



Forest ecosystem services in a changing world

Which perspectives for forest dynamics models ?

FOREM, Montpellier, 02/05/2025
Julien BARRERE



The concept of ecosystem services

“Benefits that humans derive from ecosystems” (Millenium Ecosystem Assessment, 2005)

Provisioning



Timber



Water



Berries



Game

Cultural



Aesthetic value

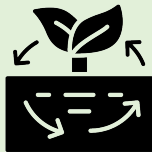


Recreation

Supporting / Regulating



Pollination



Carbon sequestration



Erosion mitigation



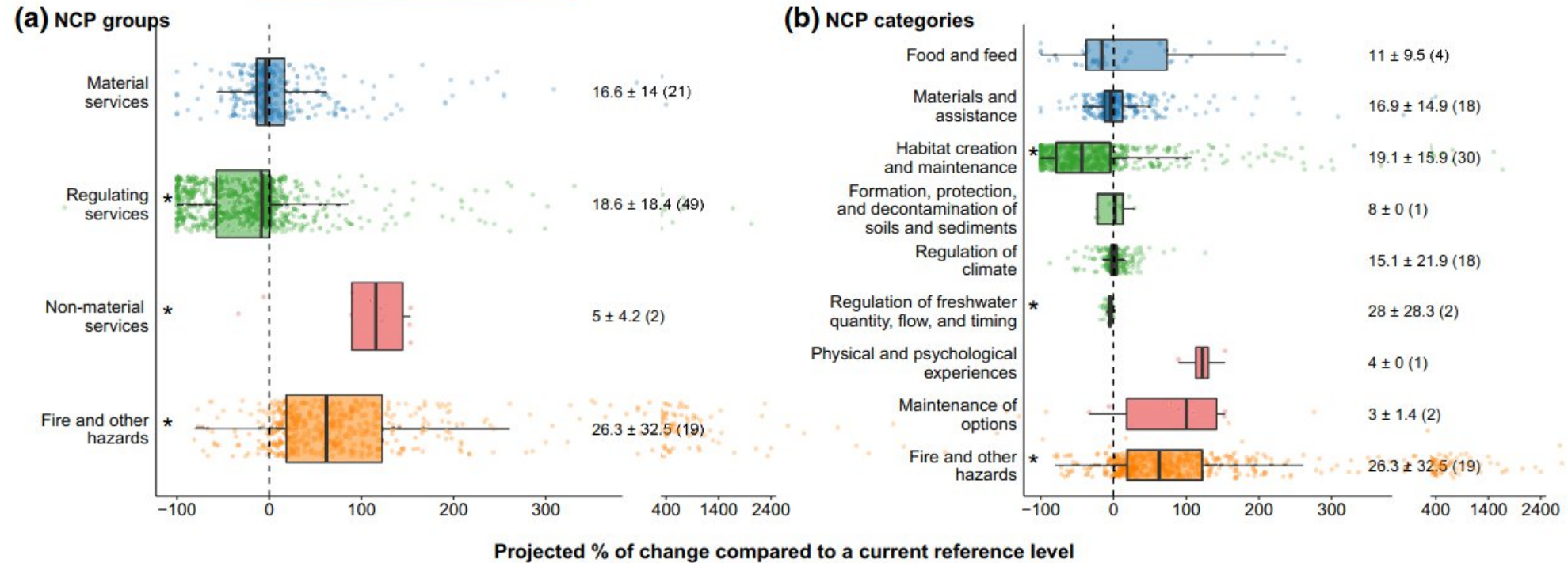
Habitat for biodiversity



Disturbance regulation



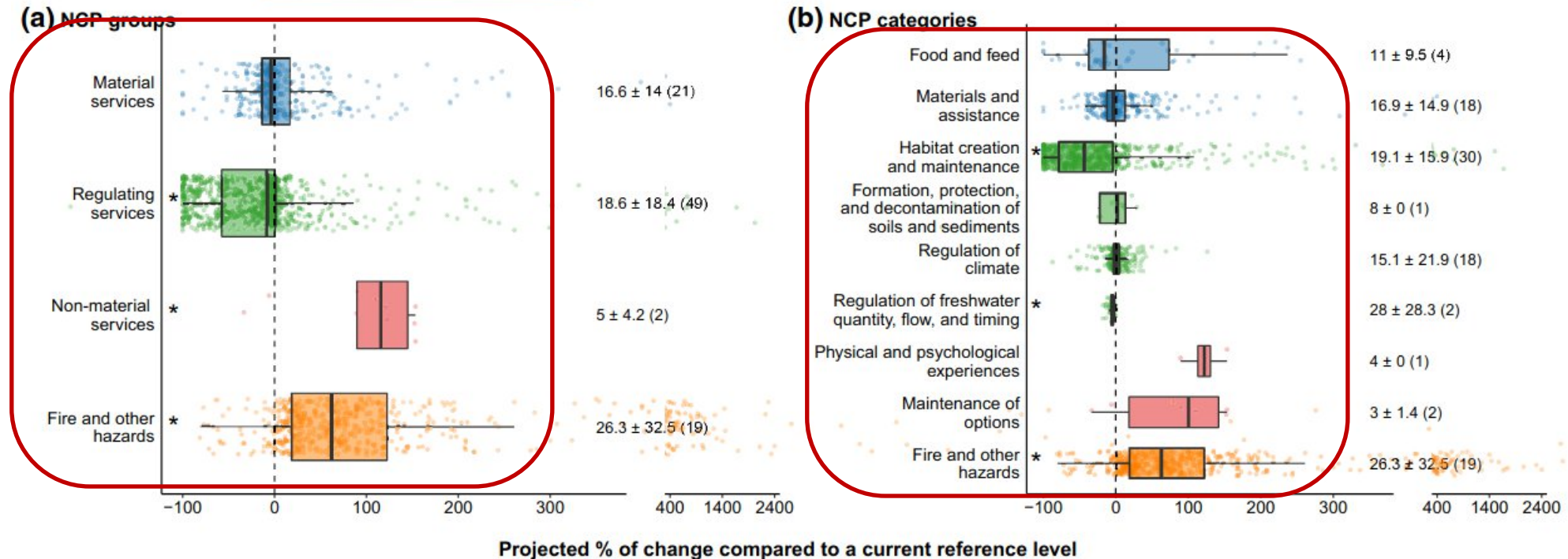
Forest ecosystem services in a changing world



Morán-Ordóñez et al. 2021 - *Global Change Biology*



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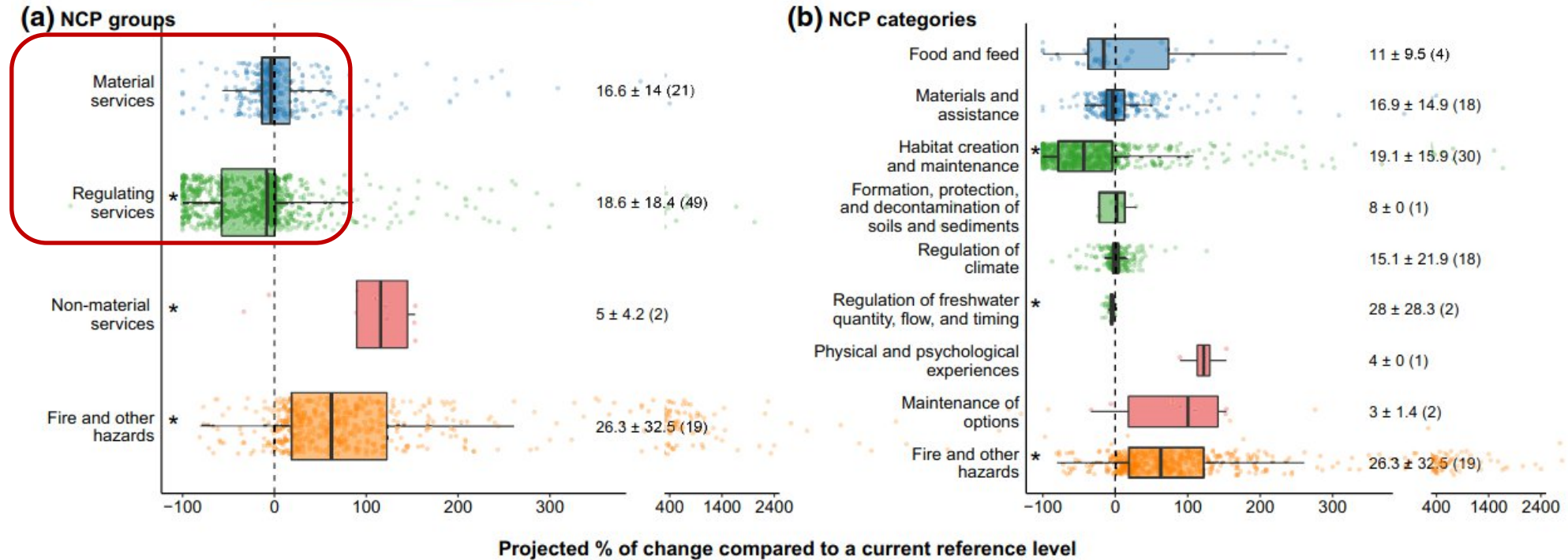


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- Variable impact of CC across ecosystem services



Forest ecosystem services in a changing world



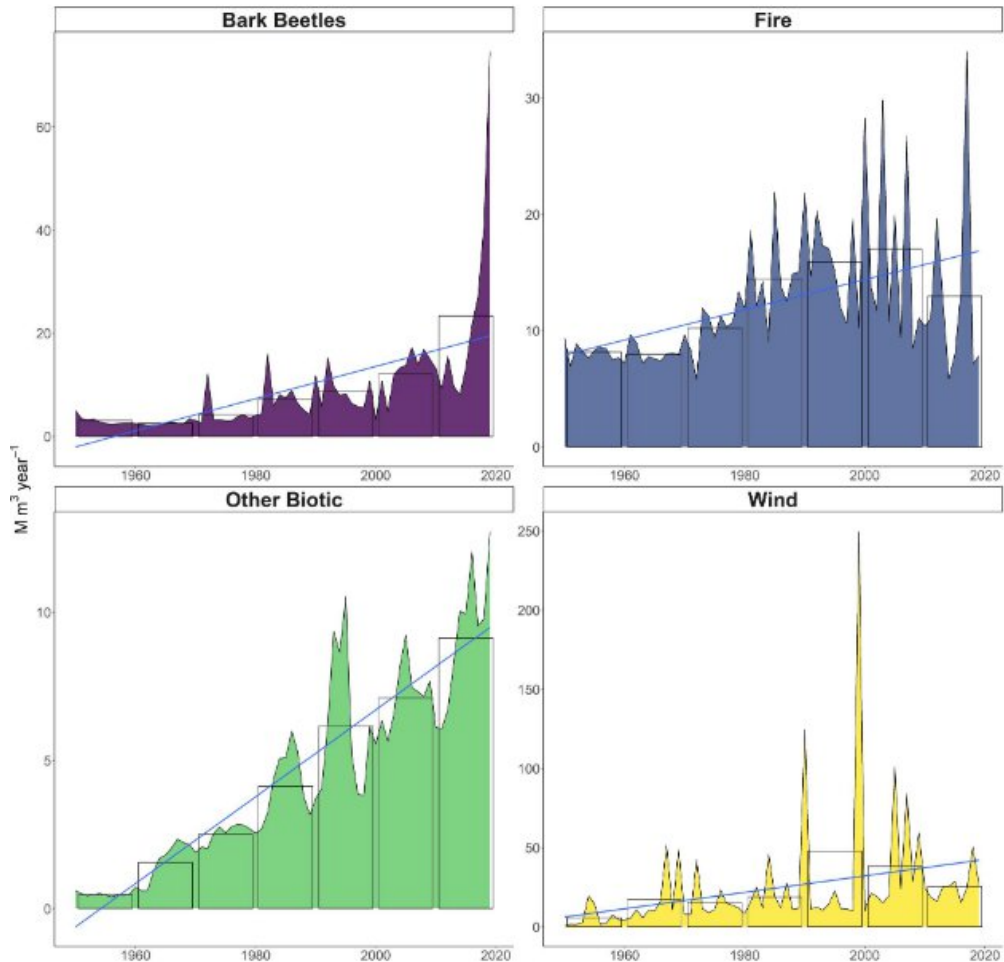
Morán-Ordóñez et al. 2021 - *Global Change Biology*

- Variable impact of CC across ecosystem services
- Main ecosystem services negatively affected by climate change



Forest ecosystem services in a changing world

The key role of disturbances



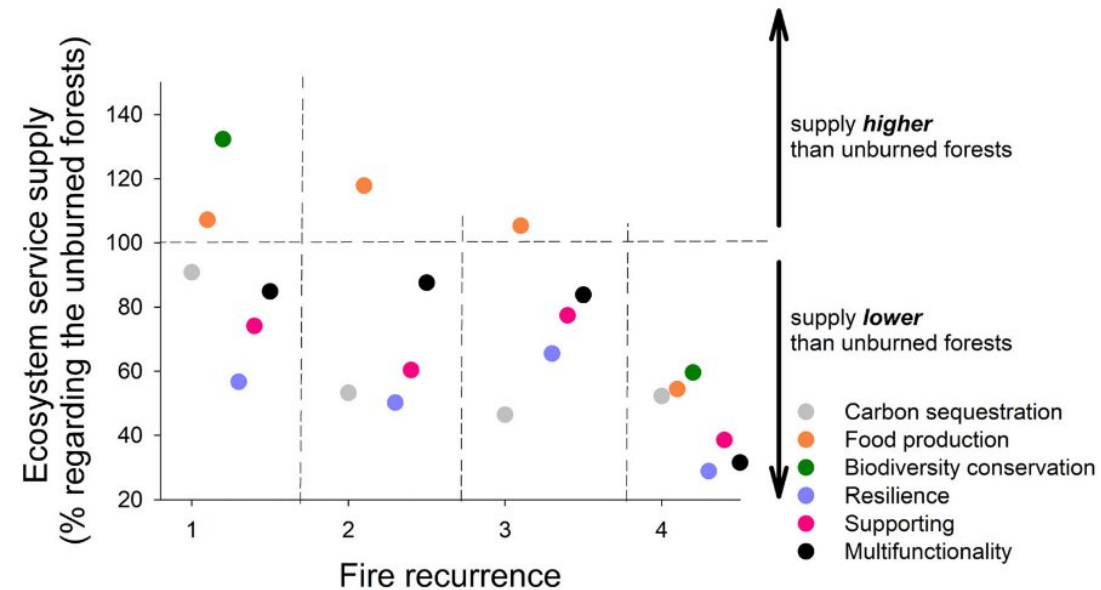
- Significant increase in disturbances frequency, intensity and size across Europe



Forest ecosystem services in a changing world

The key role of disturbances

- Significant increase in disturbances frequency, intensity and size across Europe
- Negative impact of disturbances reported on most ecosystem services

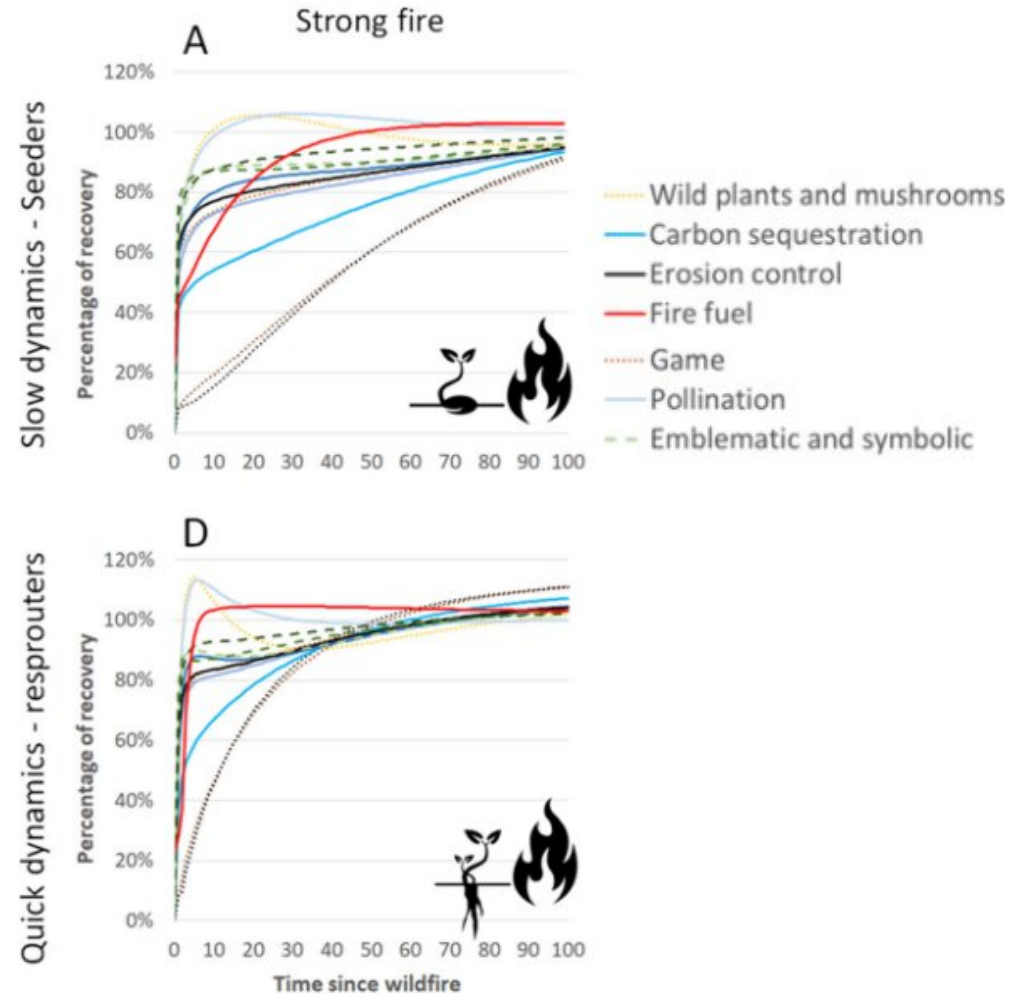


Moghli et al. 2022 - Ecosystems



Forest ecosystem services in a changing world

The key role of disturbances



- Significant increase in disturbances frequency, intensity and size across Europe
- Negative impact of disturbances reported on most ecosystem services
- Resilience of multiple (> 4) ecosystem services so far mostly limited to theoretical studies

—> **Key challenge to identify drivers of forest ecosystem services resilience empirically**



What field data could teach us

Two main approaches to consider :

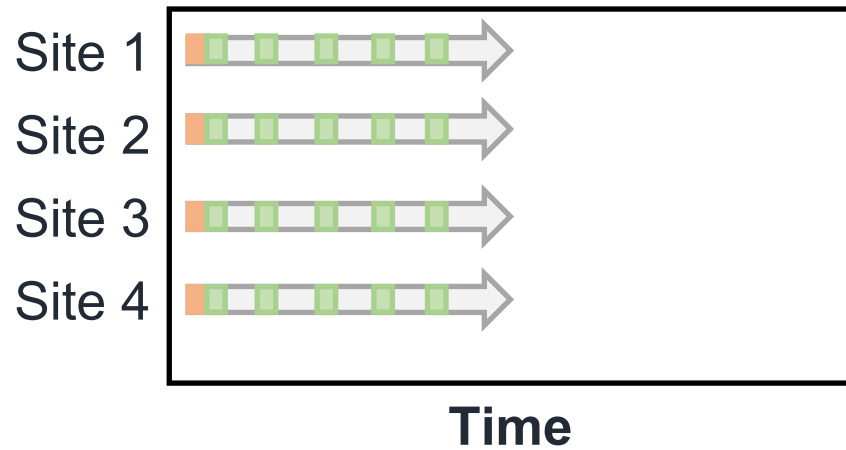


What field data could teach us

Two main approaches to consider :

■ Disturbance occurrence

■ Field measurement of ES



1. Post-disturbance permanent plots

Better estimation of the dynamics and of the initial state, but poor temporal coverage

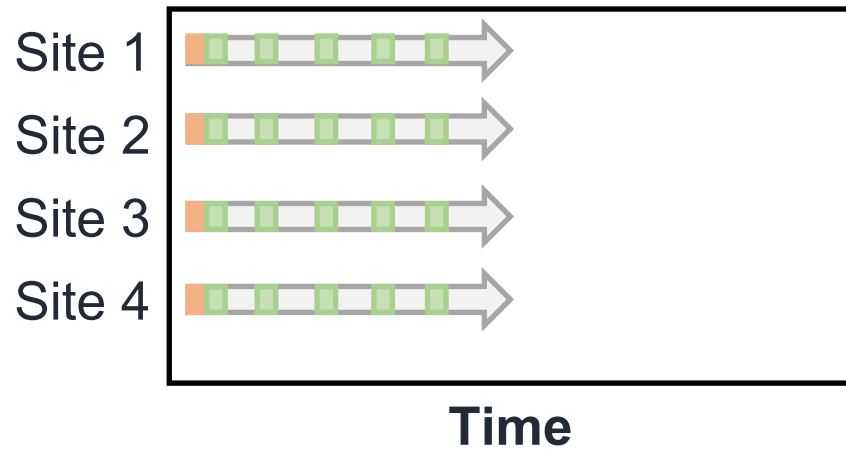


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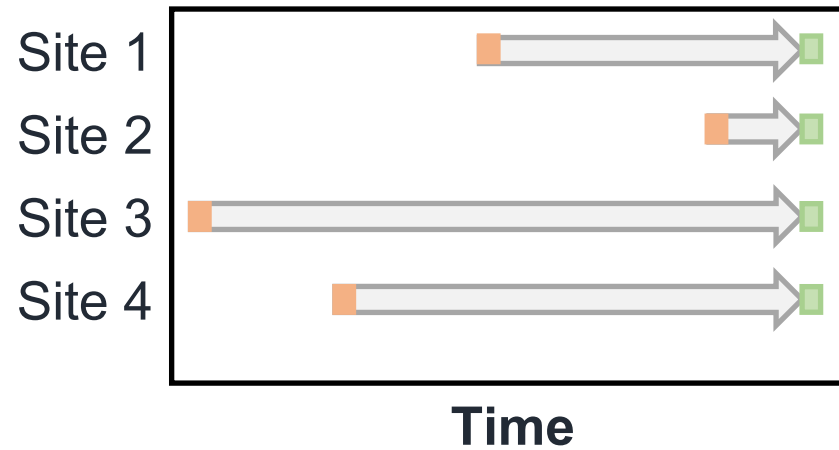
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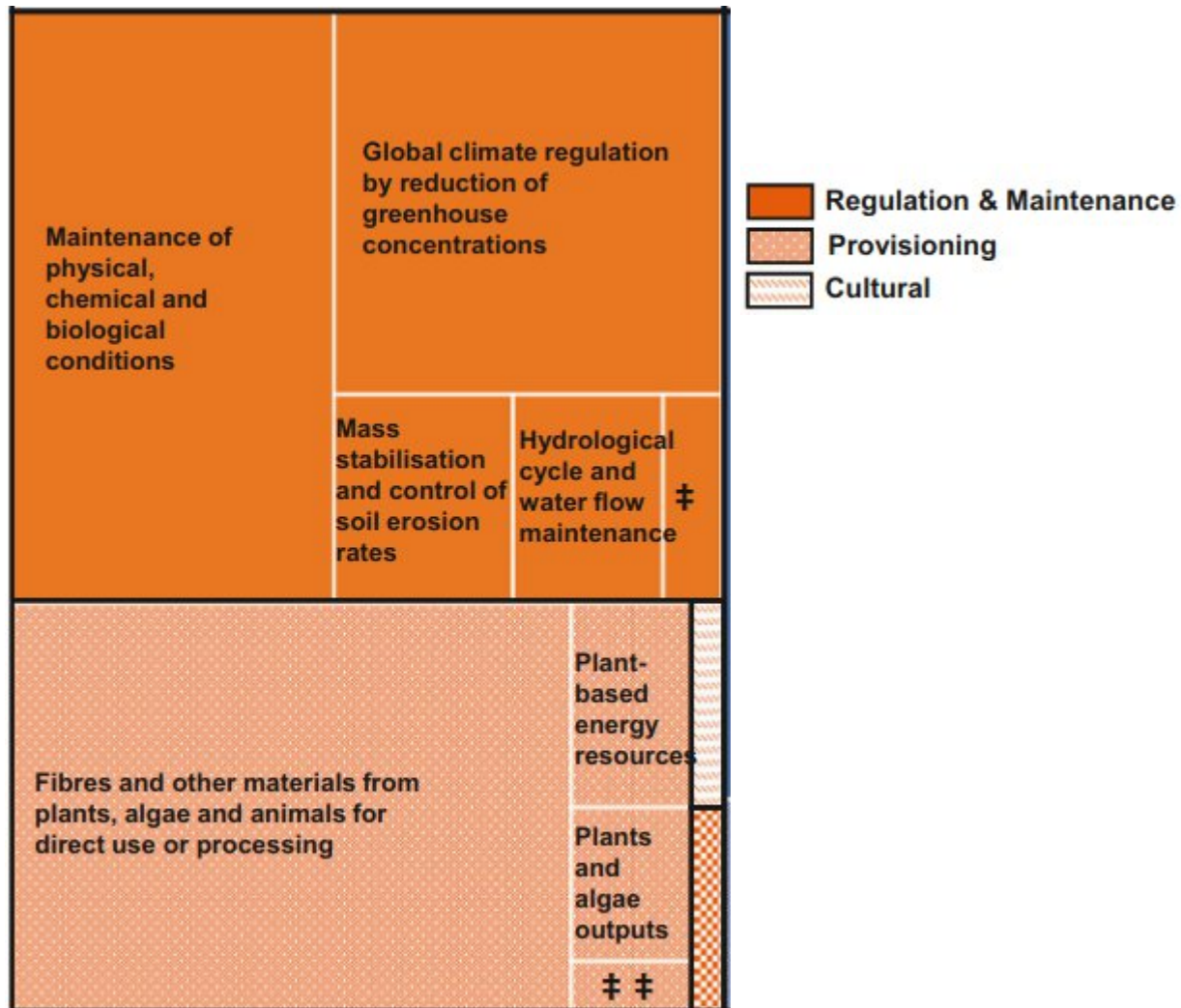


2. Sampling of historically disturbed sites
Poor estimation of the dynamics and of the initial state, but good temporal coverage

➡ No perfect solutions : key role of modeling ?



Ecosystem services in models of forest dynamics

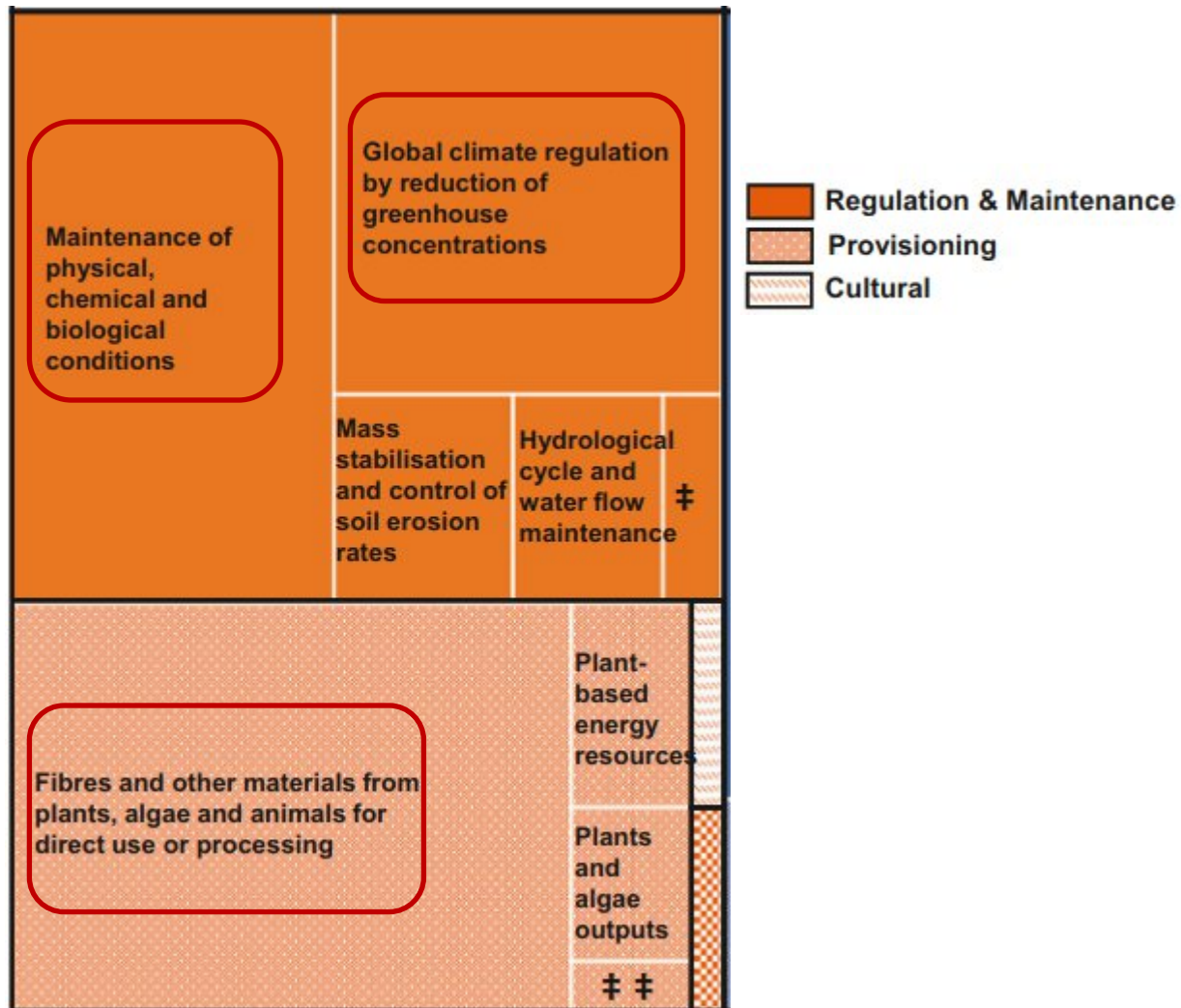


± Others: flood protection, pollination, etc.

± ± Materials from plants, animal and algae for agricultural use



Ecosystem services in models of forest dynamics



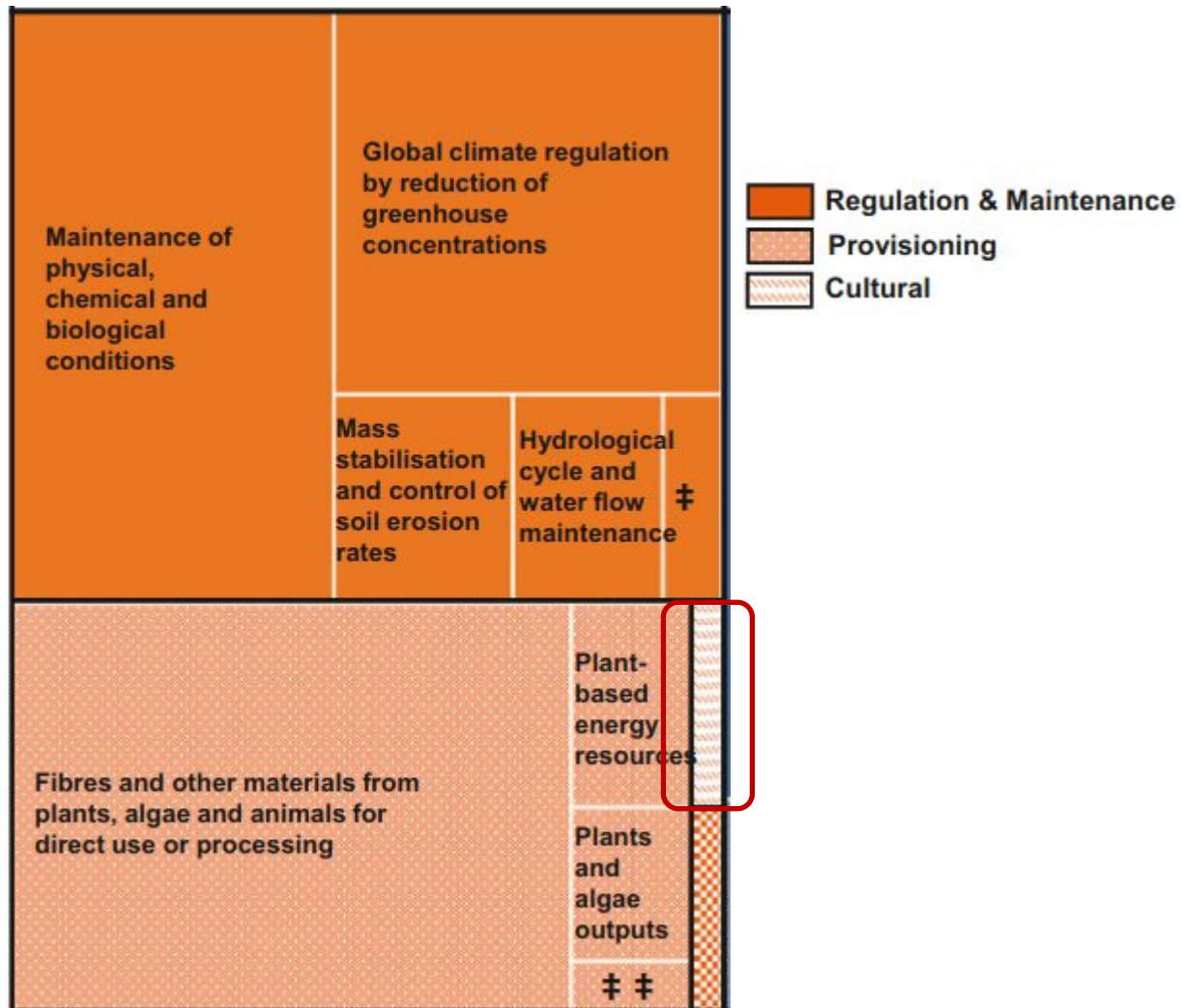
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- Large over-representation of fire risk, carbon sequestration and timber production
- Dominant services are easily quantifiable from dendrometric and climatic data, and generally computable at stand scale



Ecosystem services in models of forest dynamics



⊠ Others: flood protection, pollination, etc.

⊠ ⊠ Materials from plants, animal and algae for agricultural use

- Large over-representation of fire risk, carbon sequestration and timber production
- Dominant services are easily quantifiable from dendrometric and climatic data, and generally computable at stand scale
- Huge under-representation of cultural services



Identified priorities in the year to come

Provisioning



Timber



Water



Berries



Game

Cultural

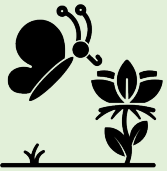


Aesthetic value

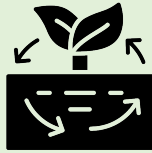


Recreation

Supporting / Regulating



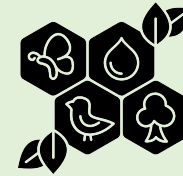
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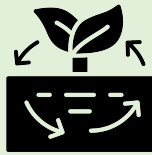


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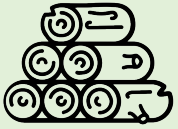
Disturbance regulation

- Priority 1 : calibrate poorly studied ecosystem services



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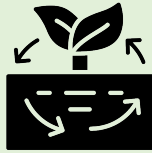


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Disturbance regulation

- Priority 1 : calibrate poorly studied ecosystem services
- Priority 2 : improve the calibration of already frequent ecosystem services



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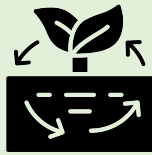


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Disturbance regulation

- Priority 1 : calibrate poorly studied ecosystem services
- Priority 2 : improve the calibration of already frequent ecosystem services
- Priority 3 : homogenize across models the calculation of services



Priority 1 - calibrating new services

Focus on the provision of edible and medicinal plants

Ongoing work to calibrate the provision of edible and medicinal plants as a function of stand structure, composition, climate and topography



French National
Forest Inventory
data



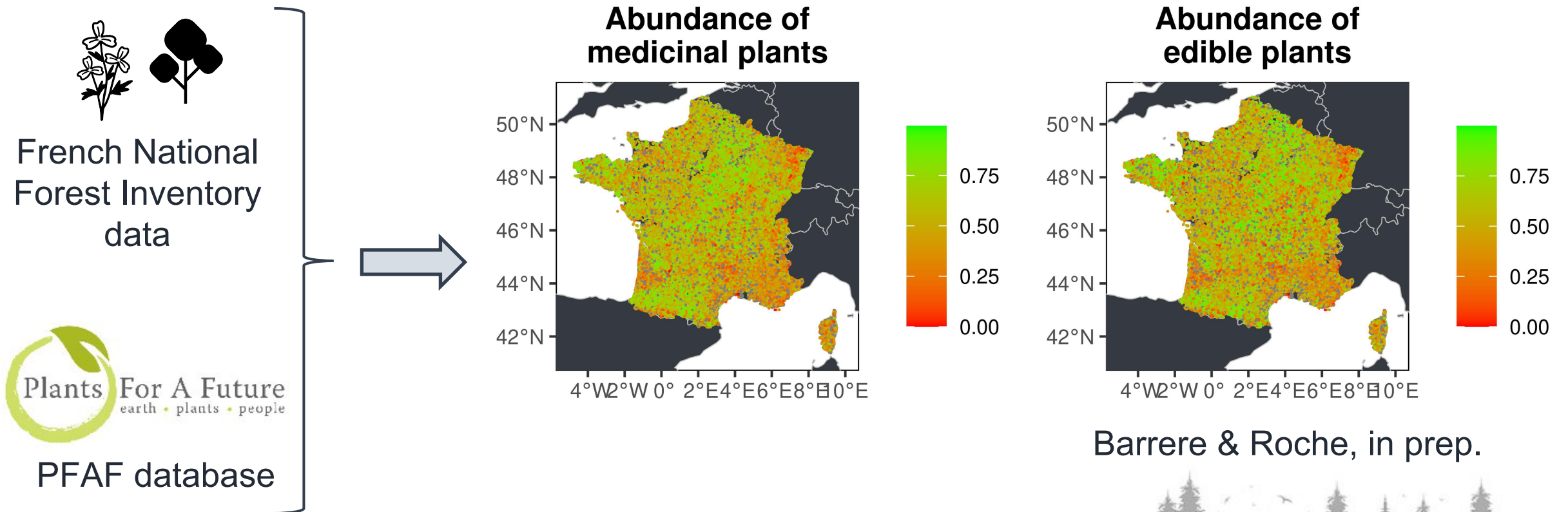
PFAF database



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Priority 1 - calibrating new services

Focus on the recreational value

For aesthetic value and recreational use, possibility to go beyond expert knowledge with social network data



Social networks, naturalist
apps, sport app



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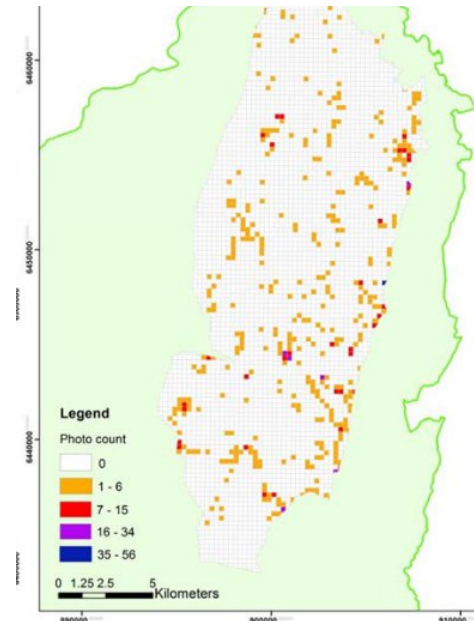
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Density maps of
recreational use



Tenerelli et al. 2016 - Ecological indicators



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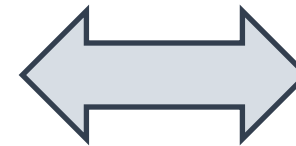
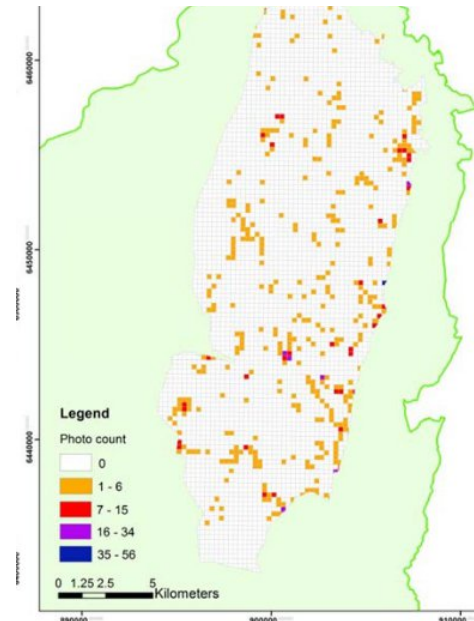
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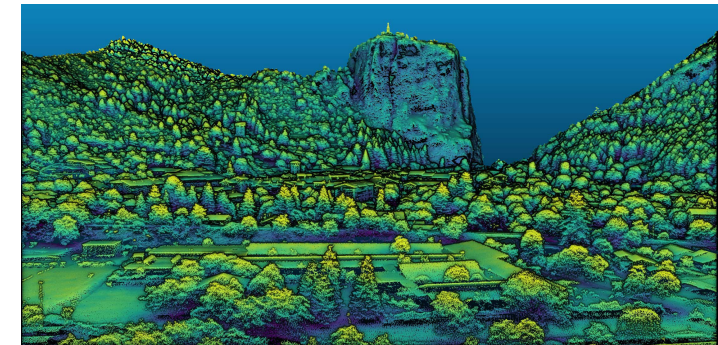
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Lidar HD data



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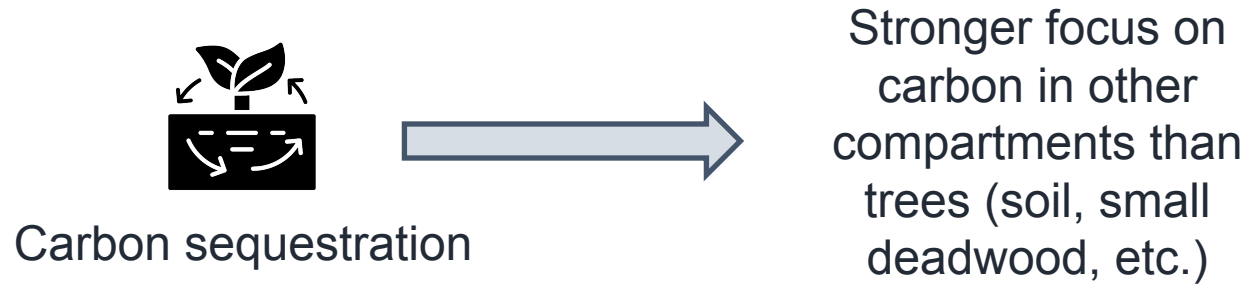
Priority 2 – Improving the calibration of existing services

A few examples



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Carbon sequestration



Stronger focus on
carbon in other
compartments than
trees (soil, small
deadwood, etc.)



Erosion mitigation



Go beyond the RUSLE
with more mechanistic
approaches



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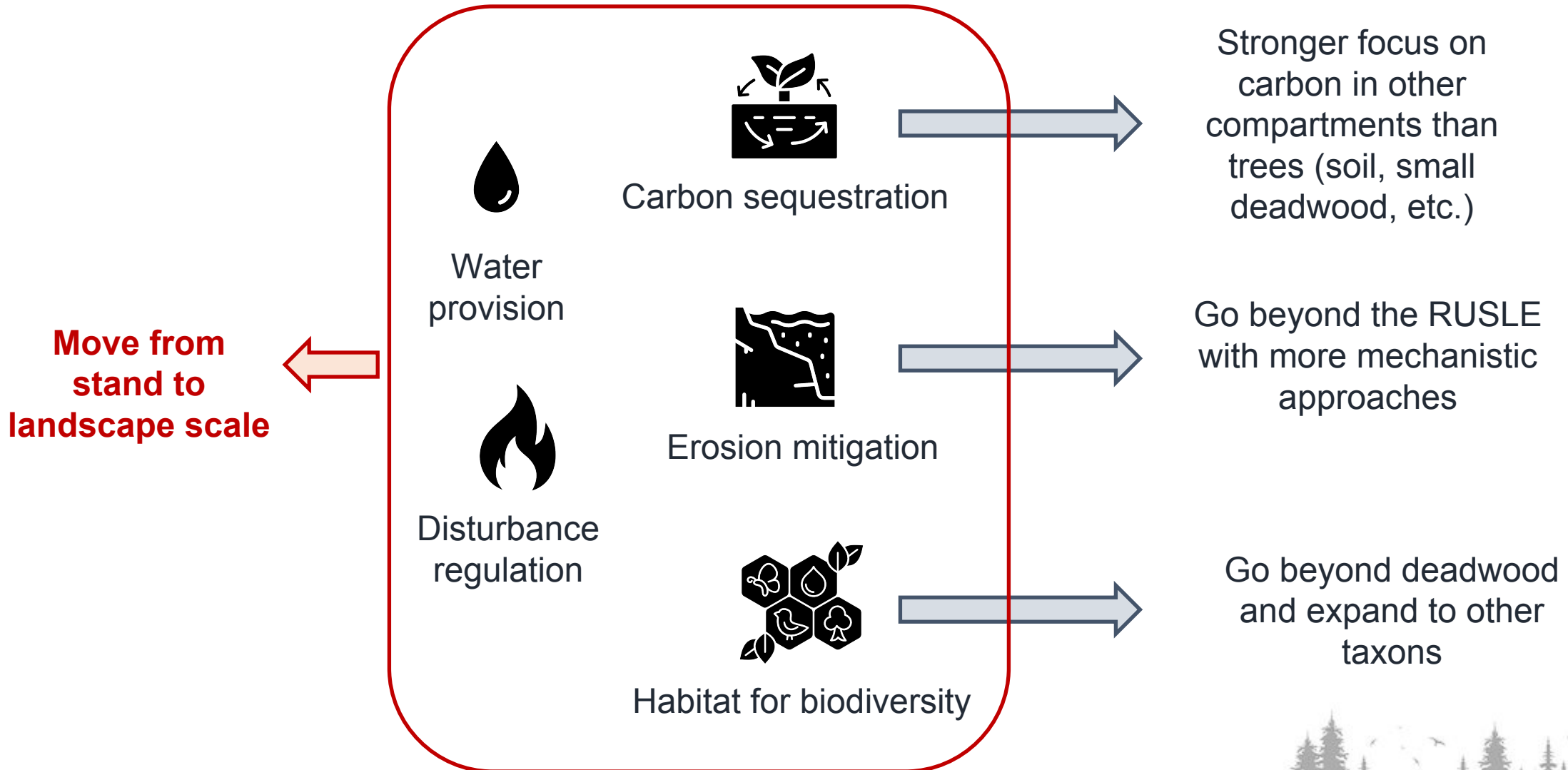


Go beyond deadwood
and expand to other
taxons



Priority 2 – Improving the calibration of existing services

A few examples



Priority 3 – Homogenize the calculation of services across models



R package currently
developed in CREAMF,
applicable to the widest set of
models possible
(De Caceres et al. in prep)



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R package currently
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Similar approach to build a
dedicated library in Capsis ?



Questions ?

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