Observing the forest ecosystems: links between climate change, biodiversity and human activities

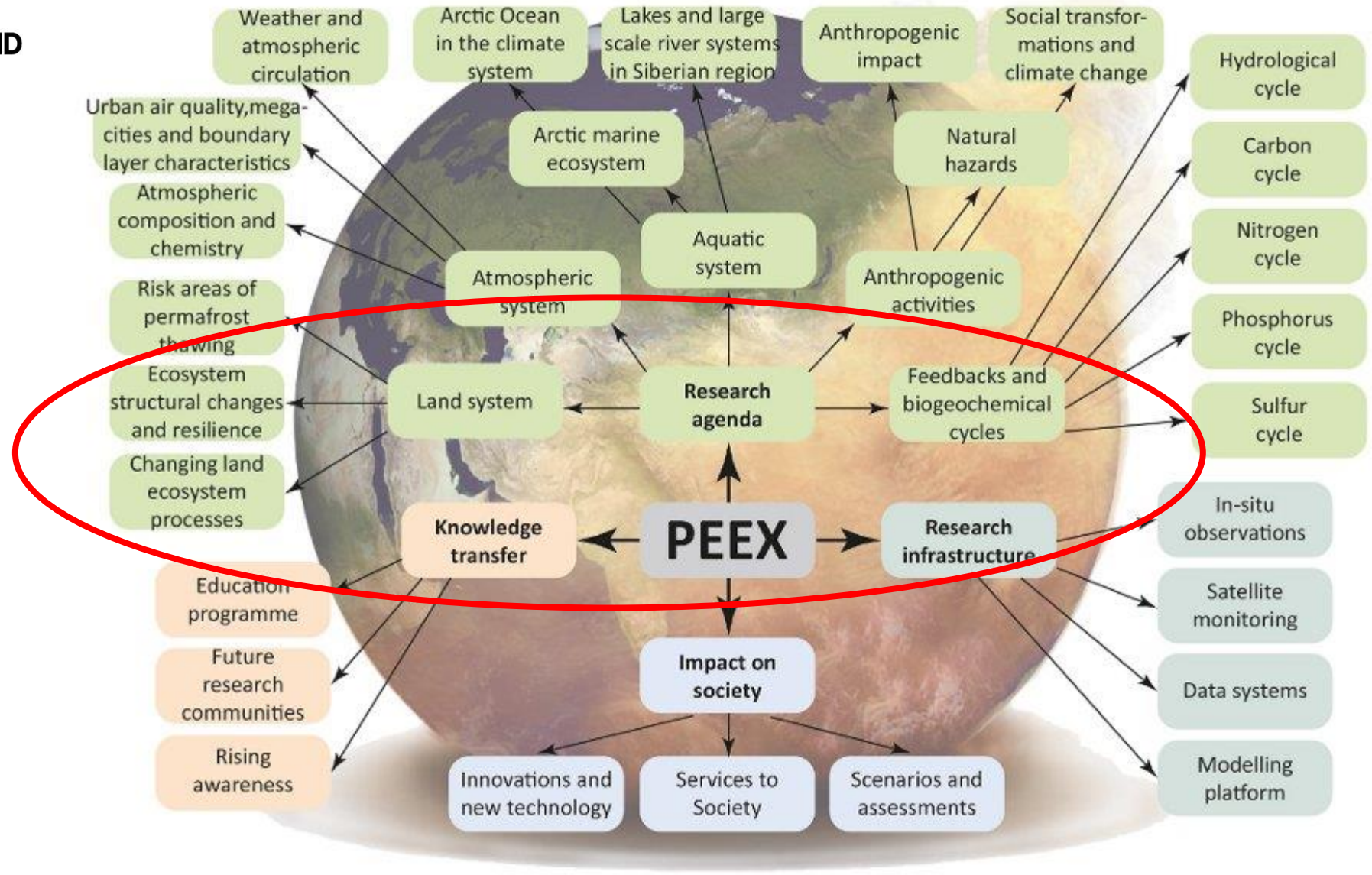
Jaana Bäck, University of Helsinki

SRCES – UHEL virtual meeting, June 17, 2020

INAR

INSTITUTE FOR ATMOSPHERIC AND EARTH SYSTEM RESEARCH

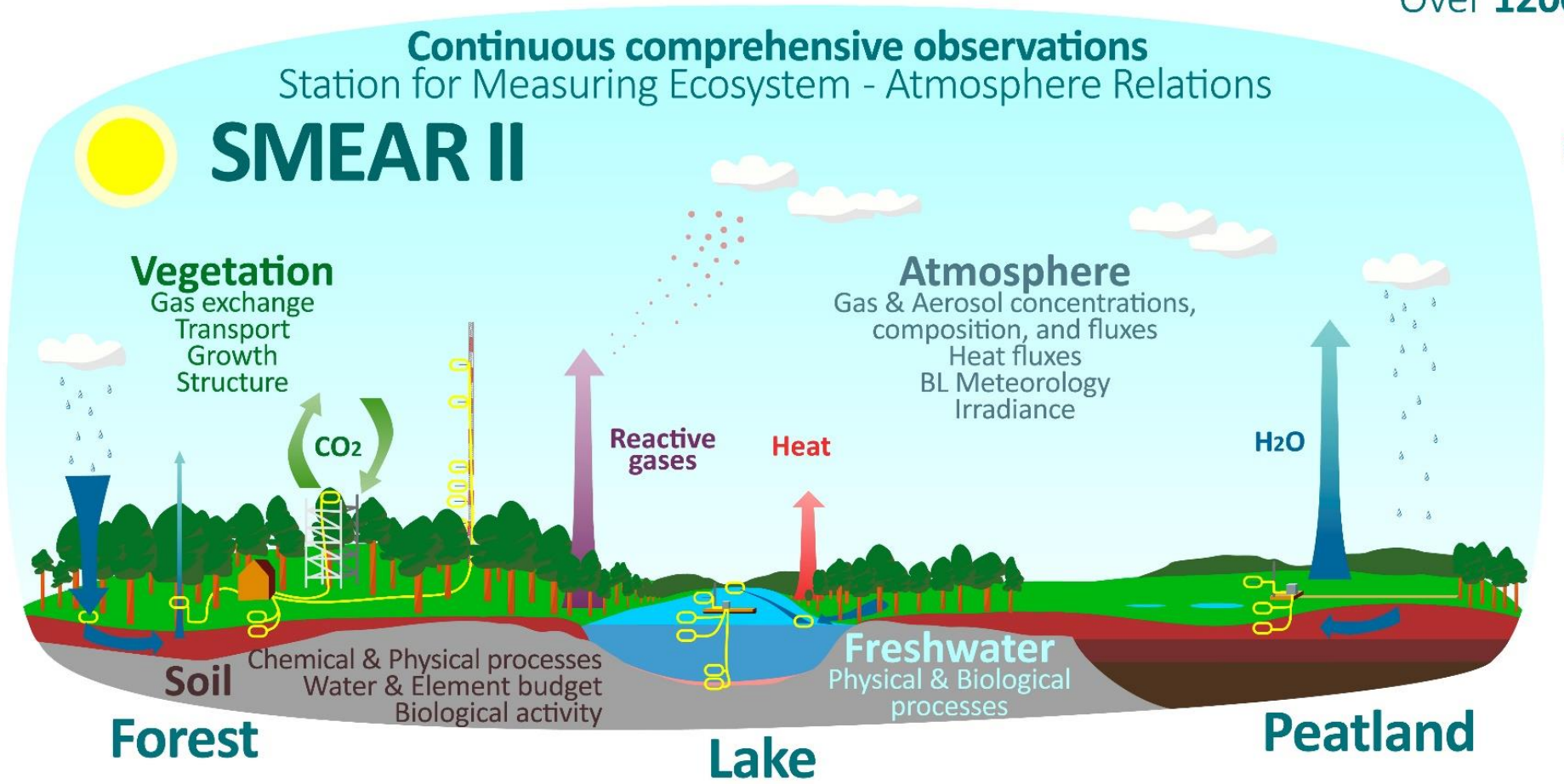
Land system, resilience, ecosystem processes and feedbacks



INAR

INSTITUTE FOR ATMOSPHERIC AND EARTH SYSTEM RESEARCH

Over **1200** different variables



Flagship site for integration: combines all IPCC components.

Contributes to :

ACTRiS

ICOS INTEGRATED CARBON OBSERVATION SYSTEM

AnaEE Analysis and Experimentation on Ecosystems

LTER europe

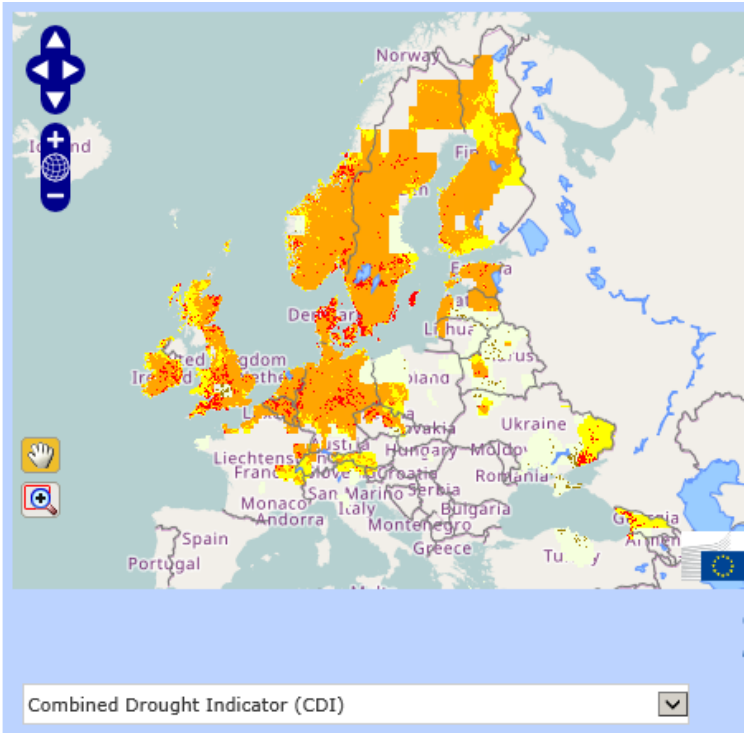
Pan-Eurasian Experiment PEEX

World Meteorological Organisation

INAR
INSTITUTE FOR ATMOSPHERIC AND EARTH SYSTEM RESEARCH

Links between (boreal) forests, biodiversity and climate change

- Forests cover 30% of the Earth surface area
  - Diversity in history, ecological and climatic factors, stocks and growth, management, ownership
- Forest structural elements, old growth forests, and forest continuity are crucial for biodiversity
  - Forest *management* is central in maintaining or loosing biodiversity values of production forests: genetic, species and habitat diversity
  - Forest biodiversity is under pressure in most regions
- Forests contain 80% of all the carbon stored in terrestrial vegetation
  - Forest growth has been increasing in last decades more than harvests in Europe, however their resilience to climate extremes is decreasing



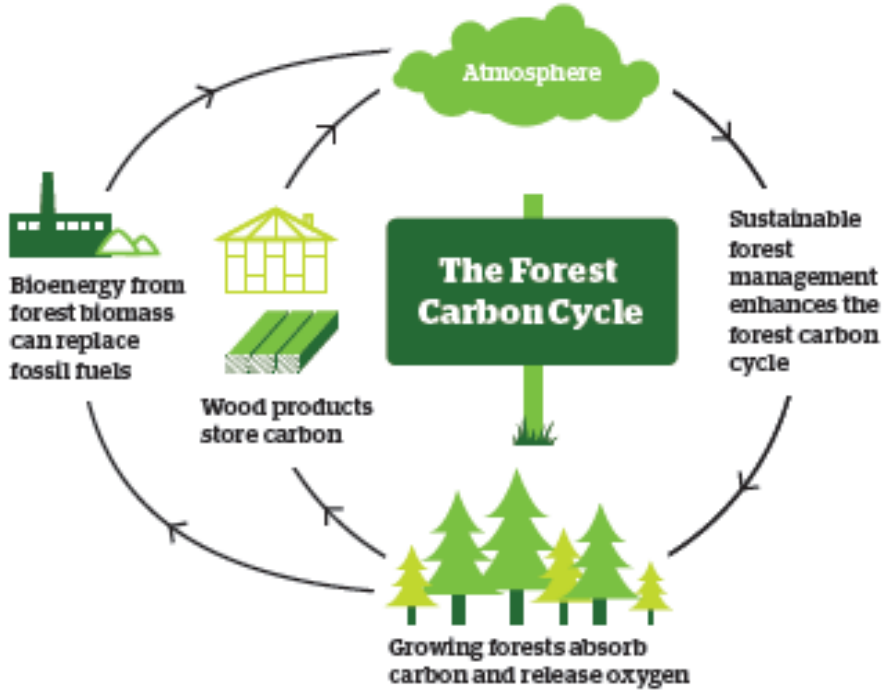
source: European Drought Observatory

INAR
INSTITUTE FOR ATMOSPHERIC AND EARTH SYSTEM RESEARCH

Forests contribute to climate change

- **Climate benefits from forests:**
  - sequestering carbon,
  - contributing to cloud formation,
  - protecting from erosion,
  - products for substituting FF and other C-intensive materials

- Forest sink accounts for ca. 10% of EU fossil fuel emissions
- Forest carbon sink and storage are dynamic and depend on forest management
- Most of the carbon harvested will be back in atmosphere in a few (less than 10) years



INAR
INSTITUTE FOR ATMOSPHERIC AND EARTH SYSTEM RESEARCH

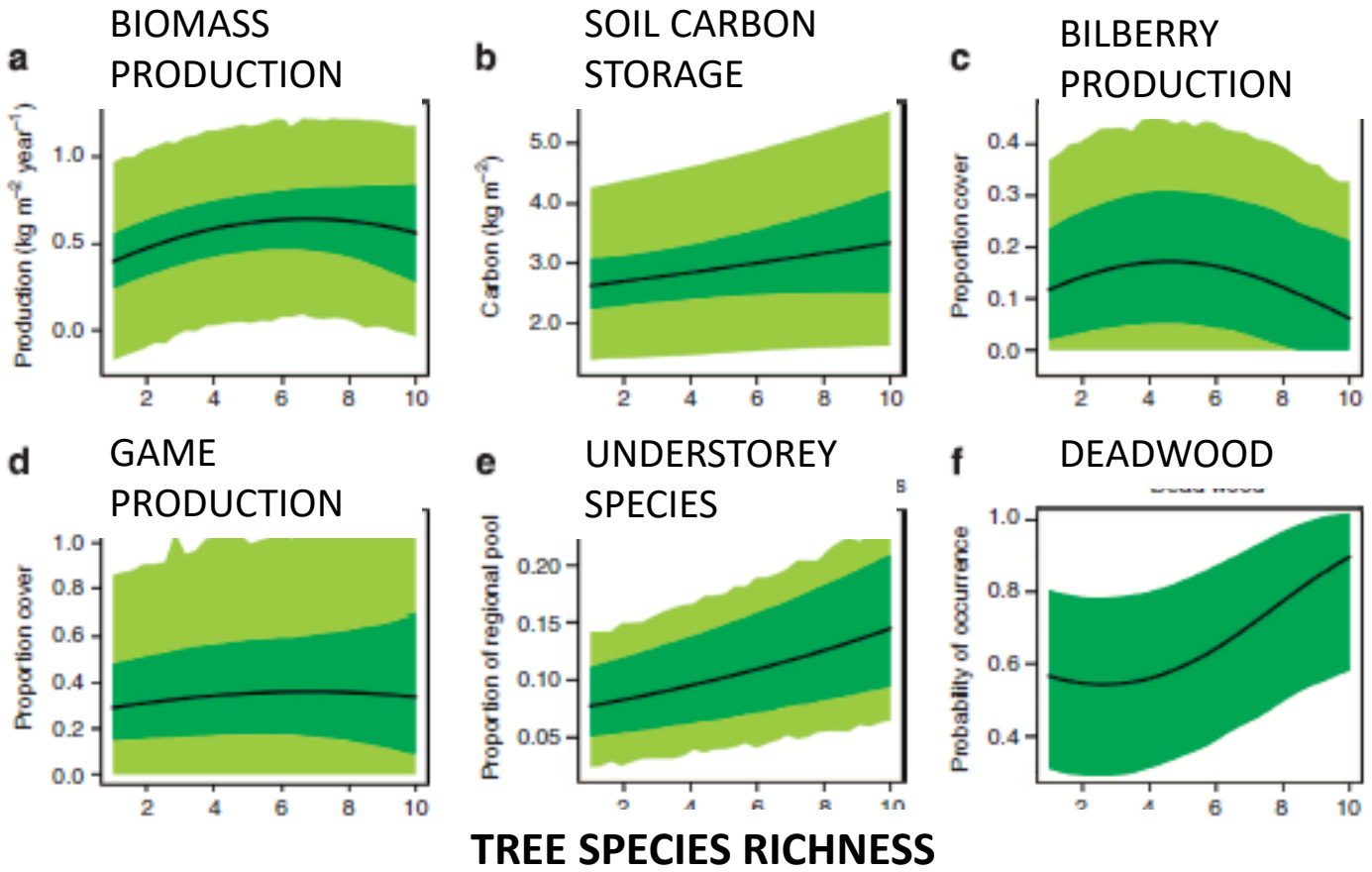
Climate change and biodiversity in forests are interconnected

- Forests house 60% of all known terrestrial species
- In the last 8000 years, 45% of Earth's original forest cover has been converted, mainly to agricultural lands
- Deforestation: loss of stored carbon, loss of biodiversity
- Loss of biodiversity will further lead to decreased resilience of ecosystems to environmental changes
- Good biodiversity implies often good productivity, resilience and climate benefits:
  - 10% decrease in tree species → annual losses of 150-420 billion €

INAR
INSTITUTE FOR ATMOSPHERIC AND EARTH SYSTEM RESEARCH

Tree species richness correlates with other ecosystem services

NATURE COMMUNICATIONS | DOI: 10.1038/ncomms2328

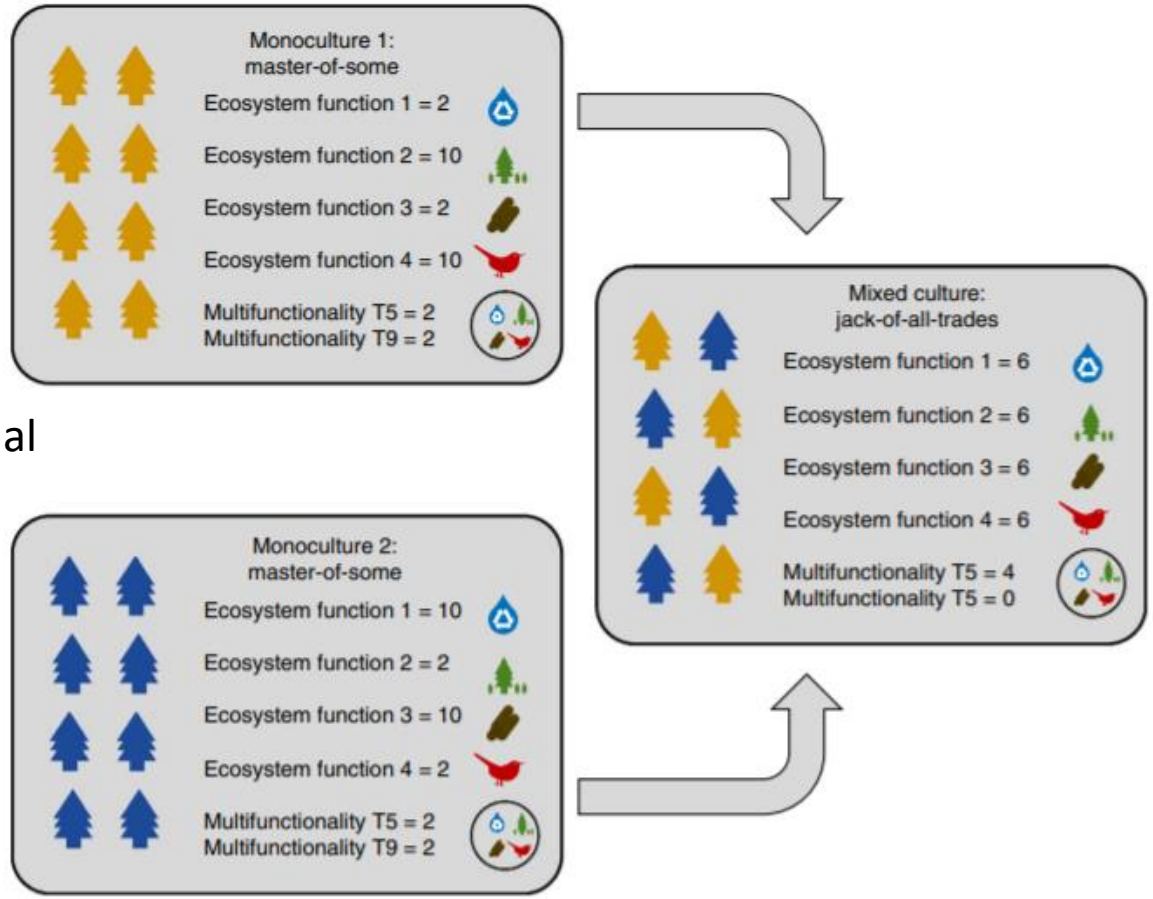


Gamfeldt et al 2012

Figure 1 | Relationships between tree species richness and ecosystem services. (**a**) Tree biomass production; (**b**) soil carbon storage; (**c**) bilberry production; (**d**) game production potential; (**e**) understory plant species richness; (**f**) occurrence of dead wood. We show mean relationships (black) and 95% Bayesian confidence intervals for the relationships excluding (dark green) and including the residual variation (light green). Other model explanatory

INAR
INSTITUTE FOR ATMOSPHERIC AND EARTH SYSTEM RESEARCH

’Multifunctionality’ increases both the climate and biodiversity benefits from forests



Van der Plas et al 2015 Nature

Mixed species, heterogenous forests provide best ecosystem services

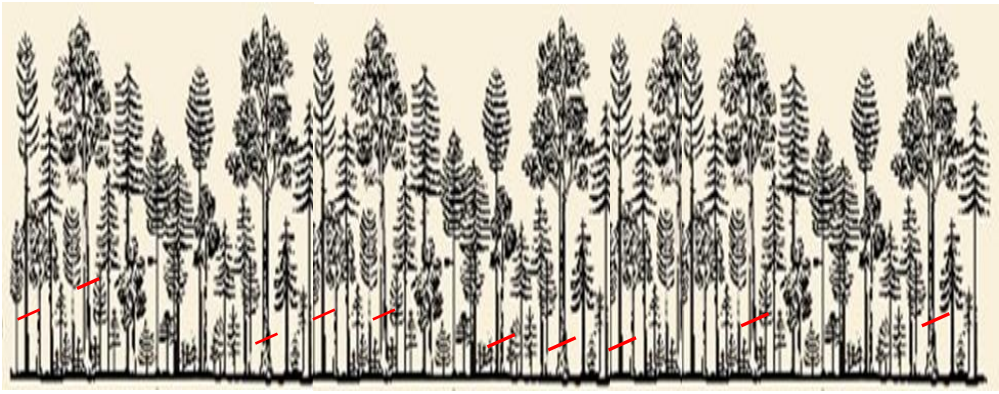
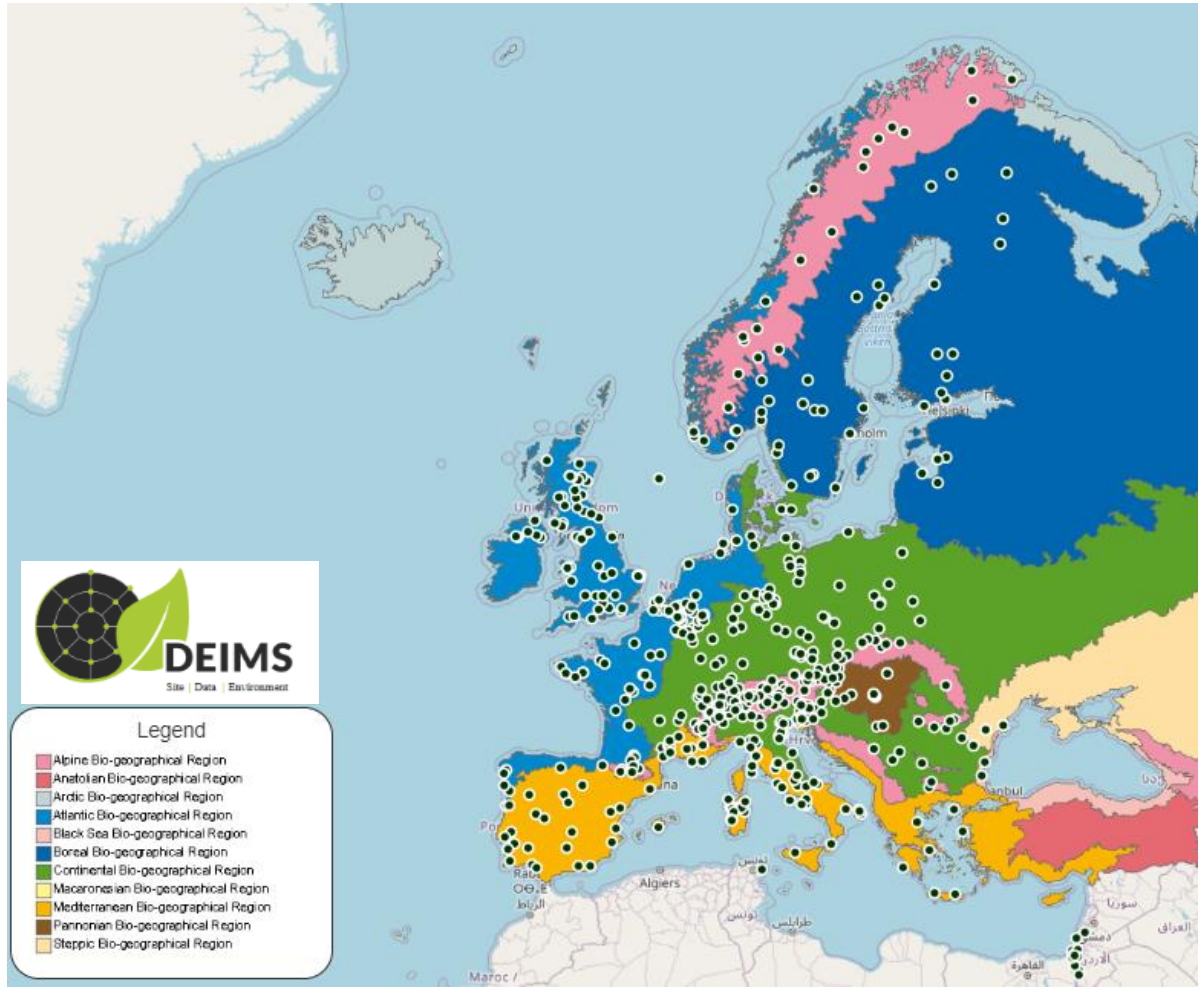
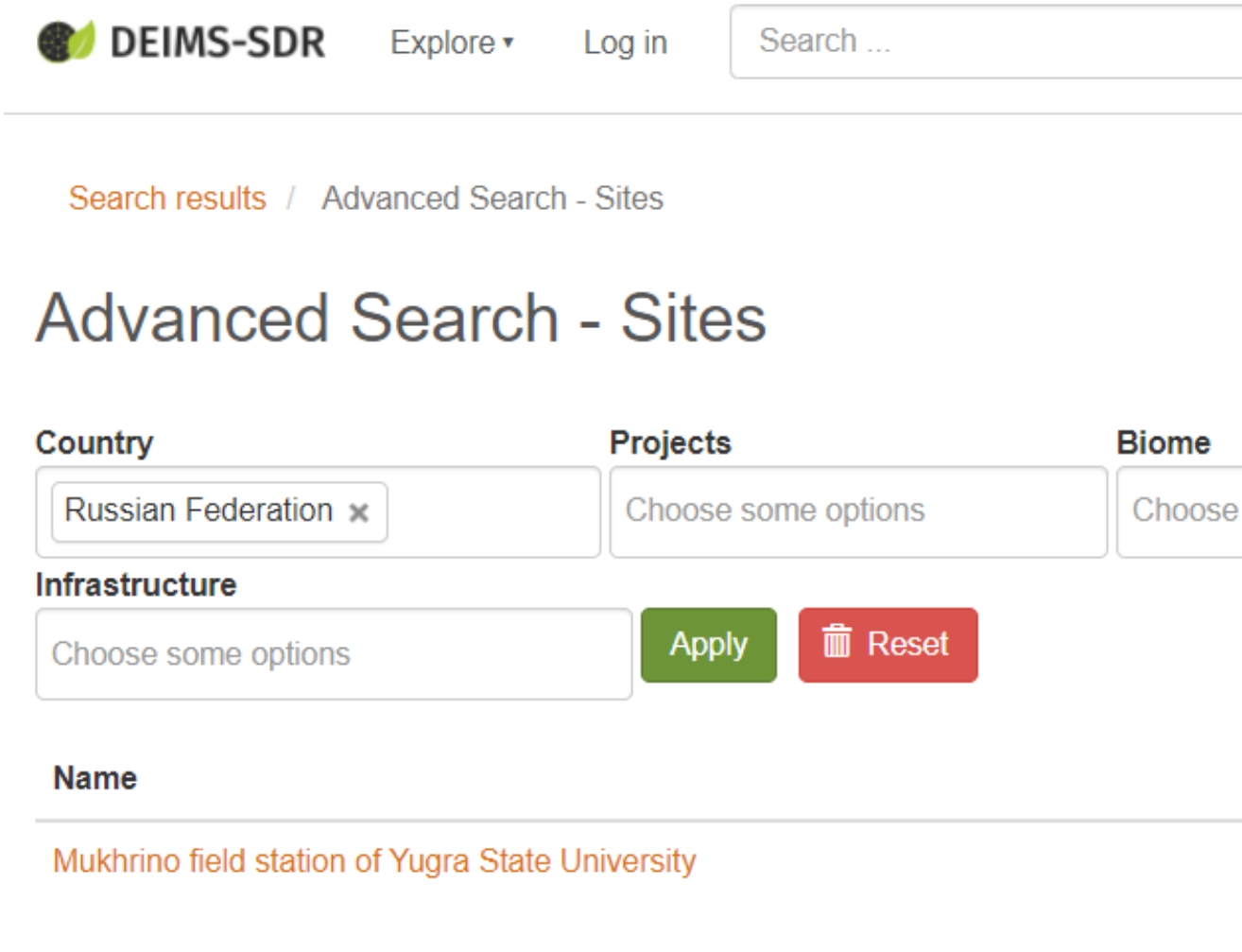


Figure 1 | Hypothetical example where the mixing of two species causes a ‘jack-of-all-trades, but master-of-none’ effect. The two monocultures (left panels) each support two functions at high levels and two functions at low levels. In the absence of complementarity or selection, the mixing of the two species results in a combined functioning that is intermediate between monoculture function values of the component species. As a result, when multifunctionality is quantified as the number of functions exceeding a moderate threshold value (for example, a value of 5, as indicated by multifunctionality T5), a positive diversity–multifunctionality relationship is found, while this relationship is negative at a higher threshold value of 9.

INAR
INSTITUTE FOR ATMOSPHERIC AND EARTH SYSTEM RESEARCH

How to study the links between human activity, climate change and biodiversity?



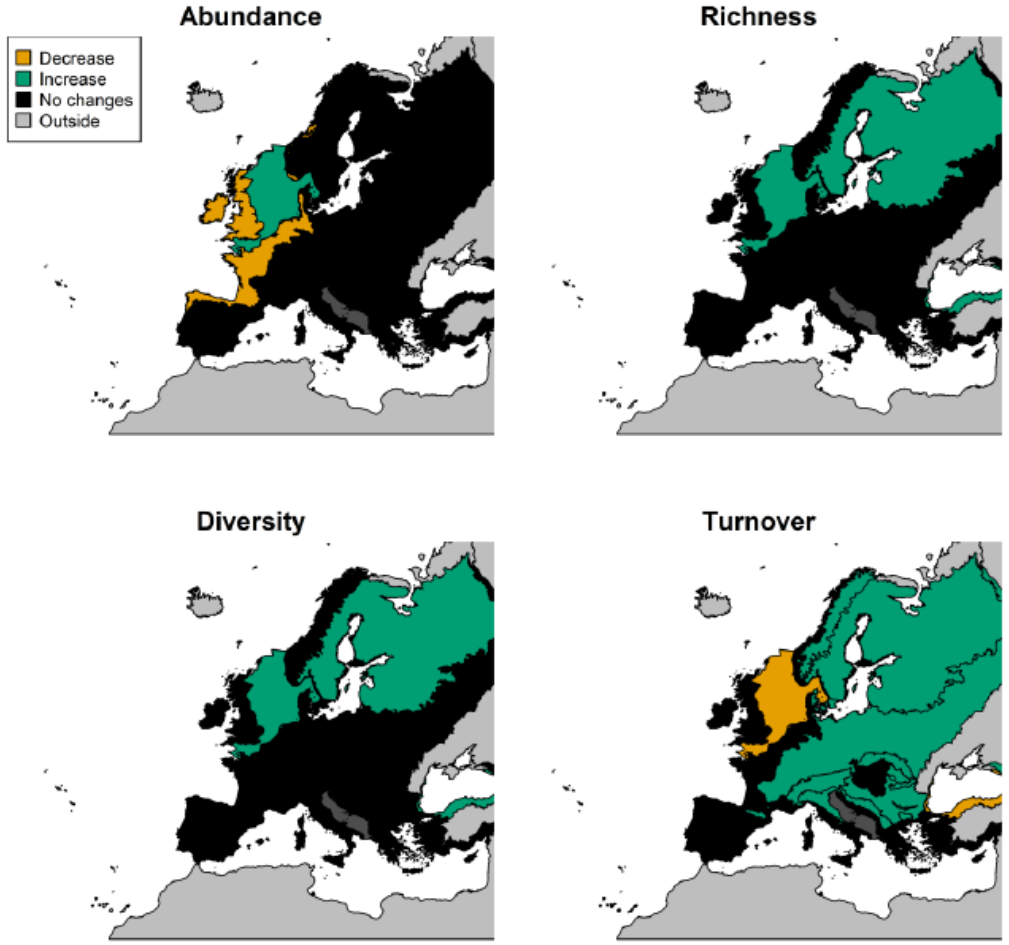


INAR
INSTITUTE FOR ATMOSPHERIC AND EARTH SYSTEM RESEARCH

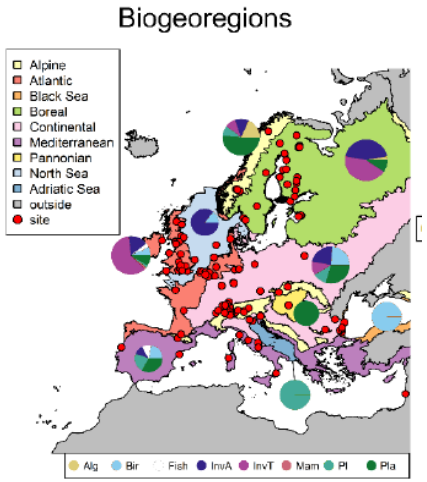
Example 1: Long-term data from >6000 taxa reveals local and species specific patterns

- Increases in species richness, diversity and turnover in northern regions (birds, aquatic invertebrates and trees)

- Decreases in abundance and turnover in Central Europe (terrestrial invertebrates) and North Sea (benthic algae)



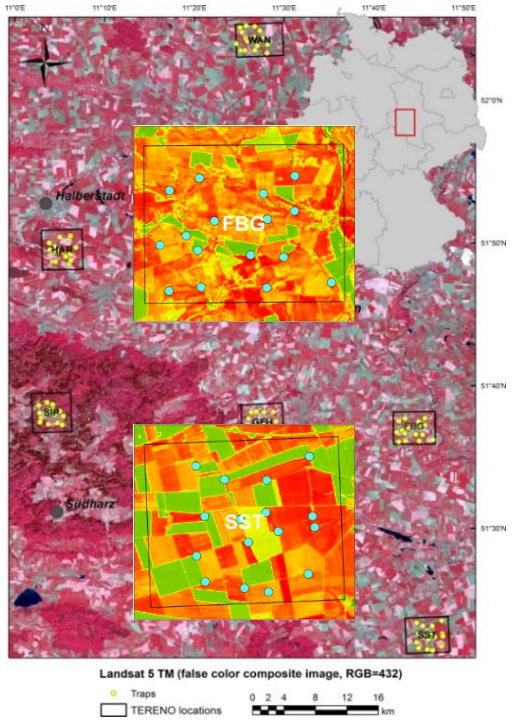
DEIMS
Site | Data | Environment



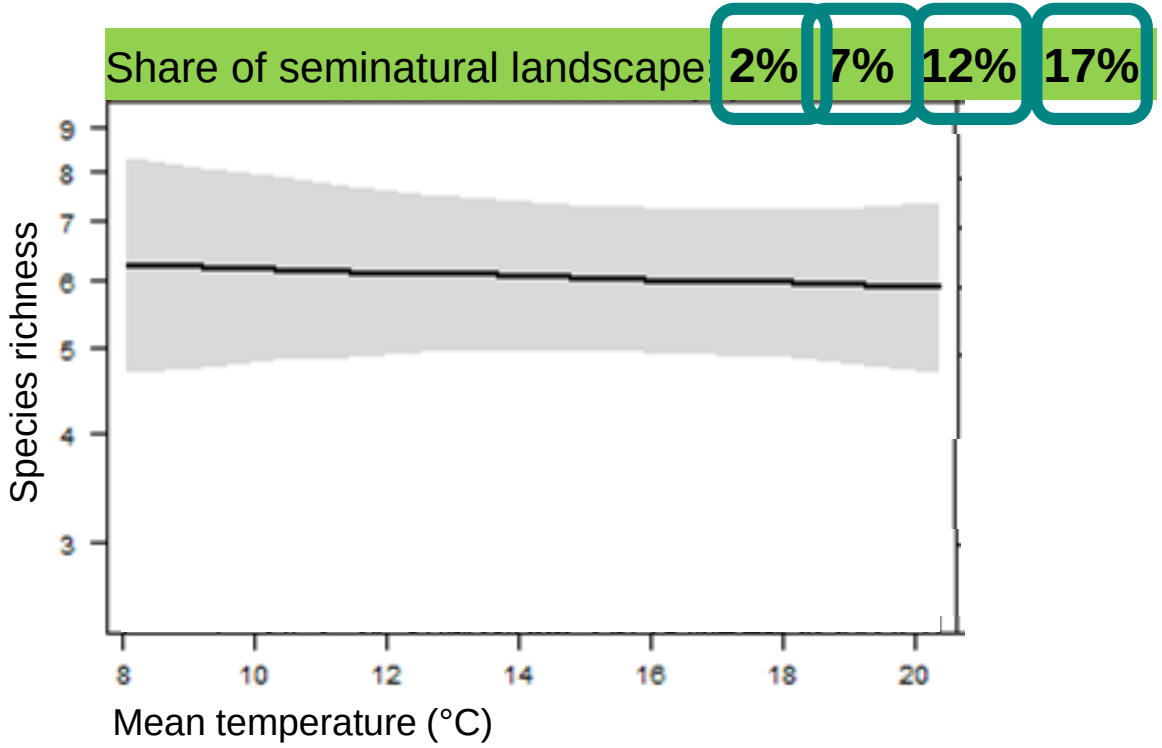
Pilotto et al 2020 Nature Communications, accepted

INAR
INSTITUTE FOR ATMOSPHERIC AND EARTH SYSTEM RESEARCH

Example 2: Impact of land use on pollinators' response to climate change



Hofmann et al. (2017) PLoS ONE



Papanikolaou et al. (2017) Journal of Applied Ecology

>> Upscaling to Europe using the DEIMS SDR and eLTER network

DEIMS
Site | Data | Environment

TERENO
TERRESTRIAL ENVIRONMENTAL OBSERVATORIES


INAR
INSTITUTE FOR ATMOSPHERIC AND EARTH SYSTEM RESEARCH
FOR THE ONLY PLANET WE HAVE