

Digital Forests: How Data-Driven Management Boosts Growth and Carbon Capture

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Climate Challenge → Policy Response → Our Solution

Problem: Current Carbon Offsets Are Fundamentally Problematic

- **Offset Problems**
- **Transparency Issues**
- **Accuracy Problems:**
low-resolution data
- **Structural Barriers:**
reliance on tropical forests faces challenges—boreal forests offer a transparent, verifiable alternative



Policy / Path Forward

- 2024: CRCF Regulation in force
- 2025-2027: first certified units
- 2028: EU registry opens

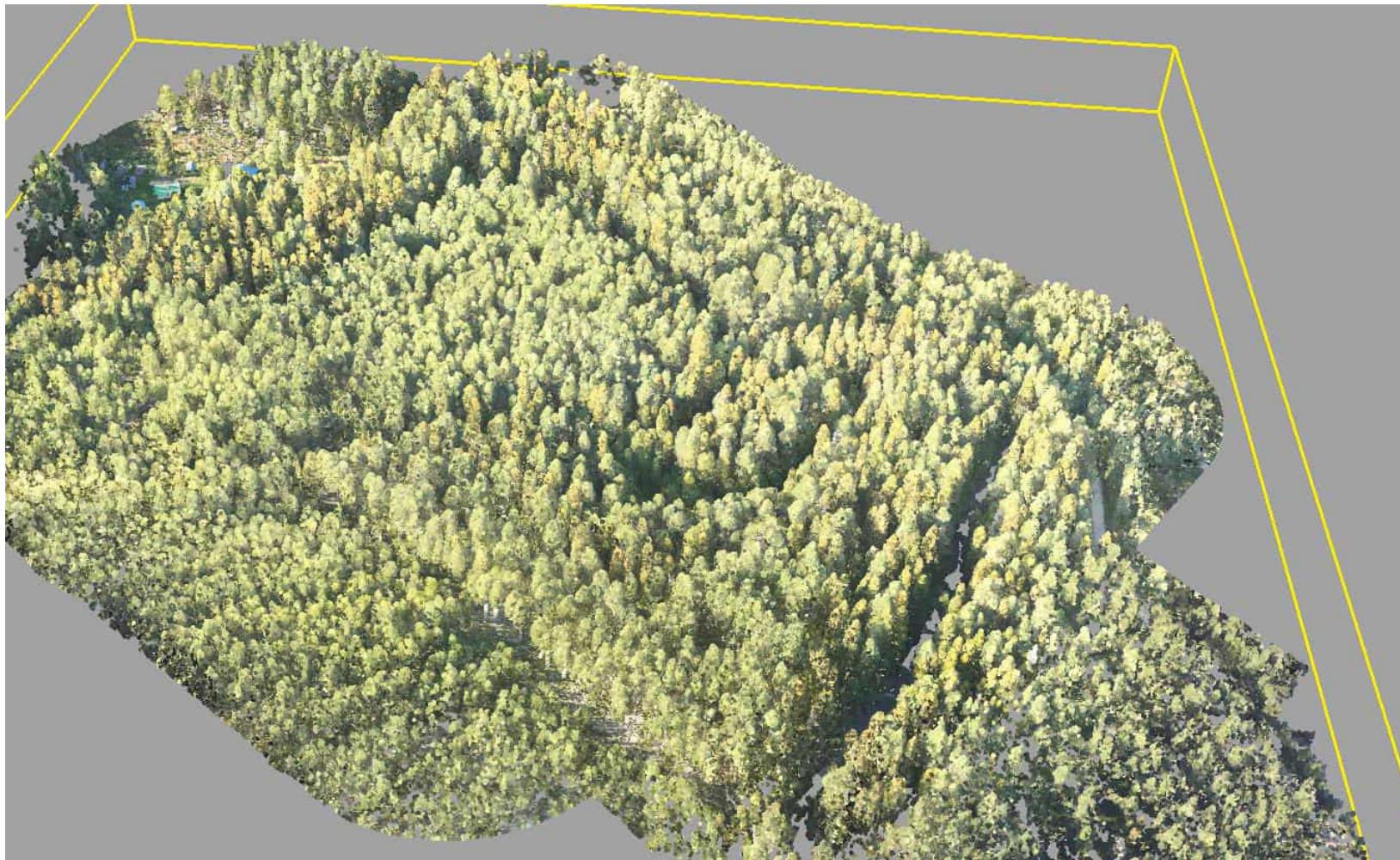


Need for Better Solutions: To restore trust in carbon markets, we must measure and manage forests with precision. Europe is moving towards high-quality carbon credits under the new EU framework.

Our work delivers this: data-driven digital twins that provide verifiable carbon gains.

What Are “Digital Forests”?

- **Digital Twin:** Virtual replica of a forest from 3D scans, capturing every tree’s size and position.
- **Tree-Level Data:** Height, diameter, species, and health measured for all trees — far beyond traditional sample plots.
- **Benefits:** Enables competition analysis, growth and carbon modeling, and virtual testing of management scenarios.

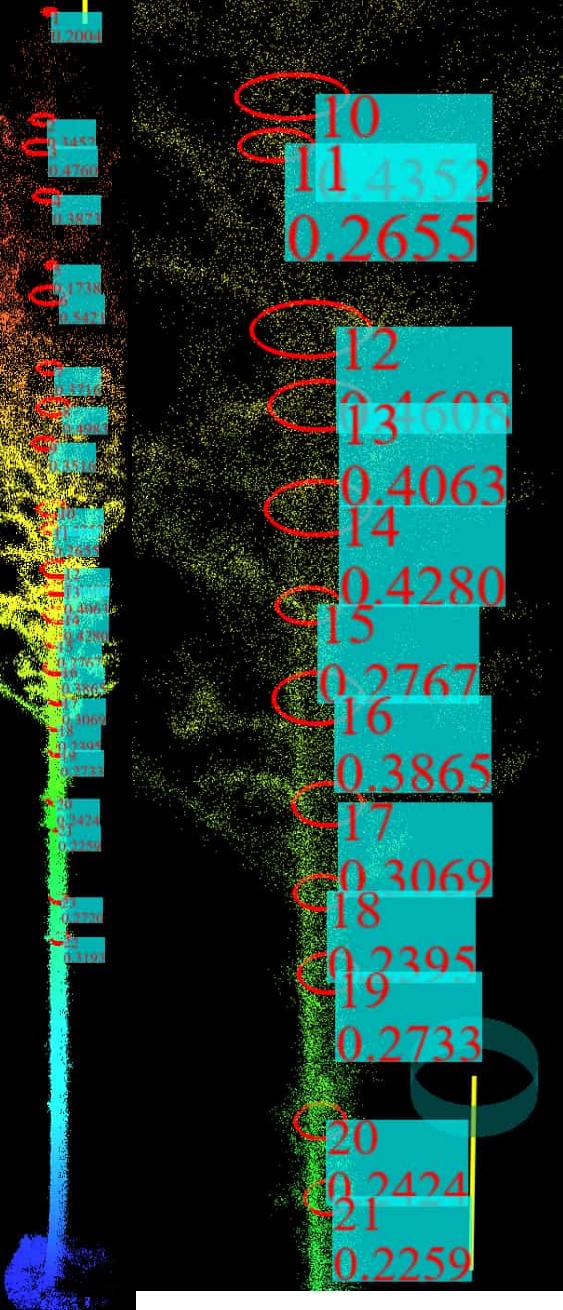


Data Collection – Drones & Harvesters for Tree-Level Inventory



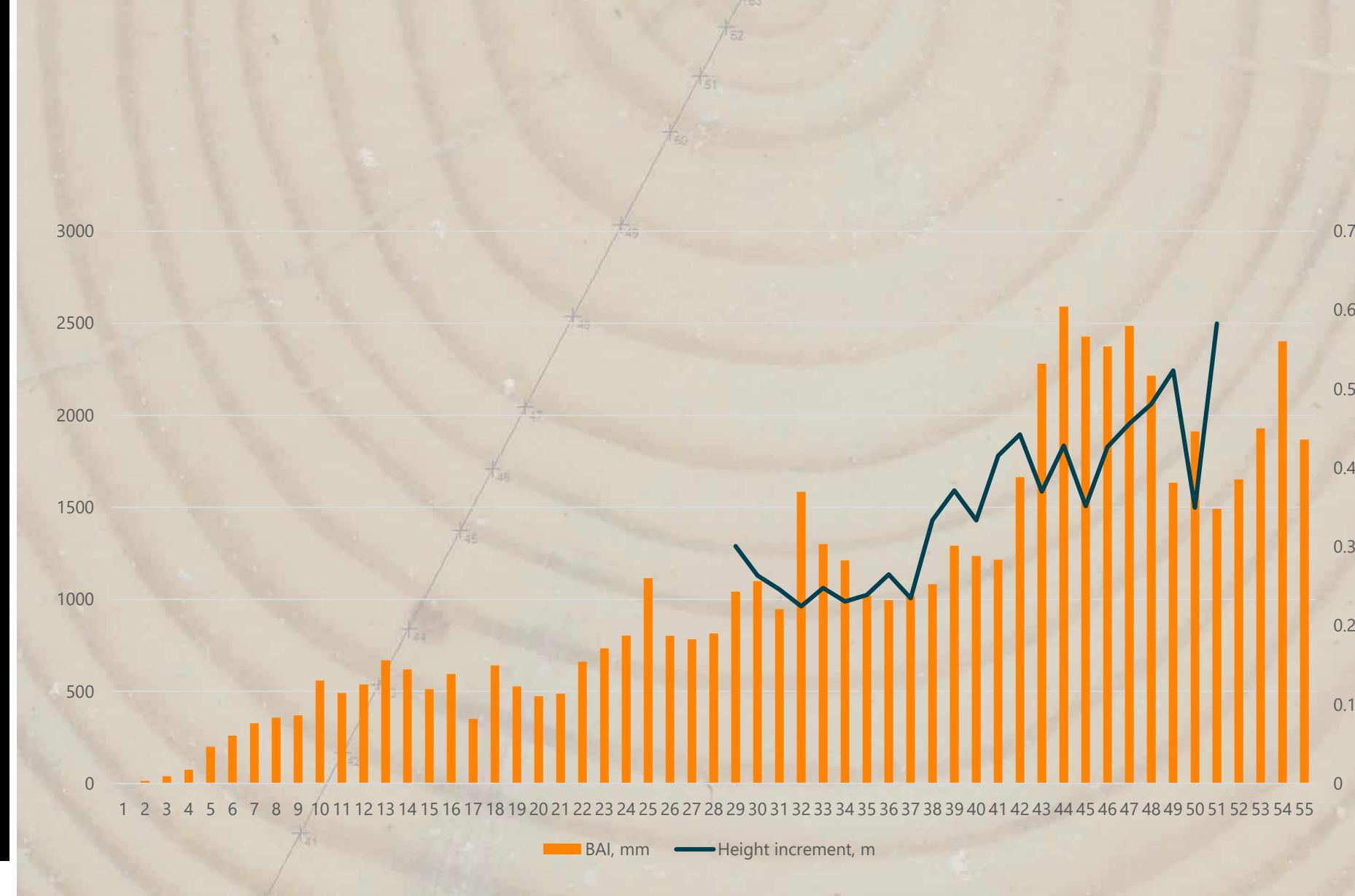
- **Drone LiDAR survey (Evo, Finland):** 1.3 ha scanned → ~1,500 trees (birch, spruce, pine).
- **Tree-level attributes:** Height, DBH, species from LiDAR; validated with ground plots + harvester GPS.
- **Digital twin created:** Every tree mapped, enabling precise stand volume and carbon calculations — a true *forest census*.





Tree growth assessment: laser scanning vs. tree-rings

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An aerial photograph of a dense forest. The forest is composed of numerous tall, thin green trees, likely conifers, arranged in a grid-like pattern. Scattered throughout the forest are numerous fallen tree stumps, which are visible as circular brown spots on the forest floor. These stumps are concentrated in certain areas, suggesting a traditional thinning or logging operation. The overall scene is a mix of vibrant green and earthy brown tones.

**Traditional thinning limitations:
subjective, suboptimal tree selection**

Data-Driven Forest Management (Our Approach)

-  **Traditional thinning**

Operator selects trees by guidelines/experience → often suboptimal for growth and carbon.

-  **Optimized thinning**

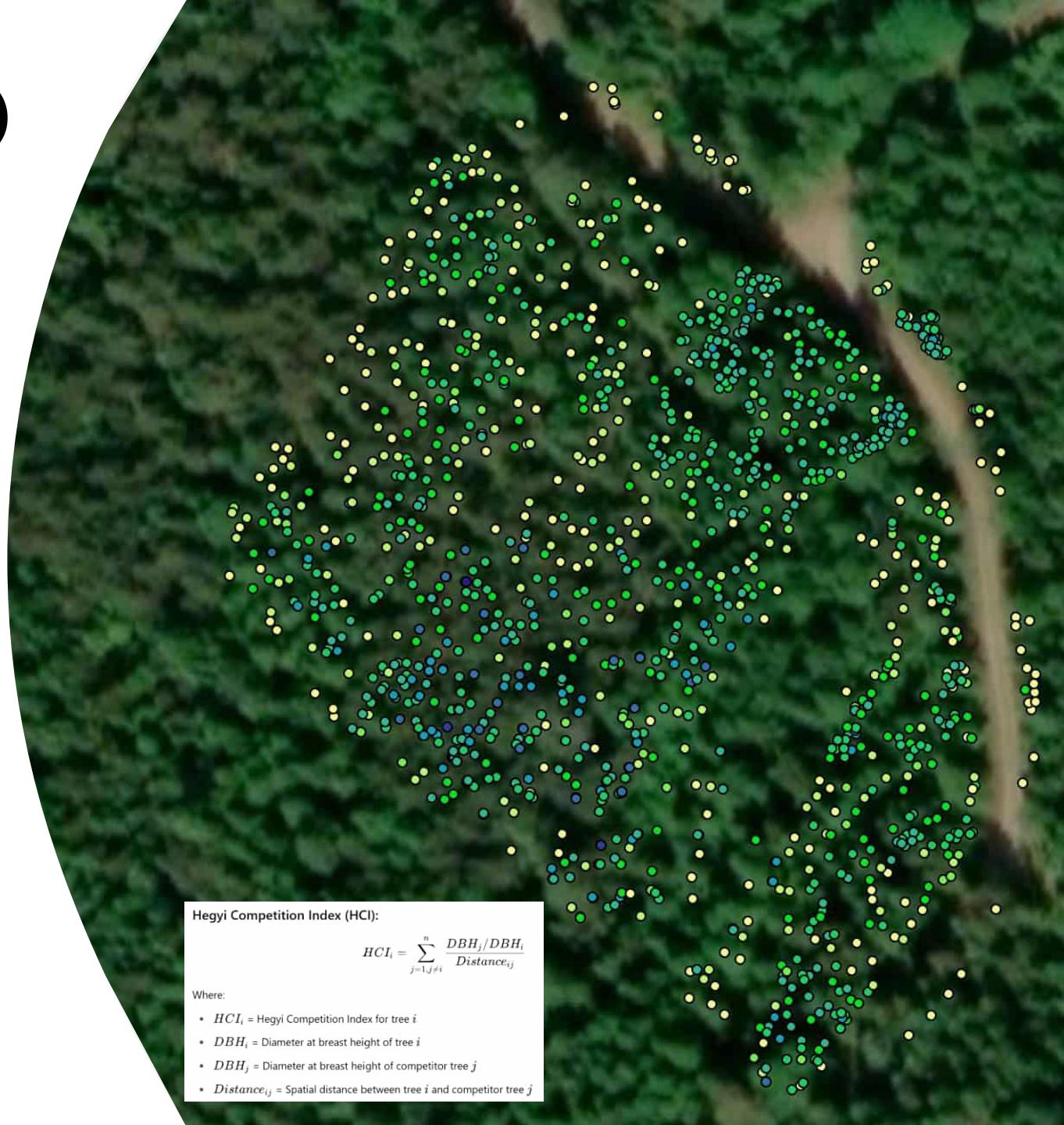
Digital twin + species-specific growth models + competition analysis → algorithm chooses trees to remove.

-  **How it works**

- Competition index (e.g., Hegyi) for each tree.
- Simulate growth (DBH, height, volume) under different thinning options.
- Select scenario that maximizes timber yield + carbon storage.

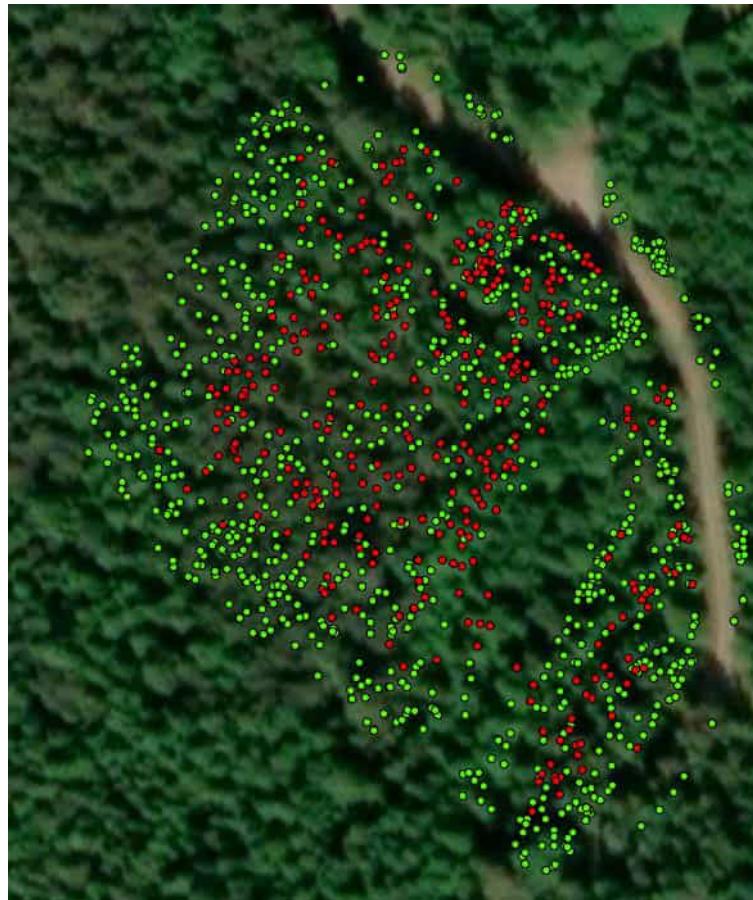
-  **Practical constraints**

Optimization respects real-world limits (e.g., harvester reach ~12 m) → plans are realistic and field-ready.

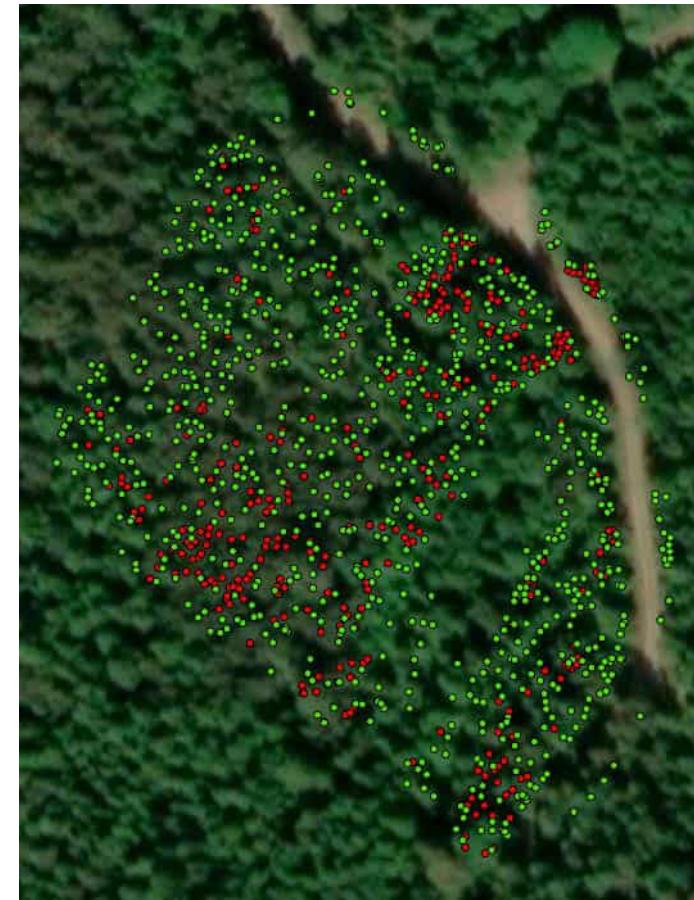


Conventional vs Optimized Thinning – Visual Comparison

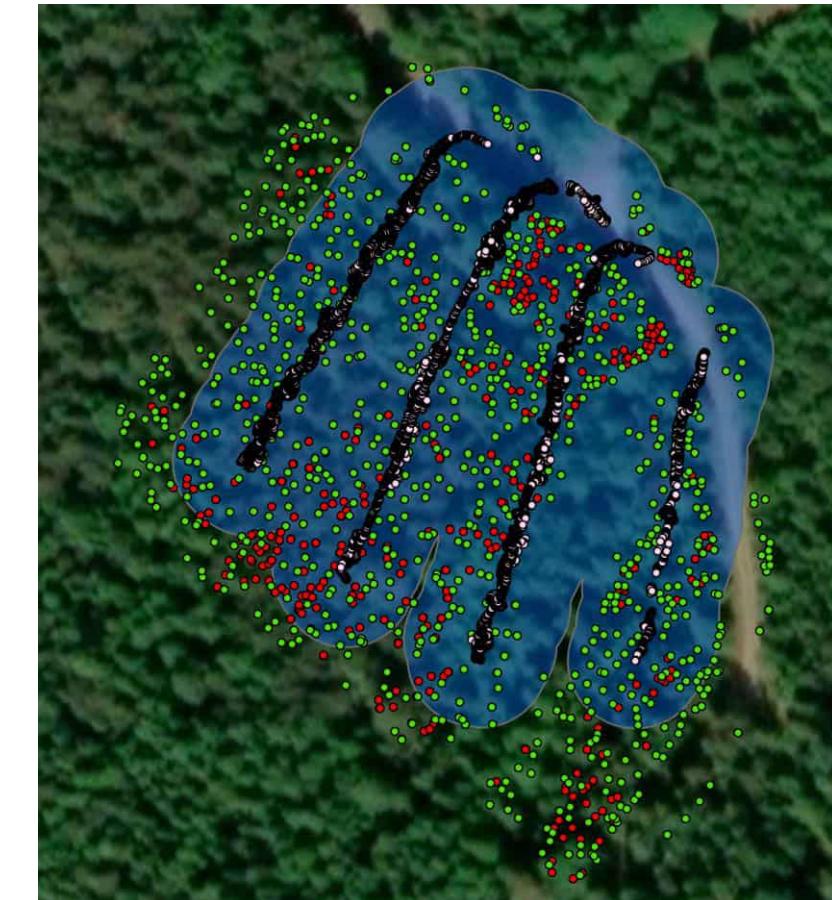
Operator's decision



Future growth maximized decision



Machine-constrained tree selection



Results – Boosting Forest Growth

 **Significant growth increase:** Data-driven thinning boosted forest growth in 10-year simulations.

 **Additional volume growth:**

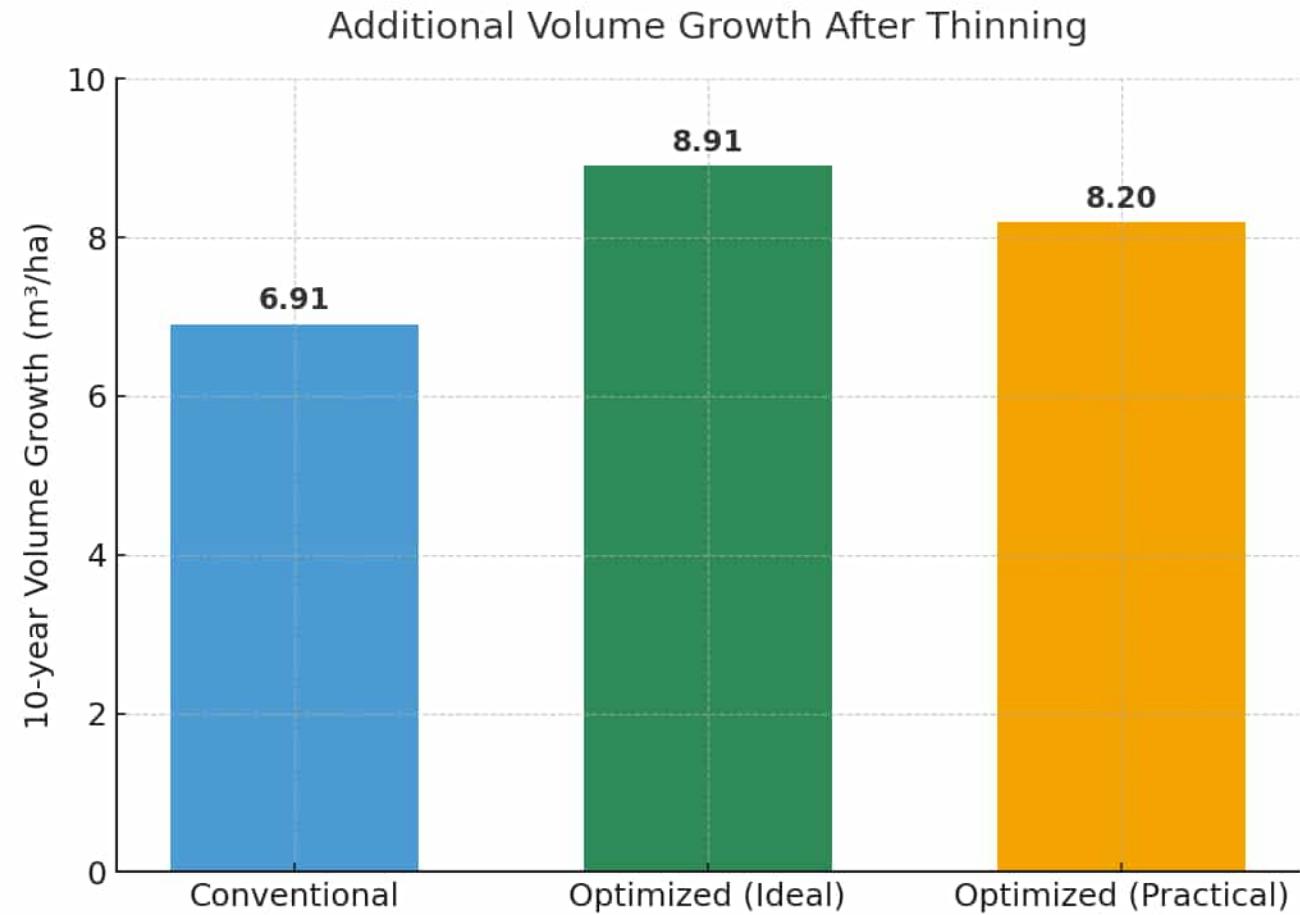
Conventional thinning → ~6.9 m³/ha

Optimized thinning → ~8.9 m³/ha

Even with machine limits → strong gains maintained.

 **Implication:** +29% growth = more timber, higher economic value.

 **Result:** Conventional vs Optimized → clear +29% increase.



Results – Enhanced Carbon Capture

-  **More carbon sequestered**

Optimized thinning boosts growth → ~30% more carbon stored in 10 years.

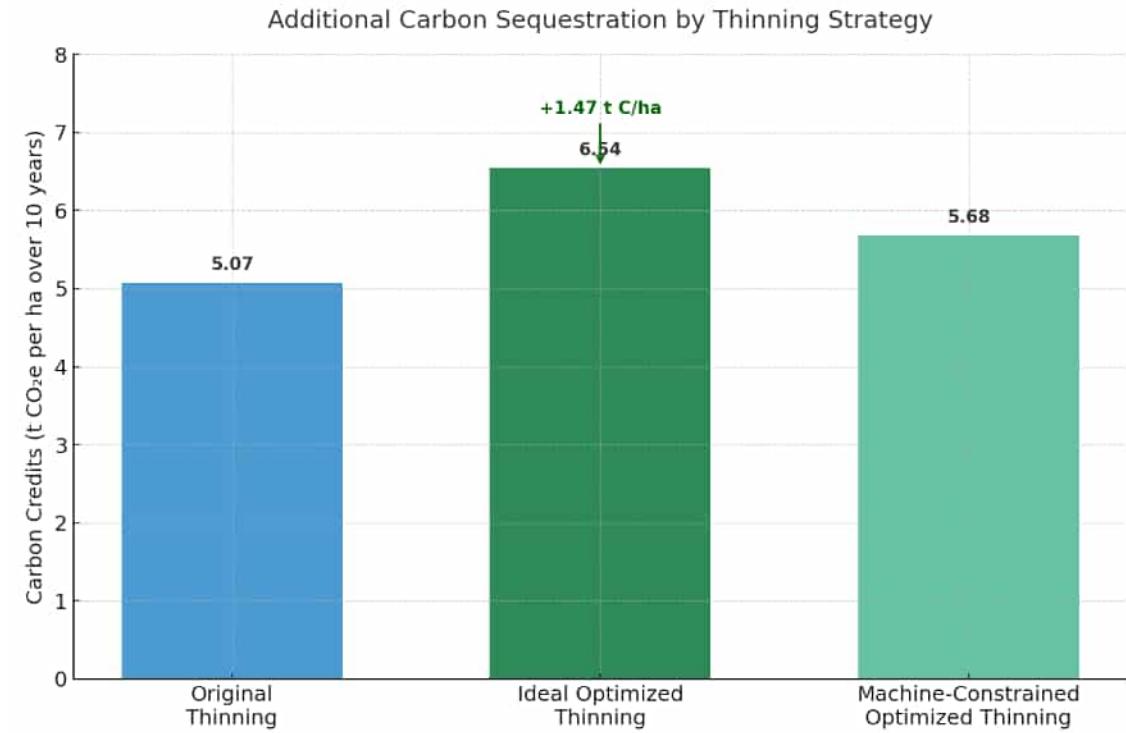
-  **Numbers**

- Conventional: ~5.1 t C/ha
- Optimized: ~6.5 t C/ha
- Extra gain: **+1.4 t C/ha (~5.1 t CO₂)**

-  **Climate impact**

Digital forests help meet climate goals by locking more CO₂ per hectare.

→ Scaled up: bigger carbon stocks & reliable, data-backed carbon credits.



Ilmostar as a Catalyst for New Research Projects

**BUSINESS
FINLAND**

Interreg  Co-funded by
the European Union
Northern Periphery and Arctic

- **Digital Forest Carbon Twins** (2025-2026), €700k
- **FORESTCARBOVISION Empowering Communities through Forest Carbon Farming: Building Climate Resilience and Sustainable Resource Management** (2025-2028), €975k

Conclusion

Data-driven forestry is here now

Digital twins + optimized management → **~30% gains** in growth & carbon uptake.
→ Scalable solution for smarter, climate-friendly forestry.

Goal

Scale innovations from **pilots** → **regional & international deployment**.

Partners

Cross-border collaboration (**Finland, Iceland, Ireland, etc.**).

