
HoliSoils
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Holistic management practices, modelling and monitoring for European forest soils

Name

Organisation

HoliSoils objectives

- Advance knowledge of **soil properties, processes, biodiversity, and activity of soil microbiota**
- Develop and improve **state-of-the-art soil models,** harmonise them into a **monitoring framework for estimation of C and GHG fluxes**
- Develop **standardised sampling and monitoring protocols** for GHG reporting, harmonise **legacy soil data** to facilitate **model upscaling** to the European scale
- Determine **effects of management on soil functionality, biodiversity, nutrient stocks** and develop **holistic CSF management**
- Determine effects of **natural disturbances on soil functioning and resilience,** identify **good management** practices for preventing soil degradation, and **map soil vulnerability**
- Study the **impacts, trade-offs, and synergies of CSF management scenarios** for soils and forests on the Europe-wide GHG balance and water budget, under future climate conditions and disturbance regimes
- Boost **collaboration between universities, research institutes, and intergovernmental bodies** such as the EU, UNFCCC, IPCC, and FAO, and facilitate the **transfer of developed approaches, knowledge, and tools globally** to operators within the forest sector via a **multi-actor approach**

HoliSoils partners

	Partner organisation	Type	Country
1	Natural Resources Institute Finland (Luke) Coordinator	Research Institute	Finland
2	Institute of Microbiology of the Czech Academy of Sciences (IMIC)	Research Institute	Czech Republic
3	French National Centre for Scientific Research (CNRS)	Research Institute	France
4	Johann Heinrich von Thünen Institute (TI)	Research Institute	Germany
5	Basque Centre for Climate Change (BC3)	Research Institute	Spain
6	Vrije University Amsterdam (VU)	University	Netherlands
7	European Forest Institute (EFI)	Research Institute	Int'national
8	Wageningen Research Foundation (WR)	University	Netherlands
9	International Soil Reference & Information Centre (ISRIC)	Research Institute	Netherlands
10	Stockholm University (SU)	University	Sweden

	Partner organisation	Type	Country
11	Transylvania University of Braşov (UTBV)	University	Romania
12	University of Barcelona (UB)	University	Spain
13	University of Aberdeen (UNIABDN)	University	United Kingdom
14	Vytautas Magnus University (VMU)	University	Lithuania
15	Aix-Marseille University (AMU)	University	France
16	Technical University of Munich (TUM)	University	Germany
17	Technical University of Zvolen (TUZVO)	University	Slovakia
18	Forest Science & Technology Centre of Catalonia (CTFC)	Research Institute	Spain
19	National Institute for Agricultural Research (INIA)	Research Institute	Uruguay
20	Forestry & Forest Products Research Institute (FFPRI)	Research Institute	Japan

HoliSoils work packages

Petr Baldrian (IMIC)

Bertrand Guenet (CNRS)

Nicole Wellbrock (Thunen)

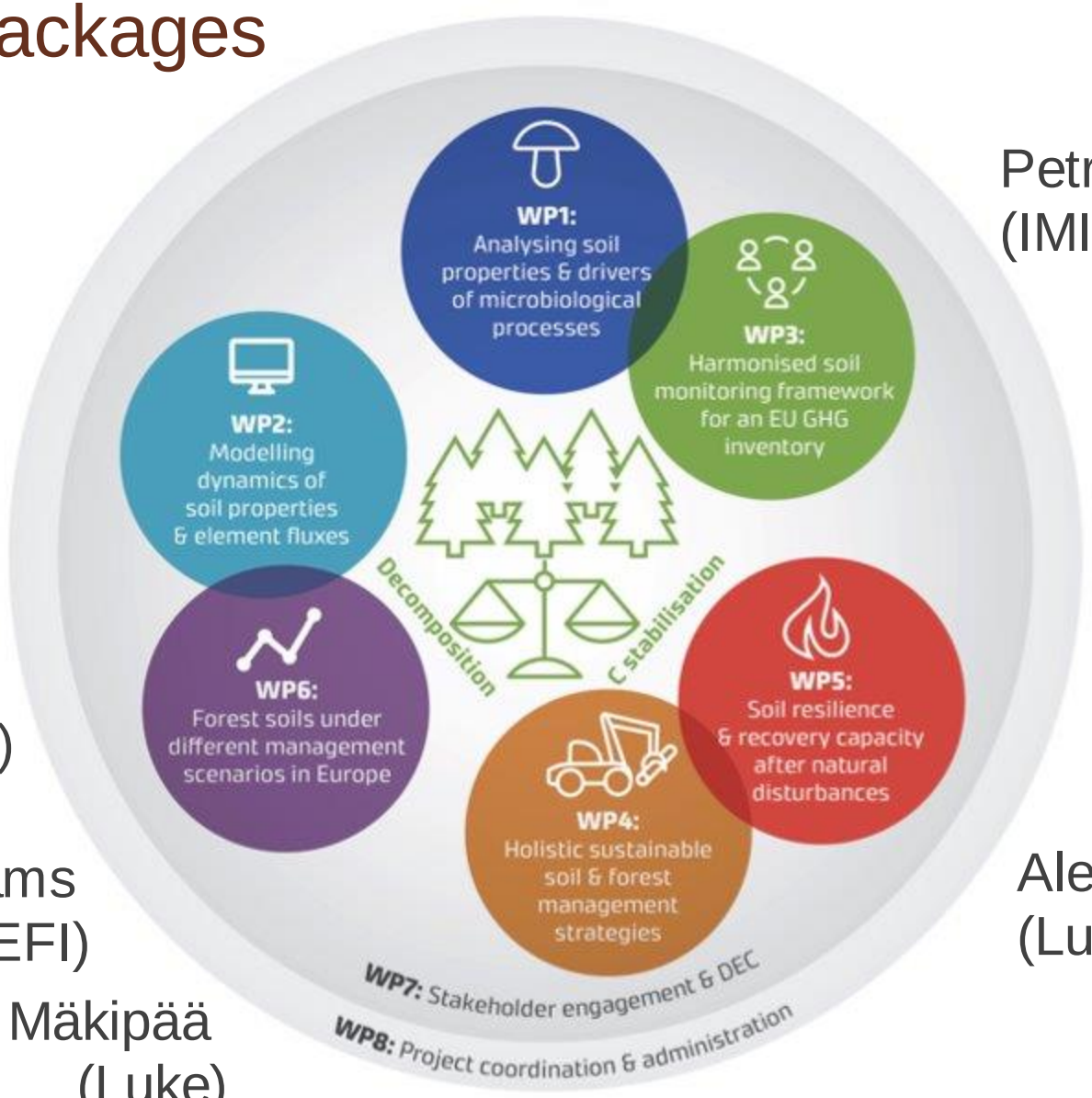
Sebastiaan Luyssaert (VU)

Jorge Curie Yuste (B3C)

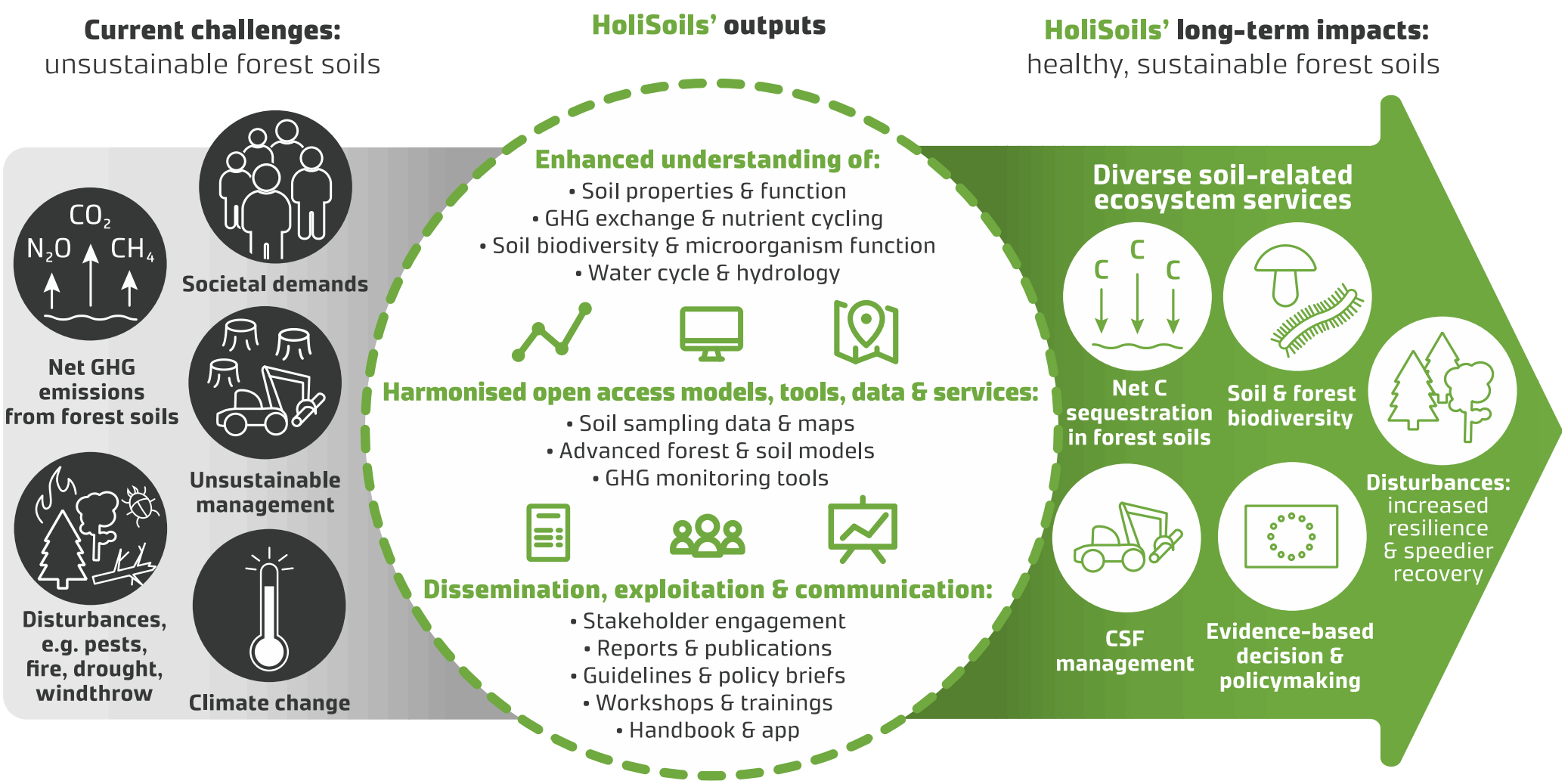
Sarah Adams (EFI)

Aleksi Lehtonen (Luke)

Raisa Mäkipää (Luke)



HoliSoils – challenges – outputs – impacts



WP1 - Analysing soil properties & drivers of microbiological processes (IMIC)

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Key outputs

- Identification of microbial processes that most affect GHG & nutrient fluxes & decomposition
- Map of microbial diversity & guild composition in European forests

WP1 Petr Baldrian initiative - GlobalFungi

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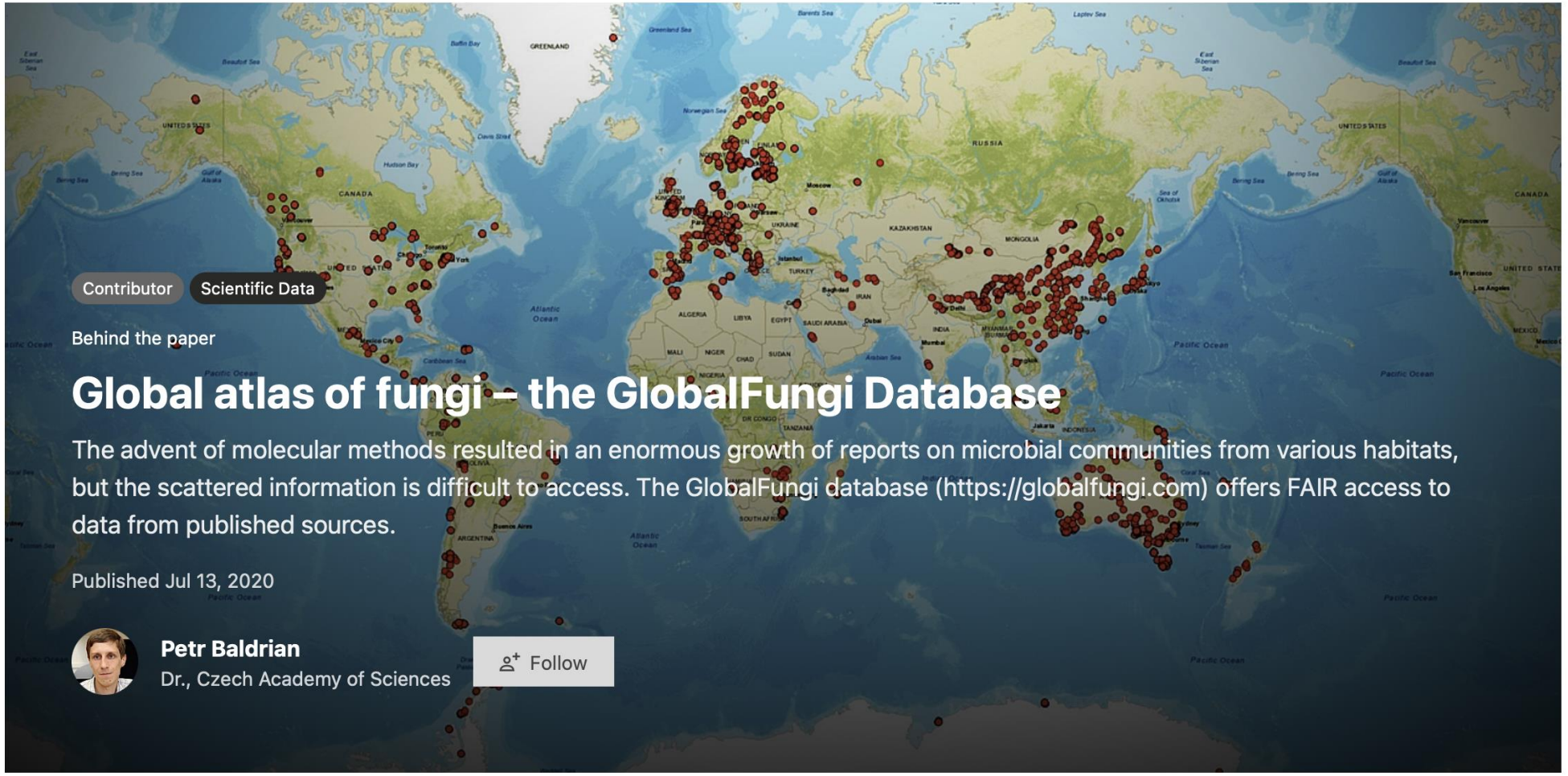
A community from nature portfolio

MENU MICROBIOLOGY Search Nature Portfolio Microbiology Community...



WP1 Petr Baldrian initiative - GlobalFungi

- Within WP1, we call for **volunteers who want to help with data mining** that will serve both the HoliSoils and the **GlobalFungi** databases. Within HoliSoils, the expected result is (1) a database of fungal communities in European forests with a map application containing additional metadata related to environmental factors and forest management and (2) a paper analyzing the drivers of fungal biodiversity in European forest soils

  - All contributors will become full co-authors of the HoliSoils papers. In addition, contributors of fungal data will become "group co-authors" of papers describing novel versions of the GlobalFungi database.

  - All contributors will be acknowledged online and will contribute to building a FAIR community resource that speeds up discovery in microbial ecology!

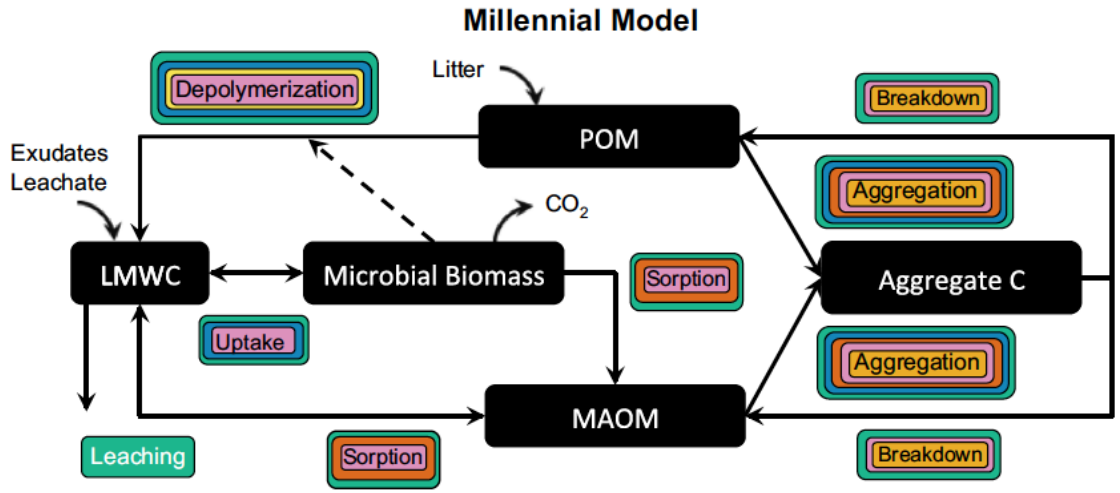
- https://microbiologycommunity.nature.com/posts/global-atlas-of-fungi-the-globalfungi-database

- If you have a potential data miner candidate in your team, please forward this information to them. You can, of course, participate also yourself. People considering their involvement should contact the GlobalFungi administrator Clémentine Lepinay (clementine.lepinay@biomed.cas.cz) who will explain details and help to start.

WP2 - Modelling dynamics of soil properties & element fluxes (CNRS)

Key outputs

- Model ensemble script + Online model launching interface
- Stakeholder-oriented tools for predicting future GHG balances from forest soils
- Report on model simulations
- Open access model for GHG-inventories
- Impact of soil biodiversity to decompositions (S. Manzoni, Stockholm)



WP2 soil model ensemble

- https://elisabruni.shinyapps.io/test4/
- To support GHG inventories and scenario work

Models description

A part from SG, all models represent SOC with a conventional multi-compartmental structure that can be summarized with the following equation :

$$\frac{d\mathbf{C}}{dt} = \mathbf{I}(t) - \mathbf{A} \times \mathbf{K} \times \xi(t) \times \mathbf{C}(t)$$

where: $\mathbf{C}(t)$ is a vector describing the masses of SOC of the n compartments as a function of time t;

$\mathbf{I}(t)$ is the vector of the C input to the soil;

$\mathbf{A}$ is a matrix describing the mass flow within each pool;

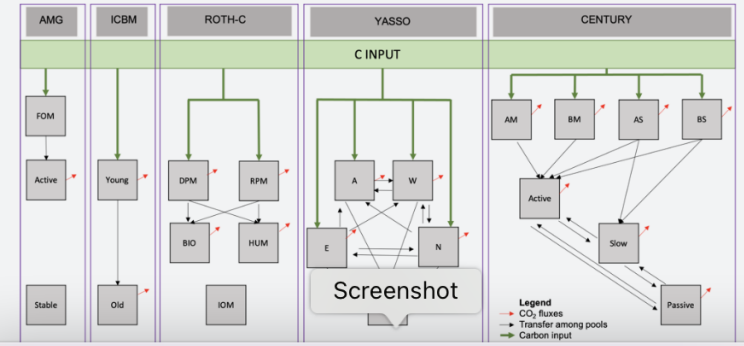
$\mathbf{K}$ is a diagonal matrix containing the decomposition coefficients of the compartments;

and $\xi(t)$ is the scalar effect of the pedo-climatic conditions on the decomposition of C.

The models that are included in the first version of the multi-model ensemble are:

- AMG (Andriulo et al., 1999)
- Century (Parton et al., 1988)
- ICBM (Andrén and Kätterer, 1997)
- Roth-C (Coleman and Jenkinson, 1996)
- Yasso07 (Tuomi et al., 2009)
- SG (Hashimoto et al., 2011)

Schematization of the SOC models



Screenshot

WP3 - Harmonised soil monitoring framework for an EU GHG inventory (Thunen)

Key outputs

- Report on existing GHG monitoring methods
- Report on guidelines for combining GHG monitoring data
- Soil sampling design, monitoring measurement protocols
- Open access harmonised maps + web server (ISRIC)

WP4 - Holistic sustainable soil & forest management strategies (Luke)

Key outputs

- Review of existing CSF management, their potential impacts on soils & critical knowledge gaps
- Analysis of feasibility & trade-offs between conventional forest & CSF management & willingness to adopt CSF management
- Good practise guidance for CSF management

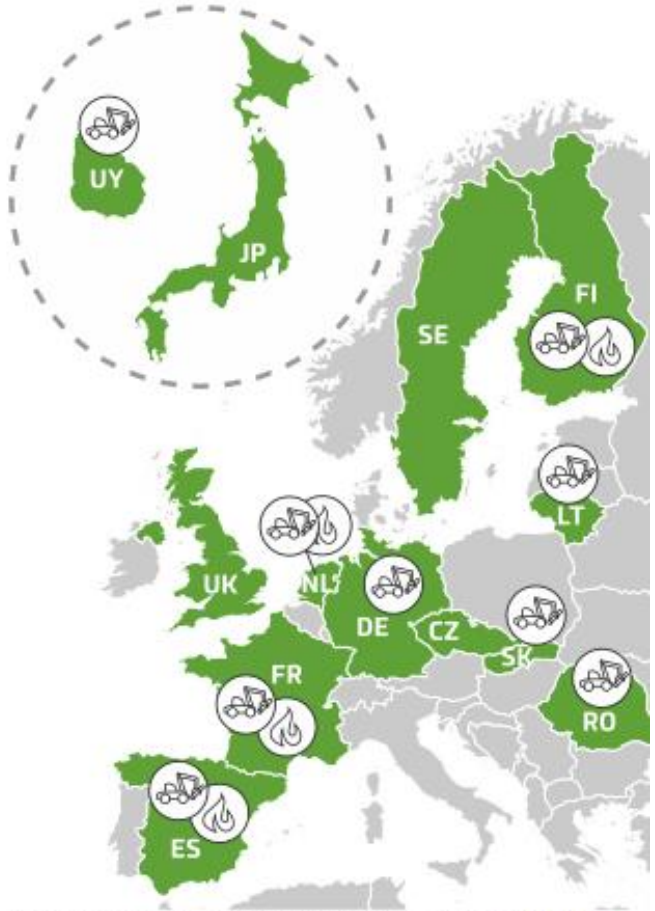


Figure 1.3.b. Geographical distribution of *HoliSoils'* consortium participants & test sites.

WP4 – test sites

See: https://holisoils.eu/test-sites/

For more details

Germany – Thunen (Großes Eisenstraßenmoor)

Established
2022

Organization
Thünen Institute of Forest Ecosystems (Thünen)

Contact
Cornelius Oertel
Nicole Wellbrock

Location
50°26' (N), 12°41' (E)
Ore Mountains (Germany)

Soil type
Fibric Histosol and Sapric Drainic Histosol

Dominant species
Picea abies

Ground vegetation
Sphagnum spec., Sphagnum girgensohnii, Dicranum spec., Lophocolea spec., Polychtrium formosum, Plagiothecium spec., Vaccinium myrtillus, Vaccinium vitis-idaea, Melampyrum pratense

Aim of the study

Netherlands – Ugchelen & Kroondomein

Established
2019

Organization
Wageningen University & Research

Contact
Frank Sterck
Sara Filipek
Marleen Vos
Steven de Goede
Ciska Veen

Location
BE: 52.182931, 5.877977;
DG: 52.178796, 5.875220;
SP: 52.205046, 5.865131

Soil type
Poor sandy with low ground water levels

Dominant species
European beech (Fagus sylvatica; BE), Douglas fir (Pseudotsuga menziesii; DG), Scots pine (Pinus sylvestris; SP)

Ground vegetation
Vaccinium spp., Calamagrostis spp.

WP4 – test site Ränskälänkorpi – drained peatland

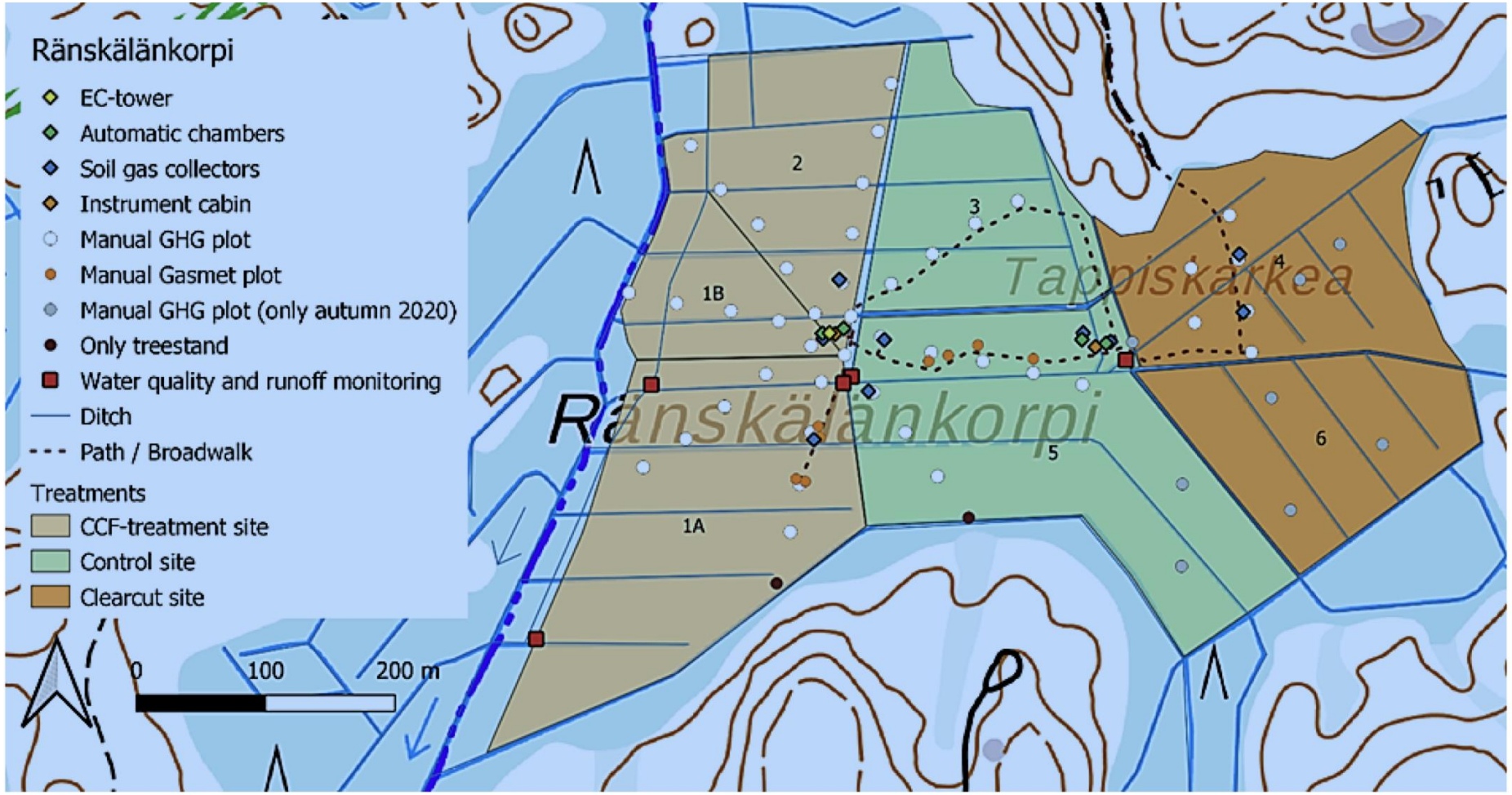


Figure 2. Experimental setup of the Ränskälänkorpi site. Permanent sample plots for tree stand measurements and coverage of understorey vegetation (n=45) and for GHG measurements (n=43, white circles) were established in 2019.

Screenshot

WP5 - Soil resilience & recovery capacity after natural disturbances (B3C)

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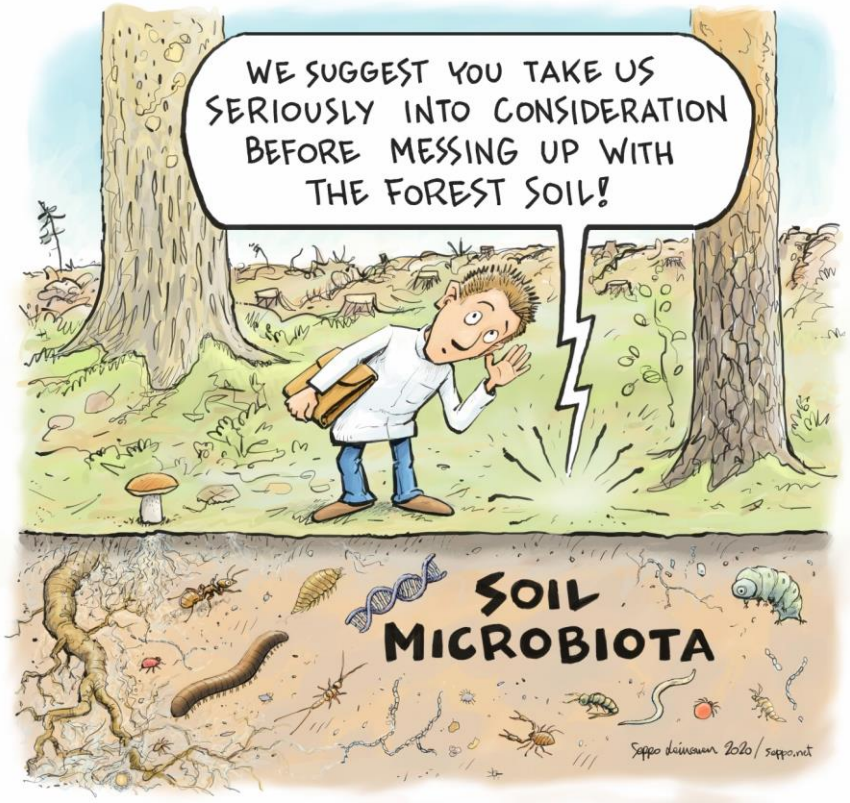
Key outputs

- Knowledge of soil functional resilience and tipping points on key soil functions integrated into soil models
- European map of soil vulnerability
- Guidelines for best post disturbance practise



WP6 - Forest soils under different management scenarios in Europe

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Key outputs

- Atlas of initial conditions & model evaluation
- Atlas of optimal forest management strategies
- Scenarios for European forest according to different management options + European atlas on optimal climate smart management choices

WP7 - Stakeholder engagement, dissemination, exploitation & communication (EFI)

Key channels / outputs

- HoliSoils website www.holisoils.eu
- Twitter account @holisoils
- Newsletter and synthesis reports
- Training programme for LULUCF experts, forest owners & managers, forest extension services
- Policy brief
- Final conference

Impact of the forest management to soils

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A)

IMPACT OF FOREST MANAGEMENTS ON SOIL C AND CLIMATE CHANGE

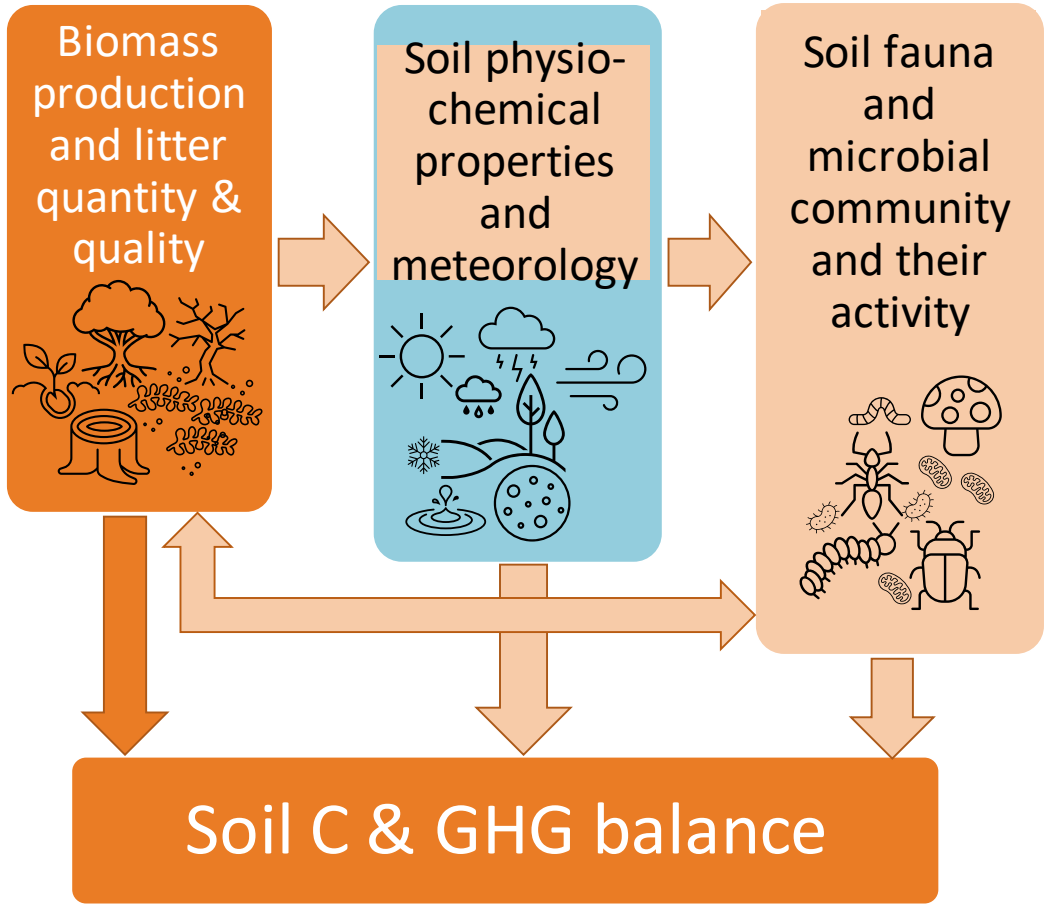
Soil C sink or reduction of C loss

Soil C loss

Climate change mitigation	Climate warming
Species selection according to site	Intensive thinning
Uneven age and continuous cover	Clear cut and residues (stumps) harvesting
Nitrogen and wood ash addition	Preparation on organic soils
Biodiversity promotion	Drainage on organic soils
Hydrological restoration on peatland forests	
Prevention of intensive fires	

B)

KEY DRIVERS FOR MODELLING FOREST MANAGEMENT IMPACT ON SOIL



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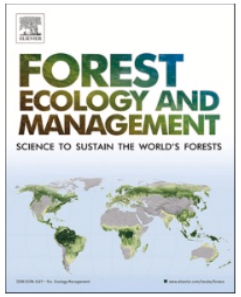

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How does management affect soil C sequestration and greenhouse gas fluxes in boreal and temperate forests? – A review

Raisa Mäkipää [a,*], Rose Abramoff [b], Bartosz Adamczyk [a], Virginie Baldy [c], Charlotte Biryol [c], Michal Bosela [d], Pere Casals [e], Jorge Curiel Yuste [f,g], Marta Dondini [h], Sara Filipek [i], Jordi Garcia-Pausas [e], Raphael Gros [c], Erika Gömöryová [d], Shoji Hashimoto [j], Mariana Hassegawa [k], Peter Immonen [a], Raija Laiho [a], Honghong Li [a], Qian Li [a], Sebastiaan Luyssaert [l], Claire Menival [c], Taiki Mori [j], Kim Naudts [m], Mathieu Santonja [c], Aino Smolander [a], Jumpei Toriyama [j], Boris Tupek [a], Xavi Ubeda [e], Pieter Johannes Verkerk [k], Aleksi Lehtonen [a]

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[b] *Environmental Sciences Division, Oak Ridge National Laboratory, 1 Bethel Valley Road, Oak Ridge, TN 37830, USA*
[c] *Aix Marseille Univ, Avignon Univ, CNRS, IRD, IMBE, Marseille, France*
[d] *Faculty of Forestry, Technical University in Zvolen, T.G. Masaryka 24, 96001 Zvolen, Slovakia*
[e] *Forest Science and Technology Centre of Catalonia (CTFC), 25280 Solsona, Spain*
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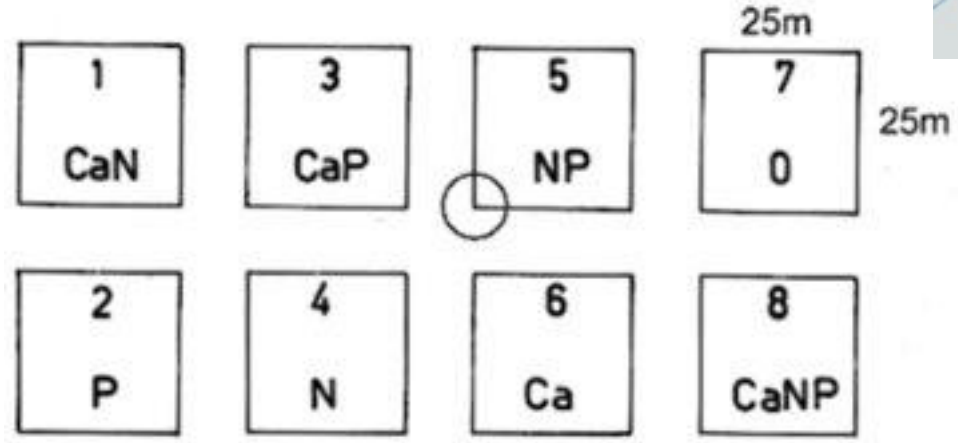
[g] *Ikerbasque, Basque Foundation for Science, Bilbao, Bizkaia, Spain*
[h] *School of Biological Sciences, University of Aberdeen. 23 St Machar Drive, Aberdeen AB24 3UU, Scotland, UK*
[i] *Wageningen University and Research, Wageningen Environmental Research (WENR), Droevendaalsesteeg, 3, 6708PB Wageningen, The Netherlands*

Example: Karstula fertilisation plot

- Karstula in central Finland
- pine stands, mineral soil
- Fertilization experiment (1959→):
- 3 blocks (75, 76, 77), 8 plots inside each
- Ca, N & P



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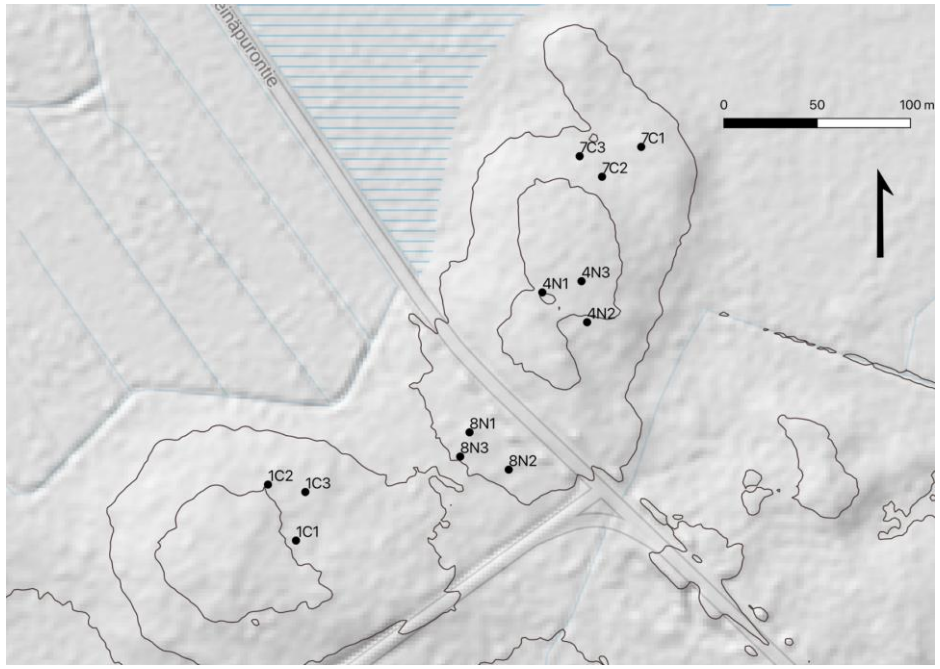
- **2021**:
- 75, 76
- **N & control** (unfertilized)
- 3 subplots in each plot



Preliminary measurements – soil respiration

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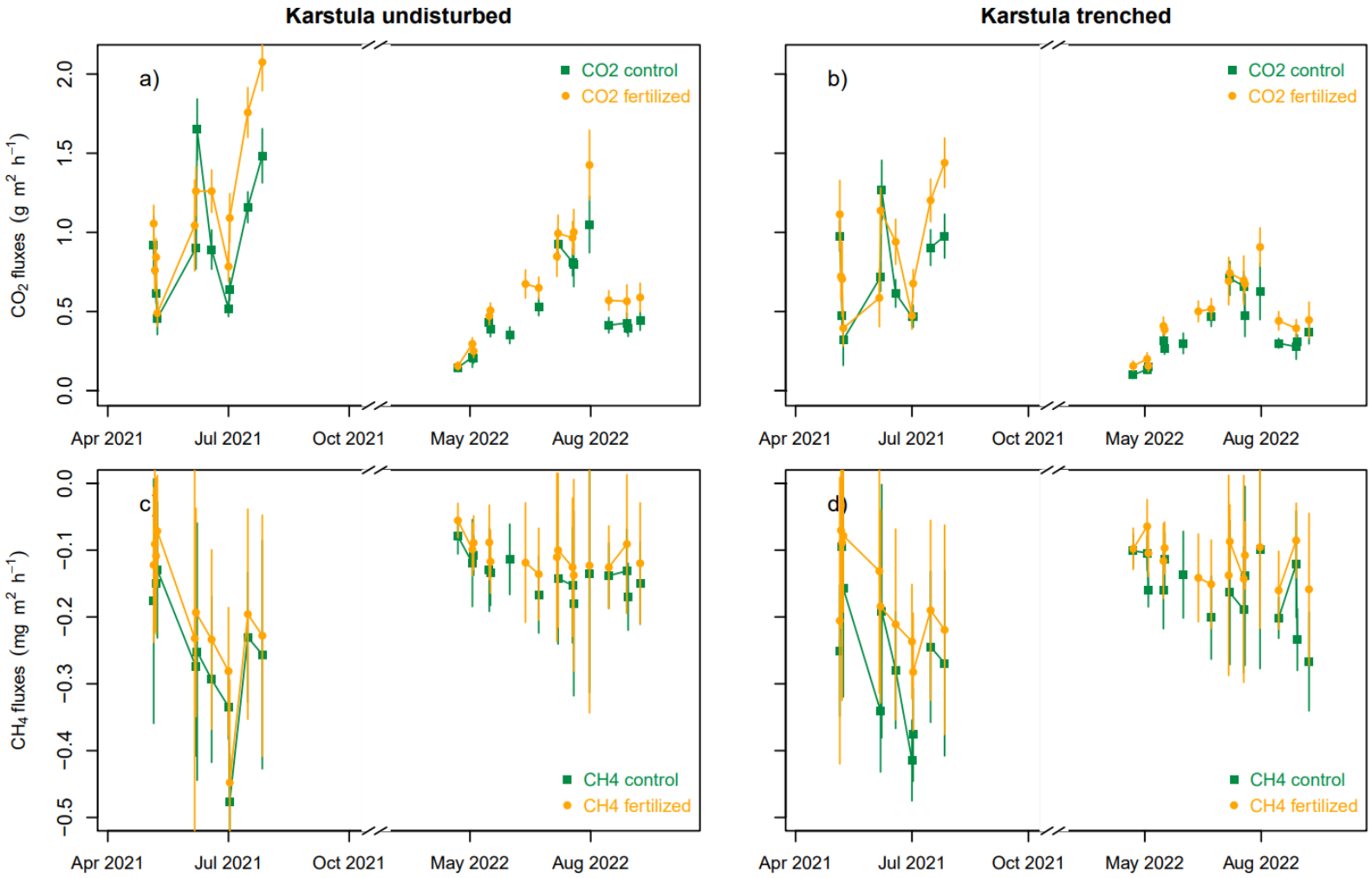
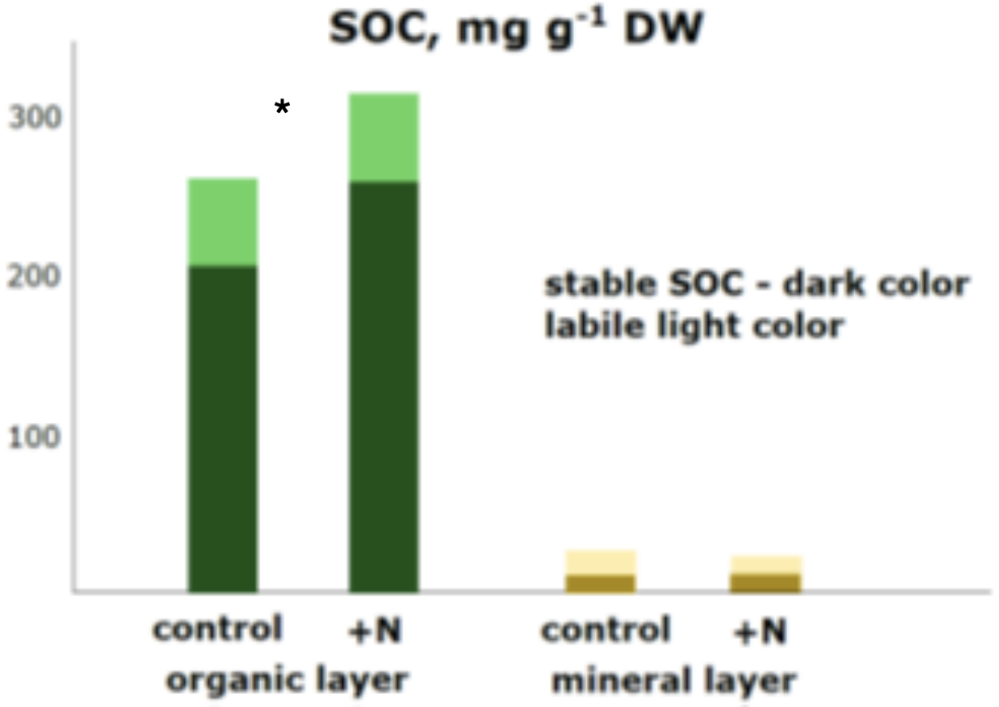
Karstula test site:
Nitrogen fertilisation vs. conrol

Research question: what is the impact of nitrogen fertilisation to soil C stocks and soil GHG exchange.

Is nitrogen fertilisation in boreal forests climate smart practice?

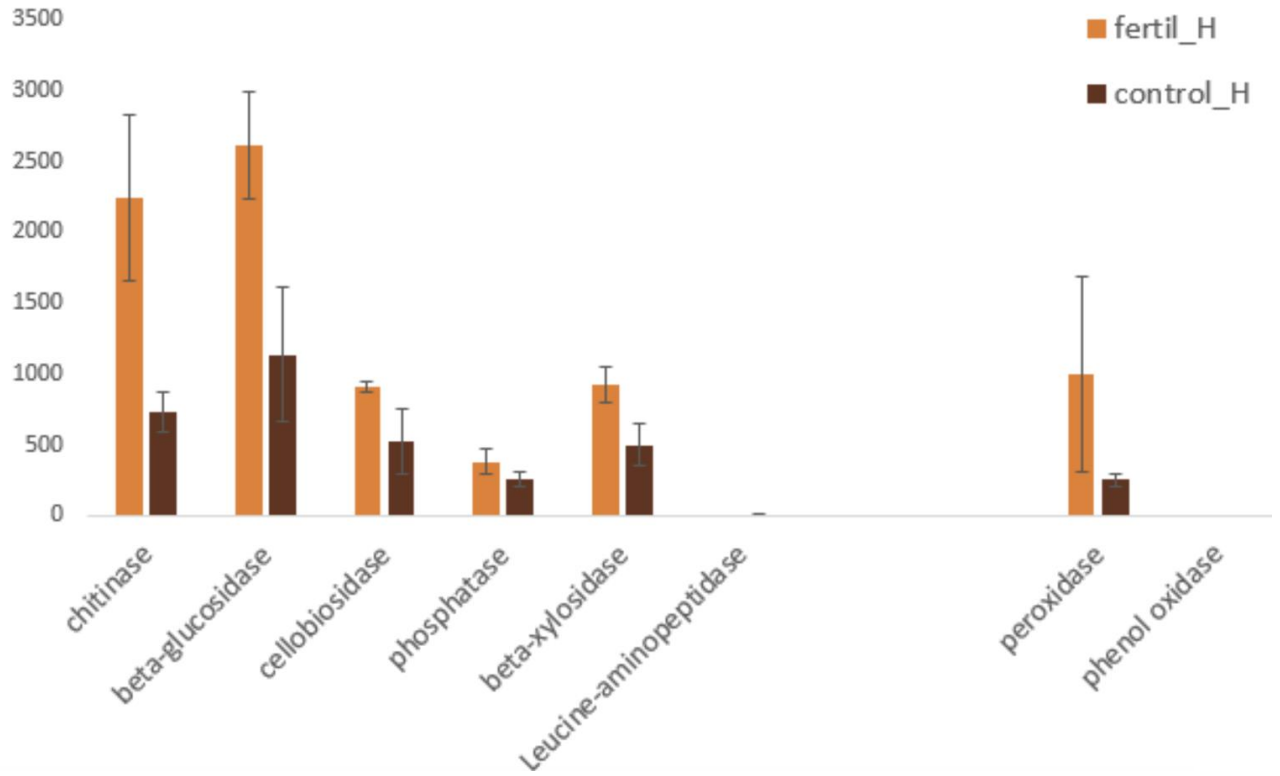


C content: chemically labile and stable SOC (acid hydrolysis)



+N, more SOC & more stable SOC, no difference in labile SOC / mineral layer

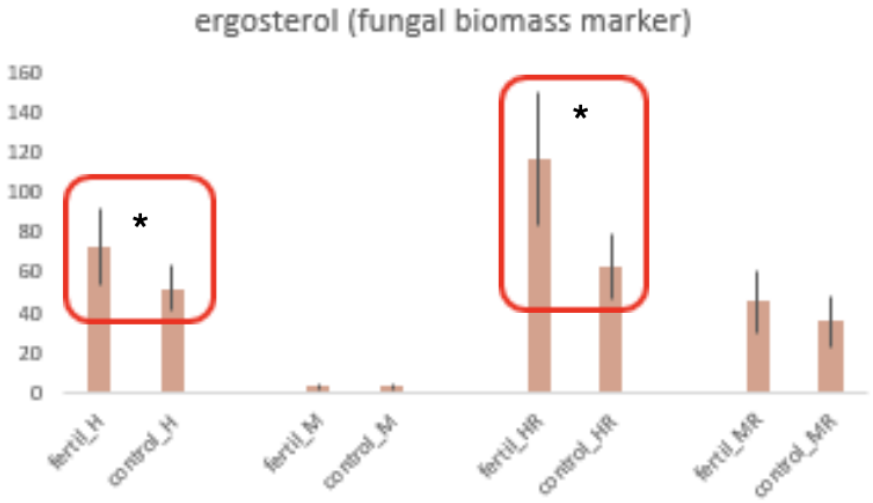
Enzymes, organic layer

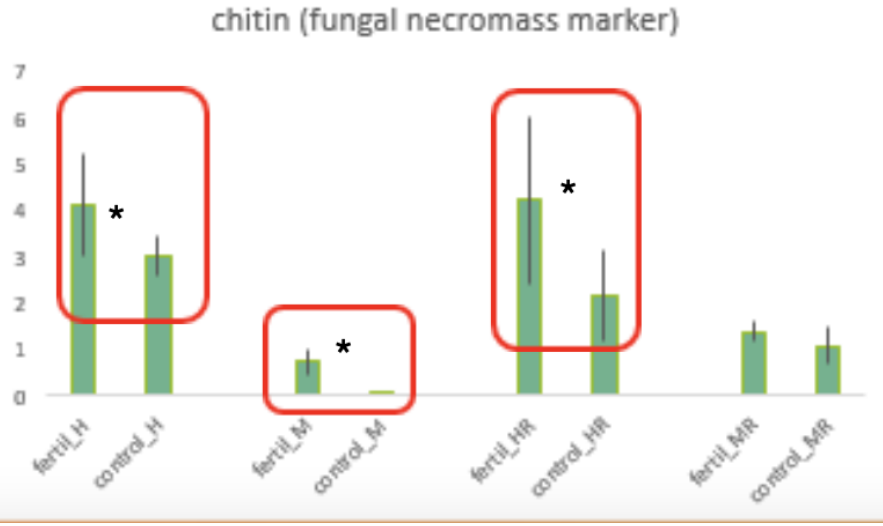


* for acid phosphatase nmol g DW min-1
** for peroxidase pmol g DW h-1

Higher enzyme activities in organic layer +N

Microbial biomass and necromass





On fertilized plots in soil (H) and in roots:
-more fungal biomass and necromass

More fungal necromass also in **mineral layer** under N fertilization

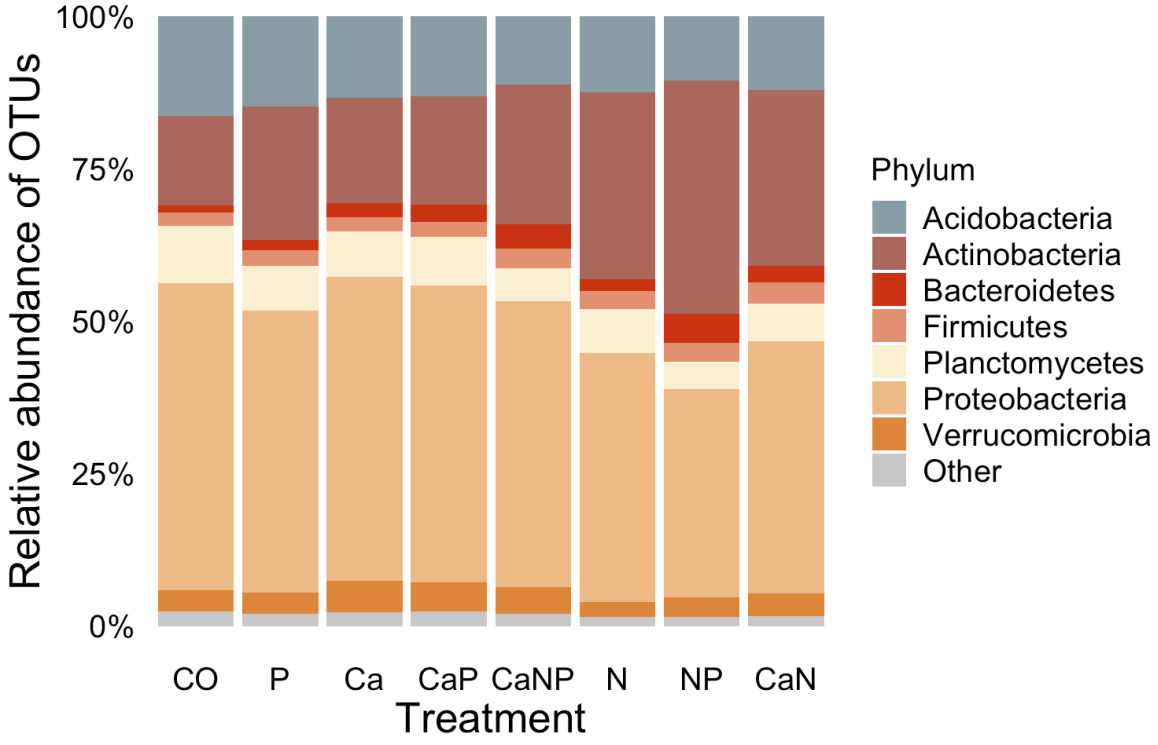
N fertilization leads to higher amount of fungi (biomass and necromass)

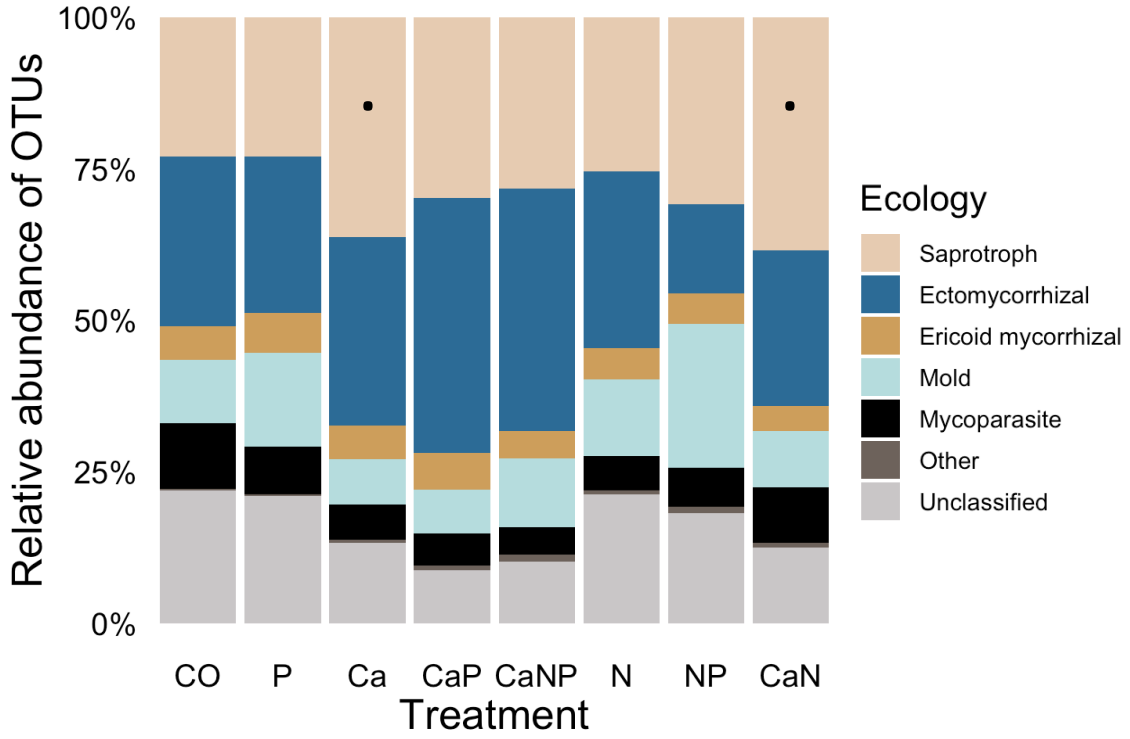
CONCLUSIONS

N fertilization affects especially humus (organic layer) of the soil:
Higher content under N fertilization:
stable SOC, enzymatic activities, ammonium, fungal biomass and necromass.

Mechanism of increased SOC under N fertilization:
increased microbial residues.

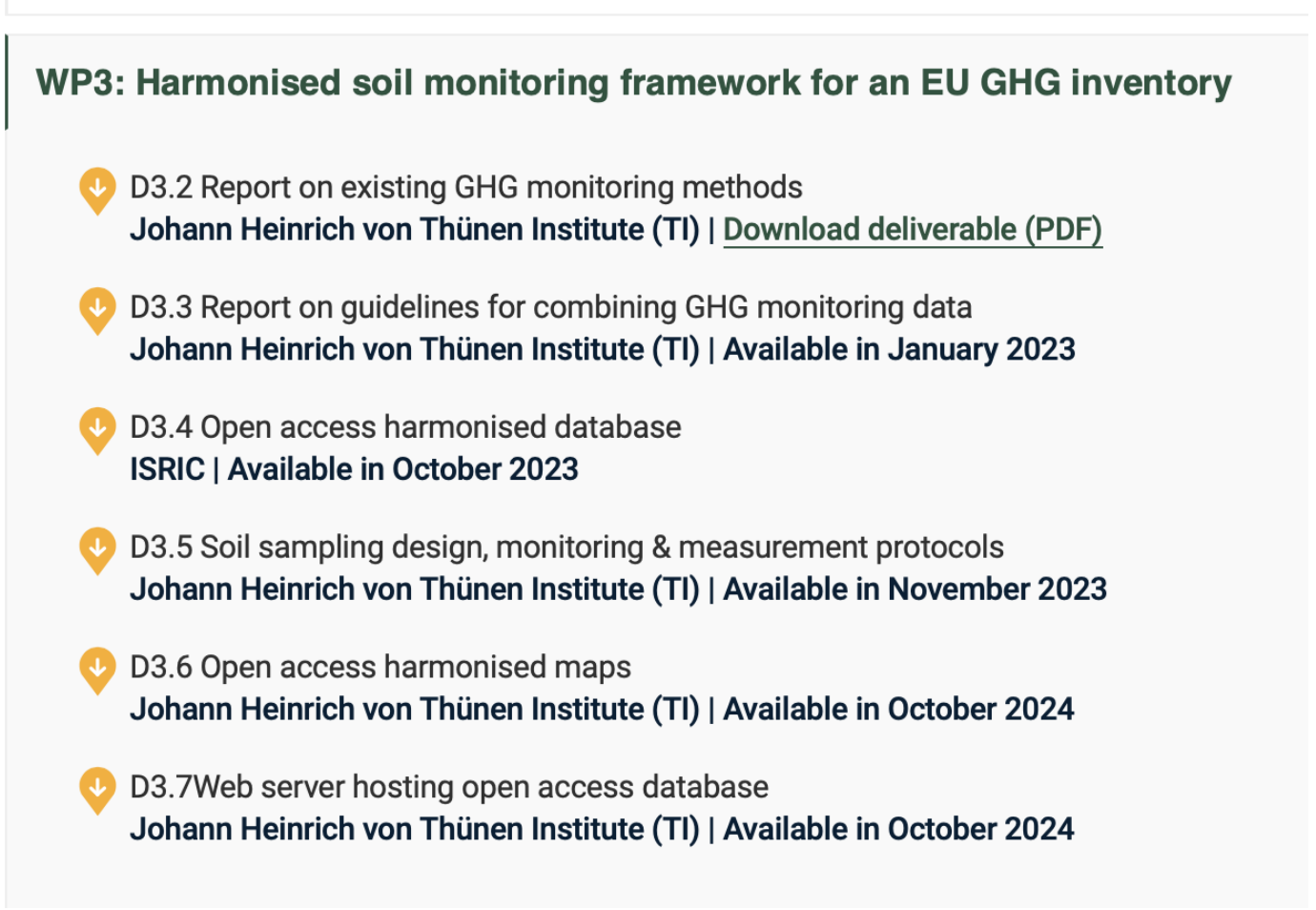
Preliminary results from P. Baldrians group - Influence of the fertilisation on the prokaryotic and fungal communities





https://holisoils.eu/deliverables/

- Products of the project are available from here



WP3: Harmonised soil monitoring framework for an EU GHG inventory

D3.2 Report on existing GHG monitoring methods
Johann Heinrich von Thünen Institute (TI) | Download deliverable (PDF)

D3.3 Report on guidelines for combining GHG monitoring data
Johann Heinrich von Thünen Institute (TI) | Available in January 2023

D3.4 Open access harmonised database
ISRIC | Available in October 2023

D3.5 Soil sampling design, monitoring & measurement protocols
Johann Heinrich von Thünen Institute (TI) | Available in November 2023

D3.6 Open access harmonised maps
Johann Heinrich von Thünen Institute (TI) | Available in October 2024

D3.7Web server hosting open access database
Johann Heinrich von Thünen Institute (TI) | Available in October 2024

Project managment contacts

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Thank you!