– Our Future Forests –
Global Challenges and Local Opportunities

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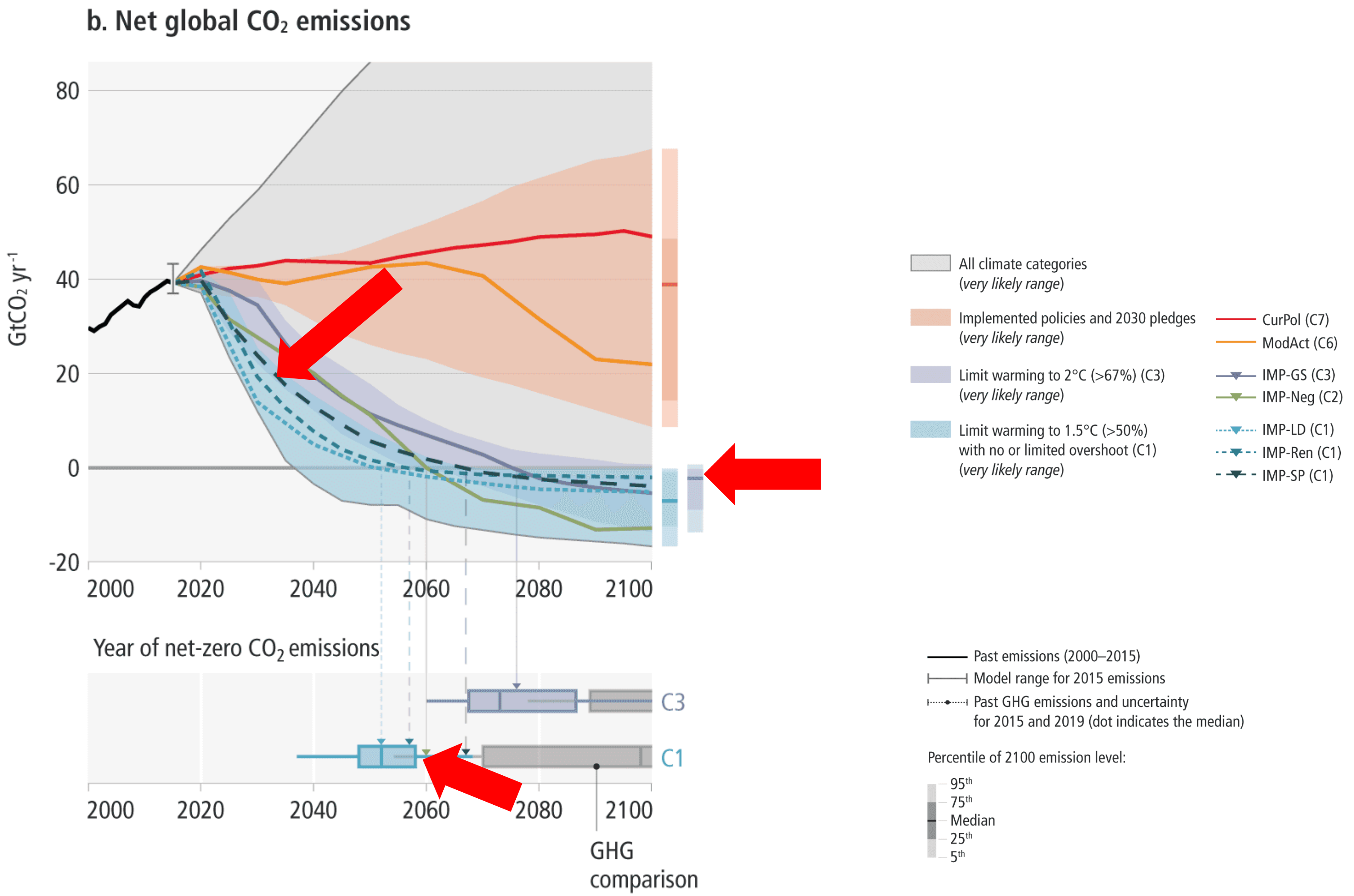
International Institute for
Applied Systems Analysis
IIASA www.iiasa.ac.at

"Demands on forests have never been so high. The need for timber is increasing, but forests are also critical climate change mitigation champions and biodiversity hosts. We need to meet and exceed society's changing expectations of forests."

Info graphics: GLF; Quote: M. Berger

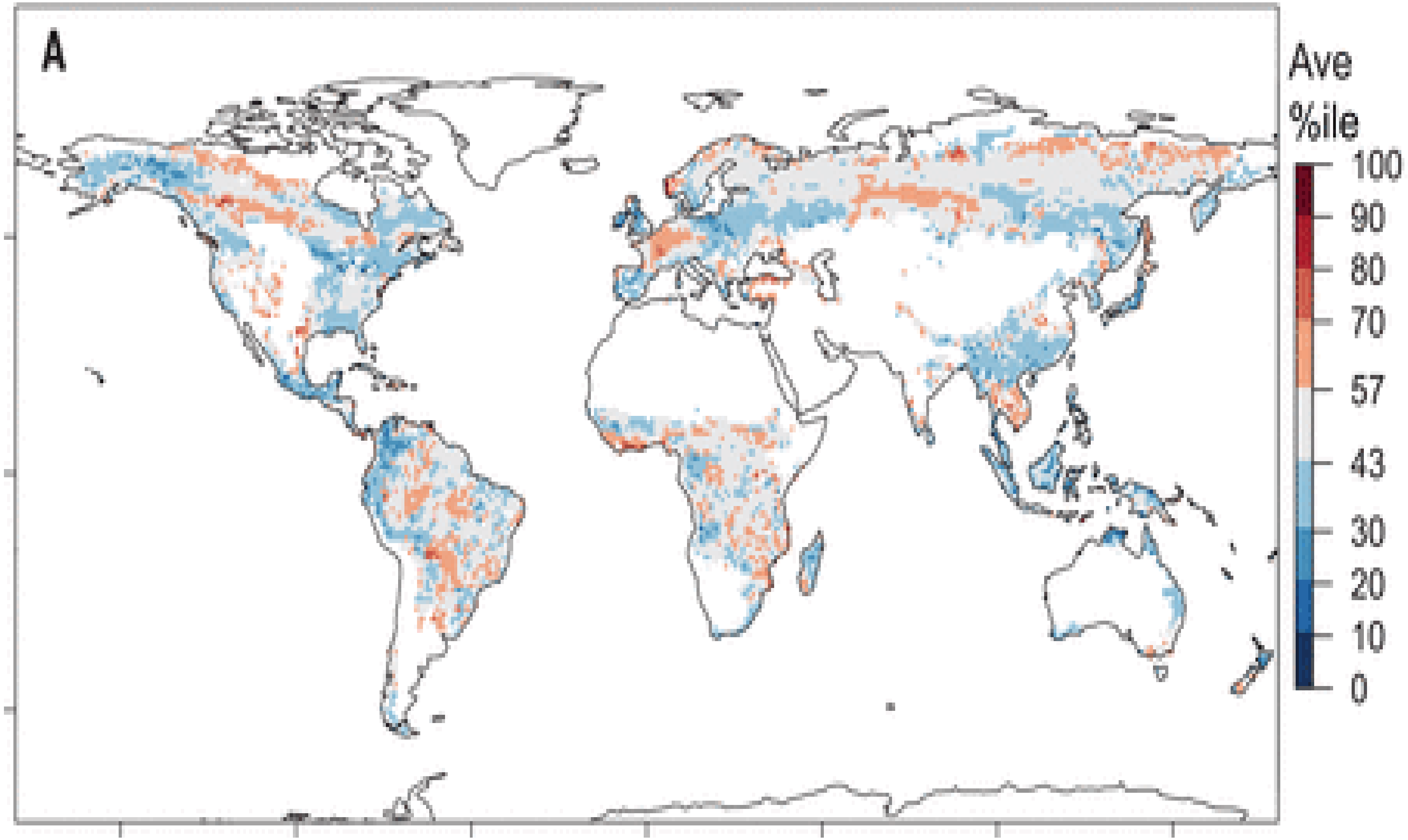
Where do we stand? IPCC AR6 1.5-2°C pathways



Source: IPCC AR6 WG3, SPM

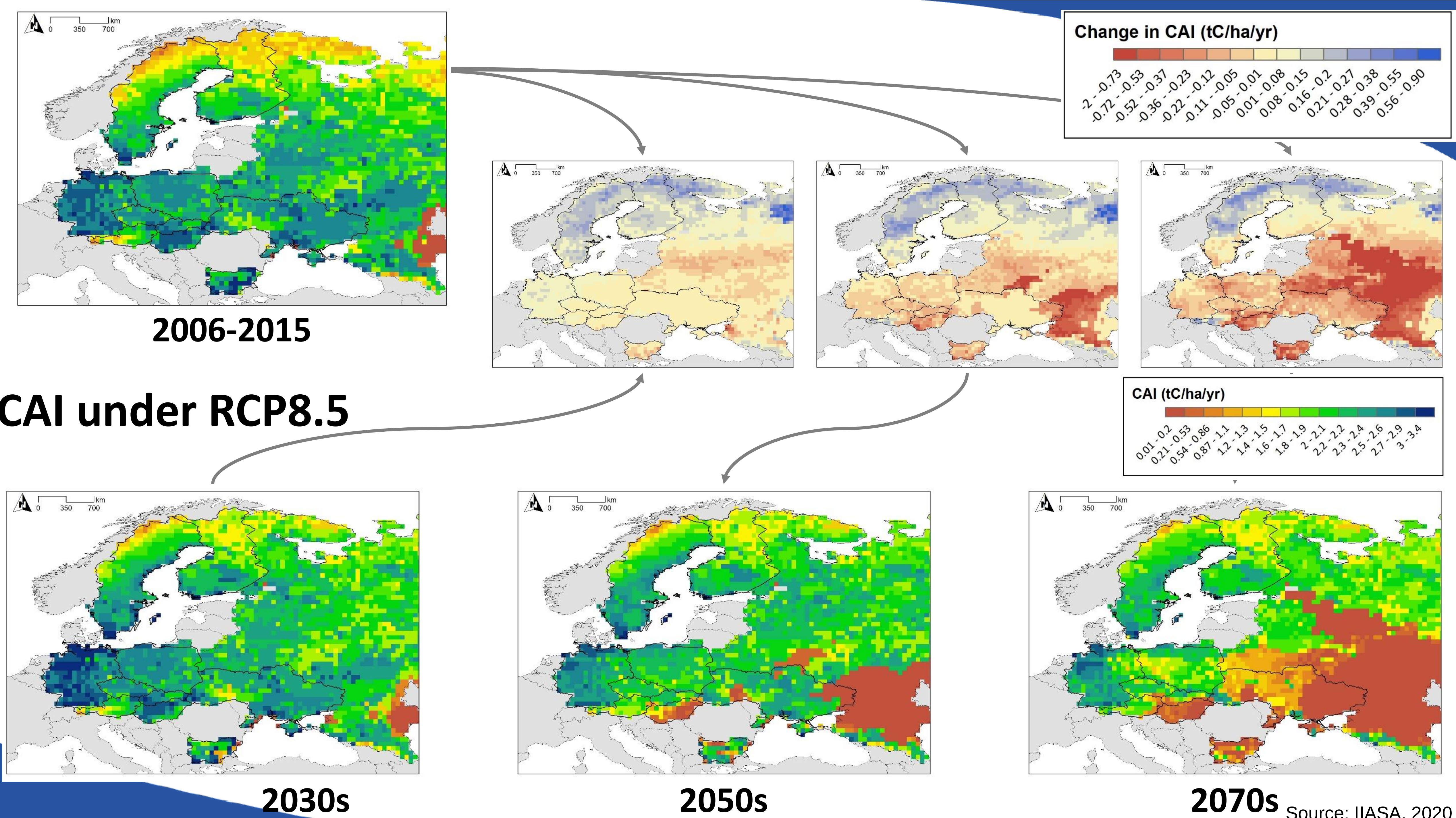
(Some of) The Global Challenges…

Global Climate Risk Hotspots for Forests



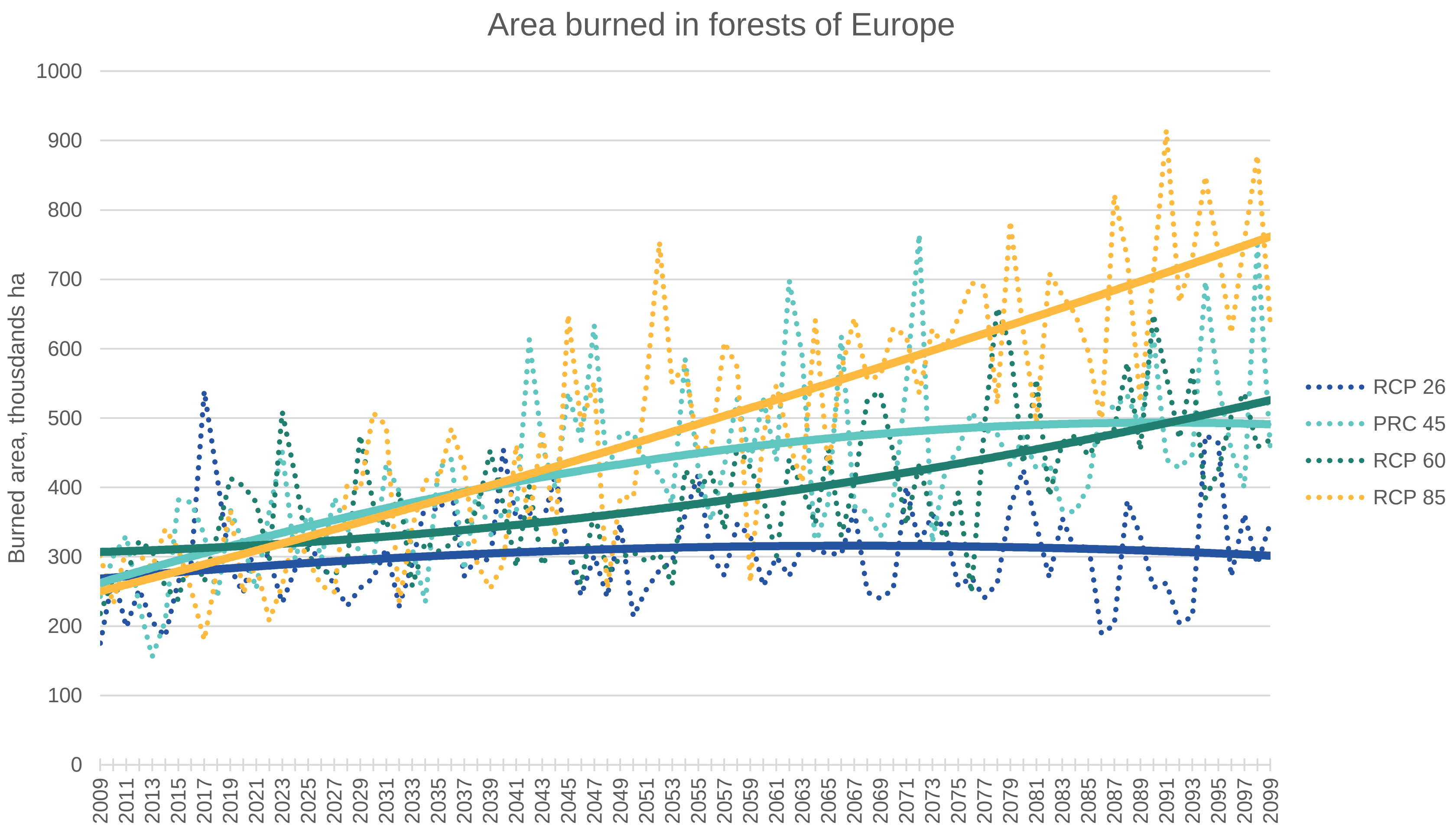
Source: Anderegg et al., 2022. *SCIENCE*

CAI under RCP8.5



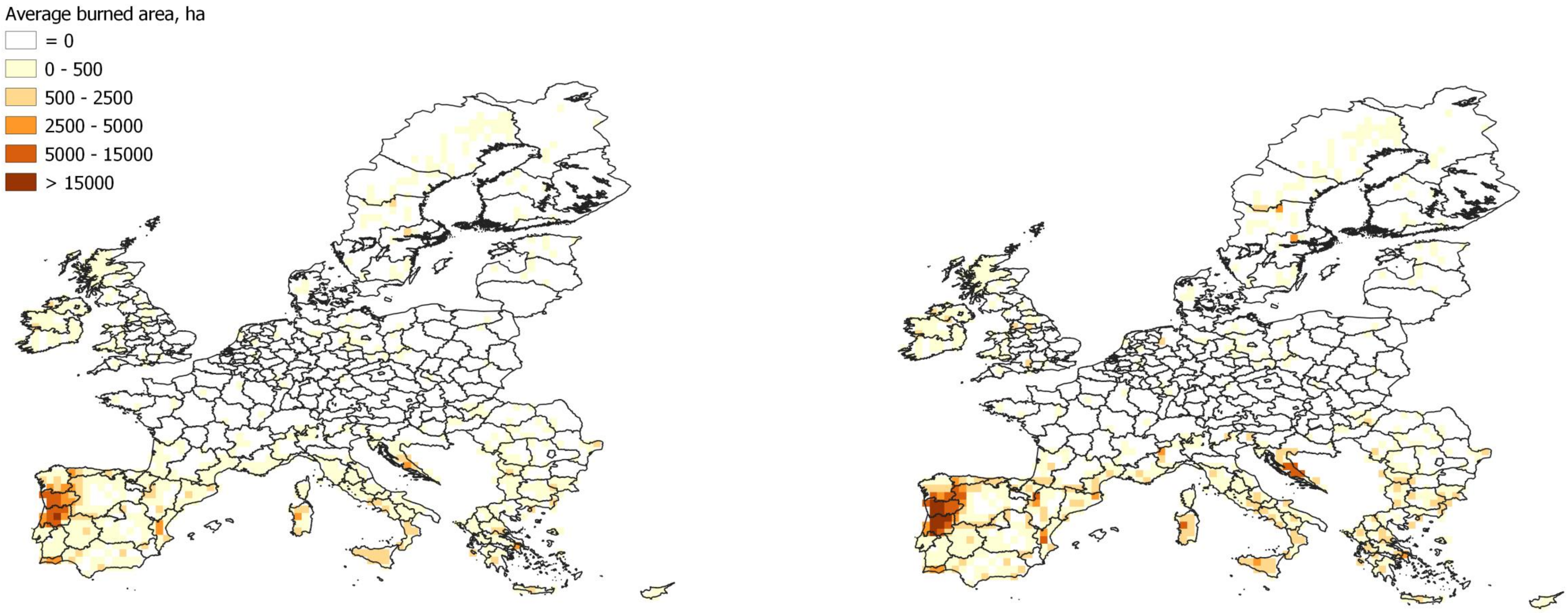
Source: IIASA, 2020

FLAM projections for forest fires in Europe - preliminary



Calibration period: 2009-2018 (Data were provided by the European Forest Fire Information System – EFFIS (http://effis.jrc.ec.europa.eu) of the European Commission Joint Research Centre. Reference)
Projection period: 2019-2099
Climate data: HadGEM2-ES model (ISIMIP2b)

Spatial distribution of burned areas RCP 4.5



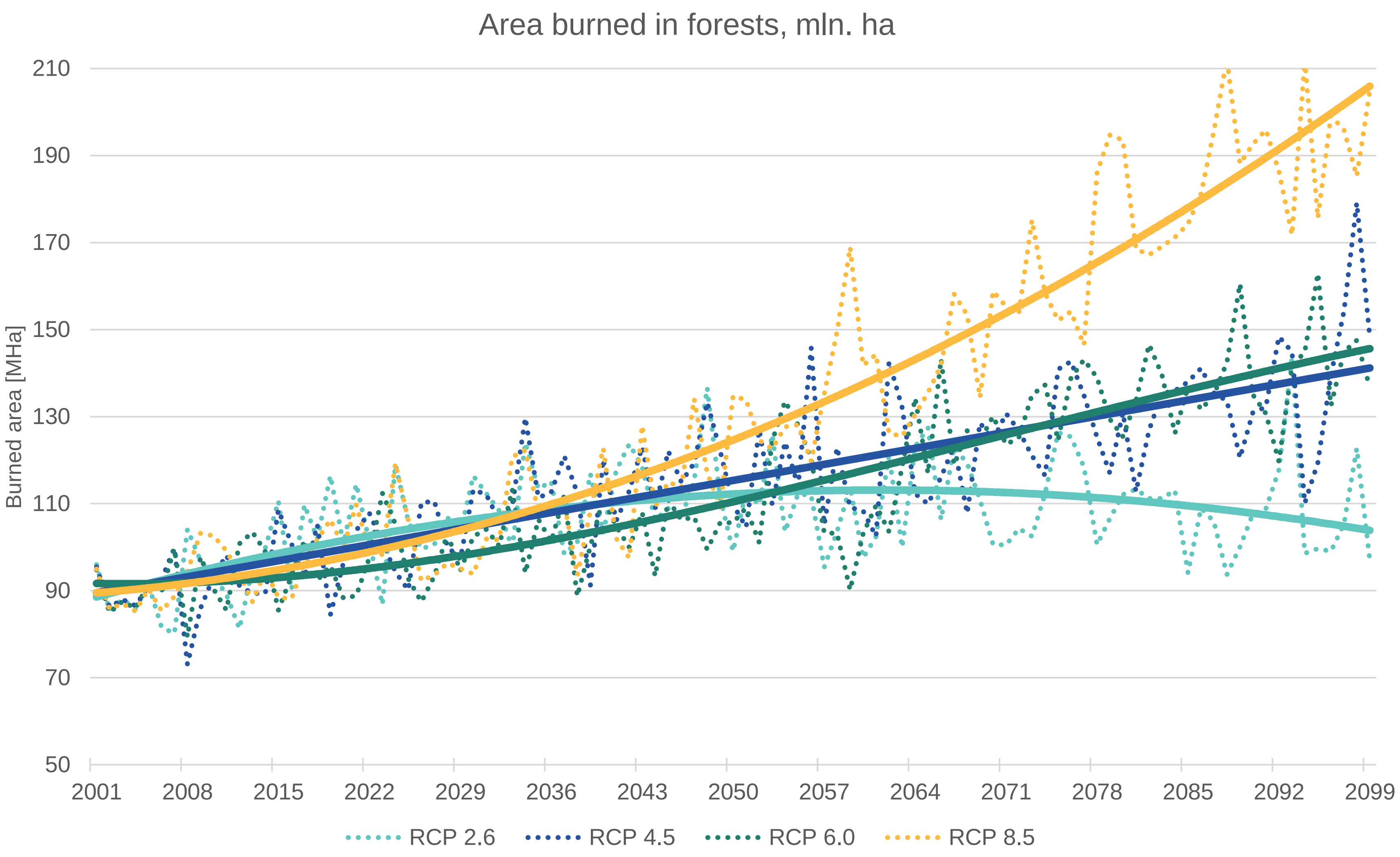
2010-2019

2080-2099

Chernobyl Exclusion Zone – Forest Fires in Ukraine under War

Source: TheGuardian.com

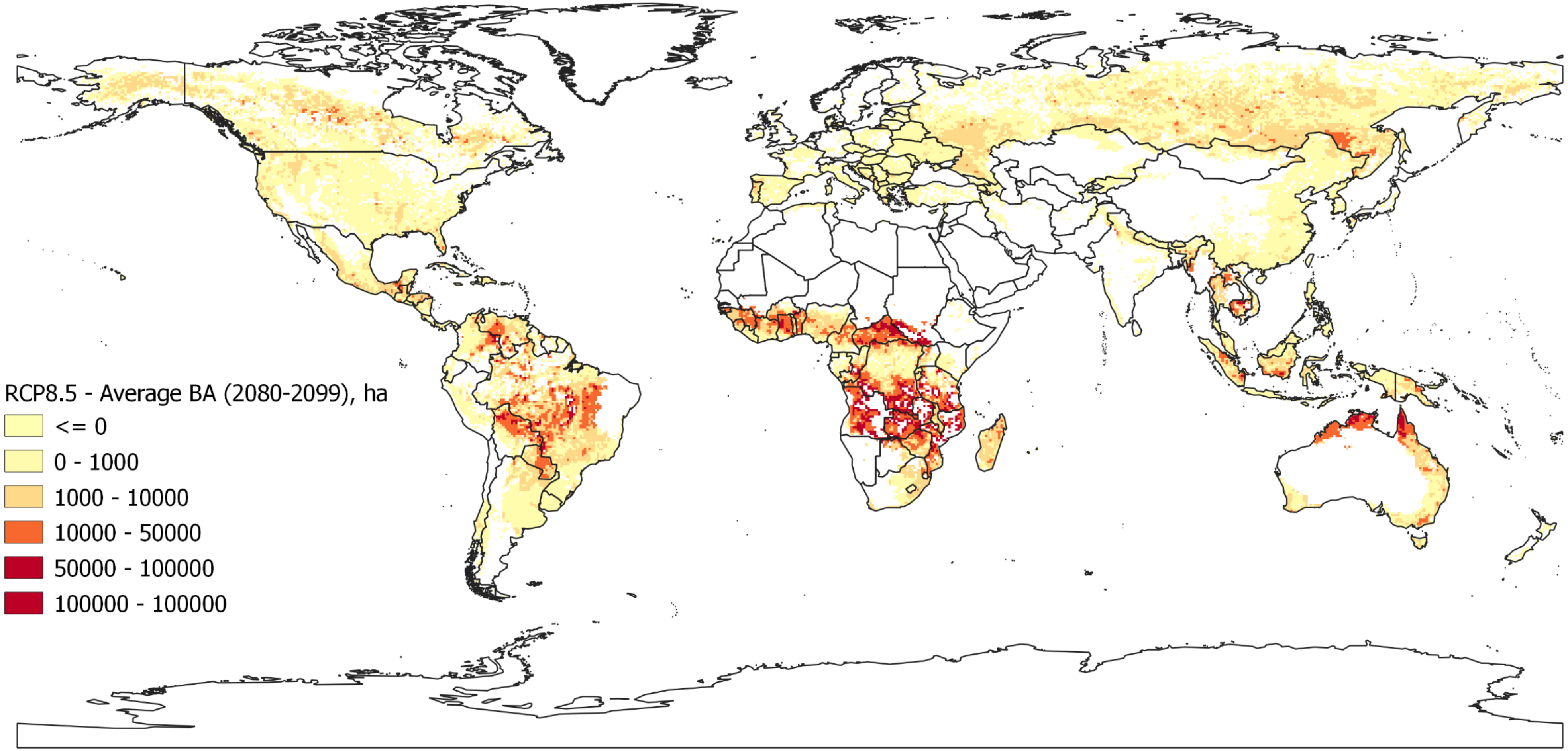
Global projections – burned area under RCPs



Calibration period: 2001-2016
Projection period: 2017-2099
Climate data: HadGEM2-ES model (ISIMIP2b)
Forest growth: G4M

Source: www.iiasa.ac.at/flam. IIASA 2021. Krasovskiy et al., unpublished!

Permanence?? FLAM – identified forest Fire Hot Spots (2080-2100), RCP 8.5

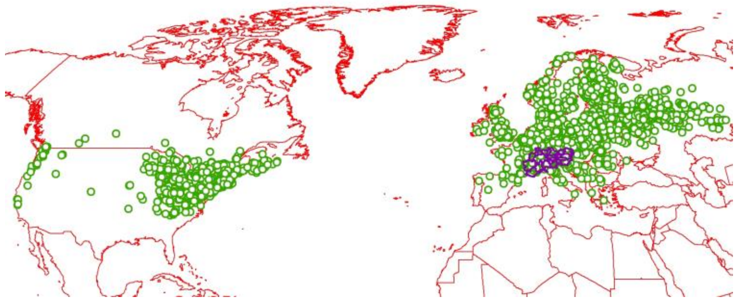


Source: IIASA-FLAM, Krasovskiy et al, 2021

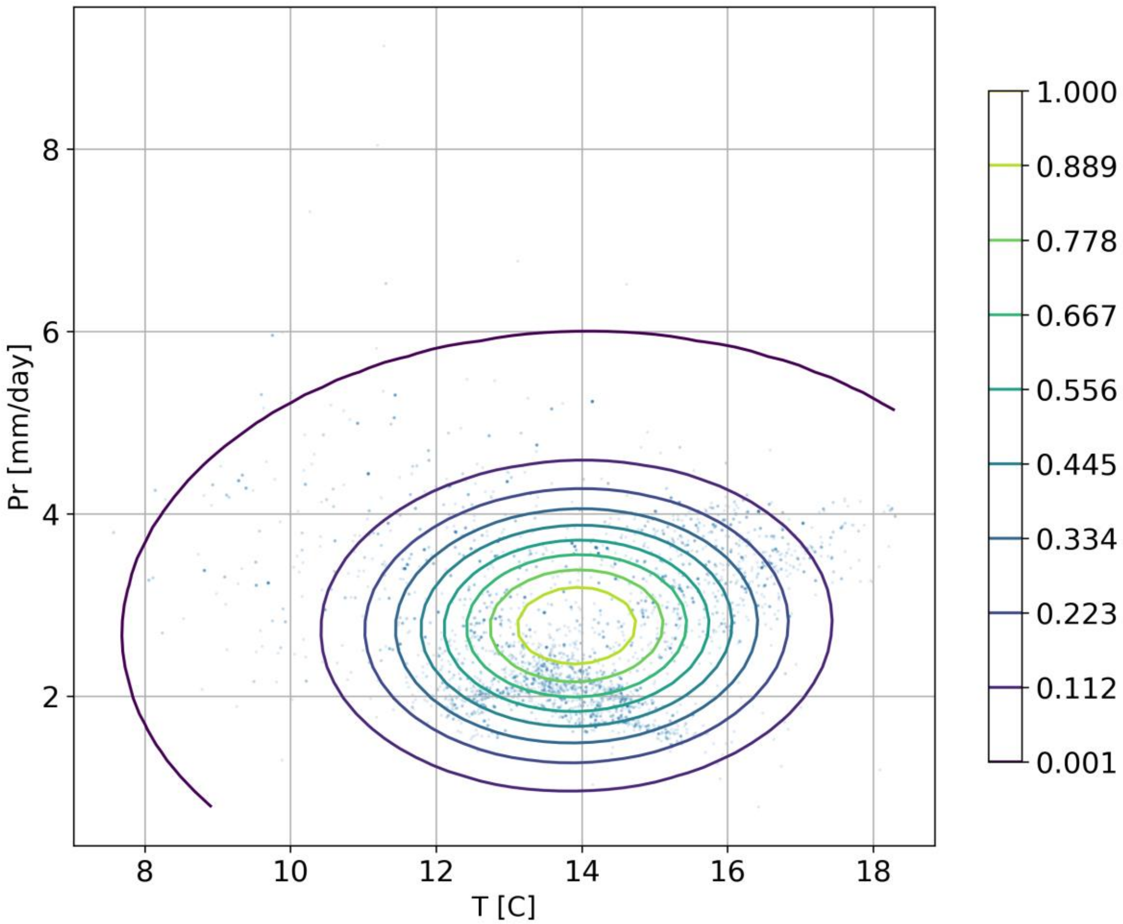
(Some of) The Local Opportunities…

Forest Tree Species @ Climate Risk

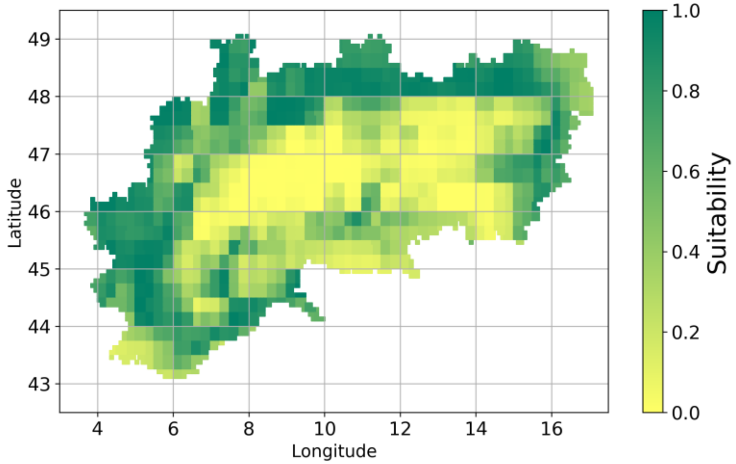
Citizen Science from iNaturalist global occurrence



Climate ordination/modeling



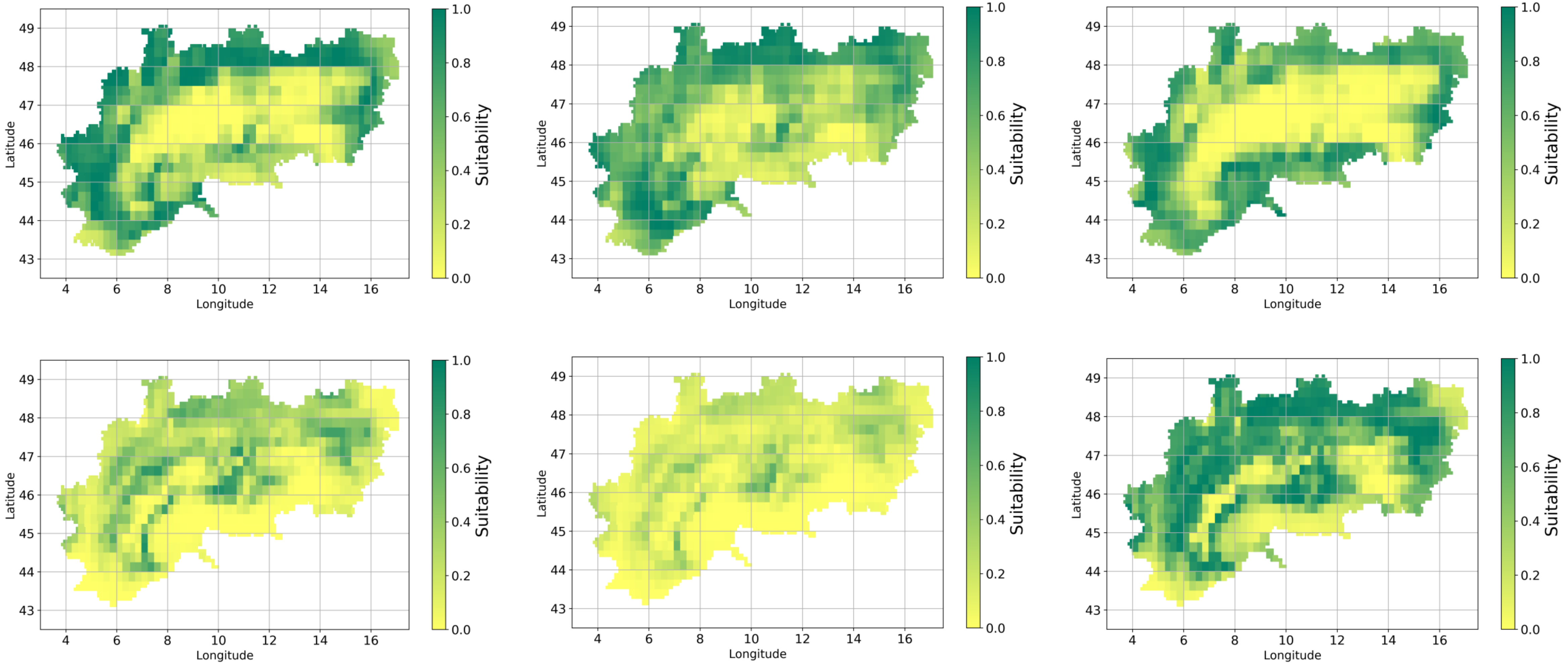
Tree Species Suitability



Source: IIASA, Krasovskiy et al., 2021

Climate risk for the tree species (RCP8.5)

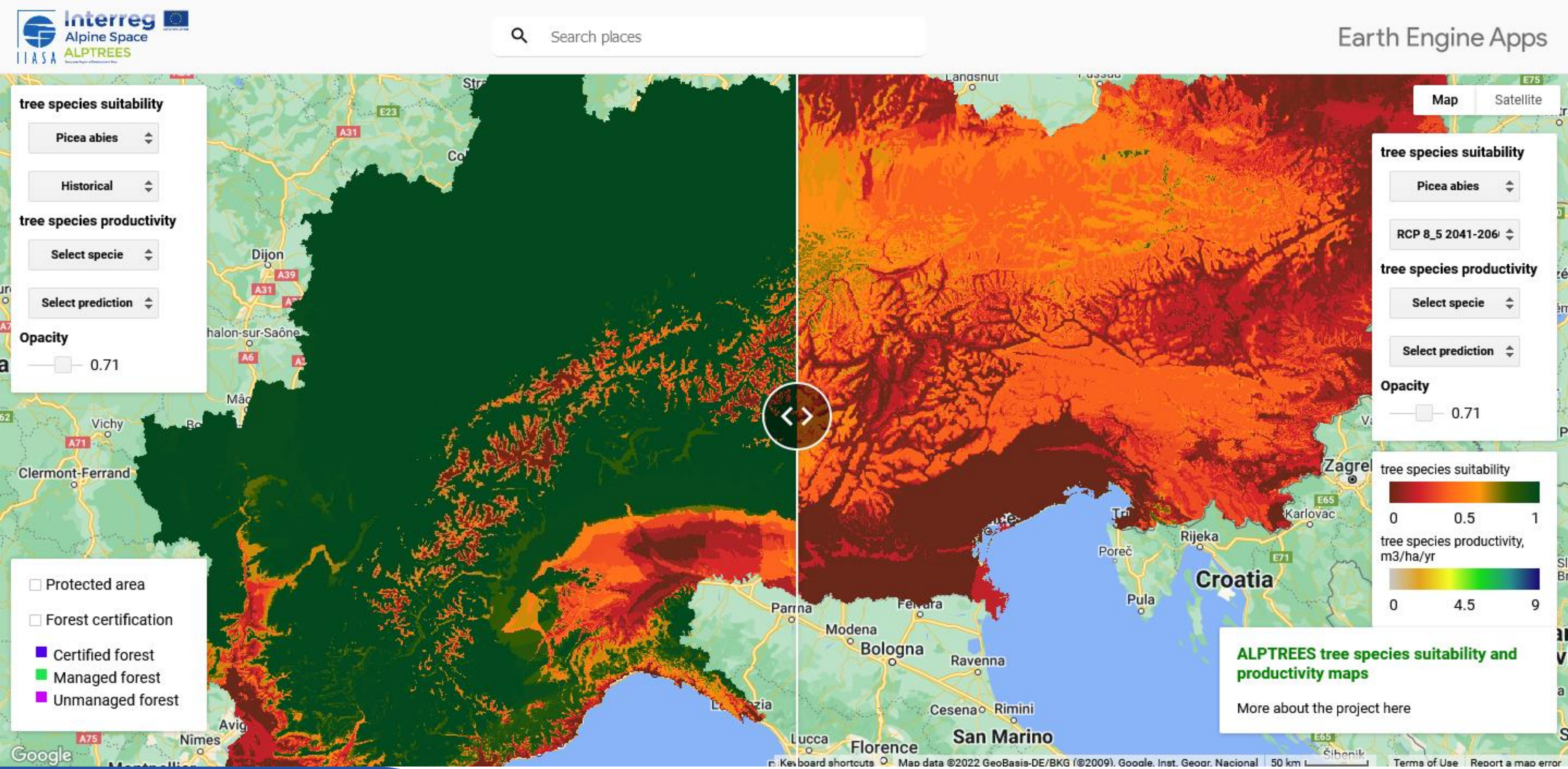
	Norway spruce	Douglas fir	Black locust
2001 - 2010			
2081 - 2090			

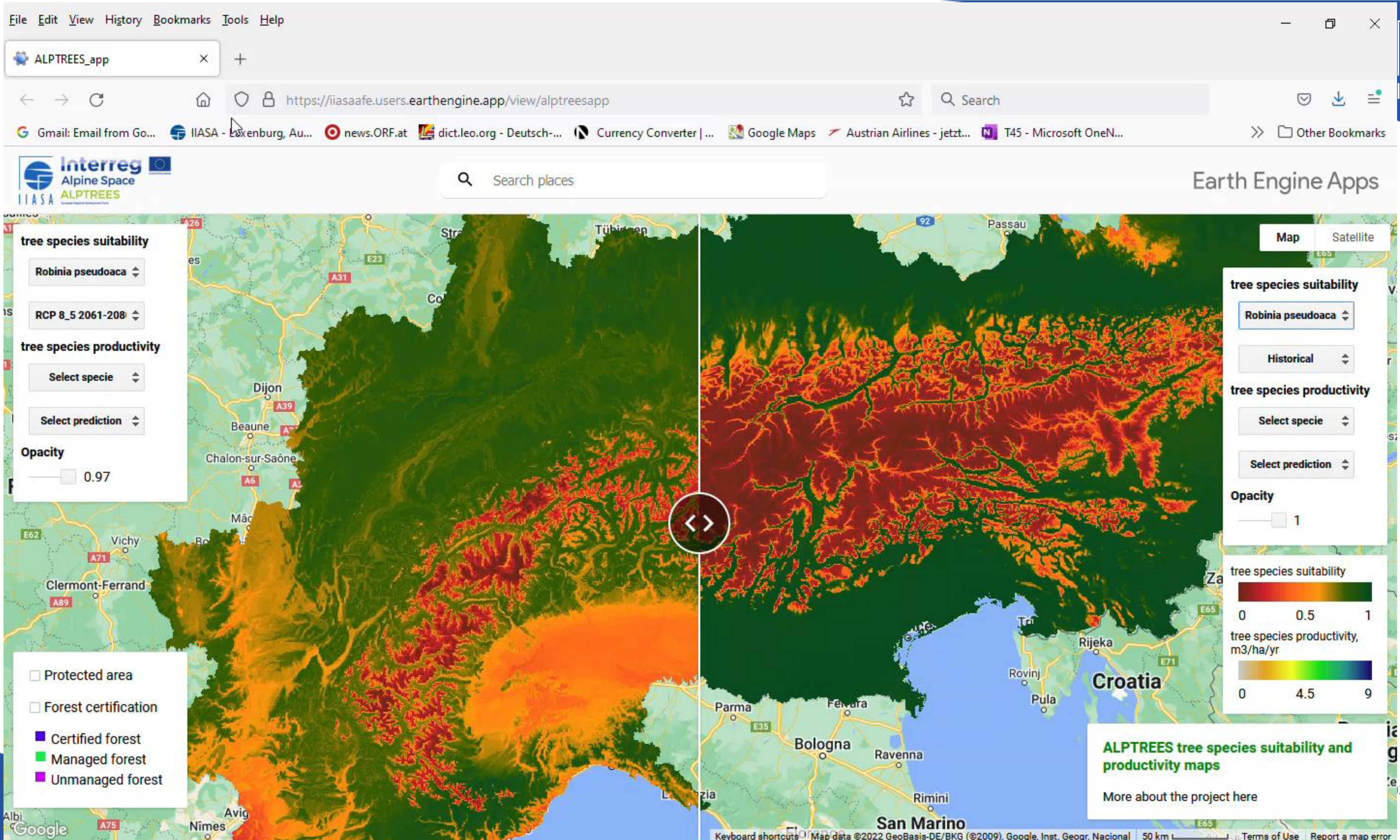


Source: IIASA, Krasovskiy et al., 2021

Tree Species Suitability Maps on *Google Earth Engine*

Go to: https://iiasaafe.users.earthengine.app/view/alptreesapp





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tree species productivity, m3/ha/yr
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ALPTREES tree species suitability and productivity maps
More about the project here
Passau
Dijon
Beaune
Chalon-sur-Saône
Vichy
Clermont-Ferrand
Nîmes
Rijeka
Croatia
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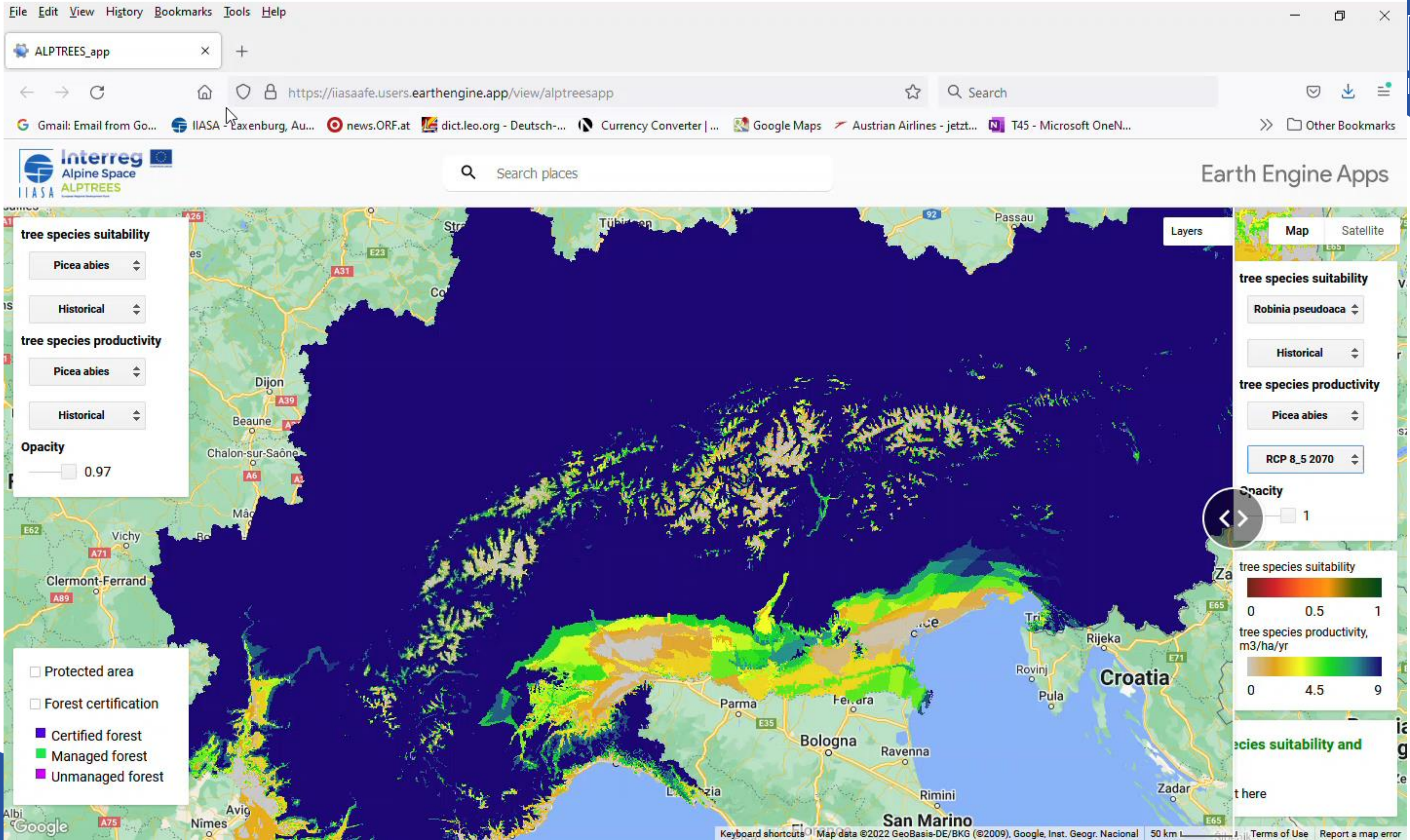
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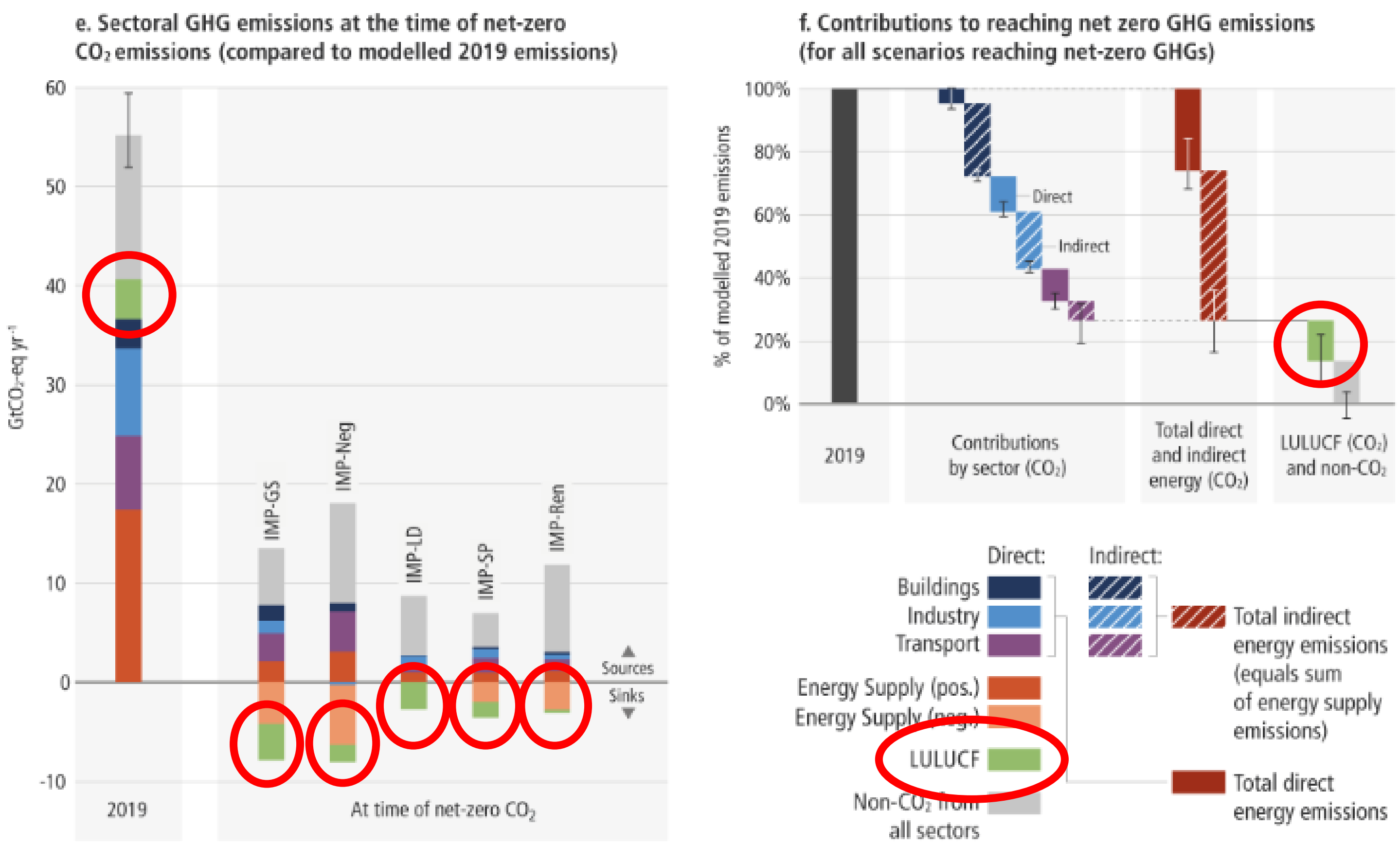
Net zero CO_2 and net zero GHG emissionsare possible through different modelled mitigation pathways.



AFOLU/LULUCF aka Forests

- **Climate Mitigation** including e.g, Reforestation and REDD

+

- **CDR technologies** – i.e., additional afforestation, BECCS - to reach 2/1.5 °C with the help of net negative emissions

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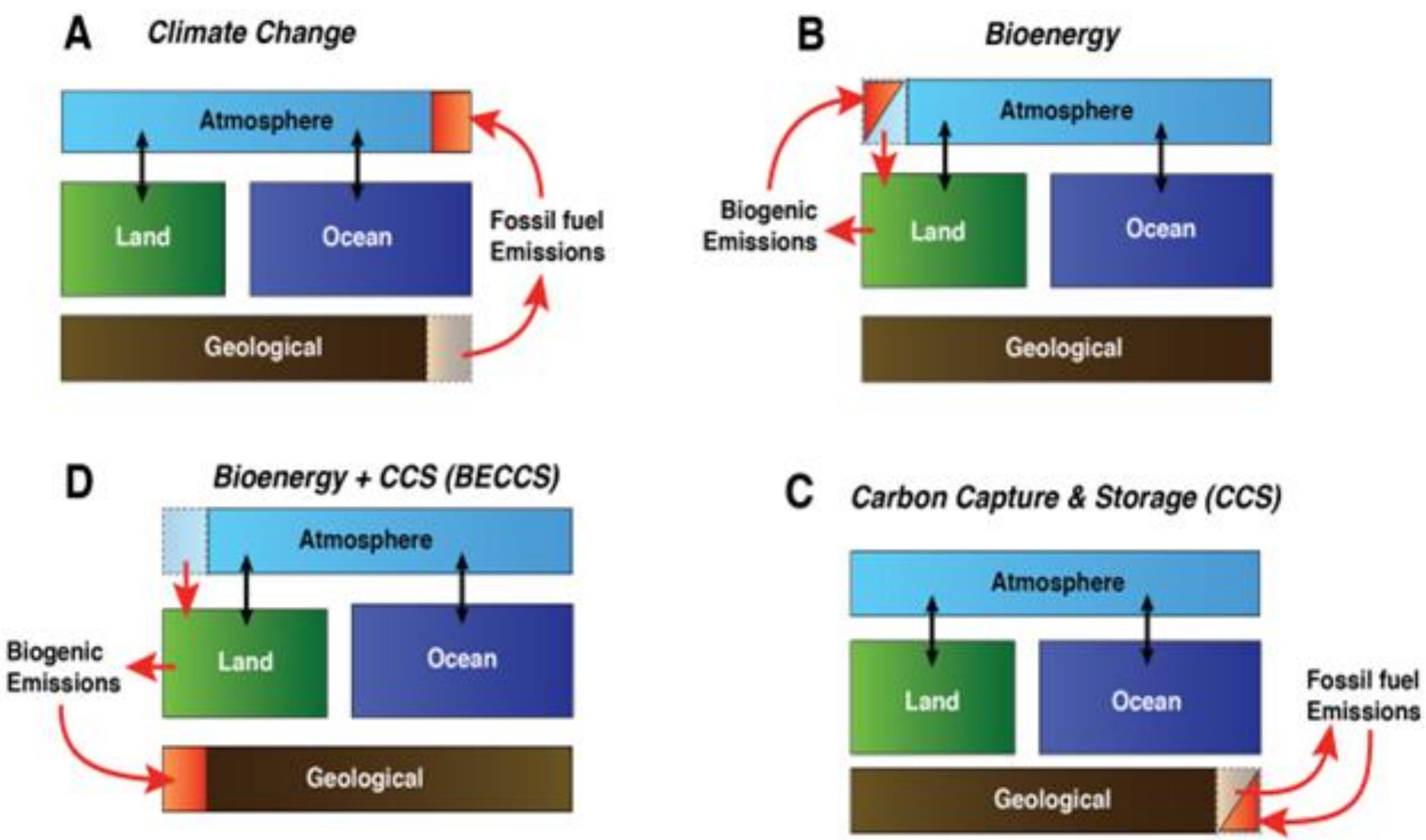
Dimensions:
30-780 $GtCO_2$ (CDR) – until 2100
20-400 $GtCO_2$ (AFOLU)

Includes **compensation** for other sectors that cannot become neutral

All mitigation strategies face **implementation challenges**, including technology risks, scaling, and costs. Many challenges, such as dependence on CDR, pressure on land and biodiversity… are significantly reduced in modelled pathways that assume using resources more efficiently

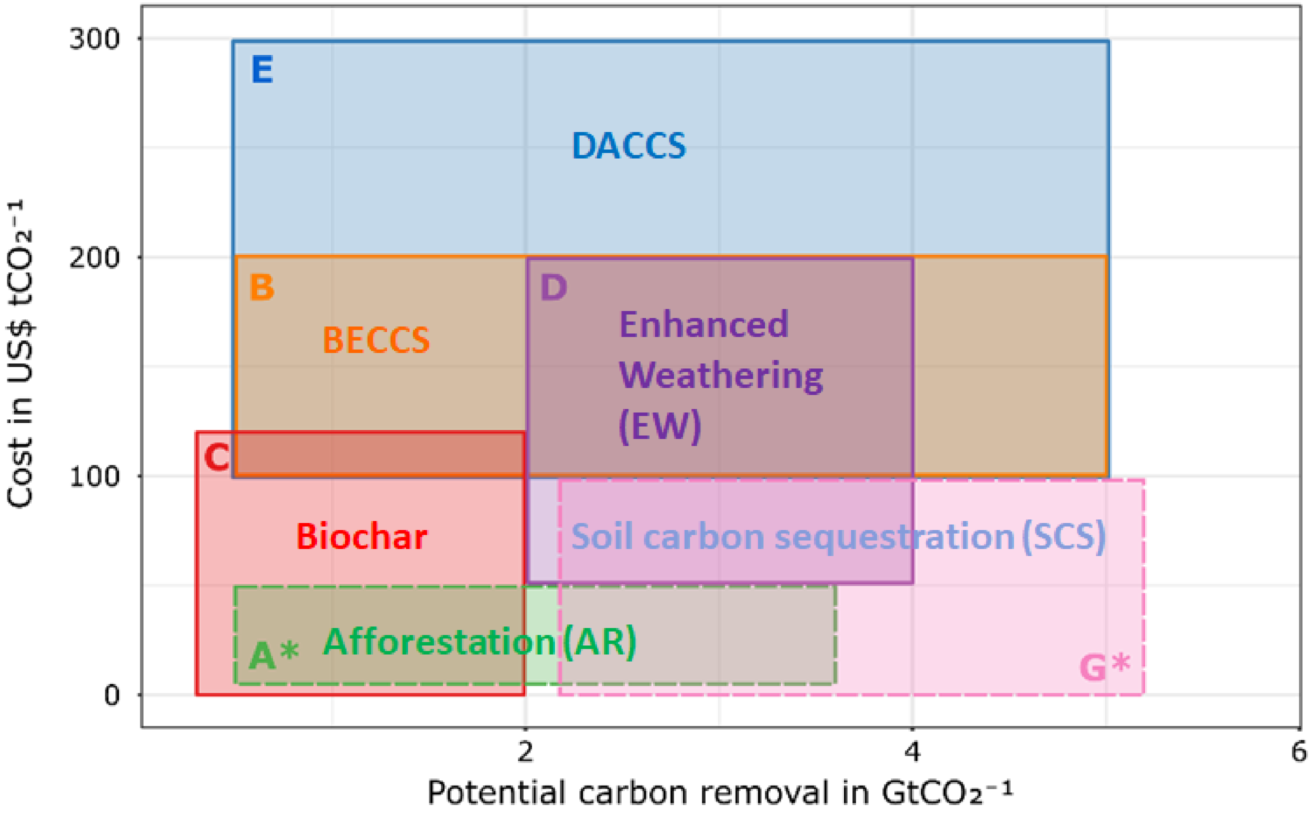
Source: AR6, WGIII, Fig. SPM.5

Carbon cycle impact of Carbon Dioxide Removal



Source: Smith et al. 2016

The debate around Natural Climate Solutions



- Technologically mature
- Relatively less costly

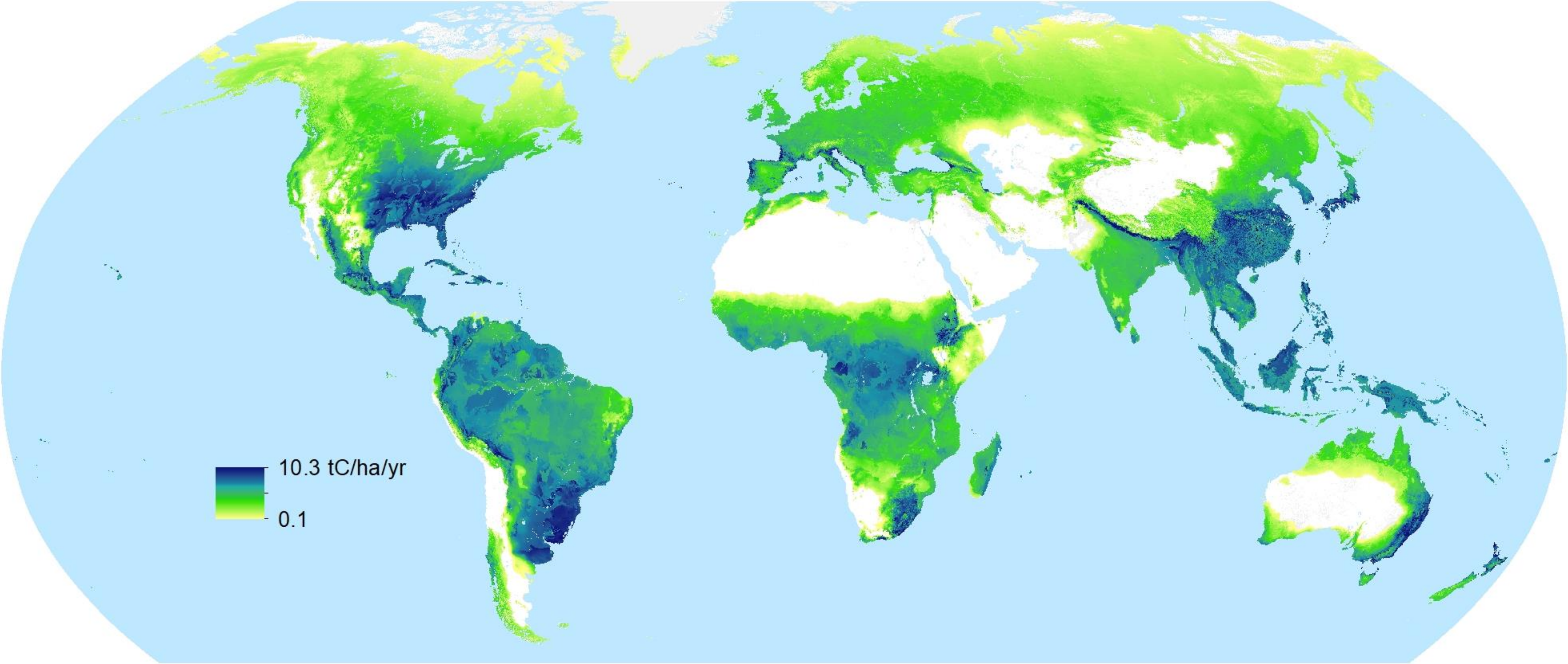
- Potential co-benefits
- Less public resistance

However, there are also concerns:

- Cheap credits undermining more costly emissions reductions.
- Permanence, reversibility, ongoing climate change and disturbances
- Monitoring, reporting and verification (MRV) challenges
- Land footprint, resource constraints, land-based leakage
- Need to address distributional impacts

Sources: Fuss et al. *ERL* 2018

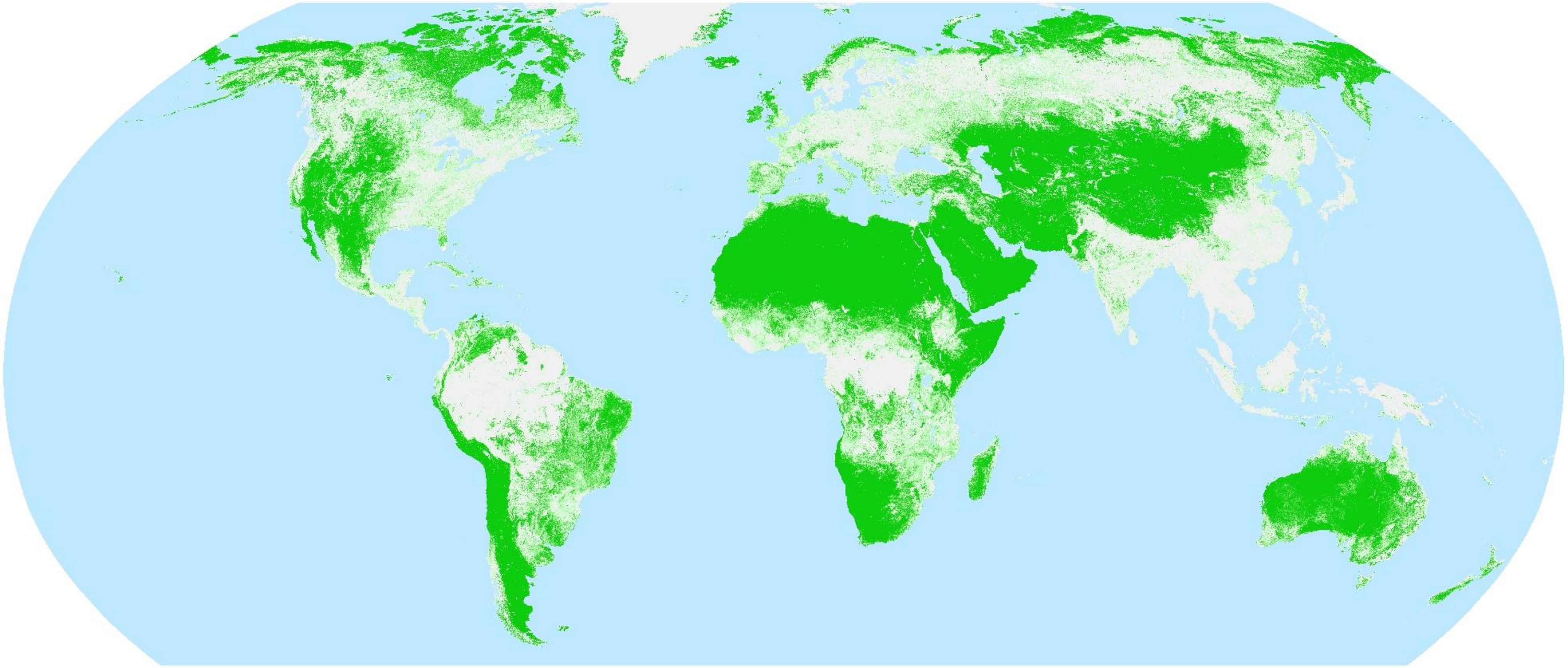
Where can forests grow?
→ Potential forest productivity under present climate



The basis for forest productivity potential assessment is provided by IIASA's Global Forestry Model (G4M). Figure representsing potential forest productivity (in t C /ha/year) estimated based on biophysical parameters under present climate.

Source: G4M simulation, IIASA, Kindermann, 2020

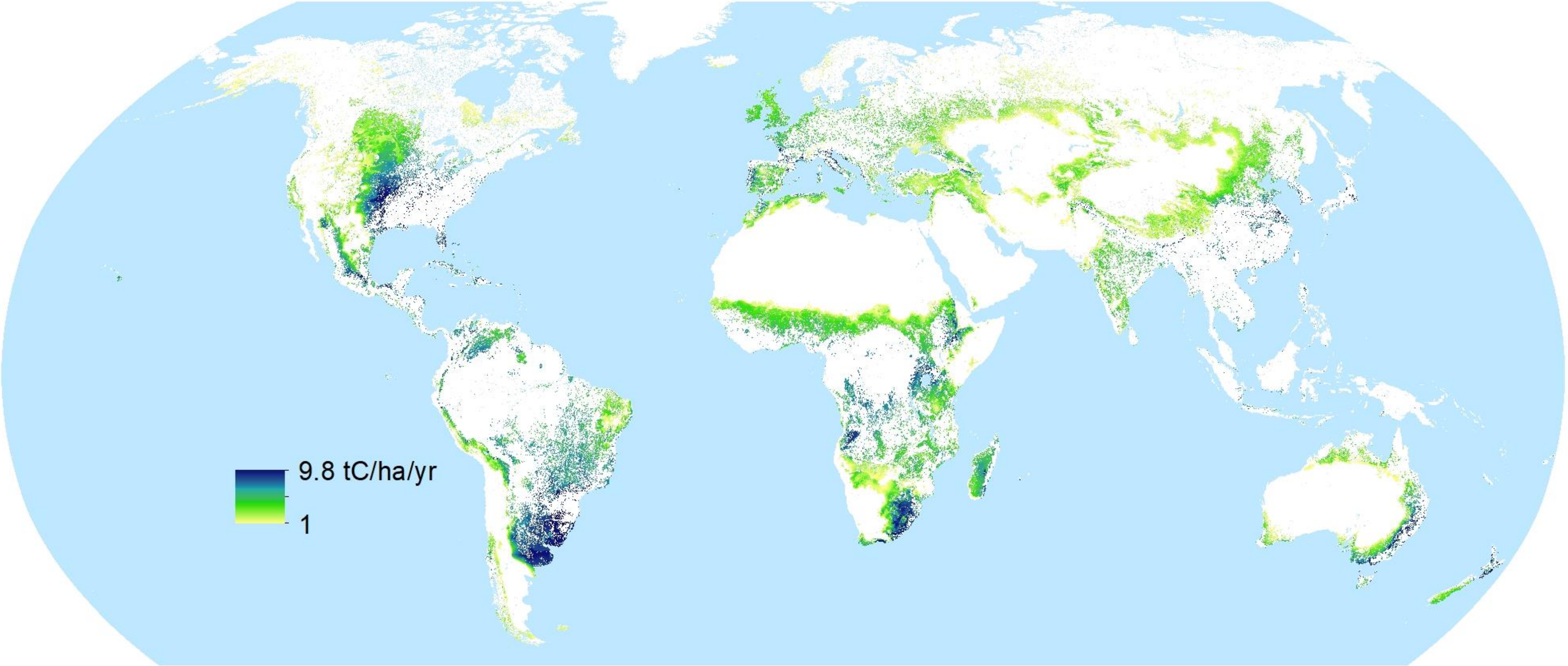
Where can we do (additional) afforestation?
→ Global extent of grass-, shrub- and bare land



Afforestation
The Afforestation scenario implies additional active afforestation (forest expansion) to the area currently covered by forest → grass- or shrub- or bare land, where forest can successfully grow (i.e. provide mean woody biomass increment of **at least 1 tC/ha/year** over rotation time).

Source: Copernicus Land Cover Service, 2019

How can we make use of the identified area without interfering…?
→ Global area of potential carbon sequestration (tC/ha/yr) by afforested grass-, shrub- and bare land

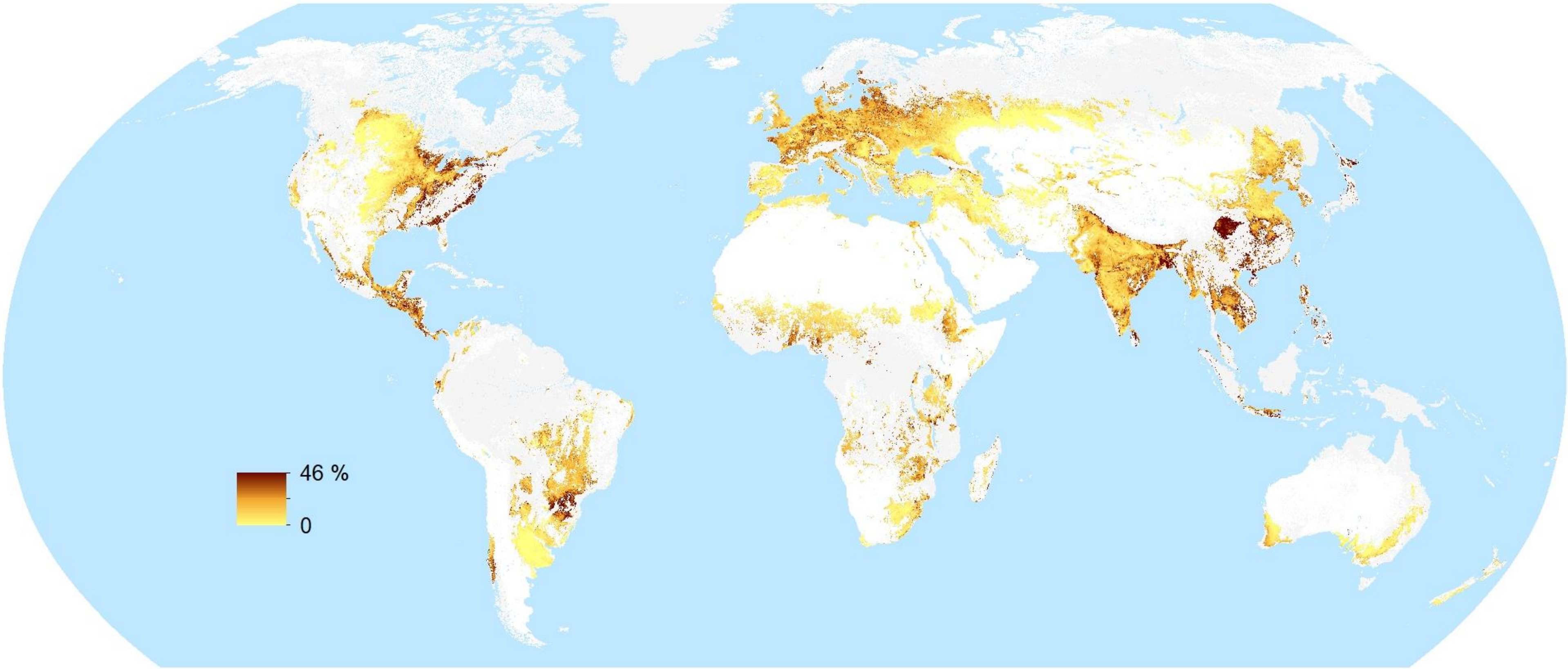


Afforestation on Grassland

Grass- and shrubland are important for grazing to support livestock and wildlife. Most of the grass- and shrubland are used (or will be used) for this purpose.

→ We assumed that afforestation of grassland by **introducing trees up to 20% of area will not harm** and even promote the primary function (grazing/habitat).

How about agricultural land?
Tree shares within crop-dominant land cover class

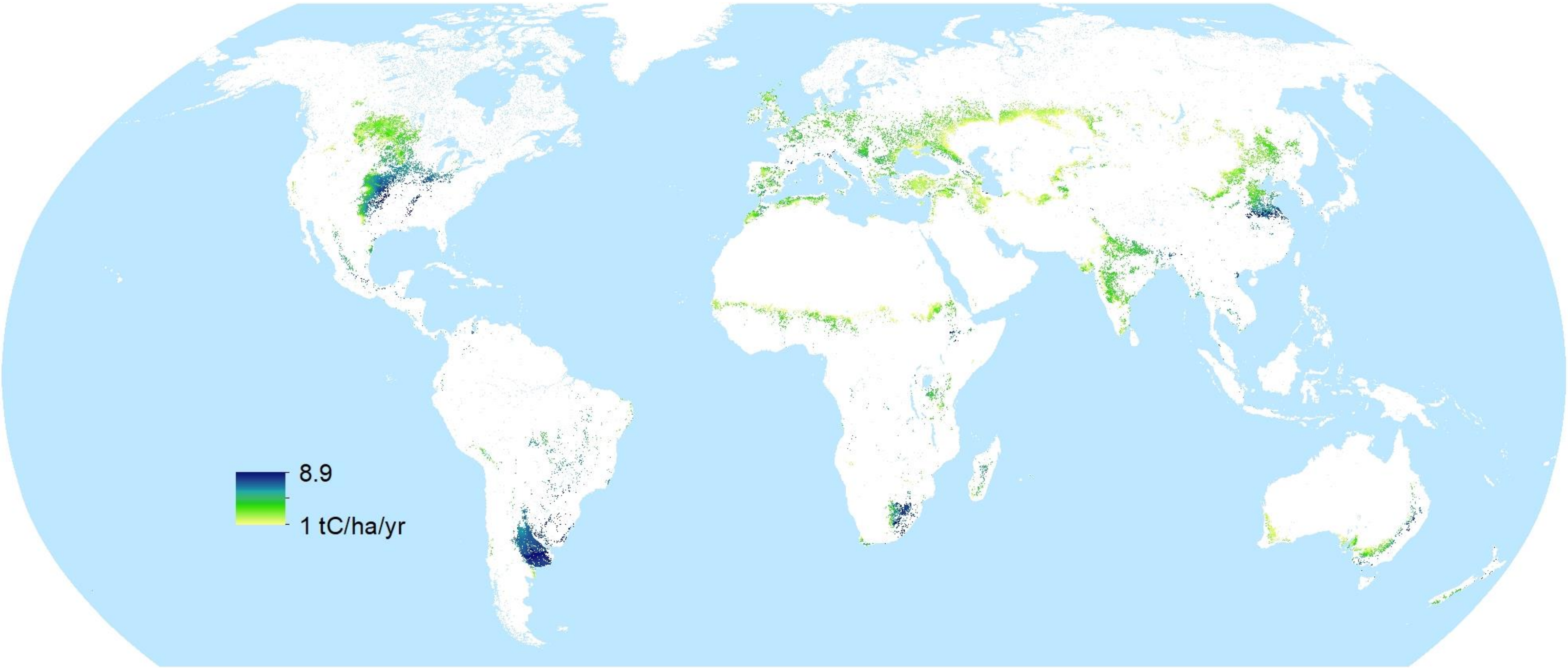


→ Protection forest on cropland (shelter belts)

Large-scale agriculture land use where there is no or little tree cover and hence introduce a minimum threshold of **5% tree cover** mimicking hedges and shelterbelt/protection forest stripes against erosion from wind and water etc… which will have an additional benefit in potential biomass (hence sequestering carbon), but also positive feedback on crop land and biodiversity.

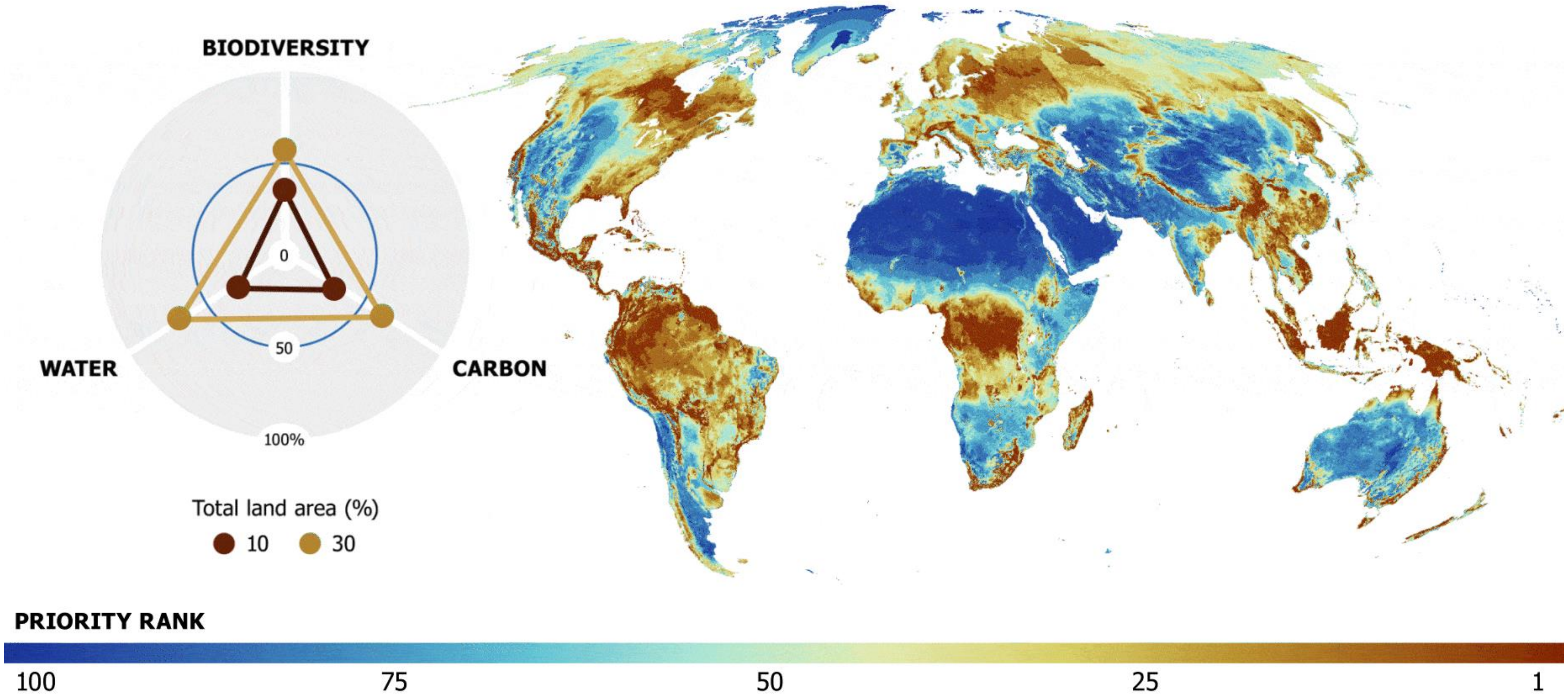
(Copernicus land cover service, 2019)

Carbon sequestration potential at cropland with tree cover less than 5%



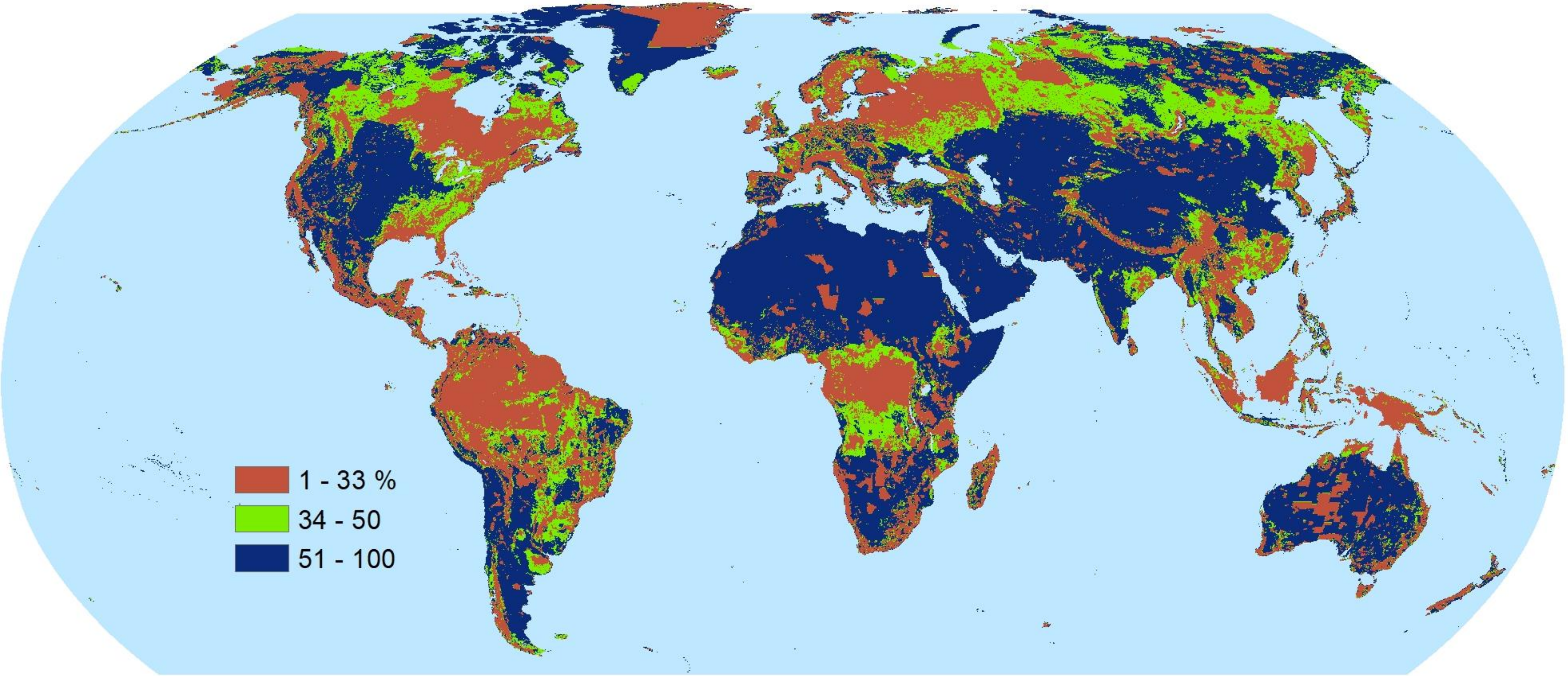
Total area of proposed protection forest on cropland is estimated at 22.6 million ha with carbon sequestration potential at **56.0 million tC per year**.

GLOBAL AREAS OF IMPORTANCE FOR TERRESTRIAL BIODIVERSITY, CARBON AND WATER



Ref: Jung et al., 2021 https://doi.org/10.1038/s41559-021-01528-7

Global area of conservation priorities considering biodiversity, carbon storage, and water provision importance.



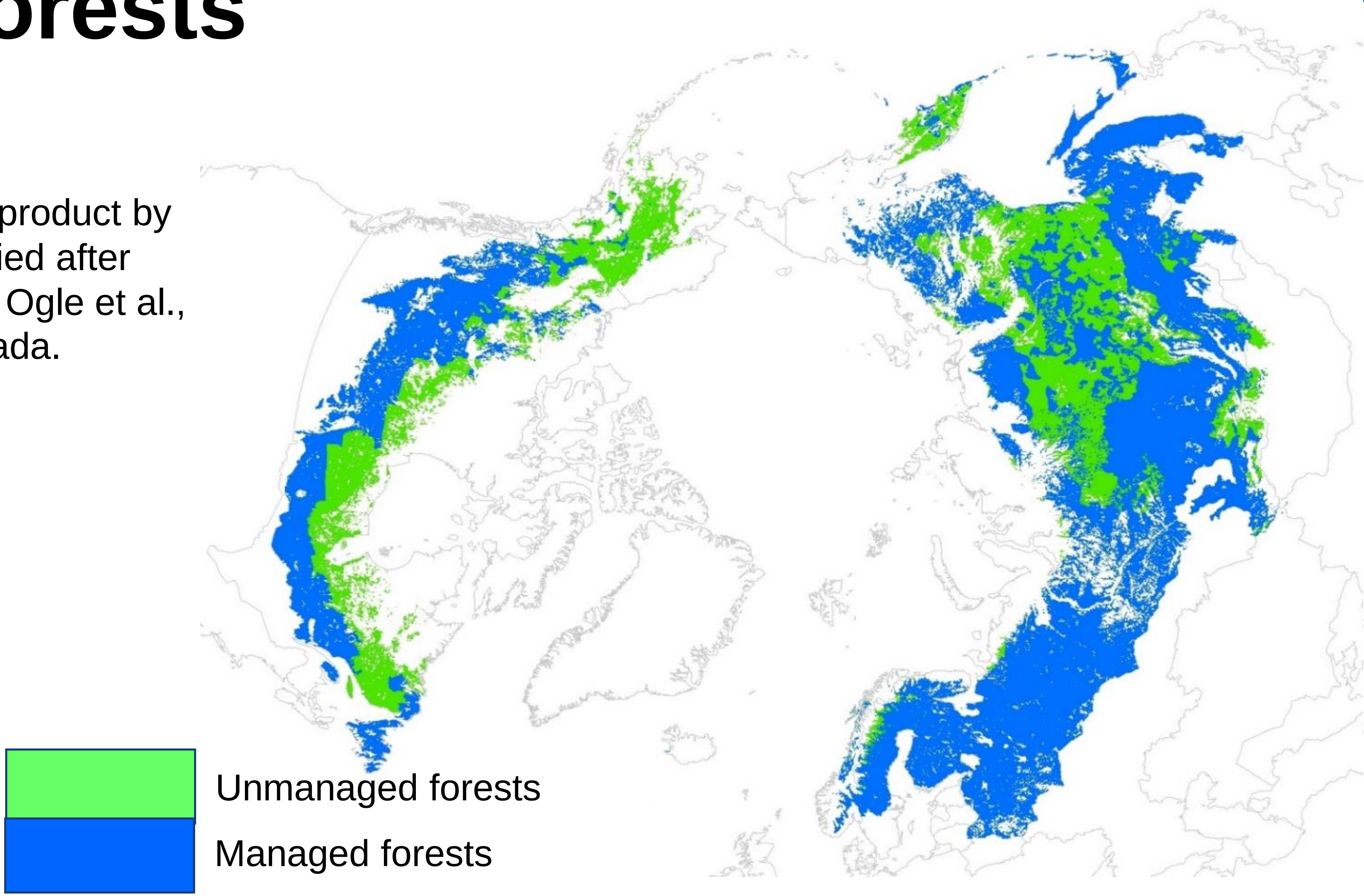
1-33% - one third of the most important land area, including currently protected areas.
→ Afforestation of grass-/shrubland potential dropping by 22% in terms of area and 25% in carbon increment.
→ Protection forest potential on cropland reducing by 7% and 9% respectively.
→ Burnt area reforestation potential reducing by 34% and 35%.
However, these areas are not completely out of NBS reach. AF/RE with native species can promote development of ESS

Total carbon sequestration potential in woody biomass over three scenarios

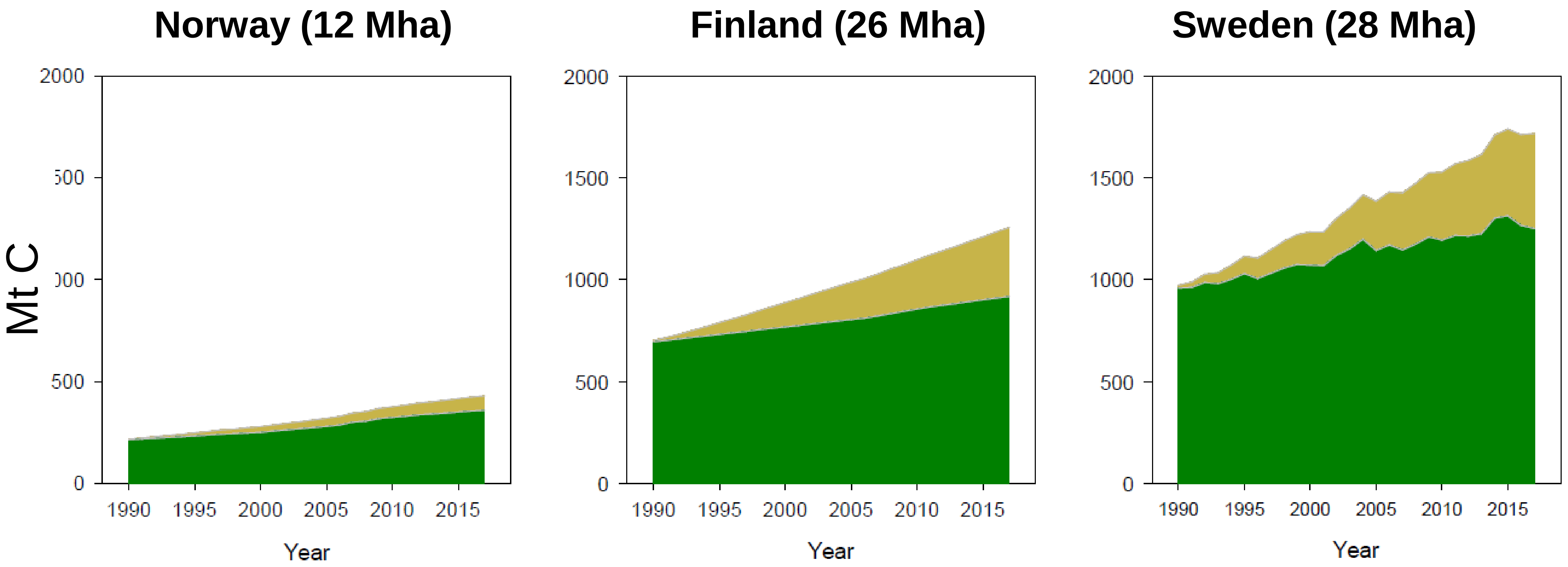
Scenario	Full sequestration potential, **MtC/yr**	C sequestration potential, excl. ⅓ Earth, **MtC/yr**	Accumulated C sequestration 2025-2100, **Gt CO2 eq.**
Afforestation	294.2	221.5	**60.9**
Protection forest	56.0	50.5	**13.9**
Burnt area restoration	258.8	168.4	**46.3**
Total	**609.0**	**440.4**	**121.1**

Boreal forests

The map is a hybrid product by IIASA © 2021, modified after Kraxner et al., 2017, Ogle et al., 2018 and NFIS Canada.

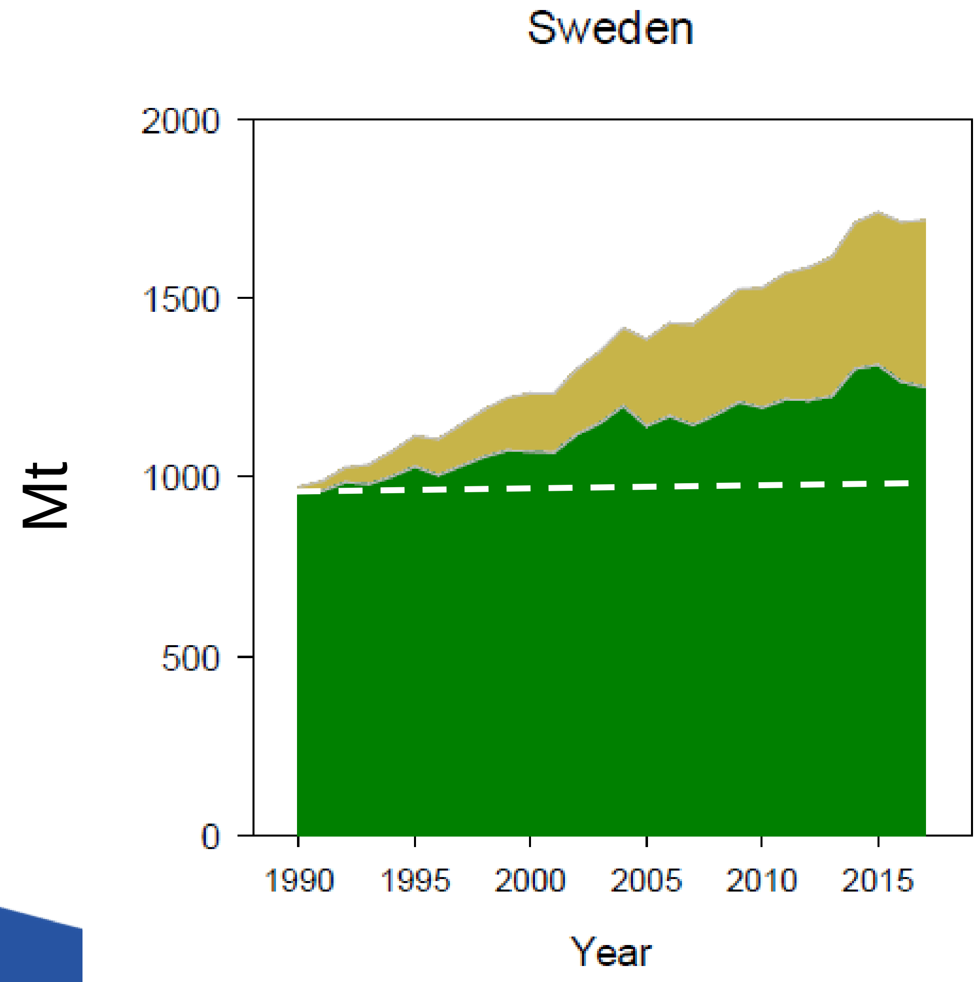


C stocks in living tree biomass (**dark green**) and C in <u>cumulative</u> harvests (**yellow**).
Forests in Norway, Finland and Sweden 1990-2017.



Source: IBFRA Insight Report 2021

C stocks in living tree biomass (**dark green**) and C in <u>cumulative</u> harvests (**yellow**) in Sweden 1990-2017.



Cumulative Harvest

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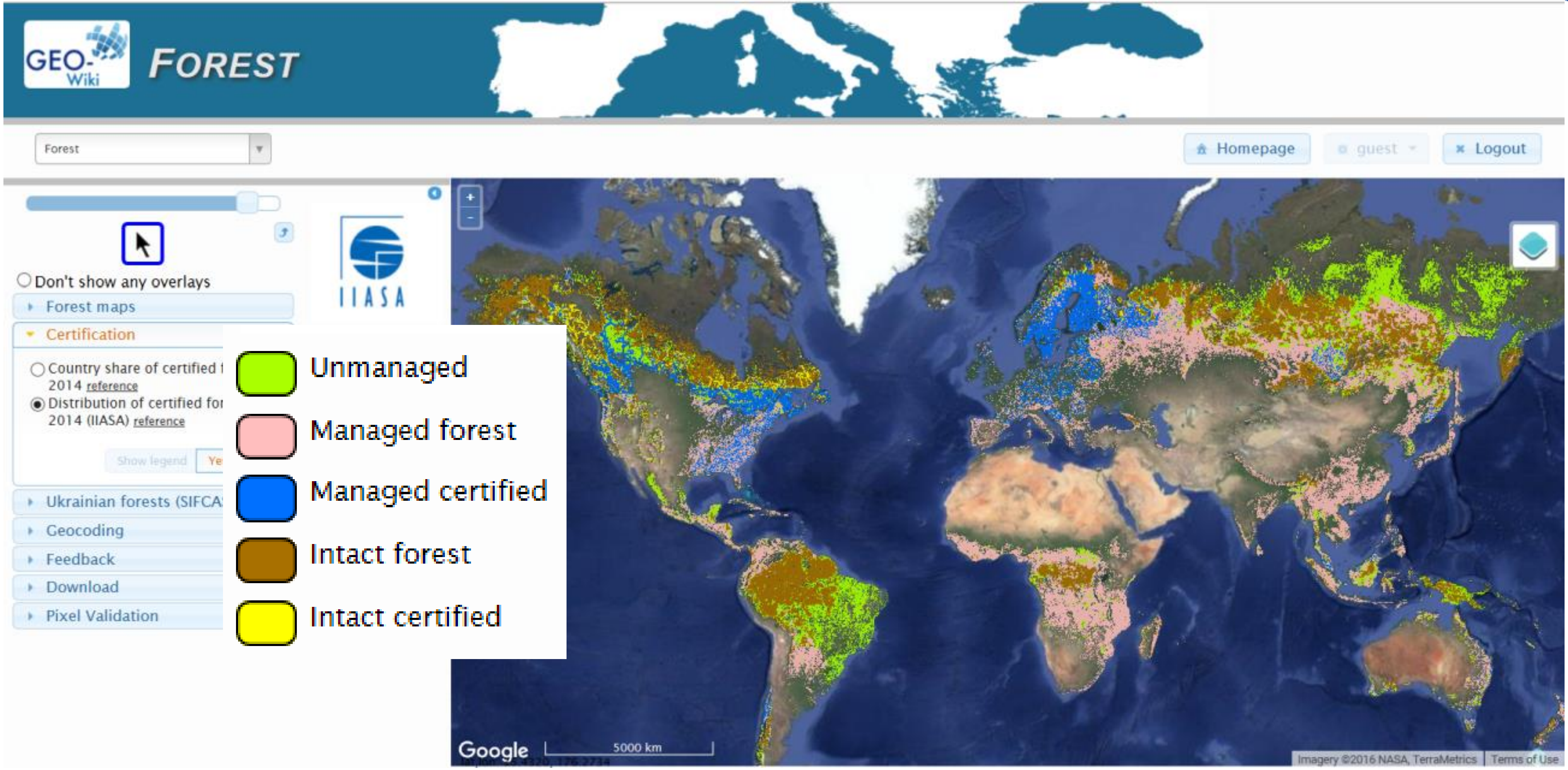
Biomass C increase

= C removed from the atmosphere

How much of harvested C is returned to atmosphere depends on wood use.

Source: IBFRA Insight Report 2021

Geo-Wiki – Forest Management Certification



Source: Kraxner et al., (2017)

Take home…

Challenges

- Forests – the way we know them – are under multiple threats
- Highest Expectations
- Climate Change and Land Use Change/Deforestation
- Increased Risk of Disturbances
- We are terribly late with Climate Change Mitigation

Opportunities

- Support Forest Transition
- Afforestation under a changing climate
- Management is a key
- Local details make a difference
- CDR, i.e. BECCS and targeted afforestation, wetlands
- Further research and ACTION needs to go into MRV/certification

CONTACT

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More about IIASA's Global Models

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