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FINNISH METEOROLOGICAL INSTITUTE

Measuring the climate effects of Carbon Farming

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29.11.2022 **Geoscience Day, Helsinki**

Photo: Sanne Katainen / Maaseudun Tulevaisuus

Team

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Lead and coordination

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- Mikko Skokberg

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BALTIC SEA
ACTION GROUP
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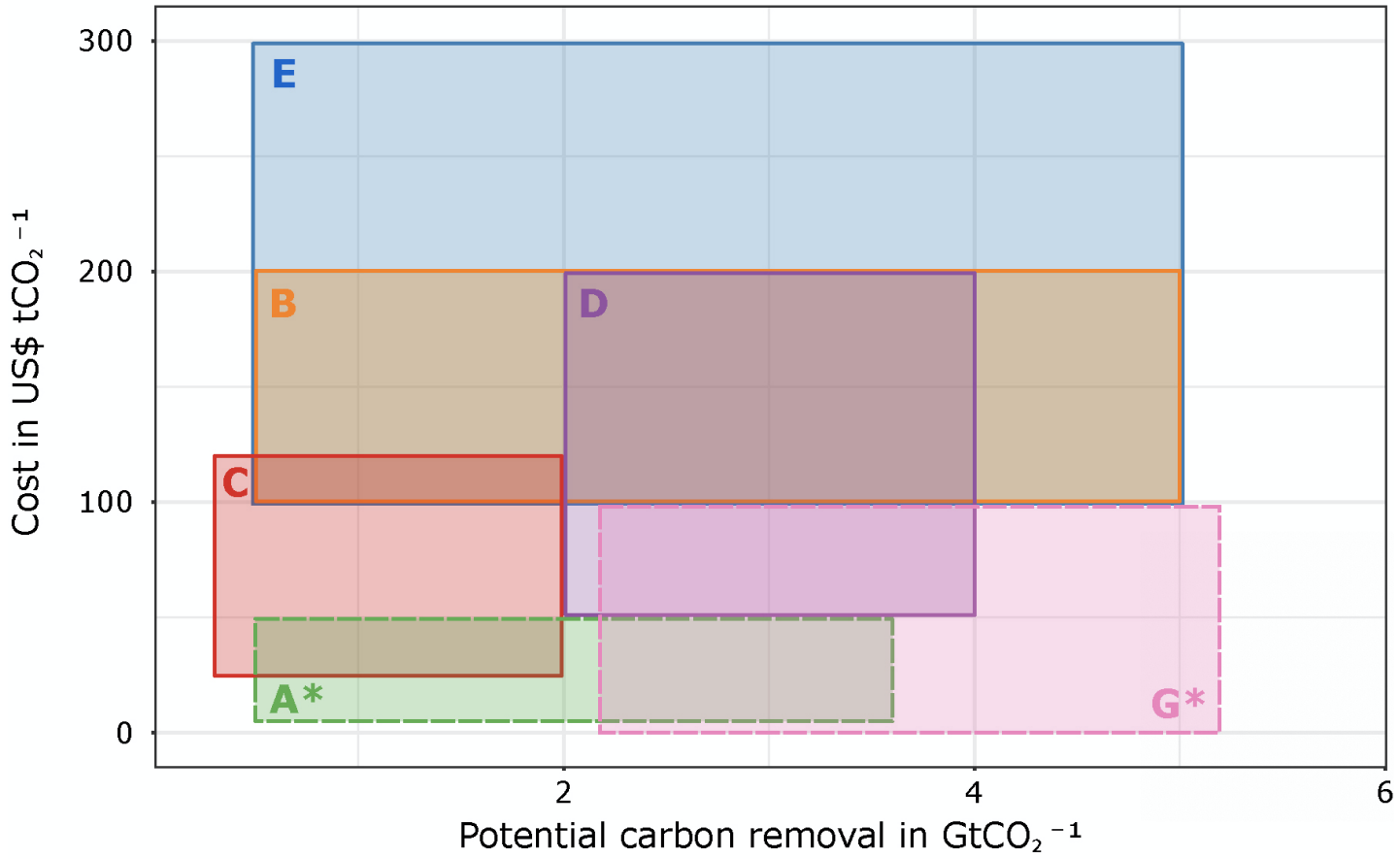
CARBON
ACTION
CLIMATE - SOIL - BALTIC SEA - BIODIVERSITY
2017-
100 Farmers
14 Companies
24 Research Projects
carbonaction.org

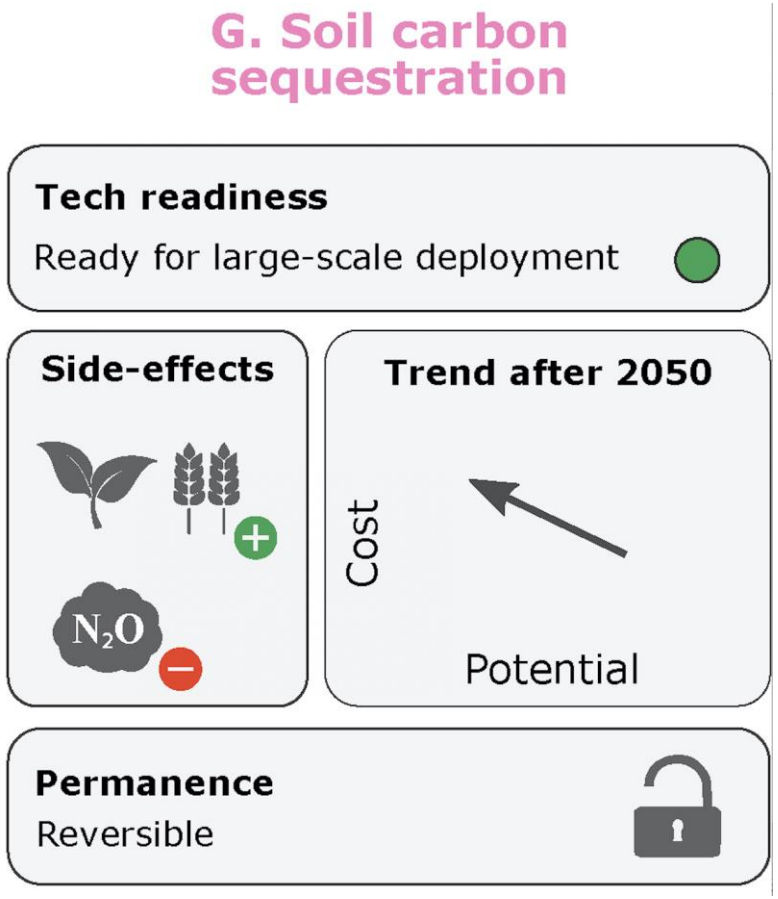
FOOD AND FARMING | 25 August 2017 13:37

World's soils have lost 133bn tonnes of carbon since the dawn of agriculture

Grafiikka YLE, Luvut Jari Liski, Juuso Joona

CO_2-removal (A-F) cost and potential





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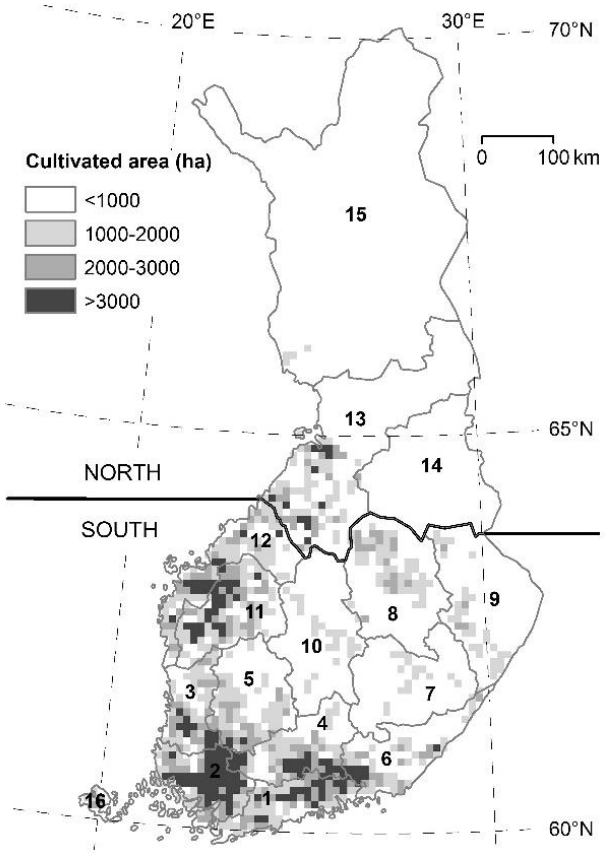
Arvio v. 2050, Minx et al. 2018. Environmental Research Letters.

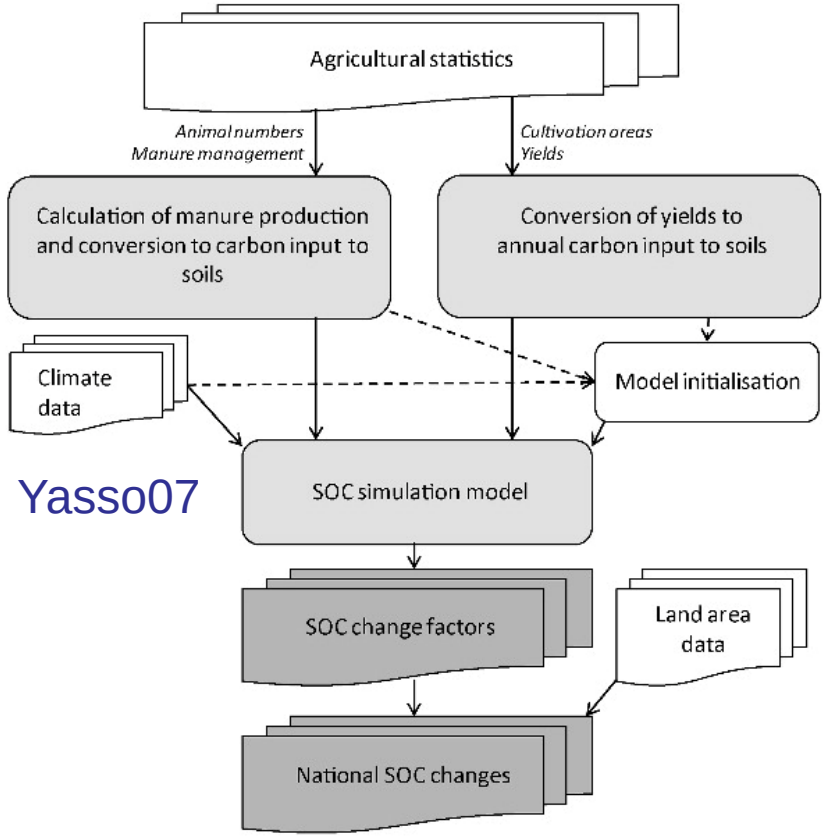
Central questions

1. How much carbon is sequestered?
2. How much of it is additional?
3. For how long it stays in soil?
4. How it is accounted for in various applications?

Farmer and photo: Juuso Joona, Tyynelä farm. October 2018

[The current] Method for estimating soil carbon stock changes in Finnish mineral cropland and grassland soils: by ELY center and plant type

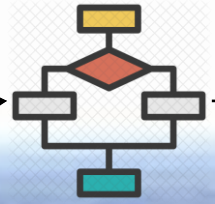




Palosuo et al. 2016. Carbon Management.

Carbon and greenhouse gas verification system (FMI and collaborators)

Satellite measurements
- Sentinel-2: Leaf Area Index, NDVI



Predictive Ecosystem Analyzer (PEcAn)
- IT platform: data, models, data-analyses

Agriculture ecosystem models
- BASGRA-N, BASGRA-BGC, STICS, Land-DNDC

Yasso soil model
- FMI's soil model

Reference sites:
- Eddy covariance
- Soil chambers
- Soil and vegetation measurements

Field Observatory
- www.fieldobservatory.org

Ordinary fields
- Farming practice information
- Soil quality information

GHG inventories

Life-cycle analysis

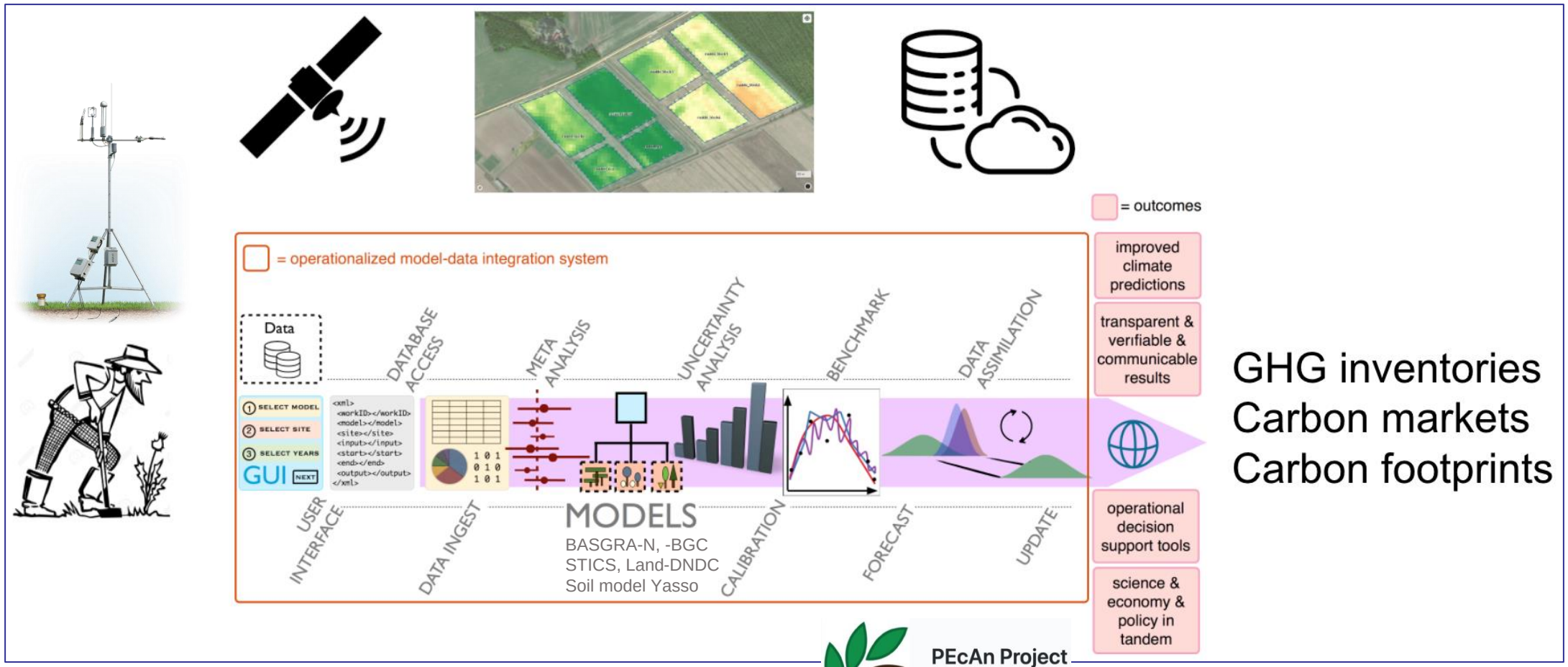
Carbon footprint

Carbon market

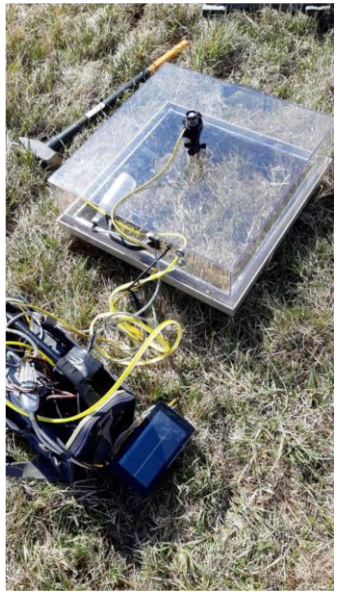
Verification method components

1. Method overview
2. Measurements
   - CO_2 fluxes: eddy covariance, chambers
   - Satellite measurements
   - Soil and vegetation analyses
   - Microbial analyses
   - Models' drivers
3. Models
   - Process-based simulation models, statistical models
   - Crop fields, grass fields
   - Mineral soils, organic soils
4. Model-data integration system
   - Predictive Ecosystem Analyzer (PEcAn) https://pecanproject.github.io/
5. IT system
6. Visualisation tool
   - www.fieldobservatory.fi
7. Applications
   - GHG inventories
   - Carbon footprint estimates
   - Life-cycle analyses
   - Carbon offset markets

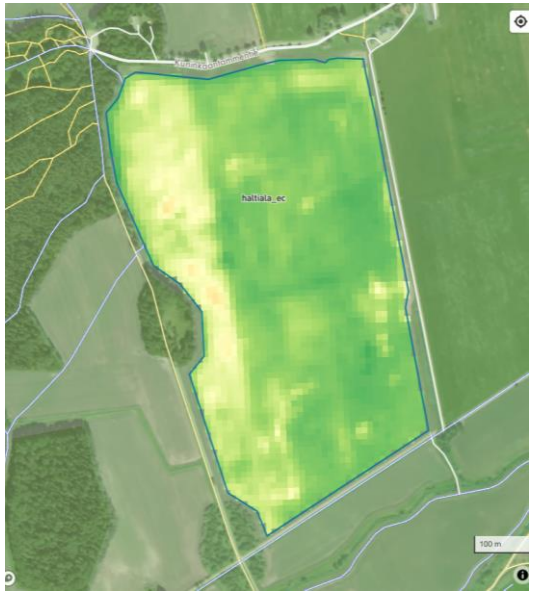
Verification method for carbon and greenhouse gases



Fer et al. 2020. Global Change Biology. https://doi.org/10.1111/gcb.15409



Chambers



Satellite measurements

Carbon Action projects

https://carbonaction.org/en/projects/

JÄRKI and the Carbon Action farmer collaboration

Baltic Sea Action Group's JÄRKI project has been working actively to promote sustainable agriculture since 2009. In 2019 Louise and Göran Ehrnrooth Foundation and the Sophie von Julinin's Foundation granted the third 5-year funding for JÄRKI and the collaboration with carbon farmers.

Read more

TWINWIN project

The Nessling Foundation finances the Carbon Action project platform's research on how biodiversity impacts the ability of fields to store carbon. In addition to scientific research, the emphasis is on creating impact.

Read more

STN MULTA research consortium

Strategic funding for Carbon Action targets "stn MULTA: Multi-benefit solutions to climate-smart agriculture"

Read more

LOHKO-KHK

LOHKO-KHK is funded by the Ministry of Agriculture and Forestry as part of the 'Catch the carbon' -programme. The main goal of the project is to develop a system for Finnish parcel-specific greenhouse gas calculations.

Read more

FIN SOIL ACTION

FIN SOIL ACTION is funded by the Ministry of Agriculture and Forestry as part of the 'Catch the carbon' -programme. The project strengthens the impact and visibility of Finnish soil know-how and co-operation with key international networks.

Read more

SOILADVICE project

The project "SOILADVICE: Sustainable soil management and carbon farming through extensive use of research findings and advisor practices", funded by Maa- ja vesitekniikan tuki, focuses on advancing agricultural advisor practices.

Read more

SOIL AMENDMENTS project

The project studies how wood-derived soil amendments affect microbes in agricultural soil and in oat roots. The project is mainly funded by Maj and Tor Nessling Foundation and Finnish Cultural Foundation.

Read more

FluCS Tool project

"Solutions for reliably quantifying carbon sequestration in soil", funded by Maj and Tor Nessling Foundation, develops a tool for reliably measuring soil carbon sequestration.

Read more

Carbon Action Svenskfinland project

Carbon Action Svenskfinland -project expands the Carbon Action platform to the Swedish-speaking region of Finland. The project is funded by SLC, Jordfonden and Svenska Kulturfonden.

Read more

INAR RI Agriculture project

The INAR RI Agriculture project, funded by the Academy of Finland and coordinated by the University of Helsinki, investigates the greenhouse gas emissions and carbon sequestration capacity of northern agricultural lands.

Read more

LIFE CarbonFarmingScheme

LIFE CarbonFarmingScheme -project aims to put forth concepts to incentivize climate action and carbon sequestration by farmers and foresters. More specifically, the project outlines the preconditions and opportunities to implement novel incentives which combine EU climate objectives, voluntary carbon markets and agriculture and forestry policies and would accelerate carbon sequestration in European agriculture and forestry. The project receives funding from the European Union LIFE programme.

Read more

Pollinator-Friendly Farms

The Nessling Foundation funded project aims to develop a pollinator-friendly farms concept and provide farmers with the information they need to improve conditions for pollinators on their farms.

Read more

CO-CARBON

Strategic funding for quantifying the carbon storage of green spaces.

Read more

ACCC –Flagship

The Academy of Finland funded ACCC researches the interaction between agricultural soil and the atmosphere.

Read more

PROJECTS HAVSMANUALEN 2 & 3

This assemblage of projects, financed by the Bergsrådinnan Sophie von Julin Foundation and the Programme to Enhance the Effectiveness of Water Protection, delves into the flow of carbon and nutrients between the land, the sea and the atmosphere by combining basic research with methodological development and environmental management.

Read more

BIOHILA

BIOHILA is funded by the Ministry of Agriculture and Forestry as part of the 'Catch the carbon' -programme. The project will develop a method for producing accurate information on field biomass, which is linked to key decision-making and operational accounting applications used for agricultural climate solutions.

Read more

DEEP-SOM project

The DEEP-SOM project, funded by the Academy of Finland and coordinated by the University of Helsinki, investigates the formation and dynamics of soil organic matter (SOM) in the deep layers of soil.

Read more

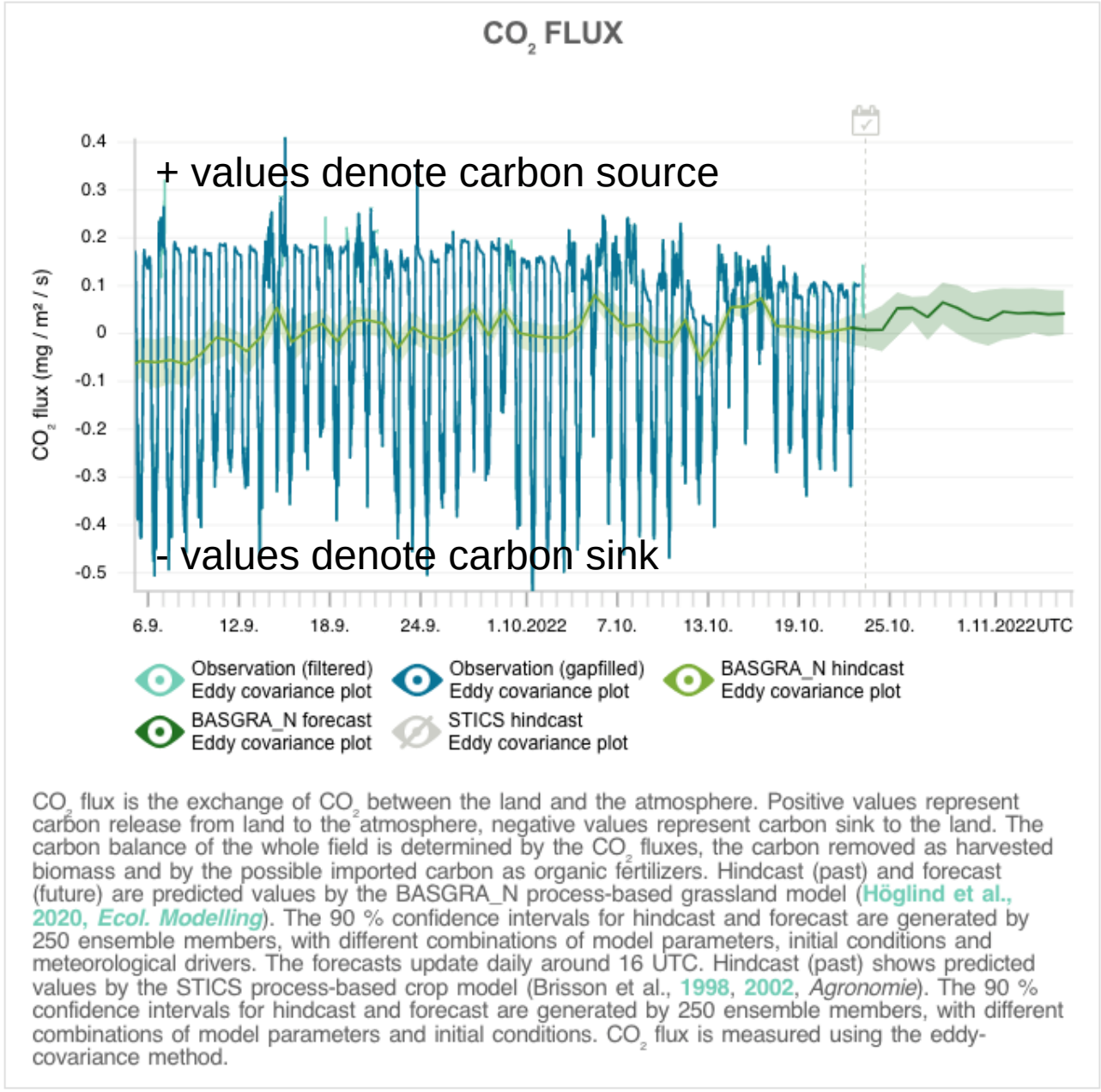
SOCCHA project

The SOCCHA project, funded by the Academy of Finland, studies the carbon content and its depth distribution in soil by using Laser-induced Breakdown Spectroscopy (LIBS).

Read more

Qvidja grass field carbon balance monitoring and forecasting

- CO_2 balance is monitored continuously and automatically using eddy covariance equipment
- Invalid and missing data are gap-filled automatically
- Hindcast and forecast update automatically daily
- 15-day carbon balance forecast
  - Updates daily around 6 pm Finnish time
  - Accounts for weather forecast, satellite leaf area measurement and CO_2 measurement
  - One of the first operational carbon balance forecasts in the world



CO_2 flux is the exchange of CO_2 between the land and the atmosphere. Positive values represent carbon release from land to the atmosphere, negative values represent carbon sink to the land. The carbon balance of the whole field is determined by the CO_2 fluxes, the carbon removed as harvested biomass and by the possible imported carbon as organic fertilizers. Hindcast (past) and forecast (future) are predicted values by the BASGRA_N process-based grassland model (Höglind et al., 2020, *Ecol. Modelling*). The 90 % confidence intervals for hindcast and forecast are generated by 250 ensemble members, with different combinations of model parameters, initial conditions and meteorological drivers. The forecasts update daily around 16 UTC. Hindcast (past) shows predicted values by the STICS process-based crop model (Brisson et al., 1998, 2002, *Agronomie*). The 90 % confidence intervals for hindcast and forecast are generated by 250 ensemble members, with different combinations of model parameters and initial conditions. CO_2 flux is measured using the eddy-covariance method.

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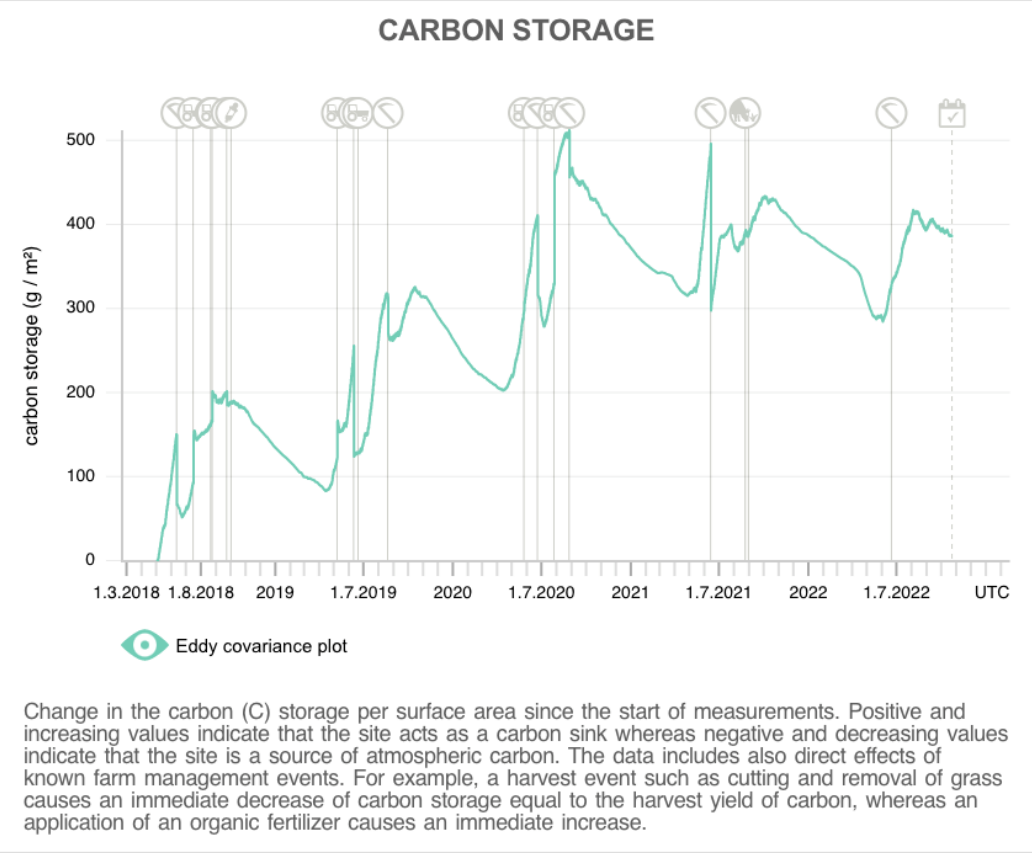
www.fieldobservatory.org -> Qvidja, Heimsch ym. 2021. Biogeosciences, Nevalainen ym. 2022. Geosci. Instrum. Method Data Syst.

Carbon accumulation in Qvidja grass field on mineral soil between 2018 and 2022



Change in the carbon (C) storage per surface area since the start of measurements. Positive and increasing values indicate that the site acts as a carbon sink whereas negative and decreasing values indicate that the site is a source of atmospheric carbon. The data includes also direct effects of known farm management events. For example, a harvest event such as cutting and removal of grass causes an immediate decrease of carbon storage equal to the harvest yield of carbon, whereas an application of an organic fertilizer causes an immediate increase.

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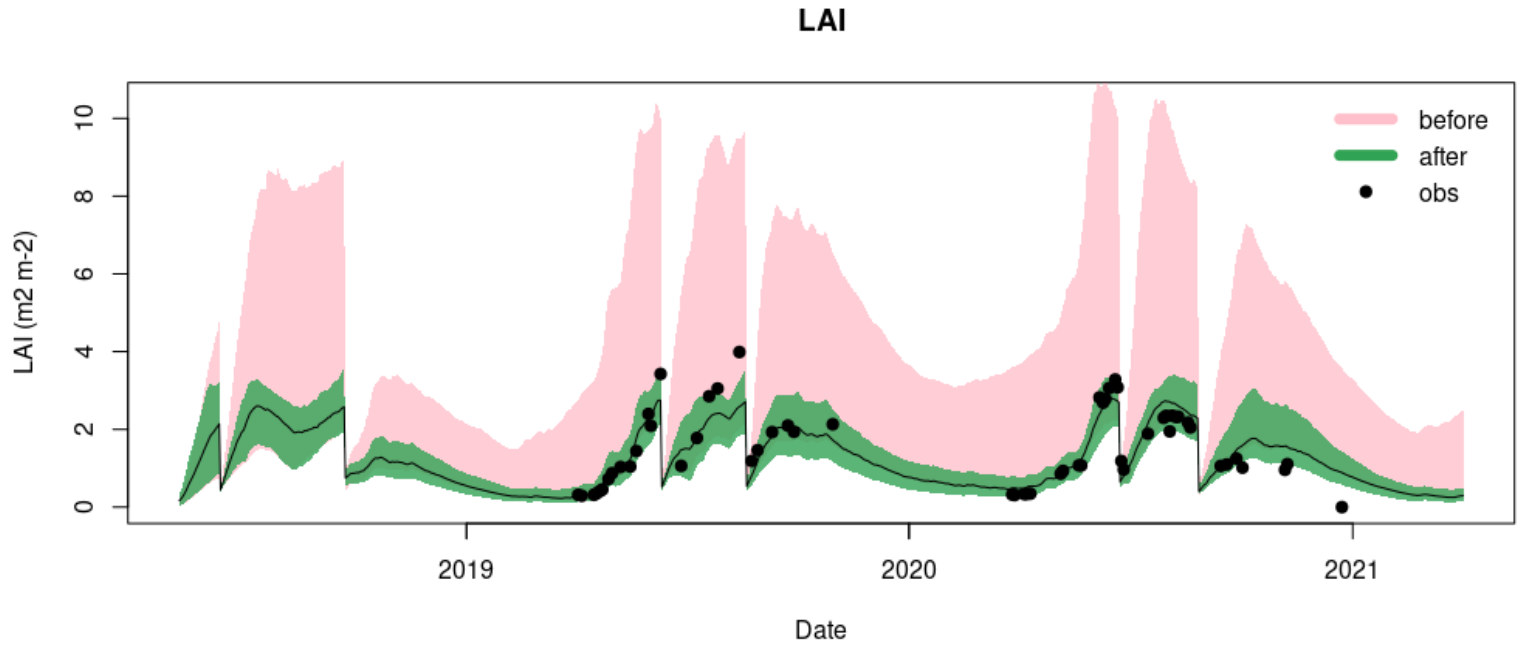
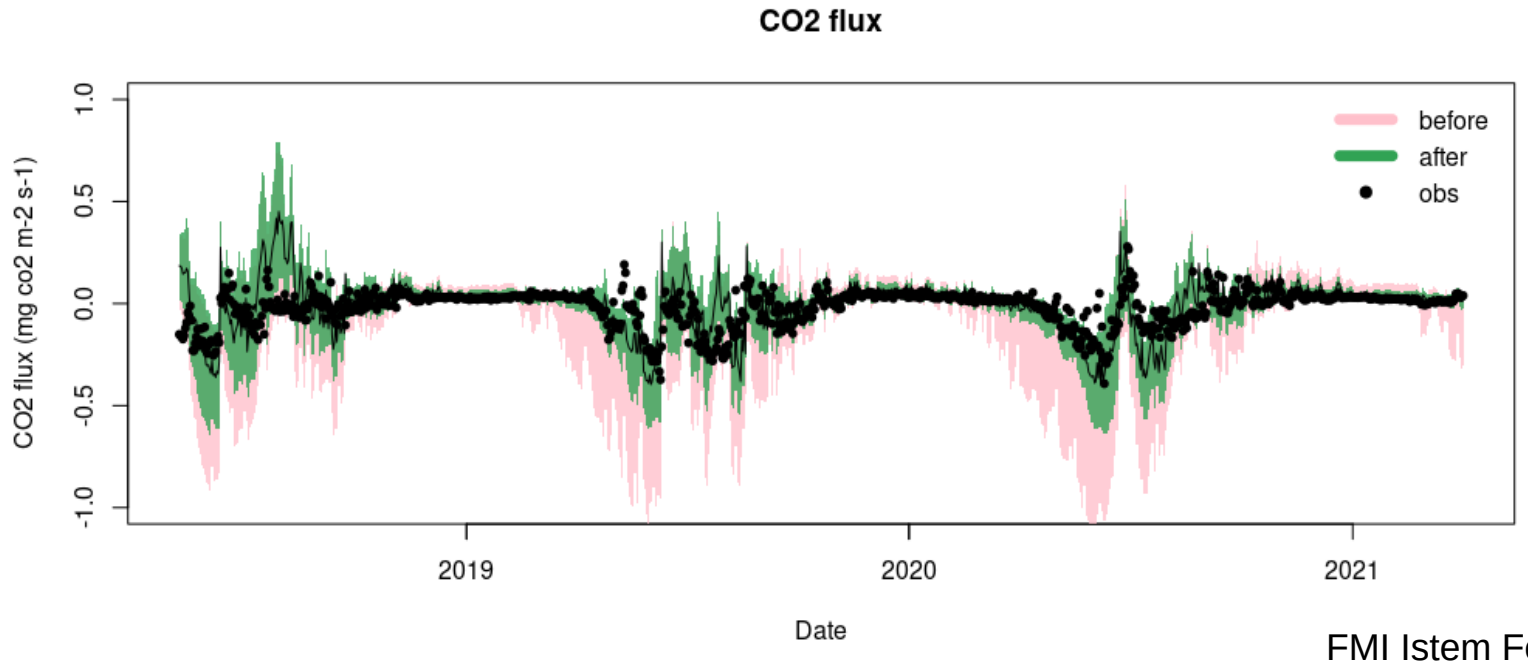
www.fieldobservatory.org -> Qvidja, Heimsch ym. 2021. Biogeosciences, Nevalainen ym. 2022. Geosci. Instrum. Method Data Syst.

Bayesian calibration with multiple data streams – BASGRA-N model Qvidja





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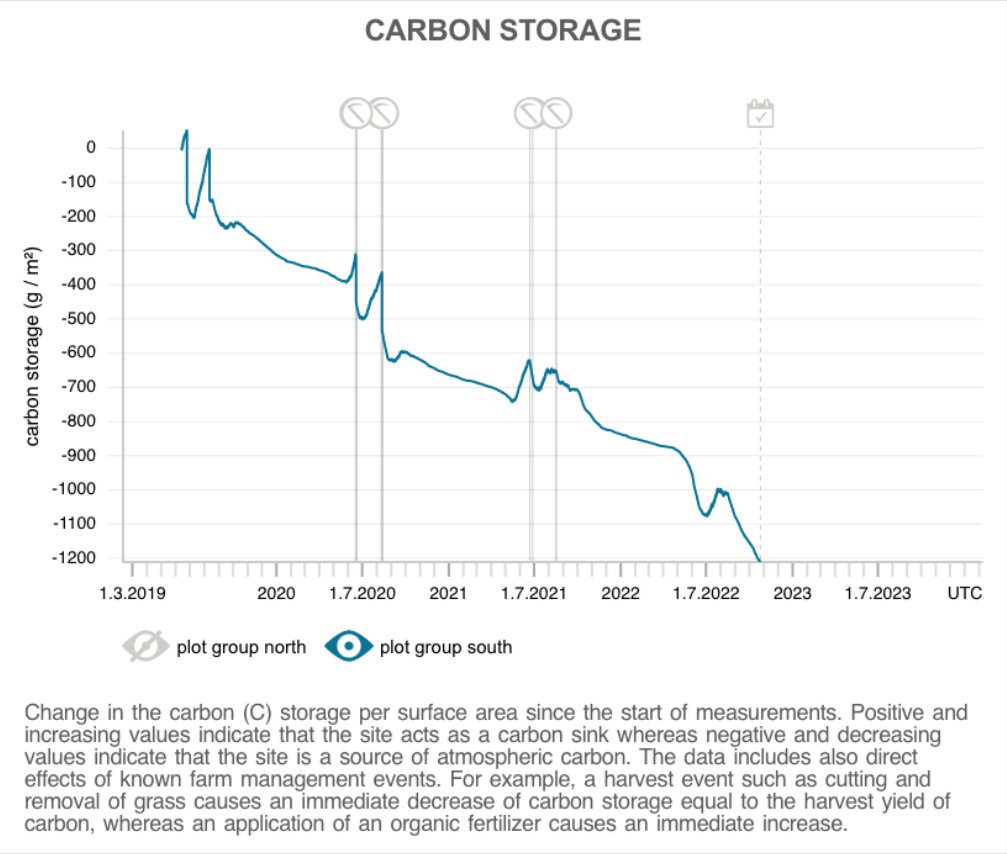
FMI Istem Fer

Carbon loss from Ruukki grass field on organic soil between 2019 and 2022



Change in the carbon (C) storage per surface area since the start of measurements. Positive and increasing values indicate that the site acts as a carbon sink whereas negative and decreasing values indicate that the site is a source of atmospheric carbon. The data includes also direct effects of known farm management events. For example, a harvest event such as cutting and removal of grass causes an immediate decrease of carbon storage equal to the harvest yield of carbon, whereas an application of an organic fertilizer causes an immediate increase.

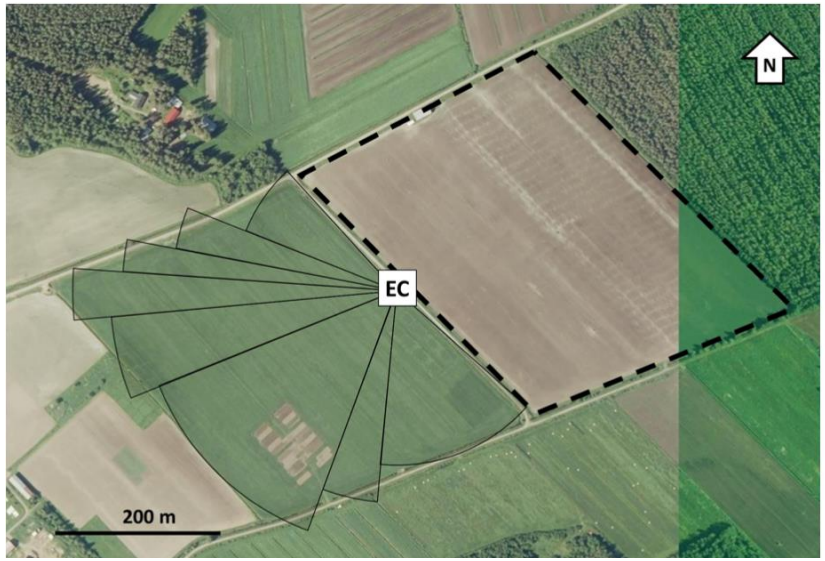


Photo: Gerin's presentation

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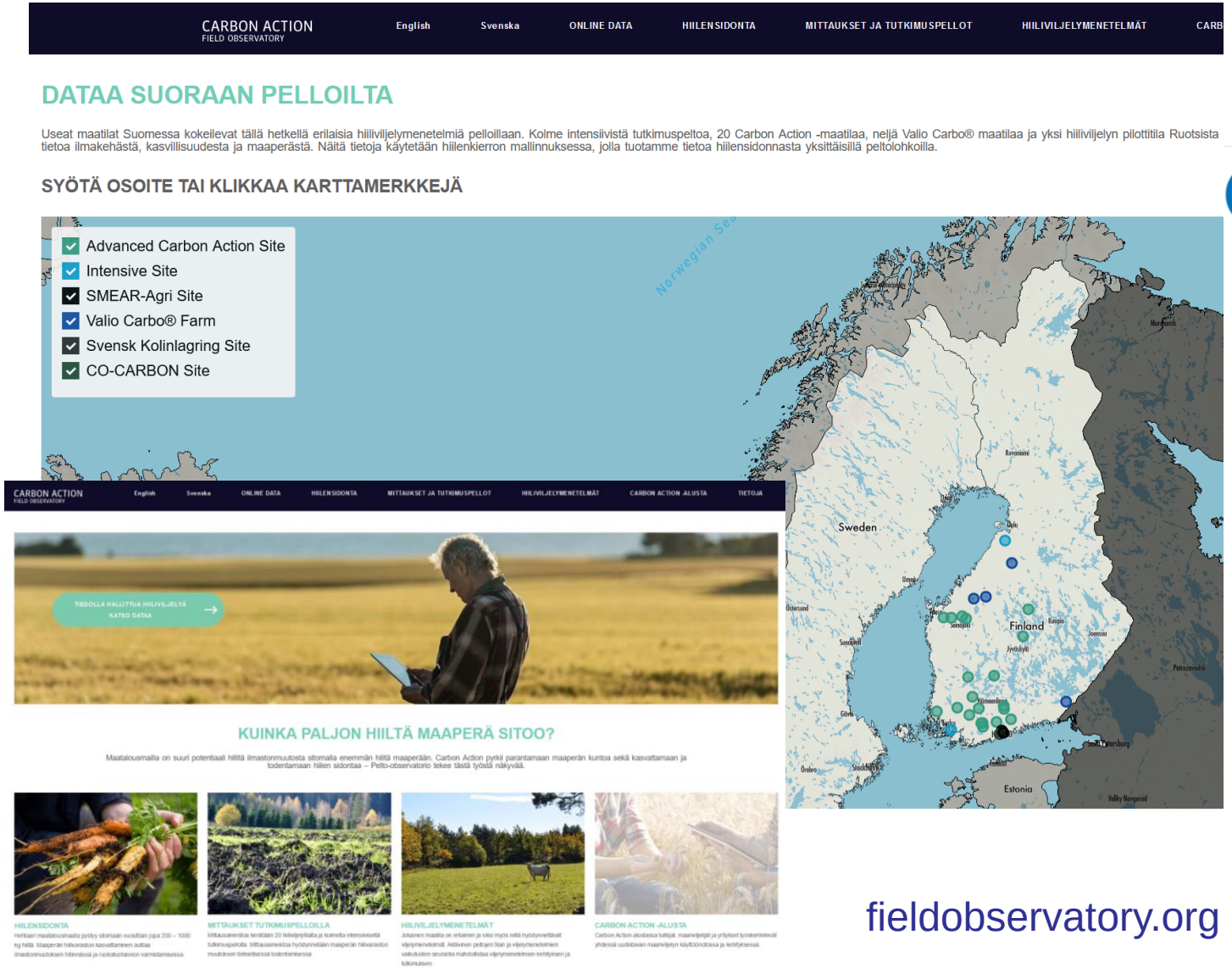
www.fieldobservatory.org -> Ruukki, Gerin ym. 2022. Manuscript in review http://ssrn.com/abstract=4177973, Nevalainen ym. 2022. Geosci. Instrum. Method Data Syst.



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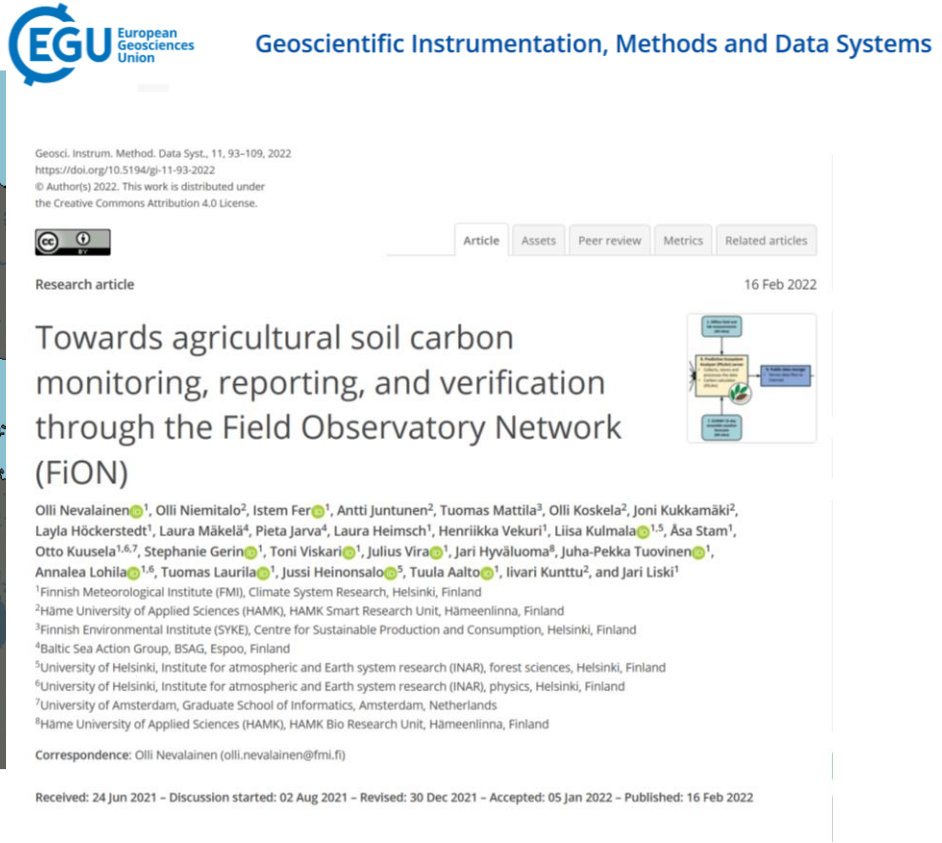

Next steps:

- **Measurements continue**

- **Yasso soil C development (N and POM/MOM)**

- **Further testing and validation of process-based models**
  - How various management options actually work?

  → Climate effects of Carbon Farming practices
  - Combining weather data, long-term forecasts?
  - New models besides old ones (e.g. Landscape_DNDC)

- **IT development**
  - Data streams and calculations of thousands of fields
  - APIs for new applications

→ More (digested) information available for stakeholders and for different purposes

1st Northern Europe "4 per 1000" Regional Meeting

6–8 JUNE, 2023 IN HELSINKI

MORE CARBON IN THE SOIL
FOR MULTIPLE BENEFITS

Catch the carbon
CLIMATE SOLUTIONS IN THE LAND USE SECTOR

CARBON ACTION

4 PER 1000
SOILS FOR FOOD SECURITY AND CLIMATE

https://www.bsag.fi/4p1000-2023/

Kiitos!