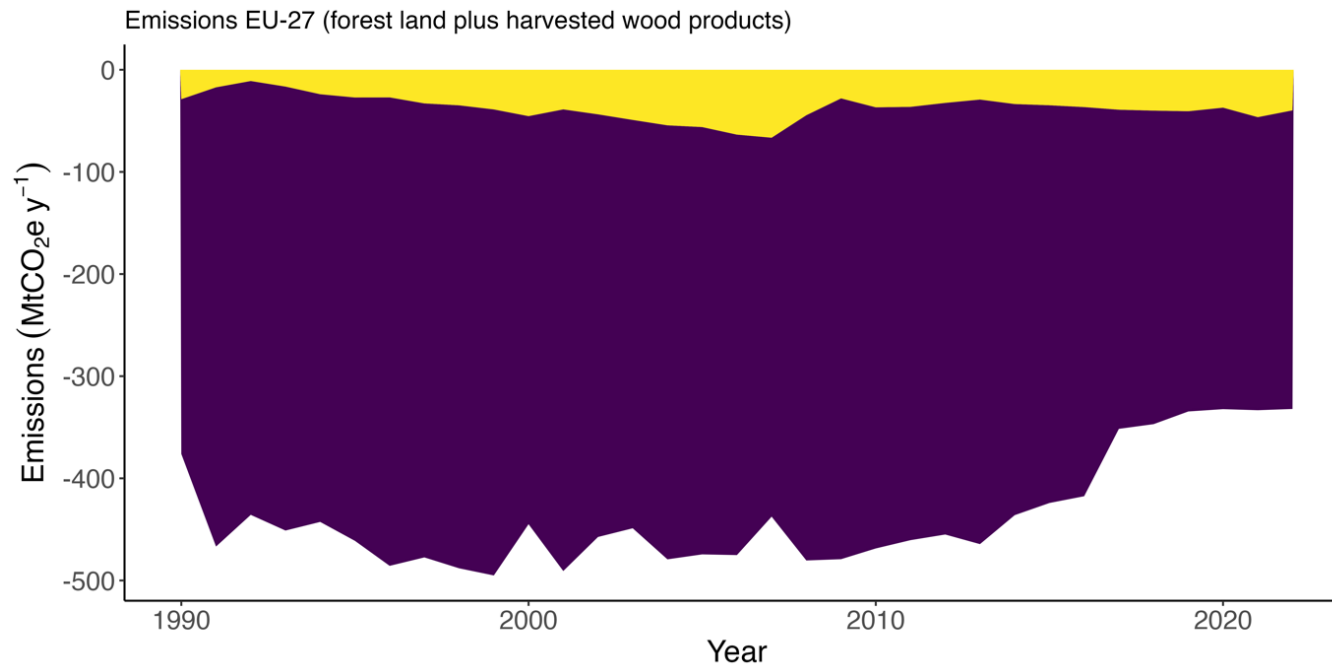


Supporting EU Climate Goals through Improved Satellite based Monitoring and Modelling

Mirco Migliavacca, Giacomo Grassi, Alessandro Cescatti,
Ana Bastos, Guido Ceccherini, Philippe Ciais, Greet Janssens-Maenhout, Emanuele
Lugato, Miguel D Mahecha, Kimberly A. Novick, Josep Peñuelas, Roberto Pilli, Markus
Reichstein, Valerio Avitabile, Pieter S.A. Beck, José I. Barredo, Giovanni Forzieri, Martin
Herold, Anu Korosuo, Nicolas Mansuy, Sarah Mubareka, Paul Rougieux, Rene Orth

Motivation

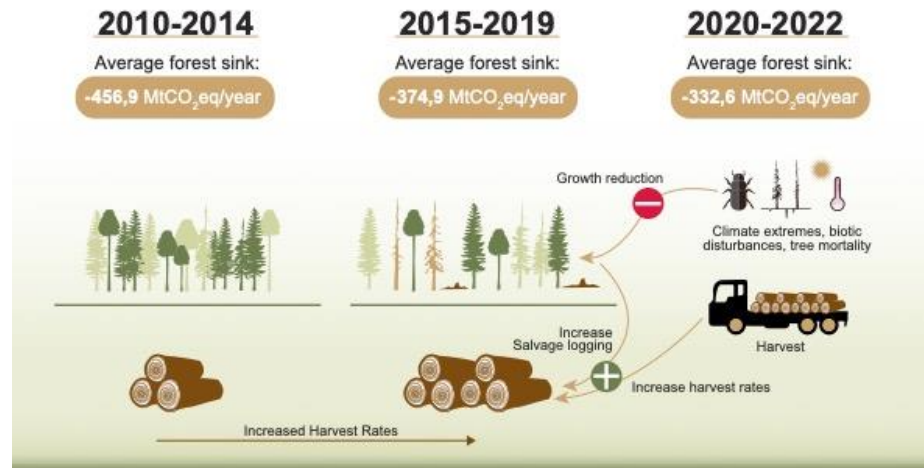
Widespread decline of forest carbon sink in Europe\





How can research support climate policies?

What are the causes?

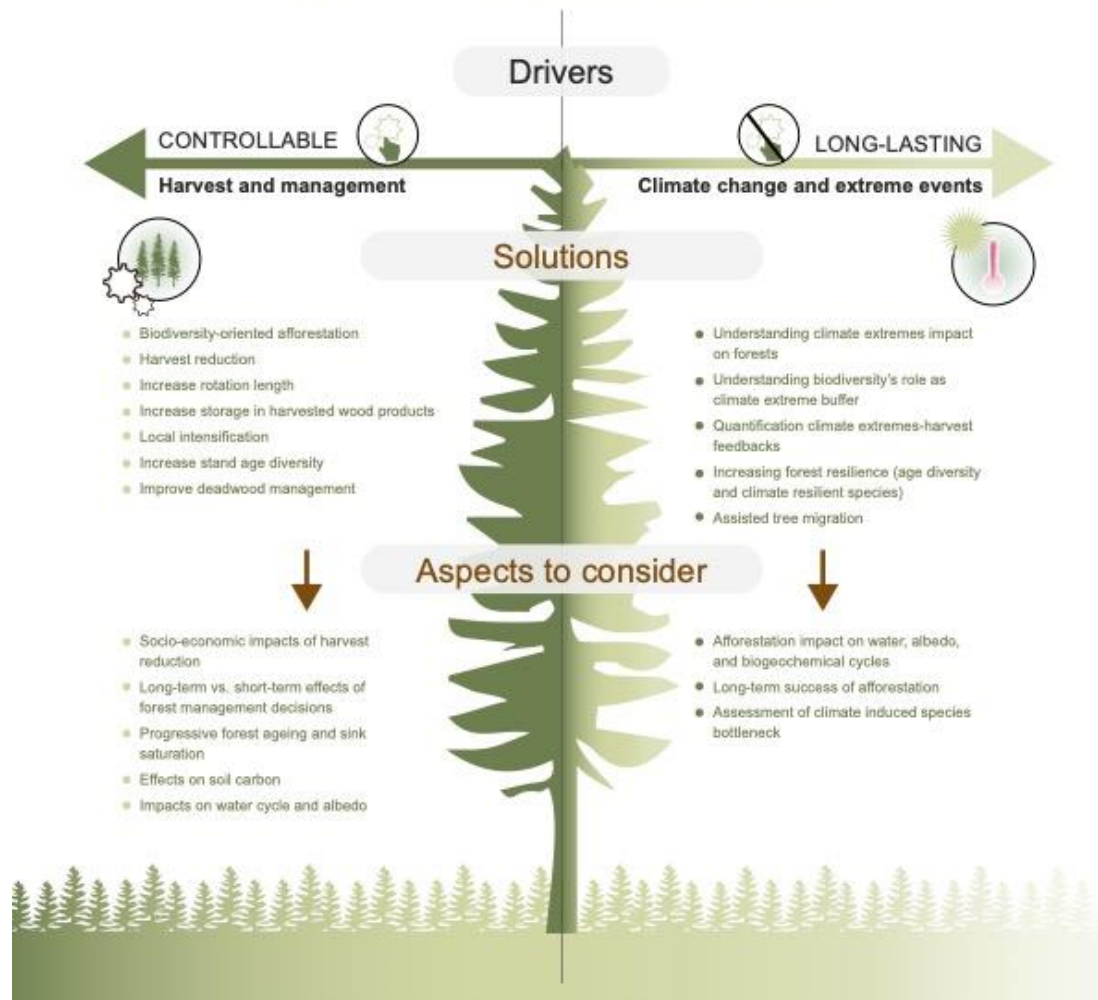


Migliavacca et al., 2025 Nature (in press)

How much is the importance of long-lasting vs controllable (mgmt) drivers?



Is it possible to reverse the trend?



Research priorities



High spatial and temporal resolution mapping of forest characteristics

Current solution



New generation of products under development (e.g. disturbance atlas, tree height, biomass)

Ways forward



Map key variables for policy support: forest management, disturbance type, mortality

S

Scalable and consistent biodiversity monitoring

S

Building open datasets of tree mortality and biomass

S

Adoption of privacy-preserving technologies to train machine learning models

S

Adapt the ground data to the needs of earth observation

M

LULUCF

European Climate Law

Soil Monitoring Directive Proposal

Nature restoration law

Biodiversity strategy

Carbon Removals Certification

Forest monitoring law

Forest strategy

S Short-term (1 to 3 years)

M Medium-term (3 to 5 years)

L Long-term (<5 years)

Research priorities



High spatial and temporal resolution mapping of forest characteristics

Modelling of present time and future forest carbon sink

Current solution



New generation of products under development (e.g. disturbance atlas, tree height, biomass)

Improved representation of key processes that influence forest resilience in DGVM

Landscape forest modelling

Ways forward



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S Use of flux tower data and stocks to constraint statistical flux modelling at a scale that is useful for the real world applications

M Hybrid models to improve the description of response of vegetation to droughts, disturbance and fires

S Better implementation of forest management in current modelling frameworks.

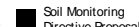
M Develop digital twins



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Forest strategy



Short-term (1 to 3 years)



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High spatial and temporal resolution mapping of forest characteristics

Modelling of present time and future forest carbon sink

Quantifying the importance of long-lasting and controllable drivers forest carbon sink decline



New generation of products under development (e.g. disturbance atlas, tree height, biomass)

Improved representation of key processes that influence forest resilience in DGVM

Landscape forest modelling

Quantification direct effects of climate change on forests sink

Quantification of harvest at a continental scale



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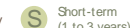
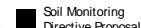
S Better implementation of forest management in current modelling frameworks.

M Develop digital twins

M Develop the capability to quantify and anticipate high-impact events (heat waves – droughts) and assess worst-case scenarios

S Quantify the feedback between future climate change impact and harvest rates needs to be quantified

S Develop EU-wide data on climate-induced harvests due to tree mortality





High spatial and temporal resolution mapping of forest characteristics

Modelling of present time and future forest carbon sink

Quantifying the importance of long-lasting and controllable drivers forest carbon sink decline

Sustainable forest management (tree planting, biodiversity, harvest, and deadwood)



New generation of products under development (e.g. disturbance atlas, tree height, biomass)

Improved representation of key processes that influence forest resilience in DGVM

Landscape forest modelling

Quantification direct effects of climate change on forests sink

Quantification of harvest at a continental scale

Quantifying influence of biodiversity on ecosystem resilience

Harvest reduction to increase the forest carbon sink



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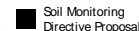
S Tools to assess management options

L Datasets on deadwood and soil carbon

L Understanding of forest management effects on soils

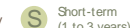
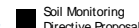
M Understanding feedback between management choices, disturbances, and socio economics

M Relevance of taxonomic, structural, and functional diversity on resilience





High spatial and temporal resolution mapping of forest characteristics	Modelling of present time and future forest carbon sink	Quantifying the importance of long-lasting and controllable drivers forest carbon sink decline	Sustainable forest management (tree planting, biodiversity, harvest, and deadwood)	Potential trade-offs of nature based climate solutions
New generation of products under development (e.g. disturbance atlas, tree height, biomass)	Improved representation of key processes that influence forest resilience in DGVM Landscape forest modelling	Quantification direct effects of climate change on forests sink Quantification of harvest at a continental scale	Quantifying influence of biodiversity on ecosystem resilience Harvest reduction to increase the forest carbon sink	Assessment of the large potential biophysical impacts of nature based climate solutions
<p>Map key variables for policy support: forest management, disturbance type, mortality</p> <p>S</p> <p>Scalable and consistent biodiversity monitoring</p> <p>S</p> <p>Building open datasets of tree mortality and biomass</p> <p>S</p> <p>Adoption of privacy-preserving technologies to train machine learning models</p> <p>S</p> <p>Adapt the ground data to the needs of earth observation</p> <p>M</p>	<p>Use of flux tower data and stocks to constraint statistical flux modelling at a scale that is useful for the real world applications</p> <p>S</p> <p>Hybrid models to improve the description of response of vegetation to droughts, disturbance and fires</p> <p>M</p> <p>Better implementation of forest management in current modelling frameworks.</p> <p>S</p> <p>Develop digital twins</p> <p>M</p>	<p>Develop the capability to quantify and anticipate high-impact events (heat waves – droughts) and assess worst-case scenarios</p> <p>M</p> <p>Quantify the feedback between future climate change impact and harvest rates needs to be quantified</p> <p>S</p> <p>Develop EU-wide data on climate-induced harvests due to tree mortality</p> <p>S</p>	<p>Tools to assess management options</p> <p>S</p> <p>Datasets on deadwood and soil carbon</p> <p>L</p> <p>Understanding of forest management effects on soils</p> <p>L</p> <p>Understanding feedback between management choices, disturbances, and socio economics</p> <p>M</p> <p>Relevance of taxonomic, structural, and functional diversity on resilience</p> <p>M</p>	<p>Trade offs between carbon, energy, and water cycle</p> <p>M</p> <p>Assessment of the long term effects of nature based climate solutions</p> <p>M</p> <p>Feedbacks of biodiversity to the climate systems</p> <p>M</p>





How can research support climate policies?

Timely and EU-wide consistent spatially resolved information on state of forest and carbon cycle dynamics

Understanding and timely predicting the relative contribution of the long-lasting vs controllable drivers

Develop tools to assess potential trade offs in NbCS and forest management decisions