



# **The role of forest recovery from biotic and abiotic threats for risk resilient management**

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Funded by  
the European Union

**ForestValue2**



# Aims

1. Provide strategies for sustainable forest management in a changing climate
2. Understand the dynamics of disturbances in European forests
3. Investigate and predict recovery patterns after disturbance



# Addressing constraints of sustainable forest management

COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN  
PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL  
COMMITTEE AND THE COMMITTEE OF THE REGIONS

**EU Biodiversity Strategy for 2030**

Bringing nature back into our lives

**Adapt forests to climate change  
Improve multi-functionality  
Promote mixed forests**

REGULATION (EU) 2018/841 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL  
of 30 May 2018

on the inclusion of greenhouse gas emissions and **removals from land use, land use change and  
forestry** in the 2030 climate and energy framework, and amending Regulation (EU) No 525/2013  
and Decision No 529/2013/EU



European  
Commission



European  
Parliament

**Protect 30% of EU land area  
Strictly protect 10% of EU land area**

COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN  
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COMMITTEE AND THE COMMITTEE OF THE REGIONS

**New EU Forest Strategy for 2030**

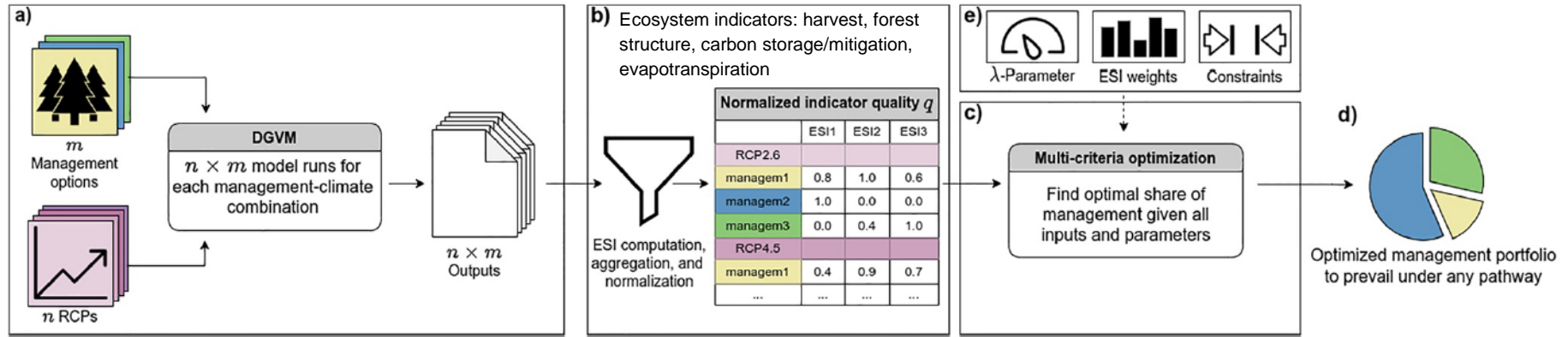
**EU forests must be a sink in  
every country  
Total EU forest sink of 310  
MtCO<sub>2</sub>/yr**

**→ all the while wood demand is increasing!**

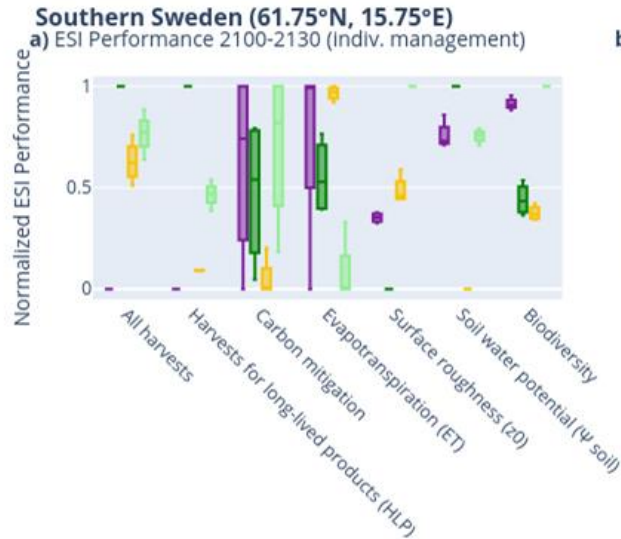


Gregor, K., Reyer, C. P. O., Nagel, T. A., Mäkelä, A., Krause, A., Knoke, T., & Rammig, A. (2024).  
Reconciling the EU forest, biodiversity, and climate strategies. Global Change Biology, 30(8), e17431.

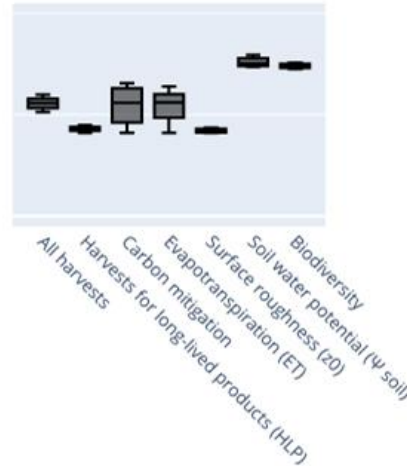
# Using dynamic vegetation modelling and robust optimization



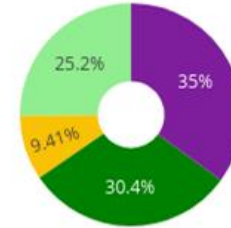
# Addressing constraints of sustainable forest management



**b) ESI Performance 2100-2130 (default-opt)**



**c) default-opt portfolio**



Forest  
management  
options

- unmanaged
- broadleaved
- needleleaved
- coppice

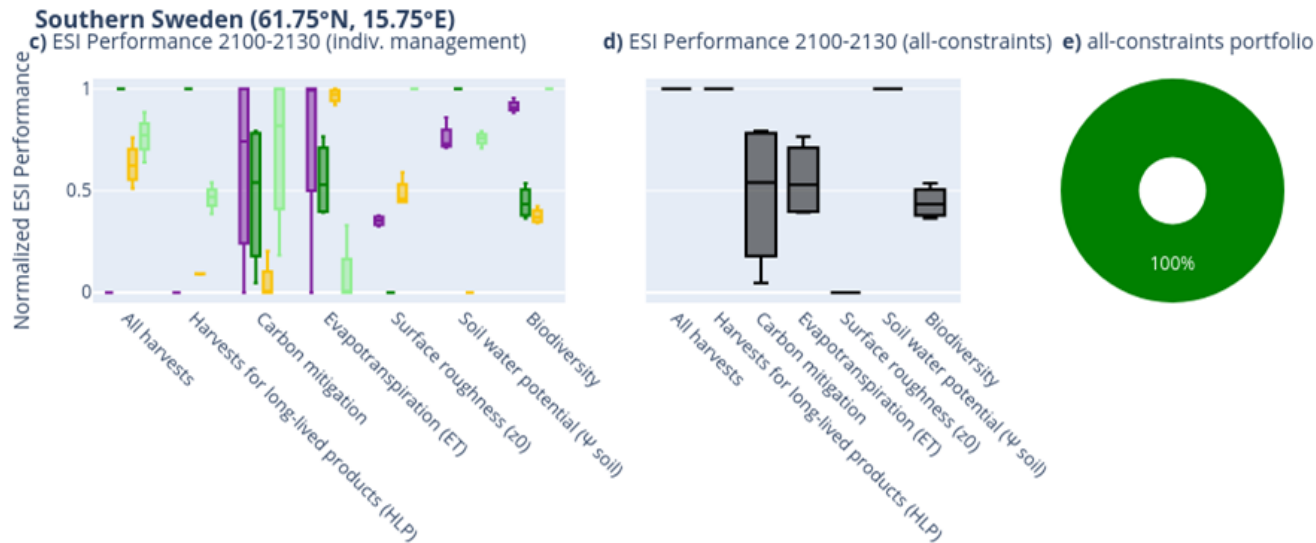


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# Addressing constraints of sustainable forest management

## + Add constraints

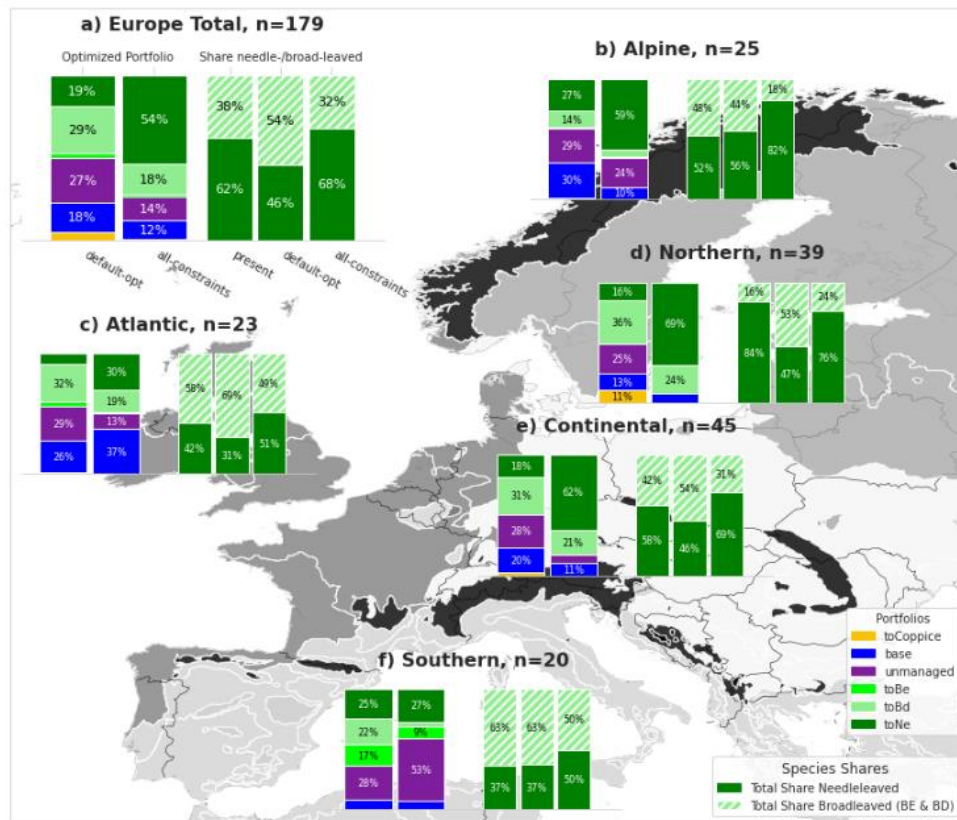
- ✓ Enforce stable harvest levels
- ✓ Enforce strict protection on 10% of land area
- ✓ “Hard constraints”: must be met under all scenarios



Gregor, K., Reyer, C. P. O., Nagel, T. A., Mäkelä, A., Krause, A., Knoke, T., & Rammig, A. (2024). Reconciling the EU forest, biodiversity, and climate strategies. *Global Change Biology*, 30(8), e17431.



# Addressing constraints of sustainable forest management



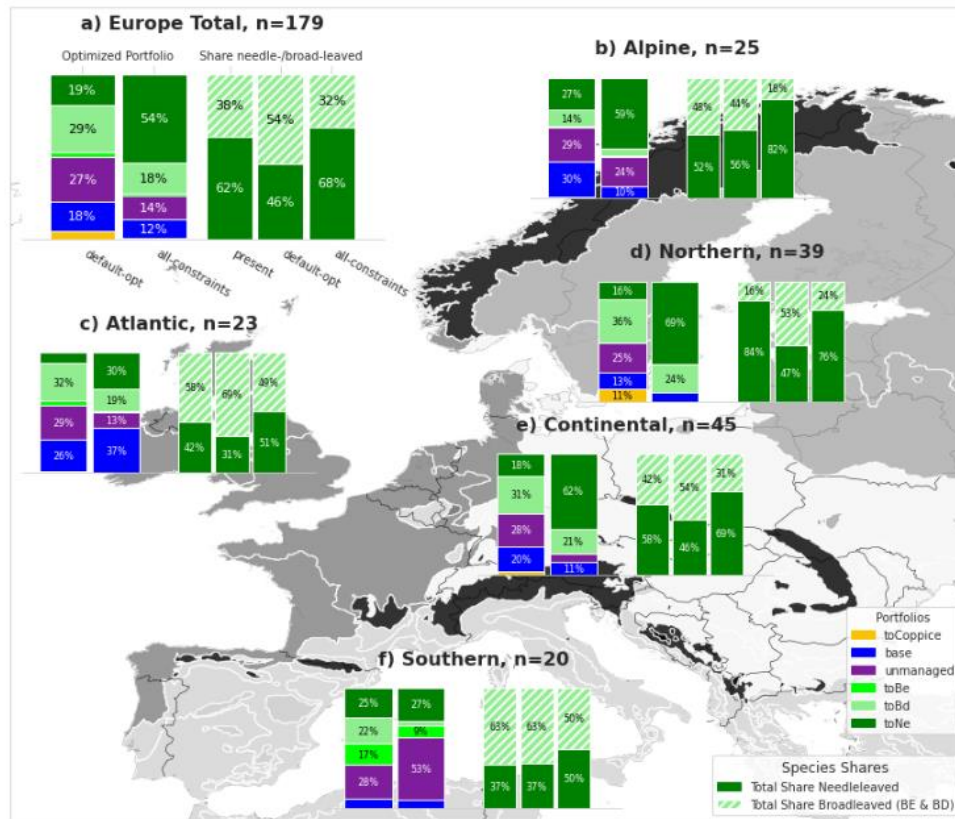
Constraints heavily restrict the balanced provision of ecosystem services

Less diversification



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# Addressing constraints of sustainable forest management



Constraints heavily restrict the balanced provision of ecosystem services

Less diversification

How to include the impacts of disturbance in more detail?  
Are simulated recovery patterns realistic?





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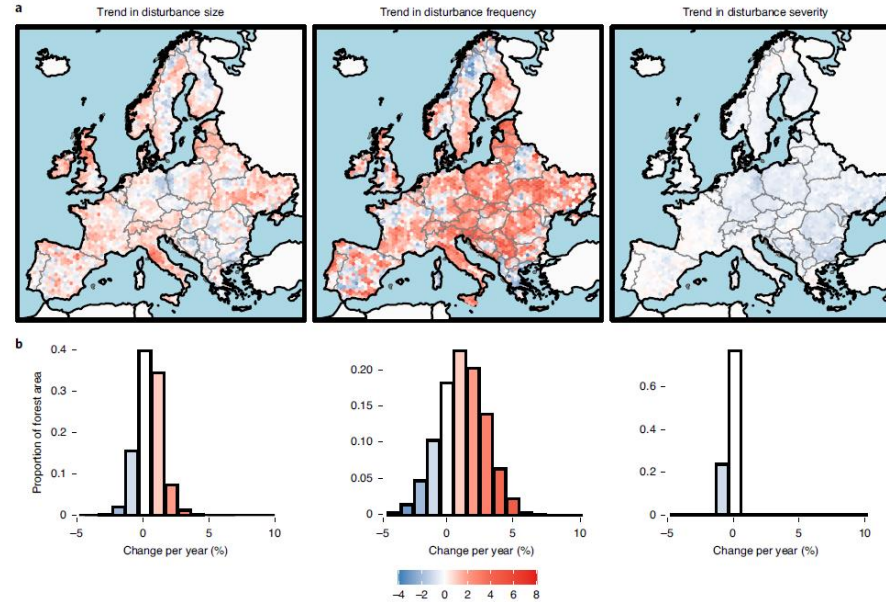


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# Understanding disturbance dynamics

- Disturbance size and frequency are increasing across Europe.
- Additional increase with future climate change is expected.
- Implementation in models ongoing.
- What about forest regeneration?



From Senf & Seidl 2021





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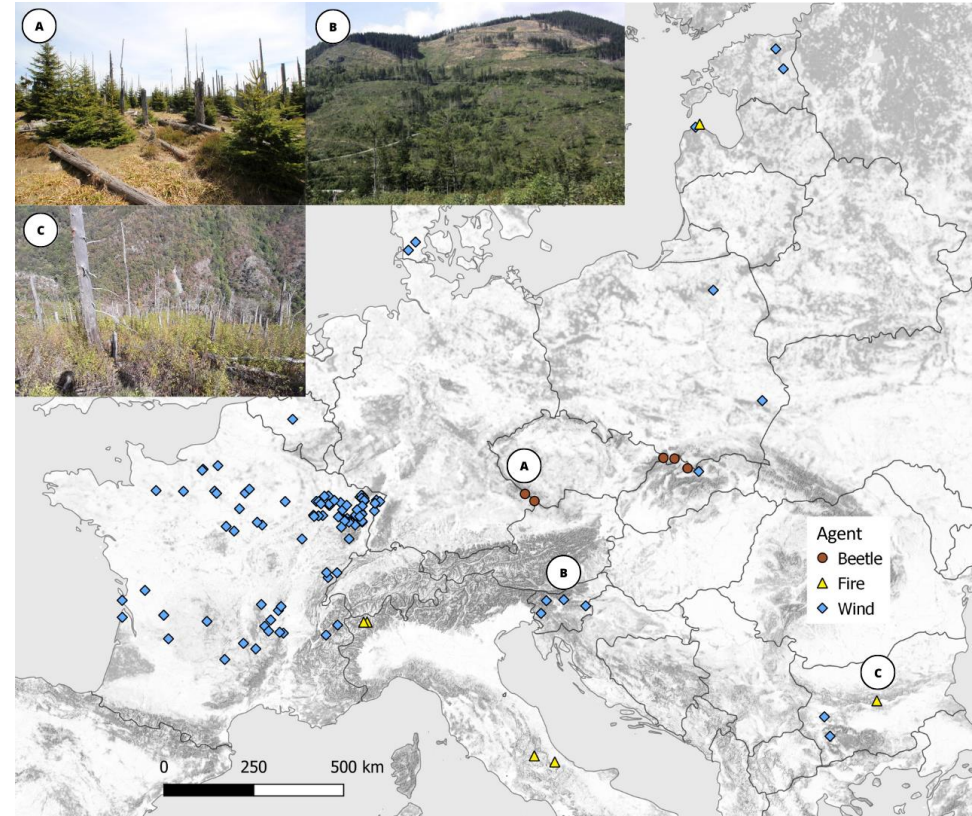


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# Recovery patterns after disturbance

- Reports on regeneration failure after large-scale disturbances under dry and warm conditions.
- Assessment of post-disturbance tree density, structure, and composition at 143 sites across European temperate forests.

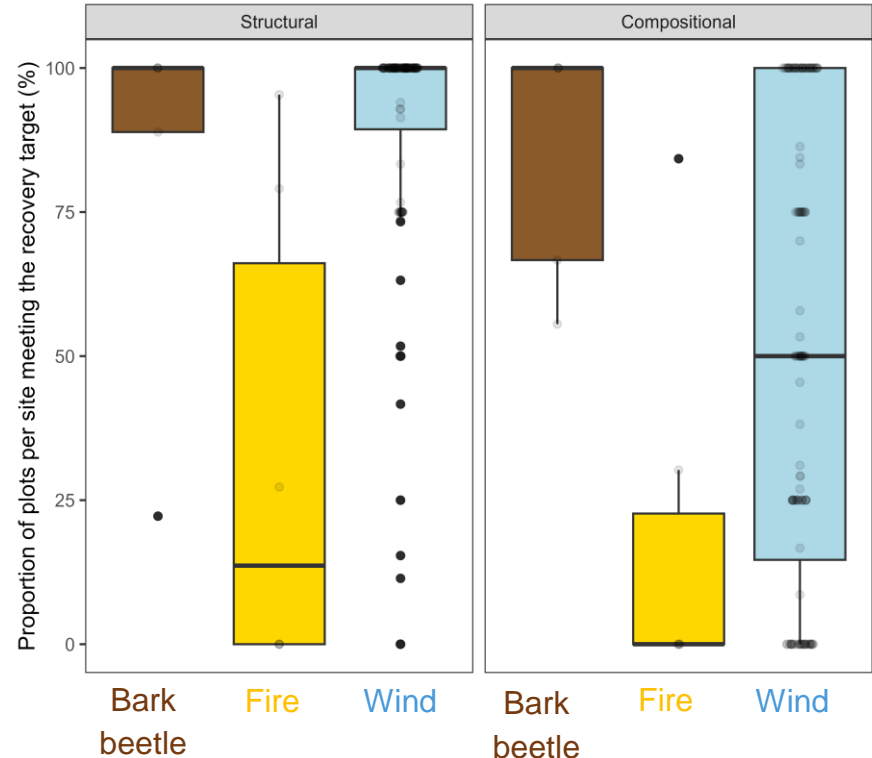


Cerioni, M., ... & Nagel, T. A. (2024). Recovery and resilience of European temperate forests after large and severe disturbances. *Global Change Biology*, **30**, e17159.



# Recovery patterns after disturbance

- Reports on regeneration failure after large-scale disturbances under dry and warm conditions.
- Assessment of post-disturbance tree density, structure, and composition at 143 sites across European temperate forests.
- High recovery potential ~18 years after large-severe disturbances but not after fire.
- Structural recovery generally higher than compositional recovery.

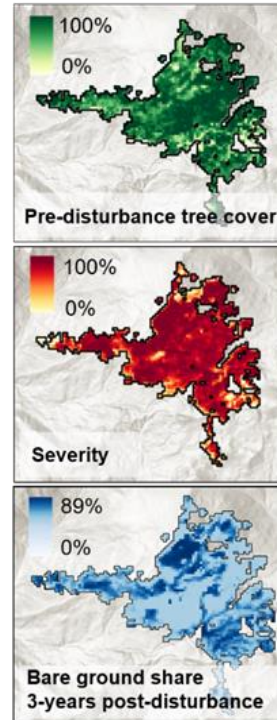


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# Mapping recovery from space

- Novel ecologically informed, tree-based recovery indicator from Landsat and Sentinel 2.
- Effectively distinguishes tree regeneration from other post-disturbance vegetation (shrubs etc.).
- Considerably more realistic recovery intervals than approaches based on spectral indices.

Recovery after a storm event in Crnivec, Slovenia, 2008

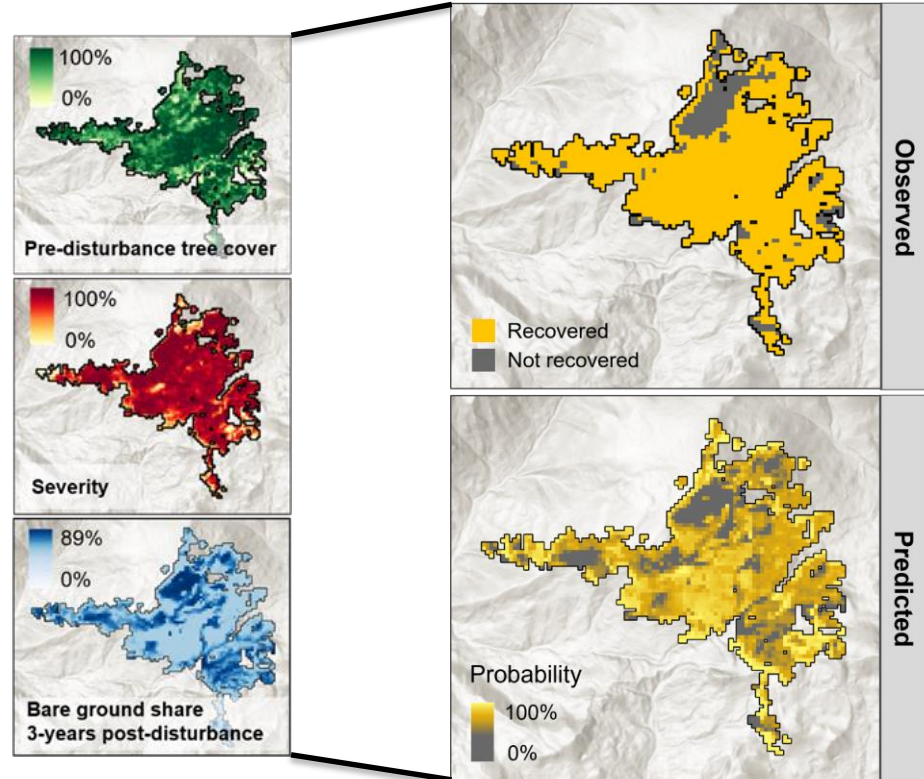


Mandl et al. (2024), Unmixing-based forest recovery indicators for predicting long-term recovery success. Remote Sensing of Environment (308) 114194

# Mapping recovery from space

- Novel ecologically informed, tree-based recovery indicator from Landsat and Sentinel 2.
- Effectively distinguishes tree regeneration from other post-disturbance vegetation (shrubs etc.).
- Considerably more realistic recovery intervals than approaches based on spectral indices.
- Predict the long-term forest recovery success based on short time series.
- Suitable for monitoring and forest management.

Recovery after a storm event in Crnivec, Slovenia, 2008



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# Summary

- We provide novel tools to evaluate and monitor sustainable forest management and forest recovery after disturbances.
- We are happy to share and distribute our results, please get in touch!

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# Thank you!

Lisa Mandl, Cornelius Senf, Tom Nagel, Tom Pugh,  
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## Project partners:

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FSC International  
EIT Climate-KIC

