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DIVISION OF
FOREST, NATURE & LANDSCAPE
for nature-based solutions

Raw material supply and climate change

Prof. Bart MUYS

International Hardwood Conference Antwerp 2026

Drivers of wood availability

Supply side: social-ecological drivers

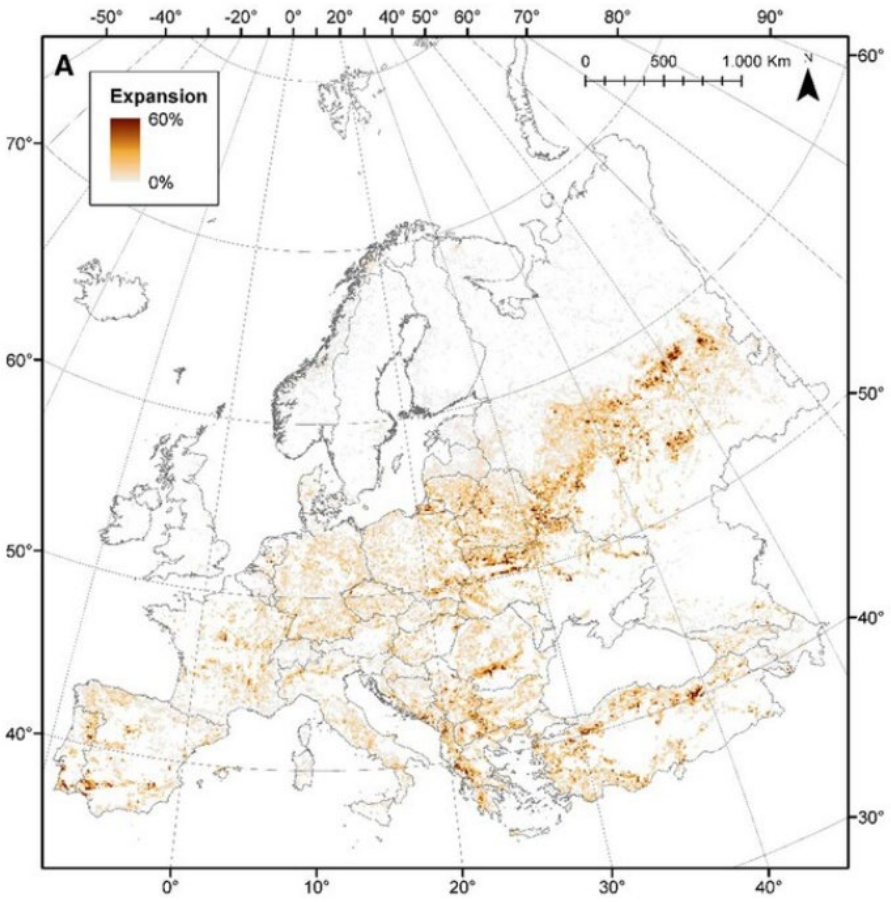
- Forest area trend
- Forest vitality and increment
- Trend in climate change related disturbances
- Trend in species composition
- Trend in set-aside for conservation

Demand side: socio-economic drivers

- Population
- Economic climate
- Demand for biobased products (awareness, subsidies)
- Defossilization policies (green deal, EUDR, energy autonomy)
- Wood and energy prices

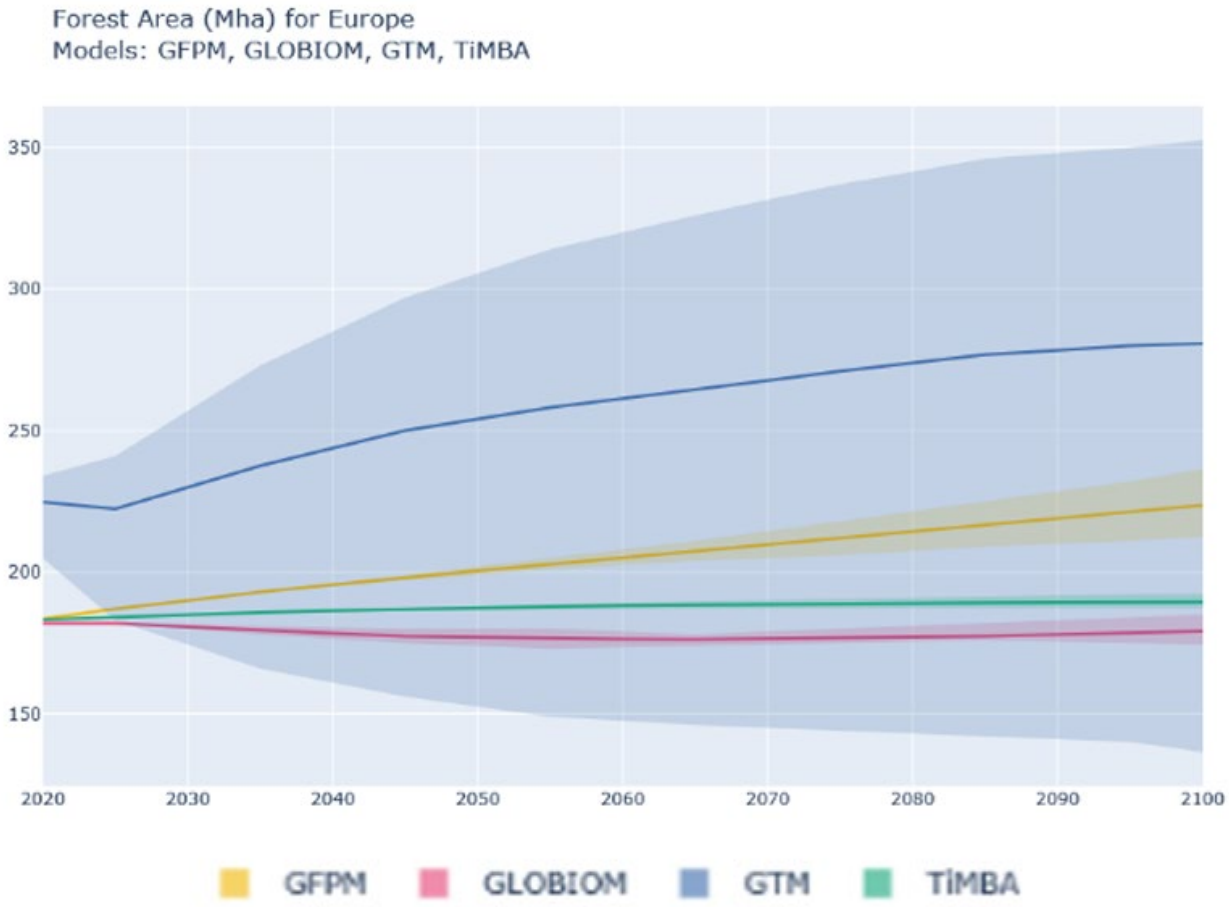
1. Forest Area trend

9% increase of Europe's forest cover in three decades (Forest Europe 2025)



1992-2015

TIMBA partial equilibrium model: forest area change

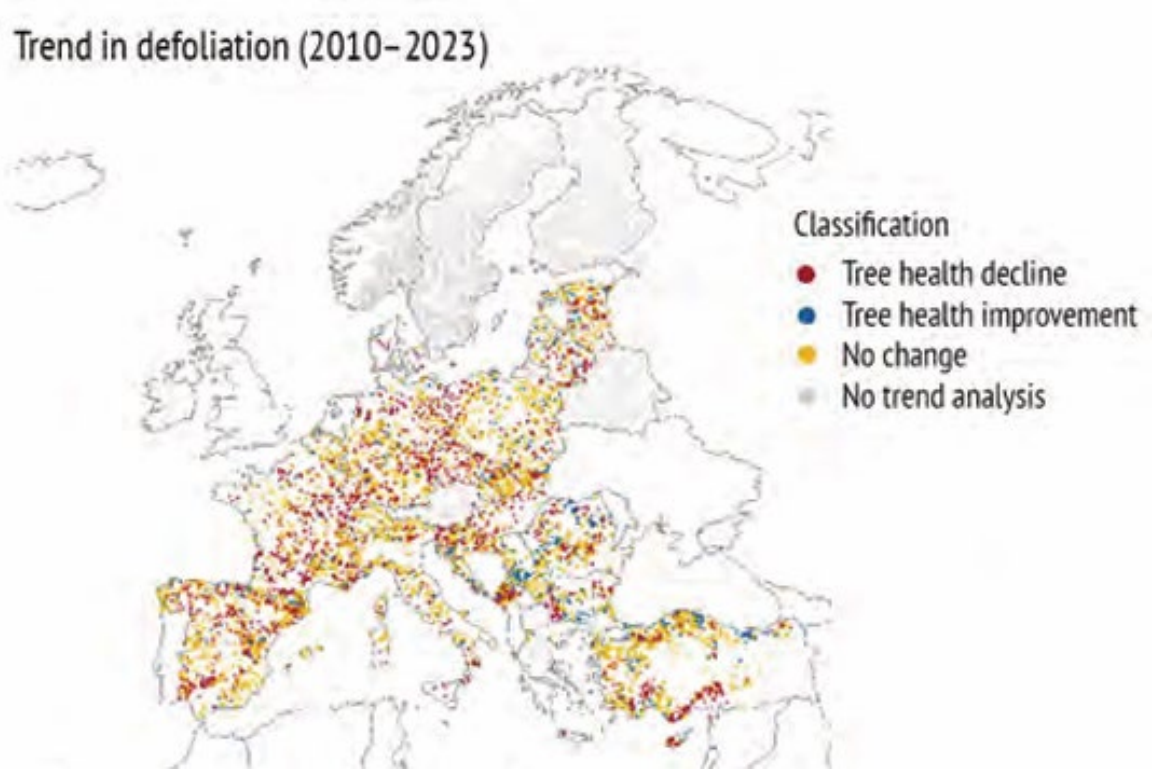


3% increase
In 2020-2100

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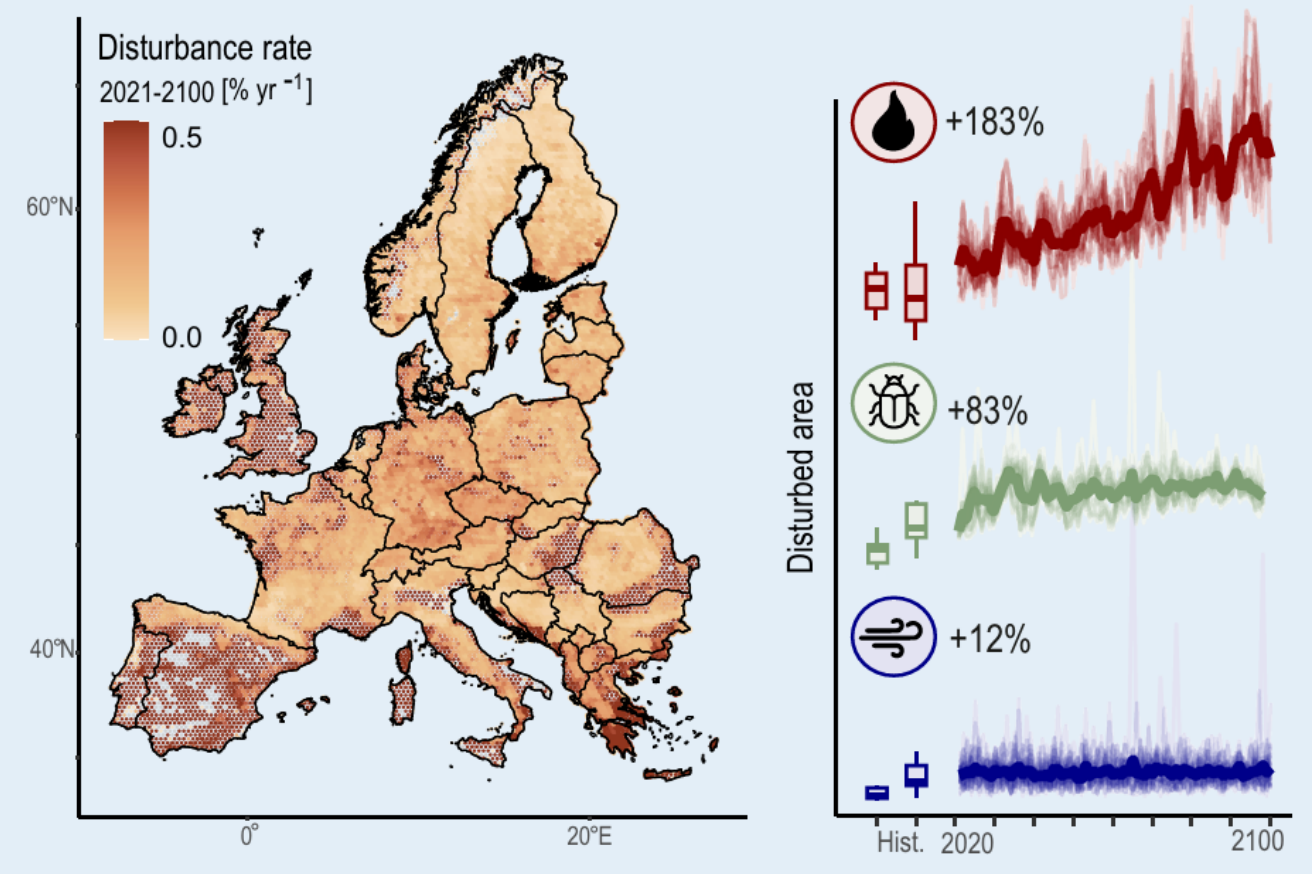
2. Forest Vitality trend

- ICP Forests Level I, 16x16 km grid
- 110,00 trees in 5600 plots, 130 species
- Decline in 33,7% of plots; Improvement in only 10,7% of plots
- On average 26% insects, 11% fungi and 16% abiotic factors



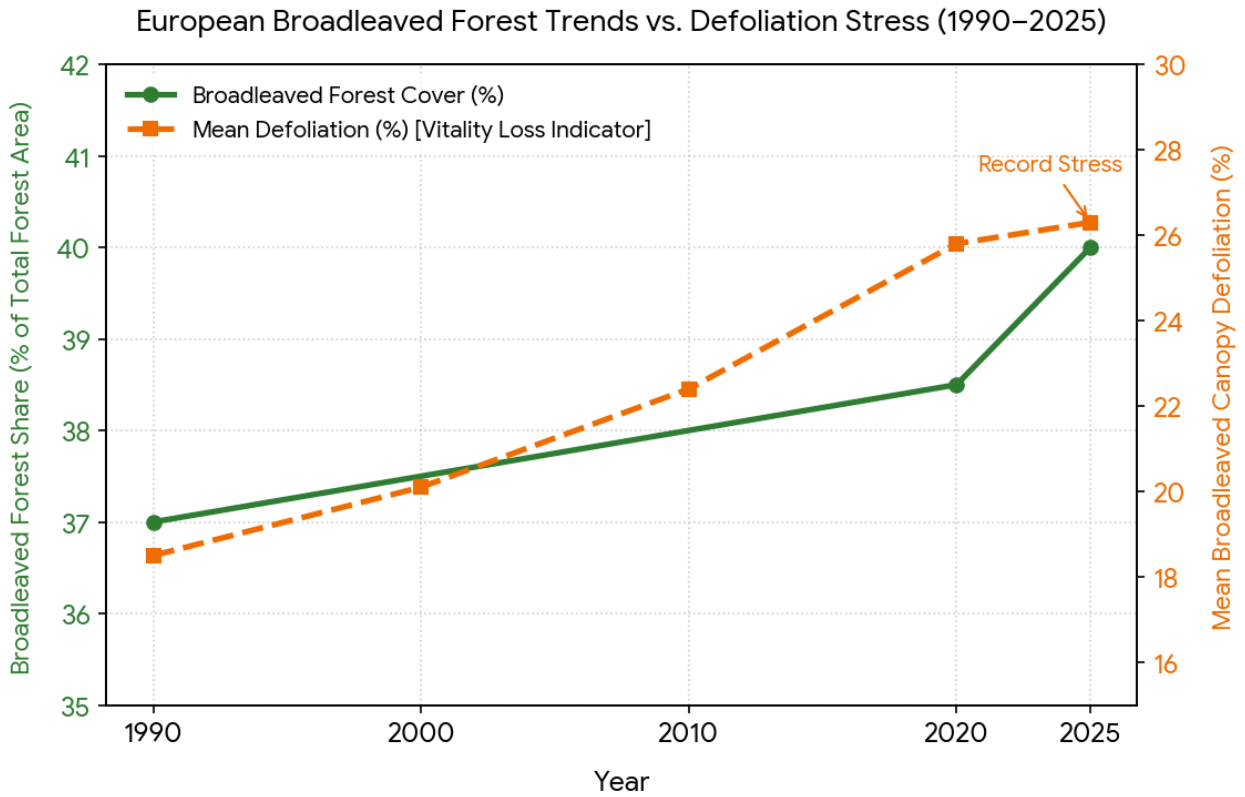
Timmermann et al. 2025. In: ICP Forests 40th Anniversary Report

forest disturbances trend



Grünig et al. 2026 *Science*

Increasing broadleaved footprint but vitality paradox

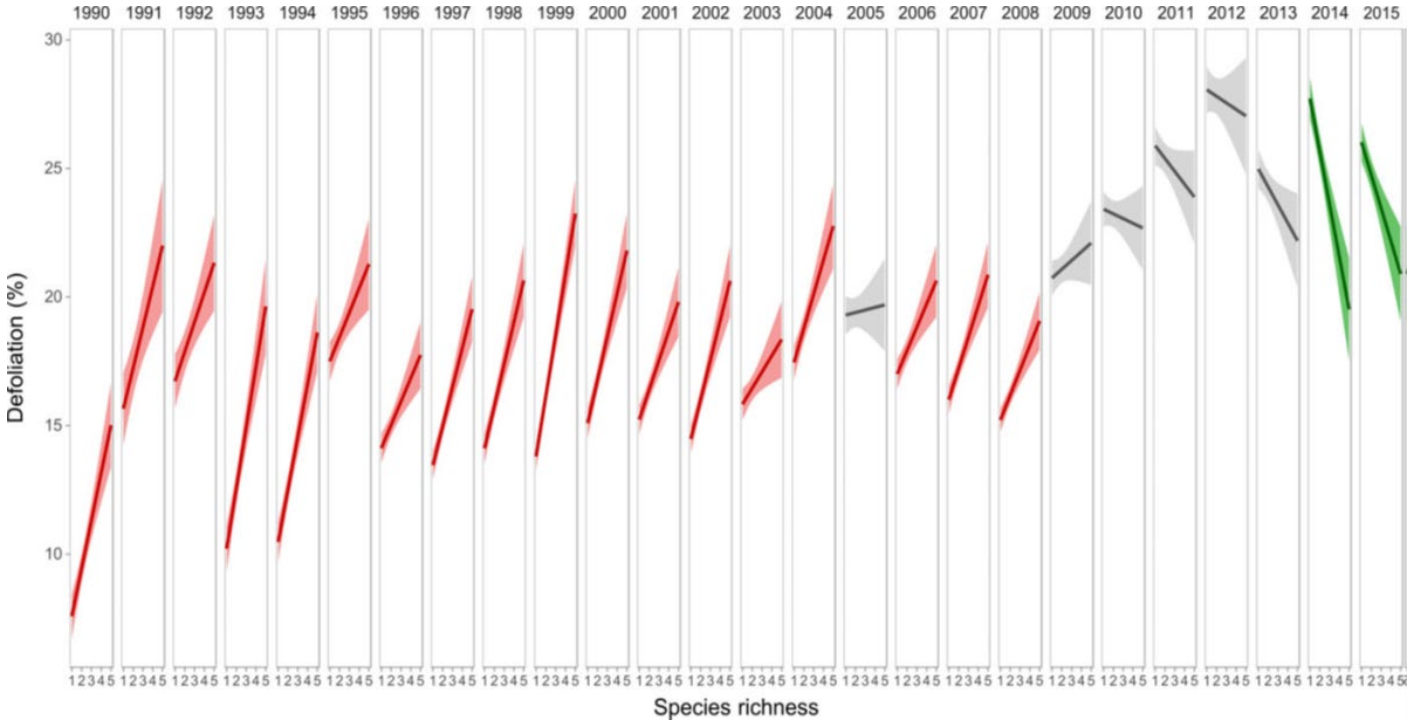


Source: Bart Muys in co-creation with Google AI, based on Forest Europe data

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EFFECT of MIXTURE

Tree diversity effect on defoliation trends in Belgian oak and beech forests (1990 – 2015)

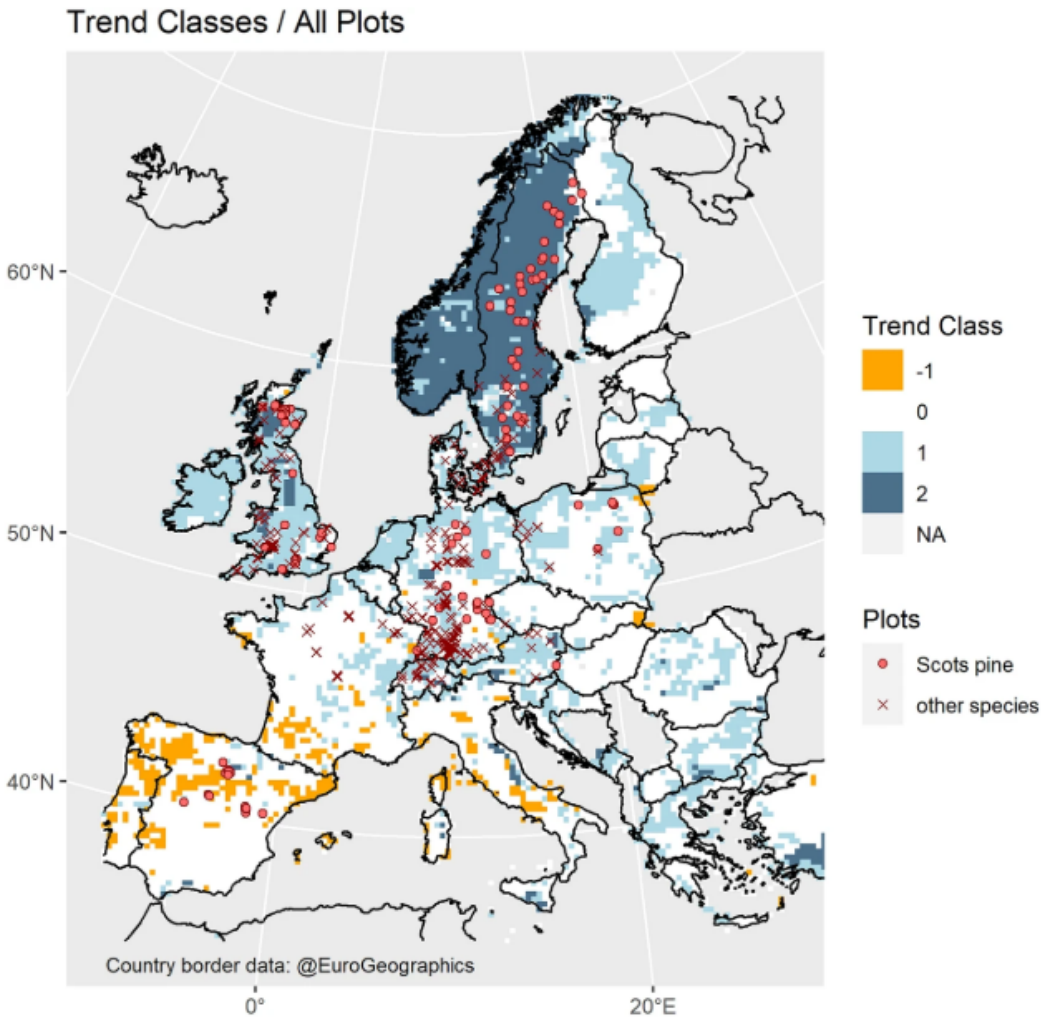


- Since 2009 there is a regime shift from vital monocultures to resilient mixtures
- Shows a **biodiversity insurance effect** under increased climate stress.

Sousa-Silva et al., 2018 *Global Change Biology*

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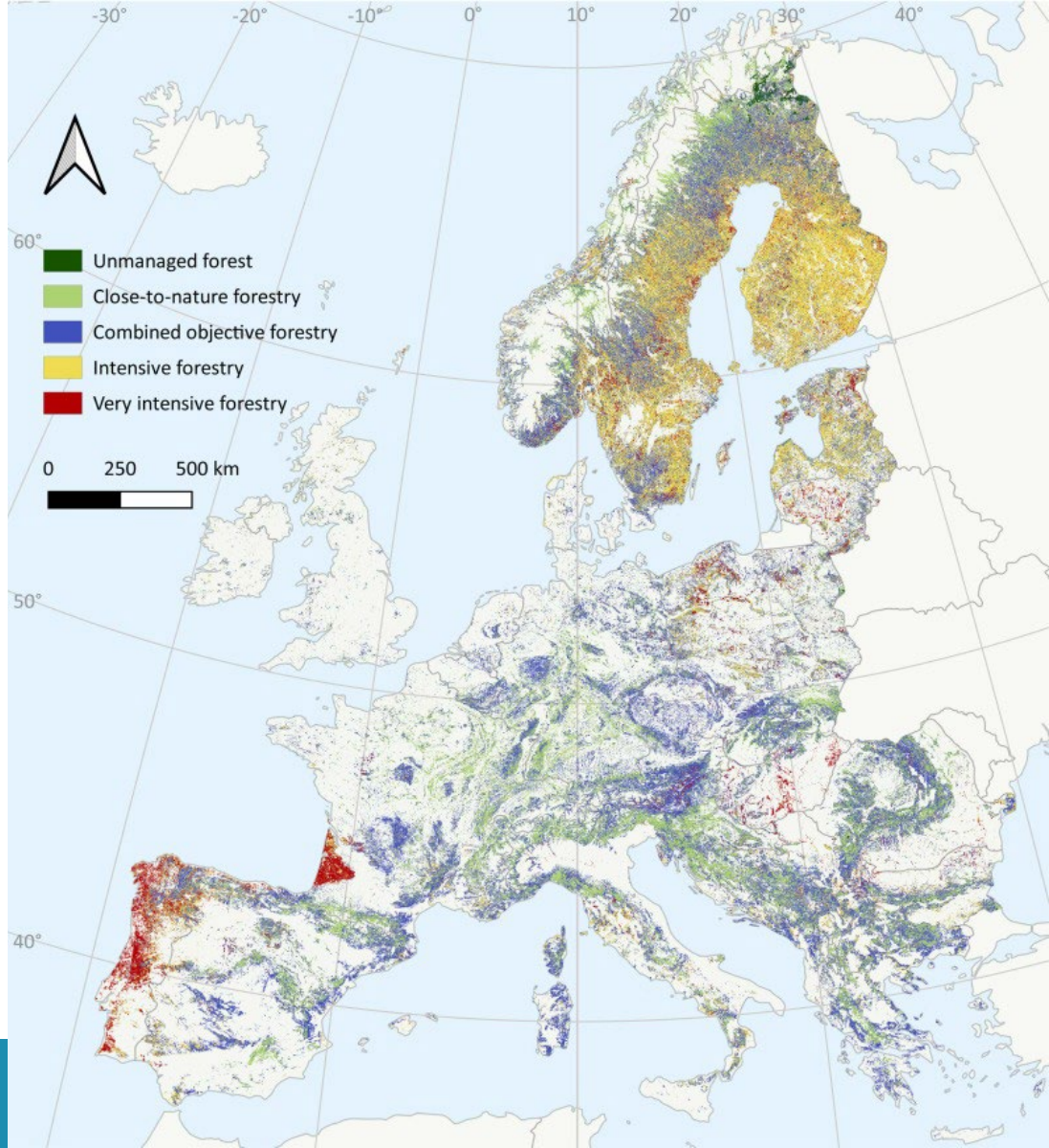
3. Forest Growth trend



Pretzsch et al. 2023 *Scientific Reports*

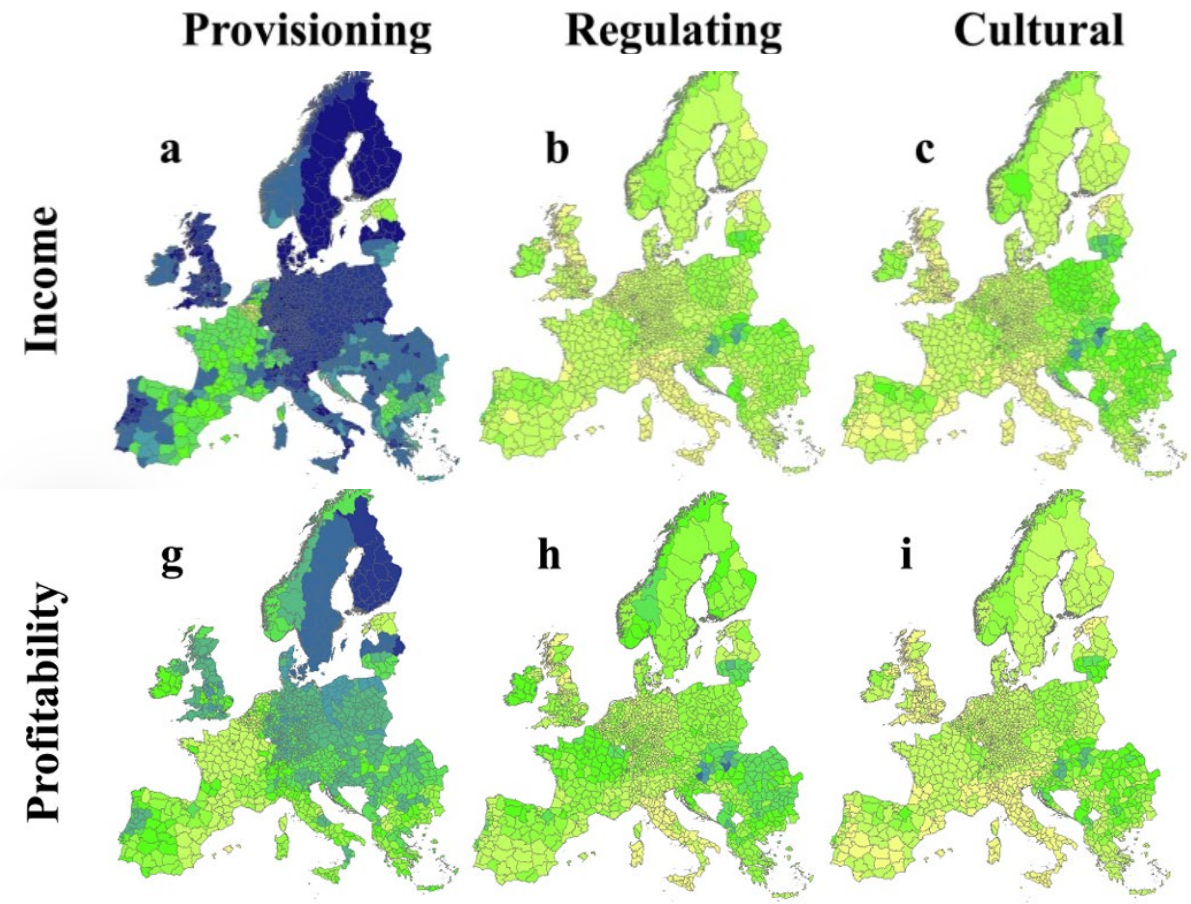
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4. Management trends



Scherpenhuijsen et al. 2025 *Foreco*

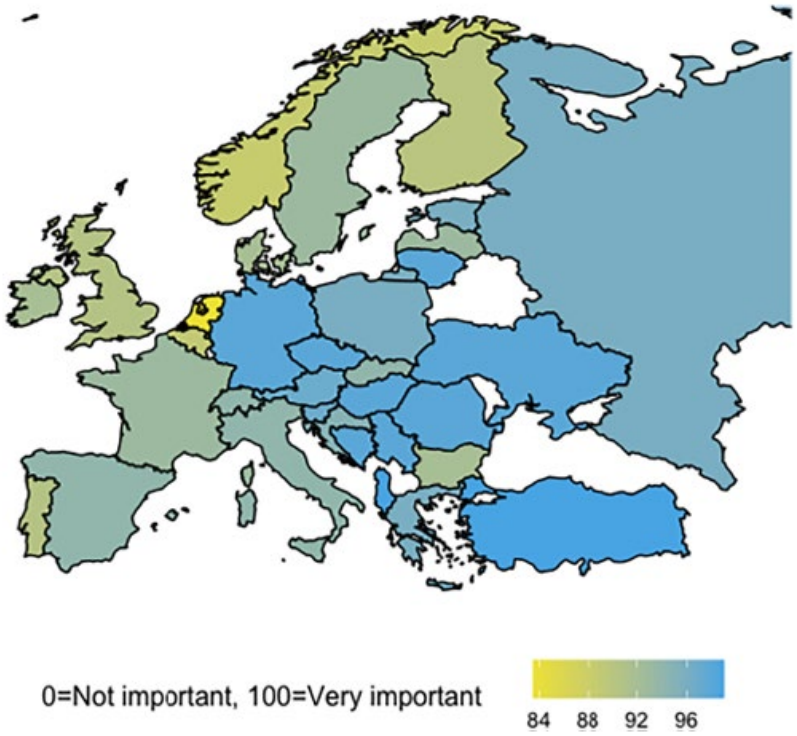
Reported income from Europe's forests



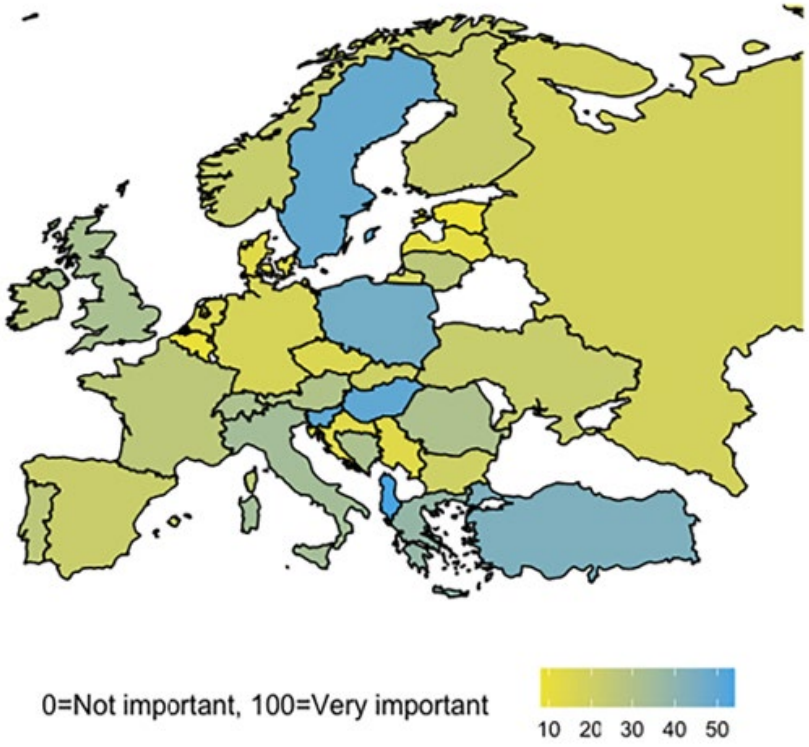
Lovric et al. 2025, *Ecosystem Services*

Social perception by European citizens about most visited forest

For biodiversity

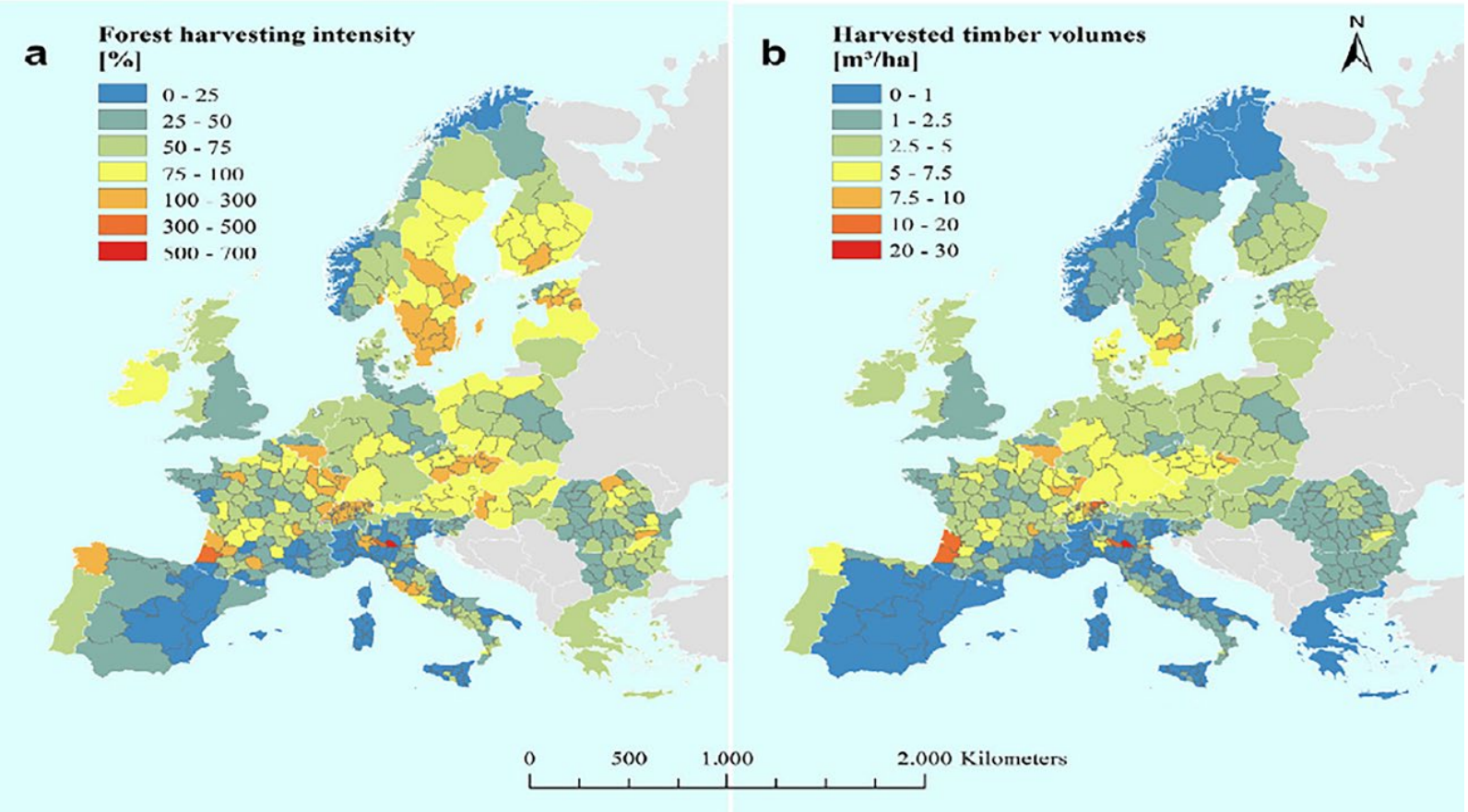


For wood production



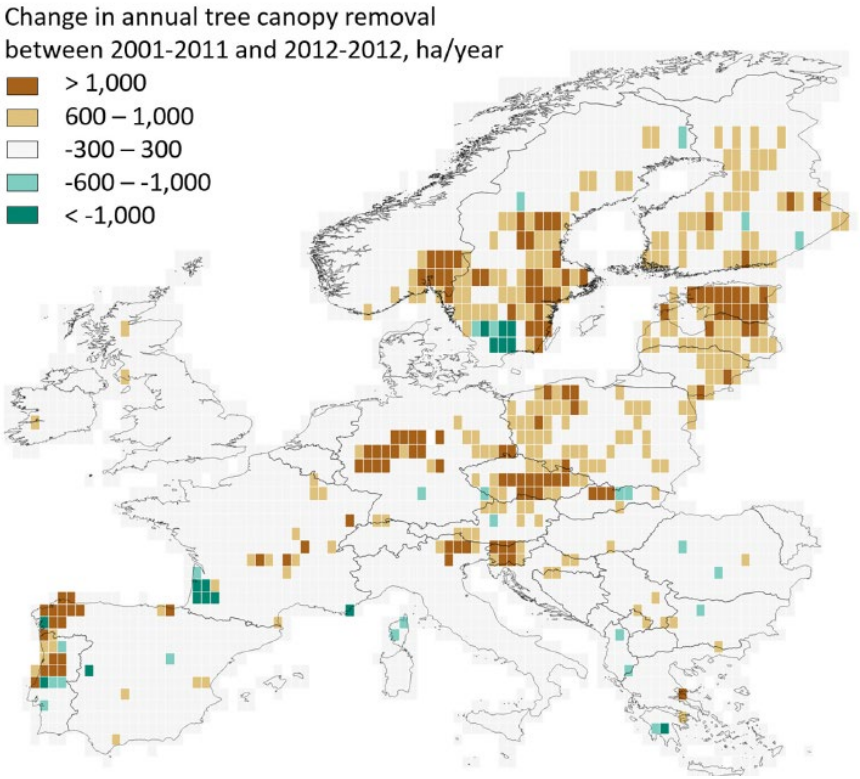
Winkel et al. 2022, *Forest Policy & Economics*

5. Wood harvest: current



Levers et al. 2014, *Forest Ecol. & Manag.*

5. Wood harvest: trend

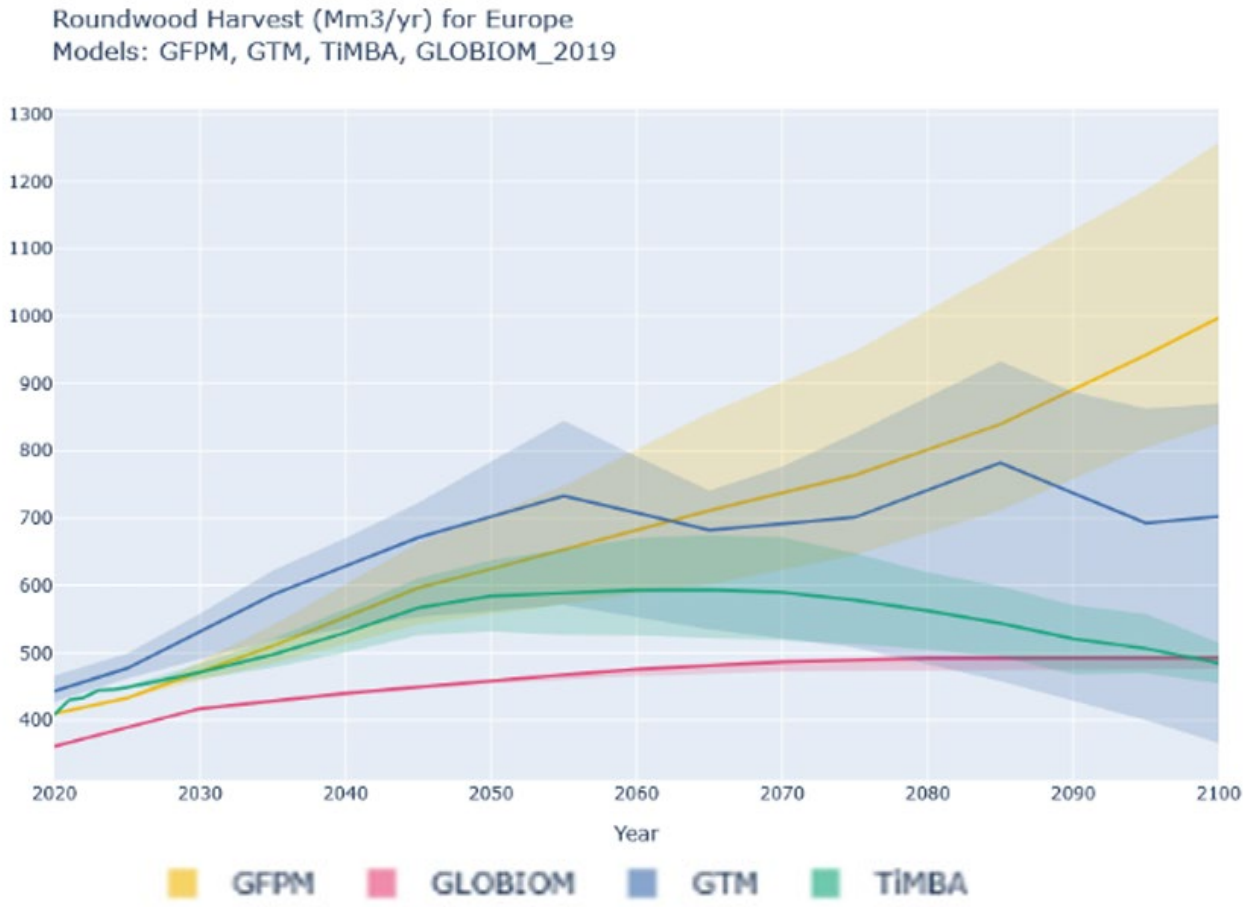


- Expressed per 50 x 50 km grid
- A considerable part is salvage logging
- RS monitoring as an early warning signal
- Needs further follow-up
- Points to the need of management plans and local monitoring

Turubanova et al. 2023 *Remote Sensing of Environment*

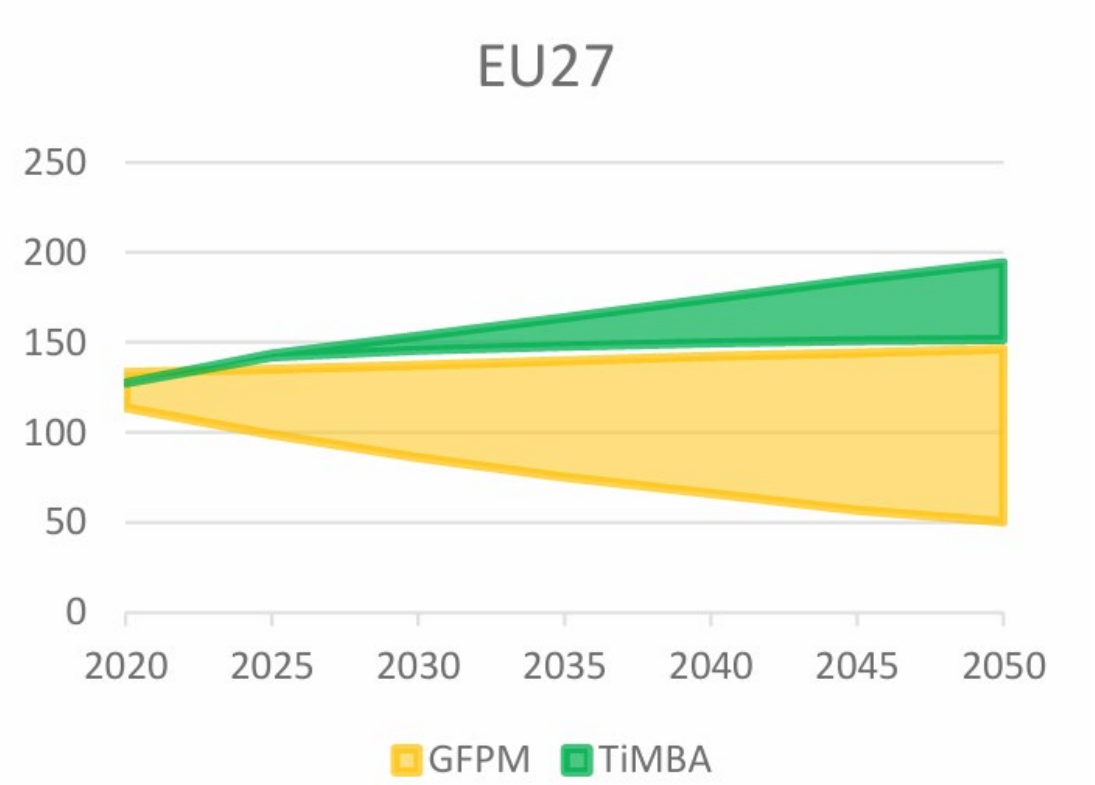
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5. Roundwood harvest prognosis (TIMBA)



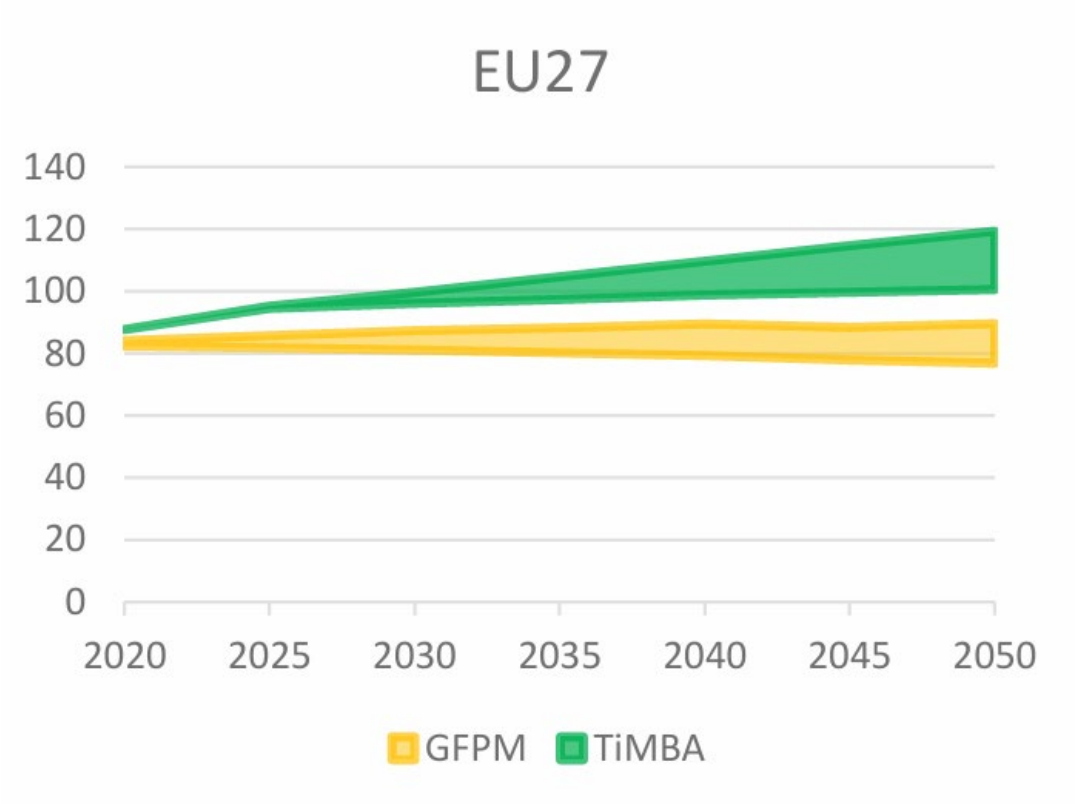
6. Demand trend

Fuelwood demand prognosis (TIMBA)



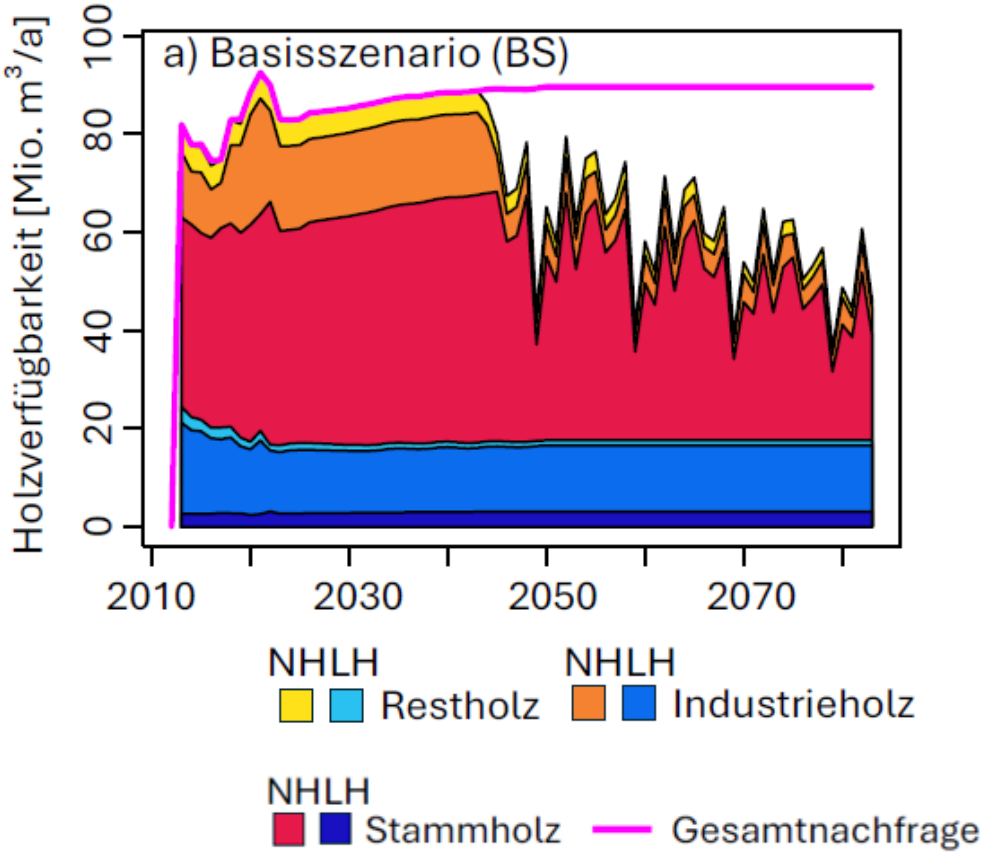
6. Demand trend

sawntimber demand prognosis (TIMBA)



6. Integration with demand

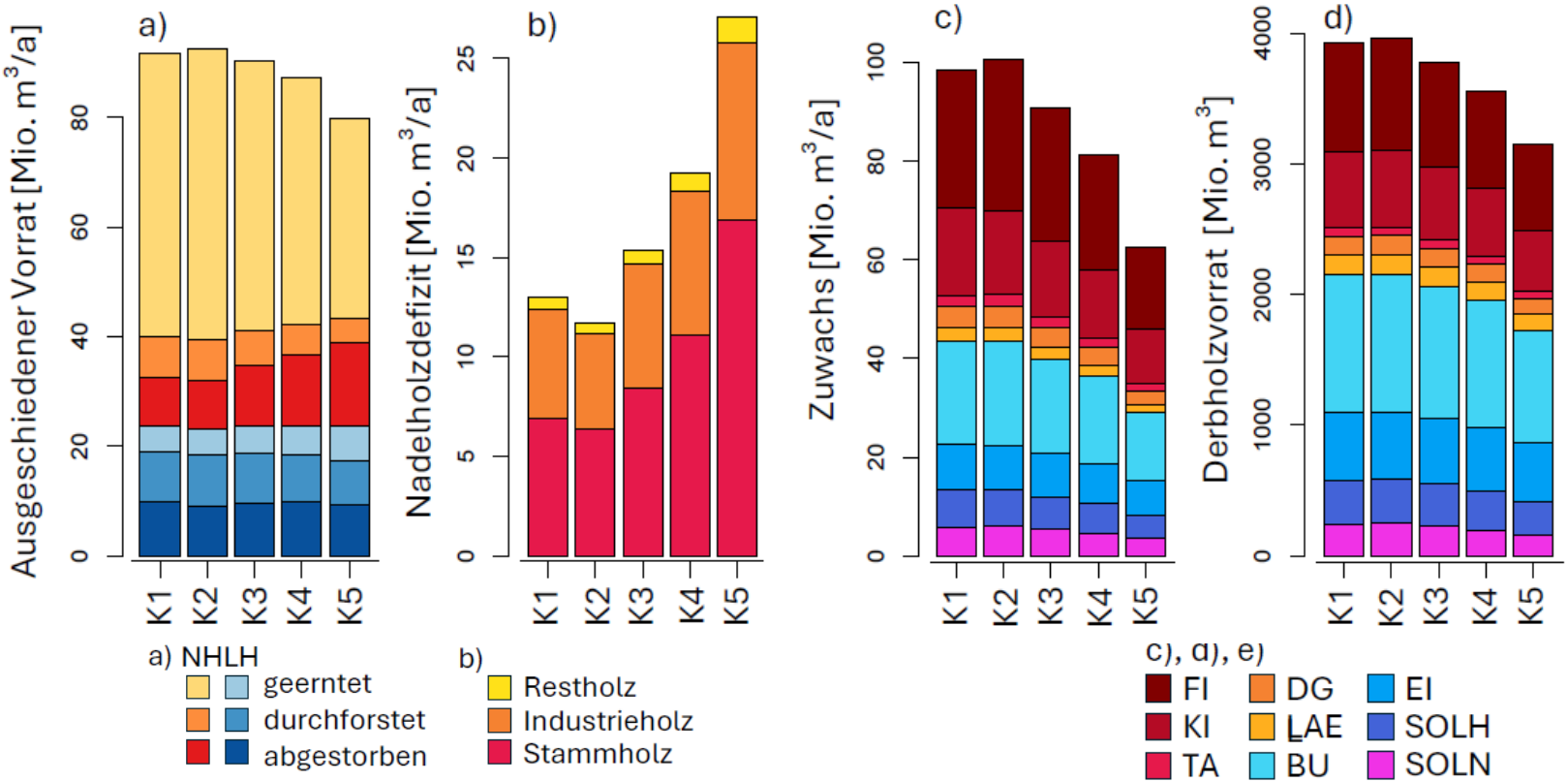
Wood availability scenario Germany



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6. Integration with demand

Wood availability scenarios Germany



7. Technological evolutions
Broadleaved as construction timber (CLT)

Wood Species	Structural Class	Density (kg/m³)	Strength-to-Weight Profile	Primary CLT Application
Norway Spruce *(Softwood Benchmark)*	Conifer	~450	**Baseline**	Standard homogenous panels
European Aspen / Poplar	Lightweight Hardwood	~420	**High** *(Equal strength to spruce but lighter)*	Core layers or lightweight panels
Silver Birch	Medium Hardwood	~620	**Excellent** *(Double the shear strength of spruce)*	Thinner, high-load homogenous panels
European Ash	Heavy Hardwood	~670	**Very High** *(Extreme elasticity and stiffness)*	High-deflection resistance & outer layers
European Beech	Heavy Hardwood	~700	**Moderate-High** *(Dense, but massive raw capacity)*	High-stress outer layers in hybrid layups

7. Technological evolutions Broadleaved in the paper industry

End Product	Hardwood Role (Short Fiber)	Conifer Role (Long Fiber)	Optimal Hybrid Blend	Key Engineering Takeaway
Premium Tissue	Maximize tactile softness & bulk	Wet-strength reinforcement	**75% HW** / 25% SW	Velvet-soft texture that won't tear apart when wet.
Copy & Book Paper	Surface smoothness & opacity	High-speed tensile strength	**80% HW** / 20% SW	Crisp, bleed-free text printing without paper jams.
Shipping Boxes	Rigid internal layer (crush resistance)	Outer liner durability	**30% HW** / 70% SW	Conifer resists transit tears; hardwood adds structural stiffness.
Liquid Cartons	Smooth outer printing skin	Puncture-resistant core	**40% HW** / 60% SW	A sandwich structure preventing bursting while keeping logos sharp.
Glossy Magazines	Fills micro-gaps for photo gloss	Reinforcing fiber mesh	**50% HW** / 50% SW	Equal balance for vibrant photo clarity and sheet stability.

7. Technological evolutions
Hardwood Biorefineries & "Lignin-First" Revolution

Hardwoods feature syringyl-rich (S-type) lignin, which allows for clean extraction without destroying the sugars.

Sels Group Breakthrough (KU Leuven): Reductive Catalytic Fractionation (RCF) "Lignin-First" process that simultaneously extracts and stabilizes lignin into high-value oils while preserving immaculate carbohydrate pulp [Science, 2024] [Science, 2020].

Process Parameter	Traditional Biorefinery	Sels Group RCF Process
Primary Wood Input	Conifer *(High chemical resistance)*	**Hardwood** *(Birch / Beech / Poplar)*
Lignin Fate	Burned on-site for low-value heat	**Upgraded into chemical building blocks**
Key Yield Outputs	Coarse cellulose pulp only	**Phenol (20%), Propylene (9%), Pure Pulp**
Total Wood Valorization	~40% – 50% *(Sugars only)*	**~78% of total wood weight utilized**
Economic & Eco Impact	High carbon footprint from burning	**Replaces petroleum**; locks carbon into plastics

Take home messages

- Wood supply from European forests is expected to decrease due to slowing forest expansion, climate change related mortality, and set aside for conservation
- Wood supply from European forests will gradually shift from softwood to hardwood, and to lower qualities.
- Forest products will remain valuable resources. Wood demand is expected to grow in a context of defossilization, energy and resource autonomy. Hardwoods have strong technological features to fill the demand.
- Homegrown wood scarcity may appear from 2050, and may not be easily compensated by import, given huge increases in demand in other continents

Thank you for your attention

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