

## Forestry and demographic transition in Europe: exploring the nexus

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**ABSTRACT** Europe's future is being shaped by a demographic transition of unprecedented scale, characterized by population ageing, a declining labour force, and the abandonment of rural areas in favour of urban centres. Within the forestry sector, these dynamics pose critical challenges, particularly in relation to ageing forest landowners and an increasingly elderly workforce. Despite their relevance, the interconnections between demographic change, spatial reorganization of population, and forest management remain insufficiently explored in the forestry literature. This concept note seeks to address this gap by identifying critical risks, emerging needs, and key research opportunities, and by proposing an evidence-based framework to support analysis and decision-making within this complex and evolving context.

**KEYWORDS:** Aging forest owners, aging workforce, rural land abandonment, silviculture.

### Introduction

Europe's future is being shaped by the convergence of two profound transformations. The first is a demographic transition of historic scale, characterized by population ageing, a declining labour force, and a fundamental spatial reorganization marked by population shifts from rural areas toward urban centres. The second is an ecological transition, in which Europe's forests, despite an overall expansion in area and an increase in biomass per unit area, are increasingly subject to unprecedented pressures driven by climate change, intensifying disturbances, and evolving societal demands.

Treating these processes as separate and parallel phenomena represents a critical analytical limitation. Rather, they are partially intertwined and together constitute a coupled social-ecological system, in which demographic drivers are reshaping not only the physical structure of Europe's forests, but also forest management paradigms, governance arrangements, and the societal expectations placed upon forest ecosystems.

Despite its relevance, the demographic dimension remains largely overlooked in the forestry literature, and demographic transition processes are only rarely examined explicitly. This concept note seeks to address this gap by identifying critical risks, emerging needs, and key research opportunities, and by proposing an evidence-based framework to support analysis and decision-making within this complex and evolving context.

### Europe's demographic profile

Key statistics paint a clear picture of a continent that is simultaneously growing older, more urban, and more demographically fragmented, creating a set of pressures and challenges that radiate across all sectors, including land management and forestry.

According to Eurostat (2025), the share of the population aged 65 and over in the European Union has increased

significantly, rising from 16.4% in 2004 to 21.6% at the beginning of 2024. This demographic shift reflects a profound change in the continent's age structure, accompanied by a decline in the proportion of children aged 0–14, which now stands at 14.6%. Population ageing is even more pronounced among the oldest cohorts: the share of individuals aged 80 and over has grown from 3.8% to 6.1% over the same two-decade period.

Crucially, this aging process is not evenly distributed. A clear geographical divide is apparent, with Southern and Eastern European nations experiencing the most advanced stages of population aging. In 2024, countries such as Italy (24.3%), Portugal (24.1%), Bulgaria (23.8%), and Greece (23.3%) recorded the highest shares of people aged 65 and over. In contrast, countries like Ireland (15.5%) and Luxembourg (15.0%) have comparatively younger populations, though they too are on an aging trajectory (Pinkus and Ruer 2025).

A direct consequence of population aging is the pressure it exerts on the labor market through the shrinking of the working-age population. While the cohort of individuals aged 15 to 64 currently accounts for 63.8% of the EU population, this figure masks a looming decline. Projections show that the EU as a whole is expected to enter a period of overall population decline after 2026, driven primarily by a decrease in the number of working-age individuals. By 2050, it is anticipated that 22 out of the 27 EU member states will experience a decline in their working-age populations (Eurostat 2024).

Concurrent with aging is a profound spatial reorganization of Europe's population, characterized by sustained depopulation in rural areas and increasing concentration in urban centers. This internal migration is a key driver of landscape change and has significant implications for the management of natural resources. Projections to 2051 reveal that this trend is set to continue, further sharpening the divide between thriving urban hubs and declining rural peripheries (Eurostat 2024).

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### Demographic imprint on rural landscapes and forestry

According to Forest Europe (2020), the total forest area across the pan-European region has increased by 9% since 1990: forests now cover more than one-third of Europe's land surface, representing a significant ecological and aesthetic transformation of the landscape in the last decades. This expansion has been accompanied by a substantial increase in forest biomass. The total growing stock has risen by 50% over the same 30-year period, a result of both the expanding forest area and management practices in which, on average, only about three-quarters of the net annual wood increment is harvested, allowing the overall wood volume to accumulate.

Demographic processes have a clear imprint on the current condition of European forests.

First, a substantial share of recent forest expansion represents a passive outcome of rural land abandonment, whereby formerly cultivated agricultural areas revert to forest cover that is frequently unmanaged. Notably, this phenomenon is not confined to remote rural regions but also characterizes peri-urban landscapes (Salvati et al. 2017). Although these newly established forests contribute to increases in overall forest area and carbon sequestration, they are generally less resilient to disturbances, such as wildfires and pest outbreaks, than more heterogeneous and actively managed forest-agricultural mosaics. A direct and well-documented causal relationship links rural depopulation to a marked increase in wildfire risk, particularly in Southern Europe. The abandonment of agricultural land initiates natural succession processes that promote shrub encroachment and the development of dense, often unmanaged forest stands, leading to substantial fuel accumulation (Regos et al. 2023). Under climate change conditions characterized by more frequent and intense droughts and heatwaves, these fuel-rich landscapes exhibit a non-linear escalation in the likelihood and severity of extreme wildfire events (Moreira et al. 2011). These biophysical changes are reinforced by parallel social transformations. Rural depopulation results in the loss of local ecological knowledge, a decline in traditional fire-prevention practices, and a reduced capacity for early detection and rapid suppression of fires. The combined effect is a self-reinforcing feedback loop: land abandonment increases fire intensity and extent, which in turn accelerates landscape degradation and further undermines the socio-economic viability of rural areas, thereby perpetuating depopulation trends.

Second, issues of land ownership pose substantial governance challenges. Across Europe, forest ownership is split roughly evenly between public (state or communal) and private land, although this aggregate figure masks wide variation among countries. The most significant structural challenge in the private sector is the extreme fragmentation of holdings: nearly three-quarters of all private properties are smaller than 3 hectares (Hirsh et al. 2007, FAO-UNECE 2019). This fragmentation is compounded by social trends linked to demographic

change. The population of private forest owners is aging, with a large share now over 60 years old. At the same time, a new category of "forest owners" is emerging: often urban-based, they inherit small parcels of land, lack a traditional connection to agriculture or forestry, and may have little economic dependence on or active interest in land management (FAO-UNECE 2019).

Third, as the majority of Europeans now live in cities, their relationship with forests is undergoing a profound transformation. The "urban gaze" increasingly values forests not only as sources of timber and other raw materials but mainly as providers of regulating and cultural ecosystem services essential for urban well-being. This evolution in societal demand is reshaping the political and economic context of forest management, creating both opportunities and tensions. On one hand, urban demand for ecosystem services can open new income streams for forest owners and rural communities; on the other, it can generate conflicts with traditional productive uses such as timber harvesting. Managing these trade-offs has become a central challenge for forest governance.

Fourth, the European forestry sector faces a looming human capital crisis, directly reflecting broader demographic aging: the workforce is heavily skewed toward older age groups, with an average age between 40 and 59 years; a significant proportion of workers aged 50 and above is expected to retire within the next 10–15 years, creating a substantial labor and knowledge gap (da Silva & Schweinle 2022). This deficit poses a direct threat to the implementation of sustainable management practices.

These intersecting pressures (rural land abandonment, ownership fragmentation, urbanization, aging forest owners, aging workforce) create relevant challenges for policymakers. Europe's forests, especially those in depopulating rural regions, are caught in a "trilemma" of conflicting demands. First, there is the imperative for active, climate-adaptive management to reduce risks and enhance resilience to catastrophic disturbances such as wildfire and windstorms. Second, there is the economic demand from the bioeconomy for a sustainable and reliable supply of goods, above all wood for industry and energy. Third, there is the growing societal and urban demand for multiple uses, such as maximizing carbon sequestration and promoting biodiversity through rewilding and strict protection. These three objectives (risk reduction and resilience enhancement, goods production, and passive conservation) are often mutually exclusive on the same parcel of land. Critically, this trilemma tends to be most acute in landscapes with the least human and institutional capacity to negotiate trade-offs.

### Updating the forest research agenda

The challenges arising at the intersection of demographic change and forestry call for partial reorientation of forest research. While silviculture-centred approaches

remain essential (Corona et al. 2025), they are no longer sufficient on their own to address the systemic nature of the issues involved. A more integrated research and innovation agenda is therefore required, one that explicitly places demographic drivers at the core of the analysis.

The future of forest science lies in moving beyond purely biophysical and economic models toward a social–ecological systems perspective. Within this framework, forests are not conceived as static natural resources to be managed, but as dynamic systems in which human and environmental components are inextricably intertwined and co-evolve (Nocentini et al. 2017, 2021). Advancing this paradigm requires sustained interdisciplinary collaboration among forest scientists, ecologists, sociologists, economists, and other relevant disciplines. In particular, research efforts should focus on identifying and quantifying the feedback mechanisms linking social transformations to ecological responses.

In this context, Table 1 outlines several aspects that can be identified as research opportunities from an operational perspective in Europe under current demographic transition dynamics. Two of these aspects are discussed in greater detail here below as illustrative examples.

The digital transformation offers a powerful suite of tools to address many of the challenges posed by demographic change. However, it should not be regarded merely as a technological upgrade, but as a necessary strategic adaptation to a future with less human capital available on the ground. The research and innovation agenda must therefore focus on developing and deploying these technologies to tackle specific demographic-driven challenges. A primary application concerns mitigating the impacts of labor shortages. Research into robotics, automation, and remote operation for physically demanding tasks (e.g. planting, stand tending, harvesting) is critical for sustaining forest productivity and implementing management regimes with a smaller and older workforce. Digital technologies are also essential for monitoring and managing the vast, depopulating landscapes that are becoming increasingly common. Moreover, digitalization can help address governance challenges stemming from fragmented ownership: for example, digital platforms can connect thousands of disparate smallholders, giving them access to tailored management

solutions (e.g., see the Forest Sharing initiative: Giannetti et al. 2025). Nevertheless, technology is not a panacea, and its uncritical promotion may inadvertently exacerbate existing inequalities (Corona 2025).

The second aspect concerns the design and implementation of effective and scalable schemes for payments for the so-called ecosystem services. While the concept enjoys broad support, its practical application remains challenging, with the notable exception of carbon sequestration under carbon farming schemes. Research should therefore focus on developing robust, scientifically credible, and cost-effective methodologies for quantifying these utilities and structuring payment mechanisms (e.g., Clifton and Schwerdtner Manez 2025). The ultimate goal is to create tangible new income streams for forest owners and rural communities, thereby consolidating their presence in rural landscapes and possibly attracting younger generations.

### Conclusive remarks

The complex and interconnected challenges arising from Europe's demographic transition cannot be effectively addressed through siloed or single-sector policies. Instead, they require a coherent, integrated, and forward-looking policy framework. This calls for a shift in perspective, recognizing responsible forest management not merely as environmental and economic objectives, but as a key instrument for sustaining social cohesion and resilience in Europe's rural areas. From this standpoint, the analysis presented in this note underscores the imperative of aligning forest policies and programs with current demographic realities.

Furthermore, it is worth highlighting that the looming human capital deficit in the forestry sector not only underscores the need to equip forest owners and the workforce at all levels with the skills (particularly those related to digital innovations) required to address contemporary demographic challenges, but also highlights the necessity of enhancing the sector's overall attractiveness: addressing this latter issue requires modernizing the sector's often outdated image and, as researchers, we bear a responsibility to engage with this challenge proactively.

**Table 1** - Typology of impacts at the demography-forestry nexus.

Demographic drivers	Impacts on forest sector & landscapes	Key challenges	Opportunities for policy & research
Aging & shrinking workforce	Labor shortages, skills gaps, loss of traditional knowledge, reduced operational capacity	Loss of productivity, inability to implement labor-intensive adaptive management, succession crisis in family holdings	Automation & digital transition, defining "green forest jobs" to attract new talent, targeted training programs (e.g., European Social Fund+), knowledge transfer initiatives
Rural depopulation & land abandonment	Passive afforestation on abandoned farmland, increased fuel loads and landscape homogeneity, loss of landscape mosaics	Catastrophic wildfire risk, loss of high-nature-value farmland, decline of rural economies, degradation of ecosystem services	Payments for risk reduction (e.g., grazing), prescribed burning programs, integrated Common Agricultural Policy and forestry policies, agroforestry incentives
Urbanization & shifting values	Increased demand for recreation, ecotourism, and regulating services (carbon, water, air); decreased social license for intensive harvesting	Conflict between production and conservation goals, pressure on sensitive ecosystems from tourism, managing the urban-wildland interface	Development of ecotourism business models, payments for ecosystem services, urban forestry programs, public education and engagement
Changing ownership structure	Fragmentation of holdings, rise of "new" urban/absentee owners, management de-intensification, diversification of owner objectives	Governance of fragmented landscapes, lack of economic scale for management, reduced timber supply for bioeconomy, passive fuel accumulation	Support for forest owner associations and cooperatives, development of digital advisory services, flexible certification schemes, new models for landscape-level planning

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