

Combining NFI and EO data – alley to success for a reliable European Forest Monitoring System?



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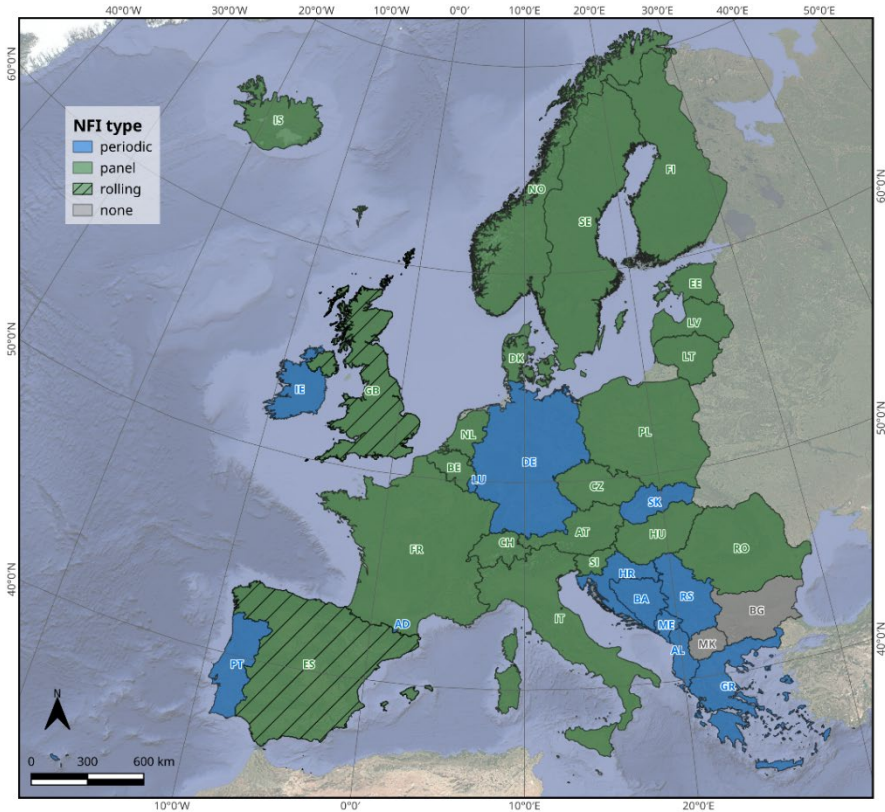


Goals of a European Forest Monitoring System (EFMS)



- Reliable annual estimates of forest attributes, e.g. C-stocks & changes
 - Reliable = design-based principles
- Timely information
- Information at the pan-European level & for regions, e.g. Mediterranean, the Alps, the Nordics, the European Union
- Produce high-resolution maps of forest attributes – enhance estimation accuracy, detect hotspots of change quickly
- Primary purpose: inform European-level forest-related policymaking
- Other uses: local decision making, research, enhanced business opportunities

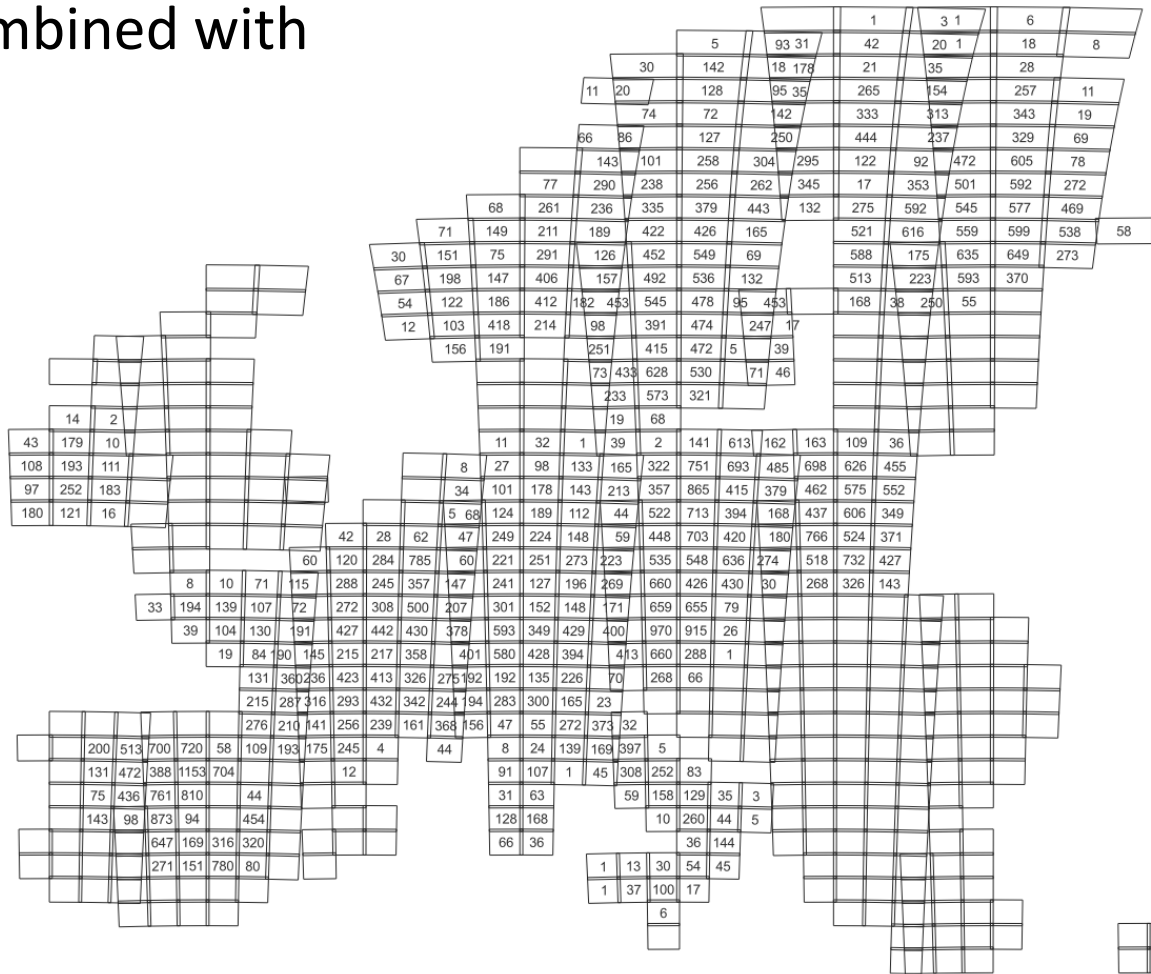
Most of Europe is annually covered by NFI data...



... economically efficient to use these data also in a EFMS

Harmonized NFI data combined with Sentinel2 data

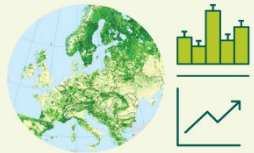
Country	FB1	FB2 (DBH, SC)	FB3 (BA)	FB4 (H)	FB5 (gai/nai)
AT	5749	1482	1482	1482	1317
BE	1061	1061			499
CH	2624	2624	2624		2170
CZ	5022	5021	5021		2206
DE	6186	6186	6186	6186	5799
ES	14454	14259	13875	13875	8377
FI	16545	16545	16545		
FR	15845	15845	15845	15845	
IE	1509	1509	1509	1509	1489
IT	6688	6656			6536
NO	7024	6575	6575	6575	6705
PL	18802				
SE	17299	17299			9973
SI	736				
	119544	95062	69662	45473	45071



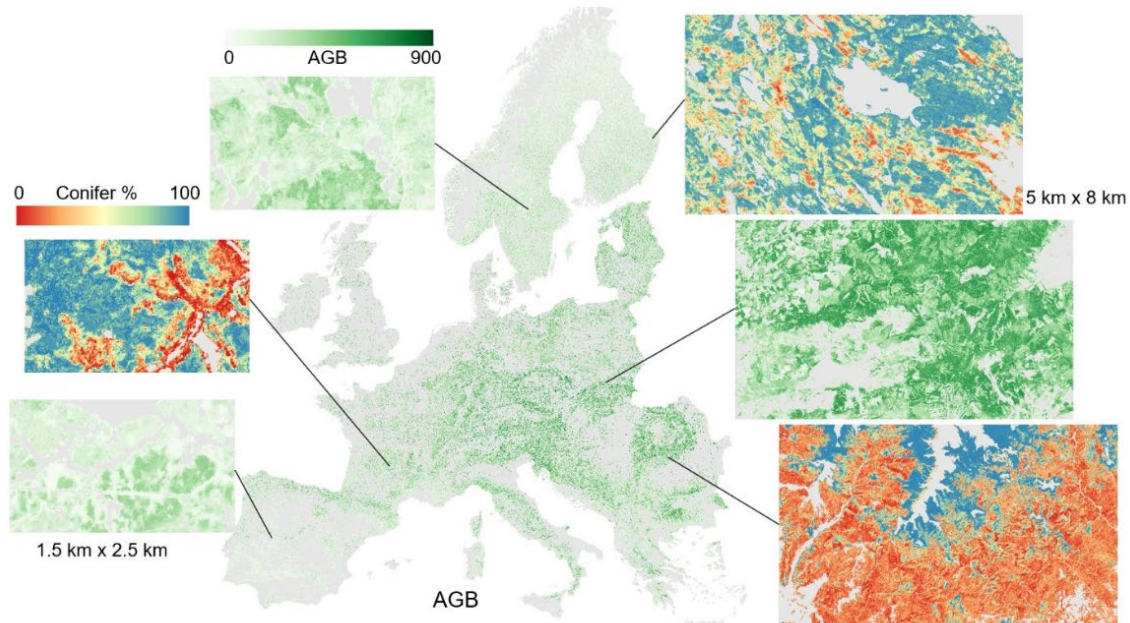
Mapping and estimation

Maps and estimates

- Forest C stock change
- Biodiversity
- Bioeconomy



- Pan-European maps combining NFI and satellite data for 2020
- 10 m resolution



For each 10 m pixel:
Predicted value and uncertainty

-Increment

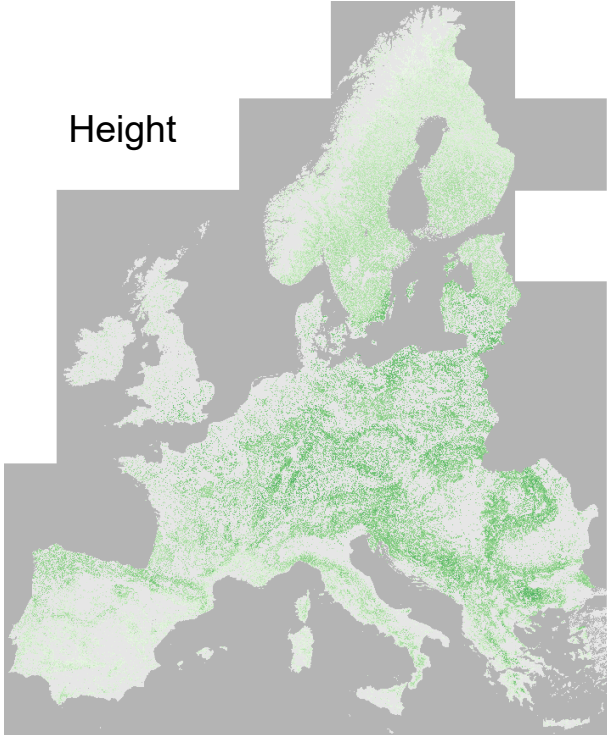
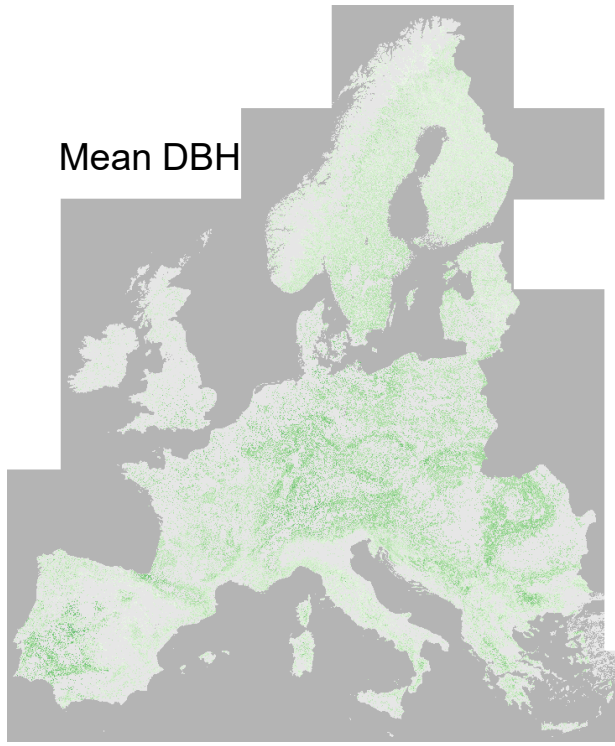
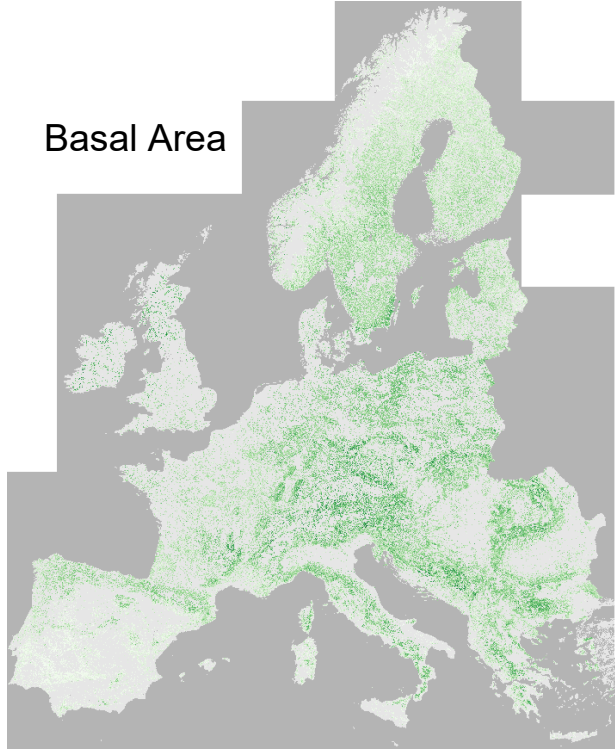
Basal Area

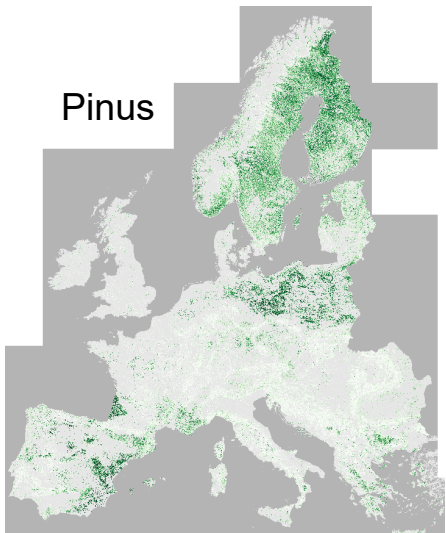
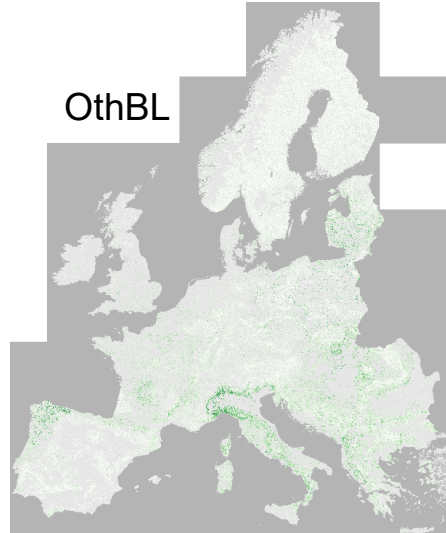
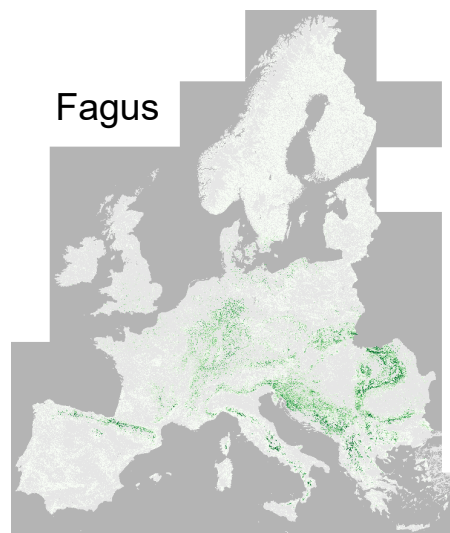
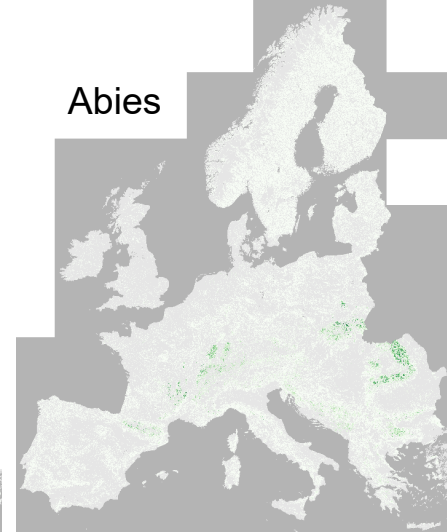
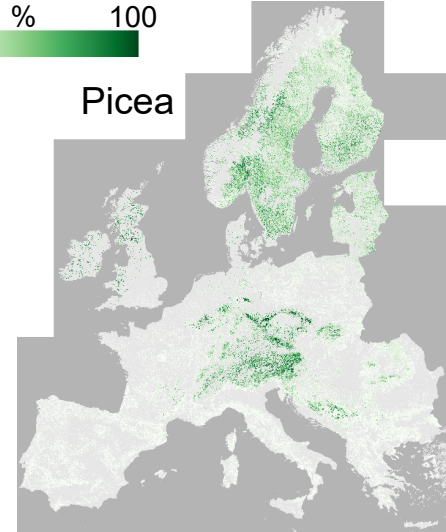
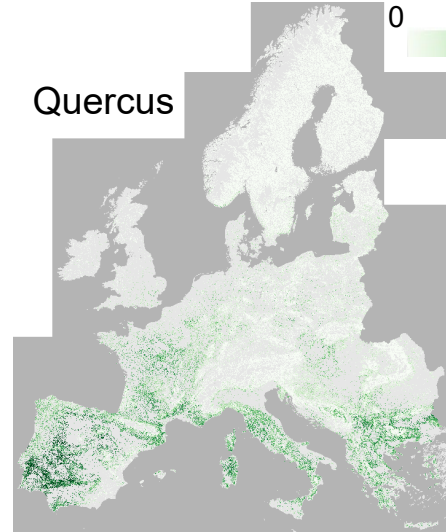
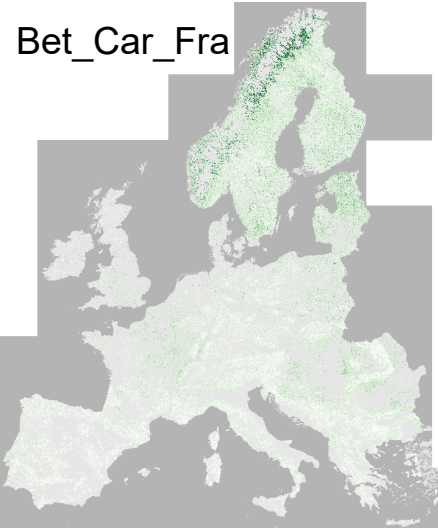
Mean DBH

0 H (dm) 500

Height

0 BA (m²/ha) 70
0 DBH (cm) 80



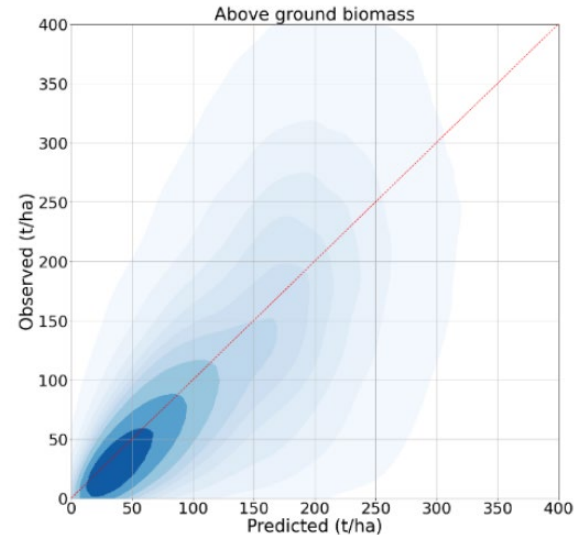
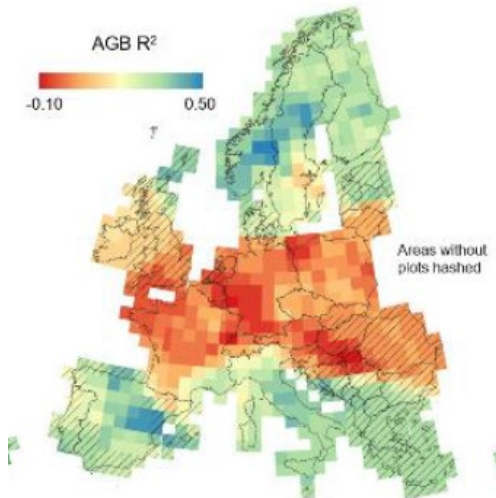


0 % 100

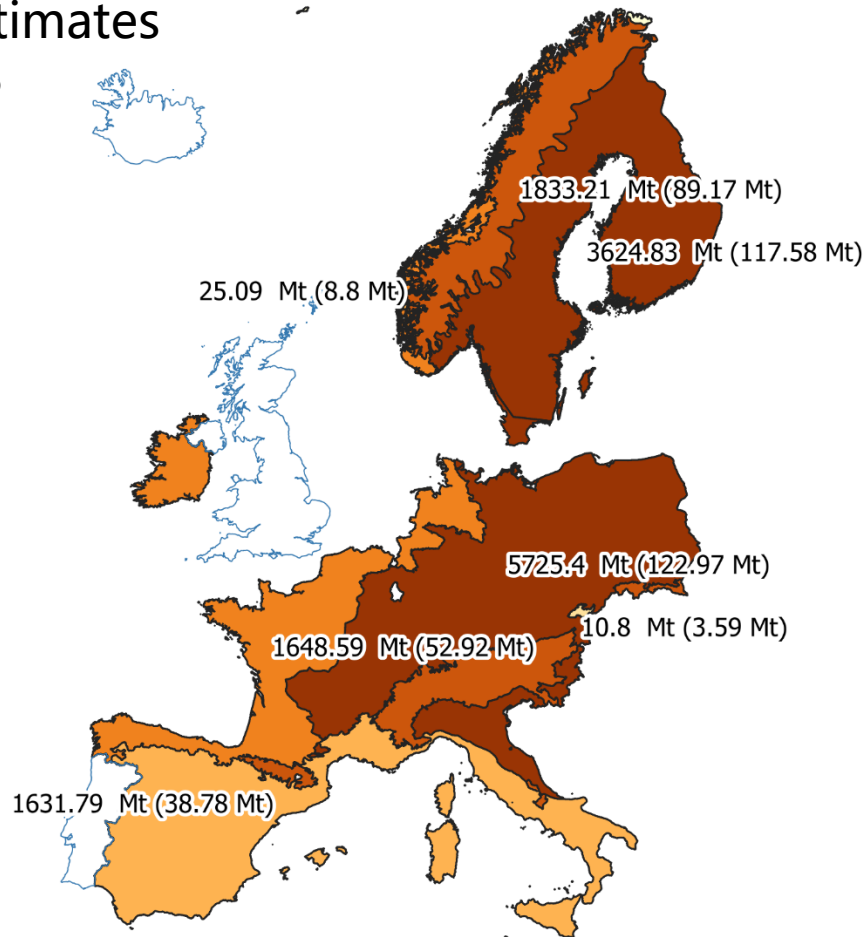
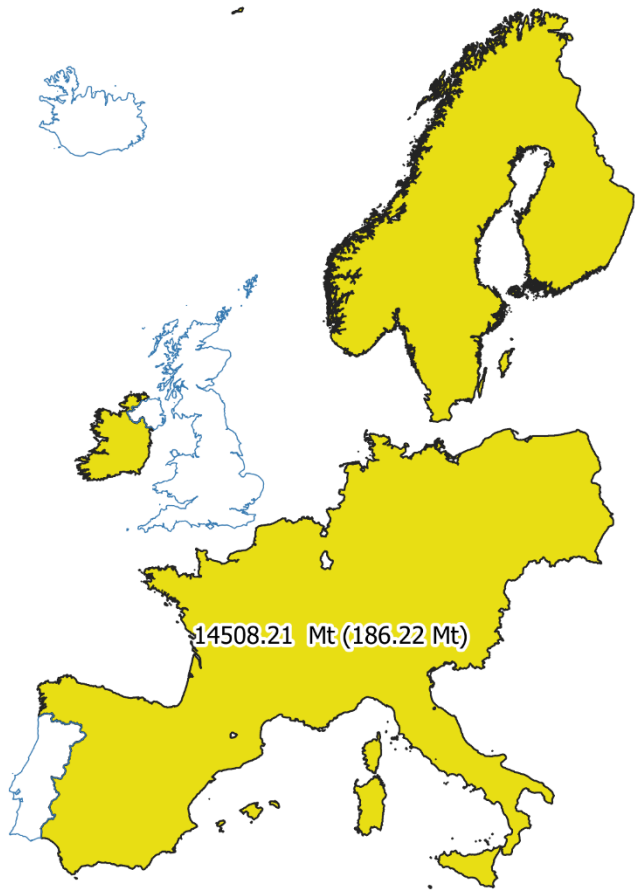
A vertical color scale legend ranging from 0% (light green) to 100% (dark green), used to indicate the percentage of species distribution in the maps.

General trends in mapping uncertainty

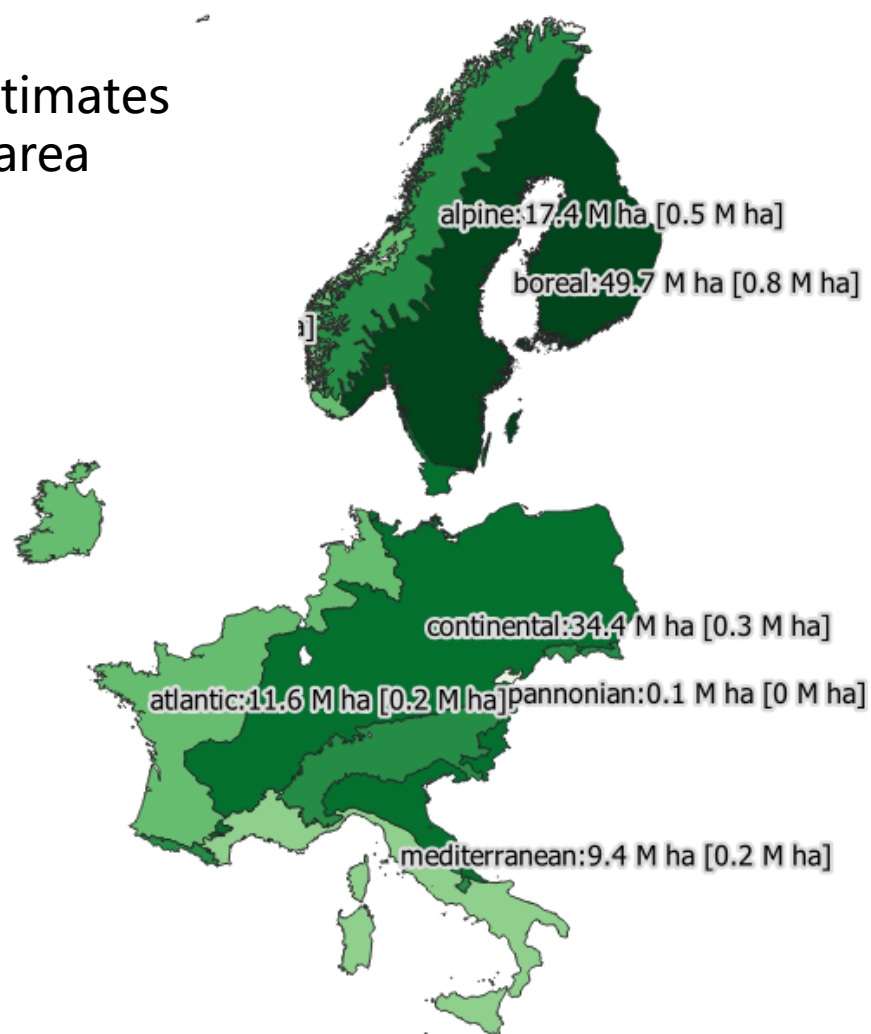
- kNN method – preserves covariation among MV responses
 - Lower map accuracy in central Europe than in north and south
 - Bias in extreme values
- ➔ Pixel counting not advised – therefore plot-based (model assisted) estimates



Reliable estimates AGB

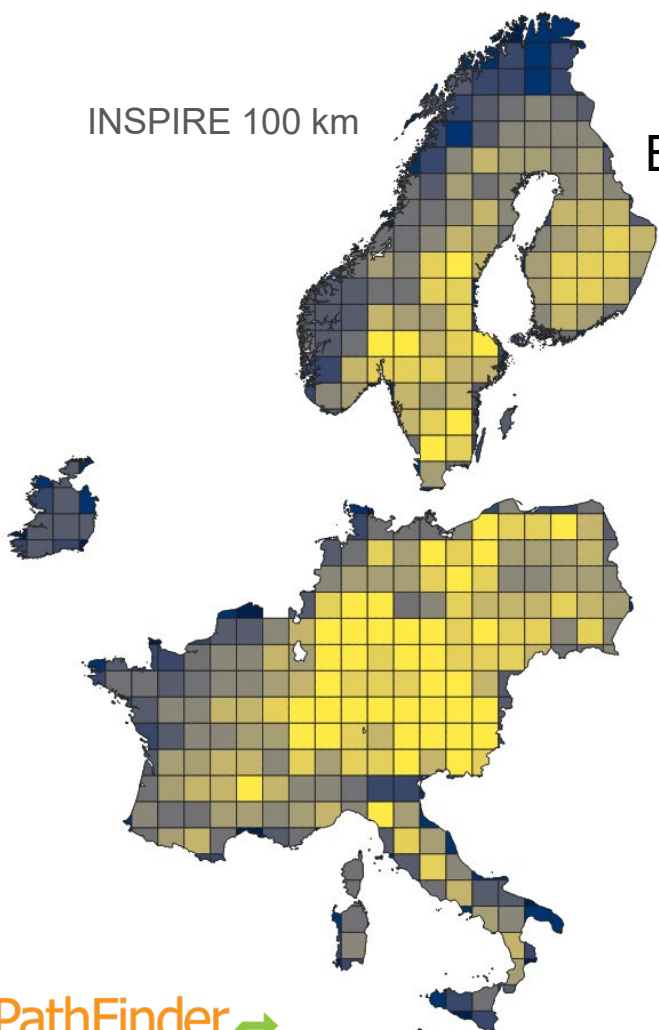


Reliable estimates Forest area

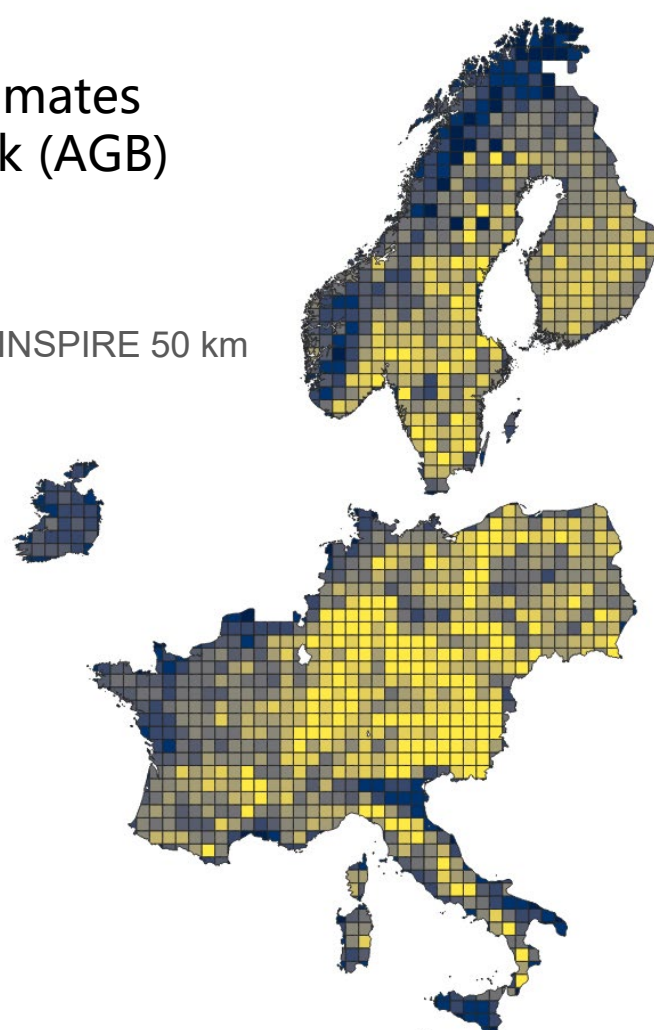


Reliable estimates Biomass stock (AGB)

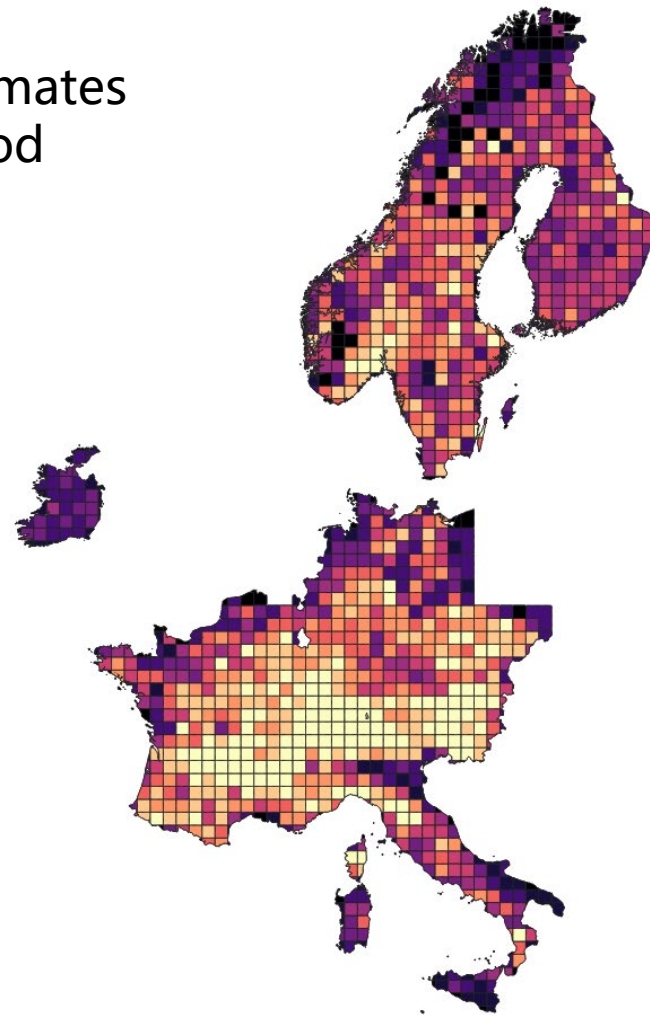
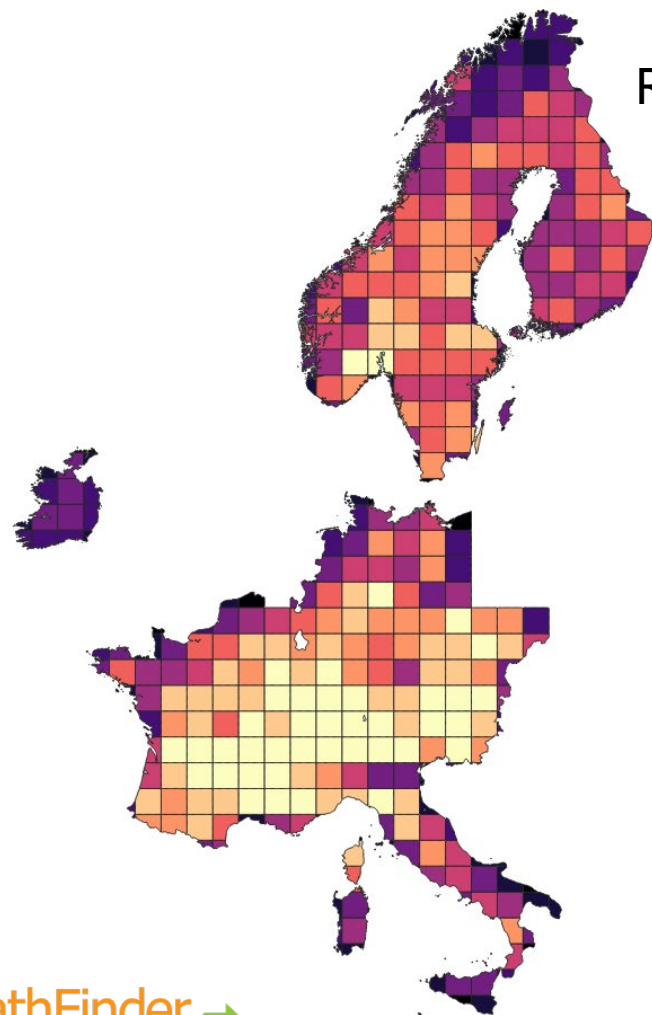
INSPIRE 100 km



INSPIRE 50 km



Reliable estimates Deadwood



Summary - estimation

- Centralized NFI database analyzed with nFIESTA
 - AGB C-stock changes of 1% can be detected reliably
 - Shown results only plot-based
 - Adding EO information can reduce SE by up to 30% for some attributes
- ➔ Not all countries yearly covered with NFI field plots

14508.21 Mt (186.22 Mt)

1631.79 Mt (38.78 Mt)

648.59 Mt (52.92 Mt)

5725.4 Mt (122.97 Mt)

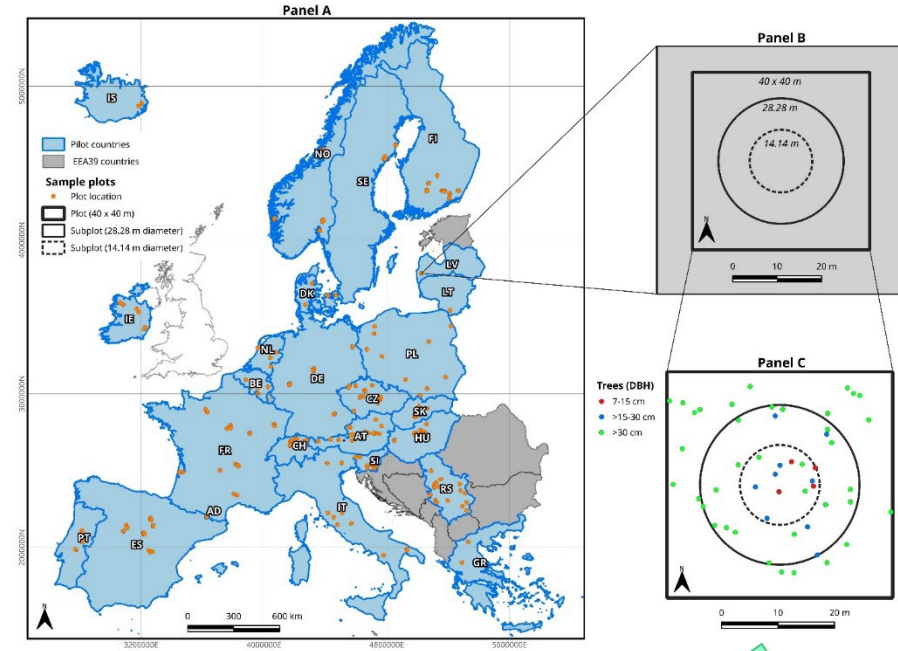
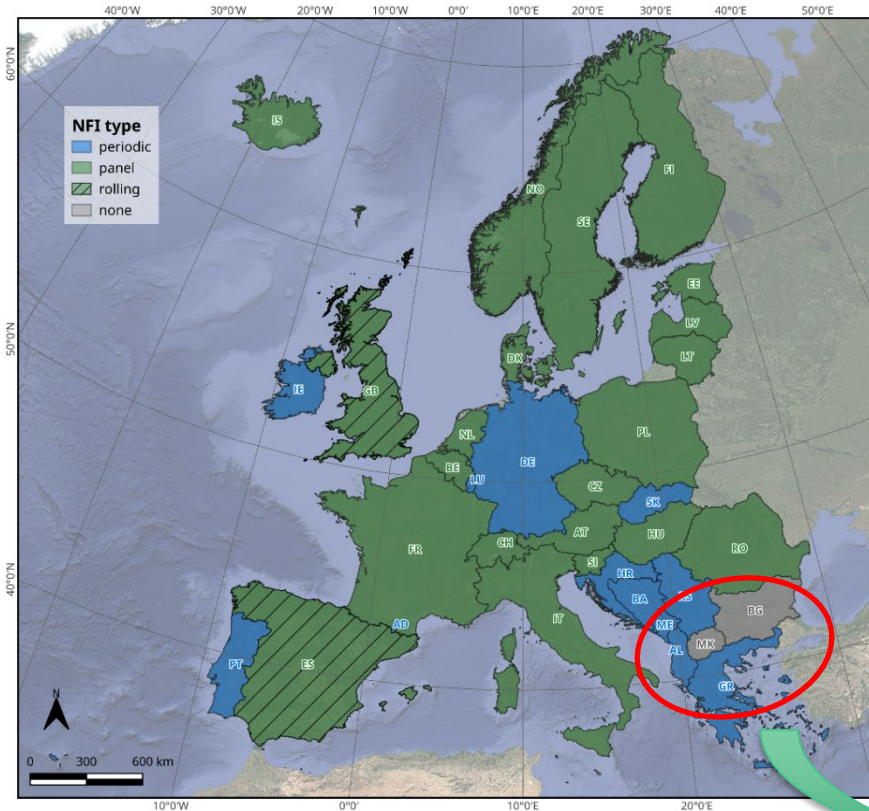
10.8 Mt (3.59 Mt)

1833.21 Mt (89.17 Mt)

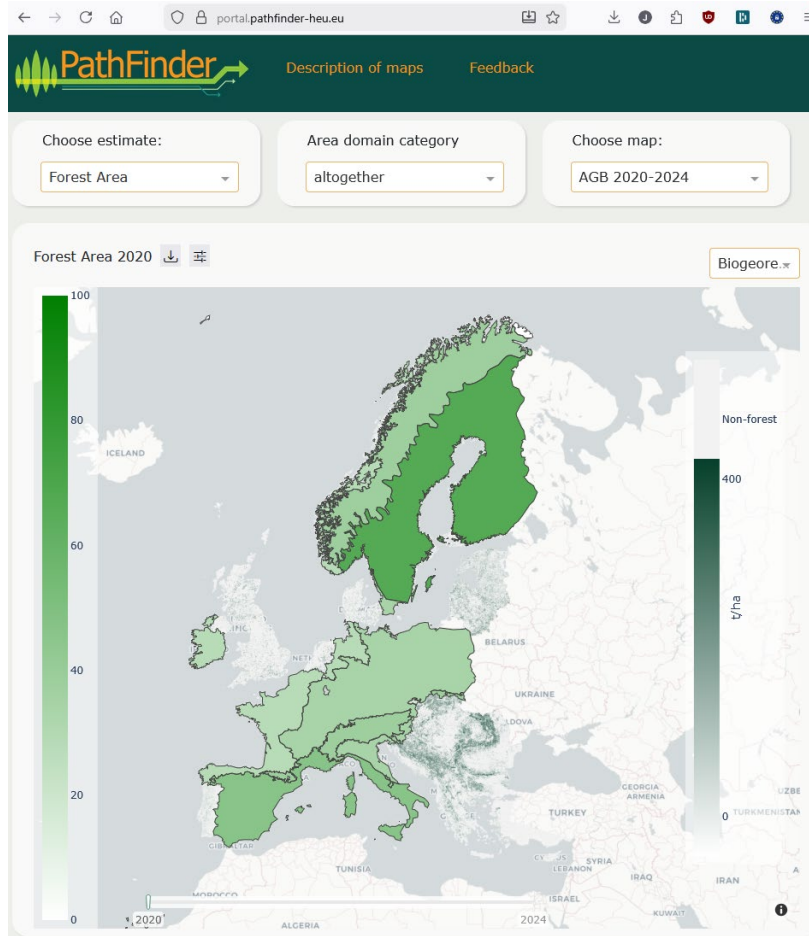
3624.83 Mt (117.58 Mt)

25.09 Mt (8.8 Mt)

Standardized EO-friendly plots if yearly data are not available



View and download data from the PathFinder portal



Answers questions like:

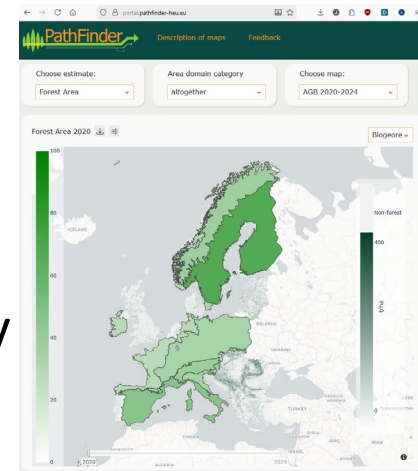
-How much pine biomass with diameters > 50 cm per biogeographic region?

-How may forest structure change in the future?

Conclusions



- A European Forest Monitoring System based on National Forest Inventories is feasible
- Combining field and remote sensing data improves estimates
- EO-based maps can give a timely first impression and are important for mapping «rare» events
- Do not base important decisions on pixel counts of maps alone
- ➔ We need institutional arrangements to proceed
- ➔ Consistent, updated, high-resolution 3D-EO data, highly correlated with forest attributes seem to be missing



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