Emerging climate risks and vulnerability of EU forests

Alessandro Cescatti

Giovanni Forzieri, Marco Girarello, Guido Ceccherini, Ramdane Alkama, Agata Elia, Samuele Capobianco, Matteo Piccardo, Mark Pickering, Luca Caporaso

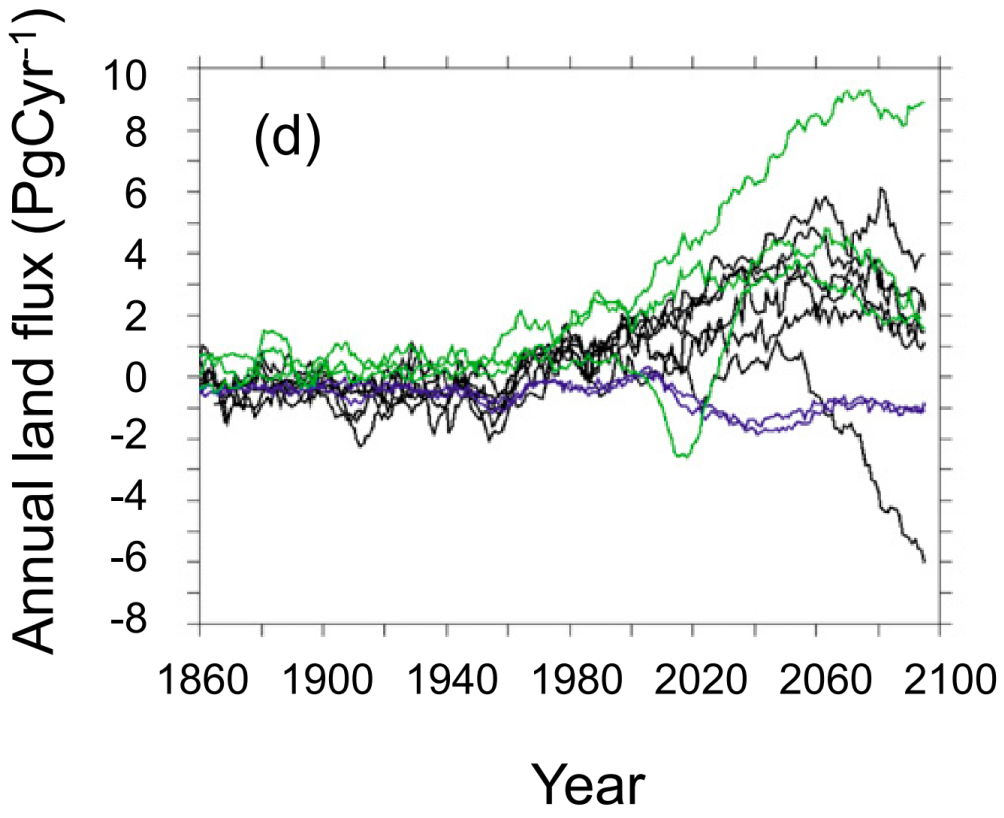
Joint Research Centre

11, May 2022

JRC Directorate D - Sustainable Resources

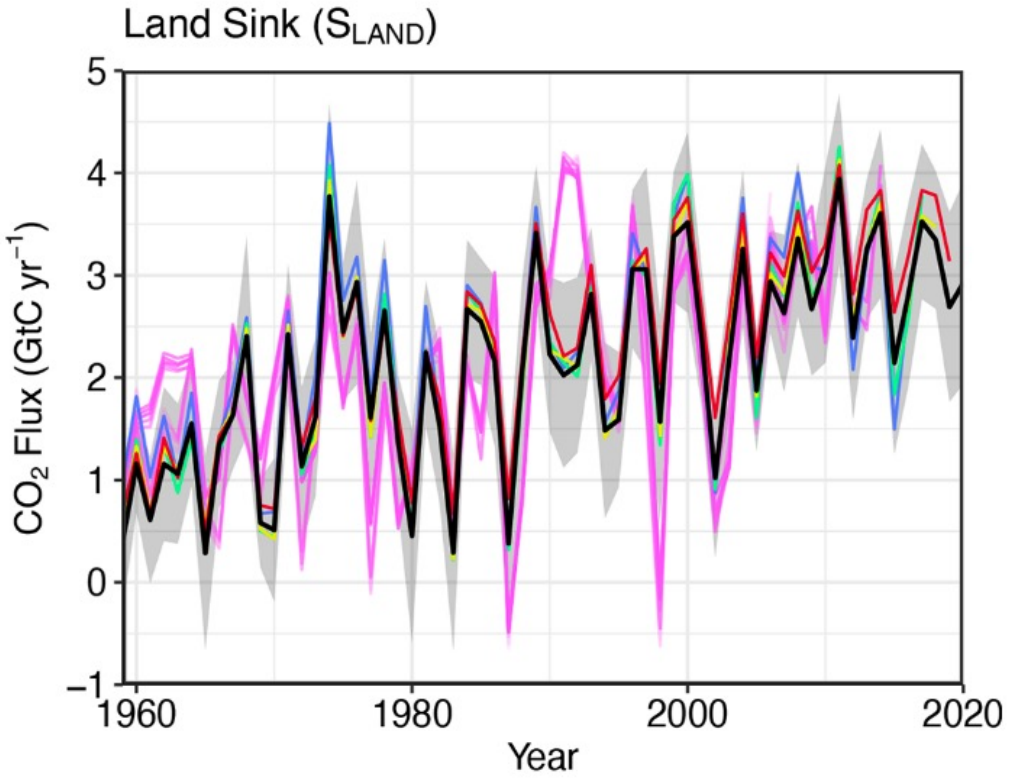
The uncertain trajectory of the terrestrial C sink

CMIP5



Friedlingstein et al., 2014

GCP 2021



Friedlingstein et al., 2022, ESSD

What is driving the saturation of the land sink?

Decline in photosynthesis related to weakening CO_2 fertilization effects?

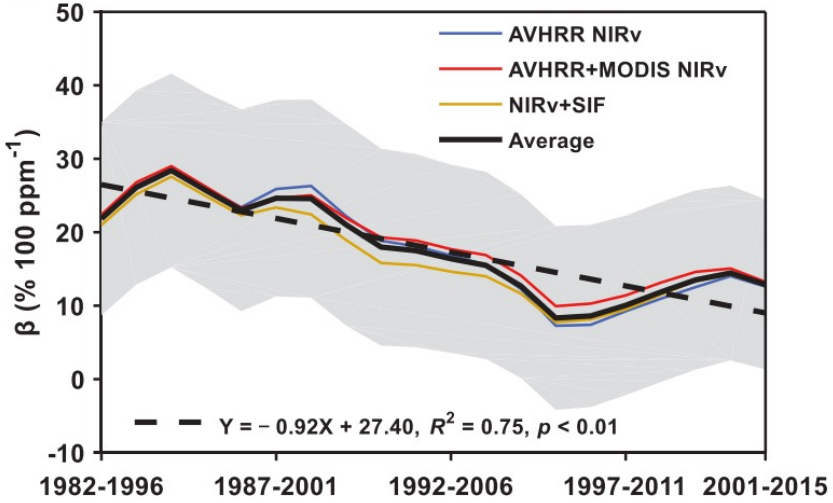
RESEARCH

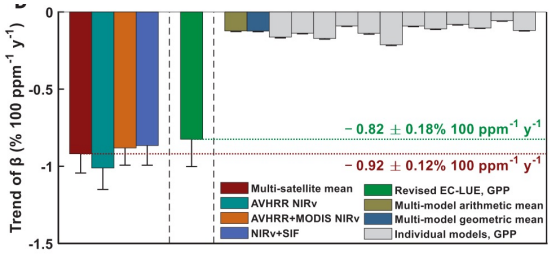
RESEARCH ARTICLE

CLIMATE CHANGE

Recent global decline of CO_2 fertilization effects on vegetation photosynthesis

Songhan Wang[1,2], Yongguang Zhang[1,2,3]*, Weimin Ju[1,2], Jing M. Chen[1,4], Philippe Ciais[5], Alessandro Cescatti[6], Jordi Sardans[7,8], Ivan A. Janssens[9], Mousong Wu[1,2], Joseph A. Berry[10],

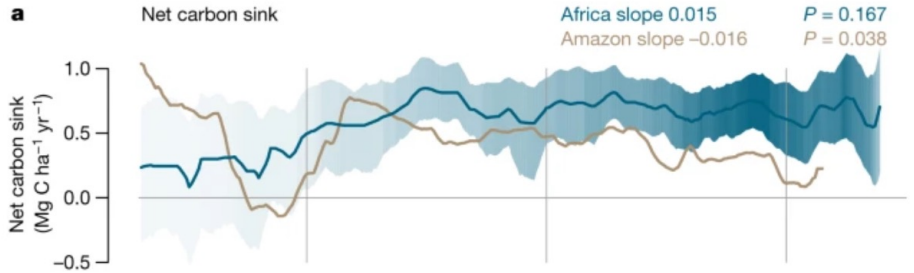




Or increasing in disturbance/mortality/respiration?

Long term decline of the C sink in amazon linked to increase in tree mortality

Fig. 1: Long-term carbon dynamics of structurally intact old-growth tropical forests in Africa and Amazonia.



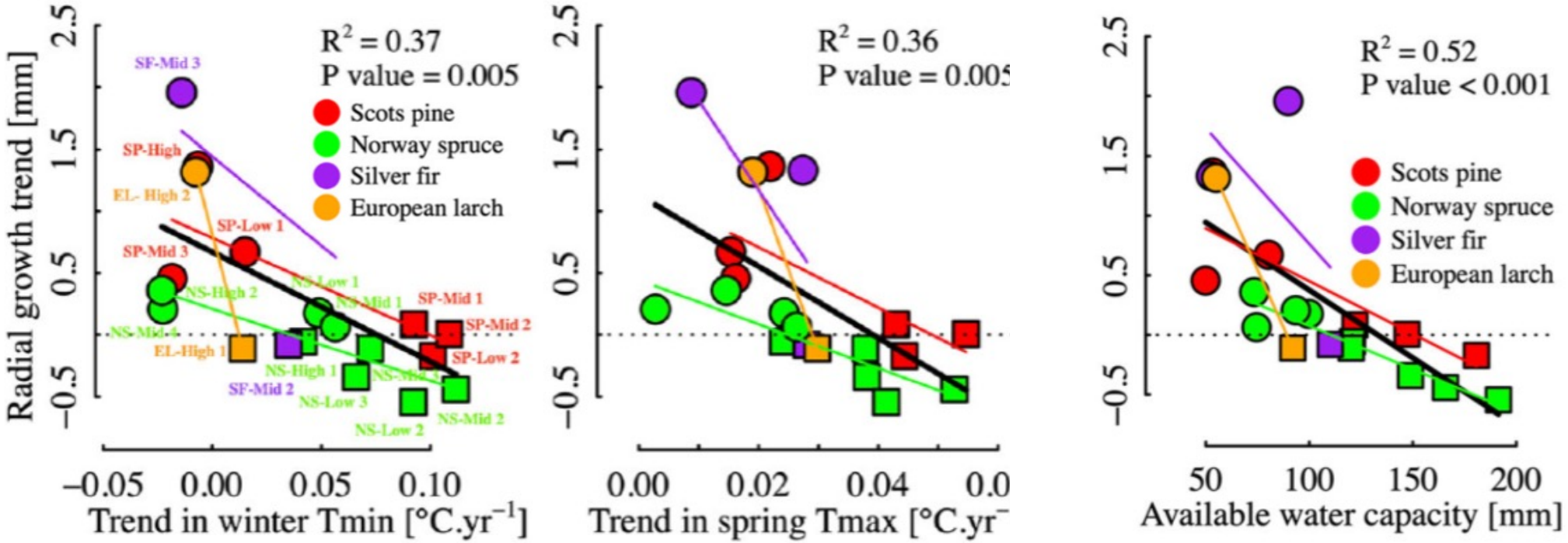
Hubau et al. 2020 Nature

Or both?

European Commission

Emerging signals from National Forest Inventories

France and Austria: Negative impact of winter and spring warming on the tree growth rate



Courtesy Clémentine OLS

Tree ring networks

780,000 ring width measurements
5800 trees
324 sampling sites

declining trend of beech growth rate in the last decades

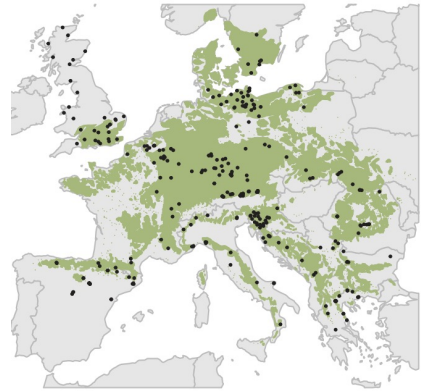
communications biology

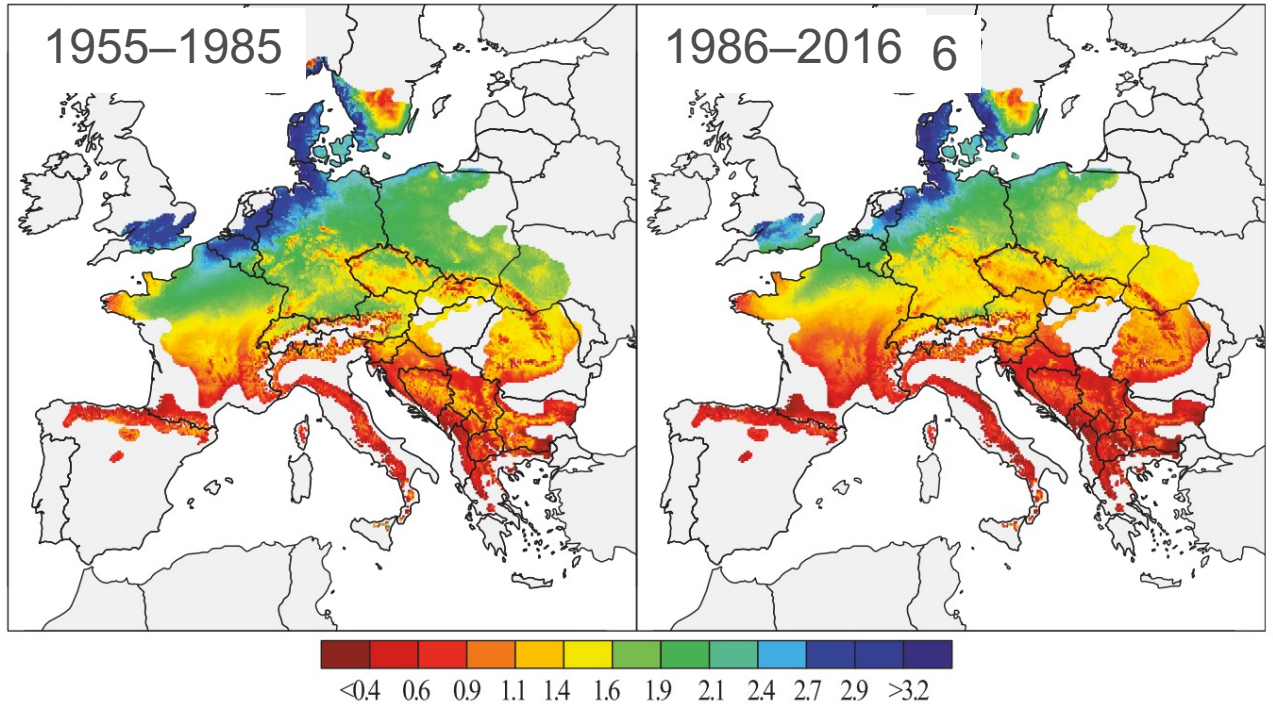
ARTICLE

https://doi.org/10.1038/s42003-022-03107-3 OPEN

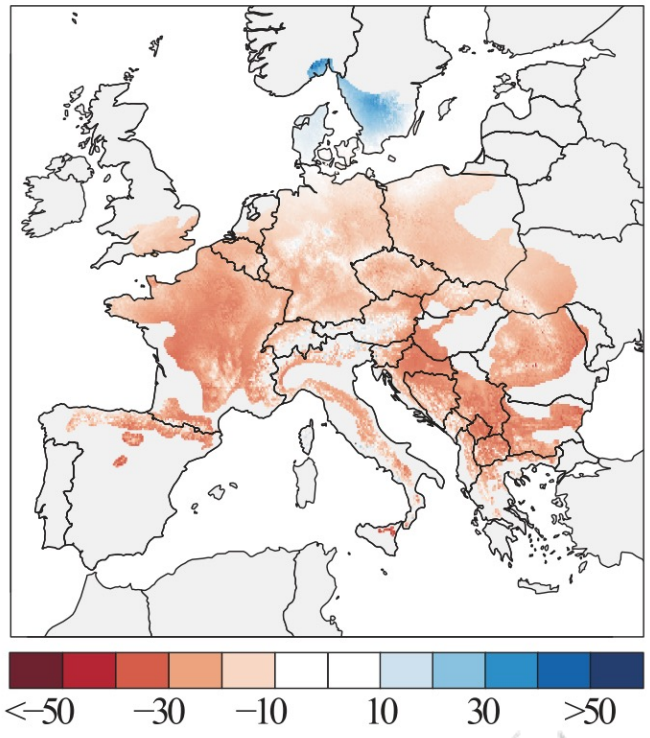
Climate-change-driven growth decline of European beech forests

Edurne Martinez del Castillo[1✉], Christian S. Zang[2], Allan Buras[3], Andrew Hacket-Pain[4], Jan Esper[1,5], Roberto Serrano-Notivoli[6], Claudia Hartl[7], Robert Weigel[8], Stefan Klesse[9], Victor Resco de Dios[10,11],





European forest beech forests: growth rate in basal area

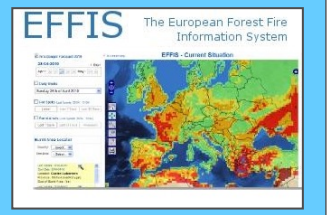


Relative change in growth rate

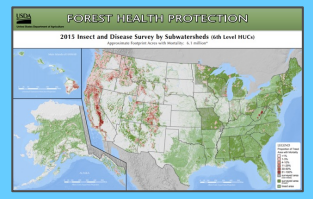
Observation-driven modelling of forest vulnerability

Disturbance databases

Forest fires
EFFIS
(~15000)

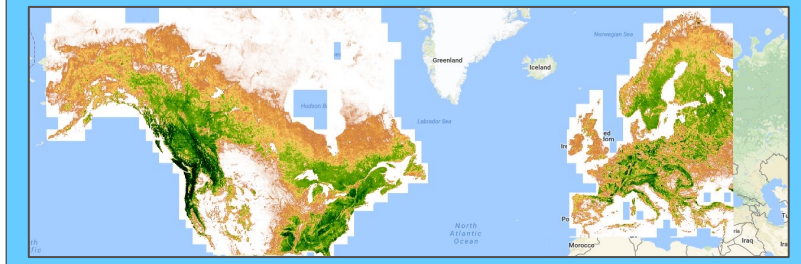


Insect outbreaks
IDS-USDA
(~42000)



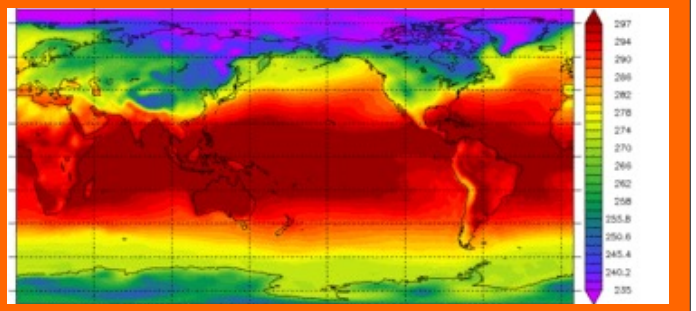
Windthrows
FORWIND
(~80000)

Biomass dynamics



Vulnerability functions
Random forest regression

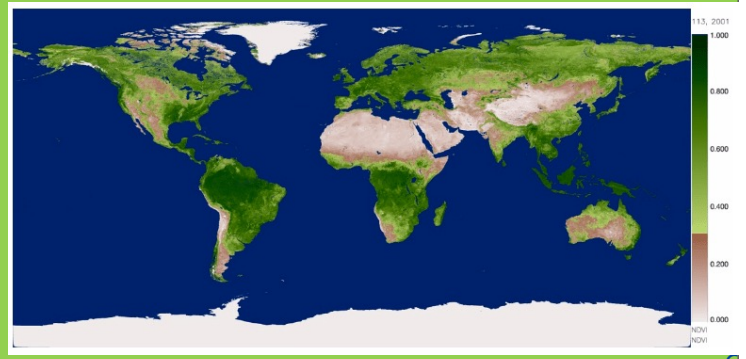
Climate indicators



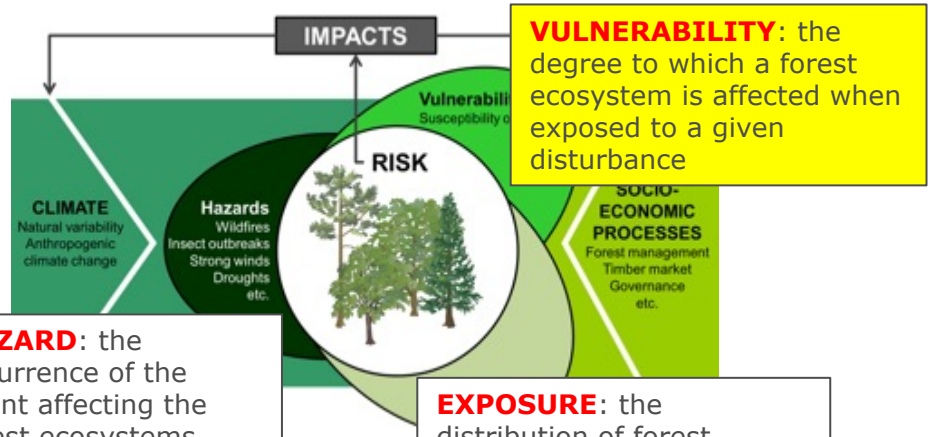
Relative biomass loss

$$BL_{rel} = V_{i,j}(C_1, \ldots, C_H, S_1, \ldots, S_K)$$

Forest and landscape indicators



Trends in climate risks for EU forests



VULNERABILITY: the degree to which a forest ecosystem is affected when exposed to a given disturbance

HAZARD: the occurrence of the agent affecting the forest ecosystems

EXPOSURE: the distribution of forest ecosystem services potentially prone to a hazard

nature communications

Explore content | About the journal | Publish with us

nature > nature communications > articles > article

Article | Open Access | Published: 23 February 2021

Emergent vulnerability to climate-driven disturbances in European forests

Giovanni Forzieri, Marco Girardello, Guido Ceccherini, Jonathan Spinoni, Luc Feyen, Henrik Hartmann, Pieter S. A. Beck, Gustau Camps-Valls, Gherado Chirici, Achille Mauri & Alessandro Cescatti

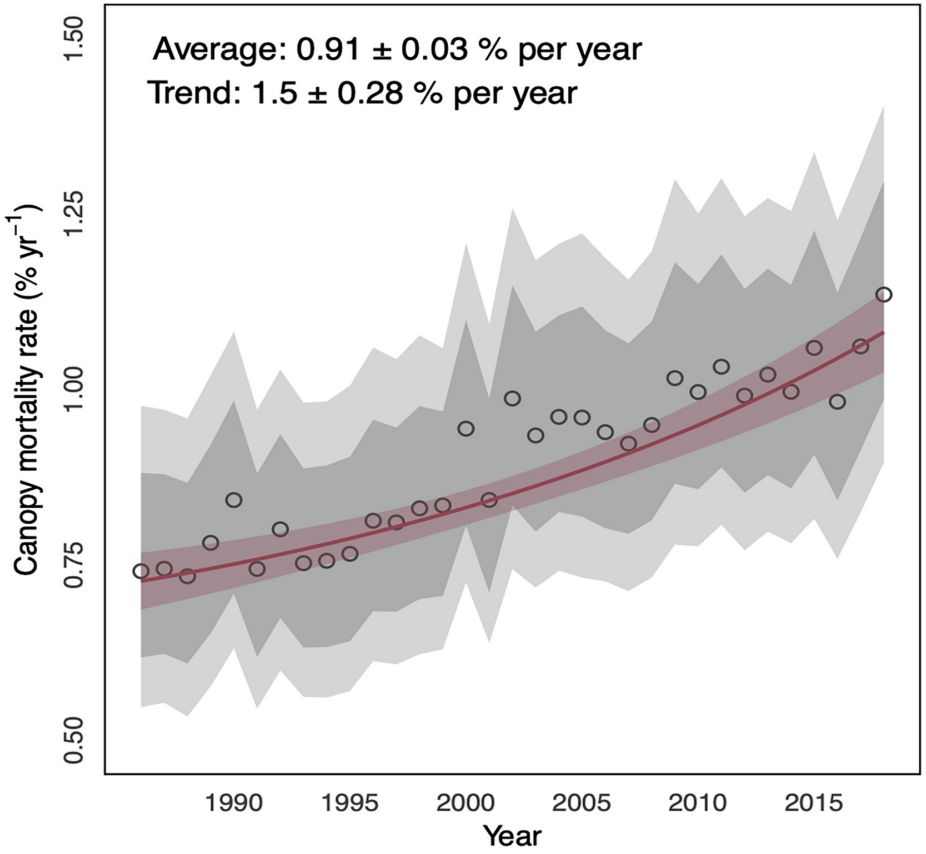
Nature Communications **12**, Article number: 1081 (2021) | Cite this article

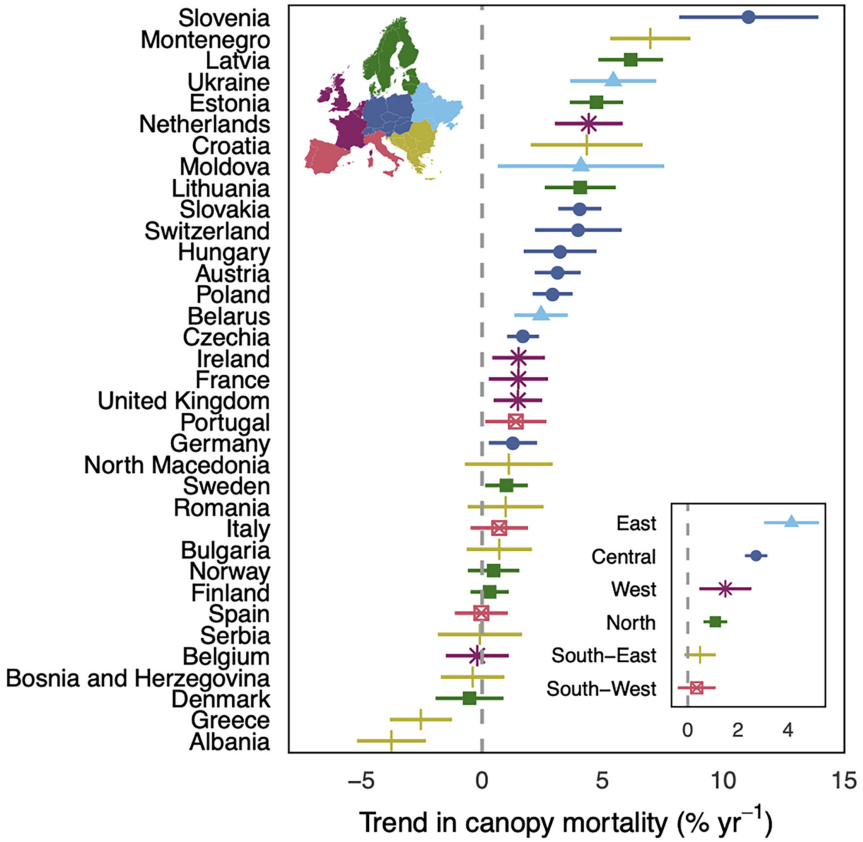
12k Accesses | **19** Citations | **248** Altmetric | Metrics

European Commission

Increasing trend in EU forest canopy mortality

Sharp increasing trend in canopy mortality from 1985 to 2018 in Europe



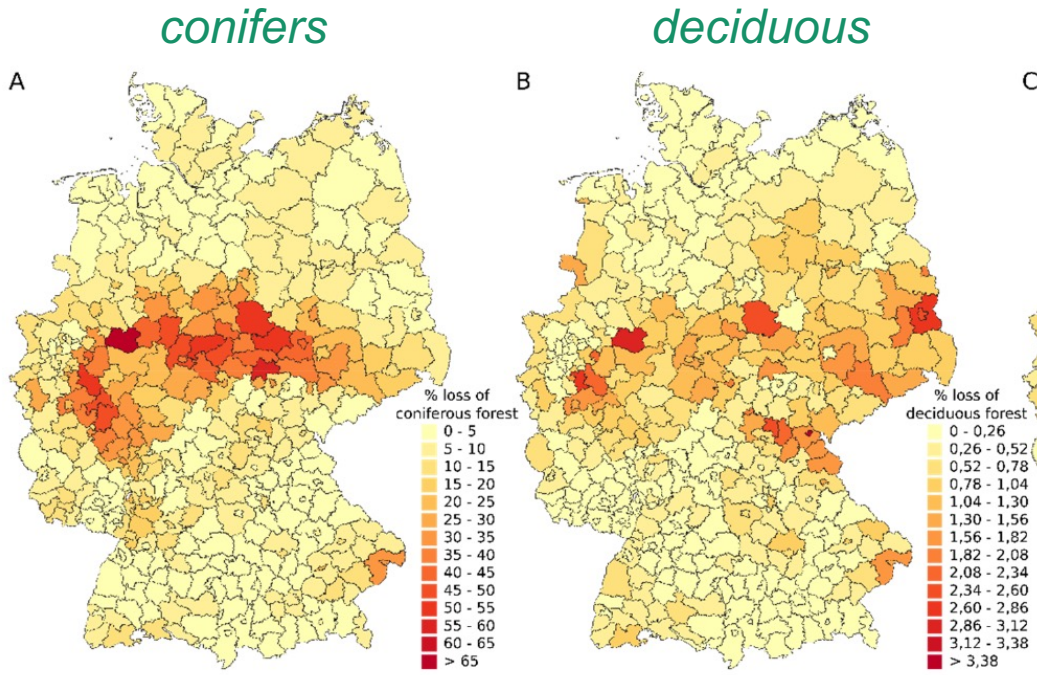


- Senf et. al. 2021 One Earth

European Commission

Bark beetle outbreaks in central EU

Tree cover loss of 501,000 ha for Germany since 2018
@check % of forest area of Germany



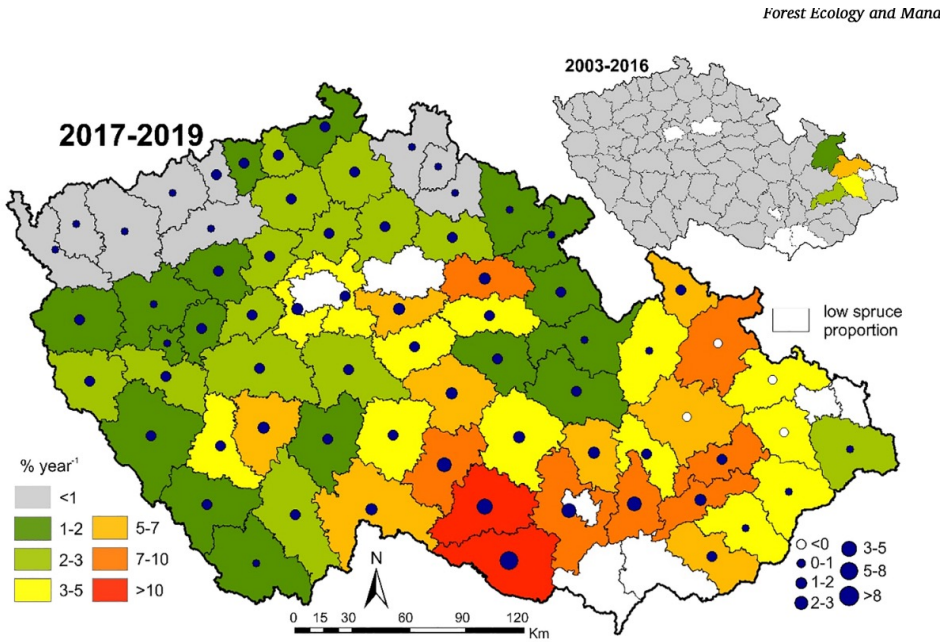
Thonfeld F. et al. 2021 Remote sensing

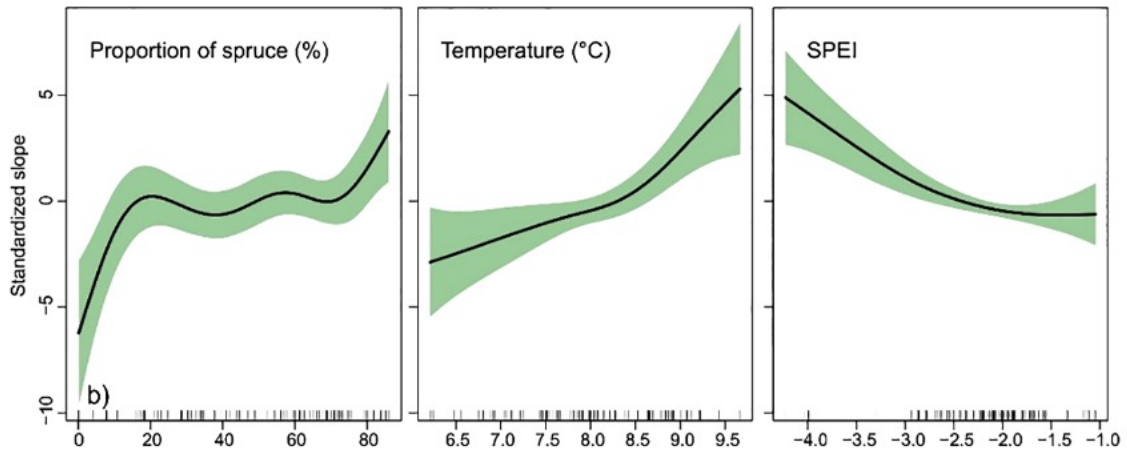
European Commission

Devastating outbreak of bark beetles in the Czech Republic: Drivers, impacts, and management implications

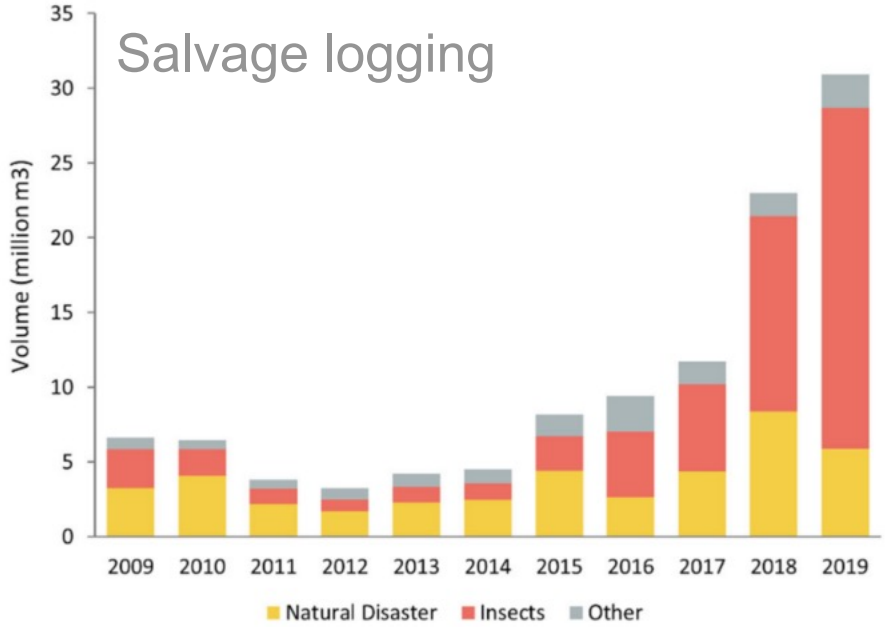
T. Hlásny [a,*], S. Zimová [a], K. Merganičová [a], P. Štěpánek [b], R. Modlinger [a], M. Turčáni [a]

[a] Czech University of Life Sciences in Prague, Faculty of Forestry and Wood Sciences, Czech Republic
[b] Global Change Research Institute, Czech Academy of Sciences, Czech Republic

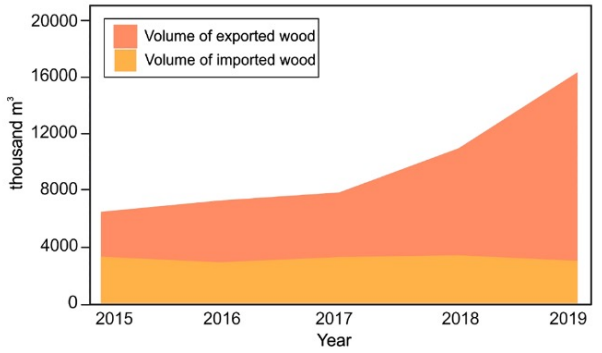




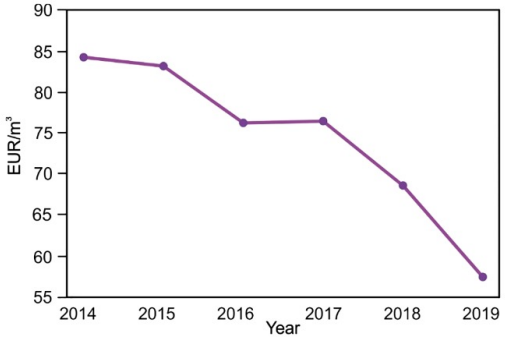
Salvage logging



import/export



wood price



The way forward

- Advanced the monitoring of forest disturbances

EU observatory on deforestation and forest degradation

- Develop tools to support forest adaptation policies

foster model-data fusion for policy support

- Improve the representation of disturbance and mortality in vegetation models

enhance cooperation with modelling community

Environment

Home > Strategy > Forest strategy

New EU forest strategy for 2030

To improve the quantity and quality of EU forests

Support better availability and quality of information on forests and supply chains

- Establish an EU Observatory on Deforestation and Forest Degradation to monitor changes in the world's forest cover and give public bodies, consumers and businesses better access to data about supply chains
- Explore strengthened use of the Copernicus satellite system for forest monitoring.

…on the basis of improved **Copernicus products**, other **remote-sensing data** and **ground-based monitoring**, strengthen the existing **monitoring of climate effects** and other **natural or human-induced disturbances** on forests…

Commission

Assessment of natural hazards on EU forests

- European Forest Fire Information System (EFFIS)

Welcome to EFFIS

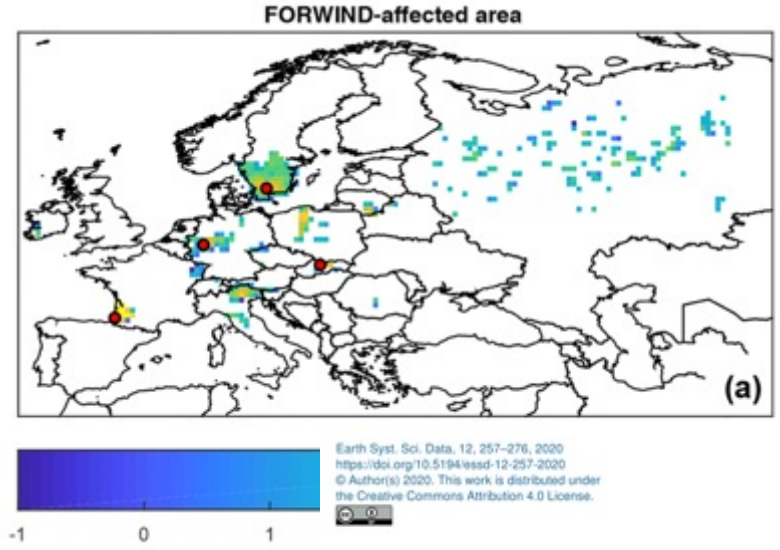
The European Forest Fire Information System (EFFIS) supports the services in charge of the protection of forests against fires in the EU and neighbor countries and provides the European Commission services and the European Parliament with updated and reliable information on wildland fires in Europe.

Since 1998, EFFIS is supported by a network of experts from the countries in what is called the

New feature

Make your specific requests of data by the new Data Request Form

- Collection of spatial data on natural disturbances (WindFor, DEFID2)



A spatially explicit database of wind disturbances in European forests over the period 2000–2018

The way forward

- Advanced the monitoring of forest disturbances

EU observatory on deforestation and forest degradation

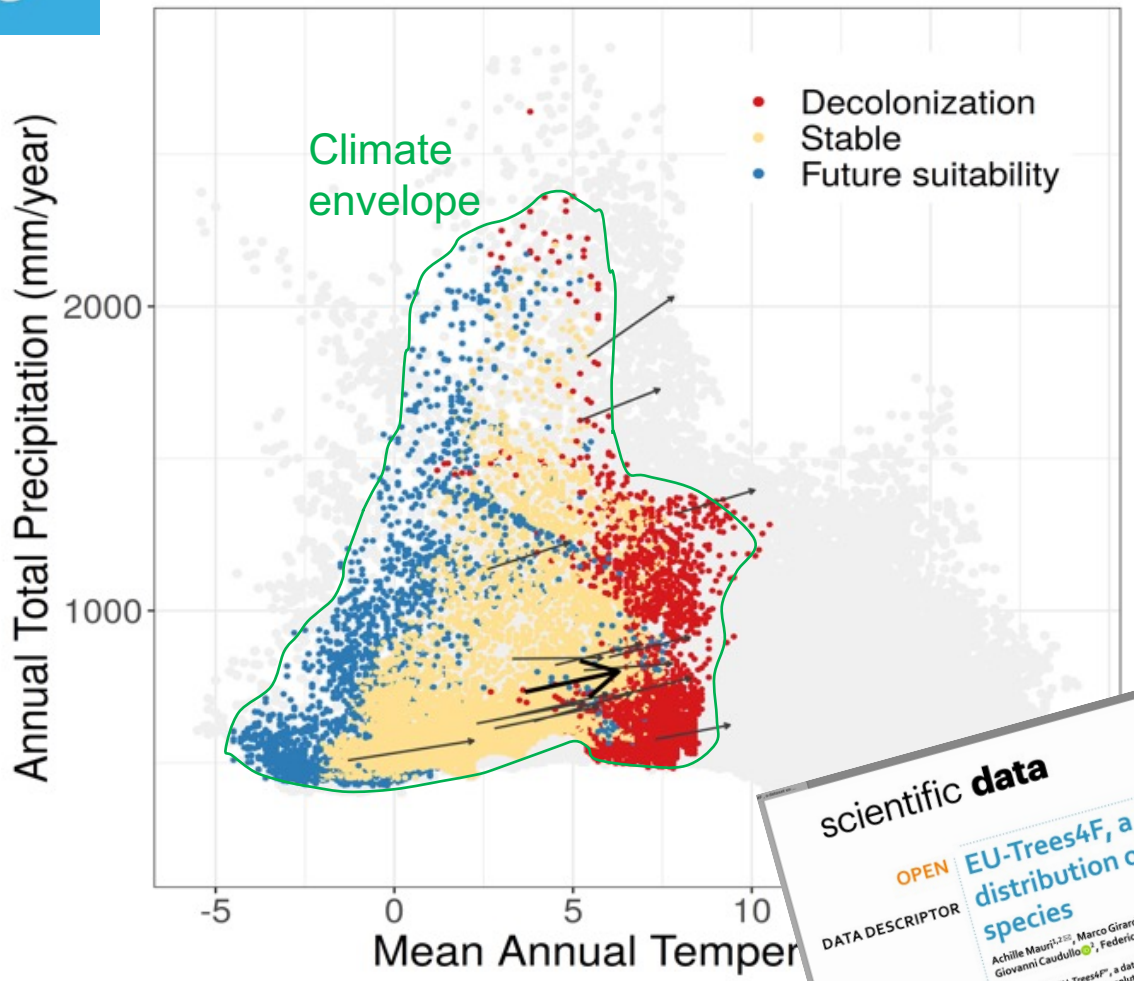
- Develop tools to support forest adaptation policies

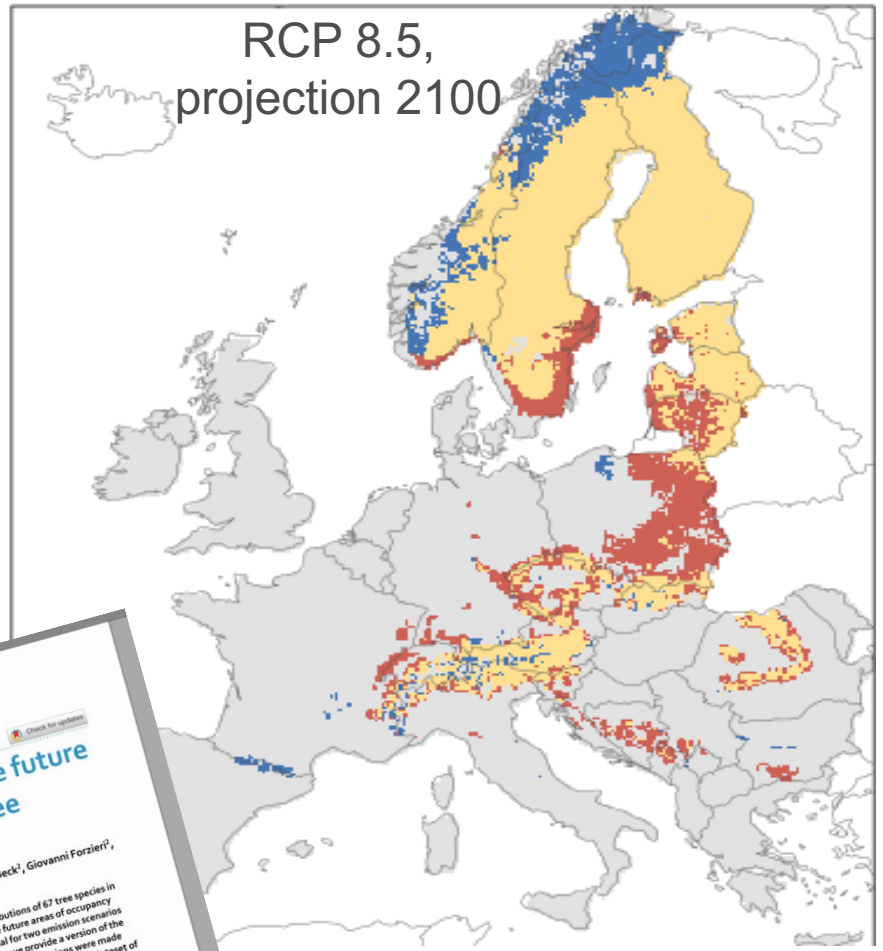
foster model-data fusion for policy support

- Improve the representation of disturbance and mortality in vegetation models

enhance cooperation with modelling community

Example for *Picea abies* – Norway spruce





scientific data

OPEN

DATA DESCRIPTOR

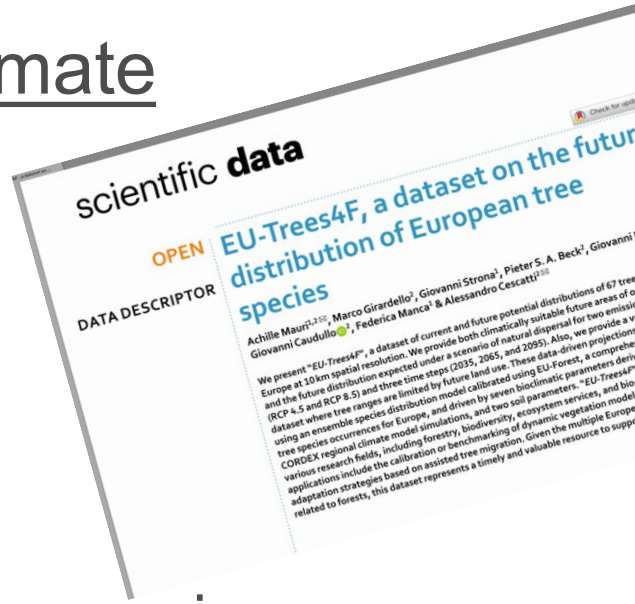
EU-Trees4F, a dataset on the future distribution of European tree species

Achille Mauri[1], Marco Girardello[2], Giovanni Strona[3], Pieter S. A. Beck[2], Giovanni Forzieri[2], Giovanni Caudullo[2], Federica Manca[3] & Alessandro Cescatti[2]

We present "*EU-Trees4F*", a dataset of current and future potential distributions of 67 tree species in Europe at 10 km spatial resolution. We provide both climatically suitable future areas of occupancy and the future distribution expected under a scenario of natural dispersal for two emission scenarios (RCP 4.5 and RCP 8.5) and three time steps (2035, 2065, and 2095). Also, we provide a version of the dataset where tree ranges are limited by future land use. These data-driven projections were made using an ensemble species distribution model calibrated using EU-Forest, a comprehensive dataset of tree species occurrences for Europe, and driven by seven bioclimatic parameters derived from EURO-CORDEX regional climate model simulations, and two soil parameters. "*EU-Trees4F*", can benefit various research fields, including forestry, biodiversity, ecosystem services, and bio-economy. Possible applications include the calibration or benchmarking of dynamic vegetation models, or informing forest adaptation strategies based on assisted tree migration. Given the multiple European policy initiatives related to forests, this dataset represents a timely and valuable resource to support policymaking.

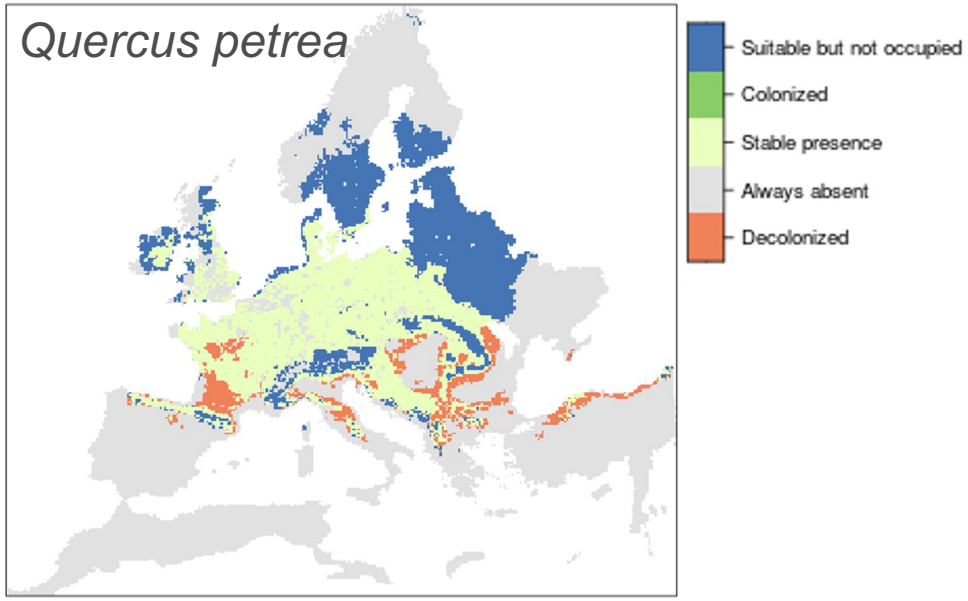
As trees have a long lifespan and low dis… need to consider which tree species and where may thrive decades from now if we …t to prevent/reduce the future loss of forest services

Predicting forest tree species distribution in a future climate



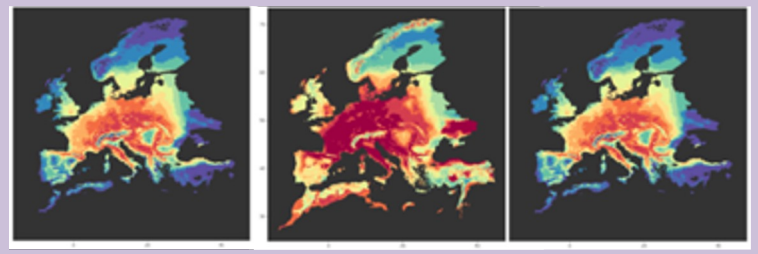
- EU-Trees4F
  Analysis of tree species distribution in the current and future climate
  - Distribution of 80 EU forest tree species
  - 2 climate scenarios (RCP 4.5 and RCP 8.5)
  - Distribution from present time to 2100

- Assessment of diversity losses and impacts on ecosystem services



Diversity metrics

Functional Diversity & Taxonomic Diversity



Mauri et al. Scientific data (2022)

European Commission

The way forward

- Advanced the monitoring of forest disturbances

EU observatory on deforestation and forest degradation

- Develop tools to support forest adaptation policies

foster model-data fusion for policy support

- Improve the representation of disturbance and mortality in vegetation models

enhance cooperation with modelling community

Emerging climate risks and vulnerability of EU forests

Alessandro Cescatti

Giovanni Forzieri, Marco Girarello, Guido Ceccherini, Ramdane Alkama, Agata Elia, Samuele Capobianco, Matteo Piccardo, Mark Pickering, Luca Caporaso

Joint Research Centre

11, May 2022

JRC Directorate D - Sustainable Resources