EO for Monitoring, Reporting, and Verification of Carbon Removals

Copenhagen, 8-11 October 2024

Breakout Group 3 - Data needs in support of baseline definition

European Environment Agency

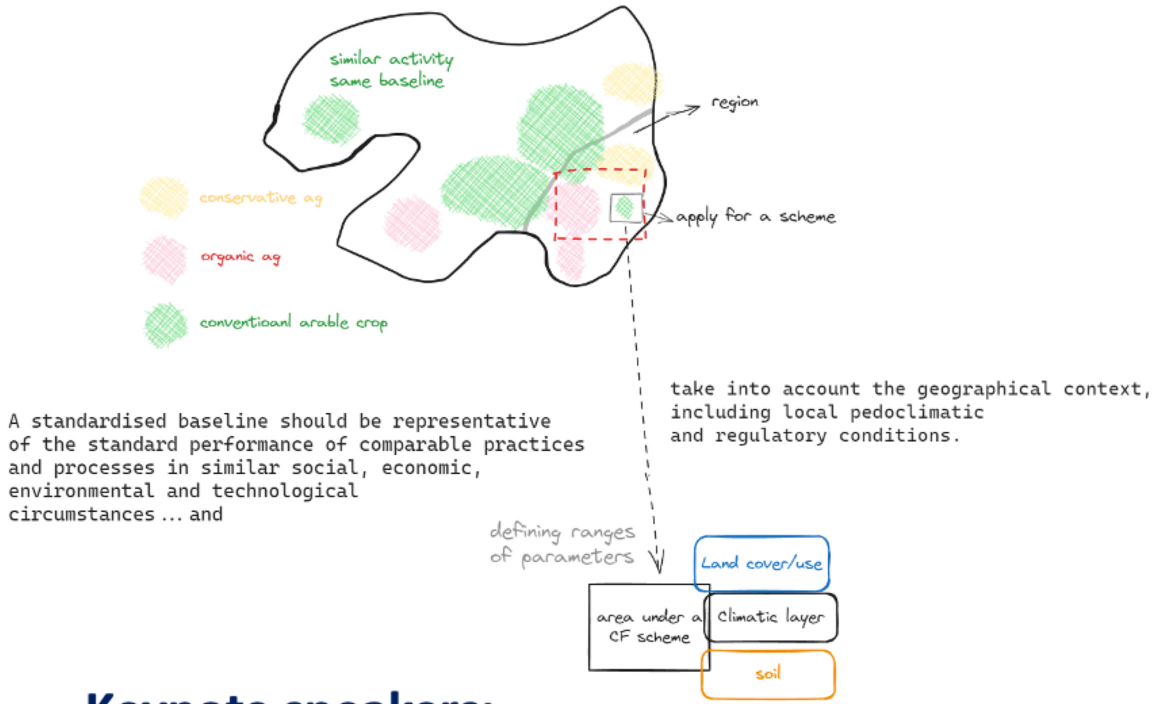
esa

Breakout Group 3 - Data needs in support of baseline definition

Chairs: Mirco Migliavacca (JRC) and Lucia Perugini (EEA)

*The CRCF regulation foreseen the use of **baselines** (standardized or project-specific);*
*The CRCF envisages a **strong use of remote sensing technologies** in this process;*
*Breakout session on **data needed** to establish baselines for carbon farming.*

$$\textbf{\textit{Permanent}}\ \text{net carbon removal benefit} = CR_{\text{baseline}} - CR_{\text{total}} - GHG_{\textit{associated}} > 0$$



Questions to be addressed:

- What are the EO data available for baseline calculation and main limitations?
- What are data gaps and what to prioritise to reduce uncertainties?
- How measurement networks (NFI, ICOS, ICP Forest, LUCAS) can improve satellite monitoring of carbon fluxes?

Keynote speakers:

Eric Ceschia,
Marta Gómez Giménez


Agroforestry

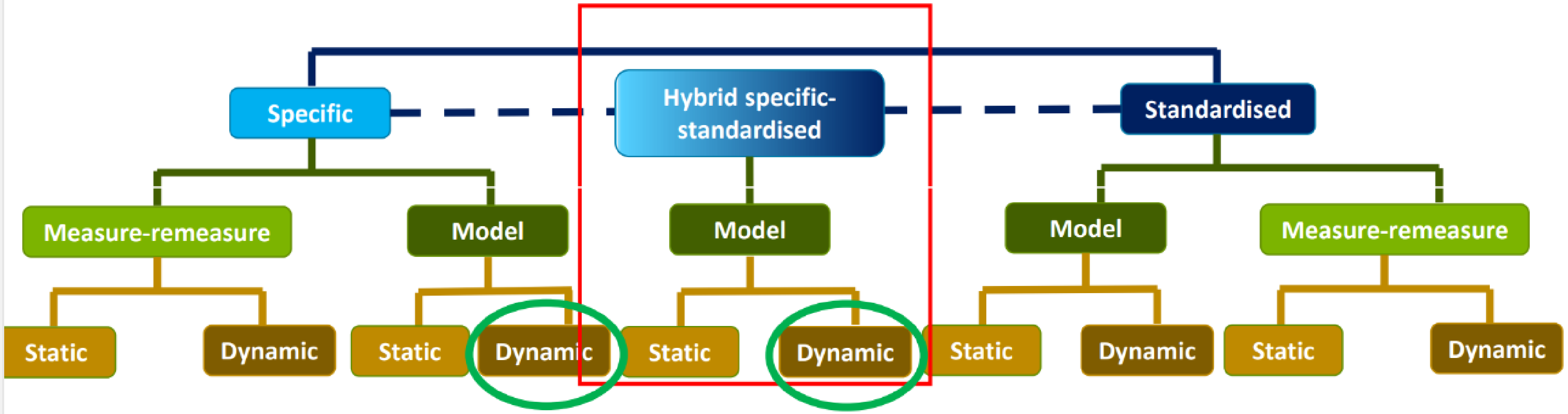
Jukka Miettinen
Ruben Valbuena

European Environment Agency

esa

Agriculture

Baseline options



Evolution in soil carbon stocks (ton C/ha.year) = f (soil, weather/climate, management practices, biomass input to soils)

specific (soil) — **standardised** (management practices)

+ ensures first movers are incentivised
+ maintaining high C stocks incentivised *(usually requires better management than average)*

MARVIC
MRV for carbon farming

Same method should be used for setting the baseline and the project scenario

The AgriCarbon-EO processing chain

A pre-operational multi-context end-to-end processing chain.

Geoscientific Model Development

Wijmer et al. (2024)

AgriCarbon-EO: v1.0.1: Large Scale and High Resolution Simulation of Carbon Fluxes by Assimilation of Sentinel-2 and Landsat-8 Reflectances using a Bayesian approach

Taeken Wijmer, Ahmad Al Bitar, Ludovic Arnaud, Rémy Fieuzal, and Eric Ceschia

Agri-food, EO & MRV companies:

Toulouse Tech Transfer

netcarbon

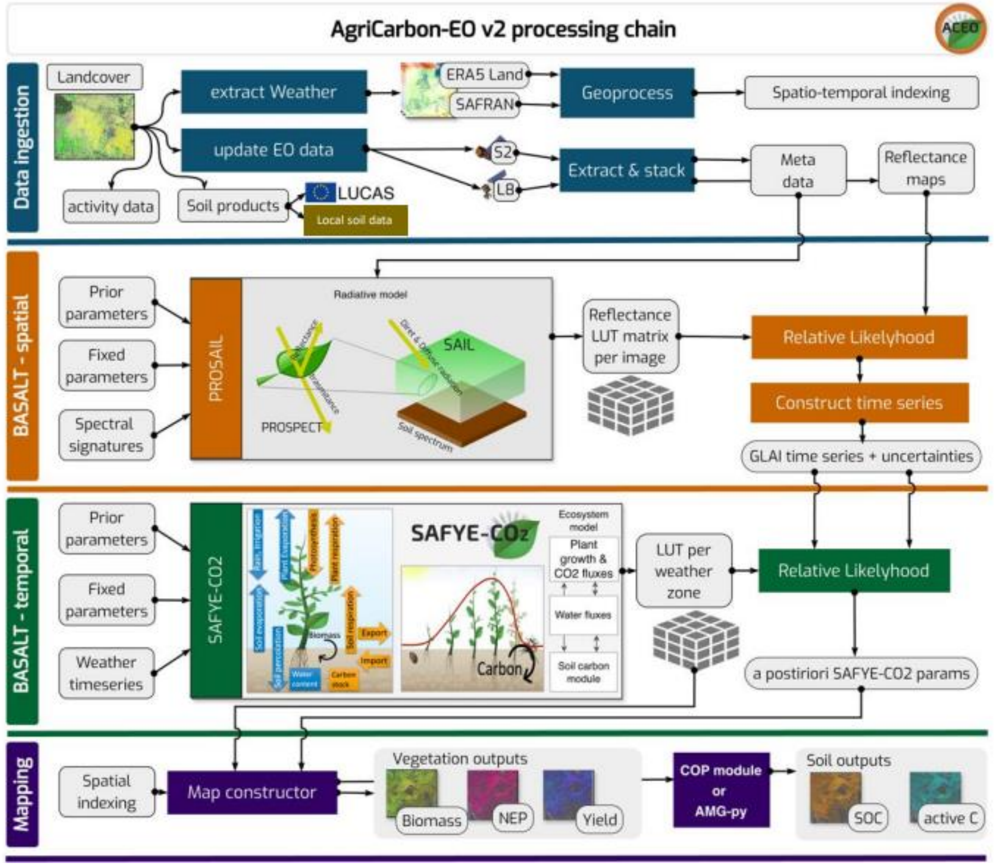
AIRBUS

KERMAP

EarthDaily agro

natais

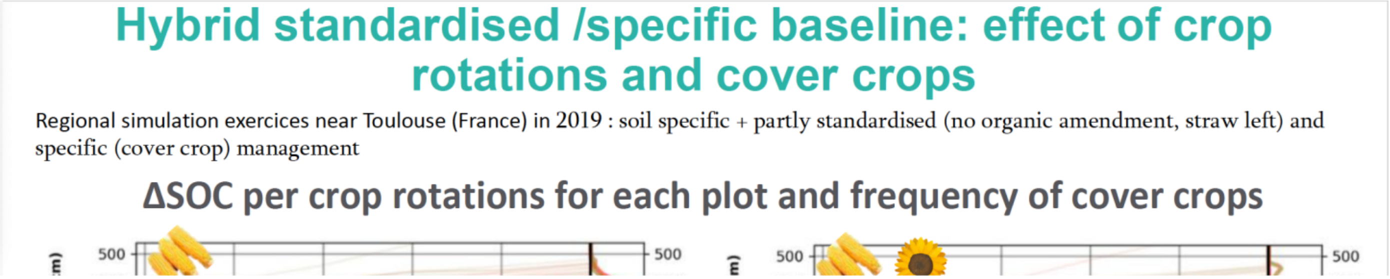
MyEasy Farm



Soil parameters that highly influence the SOC:

- Plants productivity and soil/plant respiration
- Inputs (manure)
- Residues managements
- Crop rotations
- Cover crops

Highly variable



Data limitations to develop EO based MRV approaches

- Limited to a few crops and cover crops → progressive acquisition of new in-situ datasets for CAL/VAL in Europe (e.g. at ICOS sites) but we lack of ABG biomass data with ESU protocols for more crop/cover crop species (collab with companies & cooperatives…) and of co-located AGB biomass/ΔSOC/activity data !!!!

- Use of HR optical remote sensing data only (S2, L8, Planet…) can be limiting for operational applications (long cloudy periods) → combining optical SAR (Sentinel 1) satellite data assimilation will allow to overcome this issue (PhD A. Géraud in collab with Netcarbon) → need for gapfilled LAI and/or proxy of biomass

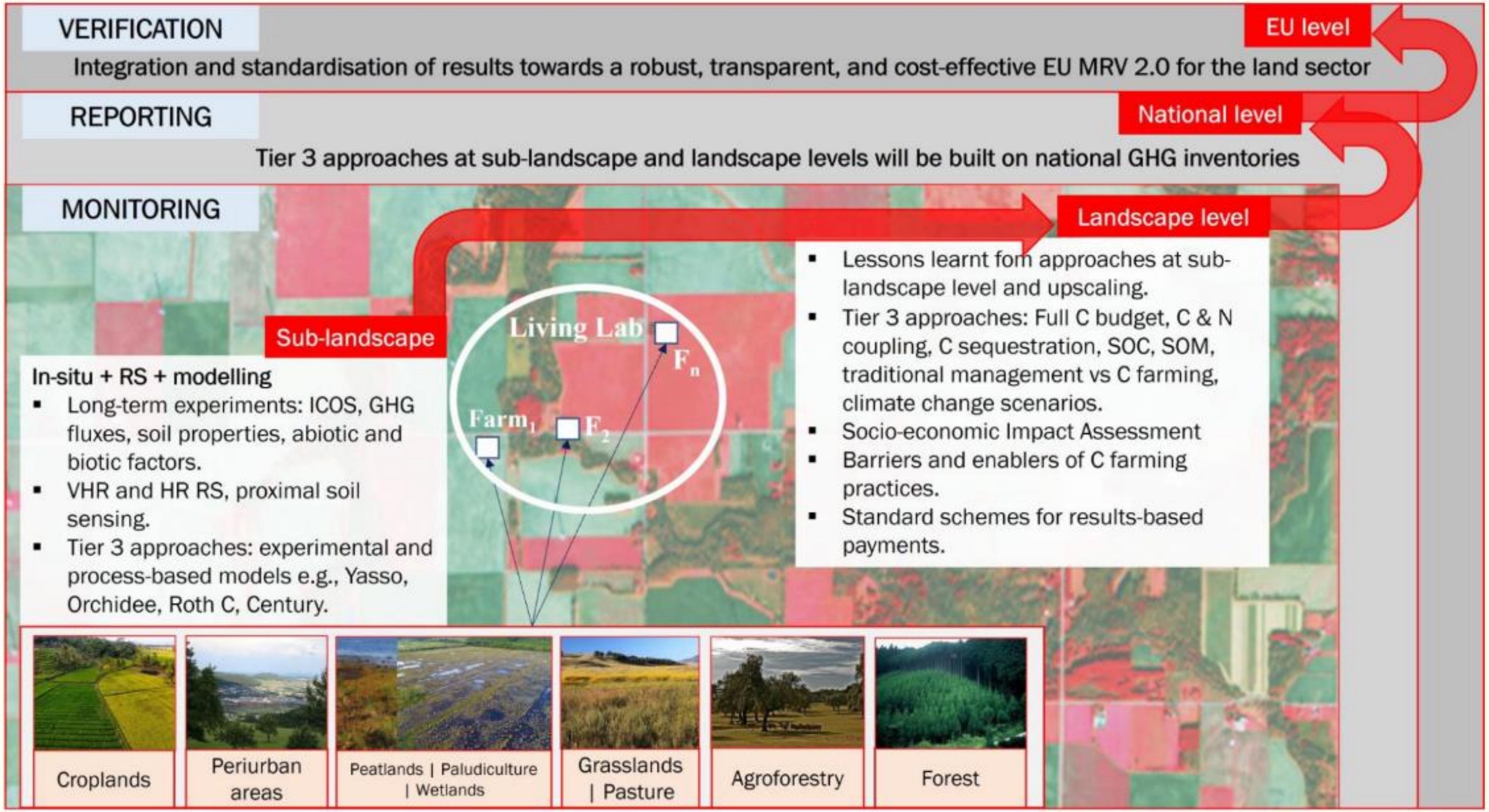
- Quality, accessibility and spatial resolution of the soil data/products (e.g. initial SOC stock, texture) → 1) use high resolution remote sensing data for digital soil mapping (collab with E. Vaudour) for regional applications and 2) use local soil data (e.g. soil samples, plot level maps) when relevant (e.g. VCM)

- Access to reliable management data on straw management and organic amendments is currently the strongest limitation for all modelling approaches at plot scale (to build specific baseline and to quantify ΔSOC stocks) → the use of API to access FMIS is not enough, management data must be verified first (agricultural advisor)

- Yet to build standardised baselines, regional statistics on management is probably good enough.

MRV4SOC PROJECT

Implementation and scales



esa

MRV4SOC considerations

1) Standardised baseline should quantify a flux, i.e., a change of carbon stock in time

- Carbon removals and soil emission reduction (CO_2, N_2O, CH_4) → we need process-based models.

2) Performance of management practices: what should be considered as standard practices?

- A clear definition of Business as Usual is needed. We proposed considering the common management practices and the regulatory conditions.
    - Short-term: Nitrate directive + additional GAECs observed by farmers that choose to take CAP subsidies.
    - Mid-term: Common practices using digital maps + LUCAS + Copernicus

MRV4SOC considerations

3) Similar circumstances.

- The standardised baseline should be fair for all farmers, i.e., conventional and early movers.

- There will be variability in initial SOC levels in the same region or under similar circumstances. A baseline should consider the same fixed range of key drivers of C removals to assess expected outcomes and the associated uncertainty.

- A range of baselines considering different initial conditions and not a unique number for all the region could account for regional variability and ensure fairness.

NEEDS AND OPPORTUNITIES

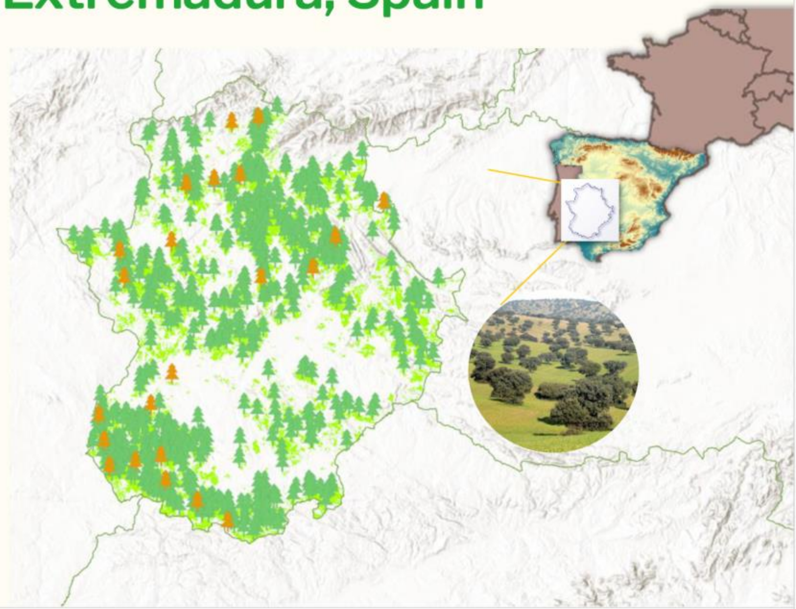
- ❑ **Accurate and updated maps of peatlands**
- ❑ **More granular** refinement of the National Greenhouse Gas Inventory, which is primarily focused on land use.
- ❑ Determining emission factors for **specific vegetation types**, GEST can provide **more precise** estimates of greenhouse gas emissions
- ❑ Lack of data to develop a Tier 3 approach.
- ❑ Products that can provide information of water table levels at different locations will be a great breakthrough.
- ❑ For cultivated peatlands, field observations of CO_2 and CH_4 fluxes are extremely important but lacking, especially in Norway.

Agroforestry

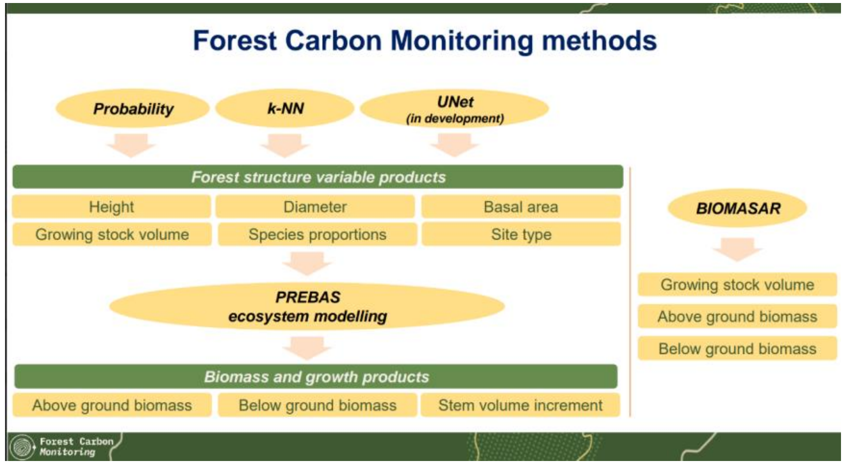
Agriculture. Lonzée, Namur, Belgium

NFI dehesas in Extremadura, Spain

- Extremadura Autonomous Community (NUTS-2)
  25% of dehesas
- *Quercus ilex L.*
- 499 NFI plots dehesas (remeasured plots between NFI 2, 3 y 4)
- Years: 1991 – 2017 (26)
  - NFI2: 1991
  - NFI3: 2002
  - NFI4: 2017



Forestry

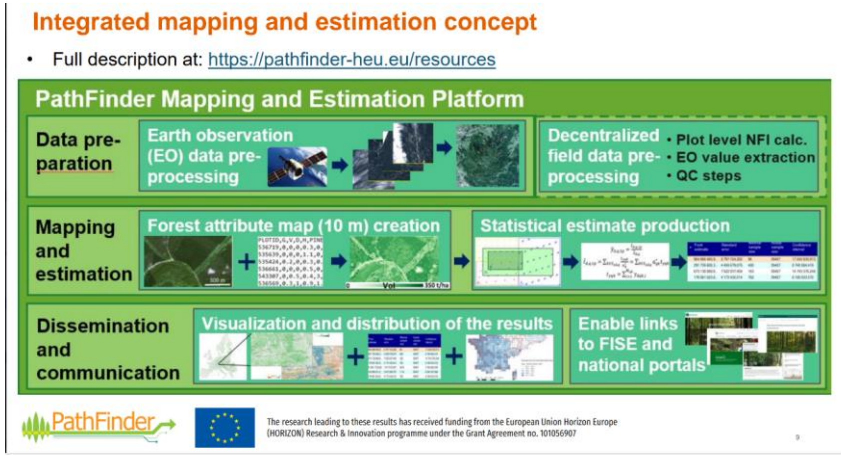


Forest carbon monitoring project 2021-2023/ 2024-2025 -- > ESA project VTT

Create a platform/toolbox for user that are interested in forest biomass and forest carbon monitoring

Focus on integration of EO and in situ data

Flexibility for use requirement to produce forest variables maps that can be used for ecosystem models



PathFinder HE project → 2022-2026

Involving the European national forest inventory network (ENFIN)

How field data (NFI) and RS data (sentinel 1-2) can be used together for harmonized products that can be published in the FISE

Standard deviation level will be provided at pixel level
Currently accuracy very variable RMSE 20-60%

European Environment Agency

esa

Combined use of EO and field-based data needed

- EO is a powerful tool for timely large area monitoring with high spatial detail
- Combined use of optical, SAR and spaceborne LiDAR bring new possibilities
- New methods are improving the accuracy
- BUT!
  - With space borne EO, uncertainty is (and will remain in the near future) high for small areas

➡ **Error intervals too high for financial or legislative monitoring**

- Field reference data is crucial!
  - Required for training and accuracy assessment
  - Important to align EO based monitoring with existing field sampling-based information
  - Combined use of EO (and other remote sensing data) with field measurements networks (NFI, ICOS, ICP Forest, LUCAS)

➡ **Model-assisted estimation for administrative regions**

→ To be evaluated in both PathFinder and Forest Carbon Monitoring projects

Key messages

- Different data for different uses: there's a gap between LULUCF national reporting and the scale of individual action-based carbon markets.
- For forest baselines in CRCF: best is to make good use of **airborne laser scanning** (ALS). A Europe-wide ALS forest mapping effort is possible.
- ALS needs to be supported by ground plots for cal/val. This can be supplied by most current **national forest inventories** (with exception of plot coordinates, which needs improvement at several NFIs)
- **Satellite** can be useful for monitoring over the baselines. Can make use of model-assisted estimation.
- These all refer mainly to carbon at standing above ground biomass. **Eddy-covariance fluxes** for any other carbon sources and sinks, and considerations of forest management alternatives.
- Uncertainties need to be determined and errors need to be quantified and employed under a principles of additivity and conservativeness. Investment in quantifying needs to be rewarded in carbon credits.

- Process-based modelling (Tier3) could be a comprhensive and cost effective approach
- EO can be used in assimilation or to provide information about vegetation, soils and management practices
- In situ data are key to reduce uncertainty and to better test models
  - is costly, but when done at scale the costs can be lower ad these are needed for the baseline calibration.
  - Few key missing parameters (e.g., water table, forest management) and more direct measurements of fluxes (included non-CO2)
- Important to include the time component in the assessment of the baseline and the change of the management foreseen in the area (including the capabiity to monitor management)