The role of social, policy and economic forces in shaping forest restoration practices in Europe

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ABSTRACT

Forest restoration in Europe has a complex history strongly influenced by various social, policy and economic factors. Understanding these influences is essential for shaping effective restoration strategies and avoiding past mistakes, particularly in light of meeting ambitious targets outlined in initiatives such as the EU Nature Restoration Regulation. Here we identify the key social, policy and economic drivers, barriers and enablers that have historically shaped forest restoration across Europe. We analyzed and synthesized detailed information from historical national narratives on forest restoration provided by experts from 18 European countries. Our work details how wars, changes in governance (centralization vs. decentralization) and forest tenure (privatization vs. nationalization), different policy instruments (regulatory, financial, persuasive and organizational), market fluctuations and sociodemographic changes (e.g., rural abandonment, changes in public opinion) have driven the development of forest restoration in Europe. The findings underscore the need to use inclusive and innovative governance mechanisms to reconcile diverging societal paradigms (e.g., rural vs. urban, conservation vs. forestry) partly reflected in incoherent forest-related policies, as well as to address the fragmentation resulting from forest privatization. Ensuring stable funding mechanisms (e.g., remuneration systems for forest ecosystem services) alongside favorable regulatory frameworks will also be key for successful large-scale forest restoration efforts. Policy recommendations are made to ensure the effective implementation of the EU Nature Restoration Regulation, including a hybrid governance model that balances strong national regulatory frameworks with local adaptability to diverse socioecological contexts, integrating socioeconomic metrics, strengthening public engagement, and leveraging market-based and green tax incentives.

1. Introduction

Forest restoration has gained significant momentum globally in recent years, spurred by ambitious policies and initiatives such as the UN Decade on Ecosystem Restoration (UNEP, 2021), the Bonn Challenge on forest landscape restoration (Bonn Challenge, 2024), and the EU Nature Restoration Regulation Regulation (EU) (2024)). These efforts have emerged in response to escalating environmental crises and signal a potential turning point in the form of a new wave of restoration.

History shows that major turning points in forest restoration are rarely driven by ecological concerns alone, but rather by broader social, policy, and economic shifts that have shaped both the development and outcomes of restoration efforts over the past two centuries (Erdozain et al., 2025). Contemporary evidence reinforces the need to understand restoration as a socio-ecological effort (Osborne et al., 2021; Tedesco et al., 2023), highlighting the importance of the human dimension in determining restoration success (Mansourian et al., 2024). For instance, case studies by Löfqvist et al. (2023) demonstrate that integrating social considerations can lead to improved ecological and social outcomes, while Shelton et al. (2024) argue that pursuing human well-being is essential for achieving ecological integrity in forest landscape restoration.

Yet, this recognition contrasts with the dominant focus of forest restoration research and practice, which remains rooted in the natural sciences (e.g., selecting appropriate sites, species and planting techniques), with far less attention given to social science perspectives (e.g., stakeholder conflict, long-term funding) (Erbaugh and Oldekop, 2018; Elias et al., 2022). This imbalance is also evident in legal frameworks; for example, the new EU NRR (Regulation (EU) 2024) places limited emphasis on human dimensions. This omission is reflected in the eight indicators proposed by the Regulation to monitor progress, none of which are socioeconomic in nature, potentially jeopardizing the long-term sustainability and success of the implemented initiatives.

The reasons behind this unbalanced focus are varied, but the result is a limited understanding of how human factors facilitate or hinder successful forest restoration. In Europe, where forest restoration has a long and complex history, there is a unique opportunity to address this gap by learning from past experiences. This is especially timely and relevant now considering that many of the drivers that shaped restoration in previous eras are re-emerging today, including geopolitical instability (Matsala et al., 2024), rural abandonment (Levers et al., 2018), insufficient funding (zu Ermgassen and Löfqvist, 2024), conflicting social demands (O'Brien et al., 2025) and conflicting policy goals (Fleckenstein, 2024). Understanding how countries have navigated these challenges in the past can provide valuable insights for the development of informed National Restoration Plans (NRPs) that avoid repeating past mistakes and capitalize on enabling conditions for the effective implementation of the EU NRR.

This article explores the key societal drivers that have shaped forest restoration practices and outcomes in Europe over the past 150 years. Specifically, we aim to: 1) identify the main social, (geo)political and economic factors that have influenced the development of forest restoration; 2) highlight the key barriers and enablers affecting restoration outcomes; and 3) derive policy-relevant insights to inform future restoration efforts and support the implementation of forest restoration strategies across Europe. Our findings are based on a comparative analysis and synthesis of 18 standardized national forest restoration reports written by country-level experts.

2. Methods

To address these questions, we gathered and synthesized expert-written national narratives on the history of forest restoration from 18 European countries, providing a comprehensive overview of the societal factors influencing forest restoration across the continent. The main steps followed to gather and synthesize the data presented in this study are outlined below (more information in Erdozain et al., 2025):

2.1. Country and expert selection

We first selected 18 European countries representing five regions and different sociopolitical and ecological contexts (Forest Europe, 2020): North (Finland, Sweden, Denmark), Central-West (Germany, France, Belgium, the Netherlands, Switzerland, Austria, UK), Central-East (Hungary, Poland, Romania), South-West (Spain, Italy), and South-East (Greece, Croatia, Slovenia) (Fig. 1). For each country, we identified potential expert candidates to produce the historical narratives on forest restoration using two approaches: by asking project partners to propose national experts and conducting a literature search for authors with expertise in this topic. This led to a final list of 120 potential experts.

All the candidates identified during the previous step were assessed and ranked according to how closely their previous work aligned with the contents of the narrative (see next section). To do so, we reviewed each candidate's publication record and professional profile, focusing on the degree to which the following five criteria were represented: 1) publications or projects directly related to forest restoration (2 points), 2) inclusion of a historical perspective in their work (1 point), 3) focus

on studies or activities with a national scope (1 point), 4) contributions addressing topics indirectly related to forest restoration (e.g., forest policy, land use change, biodiversity conservation) (0.5 points), and 5) seniority and connections within networks of forest restoration experts (0.5 points). The two experts with the highest scores from each country were invited to contribute to the development of a historical national narrative. In the end, and based on those who accepted the invitation to collaborate, 32 experts from 18 countries participated.

2.2. Data collection

We created a comprehensive template to guide the experts in writing their narratives, ensuring uniformity and facilitating synthesis. The template consisted of 38 indicators (technical, ecological, social, political and economic) distributed into 6 sections and replicated in at least two main time periods (pre-1990 and post-1990), although most experts added a third period (pre-1940) (see Supplementary Material for more details). A fictional narrative was used as a reference to ensure consistency across countries. To complement the qualitative descriptions and facilitate quantitative analysis, some indicators were presented in a table format as well to encourage clear and structured data sharing. The narratives were developed over a period of 9–12 months, starting in December 2022, and were based on peer-reviewed and grey literature, expert knowledge and personal communications.

2.3. Data analysis and synthesis

Submitted narratives were assessed for completeness and adherence to the template and harmonized to ensure consistency across narratives in terms of definitions and content provided. The definition that required a greater harmonization effort was that of forest restoration.

Experts had diverging perspectives on the broad definition we provided with the template, which read: "*any activity within the restorative continuum that aims to improve the biodiversity, ecological integrity and provision of services in forest ecosystems*" (Gann et al., 2019). For instance, countries with a history of high forest cover and intensive management (Sweden and Finland), only covered the last few decades in their narratives as they focused on ecological restoration, which only began to be used recently (last 30 years). All other countries, which experienced phases of critically low forest covers, covered a much longer time period in their narratives (>150 years), including afforestation (*establishment of forest through planting and/or deliberate seeding on land that, until then, was under a different land use;* FAO, 2018) and reforestation (*re-establishment of forest through planting and/or deliberate seeding on land classified as forest;* FAO, 2018) practices to restore the protective function of forests but also some with purely productive objectives. In these countries with lower forest cover, many of these initiatives resulted in the planting of widespread conifer monocultures, some of which have led to ecological degradation or decreased biodiversity, making it challenging to include them under restoration. However, since this study provides a historical overview of the evolution of forest restoration, it is important to recognize that the concepts and objectives of restoration have evolved alongside changing socioeconomic and environmental conditions. This broader perspective justifies the inclusion of a wide range of forest restoration–related measures, including approaches within the restoration continuum such as rehabilitation (*a management activity conducted to reinstate a level of ecosystem functioning to ensure the provision of ecosystem services;* Gann et al., 2019). Moreover, examining afforestation and reforestation initiatives from the early 20th century is essential for understanding many of the challenges European forests face today, as well as to learn from past decisions and outcomes. For these reasons, we also include afforestation and reforestation initiatives that primarily targeted
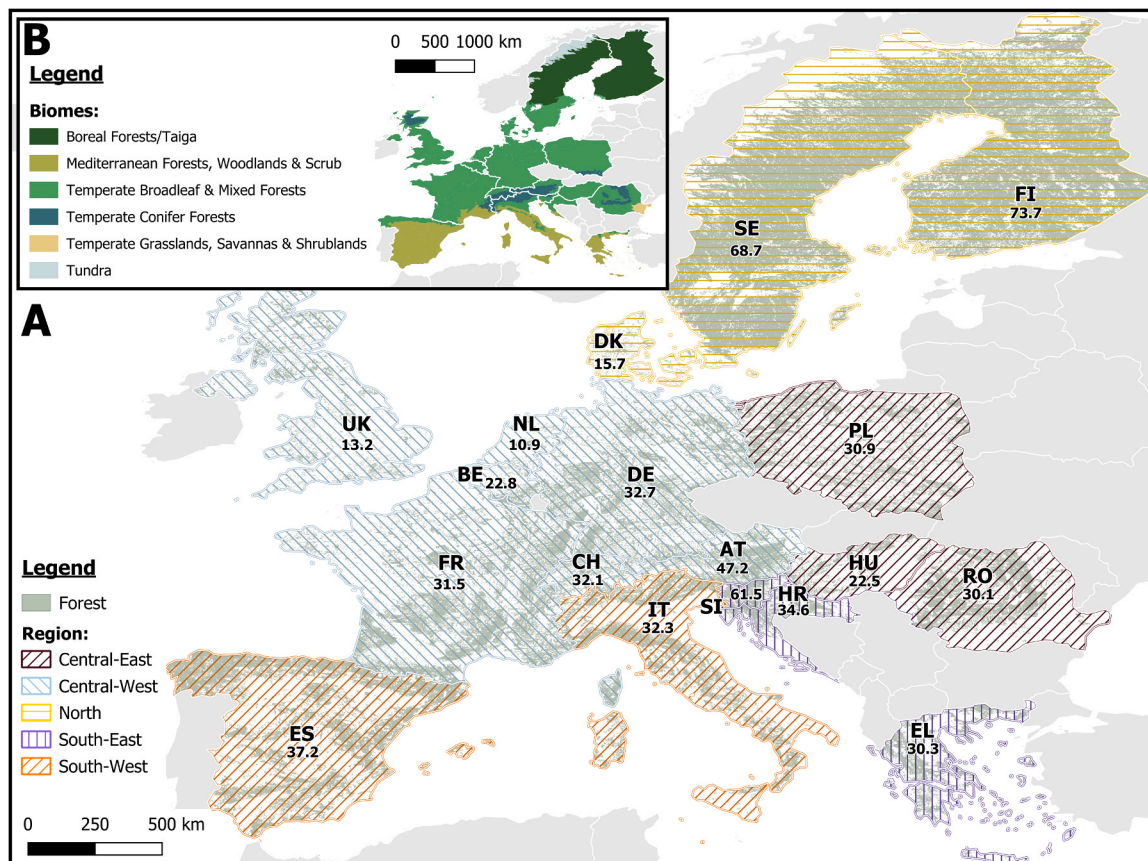
Fig. 1. The 18 European countries included in the study based on A) the five regions they represent (colors) and the % forest area relative to total land area (numbers) (FAO, 2024), and B) the terrestrial biomes they cover (Dinerstein et al., 2017). The figure has been modified from Erdozain et al. (2025).

a single ecosystem service (timber provision, erosion control) in our analysis.

The quality check and revision process continued until March 2024. The final versions of the narratives were thematically analyzed with each sentence tagged with relevant metadata. This allowed for systematic comparison and synthesis of themes across countries. First, out of the 38 indicators, the ones that were most relevant to address the objectives of this article were selected: restoration goals, funding beneficiary, funding sources, budget and costs, landowner/manager, land use and management pre- and post-intervention, sociopolitical conditions pre intervention, relevant policies, stakeholders, stakeholder involvement, stakeholder satisfaction, level of success, main obstacles, socioeconomic improvement and temporal trend. Examples of tags that were employed to classify the information provided within these indicators include: private owner, community, forestry department, national/regional/local administration, war, poverty, privatization, decentralization, EU funding, management plan, subsidies, certification, law, CAP and prohibition. The results from the narratives were supplemented with existing literature to extract and interpret the main patterns and insights. Unavoidably, the present study delineates the major trends, and deviations at national or regional levels from these general trends may exist.

3. Results

The expert country narratives showed that multiple social, economic and political factors influenced the development of forest restoration across Europe. Below, we describe the seven major factors distilled from our thematic analysis, providing country-level examples of restoration barriers (B) and enablers (E) in Table 1 to illustrate the main trends over the past 150 years.

3.1. Armed societal crises: wars

Armed societal conflicts such as world wars (WWs) have shaped forest restoration efforts across Europe in multiple ways. First, wars have been a driver of direct and indirect forest degradation. The most far-reaching degradation happened after the direct destruction of forests through shelling, looting and burning in countries where military confrontations happened (see country-level examples of this in Table 1 under barrier B.1.1). While direct destruction was typically limited to the frontline, war-related overharvesting of forests was widespread and identified as a major driver of degradation in multiple European countries. Forests were heavily logged both during and after the war, not only to supply materials and energy for military operations but also to meet local heating needs due to trade disruptions and to support post-war reconstruction efforts especially in central European countries (e.g., Austria, France, Germany, Hungary, the Netherlands, Poland, UK). Following WW2, in addition to the reconstruction of their own countries, some Axis nations were required to deliver war reparations in the form of timber to compensate the Allied countries, causing further overharvesting (Table 1, B.1.2) (Table 2).

The critical sociopolitical situation resulting from wars (e.g., famine) also increased the pressure on natural resources, thereby accelerating deforestation and land-use changes (Table 1, B.1.3). In Switzerland, for example, for the first time since the 1876 Forest Law prohibited deforestation, 7000 ha of mostly lowland forest were converted into farmland during WW2 as the country tried to reduce dependency on food imports. After the war, around 6200 ha were afforested in the mountains to compensate for the deforestation in the lowlands, which resulted in no net loss of forest area over the country but in a redistribution (from the lowlands to the mountains) and, thus, a change in the overall community composition (from deciduous to conifers) of the forests. In Greece, the emblematic riparian forest of the Nestos Delta was converted into cultivated land, shrinking from 12,000 ha in 1920 to 7200 ha during WW2 to accommodate refugees from Asia Minor, with less than half of

Table 1

Summary of the main social, political and economic barriers (B) and enablers (E) for successful forest restoration efforts and country-level examples according to the historical narratives of 18 European countries. Where examples are discussed in more detail in the main text, this is indicated with "see text.".

Barriers (B) and enablers (E)	Examples
1. Armed societal crises: wars	
B.1.1. Direct forest destruction.	**Belgium**: ~ 5,000 ha of forest destroyed due to shelling and 10–15000 ha ransacked by occupying troops during WW1. **Slovenia**: Previous afforestations destroyed due to artillery shelling and military activities along the Soča Front during WW1. **Greece**: Forest fires used as a means of warfare against partisans in WW2 and the civil war.
B.1.2. Overharvesting to support military action, to reconstruct countries and for reparation fellings.	**Poland**: Occupying forces logged ~190 million m³ of timber and deforested ~1 million ha during WW2. **Romania**: In the 1950s, over 700,000 ha of forest were cut down in Romania's northeastern part for war reparations paid to the Soviet Union (Grothusen, 1977; Banu, 2004), which triggered devastating floods in the 1970s. **Germany**: The German government was required to deliver 30,000 kg of seeds and over 10 million seedlings to Belgium each year post-WW1, although this was rarely achieved (see also Table 2).
B.1.3. Deforestation and land-use changes allowed due to critical socioeconomic situation.	**UK**: After WW2, agriculture in the UK became heavily subsidised, and affordable land for afforestation/reforestation in lower altitudes became rare, which forced foresters into more remote uphill heath- and moorland (Tsouvalis, 2000). **Belgium**: After WW1, famine-stricken state administrations tolerated local farmers converting devastated frontline woodlands into arable land; some state forests protected against deforestation by the Forest Law of 1853 were also converted to farmland (De Keersmaeker et al., 2001). **Switzerland and Greece**: *see text.*
B.1.4. Previous efforts halted due to priorities and funding changes post-war.	**Greece**: The restoration efforts that began during the first decades of the 20th century were largely interrupted by WW2, and the peri-urban afforestations were eliminated due to firewood shortage. **Slovenia**: In the inter-war period, afforestation came almost to a standstill, with only about 850 ha being afforested (Beltram, 1955). **Croatia**: *see text.*
E.1.1. Highlight the importance of self-sufficiency in timber provision, prompting large-scale afforestation/reforestation campaigns.	**France**: Fonds Forestier National was created in 1946 as a response to the severe crisis of the forestry sector post-WW2, allowing to afforest over 2.2 M ha 1947–1999. **Spain:** After the Spanish Civil War (1936–1939), Spain launched a large-scale reforestation/afforestation program and reforested over 3 M ha. **UK**: *see text.*
2. Institutional changes in forest ownership and governance	
B.2.1. Privatization of forests has been linked with slowing down efforts due to ownership fragmentation, disinterest, etc.	**Slovenia**: The restitution post-1990 of forests that had been nationalized post-WW2 led to increased ownership fragmentation and a decline in restoration initiatives due to many new owners lacking prior forest management

Table 1 (*continued*)

Barriers (B) and enablers (E)	Examples
	experience.
	Romania: *see text.*
B.2.2. Decentralization often delays implementation and leads to regional divergences.	**Netherlands**: Nature policy decentralization in the 2010s led to delays in implementation.
	Belgium: In 1980, political reforms resulted in differing legislation between Wallonia, focusing on productive forest functions, and Flanders and Brussels, focusing on recreation and conservation.
	Spain: The transference of environmental competencies to 17 autonomous regions in the 1980s created 17 different policies that diverge in aspects such as forest planning or the management of protected (forest) areas.
	Switzerland: Some cantons have met the target of establishing 10 % of the forests as reserves by 2030 while others lag behind, reflecting regional differences in ownership and policy implementation.
B.2.3. Expropriation can delay or halt initiatives due to local conflicts.	**Spain**: In the late 19th and early 20th centuries, the State used forced expropriation, among other approaches, to acquire land for erosion and flood control, often causing conflicts that delayed or halted reforestation plans.
	France: *see text.*
E.2.1. Nationalization of forests and administrative centralization have been linked to efficiency by several countries in the narratives.	**Romania**: The communist government, which in 1948 nationalized all forests, managed to centrally mobilize significant financial and human resources and to efficiently afforest/ reforest 2.7 M ha in 40 years.
	Poland: In 1944, it nationalized forested land over 25 ha and managed 83 % of the forests (Podgórski, 1965), very efficiently afforesting over 1 M ha in the 30 years following WW2.
	Slovenia, Italy, Spain, Greece: *see text.*
E.2.2. Long-term management agreements between the administration and private owners have successfully supported restoration.	**Sweden:** 5494 Nature Conservation Agreements (i.e., voluntary contracts between a landowner and the State to encourage nature conservation with a certain level of economic compensation, Statistics Sweden, 2017) have been made covering 39,795 ha (whereof 35,843 ha high productivity forestlands) between 1993 and 2022.
	Switzerland: 50-year contracts for strict forest reserves (excluding any type of intervention) and 25-year contracts for special forest reserves have been signed between forest owners and cantons, resulting in 7.3 % of the forest area under contract as strict or special forest reserves in 2022.
	Spain: *see text.*
E.2.3. Expropriation in given contexts can lead to successful restoration.	**Spain**: The expropriation of land as a result of a mining spill in 1998 in Sevilla opened the way to the functional restoration of the riparian forest of the Guadiamar river, which has been ecologically and socially very successful.
E.2.4. Purchasing land by the State can pave the way for restoration.	**UK**: By 1939, the Forestry Commission had acquired 263,046 ha for afforestation (Aldhous, 1997).
	Spain: The State Forest Heritage organism purchased 842,421 ha between 1940 and 1984 (Pemán et al., 2017).
3. Macroeconomic forces	
B.3.1. Changes in the price of land can hinder restoration by encouraging deforestation.	**Northwestern Europe:** Land use follows a revenue hierarchy: urban > agriculture > forest > marginal land, which in the 19th-century drove the conversion of

Table 1 (*continued*)

Barriers (B) and enablers (E)	Examples
	fertile forests to farmland as wood lost value to fossil fuels and imports.
E.3.1. Changes in the price of land can facilitate afforestation.	**Belgium, Denmark** and **the Netherlands**: When the economic value of heathland dropped (in relation to new fertilizers and cheaper wool imports), owners were encouraged to afforest their land as the return was higher.
E.3.2. Big changes in the demand for a given forest product can influence restoration.	**Multiple countries:** With the rise of fossil fuels (18th-19th centuries), the demand for charcoal and fuelwood decreased. Simultaneously, the demand for softwood increased, triggering increases in timber stock (e.g., 200–320 m^3/ha in Slovenia 1954–1984; 95–300 m^3/ha in West Germany 1949–1990; 250–367 m^3/ha in Switzerland 1950–1990) and shifts in forest composition.
	Belgium: The decreased timber value in the 1970s-1980s facilitated the shift towards a more multifunctional forest management.
	Sweden: Large-scale harvesting for the expanding iron and sawmill industries led to supply shortages in the 19th century. The State responded by introducing the first regulatory attempt in 1850 by compensating landowners who could demonstrate successful forest regeneration (Enander, 2007).
E.3.3. Certification schemes can promote good practices in forest management and restoration.	**Denmark**: The introduction of forest certification schemes has encouraged more sustainable practices such as leaving more deadwood and 10 % of the forest aside, as well as reducing the use of pesticides and intensive soil preparation.
	Romania: Although the FSC standard requirements were highly contingent on the requirements of the Romanian legal framework, the certification has led to better enforcement of technical norms, including those related to forest regeneration (Buliga and Nichiforel, 2019).
	UK: The UK Woodland Assurance Standard (UKWAS), an independent certification standard that is widely used across the country (Reid et al. 2021), requires that management plans identify a minimum of 15 % of the unit where management for conservation and enhancement of biodiversity is the primary objective.
	Sweden and **France**: *see text.*
4. Policies and regulations	
B.4.1. Incoherent sectoral policies (agriculture, forest, conservation, energy…) hinder restoration.	**Romania**: Grazing into forests was identified as one of the main forest degradation factors, and thus, the Forest Code from 1910 forbid it. Yet, the Agrarian Land Reform from 1920 encouraged the establishment of communal pastures to tackle poverty, leading to the deforestation of many forests (Giurescu, 1975; Axenciuc, 1996).
	Sweden: The Forestry Act (1993) states that timber production and biodiversity protection are of equal importance, but due to its liberal nature, in practice, it leads to a preference towards the former, which is partly incompatible with the Environmental Code (1995), certification rules and European nature legislation.
	Denmark and Belgium: *see text.*

Table 1 (*continued*)

Barriers (B) and enablers (E)	Examples
	EU Rural Development Policy: countries tend to prioritize the productivity of agriculture and forestry as opposed to biodiversity conservation (Sarvašová et al., 2019).
E.4.1. Strict national forest laws that support multifunctional forest management.	**Switzerland**: The Federal Forest Law (1991) mandates that forests are managed in a sustainable way, and according to the demands of wood production, close to nature forestry, and nature and cultural heritage protection (Angst, 2012). **Slovenia**: The Forest Law (1993) regulates forest related issues (protection, cultivation, use, etc.) with the aim of ensuring a sustainable and multifunctional management. **Romania**: The principle of forest multifunctionality has been incorporated into mandatory forest management planning procedures since 1954, initially based on 26 "functional categories". Currently, 86 functional categories are used in forest management planning to address multifunctional forest management (Nichiforel et al., 2021).
E.4.2. Obligations can be an effective instrument to support restoration.	**Austria**: As early as in 1852, the Imperial Forest Act made it mandatory to reforest within 5 years of harvest. **Romania**: The forest law from 1947 was a critical milestone because it stipulated that management plans should be established for all forests regardless of ownership; by 1956, all Romanian forests had management plans (Leahu, 2001). Currently, forest management plans are no longer compulsory in private forest estates < 10 ha; nevertheless, even in these cases, the obligation to ensure forest restoration is imposed regardless of the size and form of ownership.
E.4.3. Prohibitions can be an effective instrument to support restoration.	**Croatia**: As early as in 1775, the Forestry Ordinance prohibited forest grazing and bark stripping. **Switzerland**: Clearcut was prohibited in 1902 with the Federal Law on Forest Police. **Slovenia**: Clearcut was prohibited in 1949 with the Forest Act. **Greece**: The constitution prohibits changing forested land to other land cover types since 1975. **Romania**: Since 1986, clearcuts have been allowed only for pure spruce and pine stands and are limited to a maximum of 3 ha. Since 2024, clear-cuts have been prohibited in natural protected areas (i.e., Natura 2000 sites).
E.4.4. International environmental policies tend to influence national strategies regarding biodiversity conservation.	**Convention on Biological Diversity** (1992): Greatly influenced national policies and elevated the significance of biodiversity conservation on political agendas in countries such as the UK and Sweden (Raum and Potter, 2015). **The EU Habitats Directive** (1992) and its key instrument (i.e., the Natura 2000 network): a cornerstone for national nature conservation policies as mentioned in several of the narratives.
E.4.5. Centralized education and training of foresters can facilitate restoration.	**Croatia** and **Slovenia**: Heavily invested in forest education and research between 1940 and 1990, establishing forestry schools and institutes to train professionals and improve the overall management of the country's forests.

Table 1 (*continued*)

Barriers (B) and enablers (E)	Examples
	Denmark: A training and development program named "Richer Forest" for staff and stakeholders established in 1995/96 was an effective persuasive instrument. **Switzerland** and **Austria**: *see text*
E.4.6. The establishment of specialized restoration institutions facilitates success.	**Spain**: The Reforestation Commissions (1888) were created to design and conduct the afforestation following the legislation on the restoration of hydrological basins. **Slovenia**: The Karst Afforestation Commissions (1881) were established to identify areas for afforestation and prepare an afforestation cadastre. **Croatia**: The "Royal Inspection for the Afforestation of Karst in the Croatian Military Border - inspectorate for the afforestation of Karst, bare rocky grounds and flood control" (1878) played a crucial role in afforestation efforts in the Mediterranean region and served as an excellent example of successful afforestation on previously degraded Karst areas. **France**: A dedicated service for mountain reforestation (RTM) that gathered 32 forest engineers was created following the 1860 law.
5. Funding and financial policy instruments	
B.5.1. Funding mechanisms with heavy bureaucracy can discourage landowners from participating.	**Romania**: The measure for the afforestation of agricultural land had a budget of 229 M euros for the period 2007–2013 under EAFRD funding, but only 29 projects with a total budget of 185,000 euros were funded. This low absorption rate (0.08 %) was attributed to heavy bureaucracy and the low standard costs per hectare. Moreover, the current National Recovery and Resilience Plan has secured funding for the afforestation of more than 59,000 ha by 2026; nevertheless, the afforestation rate is far below the planned budget.
B.5.2. Conflicting inter-sectoral subsidy systems (agriculture vs. forest) are an obstacle to forest restoration.	**Belgium** and **Denmark**: EU subsidies for agriculture are higher and more competitive than afforestation subsidies, resulting in unmet forest cover increase objectives. Romania: Subsidies paid for pastureland management have hindered the natural expansion of forests, as the owners of forest land had to clear the pastures of woody vegetation to receive the subsidies.
B.5.3. Long-term compensatory subsidies create dangerous dependencies (financial burden for the administration; forest owners' mistrust).	**Spain**: The most attractive element of the EAFRD subsidy system was the compensatory income premium awarded to the farmers, but at the same time, there is great uncertainty in Spain about the future of these afforested lands, since many landowners may consider reverting it to agricultural land once the financing program expires.
E.5.1. State funding mechanisms derived from a tax on forest products can offer long-term, reliable funding for restoration.	**Croatia**: In 1977, a law established a Public Forestry Enterprise (SIZ) in karst areas, mandating that 0.05 % of the gross income from all economic entities in the region be allocated for forest restoration. **France**: The state implemented the National Forestry Funds (*Fonds Forestier National* or NFF) in 1945, which was mainly financed by a tax on timber sales. This fund collected 6.7 M of constant$_{2022}$ euros between 1947 and 1999, which were spent to reforest an area of 2.2 M ha with mostly (82 %) conifers. There were

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Table 1 (*continued*)

Barriers (B) and enablers (E)	Examples
	four types of financial incentives: subsidies, allowances, low-interest cash loans and contracts (Legay, Bouler, 2014). **Romania:** The Forest Code established since 1996 the Forest Conservation and Regeneration Fund, which is sourced from different forest management activities, including 10–25 % of the average price resulting from timber sales. The fund is primarily used to ensure regeneration and afforestation and applies to all forms of ownership.
E.5.2. EU funds have allowed the diversification of goals in some countries.	**Greece:** LIFE and Interreg programs have allowed for the diversification of restoration goals (e.g., biodiversity conservation) and stakeholders (e.g., NGOs).
E.5.3. Subsidy schemes can promote close-to-nature forest management and biodiversity conservation.	**Austria:** To access the 80 M euros available for reforestation under the Forest Fund which aims to promote resilience, more than 75 % of planted trees must represent the natural tree species community. **Belgium:** The gradual conversion towards mixed native forests is made possible by combining and balancing legal restrictions and financial stimuli. If landowners accept higher ecological standards in a management plan, they receive a subsidy to compensate for income loss and increased costs. **Finland:** The METSO program created in 2008 aims to protect by 10-year environmental forestry subsidy agreements or to restore by nature management projects 82,000 ha of valuable forest habitats in commercially managed privately owned forests. By 2022, 73 % of the target has been achieved with a very positive response from stakeholders. **Germany** and **Switzerland:** *see text.*
E.5.4. Tax benefits can also encourage the involvement of private forest owners.	**UK:** A favorable tax system in the 1960s encouraged large-scale afforestation by private forest investment companies, especially in the Scottish uplands (Foot, 2010; Tompkins, 1989; Price, 1971). Generous tax benefits allowed wealthy landowners to offset their taxable income against expenditure on new forest plantations (Tompkins, 1989), leading to entire landscapes becoming dominated by coniferous plantations (Bunce et al., 2014). **Poland:** After WW2, the administration encouraged afforestation on private wasteland by exempting it from land tax for 50 years and allowing owners to deduct afforestation costs from their taxable income. **Belgium:** The afforestation of unproductive private land in the period prior to 1940 was promoted by the State by offering tax reductions and active support.
6. Rural abandonment and conflicts	
B.6.1. Rural abandonment can lead to lack of management and related issues (e.g., increased fire risk, shortage of workforce).	**Greece** (*see text*), **Spain** and **Italy:** The increasing fuel accumulation and continuity at the landscape scale, mostly related to rural abandonment and fire exclusion policies, are leading to increased burn probability (Salis et al., 2022). **Slovenia:** Rural abandonment alongside the radical changes in the administrative

Table 1 (*continued*)

Barriers (B) and enablers (E)	Examples
	organization of forestry post-1990 have led to a reduction in the intensity of restoration, resulting in a growing backlog of tending in newly established plantations.
B.6.2. Poverty can aggravate the land-use conflict between agriculture and forest.	**Belgium:** Considerable conversion of forested land to agricultural land took place in the 1800s due to widespread famine. **Romania:** The efforts made by the Forest Codes in 1881 and 1910 to preserve forests by forbidding forest grazing were difficult to implement due to the increased poverty of rural populations in the lowlands (Giurescu, 1975). To address this poverty, the agrarian reform of 1920 encouraged the establishment of communal pastures; thus, between 1920 and 1935, approximately 1.2 M ha (20 % of the forest cover) were clearcut and transformed into pastureland (Haralamb, 1946). More recently, after the first restitution of forests in 1991, about 0.35 million hectares were clear-cut or overharvested by the new forest owners, who blamed their poor economic conditions and the lack of regulatory frameworks. The situation has improved since 2004 with the latest restitution law.
E.6.1. Natural regeneration due to farmland abandonment allows for passive restoration.	**France:** The abandoned farmland in the 20th century led to the natural recolonization of riparian and upland woody vegetation along with an increase in forest cover. **Italy:** Reforestation campaigns in the 1980s declined in sync with the increase in natural regeneration (37,000 ha between 1990 and 2008) that ensued the abandonment of marginal agricultural and grazing lands in the mountainous and interior parts of the country. **Slovenia:** In the last decades, afforestation in the Karst was no longer necessary due to the spontaneous overgrowth of abandoned farmland with black pine and native deciduous trees following the rapid decline in the rural population and the related landscape interventions (forest cover increased by 16 % during this period). Romania: Farmland abandonment in mountain areas has resulted in an increase of the national forest fund of about 200,000 ha since 1990, mainly owing to passive restoration of abandoned lands.
E.6.2. Decreased conflict with agricultural land use facilitates restoration.	**France** and **Greece:** *see text.* **Hungary:** The surplus of labor and land in the rural area post-WW2 also facilitated large-scale afforestation.
E.6.3. Rural unemployment and poverty can encourage humanitarian restoration projects that create jobs for the rural population.	**Netherlands:** The economic crisis of the 1930s prompted renewed afforestation efforts to provide jobs for the unemployed, with various humanitarian organizations participating to help lift the poor out of poverty (Thissen, 1991). **Italy:** Legge Fanfani (1949) enabled the reforestation of lowland areas, primarily with conifers and exotic species, under the objective of job creation to cope with the challenging socioeconomic situation post-WW2. ~30,000 ha were afforested annually over a period of 20 years, mainly using black pine. **Spain:** *see text.*
7. Social values and demands	

Table 1 (*continued*)

Barriers (B) and enablers (E)	Examples
B.7.1. Conflict between timber industry and conservationists demands; and polarization in rural vs. city perspectives hinders multifunctional restoration.	**Finland** and **Sweden**: The forestry sector was strongly lobbying against the EU Nature Restoration Law proposal. **Belgium**: The forestry sector and forest owners are voicing concerns about the decline of economic revenue and quality of wood products over the last decades. **Spain** and **Italy**: see text.
B.7.2. Mediatic actions (e.g., planting) are prioritized over those with a negative public perception (e.g., prescribed burns, predators) that are key for functional restoration.	**France**: Special attention and resources are invested in post-wildfire restoration in the 2000's because erasing wildfire traces as soon as possible is a common social demand. **Italy**: Climate smart forestry faces strong opposition from some sectors in the public opinion that are supporting a more "hands off" approach following ideological or emotional motivations. **Spain**: *see text*.
B.7.3. Conflict between agricultural and forestry stakeholders hinder successful forest restoration.	**Greece**: Shepherd's opposition to the afforestation of flood-prone watersheds in the 20th century obstructed several initiatives. **UK**: Especially in Scotland, the low and less exposed land was the preferred land for both hill sheep farming and afforestation which resulted in a conflict between the interests of forestry and farming thereby creating management problems on a local scale (Lindsey, 1977). **Belgium**: One of the main obstacles to reaching the goal of forest area extension (only 1500 out of 10,000 ha have been realised) are the conflicts with farmer organisations alongside farming legislation and subsidies. **Poland**: see text.
E.7.1. Greater environmental awareness and presence of the general public in forests leads to a greater demand for high environmental standards and multifunctional policies and management.	**Slovenia**: Urbanisation and industrialisation have increased the touristic and recreational uses of forests in the last few decades, resulting in a need to provide more resilient forests to storms due to their increasing social function. **Austria** and **Switzerland**: In the 1980s, the phenomenon of forest dieback and pollution caused a surge in environmental consciousness among the public, leading them to scrutinize forestry practices critically. **Italy** and **Spain**: Rising environmental awareness, public advocacy and the growing influence of environmental movements and NGOs have fostered a political climate increasingly supportive of environmental conservation and more multifunctional restoration initiatives in the last few decades. **Hungary**: Expectations of the society (notably urban dwellers) increasingly turned to recreational and nature conservation values of forests in the 1980s-1970s. **Netherlands** and **UK**: *see text*.
E.7.2. Media can magnify social concerns.	**Germany**: The forest dieback phenomenon in the 1980s was popularized by media, leading to policies that tackled the issue (Schäfer, 2012). **Romania**: The mass media's focus on illegal logging and 'deforestation' in recent years has had political repercussions, prompting companies to increase their corporate social responsibility efforts in afforestation projects.

Note: Abbreviations: WW = World War.

the remaining forest preserved post-war (Efthimiou, 2000; Efthimiou, Jerrentrup.. 2007). As a result of all these war-related effects, several countries, especially those directly involved in WWs, experienced a sharp decline in forest cover during and/or after the war. For example, post-WW2, Poland's forest cover was at the lowest level in the country's entire history, and forests in Germany were left with large clear-cut gaps (Table 2).

In addition to being a driver of degradation, wars can also represent an obstacle to forest management and restoration initiatives that are underway. Experts from several countries reported that previous efforts and funding were halted as priorities changed and resources were redirected into reconstructing the gray rather than green infrastructure of the country (e.g., Greece, Croatia, Austria, Slovenia) (Table 1, B.1.4). A very extreme case is Croatia, which not only left its forests unmanaged during the Croatian War for Independence (1991–1995), but also was left with a large area of forests under landmines which greatly delayed management and active restoration. The complete removal of these figurative and literal obstacles, so that restoration activities can commence, is expected by 2026 and has cost more than 7 billion kunas (929 M euros) between 1998 and 2021 (Narodne novine, 2023).

By contrast, the critical situation caused by wars also prompted far-reaching afforestation and/or reforestation campaigns, along with the enactment of key policies, as many countries aimed to achieve self-sufficiency in timber provision (Table 1, E.1.1). For example, at the beginning of the 20th century, forest cover in the UK was down to an estimated 4.7 % of the total land area (Forest Research, 2022), which created dangerous dependencies on timber imports during WW1 to the point of becoming a major national security issue (Gambles, 2019). Hence, the national government's focus in the years following WW1 was on afforestation and reforestation to drastically increase timber reserves over the following decades (Mather, 1991), as showcased by the 1918 decision to increase forest cover from 1.2 to 1.9 million ha over an 80-years period (Acland, 1918). In several countries, these large-scale afforestation and/or reforestation programs were accompanied by a post-war nationalization of forests, which facilitated the coordination of large-scale campaigns (e.g., Poland, Romania) (see Section 3.2).

Lastly, wars influenced not only the extent but also the type of restoration undertaken. Many of the aforementioned programs prioritized timber production, marking either an intensification of productive goals or a shift from earlier efforts (such as those focused on reducing natural disaster risk in some countries) to meet growing timber demand (see Section 3.3). This prioritization of forest quantity over quality had long-lasting implications for the composition and structure of European forests and, alongside other factors, initiated the shift towards the predominance of fast-growing even-aged conifer high forests.

3.2. Institutional changes in forest ownership and governance

Changes in land ownership and the transference of forest and nature governance across different administrative levels (i.e., centralization vs. decentralization) that have occurred throughout history have facilitated or hindered forest restoration in different ways. The clearest and most dramatic examples are in the 20th century, when private forests were nationalized post-WW2 by Eastern European countries such as Poland, Romania, Croatia, Hungary and Slovenia under communism. This nationalization was driven by a centralized vision and management of the land, which facilitated the achievement of ambitious afforestation and reforestation targets (Table 1, E.2.1). In Slovenia, for instance, the nationalization of larger landowner's forests, the organizational unity and the steady financing of forest management (by means of biological depreciation) post-WW2 contributed to great efficiency and achievements, such as the prohibition of harmful forest management practices (clear-cutting, forest grazing, litter raking), the implementation of close-

Table 2

The situation of the German forest before and after WW2 (Zundel and Schwartz, 1996, pp. 22, data from Reichenstein, 1950, translated from German).

		Germany with 1937 borders	Occupied Germany				
			Soviet Zone	British Zone	American Zone	French Zone	Western Zones
Timber stock > 7 cm diameter (m³/ha)	1927	114	-	-	-	-	-
	1936	110	-	-	-	-	-
	1946	93	76	90	120	106	108
	1949	-	60	71	111	88	95
Clear-cut compared to annual allowable cut (%)	1927	100	-	-	-	-	-
	1936	133	-	-	-	-	-
	1946	-	300	360	158	184	212
	1949	-	255	200	163	266	196
Clear-cut area (%)	1927	1.0	-	-	-	-	-
	1948/ 1949	-	13.0	15.0	5.0	5.0	9.0

to-nature forest management in all forests and mandatory forest planning (Mlinšek, 1972). Southern countries, such as Spain, Italy and Greece, also provide examples of how large-scale afforestation and reforestation programs in the 20th century were partly achieved due to strong governmental control, funding and management rules. In Greece, this was further facilitated by the predominantly public ownership of forests (approximately 80 %) (Tzaferos, 2001). Although this approach was less common in the third period, there are also accounts of expropriation facilitating restoration (e.g., Spain) (Table 1, E.2.3).

However, there are also examples in which expropriation interfered with forest restoration (Table 1, B.2.3). For example, following catastrophic flooding, France issued two ambitious laws in 1860 and 1864 that made reforestation mandatory by imperial decree. In the case of non-compliance, reforestation was imposed by land expropriation. This imposition gave rise to many local conflicts that led to the failure of these laws. It was not until their revision in 1882 to a less top-down approach (e.g., expropriation was financially compensated), in combination with changes in the sociopolitical context, that these laws were successfully implemented across France.

After 1990, there was a shift towards ownership privatization in several countries, often slowing down active restoration efforts (Table 1, B.2.1). In Romania, for example, after the fall of the communist regime in 1989, forest restitution to nearly 1 M owners with low involvement in forest management led to a decrease in restoration efforts (Palaghianu, 2018). Additionally, individual private owners, facing slow administrative responses to ongoing changes in property structure and citing their poor socio-economic conditions, engaged in illegal logging activities, leading to forest degradation and loss (Table 1, B.5.2). The decentralization of decision-making or the transfer of forest-related competencies from national to regional and local administrations also characterized the third period, reported in countries such as Belgium, Greece, Italy, Spain, the Netherlands and the UK. This decentralization often led to delays in implementation and regional divergences in policies and forest restoration and management approaches (Table 1, B.2.2).

The purchase of private or communal land and the establishment of consortiums by central administrations are other influential approaches that have enabled large-scale forest restoration throughout history. For example, to address the timber crisis faced during WW1 in a context of mostly (97 %) privately owned wooded land (Forbes, 1904; Holmes, 1975), the Forestry Commission in the UK had acquired 263,046 ha of formerly mainly unforested land by 1939, becoming the largest landowner in Great Britain (Aldhous, 1997). In contrast, in Spain, consortia (i.e., contracts signed between the landowner and the state whereby the state reforested at no cost to the landowner and the landowner repaid the investment costs when the created stand generated a profit – introduced in the Spanish forestry legislation in 1926) were widely used in the second half of the 20th century, resulting in 3 M ha being managed under consortium agreements as opposed to 842,421 ha being purchased (Pemán et al., 2017). In present day, several countries (e.g.,

Switzerland, Sweden, Finland) are promoting long-term management agreements or contracts to support ecosystem multifunctionality and biodiversity conservation and restoration in private forests (Table 1, E.2.2). Other mechanisms to overcome the problems of property fragmentation, and to ensure that private forests are managed and restored following sustainability principles, include payments for environmental services in the form of subsidies, forest certification, advisory services, forest management plans, and joint management and cooperation through associations (see Section 3.4).

3.3. Macroeconomic drivers

Macroeconomic changes following shifts in the demand of specific resources have influenced the value of different land uses over time, triggering land use changes that can either facilitate (Table 1, E.3.1) or hinder forest restoration (Table 1, B.3.1). For example, after the invention of chemical fertilizers and cheaper wool imports from the UK and Australia, the economic value of heathland dropped, and its traditional use came under pressure in countries such as Belgium, Denmark and the Netherlands in the late 19th century. This, in combination with an increased demand for industrial roundwood, encouraged many landowners to afforest these heathlands and transform them into what they considered "productive land". On the other hand, in densely populated or urbanized areas, the higher economic value of agricultural land has been a driving force for deforestation. In northern Belgium, these two forces (the deforestation of long-established forests for agricultural land and the afforestation of heathland) were roughly balanced (De Keersmaeker et al. n.d.), but this had ecological implications, as long-established forests support higher biodiversity than recently established plantations (De Keersmaeker et al., 2015; Bergès and Dupouey, 2021).

Fluctuations in demand for forest products such as fuelwood and roundwood over time have influenced the type of forest restoration implemented (Table 1, E.3.2). The first restoration initiatives in some countries can be traced back to the booming iron mining industry that led to an unprecedented demand for fuelwood and charcoal. In Germany, for example, the use of deciduous trees, in particular, as raw materials for charcoal and potash in glass production in the 16th and 17th century resulted in one-sided deforestation, the creation of conifer monocultures and eventually led to a shortage of resources (dos Santos Arnold, 2022). This situation prompted the first regulatory attempts to secure a sustainable wood and energy supply as early as the 16th century in countries such as Austria, France and Hungary.

Another important market change that greatly influenced forest extent and composition is the rise of fossil fuels. As coal was substituted for charcoal and fuelwood across Europe between the 18th and 19th centuries, the demand for wood changed, not in the amount of supply *per se* but in the quality and dimensions of the wood requested (Bartsch et al., 2020). Hence, while the demand for charcoal and fuelwood decreased, the demand for softwood simultaneously increased in central

Europe (e.g., Austria, Belgium, Denmark, Germany, Poland and Switzerland). The increased demand for softwood was also related, in part, to the coal mining industry, as pit props made of pine wood were widely used in tunnels of coal mines in central-European countries. This triggered the afforestation and creation of Scots pine monocultures in countries such as the Netherlands and Belgium in the late 19th century and the beginning of the 20th century (Raap and Janse, 2021; Thissen, 1991). Because of these market conditions, traditional coppice management dominated by deciduous or mixed forests was replaced by high forest management and plantation forestry using fast-growing conifers in Central Europe during the 20th century (Johann, 2006). For example, in Nord Rhine-Westphalia, Germany, the proportion of spruce and fir high forests almost doubled in extent (from 19.7 % to 38 %) between 1883 and 1937, while simultaneously, the proportion of beech forests dropped by approximately half from 50.6 % to 27 % (Mantel, 1990).

The increase in timber demand was further exacerbated between the 1950s and 1970s in all 18 focus countries as timber production became integral for the economic growth and flourishing industry post-WW2. Thus, forest "restoration" practices in the second half of the 20th century mainly focused on maximizing wood production through afforesting and/or reforesting and intensively managing fast-growing tree species largely at the expense of biodiversity and ecological aspects of forests (Agnoletti, 2006). Several countries (e.g., Germany, Slovenia, Spain, Switzerland) report significant increases in timber stock (Table 1, E.3.2) alongside a drastic change in the composition of forests. For example, in Spain, 77 % of the reforestation by area between 1940 and 1970 was done with native pine species (Vadell et al., 2022). While the forested area in Great Britain covered with conifers was relatively similar to broadleaf-dominated areas in 1947, the coniferous forest area had more than doubled by 1965, resulting in the share of conifer forests increasing from 41 % to 67 % and broadleaved forests decreasing from 37 % to 25 % (Mason, 2007).

Finally, in the 1970s and 1980s, the economic value of production started to decrease, which, alongside other social, policy and environmental factors, facilitated the move into a more multifunctional period of forest management in the 1990s as forest owners were more willing to diversify the ecosystem services promoted by restoration beyond timber production. Within this context, certification schemes, with PEFC (Programme for the Endorsement of Forest Certification) and FSC (Forest Stewardship Council) being the most used schemes in Europe, are becoming increasingly important market incentives encouraging the restoration of managed forests (Table 1, E.3.3). The introduction of these private, market-based instruments in the 1990s has promoted good practices due to growing concerns about the sustainability of timber supply chains. In Sweden, for example, FSC standards are more specific regarding forest restoration requirements than provisions in the Swedish Forestry Act and have promoted good practices such as prescribed burning to favor fire-specialist species and deadwood. It is worth mentioning that the stringency of certification requirements varies depending on the scheme and country. For example, in France, PEFC requires preserving at least one habitat tree per hectare, while FSC requires a minimum of five.

3.4. Policies and regulations

Policies and regulations have been important drivers to promote or institutionalize change. A myriad of policies from different sectors (e.g., forestry, biodiversity conservation, agriculture and rural development, water protection) and different levels of governance (e.g., international, EU, national, regional) have influenced forest restoration in the 18 countries covered here. In this section, we provide key examples of the policies and regulations mentioned in the narratives, synthesizing the core patterns that emerged.
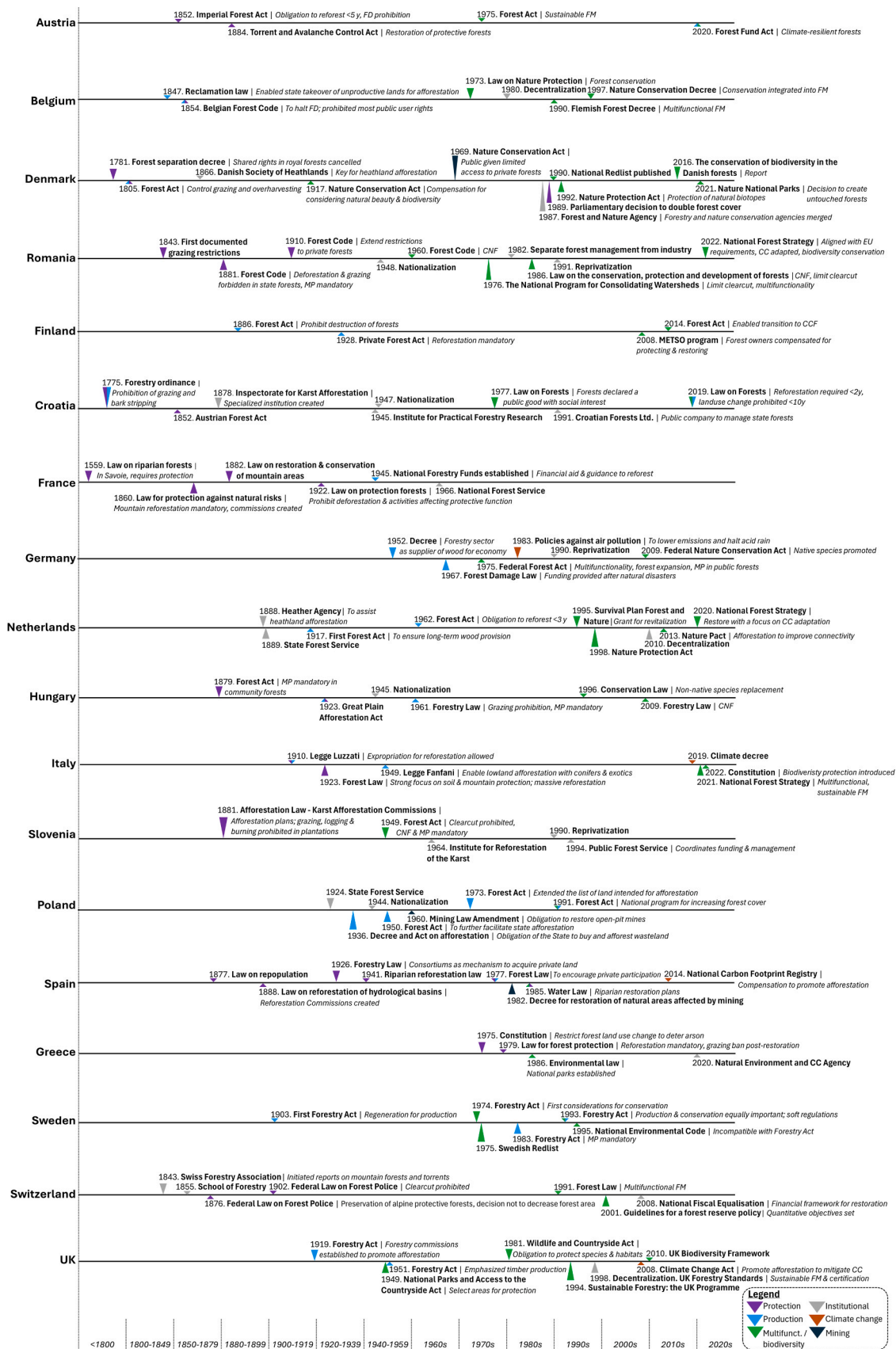
As shown in the summary of the key national policies related to forest restoration (Fig. 2), the objectives of these policies mirror major shifts in forest restoration goals over time observed across Europe, from risk

mitigation to production, to multifunctionality, to climate change adaptation (Erdozain et al., 2025). There are several examples of policies aiming to safeguard the protective function of forests in the 19th century, such as the French law for protection against natural risks (1860), the Spanish Law on Reforestation of Hydrological Basins (1877), the Slovenian Karst Afforestation Law (1881) and the Austrian Torrent and Avalanche Control Act (1884). Policies promoting the productive function of forests existed in the 19th century as seen in Fig. 2 but became more widespread in the first half of the 20th century, such as the first Swedish Forestry Act (1903), the UK Forestry Acts (1919, 1951), the Finnish Private Forest Act (1928) and the German Forest Decree (1952). Finally, at the end of the 20th century, policies that emphasize multifunctional forestry and biodiversity conservation became much more common, including the Flemish Forest Decree (1990), the Swiss Forest Law (1991), the Polish Forest Act (1991) and the Dutch Nature Protection Act (1998). However, there are examples of conservation-oriented policies much earlier as well, such as the Danish Nature Conservation Act of 1919, which compensated forest owners that showed consideration for natural beauty and biodiversity.

Forest restoration is influenced not only by forest laws and strategies but also by policies from other sectors affecting forests such as water, mining, agriculture, nature conservation, timber trade, bioeconomy, bioenergy, employment policy, climate and rural development (Aggestam and Pülzl, 2018; Sotirov et al., 2021). These policies were also highlighted in the narratives as influential, and some examples include the Spanish Water Law (1985), the Romanian Agrarian Reform Law (1921), the Polish Mining Law (1960), the UK Biodiversity Framework (2010) and the Italian Climate Decree (2019) (Fig. 2). These sometimes-competing policies formulate legally-binding rules that are relevant to forests but can often contradict each other with respect to forest policy objectives (Winkel and Sotirov, 2016; Aggestam and Pülzl, 2018; Sotirov et al., 2021). This lack of horizontal coherence across forest-related sectoral goals is not only a contemporary issue (Sotirov, et al., 2020; Fleckenstein, 2024), but it has also hampered multiple restoration initiatives over the past two centuries (Table 1, B.4.1). In countries such as Denmark and Belgium, for example, subsidized farming has prevented many landowners from implementing other options such as afforestation, conservation management or abandonment to assist natural regeneration, which is hampering the achievement of national goals on forest expansion.

In addition to horizontal policy coherence challenges, forest restoration is influenced by policies stemming from different political levels (international, European Union (EU), national, regional and local), adding vertical complexity to governance (Sotirov et al., 2020; Wolfslehner et al., 2020). The influence of each level has changed over time, influencing restoration objectives and approaches (see centralization vs. decentralization in Section 3.2). At the same time, the past three decades have been characterized by an increase in the influence of international and particularly EU policies such as the Convention on Biological Diversity (1992), the EU Birds Directive (1979) and Habitats Directive (1992), the CE Regulation 2080/1992 (aid scheme for forestry measures in agriculture, 1992), the EU Rural Development Policy (since 2003) and the recently adopted EU NRR (Regulation (EU) 2024) (Table 1, E.4.4).

Fig. 2 also shows the wide range of policy instruments (regulatory, financial, persuasive and organizational – Vedung, 1998) that have been applied to achieve policy goals. Within regulatory instruments, prohibitions have been quite common throughout history in forest restoration, with the most common ones including forest grazing, litter raking or clear-cut prohibitions (Table 1, E.4.3). The French Forest Code of 1827 restricted forest grazing and firewood collection on common lands, laying the foundation for forest legislation in many other countries. Currently, clearcut is still prohibited in the forest laws of Switzerland, Slovenia and Italy, whereas other countries allow clearcut with size limitations (Austria, Belgium, France –in mountains–, the Netherlands, Poland, Romania) or without size limits (Denmark, Finland, Sweden, UK, France, Spain) size limitations in other (Fleckenstein and Sotirov,

Austria
- 1852. **Imperial Forest Act** | *Obligation to reforest <5 y, FD prohibition*
- 1975. **Forest Act** | *Sustainable FM*
- 1884. **Torrent and Avalanche Control Act** | *Restoration of protective forests*
- 2020. **Forest Fund Act** | *Climate-resilient forests*

Belgium
- 1847. **Reclamation law** | *Enabled state takeover of unproductive lands for afforestation*
- 1973. **Law on Nature Protection** | *Forest conservation*
- 1980. **Decentralization** 1997. **Nature Conservation Decree** | *Conservation integrated into FM*
- 1854. **Belgian Forest Code** | *To halt FD; prohibited most public user rights*
- 1990. **Flemish Forest Decree** | *Multifunctional FM*

Denmark
- 1781. **Forest separation decree** | *Shared rights in royal forests cancelled*
- 1866. **Danish Society of Heathlands** | *Key for heathland afforestation*
- 1969. **Nature Conservation Act** | *Public given limited access to private forests*
- 1990. **National Redlist published**
- 2016. **The conservation of biodiversity in the Danish forests** | *Report*
- 1805. **Forest Act** | *Control grazing and overharvesting*
- 1917. **Nature Conservation Act** | *Compensation for considering natural beauty & biodiversity*
- 2021. **Nature National Parks** | *Decision to create untouched forests*
- 1992. **Nature Protection Act** | *Protection of natural biotopes*
- 1989. **Parliamentary decision to double forest cover**
- 1987. **Forest and Nature Agency** | *Forestry and nature conservation agencies merged*

Romania
- 1843. **First documented grazing restrictions**
- 1910. **Forest Code** | *Extend restrictions to private forests*
- 1960. **Forest Code** | *CNF*
- 1982. **Separate forest management from industry**
- 2022. **National Forest Strategy** | *Aligned with EU requirements, CC adapted, biodiversity conservation*
- 1881. **Forest Code** | *Deforestation & grazing forbidden in state forests, MP mandatory*
- 1948. **Nationalization**
- 1991. **Reprivatization**
- 1986. **Law on the conservation, protection and development of forests** | *CNF, limit clearcut*
- 1976. **The National Program for Consolidating Watersheds** | *Limit clearcut, multifunctionality*

Finland
- 1886. **Forest Act** | *Prohibit destruction of forests*
- 2014. **Forest Act** | *Enabled transition to CCF*
- 1928. **Private Forest Act** | *Reforestation mandatory*
- 2008. **METSO program** | *Forest owners compensated for protecting & restoring*

Croatia
- 1775. **Forestry ordinance** | *Prohibition of grazing and bark stripping*
- 1878. **Inspectorate for Karst Afforestation** | *Specialized institution created*
- 1947. **Nationalization**
- 1977. **Law on Forests** | *Forests declared a public good with social interest*
- 2019. **Law on Forests** | *Reforestation required <2y, landuse change prohibited <10y*
- 1852. **Austrian Forest Act**
- 1945. **Institute for Practical Forestry Research**
- 1991. **Croatian Forests Ltd.** | *Public company to manage state forests*

France
- 1559. **Law on riparian forests** | *In Savoie, requires protection*
- 1882. **Law on restoration & conservation of mountain areas**
- 1945. **National Forestry Funds established** | *Financial aid & guidance to reforest*
- 1922. **Law on protection forests** | 1966. **National Forest Service**
- 1860. **Law for protection against natural risks** | *Mountain reforestation mandatory, commissions created*
- *Prohibit deforestation & activities affecting protective function*

Germany
- 1952. **Decree** | *Forestry sector as supplier of wood for economy*
- 1983. **Policies against air pollution** | *To lower emissions and halt acid rain*
- 1990. **Reprivatization**
- 2009. **Federal Nature Conservation Act** | *Native species promoted*
- 1975. **Federal Forest Act** | *Multifunctionality, forest expansion, MP in public forests*
- 1967. **Forest Damage Law** | *Funding provided after natural disasters*

Netherlands
- 1888. **Heather Agency** | *To assist heathland afforestation*
- 1962. **Forest Act** | *Obligation to reforest <3 y*
- 1995. **Survival Plan Forest and Nature** | *Grant for revitalization*
- 2020. **National Forest Strategy** | *Restore with a focus on CC adaptation*
- 1917. **First Forest Act** | *To ensure long-term wood provision*
- 1889. **State Forest Service**
- 2013. **Nature Pact** | *Afforestation to improve connectivity*
- 2010. **Decentralization**
- 1998. **Nature Protection Act**

Hungary
- 1879. **Forest Act** | *MP mandatory in community forests*
- 1945. **Nationalization**
- 1996. **Conservation Law** | *Non-native species replacement*
- 1923. **Great Plain Afforestation Act**
- 1961. **Forestry Law** | *Grazing prohibition, MP mandatory*
- 2009. **Forestry Law** | *CNF*

Italy
- 1910. **Legge Luzzati** | *Expropriation for reforestation allowed*
- 2019. **Climate decree**
- 1949. **Legge Fanfani** | *Enable lowland afforestation with conifers & exotics*
- 2022. **Constitution** | *Biodiveristy protection introduced*
- 1923. **Forest Law** | *Strong focus on soil & mountain protection; massive reforestation*
- 2021. **National Forest Strategy** | *Multifunctional, sustainable FM*

Slovenia
- 1881. **Afforestation Law - Karst Afforestation Commissions** | *Afforestation plans; grazing, logging & burning prohibited in plantations*
- 1949. **Forest Act** | *Clearcut prohibited, CNF & MP mandatory*
- 1990. **Reprivatization**
- 1964. **Institute for Reforestation of the Karst**
- 1994. **Public Forest Service** | *Coordinates funding & management*

Poland
- 1924. **State Forest Service**
- 1973. **Forest Act** | *Extended the list of land intended for afforestation*
- 1944. **Nationalization**
- 1991. **Forest Act** | *National program for increasing forest cover*
- 1960. **Mining Law Amendment** | *Obligation to restore open-pit mines*
- 1950. **Forest Act** | *To further facilitate state afforestation*
- 1936. **Decree and Act on afforestation** | *Obligation of the State to buy and afforest wasteland*

Spain
- 1926. **Forestry Law** | *Consortiums as mechanism to acquire private land*
- 1877. **Law on repopulation**
- 1941. **Riparian reforestation law**
- 1977. **Forest Law** | *To encourage private participation*
- 2014. **National Carbon Footprint Registry** | *Compensation to promote afforestation*
- 1888. **Law on reforestation of hydrological basins** | *Reforestation Commissions created*
- 1985. **Water Law** | *Riparian restoration plans*
- 1982. **Decree for restoration of natural areas affected by mining**

Greece
- 1975. **Constitution** | *Restrict forest land use change to deter arson*
- 1979. **Law for forest protection** | *Reforestation mandatory, grazing ban post-restoration*
- 1986. **Environmental law** | *National parks established*
- 2020. **Natural Environment and CC Agency**

Sweden
- 1903. **First Forestry Act** | *Regeneration for production*
- 1974. **Forestry Act** | *First considerations for conservation*
- 1993. **Forestry Act** | *Production & conservation equally important; soft regulations*
- 1995. **National Environmental Code** | *Incompatible with Forestry Act*
- 1983. **Forestry Act** | *MP mandatory*
- 1975. **Swedish Redlist**

Switzerland
- 1843. **Swiss Forestry Association** | *Initiated reports on mountain forests and torrents*
- 1855. **School of Forestry** 1902. **Federal Law on Forest Police** | *Clearcut prohibited*
- 1991. **Forest Law** | *Multifunctional FM*
- 1876. **Federal Law on Forest Police** | *Preservation of alpine protective forests, decision not to decrease forest area*
- 2008. **National Fiscal Equalisation** | *Financial framework for restoration*
- 2001. **Guidelines for a forest reserve policy** | *Quantitative objectives set*

UK
- 1919. **Forestry Act** | *Forestry commissions established to promote afforestation*
- 1981. **Wildlife and Countryside Act** | *Obligation to protect species & habitats*
- 2010. **UK Biodiversity Framework**
- 1951. **Forestry Act** | *Emphasized timber production*
- 1949. **National Parks and Access to the Countryside Act** | *Select areas for protection*
- 1994. **Sustainable Forestry: the UK Programme**
- 1998. **Decentralization. UK Forestry Standards** | *Sustainable FM & certification*
- 2008. **Climate Change Act** | *Promote afforestation to mitigate CC*

Legend
- ▼ Protection
- ▼ Production
- ▼ Multifunct. / biodiversity
- ▼ Institutional
- ▼ Climate change
- ▼ Mining

Timeline axis: *<1800* | 1800-1849 | 1850-1879 | 1880-1899 | 1900-1919 | 1920-1939 | 1940-1959 | 1960s | 1970s | 1980s | 1990s | 2000s | 2010s | 2020s

Fig. 2. Historical timeline of the main policies relevant to forest restoration development in 18 European countries. The different colors represent the main aim or focus of the policy (in grey are relevant institutional changes). (Abbreviations: CC: climate change; CCF: continuous cover forestry; CNF: close-to-nature forestry; FD: forest degradation; FM: forest management; MP: management plan).

2024). Obligations are another type of regulatory policy instrument found in forest restoration, with the most common being the obligation to reforest after final harvest (e.g. clearcutting) or disturbance events, and to prepare management plans (Table 1, E.4.2). Currently, reforestation is mandatory if natural regeneration fails after final harvest in most countries included in this study, with short-term obligations (within five years) in Finland, France, Germany, Poland, Romania, Spain and Sweden, medium-term obligations (up to 10 years) in Denmark and the UK, and no specific timeframe in Austria, the Netherlands, and Slovenia (Fleckenstein and Sotirov, 2024). In general, most former-socialist countries still rely on a restrictive regulatory framework, while western countries have maintained a high level of owners' rights (Nichiforel et al., 2020).

Persuasive policy instruments such as information, advisory and training services have also been popular and influential throughout time (Table 1, E.4.5). In Austria, for example, the government initiated intensive programs in educational institutions and daily newspapers in the late 19th century to raise awareness and promote the participation of landowners in reforestation (Johann, 2001; Weigl, 2001). In Hungary, the government announced and encouraged the afforestation of the Great Plains in the second period (1940–1990) through information campaigns. The education of foresters became a government task in Switzerland in 1855 and was centralized at the Swiss University for Science and Technology (ETH) and regional foresters' schools (since 1926 and increasingly since 1960), resulting in a sharpened self-image of foresters and a unified, hierarchical and sovereign management system. The Swedish Forest Agency carried out a sequence of education and training campaigns in the 1980s and 1990s (i.e., overlapping with the revised Forestry Act of 1993) to promote sustainable forestry among private forest owners, decisions-makers and professionals.

Organizational instruments such as structural forest sector reforms have also influenced forest restoration over time in most countries. In Romania, for example, during the latter half of the 20th century, forest management, harvesting and timber processing were controlled under a single administrative body, leading to forestry industry influencing decisions that resulted in substantial harvesting, challenging the sustainability limits (Giurgiu, 1995). A reform in 1982 separated forest management from the timber industry, which partially alleviated this problem. Fig. 2 shows other examples of institutional reforms (in grey) including the nationalization of forests (see Section 3.2), forest restitution (Section 3.2) and the establishment of institutions that were influential for forest restoration (Table 1, E.4.6).

3.5. Funding and financial policy instruments

Just as cuts in funding have hindered restoration, new funding mechanisms have facilitated it, which is exemplified by several successful state funding mechanisms (Table 1, E.5.1). In Slovenia, for instance, during the second half of the 20th century, a biological depreciation fund was set up from forestry income to cover the costs of the public forest service as well as the investments on forest regeneration and tending of young forests. Forest holdings contributed between 66 % and 90 % to the fund and other timber consumers the remaining part (Gradišar, 1987). This funding system, which was discontinued by forest restitution in the 1990s (resulting in a sharp decline in restoration activities), contributed to successful initiatives such as the Karst afforestation, the diversification of conifer monocultures and the restoration of scrubland and low-yield forests (Winkler and Krajčič, 1998).

Subsidy systems and tax benefits are other financial mechanisms that have influenced both the extent and type of restoration conducted (Table 1, E.5.4). As early as 1752, in Belgium (then part of the Austrian Netherlands), Empress Maria Theresa sought to reclaim degraded common land by offering tax reductions for its conversion to arable land, grassland or forest. While financial instruments in the 1945–1990 period encouraged conifer plantations, the post-1990 period is characterized by subsidy schemes promoting close-to-nature forest management in

several countries (Table 1, E.5.3). For example, in Germany, the state recently created a funding program with a total budget of 900 M euros to support climate change adaptation and biodiversity in forests (BMEL n. d.). In order to obtain funding, 11 out of 12 mandatory criteria must be met, which include the avoidance of clearcutting, fertilizers and pesticides, as well as the promotion of native tree species, natural regeneration, deadwood in managed forests, water retention, tree diversity and forest set asides. In Switzerland, a state-led program promoting forest biodiversity was launched in 2008 in collaboration with the cantons, which oversee planning and implementation; guided by a national framework that accounts for regional differences (Imesch et al., 2015), from 2008 to 2019 the program supported with 67.6 M CHF (71.8 M euros) in federal funding habitat improvements on 26,600 ha (Stadler and De Sassi, 2021).

A new source of funding that has been shaping the type of restoration conducted post-1990 are the EU funds. The European Agricultural Fund for Rural Development (EAFRD), which is implemented by EU countries and co-financed by national/regional budgets, has funded multiple restoration programs (e.g., afforestation of agricultural land, reforestation post natural disturbances) across most countries. In Poland, for example, EAFRD and other EU funding programs (e.g., SAPARD, PHARE, ISPA) to support countries waiting for membership in the EU financially contributed to the afforestation of an average of 10,000 ha per year between 1990 and 2021, but note that EAFRD funds are becoming less relevant in the last years (Fleckenstein, 2024). This funding can influence the species used in afforestation, as initiatives using slow-growing broadleaves received more subsidies than those with fast-growing conifers. In Spain, for example, this meant that, unlike in the 1940–1990 period, oaks (namely *Quercus ilex* L. and *Quercus suber* L.) were the most used tree species in afforestation in the post-1990 period. However, heavy bureaucracy and more competitive EU subsidies for agriculture have resulted in low uptake in some countries (Table 1, B.5.1 and B.5.2), and the latest reform of the Common Agricultural Policy (CAP) and the EAFRD appear to not fully integrate forest policy goals such as formulated under the EU Forest Strategy for 2030 (Fleckenstein, 2024). In the recent past, CAP funding for Natura 2000 in forests has not been effectively used by many European countries due to cross-sectoral policy incoherence between the forestry, agricultural and nature conservation sectors, national economic priorities and distrust in EU policies (Sotirov, 2017). In addition, the long-term financial burden for the administration can create dangerous dependencies (Table 1, B.5.3). EU funded National Recovery and Resilience Plans have also been used for forest restoration; for example, Romania allocated these funds to afforest over 59,000 ha of unforested lands by 2026, although the afforestation rate remains well below the planned target.

EU funding through LIFE and Interreg programs has also been influential in most countries by financing projects that aim at ecological forest restoration. In Austria, for example, the EU has funded 32 projects with an average budget of 4.5 M euros. For countries such as Greece, although spatially limited, this type of EU funding has been pivotal in supporting a new orientation of restoration with new objectives (e.g., biodiversity conservation) and stakeholders (e.g., NGOs). However, the increase in EU funding has been accompanied by a decrease in state funding, suggesting that the state has gradually retreated from financing restoration projects. In Poland, water retention restoration programs that aimed to maximize the amount of water stored in forests to reduce the risk of flooding and drought started in the mid-1990s and were initially financed by the national forest fund and benefited from provincial funds and the EcoFund. However, in 2006 these programs were concentrated and applied for funding to the EU Cohesion Fund, which financed 85 % of the activities between 2007 and 2020. Hence, the EU funding, in this case, has not been a major driver of change in the type of restoration done, but a way to ensure the continuity of previous initiatives.

Private funding is becoming an increasingly important source of support for forest restoration. While public funding has historically

dominated, there have also been instances where private investments played a key role. In the Netherlands, for example, wealthy nobility and industrialists purchased state lands and commons in the 19th century, funding early afforestation initiatives with the expectation of future financial returns (Boosten, 2016). Today, private sector involvement continues to grow, particularly through Corporate Social Responsibility (CSR) initiatives, with companies funding afforestation and reforestation projects to compensate for carbon emissions and biodiversity loss. Such private contributions are now considered essential for large-scale forest and landscape restoration worldwide (Löfqvist and Ghazoul, 2019).

3.6. Rural abandonment and conflicts

One of the main sociodemographic factors driving change in forest restoration dynamics is rural abandonment. This sustained movement of people from rural to urban areas began in Europe during the Industrial Revolution in the 18th century and has continued ever since with varying degrees of intensity. The economic crisis post-WW2 triggered a wave of rural abandonment and, currently, most European countries are experiencing a decrease in the proportion of young and working aged people living in rural regions (Fig. 3).

This movement out of rural areas can directly influence passive restoration by giving way to natural regeneration (Martín-Forés et al., 2020; Frei et al., 2024) as shown in the examples of Table 1 (E.6.1). Rural abandonment can also indirectly facilitate restoration initiatives by reducing conflicts with agricultural and pastoral land use, which has been a long-standing obstacle for forest restoration over the past two centuries (Erdozain et al., 2025) (Table 1, B.7.3). This conflict continues in the 21st century, as the type of subsidies for agricultural land are more attractive compared to the financial support for afforestation in countries such as Poland, which acts as a deterrent for forest restoration (Kaliszewski et al., 2016 after: Wysocka-Fijorek et al., 2020). Therefore, a reduced pressure of agricultural land uses due to rural abandonment has been shown to improve the implementation and success of forest restoration initiatives in some instances (E.6.2). For example, in France, the large-scale afforestation initiative that began in 1945 to reconstruct the country (National Forestry Fund) was successful partly due to the large area that became available following the rural exodus that peaked post-WW2. In Greece, the pressure from uncontrolled wood harvesting and forest grazing declined in parallel with the continuous decline of the rural mountain population, enhancing the success of mountain watershed restoration initiatives that had previously been hindered by opposition from shepherds.

Poverty, one of the driving forces of rural exodus, tends to exacerbate the tension between agricultural and forest land uses, as shown by the examples in Table 1 (B.6.2). However, poverty eradication has also been a driving force in some initiatives across time (Table 1, E.6.3). The large-scale afforestation and reforestation projects that were conducted in the 20th century in Spain and Italy also had a social objective, aiming to address the high unemployment rates in rural areas. Hence, the large investment in labour that was implicit in these projects with a low level of mechanization constituted an alternative to rural abandonment. For example, in 1975, a project was launched in Italy that involved the afforestation of 46,000 ha and foresaw the direct employment of 20,000 people plus an estimated additional workforce of 12,000.

When studying the relationship between rural exodus and poverty, and forest restoration, the chicken or egg dilemma may emerge. For example, in Spain, criticism over the large-scale reforestations of mid-20th century arose because to develop these massive campaigns, the lands of entire municipalities were purchased by the state, forcing inhabitants to abandon mountain villages. These criticisms have been challenged by stating that the rural abandonment of mountain villages was already an ongoing process, and that reforestation was the means to facilitate this migratory process. Similarly, the restorations of the first period in Austria, which involved restrictions on firewood collection and prohibitions on forest grazing and litter collection, greatly impacted the well-being of rural people from lower classes, which may have pushed them to emigrate. The grazing ban in Switzerland to support the protective functions of forests had a strong impact on farmers as well and led to migratory movements of rural people.

However, forest regrowth on abandoned land does not always facilitate ecological improvement and may, in fact, act as a driver of degradation, especially in Mediterranean regions of southern Europe (Quintas-Soriano et al., 2022) (Table 1, B.6.1). For example, in Greece, resin collectors are granted access to pine stands and manage the forests in a way that confers protection against wildfires. But due to rural abandonment, along with a decline in raisin price and alternative job opportunities in tourism sector, the number of resin collectors has been declining over the past decades (from around 5900 in 1975–2422 in 1990 and 807 in 2011 – Forest Resources Development Directorate, 2014), which has led to increased flammability. Currently, many stakeholders point to a shortage of workforce derived from rural abandonment as an obstacle to implementing restoration initiatives (Cortina-Segarra et al., 2021; Lapin et al., 2025).

3.7. Social values and demands

Changes in societal values and demands were very influential in the shift from more production-centered (pre-1990) to more multifunctional (post-1990) forest restoration approaches according to most national narratives. Between the 1970s and the 1990s, societies started to demand change in forest management in most countries based on two main driving forces: 1) a growing demand for recreation and tourism, and 2) growing environmental concerns. Improved living standards, as well as the increasingly urban and industrial societies, contributed to the diversification of restoration objectives; thus, in addition to providing materials and protective functions, aesthetic and recreational benefits of forests started to become increasingly important in all national forest strategies (Table 1, E.7.1). The increased public presence in forests due to a greater demand for recreation was often facilitated by policies. For example, in 1965, a law was introduced in the Netherlands making forest managers obliged to open their forests to the general public for recreation, which led to a greater public appreciation of forests (Boosten, 2016). Also, during the 1960s, various NGOs and statutory bodies in the UK discussed the need to make the wider countryside, including forests, more attractive and accessible to the public (Raum and Potter, 2015), to which the Forestry Commission responded by providing recreational facilities such as holiday cabins in state forests (Nail, 2010).

The increased presence of people in the forests for leisure activities, alongside other factors, heightened social awareness of the excessive human pressure on natural ecosystems. In central European countries such as Austria, Belgium, the Netherlands and Germany, the so-called forest dieback phenomenon and the subsequent clearcuts fueled the criticism against production forestry. The growing influence of NGOs and global environmental movements which were marked by milestones such as the 1992 UN Conference on the Environment and Development in Rio de Janeiro (in which forests played a prominent role), strongly influenced social perception as well. Finally, the media has been playing an increasingly important role in magnifying many social environmental concerns (Table 1, E.7.2).

This growing environmental awareness and recreational demand of society has intensified the conflict between timber industry related stakeholders and environmentalists or recreationalists, resulting in a backlash against the recent biodiversity- and recreation-oriented initiatives (Table 1, B.7.1). The forestry vs. conservationism dichotomy is further being polarized by the diverging rural vs. urban worldviews (Bonnie et al., 2020; Martín-Forés et al., 2020). In Spain and Italy, for example, urban society increasingly advocates for forest protection and expansion, focused on values like recreation and conservation. In contrast, rural stakeholders (e.g., hunters, livestock farmers, foresters)
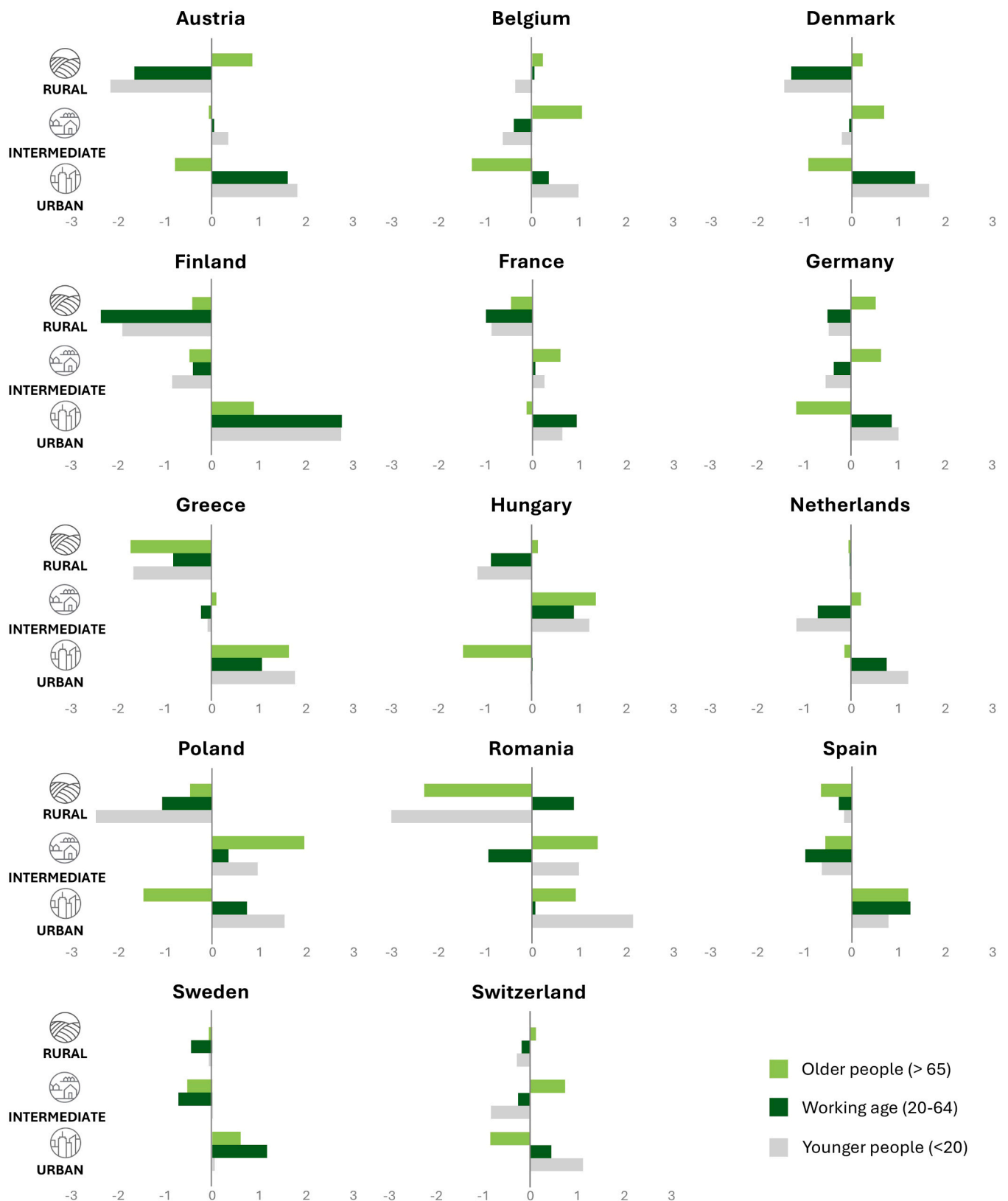
Fig. 3. Change in the proportion of young (<20, blue), working age (20–64, orange) and older people (>65, green) living in predominantly rural regions, intermediate regions and predominantly urban regions between 2014 and 2023 for 14 European countries for which data was available. Data source: Eurostat, (2024)).

may feel their land-use practices are misunderstood or questioned. When these views become polarized, the emphasis shifts from shared goals to perceived differences, reinforcing contrasting visions, i.e., ecocentric in urban areas and more utilitarian in rural ones (Lapointe et al., 2019).

These social perceptions can condition the type of restoration approach used or prioritized (Table 1, B.7.2). For example, in Spain and Italy, although passive restoration and a focus on the recovery of ecological functionality is being increasingly favored, tree planting has also continued to be used in many restoration projects because funders demand the use of this highly mediatic action at the social level (Löfqvist et al., 2023). Similarly, negative social perceptions of natural phenomena, such as fire, floods or vertebrates that cause coexistence conflicts (namely, large herbivores and predators), hinder the integration of these processes in restoration projects that pursue ecological functionality (Titus et al., 2024).

4. Discussion

History offers valuable insights into many of the forest restoration challenges we face today, which are often complex and deeply rooted, resisting simple solutions. Examining how social, policy and economic forces have shaped past restoration efforts can help policymakers and practitioners anticipate obstacles and avoid repeating past mistakes. Below, we explore the influence of geopolitical and macroeconomic forces, shifts in forest ownership and governance, and competing land use priorities, and then offer policy recommendations to harness enablers and overcome barriers to effective forest restoration with a particular focus on the ongoing implementation of the EU-NRR.

4.1. The cascading effects of geopolitical crises

One of the most significant human factors influencing forest restoration are geopolitical crises, which mostly act as substantial barriers. Armed conflicts and warfare have been clear drivers of environmental degradation across Europe as shown by the decrease in forest cover characterizing the countries involved in wars during the first half of the 20th century. Unfortunately, in addition to historical accounts, current evidence from countries such as Ukraine or Syria also showcases the destructive effect of wars on forests (Daiyoub et al., 2023; Matsala et al., 2024; Matsala et al., 2025). Interestingly, history also shows that wars have, at times, promoted passive restoration. One of the clearest examples in Europe is the Green Belt, which emerged along the Iron Curtain during the Cold War due to human activity being restricted for almost 40 years in this "forbidden zone" (Terry et al., 2006).

The negative impact of wars extends far beyond just a reduction in forest cover as they have cascading effects on most of the other human aspects that influence forests and restoration efforts. Firstly, funding mechanisms and previously established restoration projects are often disrupted as financial resources and priorities shift. For instance, close-to-nature forest management and conservation ideas had started to emerge during the first half of the 20th century in several countries (e.g., the Netherlands and Belgium), but the materialization of action behind these ideas was halted by the geopolitical turmoil that sought to maximize timber production (Hoste, Diagre-Vanderpelen, 2016). Furthermore, wars can exacerbate poverty, leading to an intensified conflict between agricultural and forest land uses (see Section 4.3), as well as a higher tolerance of illegal deforestation for subsistence farming. Poverty, in turn, can prompt rural abandonment, which has acted as both an enabler and a barrier for forest restoration (see Section 4.3). Notably, history demonstrates that forest restoration can also help alleviate rural poverty by supporting rural livelihoods and offering natural insurance (Oldekop et al., 2019; Miller et al., 2020).

Geopolitical crises also highlight the critical importance of securing a domestic timber supply, often prompting large-scale afforestation and reforestation initiatives. These initiatives have frequently been

facilitated by significant changes in governance and forest ownership that follow geopolitical upheavals. For instance, the nationalization and centralized management of forests that characterized the second period in many European countries enabled the achievement of ambitious reforestation targets, leading to a sharp increase in forest cover. In contrast, the decentralization and devolution that occurred in the 1990s often resulted in delays and unmet targets. It is important to recognize that many of these large-scale afforestation and/or reforestation initiatives were primarily driven by productive goals, often resulting in monocultures that would not be considered ecologically successful by today's standards (Erdozain et al., 2025) and with long-lasting implications for the composition and structure of European forests. However, there are examples, such as in Slovenia, where multifunctional and close-to-nature forest management was effectively implemented within this type of centralized governance system. While some countries point at decentralized local initiatives as success stories (Krumm et al., 2020; Börner et al., 2020), other studies record that decentralized resource management does not necessarily result in positive outcomes as it depends on various contextual factors (Larson and Soto, 2008), such as the economic importance of the forestry sector (Schulz et al., 2014). In the current geopolitical context, with increasing instability and ongoing concerns and debates over how forest restoration and the NRR may impose production restrictions and threaten rural economies (Fleckenstein et al., 2025), it is more important than ever to highlight examples such as those described for Switzerland and Slovenia, which demonstrate that forest restoration can proceed without jeopardizing timber production or rural livelihoods.

4.2. Incentivizing private participation

Another critical and persistent issue that has significantly influenced the success of restoration efforts over time is private forest ownership. While most restoration initiatives in Europe are led by central or regional administrations, one of the primary challenges these initiatives face is the limited availability of public land for restoration efforts (Erdozain et al., 2025). This challenge is particularly pronounced in countries or regions with a high proportion of privately owned forests (Pulla et al., 2013) and revolves around the fragmentation of land holdings, the large number of individual owners and a perceived lack of interest in forest restoration among these owners (United Nations and FAO, 2019). Our results demonstrate that a variety of strategies have historically been employed to address these challenges, including forced expropriation, land purchases, nationalization, land consolidation, tax incentives, consortiums, and long-term contracts or subsidies, each with its own strengths and weaknesses (Table 1). While all these approaches have shown limitations, tax incentives for landowners engaging in restoration appear to have yielded the most consistent and positive outcomes historically. In the past two decades, long-term contracts and subsidies have played an important role in promoting ecological restoration on private lands in several countries; however, their implementation remains challenging (Segerson et al., 2024). For instance, many private owners are reluctant to rely on government compensation schemes, which can be perceived as unpredictable and vulnerable to policy shifts over time.

Given these challenges, and that insufficient local participation and inclusion in the policy-making process is one of the main critiques to the EU-NRR (Fleckenstein et al., 2025), there is a clear need for innovative governance and financing mechanisms that can overcome the limitations of traditional approaches. Our findings underscore the significant influence of market dynamics and the relative success of funding mechanisms linked to forest products. To build on these strengths, new approaches should more effectively integrate the ecosystem services provided by restored forests into market value chains (Ha et al., 2022), as seen in the development of carbon markets and biodiversity credits (Deutz et al., 2020). At the same time, reducing dependence on public funding and fostering greater private sector involvement is essential to

scale up forest restoration globally (Löfqvist and Ghazoul, 2019; Deutz et al., 2020). This shift could help create more sustainable and attractive incentives for private forest owners to engage in restoration, while addressing two persistent barriers: limited funding and the complexity of private ownership (Erdozain et al., 2025). Nevertheless, strong public oversight and regulation remain crucial to both derisk private investments and ensure that they deliver positive ecological outcomes (Löfqvist et al., 2023; zu Ermgassen et al., 2025).

4.3. Conflicting land uses and restoration goals

Another persistent issue, both historically and today, is the conflict between different land uses and goals, which continues to create social, political and economic barriers. The tension between timber production and forest biodiversity conservation, as well as the competition between agriculture and forestry, are not new (Erdozain et al., 2025) and remain highly prevalent (Sotirov and Arts, 2018; Fleckenstein, 2024; O'Brien et al., 2025). Conflicts among stakeholders, as well as incoherent policies and financial instruments, often hinder efforts to implement multifunctional forest restoration. Additionally, there are growing concerns that climate change mitigation and bioenergy policies may intensify timber use and planting, potentially contradicting forest biodiversity goals and leading to policy fragmentation and ecological degradation (Sotirov and Arts, 2018; Stevens and Bond, 2023).

Part of this conflict arises because society now demands a broader range of ecosystem services (Winkel et al., 2022), while the development of a remuneration system that values these services has lagged, making them economically less competitive than agriculture or timber products (Lovrić et al., 2025). As highlighted earlier, it is crucial to establish public and private financial instruments that ascribe value to the diverse ecosystem services provided by multifunctional forests beyond just timber production and carbon sequestration. At the same time, it is important to recognize that the world will require more wood for the green transition (FAO, 2022; Jonsson and Sotirov, 2025). Therefore, making decisions that balance society's demands on forests, neither demonizing timber production nor neglecting forest biodiversity conservation and the provision of other ecosystem services is essential (Winkel et al., 2022).

Engaging private landowners is crucial not only to address property fragmentation and achieve restoration targets, but also to tackle rural abandonment, i.e., a historical and ongoing phenomenon shaping forest restoration in Europe. On the one hand, rural abandonment has facilitated natural regeneration and passive restoration (Martín-Forés et al., 2020; Frei et al., 2024). On the other, it has led to a lack of management, increasing risks such as wildfires in Mediterranean regions (Mantero, et al., 2020; Lecina-Diaz et al., 2023) and biodiversity loss in open habitats (Halada et al., 2011). Since engaged rural communities are essential for long-term restoration success (Mansourian et al., 2024), a holistic approach that develops a sustainable and socially inclusive forest-based bioeconomy is essential (Hetemäki et al., 2017).

4.4. Policy recommendations

As EU member states develop NRPs under the NRR, it is essential to draw lessons from past experiences to overcome persistent barriers and harness enabling factors. Given the complex interlinkages between geopolitical shifts, economic volatility, social expectations, and environmental policy, restoration strategies must address the interconnected global crises of biodiversity loss, water scarcity, food insecurity, health risks, and climate change (IPBES et al., 2024). To do so, we recommend the following key policy directions:

4.4.1. Foster hybrid governance models

A balanced approach that combines centralized coordination with decentralized competences is essential. Centralized governance models in the past showed efficiency in achieving large-scale restoration goals,

and therefore, to ensure the successful implementation of the NRR, supranational and national frameworks should formulate clear restoration goals, promote landscape-scale planning and secure long-term financial security (see below for policy instruments that have worked in the past). At the same time, local and regional authorities must retain the autonomy to develop tailored to their specific needs, and in close collaboration with forest owners and managers. This approach will allow them to address diverse ecological contexts and social demands in the developments of NRPs, thereby strengthening acceptance and ownership of restoration sites and measures. Alongside challenges related to centralized versus decentralized governance, fragmented forest ownership has historically and continues to hinder restoration efforts. Our analysis indicates that some of the most successful strategies to address limited land availability, which is bound to be an issue for the implementation of the NRR, include tax incentives, direct land purchases, long-term contracts, land consolidation and payments for ecosystem services.

4.4.2. Strengthen regulatory instruments and responsible institutions

Historical evidence shows that robust national regulatory frameworks that include clear obligations and restrictions for forest management, significantly contribute to successful multifunctional restoration. Countries that adopted such instruments early on have developed forest management approaches that support multifunctionality, in contrast to those with more liberal regulations that prioritize timber production over other ecosystem services. Therefore, national forest regulatory frameworks should comprise clear provisions on key forest restoration practices, indicators and targets, as set out in the NRR (Article 12). Complementing robust regulatory frameworks with clear multidisciplinary institutional responsibilities and centralized training for foresters can support regulatory compliance and foster long-term institutional capacity for forest restoration.

4.4.3. Address land use conflicts and incoherent policies

Conflicting land-use goals, and the institutions, policies and interests that support them, remain a key barrier to restoration. Addressing this issue requires intensified cross-sectoral collaboration to streamline forest restoration policies stemming from various related policy areas. This approach will enable potential trade-offs to be identified and resolved, such as harmful subsidies, between policy areas whose goals are predominantly based on forest resource extraction (e.g. bioenergy and the bioeconomy) and those that promote more extensive approaches to forest management (e.g. nature conservation and climate action). Furthermore, there are undoubtedly synergies between forest restoration-related policy areas (e.g. nature conservation, climate and water) and their respective goals and policy instruments, which should be identified and utilised to support the effective long-term implementation of forest restoration measures under the NRR.

4.4.4. Ensure sufficient long-term financing (public, private)

The economic undervaluation of ecosystem services beyond timber and carbon remains a crucial challenge that deserves increased attention. Many restoration benefits, such as biodiversity, water regulation and climate resilience, are not monetized, making restoration financially unappealing. Furthermore, as forest restoration often competes with more lucrative land uses, the opportunity costs are usually high. Therefore, and based on the evidence of what has worked in the past, expanding payment for ecosystem services, translating EU biodiversity credit schemes into national policy and offering incentives like green tax benefits can help close this gap. Clear incentives and market-based tools, alongside strong public oversight and regulation, are essential to mobilize private sector engagement and make restoration a viable, competitive land-use choice. Aligning restoration with rural development, through job creation and regulatory/financial support for sustainable bioeconomy activities, can further enhance private sector engagement. Socioeconomic indicators should be examined during the

implementation of the NRR to assess the link between ecological and socioeconomic performance, since both are key factors in the successful restoration of forests.

4.4.5. Encourage cultural change and public engagement

Historical evidence shows that persuasive policy instruments, such as training services and public awareness and education campaigns, play an important role in shifting societal values and building broad support for restoration. As companies increasingly respond to sustainability-minded consumers, societal pressure can incentivize stronger corporate involvement. Equally important is fostering communication and understanding between urban and rural communities to ensure broad-based support and reduce tensions over land-use priorities. Strengthening this dialogue will help align perceptions, responsibilities and benefits, which is critical for the success of multifunctional forest restoration. In the context of the NRR, this momentum could be amplified by: 1) supporting national and regional communication campaigns that translate restoration goals into tangible local benefits, 2) creating participatory platforms and local "restoration forums" where forest owners, farmers, NGOs, scientists and municipalities can co-design and monitor restoration actions, 3) integrating restoration themes into education and vocational training, linking schools, universities and forestry sectors.

4.4.6. Secure policy continuity and adaptive restoration policies

Past geopolitical and economic crises have repeatedly disrupted restoration progress, leading to long-lasting environmental consequences. Today, intensifying geopolitical tensions and conflicts are again shifting policy priorities and funding towards security and away from environmental action. However, history shows that sidelining environmental goals has enduring costs that we continue to face. It is therefore crucial not to lose sight of the escalating environmental crises and the urgent need to restore forest biodiversity and ecosystem function. To ensure continuity amid global uncertainty, restoration policies, including the NRR, must be adaptive and supported by consistent long-term policy frameworks. This requires diversifying funding sources, securing long-term commitments and embedding restoration within broader climate and sustainable development agendas. Moreover, climate-adaptive restoration approaches should be standard practice to build resilience to evolving disturbance regimes.

Finally, it is important to acknowledge that, although this historical analysis provides valuable lessons and recommendations for the successful implementation of large-scale restoration efforts, its qualitative nature entails certain limitations. Despite the systematic selection of experts to develop national narratives, the limited number of experts per country cannot fully capture the complete and objective history of restoration activities. As such, some degree of subjectivity or bias may arise from each expert's background, professional environment, and area of expertise. While including a larger number of experts per country would have strengthened the analysis, this was not feasible due to resource constraints. Nevertheless, we remain confident that the information gathered offers a robust and representative overview of the main socio-economic and political factors influencing forest restoration over the past decades in Europe.

CRediT authorship contribution statement

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Declaration of Generative AI and AI-assisted technologies in the writing process

During the preparation of this work the authors used ChatGPT in order to improve language and readability. After using this tool/service, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.landusepol.2025.107876.

Data Availability

The authors do not have permission to share data.

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