed at generating regulating ecosystem services. The reforestation in the vicinity of Nuernberg, Germany was to stop erosion from sandy hills. Standing out is the desiccation debate among forestry experts who commented on or had forestry responsibilities related to colonial forestry administration or exploitation and resulting efforts to restore forestlands (Davis 2016; Fairhead and Leach 2000a; Grove 1994; Siiskonen 2015).

The evidence gathered in Section 2.3 suggests that government actors played an important role in promoting or facilitating forest restoration in all the locations reviewed. This was the case in Japan, Germany, Poland, the United States, and in most colonial forest restoration cases, but also, for instance, in post-imperial China (Songster 2003) and the Philippines (Chokkalingam et al. 2007). Government agencies often engaged with people who lived in the locations where forest restoration took place. Arrangements to undertake restoration included hiring people (less common during the early years) and formal contracts with companies or entrepreneurs. In the case of Japan, enacting regulations that required local residents to plant trees was also included. Arrangements such as taungya, which was used in several locations in Southeast Asia, can be viewed as benefit-sharing arrangements between government actors and local residents, although more benefits accrued to the forest departments than to local people (Peluso 1994).

The desiccation debate assumed a direct link between deforestation and negative environmental consequences, including lowered water flow and rainfall patterns. This debate eventually died out, not least because these causal linkages were questioned (Davis 2016; Fairhead and Leach 2000a). It is noteworthy that in recent years the argument linking forests and rain patterns has returned in full force (Ellison et al. 2017; Sheil 2009). One can also argue that today's climate change and the role assigned to forests in solving emerging challenges mirrors the desiccation debate, but in a post-colonial, globalized world. Only now, the former colonial powers lack the legitimacy to prevent tropical deforestation for the sake of protecting their agricultural interests at home or in tropical countries, to stop the negative effects that deforestation has

on rainfall patterns, or to reduce the contribution of deforestation to CO_2 emissions. Conservation measures and interventions have globalized, and forest protection and restoration are considered important measures to address the global climate crisis. Narratives are devised to suggest that forest residents will equally benefit from these measures, mirroring arguments made as the desiccation debate unfolded (de Jong et al. 2021).

The third question relates to who benefitted from forest restoration and in what sense, and who suffered detrimental impacts where and when it happened. This question refers to the consequences for the environment of early modern and pre-contemporary forest restoration. In the early industrialized countries of Europe, Japan, the United States, and New Zealand, reforestation concurred with a trend away from deforestation, that is, it is linked to forest transition. This was not the case in many colonially occupied countries: they depended on natural resource use and also often maintained considerable areas of natural forests, even though they experienced net deforestation. In these countries, forest restoration and forest transition are less closely linked (de Jong 2010), as areas restored to forests again succumbed to deforestation forces. However, some restored forests escaped such a fate, for instance teak forests planted in the 18th century or earlier in Indonesia. In other places, such as Japan, past forest restoration aided in assuring a stable forest cover that has not varied much over centuries.

The legacy of past forest restoration has manifested itself in other ways. Foresters recorded their experiences and shared their knowledge and ideas, which were passed on and influenced the administration and practice for many years to come, even after countries that experienced colonial dominance became independent (e.g., de Jong et al. 2021; Potter 2003).

The cases reviewed here demonstrate that restored forests have not always resulted in biodiversity conservation nor the creation of complex and diverse ecosystems. This is particularly the case where forest restoration was undertaken for wood or timber production, in which case the "new forests" were commonly single-species forests with limited biodiversity and ecological diversity and a limited capacity to provide regulating ecosystem services. As observed in Section 2.3.2, arguments are made that restored forests from the past replaced more diverse agriculture-forestry-cultural landscapes, and that biodiversity and ecological diversity in the new forests declined. In some places, this has resulted in calls to reverse past forest restoration and restore these early modern agriculture-forestry-cultural landscapes. More prominently, it has led to the idea to transform plantations into more biodiverse, multiple tree-species forests.

As is the case today, who benefits from forest restoration depends very much on where it is done, for what purpose, and how it is implemented. Where the state facilitated or coerced forest restoration, the benefits accrued primarily to (colonial) governments or its associates, mostly entrepreneurs affiliated with the governments. Where forest restoration was successful, these forests generated regulating ecosystem services that benefitted local and nonlocal people as well as provisioning ecosystem services that benefitted forest users.

The forest restoration histories, however, have a well-known darker side. Feudal lords in Japan imposed restrictions on forest uses on local communities to further

their own interests at the expense of those communities. A common phenomenon in multiple locations was the eviction of rural residents (and/or their agricultural practices) from land that was to be subjected to forest restoration or the imposition of the use of lands for restoration against the preference of original users of those lands.

The answer to the final two questions, what can be recognized as a historical forest restoration legacy and what lessons can be drawn from past experiences that are relevant for modern-day forest restoration, can be summarized as follows. The possibility and option to plant trees has likely been known to people since agriculture developed. Where societies or communities benefitted from trees and forests but cleared forests for land use, the possibility and option to restore forests was recognized early on and did happen in pre-modern times. When societies began to experience negative consequences of land use conversion for agriculture and its impact on forests, declining availability of forests products, and increased erosion and flooding linked to deforestation, efforts began to bring back forest cover. This happened in different places independently—in Japan, Indonesia, and various countries in Europe, possibly even in various tropical regions (e.g., Balée 1994).

What is now generally understood as forest restoration started when societies had organized as states or along similar society structures. Forest restoration was proposed, organized, and coordinated by actors with authority. However, this did not always result in long-term impact on the ground. It needed to be pushed through conflicting interests, resulting in a top-down perspective that has a legacy in today's forest restoration thinking. Not uncommon, the actors with authority imposed forest restoration to address the interests of particular groups of society. This happened in Japan, where feudal lords sought to ensure the supply of rice they taxed from their subordinates; in colonies concerned by the negative impacts of deforestation on commercial agriculture or estate production; and, in Germany, where a shortage of wood supply was seen as a threat for the success of the industrialization project. One can argue that this is a second enduring legacy of the world's forest restoration tradition: one that is becoming especially evident in recent years when the global community, including world leaders participating in the UNFCCC COP26, are calling for a stop to deforestation and to implement forest restoration to solve the looming global climate crisis. Current forest restoration plans are expected to happen in multiple locations in the world to benefit the global community. Whether local residents will enjoy benefits from forest restoration remains to be seen, while they may or may not experience negative impacts from climate change (de Jong et al. 2021; see also Chapter 10).

Another long-lasting legacy of early modern and pre-contemporary forest restoration relates to the global exchange in forest restoration ideas, knowledge, and practices and how this has influenced contemporary forest restoration thinking. When forest restoration became part of land use practice, policy, and administration in multiple locations in the world, it became heavily influenced by "scientific forestry," as happened to forestry in general. Scientific forestry is claimed to have emerged in Europe, especially Germany and France (Farrell et al. 2000), but it subsequently influenced forestry ideas not only in European colonies but also in many other countries, where forestry and forest agencies became part of the public natural resource administrations. In examples known to us, countries have set up their own national forest restoration programs and related research and experimentation institutions and programs

(Chokkalingam et al. 2007; Jong 2010). These generally follow a tradition that can be linked to 19th-century forest restoration ideas and practices, which themselves are directly linked to the global dispersal of the said European scientific forestry tradition from that same era.

If one reads documentation and academic studies on forests and forestry in the past, the dominant focus is on how societies evolved, how forests provide benefits and opportunities, and how this, largely negatively, impacted forests themselves. Most analyses of society–forest interactions make only passing reference to forest restoration, if any. The evidence synthesized here suggests a lot more has happened that fits under the term forest restoration, too little of which is known or has been explored. This is a gap in our knowledge and understanding that needs to be remedied. This points to the need to undertake more research on past forest restoration practice and experiences.

2.5 Conclusion

Forest restoration has been around for a long time. It gained prominence in the 19th and early 20th centuries, a prominence that has not diminished, although many of its ideas have since changed profoundly (de Jong et al. 2021). Early modern forest restoration heritage endures, as do the forests that persist to this day, as a legacy that is morally judged differently by different actors and that is connected to varying contexts and governance traditions, including problematic ones, such as colonial states and governments. It can be reasonably expected that this might be similar when contemporary forest restoration is analyzed in the future. To better capture the lessons from past forest restoration it is advisable to invest in historical forest restoration research.

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