POLICY BRIEF

① 2025

POTENTIAL AND LIMITS OF EUROPEAN FORESTS IN CLIMATE CHANGE MITIGATION

Potential and limits of European forests in Climate Change Mitigation

Latest data from National Forest Inventories raise doubts about whether European forests will provide the greenhouse gas sink strength that is targeted by the Regulations on Land use and land-use change.

We propose measures to maintain the forest carbon sink strength and provide information for the time horizons for achieving the targets. The recommendations aim at facilitating evidence-based decision making.

Recommendations:

1. Forest carbon sinks are dynamic, and their net sink varies between years. Realistic and measurable goals should be set for the contribution of European forests to climate change mitigation. The goals should take into account natural variability and uncertainties of sinks, forest management, EU biodiversity commitments and expectations towards the bioeconomy.
2. Implementation of forest management practices should be supported to increase the carbon sequestration capacity of forests and wood products, and to increase the resilience of forests against adverse effects of climate change.
3. The role of forest soil carbon pools should be recognized and measures that improve soil health and prevent soil degradation should be incentivized. Forest management practices that support soils as carbon stocks and improve tree growth under changing climate should be promoted.

The EU aims to be climate neutral by 2050, as set out in the European Climate Law. Despite that the reduction of CO_2 emissions from fossil-based production processes is critical for reaching the climate neutrality goal, the land use, land use change and forestry (LULUCF) sector has high potential to contribute to the removal of CO_2 from the atmosphere.

The LULUCF sector comprises managed forests and land-use changes, including harvested wood products, deforestations, managed cropland and grassland. The LULUCF Regulation 2018/841 creates the EU legislative framework for emissions and removals from the land use sector for the period 2021-2030. It is amended with Regulation LULUCF (EU) 839/2023. In the first compliance period (2021-2025), the emissions and removals of greenhouse gases from managed forests (including harvested wood products) are accounted for against forest reference levels (FRL). The FRLs are based on forest management practices between 2000 and 2009. For the second compliance period (2026-2030) a net-removal of 310 Mt CO_2 equivalents is targeted for the LULUCF sector.

The CO_2 sink of forests in the last decades has been largely caused by low harvesting rates, planting of highly productive tree species, peatland drainage, and the recovery from historic exploitative forms of forest management. Based on recent reports on greenhouse gas inventories, forest sinks have started to considerably decline, and emissions from soils have leveled or increased.

Forests are under pressure due to climate change effects, requiring considerable adaptation efforts. The net CO_2 removal from forests has been projected to decline further due to a combination of harvesting, reductions in the growth rate of ageing forests, and more abundant biotic and abiotic disturbances (pests and pathogens, fire, drought, storm). Timber from regular harvests is used for products retaining CO_2 well beyond the life-time of forests and substitutes for non-wood materials. Thereby, a relevant sink of CO_2 is created. Wood from disturbances either immediately releases CO_2 to the atmosphere (fire) or its use is confined to short-lived products that do not qualify as lasting carbon sinks. The climate mitigation targets for managed forests are ambitious, and several member states are raising doubts whether they are achievable. The FRL for the first compliance period is criticized because it insufficiently accommodates impacts of climate change that are not driven by forest management. The impact assessment for the EU 2040 acknowledges the high uncertainty of the projected performance of forests and a diminishing sink strength.

Recommendation 1

Forest carbon sinks are dynamic, and their net sink varies between years. Realistic and measurable goals should be set for the contribution of European forests to climate change mitigation. The goals should take into account natural variability and uncertainties of sinks, forest management, EU biodiversity commitments and expectations towards the bioeconomy.

The LULUCF sector has been a sink for greenhouse gases since the beginning of the emission reporting in 1990 (Figure 1). During recent decades, forest land and harvested wood products (HWPs) fully compensated for emissions from other land uses, like agriculture.

Forests grew well in Central and Northern Europe, due to improved forest management, nitrogen deposition, and warming. Only recently, abrupt declines have been reported (Figure 2), which is reflected as a decreasing sink strength of Forest land („LULUCF", Figure 1).

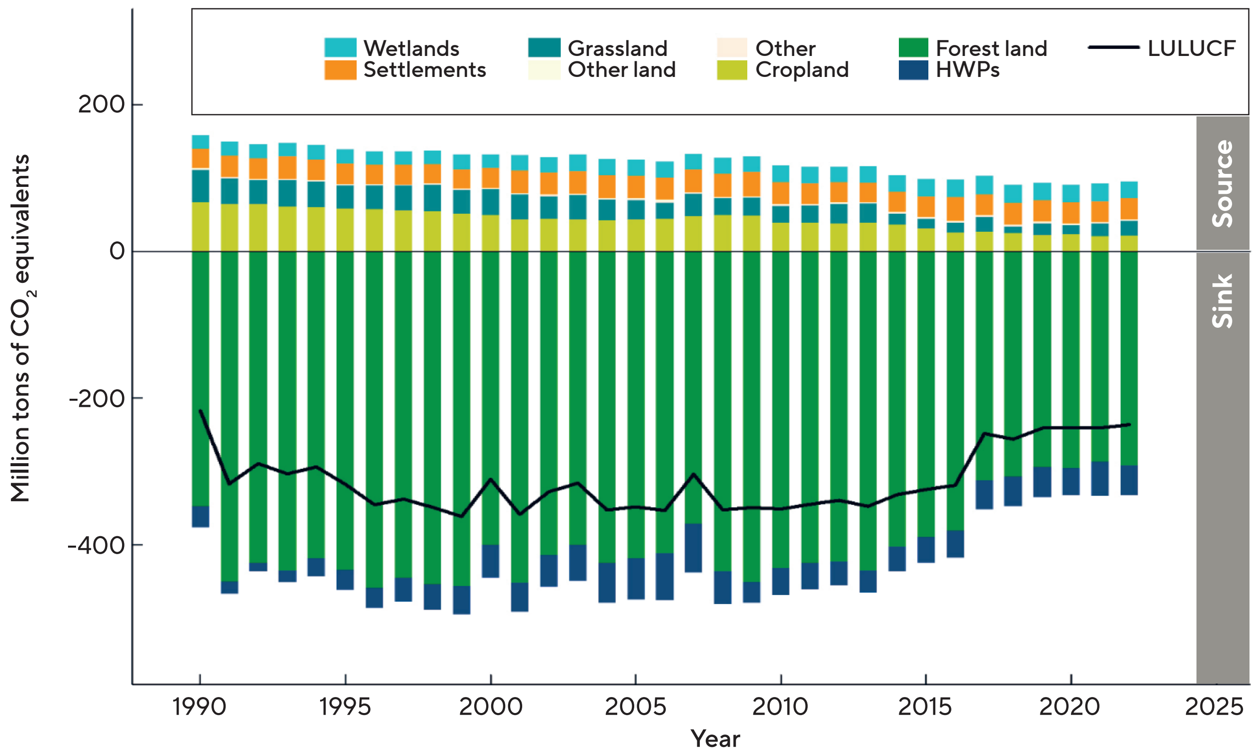

Figure 1 | EU emissions and removals of the LULUCF sector by land use category. The black line shows the balance of sources and sinks of greenhouse gases for different forms of land use. Source: EEA (2024).

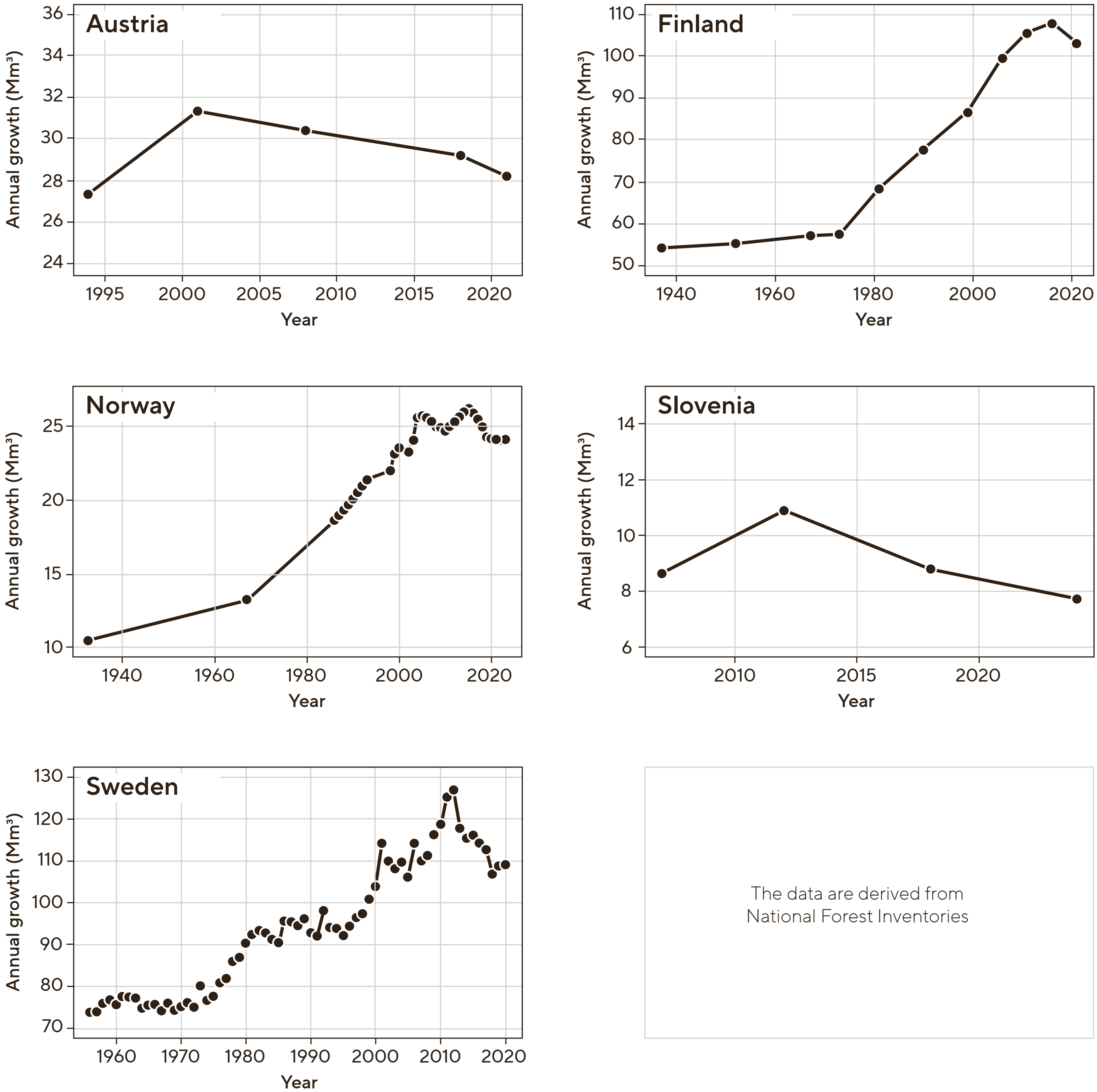

Figure 2 | After many years of increasing growth, a decline in forest growth rates has been widely observed.

Forests are highly relevant for climate change mitigation, yet their carbon sink is not permanent and many processes influencing the sink strength are beyond direct human control. EU climate change mitigation commitments include efforts to increase biomass stocks in sustainably managed forests, while reducing negative environmental impacts, like nutrient loading to waters and GHG emissions from soils. Forest inventory data and model-based scenarios should be used more to establish science-based information on realistic capabilities of CO_2 storage in forests.

Implementation of forest management practices should be supported to increase the carbon sequestration capacity of forests and wood products, and to increase the resilience of forests against adverse effects of climate change.

We recommend incentivizing specific forest management measures that efficiently deliver climate benefits in target regions. However, they are implementable step by step, and the desired effects are not immediate. **Mitigation measures** aim at enhancing the carbon sink in the biomass and the soil of forests, and in wood products. **Adaptation measures** have the primary goal to decrease the vulnerability of forests to storms, pests, and diseases. Many adaptation measures, however, do not maximize carbon sequestration in the short-term.

Necessary salvage harvestings even can compromise the targets of the LULUCF Regulation. Yet, carefully planned forest management contributes to climate change mitigation in the long run because it leads to more resilient forests. The costs for silvicultural measures are commonly shouldered by revenues from timber sales and other incomes of the respective forest enterprises. Table 1 lists several forest management activities for climate change mitigation and adaptation.

Table 1 | Recommended activities that increase forest resilience and the rate of carbon sequestration in the standing tree biomass, the forest soil, and in harvested wood products. Some activities are specific to regions and soil types, and are not generally applied.

Climate smart practices	Mitigation (M) Adaptation (A)	Potential effect on carbon retention in forests and harvested wood products High Medium	Time horizon until a relevant effect on carbon sequestration can be expected Immediate (yrs) Medium (until 2040) Long-term (> 2040)	Barriers and support
Afforestation	M	Medium	Long-term (> 2040)	Increasing the forest area may invoke competition between different forms of land use.
Avoiding pre-mature use of trees	A, M	High	Immediate (yrs)	Co-benefits with forest product C sinks and other ecosystem services.
Establishing mixed-species forests	A, M	High	Long-term (> 2040)	Mixed-species forests are more resilient towards disturbances. However, their growth and carbon sequestration rates are lower.
Tree breeding	A, M	High	Long-term (> 2040)	Increases speed of re-growth and damage resistance of forests.
Assisted migration of regeneration material	A	High	Long-term (> 2040)	Enables knowledge-based selection of genetic material that is adapted to climate change.
Avoiding deforestation	M	High	Immediate (yrs)	Competition between different forms of land use needs to be settled.
Peatland water level management	A, M	Medium	Immediate (yrs)	Reduces drought risks, can reduce greenhouse gas emissions from peat soils.
Forest fertilization	M	Medium	Immediate (yrs)	In Nordic countries nitrogen fertilization for mineral soils and ash for ditched peatlands are applied. Different national regulations on forest fertilization apply.

Forest enterprises have mostly focused on urgent adaptation measures and to a lesser degree on mitigation. Activities addressing adaptation and mitigation can be subsidized by European and national programmes.

Policies to steer mitigation have been limitedly implemented so far. However, a few examples exist in the focus countries: A dedicated national programme is the Austrian Forest Fund for the implementation of climate change adaptation measures. In Finland, subsidies for afforestation (temporary 2022-2023), targeted fertilization for health and ash fertilization for drained peatlands have been provided. In Sweden, subsidies are suggested for measures such as prolonging of the rotation length and fertilization. In Slovenia, regional forest management plans for the period 2021–2030 set out the main strategies of sustainable forest management under climate change (e.g. silvicultural systems and stand structures, tree species composition, forest reproductive material). LULUCF-related forestry implementation measures have been included in the National Energy and Climate Plan. In Norway, financial support is provided for fertilization and denser forest planting as climate mitigation measures.

Recommendation 3

The role of forest soil carbon pools should be recognized and measures that improve soil health and prevent soil degradation should be incentivized. Forest management practices that support soils as carbon stocks and improve tree growth under changing climate should be promoted.

Soil C stocks are typically 1.5 times bigger than biomass stocks. Warming leads to higher biological activities increasing the decomposition of soil organic matter and the soil CO_2 release. If plant C inputs into the soil (litter, root C) do not increase at a similar pace, forest soils become net sources of CO_2. Although soil CO_2 fluxes are similar in magnitude to biomass fluxes, the quantification of soil carbon fluxes is subject to greater uncertainties due to complex interactions between plants, soil, and climate.

Carbon accumulation in forest soils is slow, but C losses after disturbances in upland forest or after drainage of forested peatlands are fast. Therefore, efforts are required to avoid disruptive forest disturbances and soil degradation processes that reduce the carbon and nutrient pool size. In upland soils, C can be sequestered by afforestation of agricultural soil, by securing permanent tree cover or by rapid regeneration of harvested or disturbed stands.

Soil emissions of forested drained peatlands make 25 Tg CO_2 annually from EU member states (UNFCCC submissions 2024). This underlines the potentials to reduce emissions from peatland soils with more sustainable land management and with restoration of water levels through rewetting. In Finland, for example, soil emissions could be reduced by 1 Tg CO_2-eq. by converting from even-aged forestry with ditch maintenance to continuous-cover forestry in fertile forestry-drained peatlands.

Further reading

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The aim of this policy brief is the provision of constructive suggestions for the role of forests in the mitigation of climate change. The participating research institutes representing forest-rich countries in Europe are:

Natural Resources Institute Finland (Luke), Austrian Research Centre for Forests (BFW),
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Co-operation:

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