Establishment of multi actor engagement pilots – D6.1

Action Number: 101086179

Action Acronym: AI4SoilHealth
Action title: Accelerating collection and use of soil health information using AI technology to support the Soil Deal for Europe and the EU Soil Observatory

Version 1

28 June 2023
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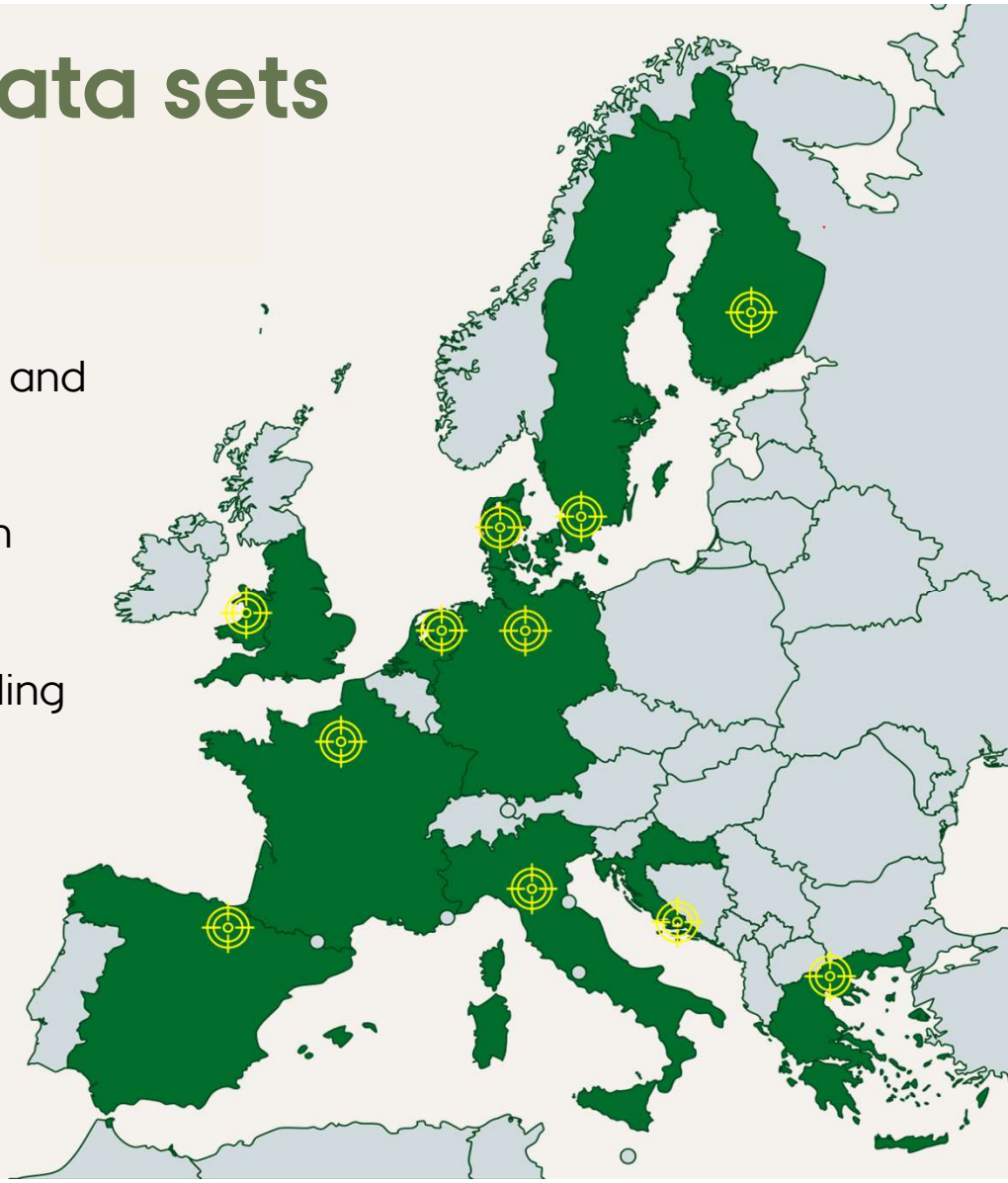
Reviewed by: Trine Nørgaard, Aarhus University

Pilot sites and regional data sets

- 11 pedo-climatic regions
- Multi-actor stakeholders and engagement; Universities, researchers, SMEs / NGOs, farmers and growers, land owners, foresters etc
- Existing and new data sets to test AI4SoilHealth predictions, varied soil health themes
- Access to pre-existing national datasets, including LUCAS sampling sites
- Existing networks; soil managers, soil user communities for co-design AI4SoilHealth tools
- Data collection resources and access to laboratories for analysis



Goals for WP6 pilot sites

- **Methodologies, protocols and frameworks**
  Framework for testing soil health activities at pilots

- **Data collection, new and existing**
  Data collection methodology and strategy scalable and capable of providing feedback (into LUCAS)

- **Testing and monitoring**
  Experimental testing / monitoring design for pilots
  Maximise utility of data collected to inform AI4SoilHealth development and pan European monitoring LUCAS

- **Collaboration and co-creation**
  Concepts developed compatible with living labs
  Rolled out to all EU living labs in complementary projects e.g. BENCHMARKS

Goals for WP6 pilot sites

- **Create a vibrant community**

  Assess and evaluate through collaborative multi-actor, co-design processes

- **Demonstrate activity**

  Evidence the link between practice, action and outcomes for soil health across a range of soil types, land management practices and pedoclimatic regions

- **Conduct knowledge exchange activities**

  Interviews, polls, workshops, to draw on experience of real soil managers, to feed into AI4SoilHealth co-creation of tools

Potential use cases of pilot outcomes (farmers)

(All suggestions from AUTh)

1. Soil Health Assessment:

- Provide valuable information about various soil properties such as organic matter content, nutrient levels, soil texture, pH, and moisture content.
- Identify areas with nutrient deficiencies, soil degradation, or other soil health issues.

2. Precision Agriculture:

- Develop detailed soil maps of the pilot site, showing spatial variations in soil properties
- Utilized for precision agriculture practices, enabling targeted soil management interventions such as variable-rate fertilizer application, site-specific irrigation, or soil amendments.
- Optimize resource allocation based on soil variability improve crop productivity and reduce input costs.

3. Decision Support System:

- The outcomes of soil spectroscopy analysis can serve as a foundation for developing a decision support system for soil management.
- By integrating soil spectral data with other relevant information such as crop type, historical yield data, and weather patterns, you can build models or algorithms that provide recommendations for optimal soil management practices.
- Informed decisions about soil nutrient management, crop rotation, and conservation practices.

4. Evaluation of the impact

- **…**of land degradation on soil health, farmland productivity and soil carbon sequestration potential in supporting carbon farming activities.

5. Long-Term Monitoring:

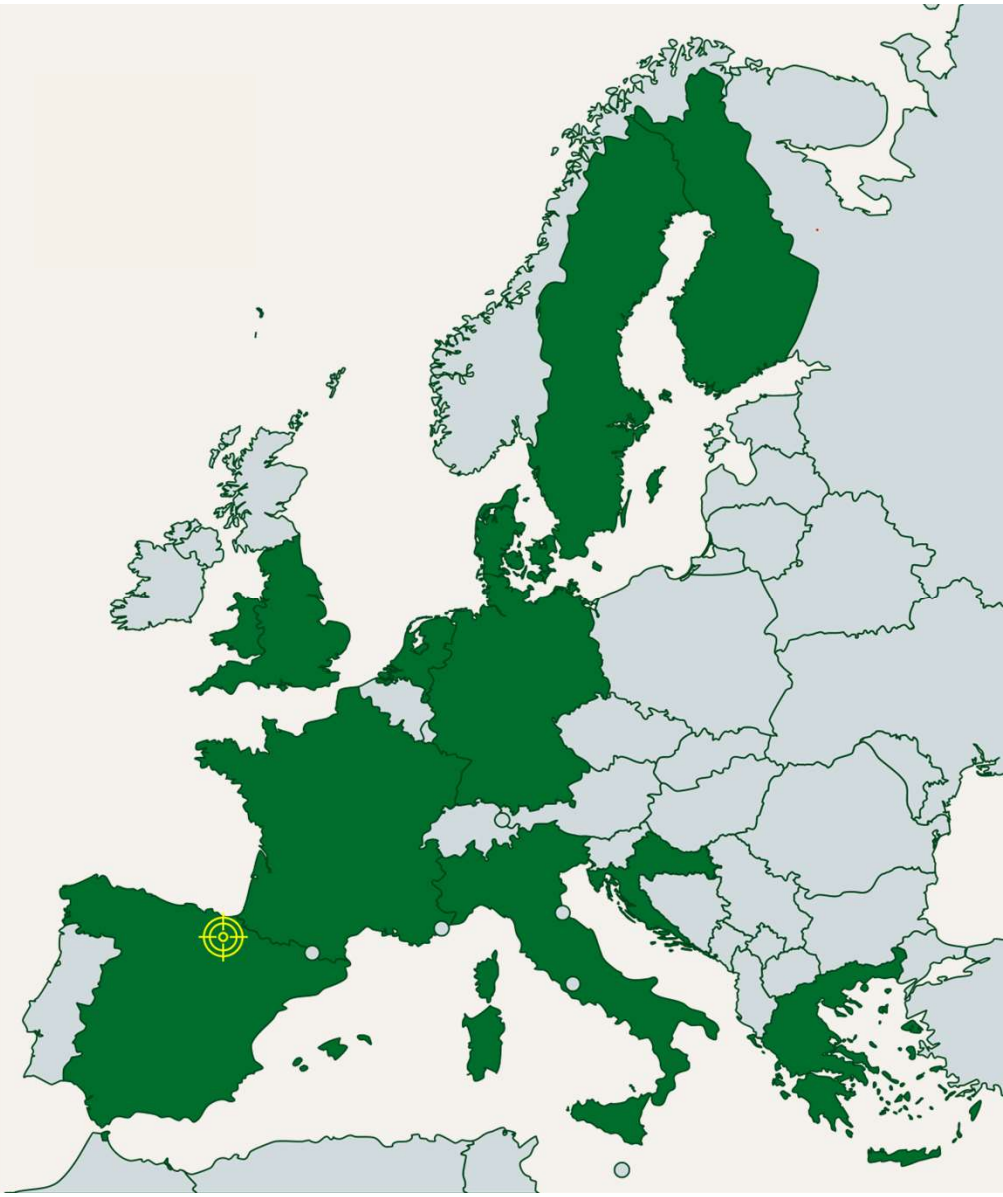
- Regularly collecting spectral data over time à track changes in soil properties and assess the effectiveness of soil management practices or interventions.
- Enable the identification of trends, patterns, and potential issues related to soil health, facilitating adaptive management strategies.

Pilot site - Spain

NEIKER
MEMBER OF BASQUE RESEARCH & TECHNOLOGY ALLIANCE

SOIL MICROBIAL ECOLOGY GROUP

Location	Spain, Araba and Bizkaia provinces
Pedo-climatic region	Atlantic central, Lusitanian, Mediterranean mountains
Soil types	tbc
Management practices	Livestock farmers, regenerative rotational grazing
Actors	Researchers, farmers
Type	Farm cluster, network of farm sites, partnerships
Data / testing	Grass production, topsoil carbon storage, DNA sequencing, enzyme activities, macrofauna
Opportunity	Erosion modelling



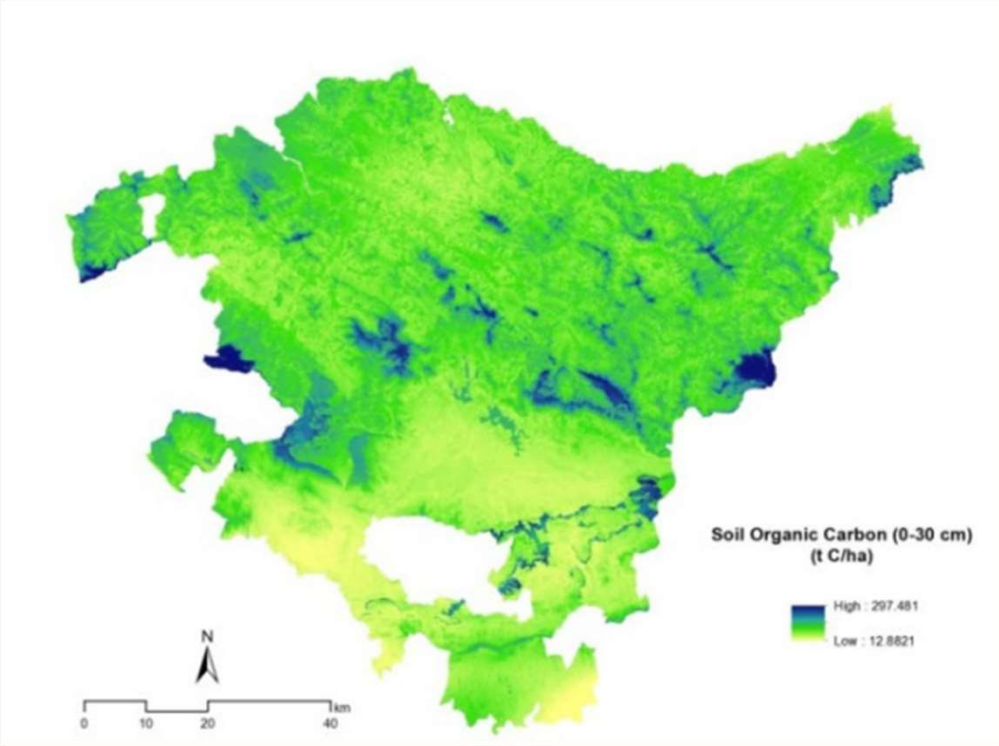
Pilot site - Spain

Legacy data from NEIKER´s edaphology lab

- Around 18.000 samples
- Since 1994
- No sampling design

Variety of determinations:

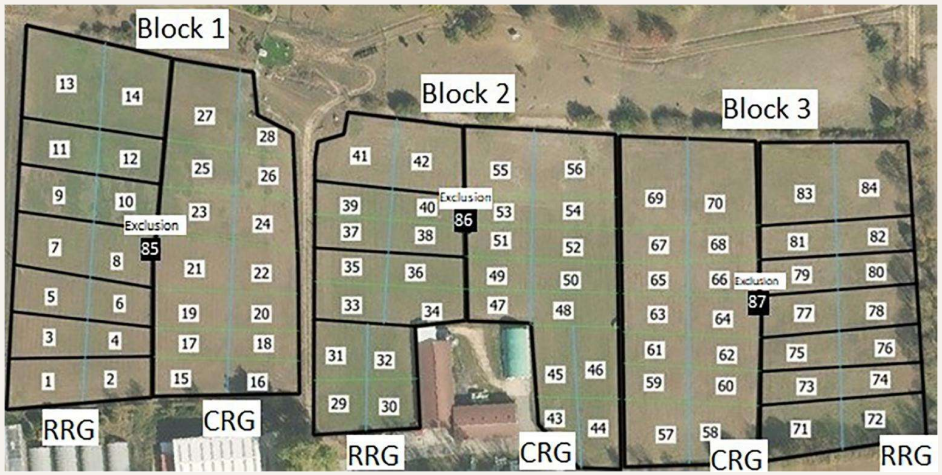
- Texture, bulk density, water holding capacity
- pH, electrical conductivity, metals, ammonium, POM, MAOM
- Organic carbon, carbonates, microbial biomass carbon, potentially mineralizable carbon
- Total nitrogen, nitrates, extractable potassium, Olsen phosphorus, cation exchange capacity,, extractable calcium, extractable magnesium, extractable sodium, extractable potasium
- Soil moisture, soil respiration

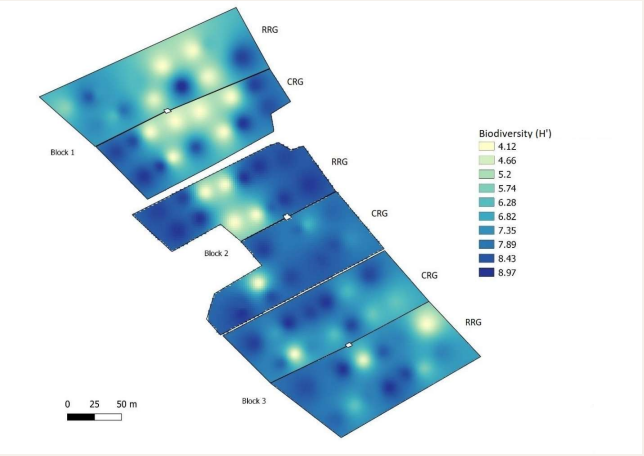


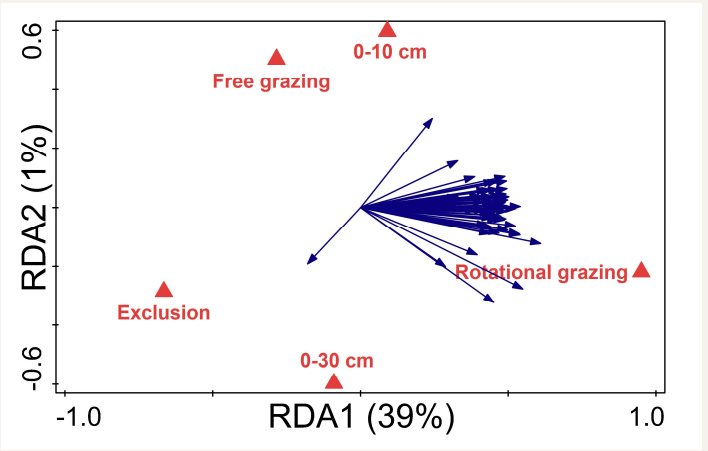
Pilot site - Spain

Rotational grazing in NEIKER´s experimental pastures and sheep flock

- Randomized block design, 4.5 ha
- Running since 2014
- 2014-2019: 30% higher springtime grass production and 3.6% higher topsoil carbon storage (Díaz de Otálora et al., 2021)
- Plan to sample grid in 2024







Pilot site - Spain

Regenerative rotational grazing with professional livestock farmers

- 4 farms
- Araba and Bizkaia provinces
- 5-20 plots each
- Sheep and cows
- Applying RRG for 0-5 years
- Plan to sample in 2023 and 2025/2026

Pilot site - Spain

Soil Health measurements: LUCAS approach

M1-PHYSICOCHEMICAL PROPERTIES:

- Texture
- pH
- Organic carbon
- Carbonate content
- Total nitrogen content
- Extractable potassium content
- Phosphorus content
- Cation exchange capacity
- Electrical conductivity
- Metals
- Nitrates
- Ammonium
- Water holding capacity
- POM/MAOM

M2-BIOLOGICAL PROPERTIES:

- Biodiversity of bacteria and archaea (16S rDNA)
- Biodiversity of fungi (ITS)
- Biodiversity of other eukaryotes (18S rRNA)
- Soil respiration
- Microbial biomass carbon
- Potentially mineralizable nitrogen
- Enzyme activities

M3-BULK DENSITY:

- Bulk density
- Soil moisture

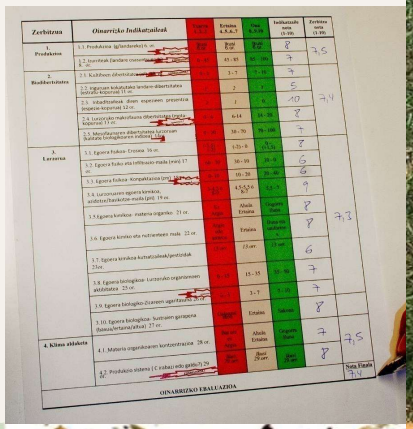
M4-FIELD MEASUREMENTS:

- Soil erosion by water and wind

Pilot site - Spain

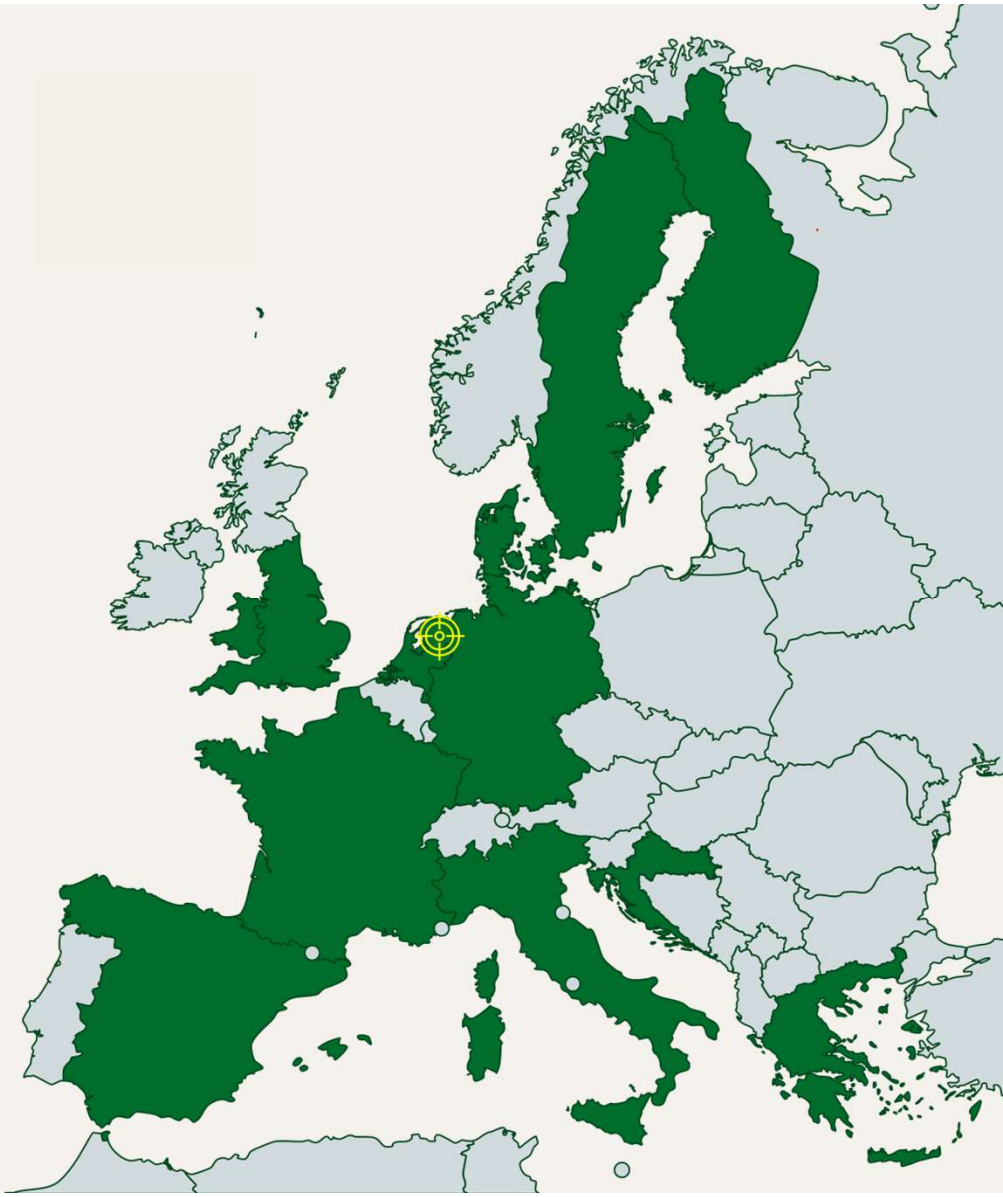
Soil Health measurements: AI4Soil Health approach

- Soil Health Cards
- Digit Soil
- Image analysis of macrofauna
- Yard Stick
- microBIOMETER
- Other...(WP4 related)



Pilot site - Netherlands

Location	Netherlands, Assen - Boermarke-Zeijen
Pedo-climatic region	Atlantic north
Soil types	Sandy soils, peat patches
Management practices	1200 ha - 1000 ha cultivated land, 200 ha forest land, mixed livestock and arable farming
Actors	Farmers, advisors, Naober Group; policy makers, water boards, industry, SMEs, citizens
Type	Farm cluster, existing network of pilot sites, partnership
Data / testing	Hydrology, in-field sensors, soil health properties – carbon, nutrients, crop yields
Opportunity	Hydrological modelling, long term data sets



Pilot site - Netherlands

Boermarke-Zeijen

https://boermarkezeijen.nl/

Pilot site - Netherlands

Boermarke-Zeijen

- Community of 11 farmers in Drenthe
- Community consists of approximately 1200 ha, of which 1000 ha is cultivated land and 200 hectares forested land, used for livestock and arable farming
- Grass (cattle), corn, wheat, potato, onion

Objectives:

- Collaboration - enhanced efficiency
- Sustainability - soil health and renewable farming
- Profitability - including reimbursement for ecosystem services

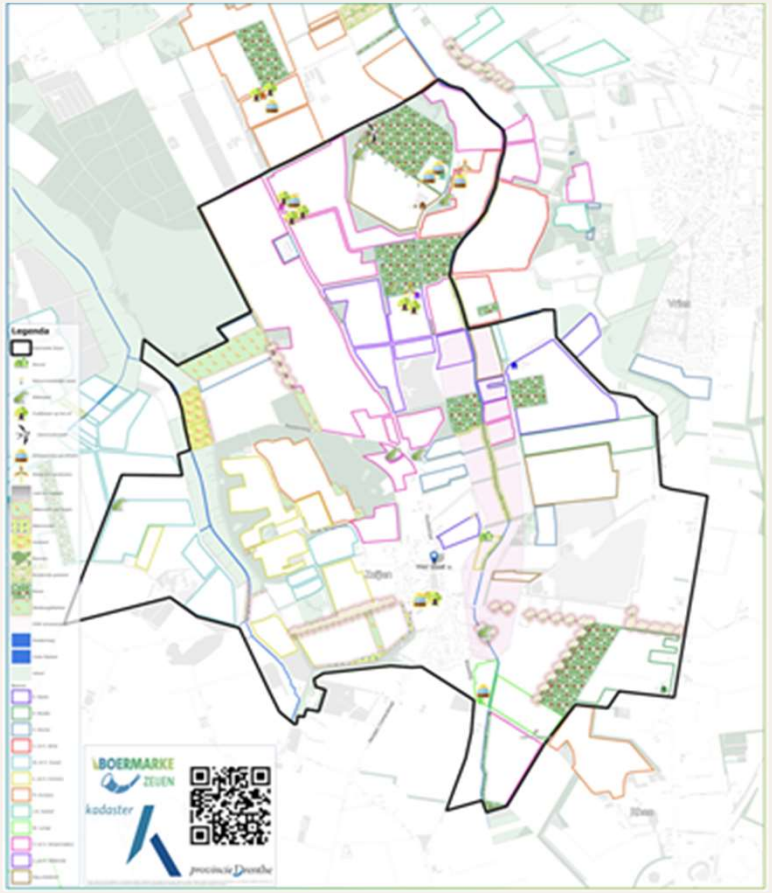
Current measurement plan:

- Continuous measurement of soil moisture, groundwater, surface water, in collaboration with the water board
- Nutrients, pH in surface water
- In situ samples and soil profiles taken at 6 parcels by RMI

Interest in:

- Nitrogen/ammonia
- Satellite soil moisture and NDVI

https://boermarkezeijen.nl/



Pilot site - Netherlands

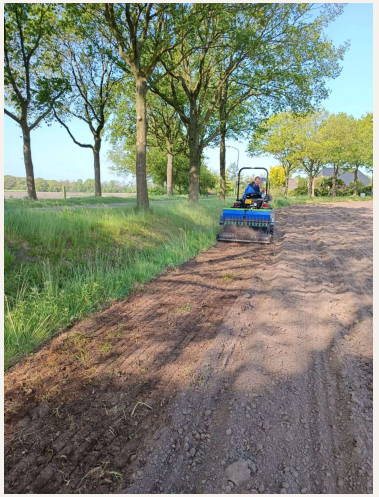
Boermarke-Zeijen

Proposed indicator

- Vegetation cover
- Landscape heterogeneity
- Forest cover
- Soil structure incl. soil sealing
- Soil organic carbon stock
- Presence of pollutants
- Soil biodiversity
- Soil nutrients & acidity

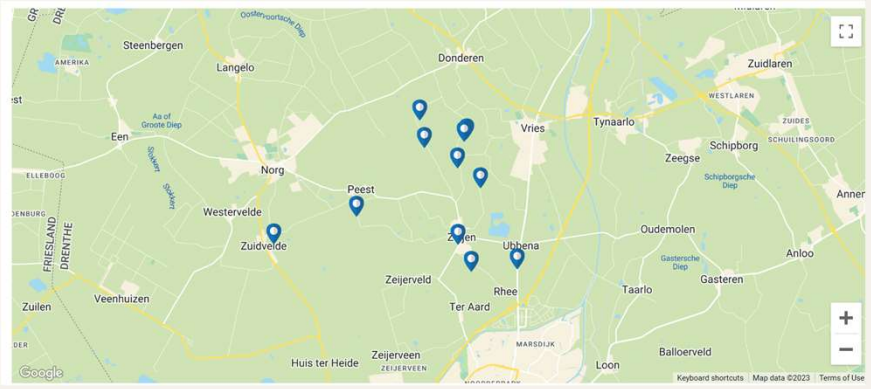
EO support

Vegetation Indices
Land Cover & Vegetation Classification
Vegetation Indices
Land Cover, SWC retention
SWC, LST, Vegetation Indices



Stakeholders and contacts

- Contacts through water board NZV, hydro-logging
- Contact person Gerko Brink
- Schedule meeting with Gerko to discuss plans

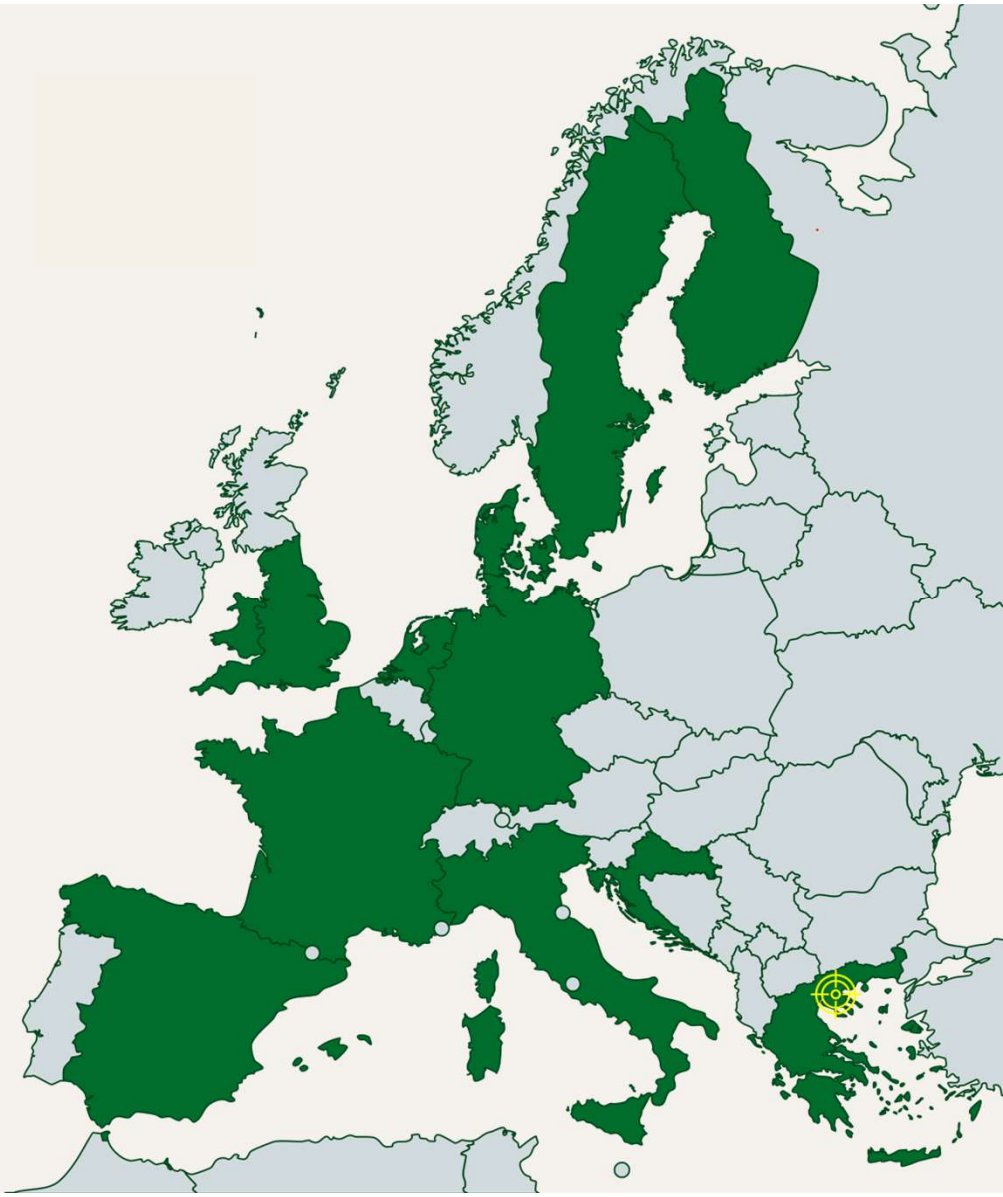


Pilot site - Greece

ARISTOTLE UNIVERSITY OF THESSALONIKI

SPECTRA LAB

Location	Greece, Central Macedonia
Pedo-climatic region	Mediterranean north
Soil types	Cambisols, luvisols
Management practices	Modern winery, agricultural cluster of orchards, arable organic and conventional
Actors	Farmers, researchers, advisors
Type	Multiple cluster, potential as 'super-connector' (IBEC, AG-CLUSTER, Region of Central Macedonia)
Data / testing	Soil health, soil carbon sequestration potential
Opportunity	Historical data sets (ESA WORLDSOILS, H2020 DIONE)



Pilot site - Greece

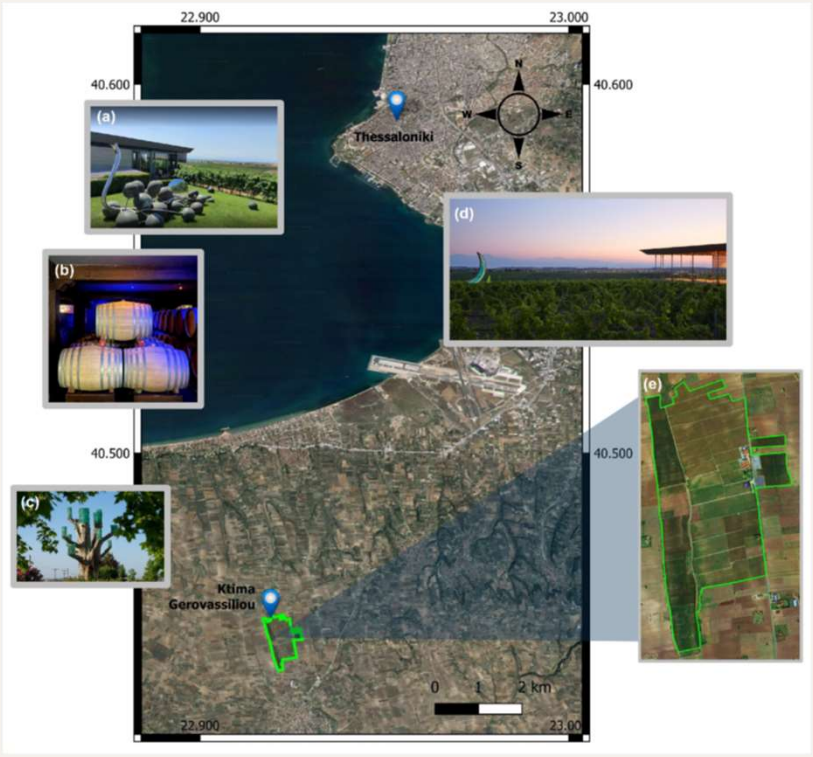
Activity will focus on evaluating the impact of land degradation on soil health, farmland productivity and soil carbon sequestration potential in supporting carbon farming activities in Central Macedonia.

Objectives:

- Development of evidence-based conservation recommendations for policies and sustainable services.

Test beds:

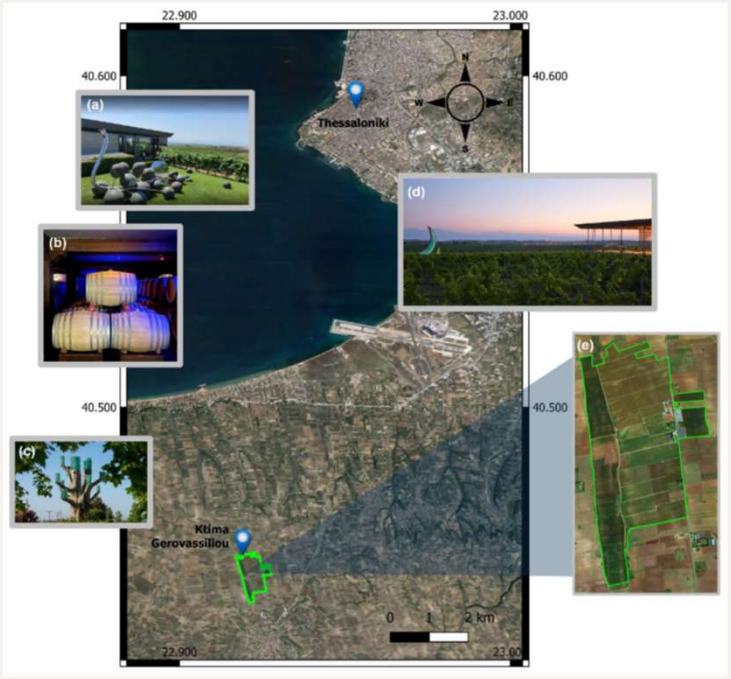
1. Modern winery, Epanomi – Gerovasiliou Domain (60 hectares)
2. Agricultural cluster of orchards – Central Macedonia, Greece (500 hectares)
3. Aristotle University of Thessaloniki test bed at the Farm (2 hectares)



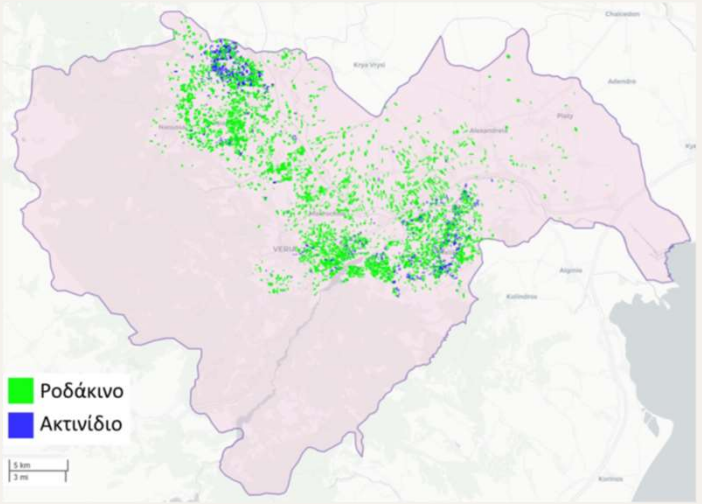
Gerovassiliou domain
60 hectares of vineyards

Pilot site - Greece

1. AUTh's pilot test-bed
Young olive grove (1 hectare)



2. Gerovassiliou domain
60 hectares of vineyards



3. Imathia region
1392 KIWI parcels
8704 peach

Pilot site - Greece

Data availability of historical soil data:

- Preserved and curated in dedicated repositories
- (ESA WORLDSOILS and H2020 DIONE projects)

Regional goal:

- Creation of modern competitive farms producing high quality products aligned with consumer demands

Collaboration with "super-connectors”:

- Region of Central Macedonia, IBEC, and AG-CLUSTER

Regulatory sandbox:

- Establishment for testing soil ecosystem ideas and technologies

Pilot site - Greece

Soil Spectroscopy

Usage of benchtop and portable spectrometers to assess soil health indicators

- Develop new regional Soil Spectral Libraries (SSL)
- Expand existing SSLs
- Participate in cross-laboratory trials to check the quality of the collected measurements and the usage protocols
- Harmonize SSLs developed with different equipment and different measuring protocols
- Compare in-situ spectra with laboratory to eliminate the effect of ambient factors such as moisture, shadows or soil roughness.
- Explore the synergies of in-situ spectrum with satellite imagery or other ancillary variables for soil properties estimation

Proposed measuring scheme

- Field spectra collected with Spectral Engines Nirone S2.2 @ 1750 – 2150 nm

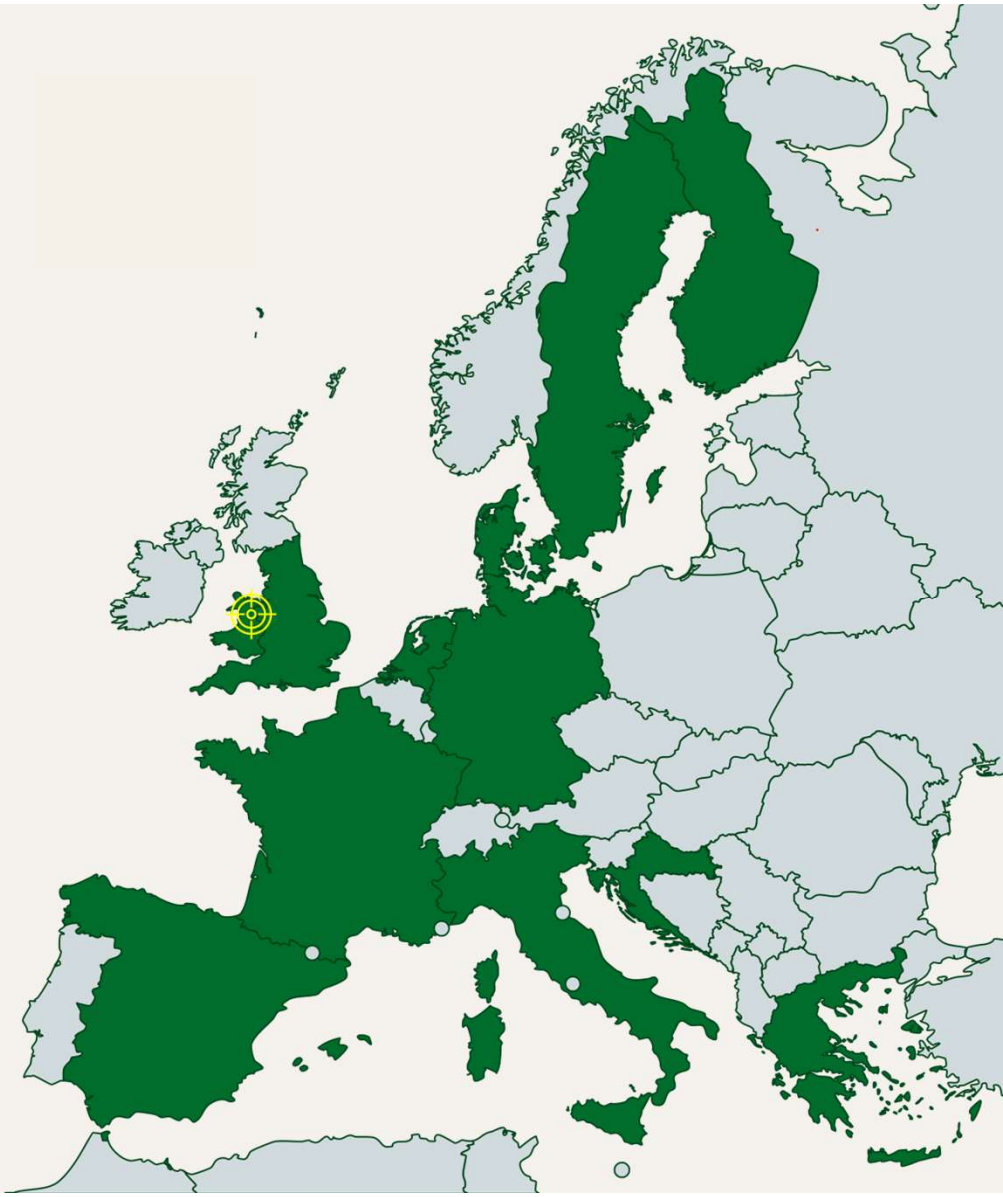
- Delta-T SM150T Soil Moisture Sensor

- Planet Fusion RGB imagery of the AOI for:
  - Blue: 464 - 517 nm
  - Green: 547 - 585 nm
  - Red: 650 - 682 nm
  - NIR: 846 - 888 nm

Pilot site – Wales UK

UK Centre for Ecology & Hydrology

Location	Wales - Plynlimon
Pedo-climatic region	Atlantic North
Soil types	Acidic - Blanket Peats and Stagnopodzols, Gley soils, Brown earths
Management practices	Conifer plantation forest, moorland, agricultural grazing
Actors	Farmers, foresters, researchers, citizens, land managers, advisors
Type	Existing pilot site
Data / testing	Long term data (c. 60 yrs); hydrological, hydrochemical, soil properties (UKCEH EIDC, UKSO)
Opportunity	Hydrological and biogeochemical modelling, high temporal resolution sampling



Pilot site – Wales UK

Plynlimon Research Catchments

An open air laboratory for studying the environment – 60 years and counting

In the 1960s, the fledgling Institute of Hydrology, now part of the UK Centre for Ecology & Hydrology (UKCEH), launched an ambitious project on the eastern slopes of Plynlimon in upland Wales to examine water use by conifer forests. That project has since become a multi-disciplinary long-term paired catchment study leading and underpinning hydrological and hydrochemical research in the UK and internationally.

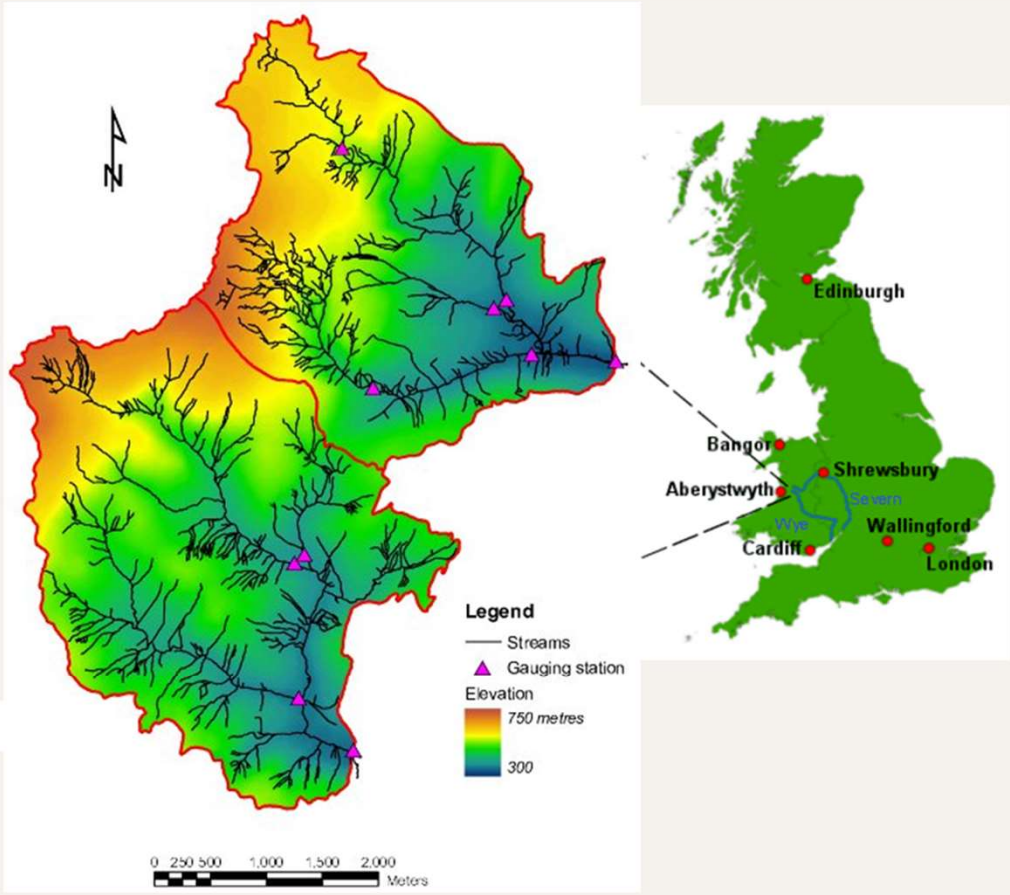
https://www.ceh.ac.uk/our-science/monitoring-sites/plynlimon-research-catchments

Pilot site – Wales UK

Paired Catchment Living Laboratory

Severn (70% conifer plantation)

Wye (Dwarf shrub heath, acid and improved grassland)



Pilot site – Wales UK

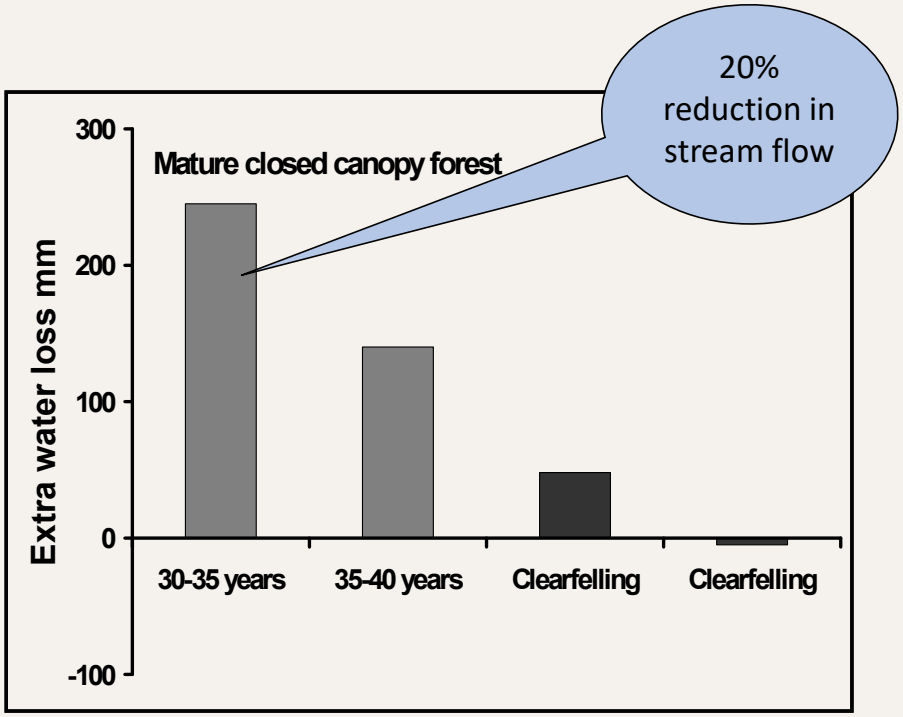
Original question

Do forests “use” more water compared to short grass?

Yes, BUT

Total evaporation varies with forest age

Forest management stage affects total evaporation



Hydrometric infrastructure

- 23 storage rain gauges
- 4 automatic weather stations
- 5 stream flumes
- 2 Stream weirs

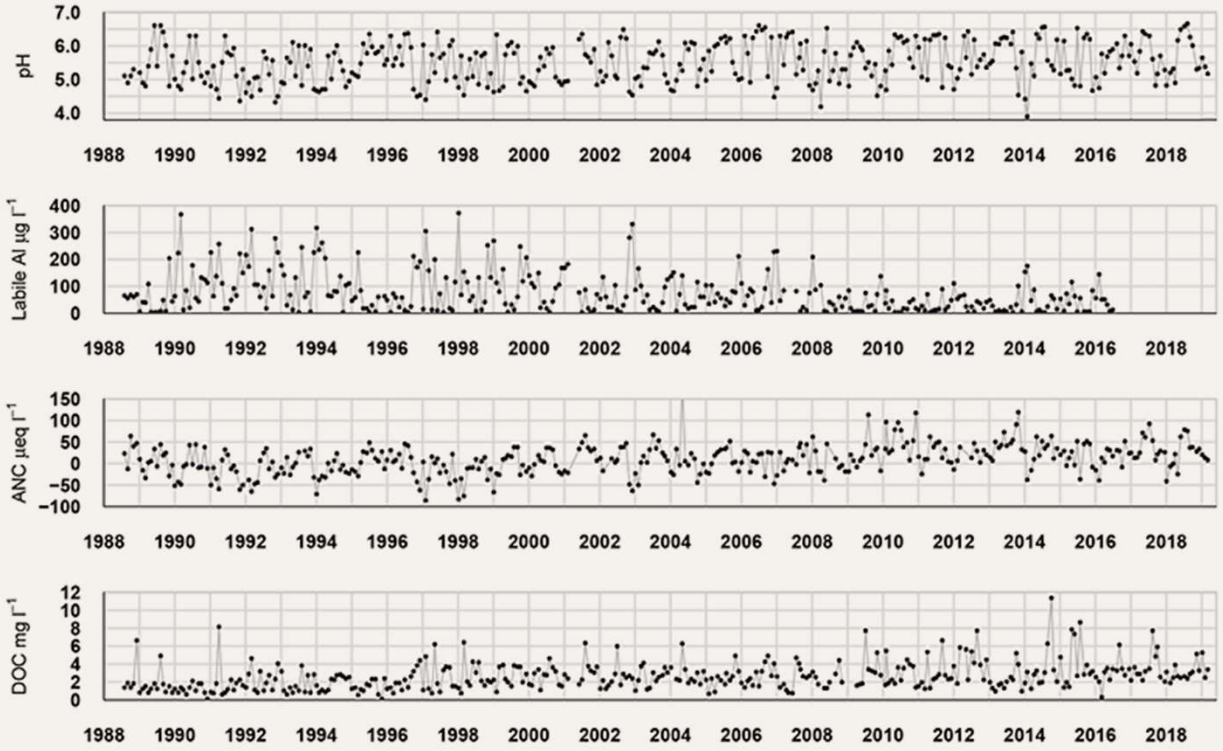
Data

- Rainfall: *hourly, monthly, annual….*
- River flow: *15 minute, hourly…..annual…*
- Climate: *15 minute, hourly…..annual…*
- Chemistry: *15 minute, hourly…..annual…*

Pilot site – Wales UK

Long Term Water Quality - UK Upland Waters Monitoring Network - UWMN

Trends in stream water chemistry; Upper Hafren, Plynlimon



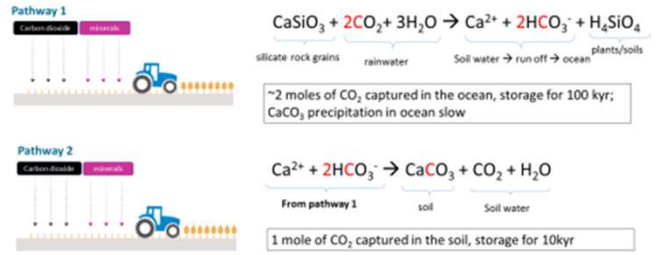
Formerly the UK Acid Waters Monitoring Network, The UWMN was set up to provide crucial chemical and biological data on surface water acidification in UK uplands and to monitor responses of aquatic ecosystems to reductions in air pollution.

Pilot site – Wales UK

Examples of research projects at Plynlimon

GGR Rock Dust Demonstration Project

Two pathways to carbon capture via ERW



Funder: BBSRC

Aims:

- Test the hypothesis that application of basalt rock dust onto upland grassland will enhance the long-term capture of carbon in the soil & water.

Activities:

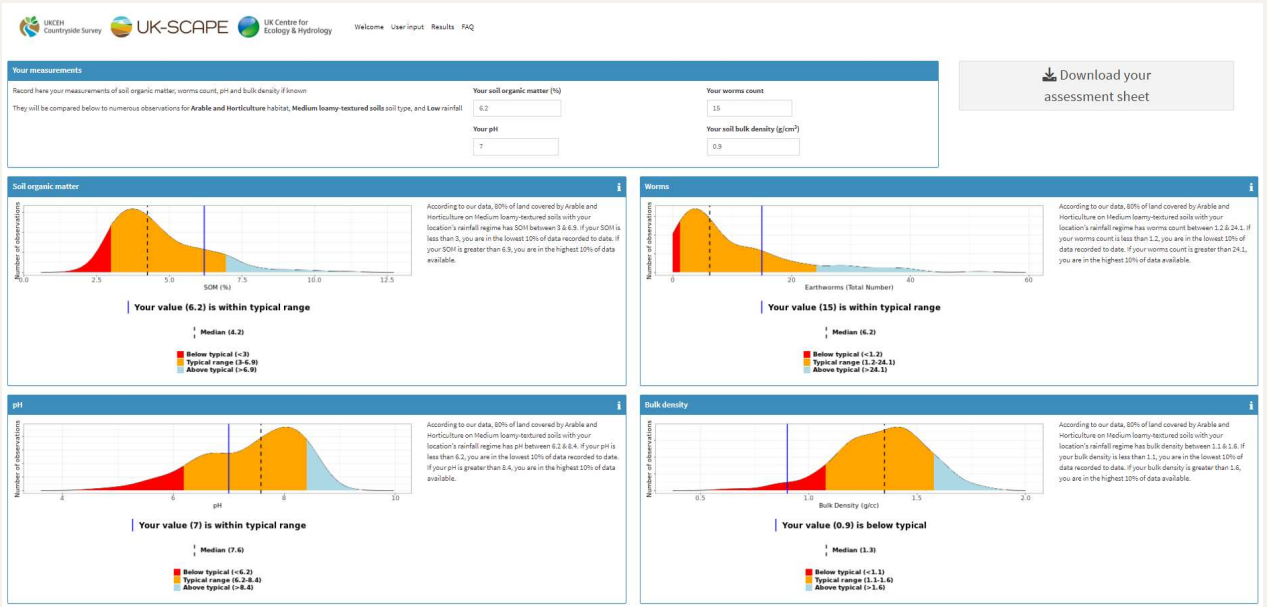
1. Lead a field site (Plynlimon) as part of the broader project.
2. 3 years of annual rock dust application to a catchment in th Plynlimon experimental research site
3. High resolution water, soil, vegetation and GHG measurements throughout the project

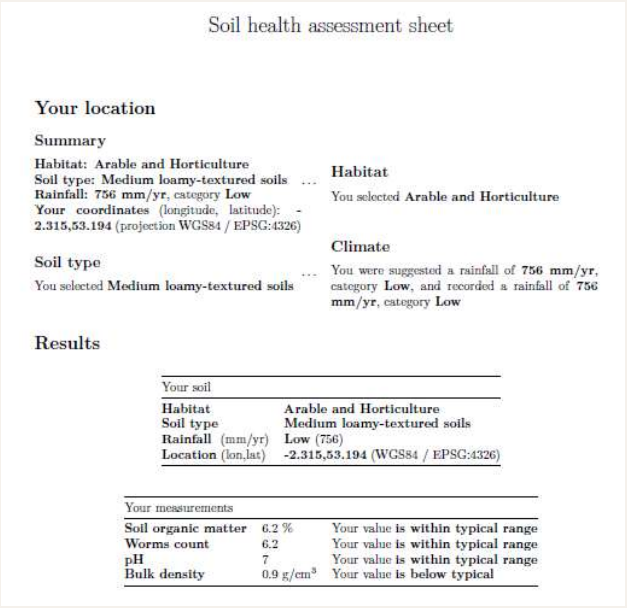
Outcome: to conduct the first large scale test to see if rockdust application can be an effective greenhouse gas removal (GGR) programme in upland grasslands

Pilot site – Wales UK

Examples of research projects at Plynlimon

Benchmark approach to set context based on habitat and soil type matrix
UKCEH Countryside Survey Soil Health Webtool: https://connect-apps.ceh.ac.uk/soilhealth





Soil health assessment sheet

Your location

Summary

Habitat: Arable and Horticulture
Soil type: Medium loamy-textured soils
Rainfall: 756 mm/yr, category Low
Your coordinates (longitude, latitude): -2.315,53.194 (projection WGS84 / EPSG:4326)

Habitat

You selected **Arable and Horticulture**

Soil type

You selected **Medium loamy-textured soils**

Climate

You were suggested a rainfall of **756 mm/yr**, category **Low**, and recorded a rainfall of **756 mm/yr**, category **Low**

Results

Your soil	
Habitat	Arable and Horticulture
Soil type	Medium loamy-textured soils
Rainfall (mm/yr)	Low (756)
Location (lon,lat)	-2.315,53.194 (WGS84 / EPSG:4326)

Your measurements		
Soil organic matter	6.2 %	Your value is within typical range
Worms count	6.2	Your value is within typical range
pH	7	Your value is within typical range
Bulk density	0.9 g/cm^3	Your value is below typical

Compares user input data with robust Countryside Survey data to determine response for the habitat and soil type: pH, SOM, worms & bulk density.

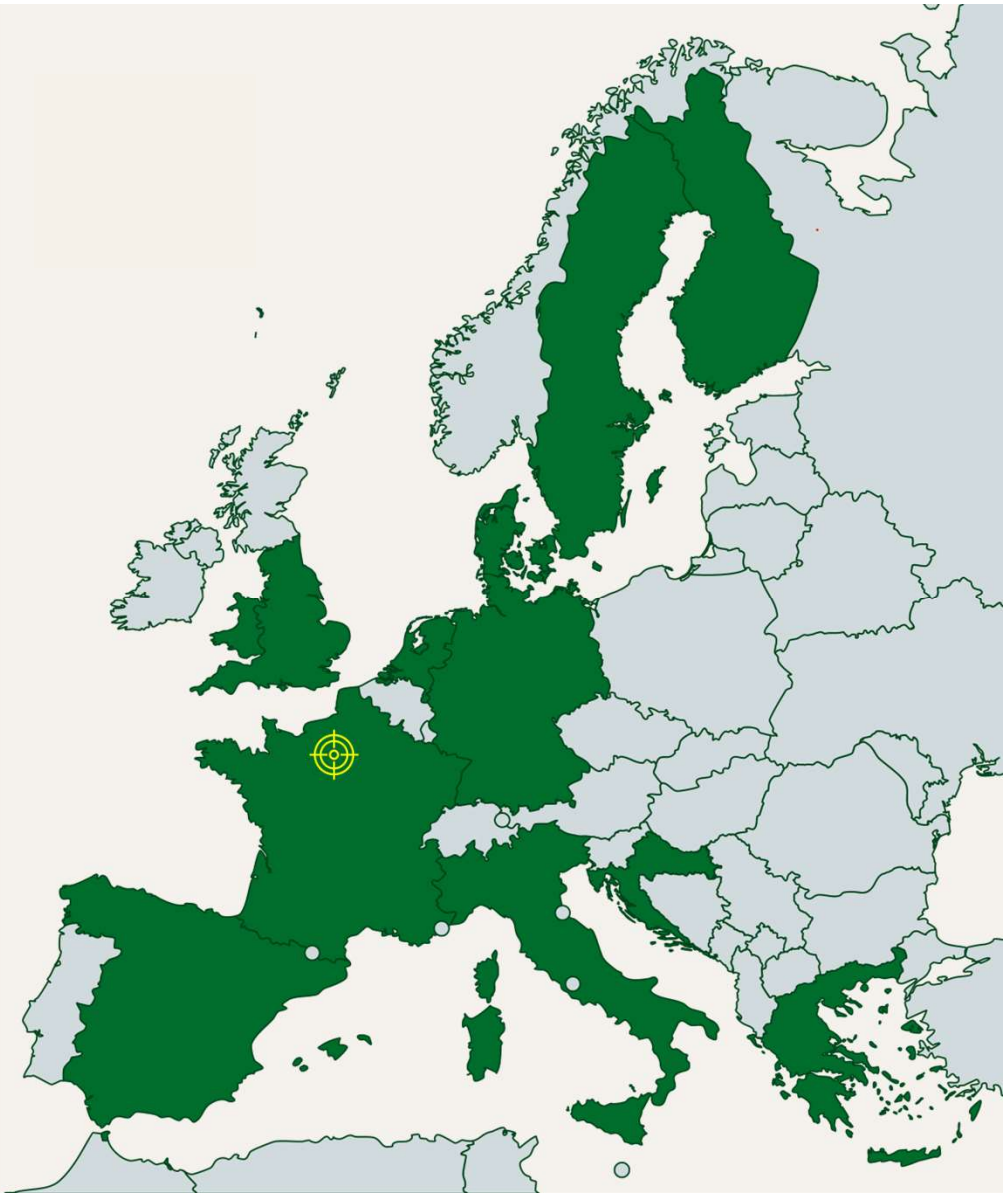
Pilot site – Wales UK

COSMOS-UK Cosmic-ray soil moisture monitoring network

- Near real time soil moisture data
- Measured over an area of about 12 hectares
- Daily weather, soil moisture and soil temperature data uploaded to a open data website

Pilot site – France

Location	France, Estrées-Mons
Pedo-climatic region	Atlantic Central, Continental
Soil types	Luvisol Orthique / Typic Hapludalf
Management practices	Arable cropping systems (20 ha)
Actors	Researchers, farmers
Type	Existing pilot site
Data / testing	Long term high depth resolution soil organic C and N, water, mineral nitrogen, N_2O emissions
Opportunity	N_2O / CO_2 emissions, extensive vegetation and water quality data, field assistance, scientific analysis



Pilot site – France

ACBB-network

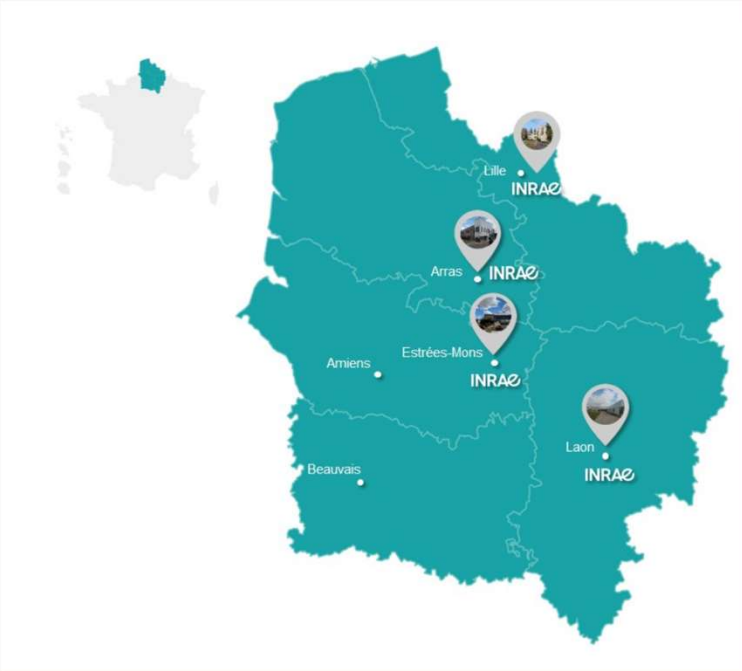
The INRAE Estrées-Mons LTER is part of INRAE's ACBB-network (Agroecosystems, Biogeochemical Cycles and Biodiversity) of which the objectives are:

1) Evaluation of the impact of agricultural systems on the environment, in particular on the atmosphere and the hydrosphere;
2) Long-term monitoring of ecosystem functions relevant to biogeochemical cycles and biodiversity;
3) Provide access to French research facilities for the international research community in order to increase scientific interactions and knowledge exchange.

The two other LTER sites in the ACBB network are located in Lusignan (grassland – crop rotation) and in Theix – Laqueuille (permanent grassland) (Fig. 1).

A common data platform is available with a selection of data from all sites involved (SI ECOINFO)

https://www6.hautsdefrance.inrae.fr/agroimpact/Nos-dispositifs-outils/Dispositifs-experimentaux-et-infrastructures/Echelle-du-systeme-de-culture/SOERE-ACBB



Pilot site – France

The INRAE ACBB long-term experimental research site (LTER) in Estrées-Mons, Northern France (49°52'25.7"N 3°01'54.1"E, 22 ha) was established in 2010. It aims to monitor environmental impacts and performance of arable cropping systems relevant to regional agriculture.

Approach
Six-yearly crop rotations are implemented for all eight treatments
(T1 - T8, Table 1 & 2) laid out on 32 plots (Fig. 1).

The main experiment includes six treatments (T1 – T6, n = 4) laid out in four blocks (MAIN, 11 ha). Two additional large plots are similar to T5 and T6 and equipped with an eddy covariance tower (FLUX, 8 ha).

In 2016, two treatments relevant to organic farming practices (T7 - T8, n = 3) were included in the experiment (ANNEX, 3 ha).

https://www6.hautsdefrance.inrae.fr/agroimpact/Nos-dispositifs-outils/Dispositifs-experimentaux-et-infrastructures/Echelle-du-systeme-de-culture/SOERE-ACBB

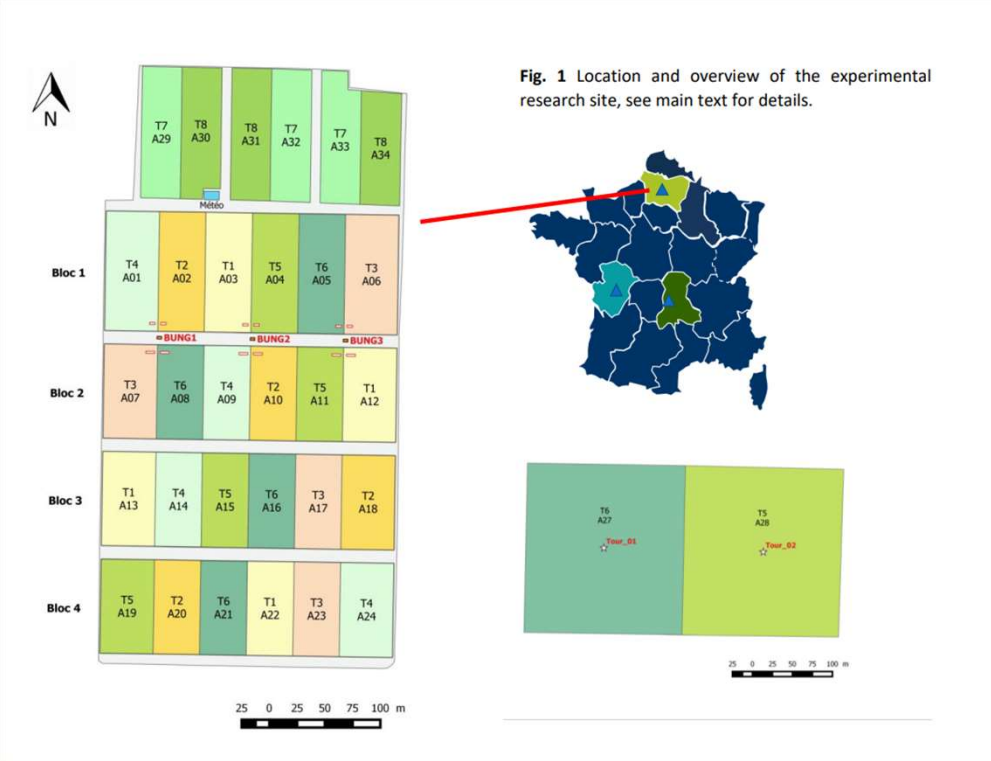


Fig. 1 Location and overview of the experimental research site, see main text for details.

Pilot site – France

Five specific treatment comparisons allow for in-depth analysis of the effects of individual drivers:

1) Tillage type (T1 vs T2; 20 cm depth vs. 7 cm depth);

2) Residue management (T2 vs T3; restitution/export);

3) N fertilization (T1 vs T4; 100% and 35% of reference treatment);

4) Perennial (biomass) crop frequency (T3 vs T6);

5) Legume frequency (T4 vs T5; low or high frequency of legumes in the rotation, as main crops or cover crops).

Three treatments resemble a system approach, i.e. multiple factors altered simultaneously, in which inputs (mineral nitrogen, pesticides) are reduced (T5), or eliminated (T7, T8) and associated management practices (tillage, mechanical weeding) are adapted.

https://www6.hautsdefrance.inrae.fr/agroimpact/Nos-dispositifs-outils/Dispositifs-experimentaux-et-infrastructures/Echelle-du-systeme-de-culture/SOERE-ACBB

Pilot site – France

Table 1. Short treatment descriptions for treatment T1 – 18 and list of cropping species per five-yearly crop rotation.

Treatment			Management	Rotation 2010-2015	Rotation 2016-2021	Rotation 2022-2028
T1	CONV	CONVentional management	Conventional management corresponding to integrated production and usual practices in 2015	Pea, Wheat, Rapeseed, Barley, G Maize, Wheat	Pea, Rapeseed, Wheat, Barley, G Maize, Wheat	Barley, Pea, Rapeseed, Wheat, Sugarbeet, G Maize, Wheat
T2	RT	Reduced Tillage	Conventional management with reduced tillage and no longer ploughing	Pea, Wheat, Rapeseed, Barley, G Maize, Wheat	Pea, Rapeseed, Wheat, Barley, G Maize, Wheat	Barley, Pea, Rapeseed, Wheat, Sugarbeet, G Maize, Wheat
T3	RT-RR	Reduced Tillage and Residues Removal	Conventional management with both reduced tillage and crop residues export (for bioenergy production)	Pea, Wheat, Rapeseed, Barley, F Maize, Wheat	Pea, Rapeseed, Wheat, Barley, F Maize, Wheat	Barley, Pea, Rapeseed, Wheat, Sugarbeet, F Maize, Wheat
T4	RN	Reduced Nitrogen	Low N fertilization management without compensation with other N inputs	Pea, Wheat, Rapeseed, Barley, G Maize, Wheat	Pea, Rapeseed, Wheat, Barley, G Maize, Wheat	Barley, Pea, Rapeseed, Wheat, Sugarbeet, G Maize, Wheat
T5	RN-LEG	Reduced Nitrogen and LEGuminous crops	Low N fertilization management compensated with N input from biological fixation (BNF)	Pea, Wheat, Rapeseed, Barley, G Maize, Wheat	Alfalfa, Alfalfa, Wheat, Barley, G Maize, Wheat	Barley, Red Clover, Rapeseed, Wheat, Sugarbeet, G Maize, Wheat
T6	RR-PER	Residues Removal and PERennial crops	Conventional management with perennial crops, reduced tillage and crop residues export (for bioenergy production)	Switchgrass (6 years)	Pea, Rapeseed, Wheat, Barley, F Maize, Wheat	Switchgrass (7 years)
T7	OA-T	Organic Agriculture and Tillage	Organic management corresponding to local practices	–	Pea, Asso. Rapeseed, Wheat, Barley, G Maize, Triticale	Barley, Asso. Pea, Rapeseed, Wheat, Sugarbeet, G Maize, Wheat
T8	OA-CC	Organic Agriculture and Cover Crops	Organic management with maximum coverage of soil	–	Alfalfa, Alfalfa, G Maize, Barley, G Maize, Asso Triticale+field pea	Barley, Red Clover, Rapeseed, Wheat, Sugarbeet, G Maize, Wheat
T3_SN	BS	Perenial bare soil	Conventional management with reduced tillage like for T3, but without crops to avoid any carbone introduction into the soil	Pea, Wheat, Rapeseed, Barley, F Maize, Wheat	perenial bare soil	perenial bare soil

Pilot site – France

Table 2. Detailed treatment information for treatment T1 – T8 per factor (soil tillage, crop residue management, mineral nitrogen fertilization, legume frequency, perennial frequency and chemical crop protection).

Treatment			Soil tillage	Crop residues management	N min fertilization	Legume frequency	Perennial frequency	Chemical protection
T1	CONV	CONVentional management	Annual ploughing	Returned	Reference N	Low	Nil	High
T2	RT	Reduced Tillage	Shallow tillage	Returned	Reference N	Low	Nil	High
T3	RT-RR	Reduced Tillage and Residues Removal	Shallow tillage	Exported**	Reference N	Low	Nil	High
T4	RN	Reduced Nitrogen	Annual ploughing	Returned	35% Reference N	Low	Nil	High
T5	RN-LEG	Reduced Nitrogen and LEGuminous crops	Annual ploughing	Returned	35% Reference N	High	Nil	Medium
T6	RR-PER	Residues Removal and PERennial crops	Shallow tillage*	Exported**	Reference N	Low	High	High
T7	OA-T	Organic Agriculture and Tillage	occasional ploughing	Returned	Nil Legume substitution	Low	Nil	Nil
T8	OA-CC	Organic Agriculture and Cover Crops	occasional ploughing	Returned	Nil Legume substitution	High	Nil	Nil
T3_SN	BS	Perenial bare soil	Shallow tillage	No résidues introduction	Reference N	None	None	High

* Ploughed once after switchgrass

** Except after rapeseed crop

Pilot site – France

Measurements & Data Storage
Key variables to assess changes in production, losses to the environment
(i.e. N2O, CO2, NO3, pesticides) and carbon storage in the soil are monitored both manually (i.e. yield, plant growth characteristics, soil and water chemistry, soil biodiversity) and with > 600 permanent sensors for continuous data acquisition (weather data, soil moisture, gas exchange)

(See Box 1: List of routine measurements). Plant (dry powder), water (frozen) and soil (dry and freeze dried) samples are archived and available for reference.

Collected data are stored in an online database (AIDA)
PostgreSQL relational database and web interface) managed by INRAE 1158 UMR BioEcoAgro. Raw data are digitized and can be extracted by queries fit to needs (upon request).

Queries provide data sets with a "row" format, i.e., for example, "plot", "date", "horizon" etc. columns, a "variable" column, a "value" column and a "unit" column, translatable to a columnar format using R. A selection of data is available through the INRAE ACBB information system SI ECOINFO
(See 'ACBB-network').

https://www6.hautsdefrance.inrae.fr/agroimpact/Nos-dispositifs-outils/Dispositifs-experimentaux-et-infrastructures/Echelle-du-systeme-de-culture/SOERE-ACBB

Pilot site – France

BOX 1. List of routine measurements:

Soil organic C and N stocks:

Measurement campaign every 6-7 years:

C and N content on 5 soil layers: 0-10, 10-20, 20-35, 35-40, 40-60 cm

Bulk density per 5 cm layer, up to 40 cm depth

Calculation of stocks at equivalent soil mass.

N_2O emissions:

Daily measurements with automatic chambers since 2012

The number of plots and treatments monitored has increased since 2012,

20 plots are currently (2022) monitored with 60 automatic chambers:

T1, T2, T3, T6, T7, T8 on 3 blocks (3 chambers per plot)

T4 and T5 on 1 block (3 chambers per plot)

Soil water and mineral nitrogen stocks:

3 sampling dates:

- post-harvest,
- autumn (in some cases)
- end of winter

Moisture, ammonium, nitrate

Depths: 0-150 cm, 5 layers (0-30, 30-60, 60-90, 90-120, 120-150)

Water quality:

Sampling with porous cups during the winter period (~ October to May)

- at 45 cm
- at 200 cm

Nitrate analysis (among others)

Plants, main crops:

Samples taken at a young stage (e.g. 1 cm ear stage for cereals):

Above-ground biomass, 4 sub samples per plot

- of crops: organ ratio (green leaves, senescent leaves and stems); No. of plants/m²; LAI
- of weeds

C and N content of plant samples, averaged per plot

Samples taken at flowering stage:

Aboveground biomass, 4 sub samples per plot

- of crops: organ ratio (green leaves, senescent leaves and stems); No. of ears/m²; LAI
- of weeds

C and N content, averaged per plot

From 2018 to 2024, identification of weed species in the framework of the System-Eco+ project

Root biomass at 40 to 60 cm depth, on specific treatments (T1, T3, T4 since 2018)

Samples taken at harvest:

Above-ground biomass, 4 subsamples per plot

- of crops, organ ratio (grains, straws + chaff), No. of ears/m², PMG
- of weeds

C and N contents averaged per plot

Plants, cover crops:

Samples taken before destruction:

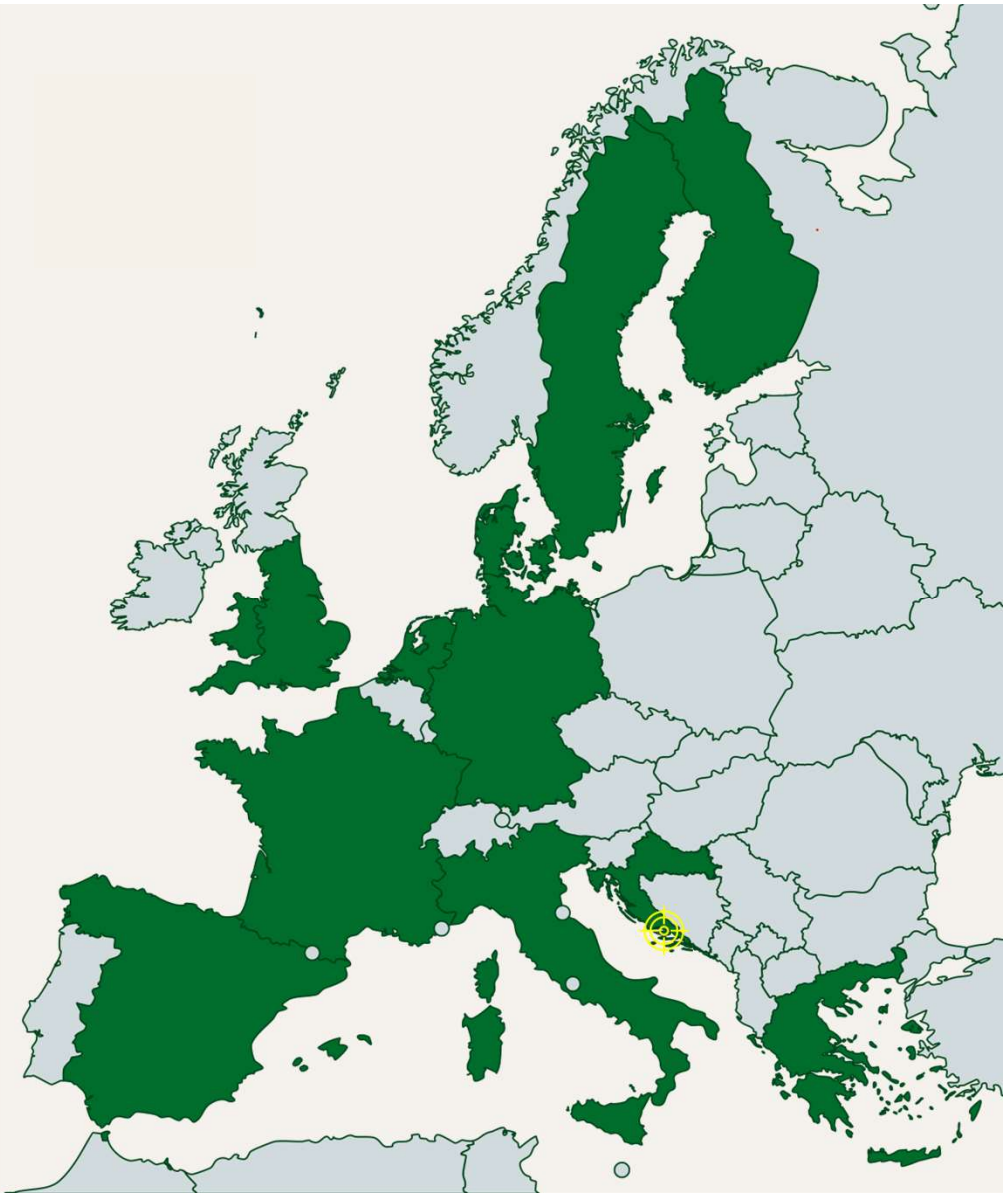
Above-ground biomass, 4 subsamples per plot

- of each species of the cover crop
- of weeds

C and N content averaged per plot

Pilot site - Croatia

Location	Croatia, The Neretva River Valley
Pedo-climatic region	Mediterranean South
Soil types	Fluvisols, Gleysols
Management practices	Polder-type land system, reclaimed land (hydro-amelioration), agriculture
Actors	Farmers, researchers, citizens
Type	Existing pilot site
Data / testing	Soil and water quality monitoring programme
Opportunity	Soil salinization



Pilot site - Croatia

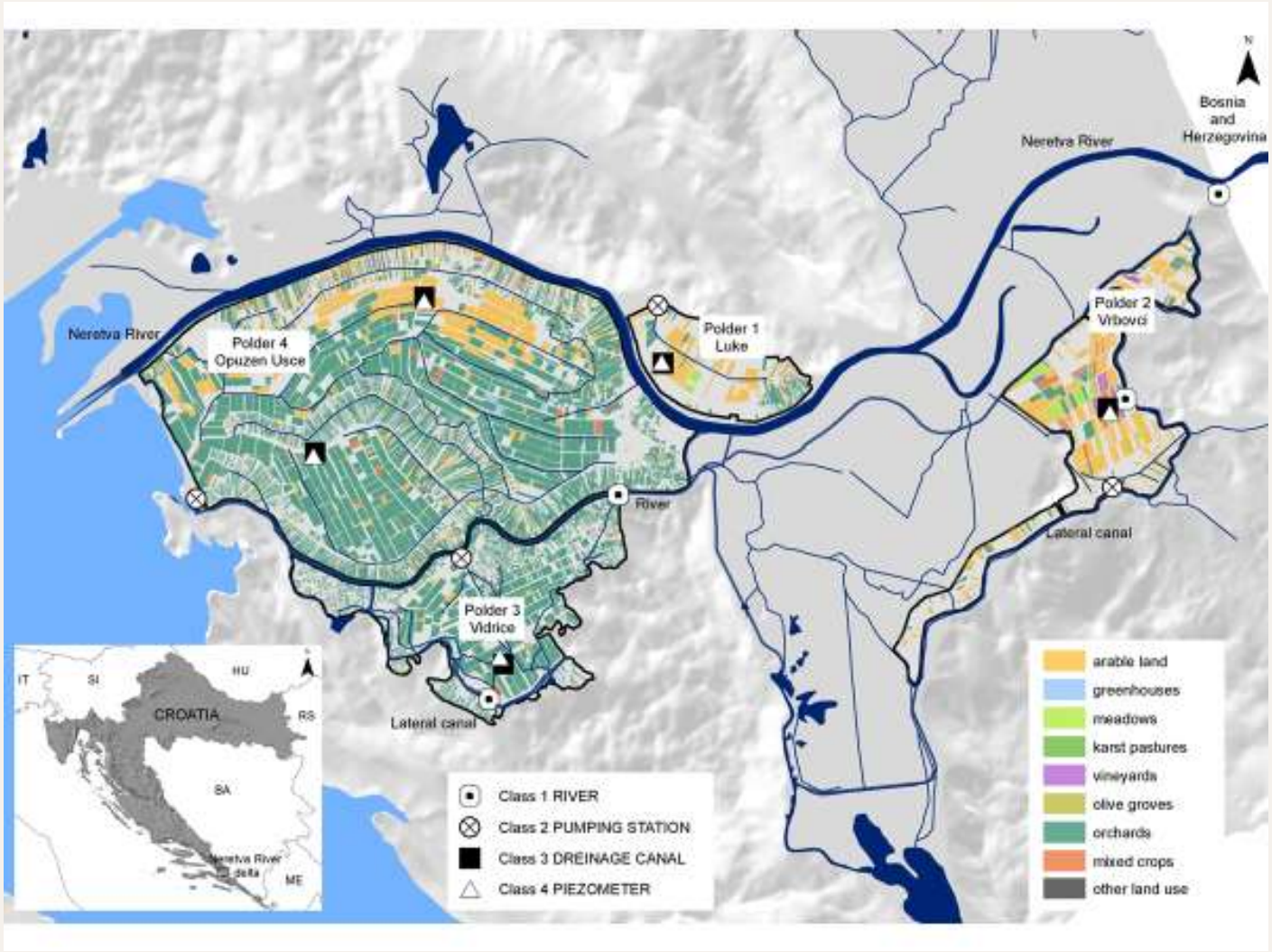
Neretva River Delta

Pilot site - Croatia

The pilot area is in the NRD, on the southeastern coast of the Adriatic Sea (43°00N, 17°30E)

The polder-type agricultural floodplain

Dominant land use citrus orchards



Pilot site - Croatia

Effects of the saline irrigation / soil salinity on crops



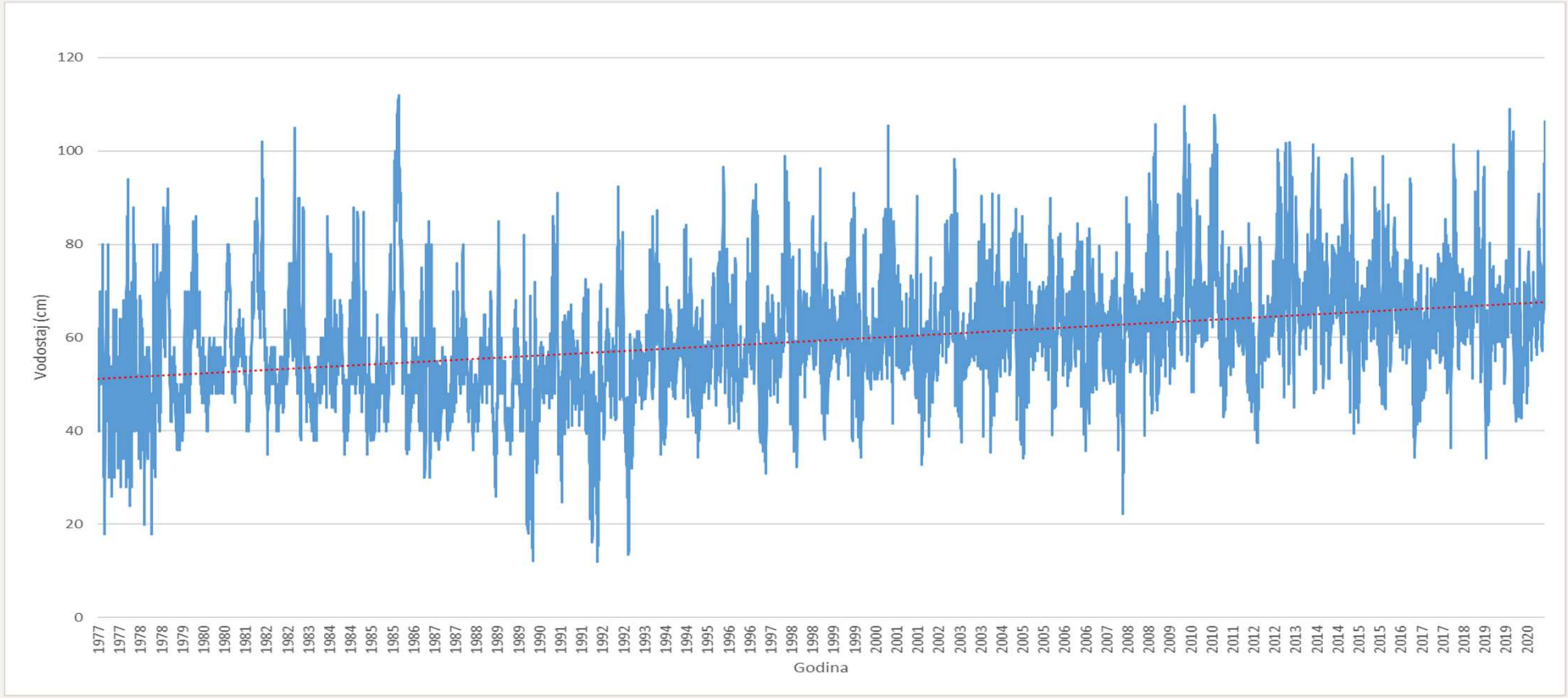



Pilot site - Croatia

Effects of the saline irrigation / soil salinity on crops

Pilot site - Croatia

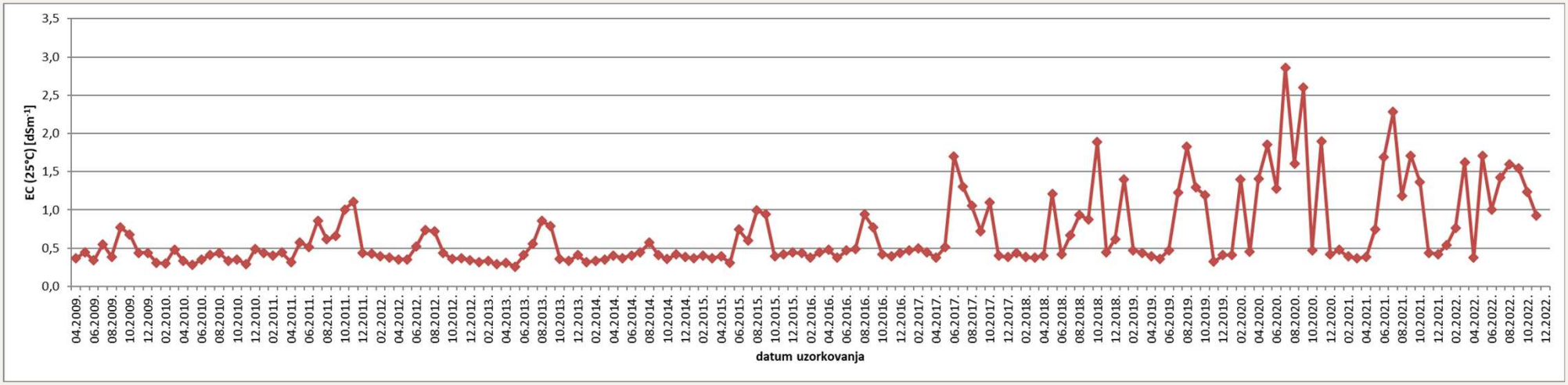
Sea level rise



Pilot site - Croatia

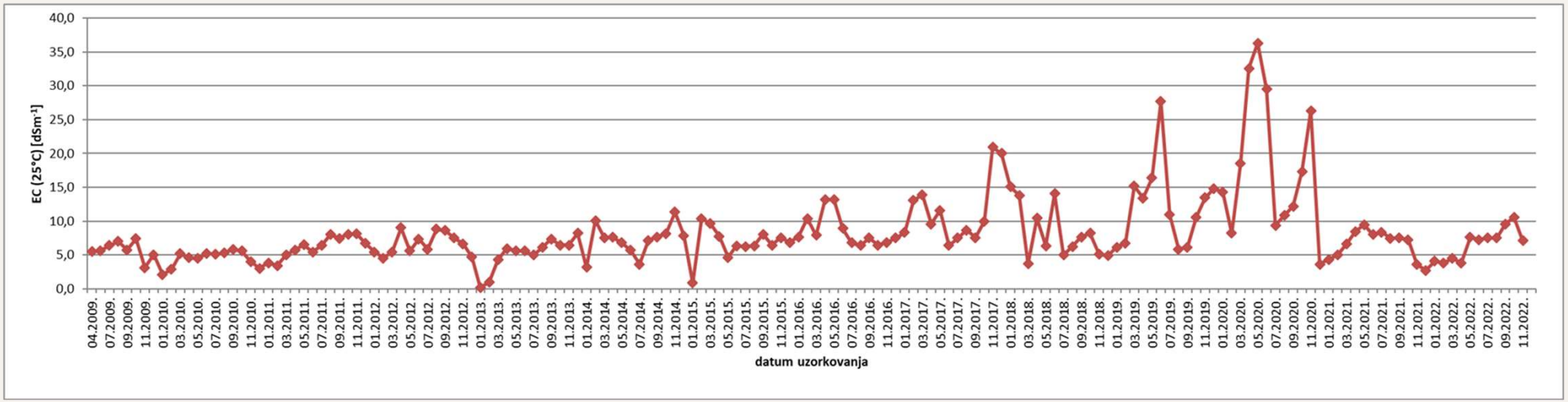
Surface water salinization is rising

River Neretva (Doljani BiH border) EC (dS/m) 2009– 2022



Pilot site - Croatia

Water salinity in the Lake canal (2009 – 2022)



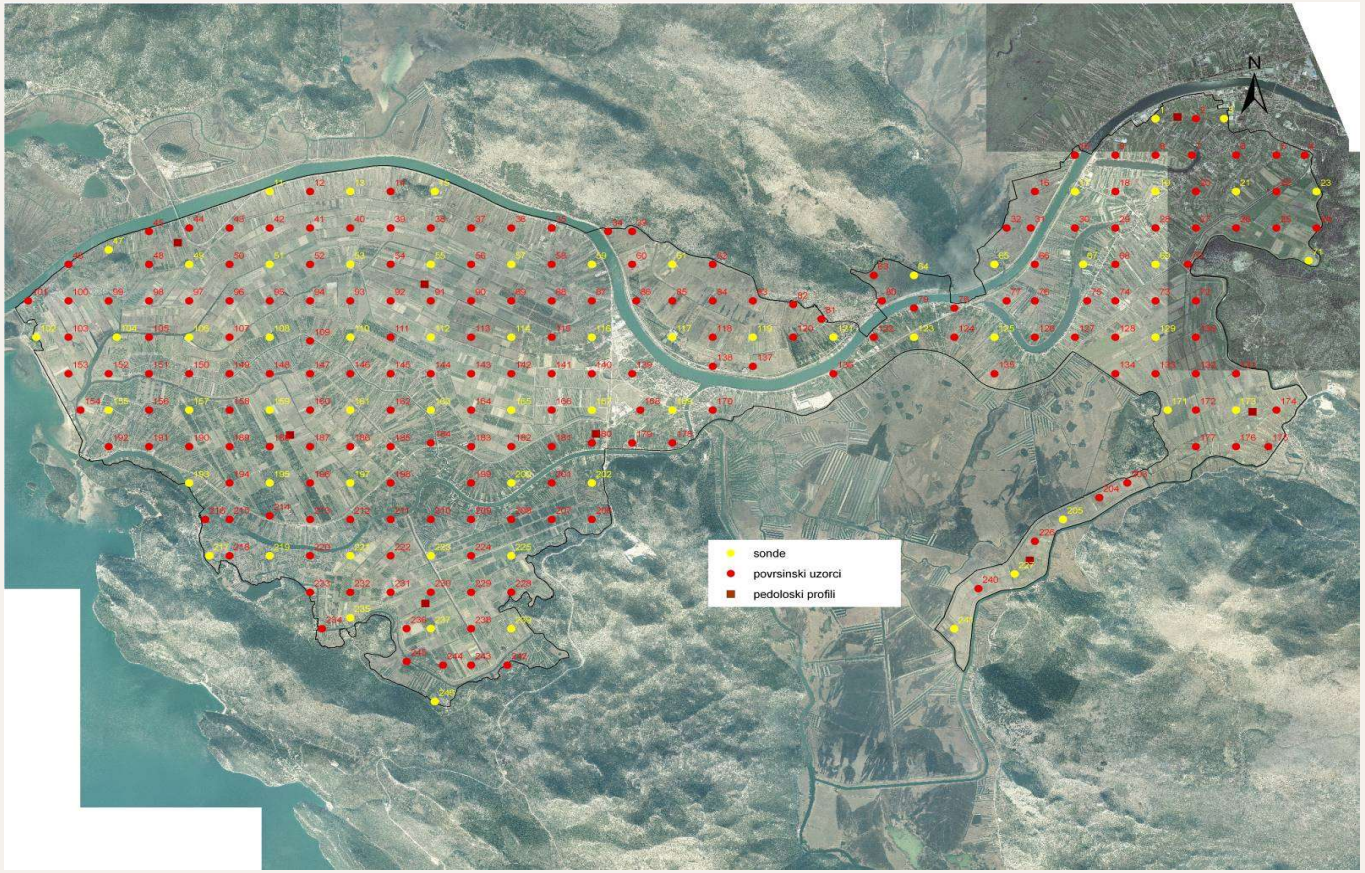
Pilot site - Croatia

High salinized groundwater at 1.5 – 2 m depth

Jasenska EC (dS/m) 2009 - 2022

Pilot site - Croatia

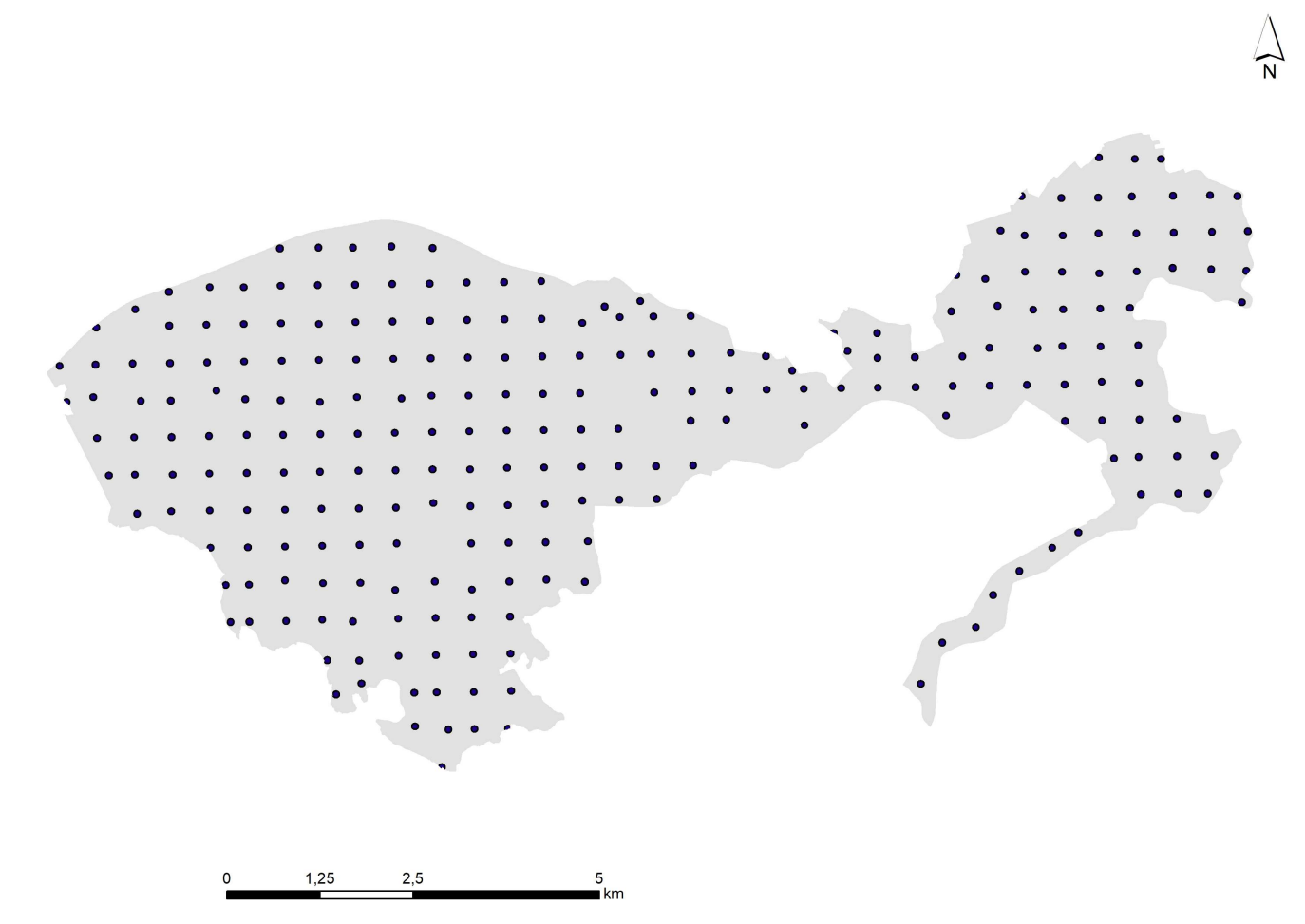
Soil sampling locations



Pilot site - Croatia

Surface soil (0-25 cm)
246 samples

- 500 m grid
- pH, ECe, ionic composition of the saturated paste
- CEC, particle size distribution
- Aqua regia elemental composition in mg/kg
- (Cd, Co, Cr, Cu, Mo, Ni, Pb, V, Zn,Mn, P, Na, Al, Ca, Fe, Mg, K)



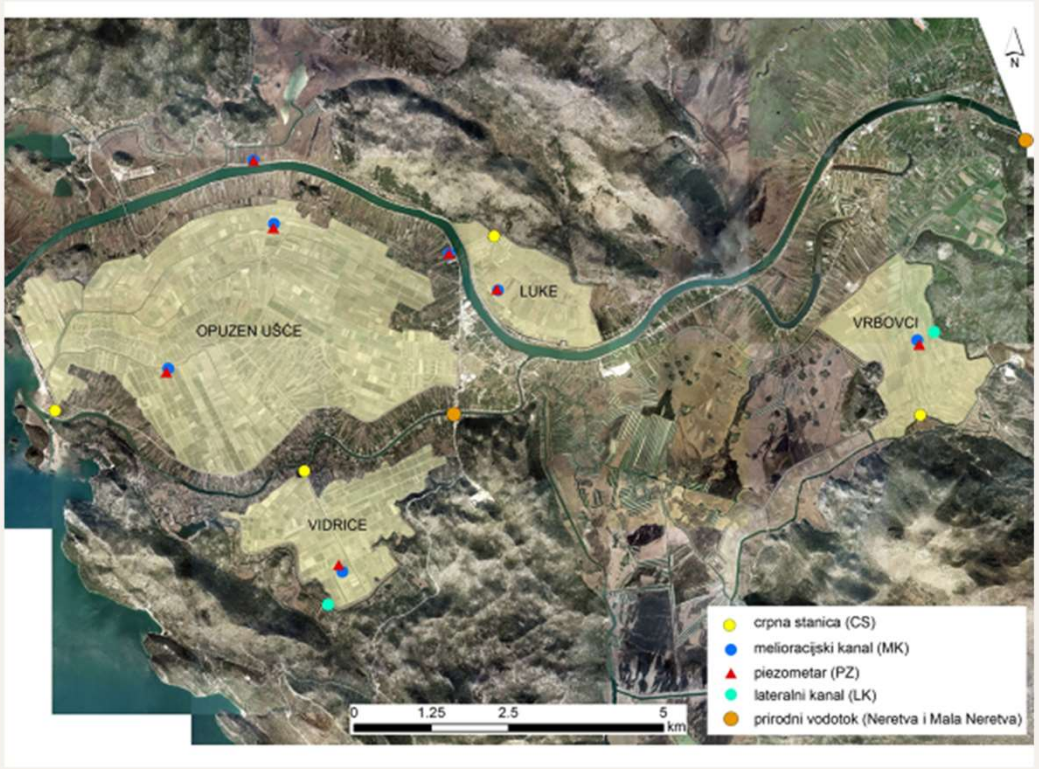
Pilot site - Croatia

Monitoring in the NRD

The monitoring network covers an area of 5 815 ha and includes four different polders with soil and surface and groundwater monitoring locations

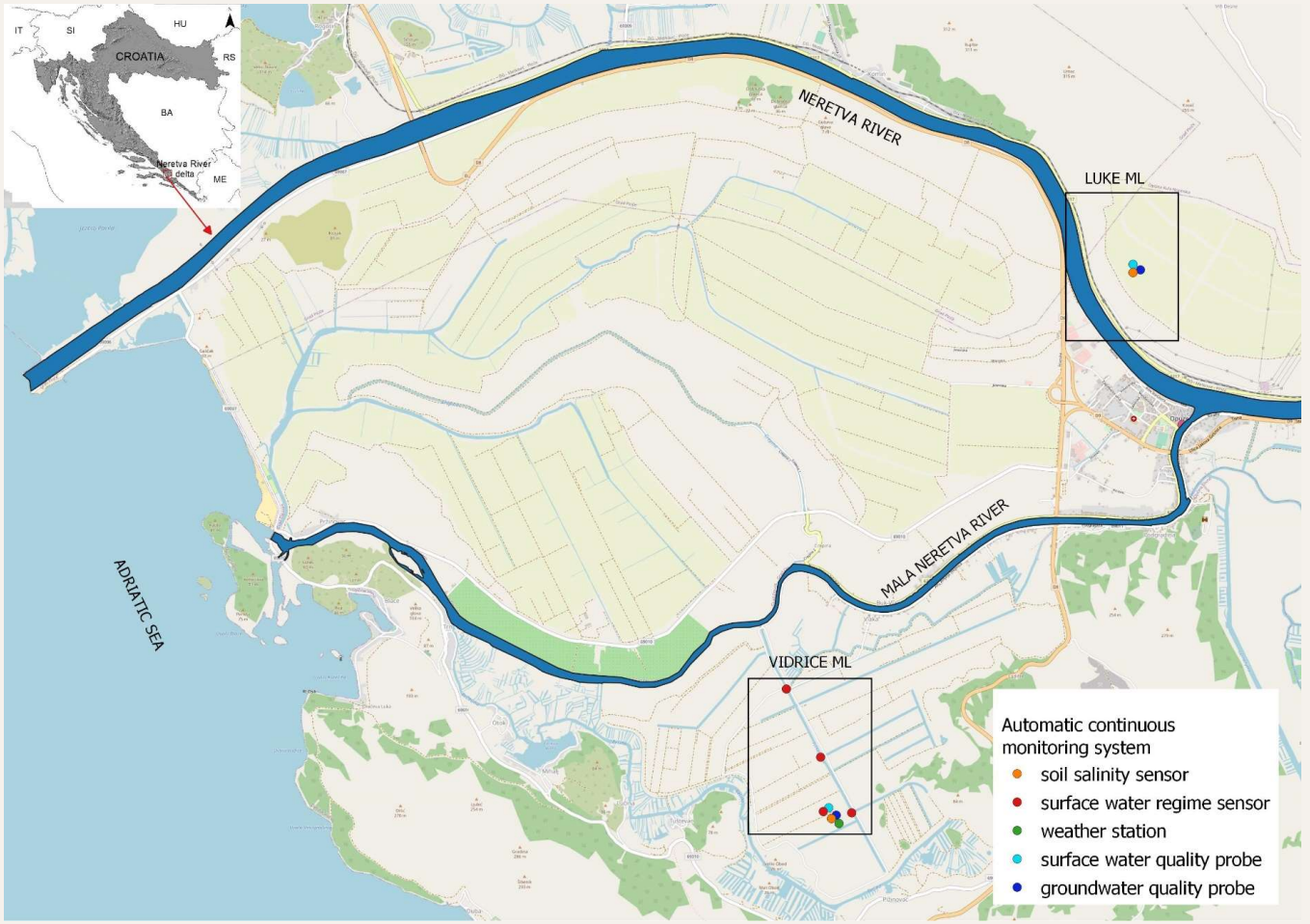
Soil sampling
- 7 locations
- 0-25, 25-50, 50-75, 75-100 cm
- Seasonal sampling 2x per year
- Soil salinity monitoring

Period
- 2010 - 2023



Pilot site - Croatia

Automated continuous monitoring



Pilot site - Croatia

Automated weather station

Parameters

- Air temperature (^{o}C)
- Relative air humidity (%)
- Wind (m/s)
- Global radiation (W/m^2)
- Precipitation (mm)

Temporal resolution

- 10 minutes

Pilot site - Croatia

Soil sensors

Parameters:

at 4 depths (every 25cm)

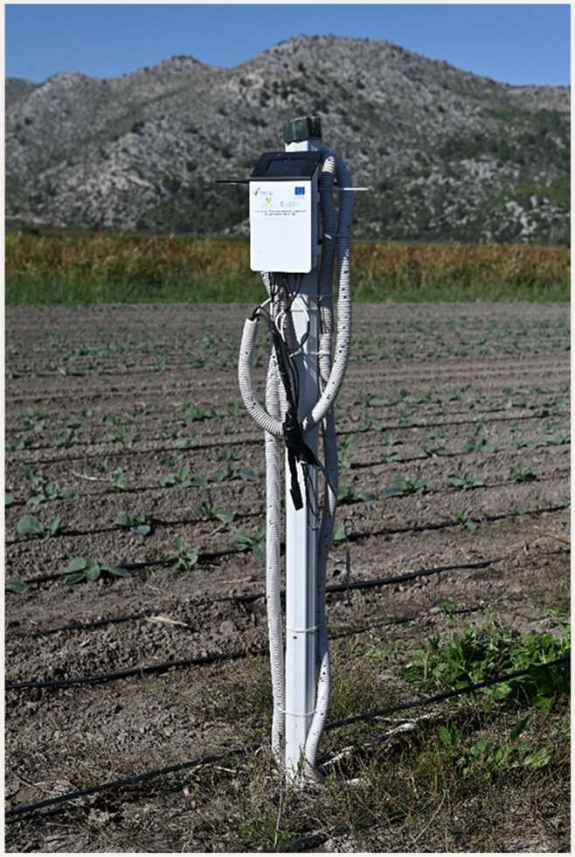
- Soil temperature (°C)
- Soil moisture (m^3/m^3)
- Electrical conductivity (dS/m)

at 2 depths (25cm and 50cm)

- Matrix potential (kPa)

Temporal resolution

- 10 minutes



Pilot site - Croatia

Water multiparameter probes

Parameters:

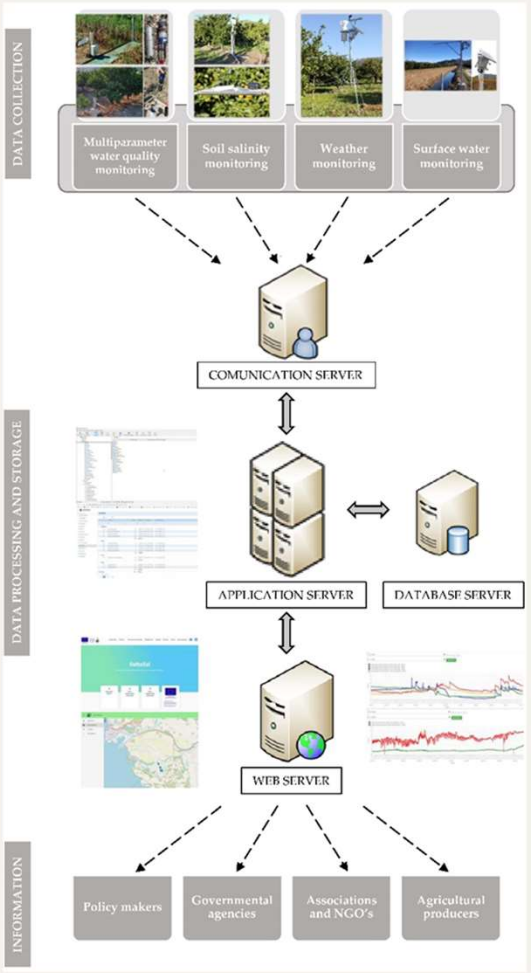
- Water depth (m)
- Water temperature (°C)
- Electrical conductivity (dS/m)
- pH
- ORP (mV)
- TDS (mg/l)
- Salinity (PSU)
- Seawater specific gravity (σT)
- Resistivity (Ωcm)

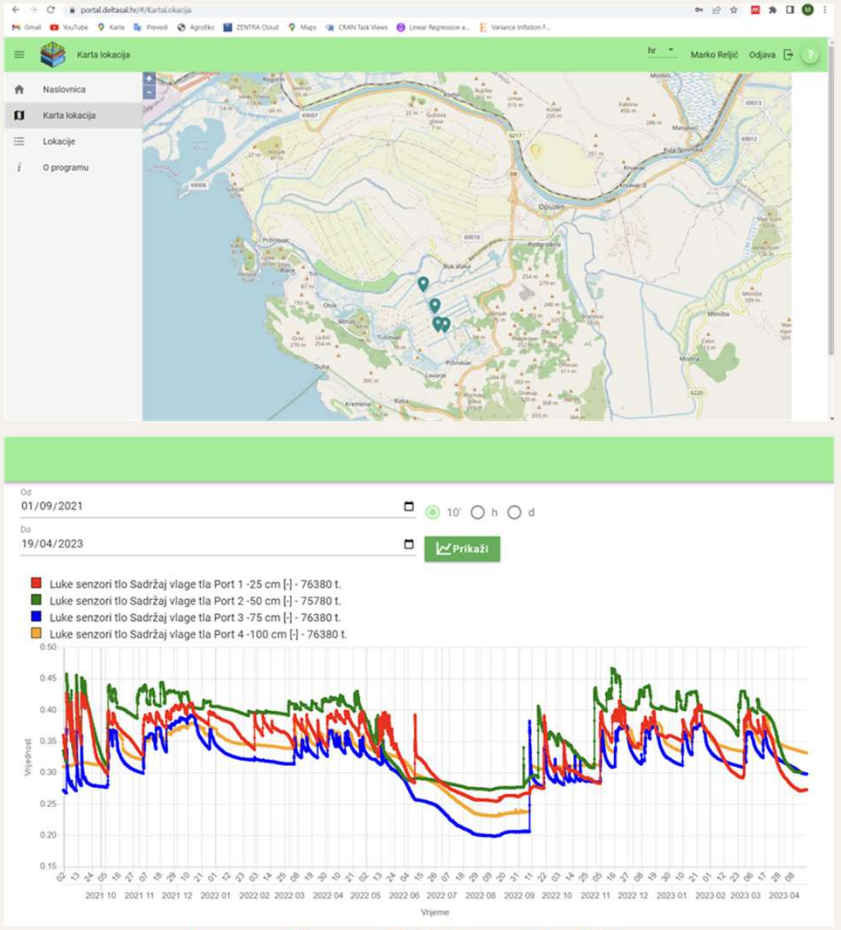
Temporal resolution

- 1 hour

Pilot site - Croatia

Data storage and usage



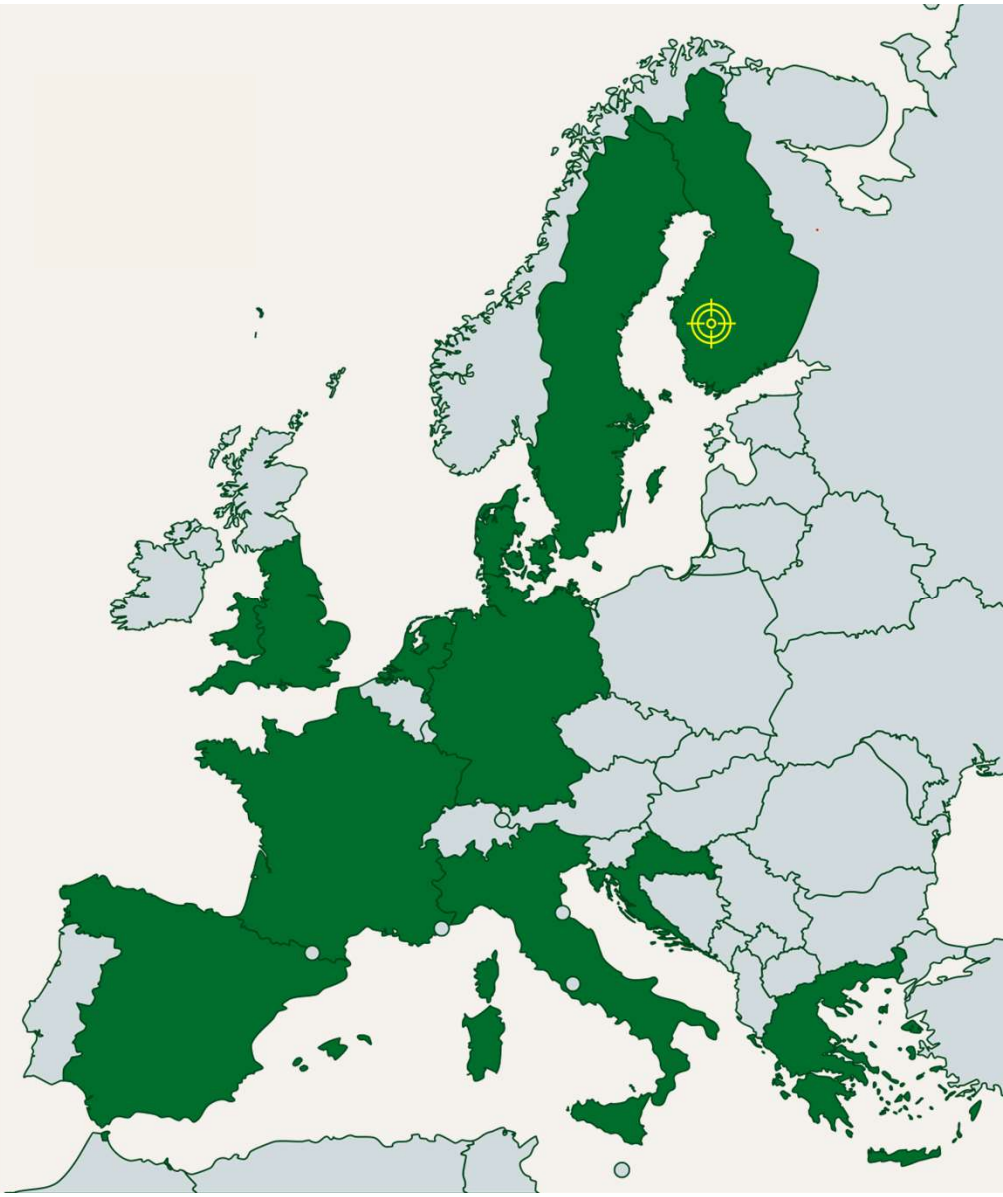


https://portal.deltasal.hr/#/

Pilot site - Finland

Luke
NATURAL RESOURCES INSTITUTE FINLAND

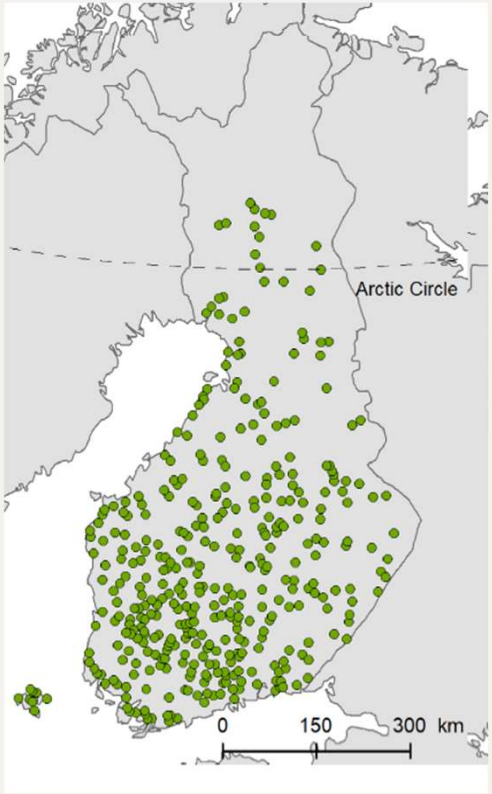
Location	Finland, south west
Pedo-climatic region	Boreal
Soil types	Clay soils
Management practices	Conventional and organic farming, livestock and arable
Actors	Researchers, farmers
Type	Existing network of pilot sites
Data / testing	Lon term field experiment data
Opportunity	Organic soils, greenhouse gases (sulphate, mineral and peat soils)



Pilot site - Finland

National soil monitoring network of arable soils (VALSE)

- Network established in 1974 (n = 2042), resampled in 1987 (n = 1362), 1998 (n = 720), 2009 (n = 611) and 2018 (n = 630; 480 original sites and 150 new sites)
  - Sampling site area 10 ×10 m
- Covers the arable area of the country
- Represents boreal zone with moist continental climate
  - Avg. temp. Jul between 8 and 18 °C, Feb between -14 and -2 °C
  - Annual precipitation ca. 500-550 mm
  - Young soils formed after the Weichselian glaciation
- Data exists on soil fertility throughout the monitoring (pH, soil test nutrients, selected harmful metals, total C)
  - From 2018 sampling: pesticide residues, microbial diversity
    - Amplicon sequence data of bacterial 16 S and fungal ITS2 barcoding regions (manuscript in preparation, Velmala et al.)
- Archived soil samples available

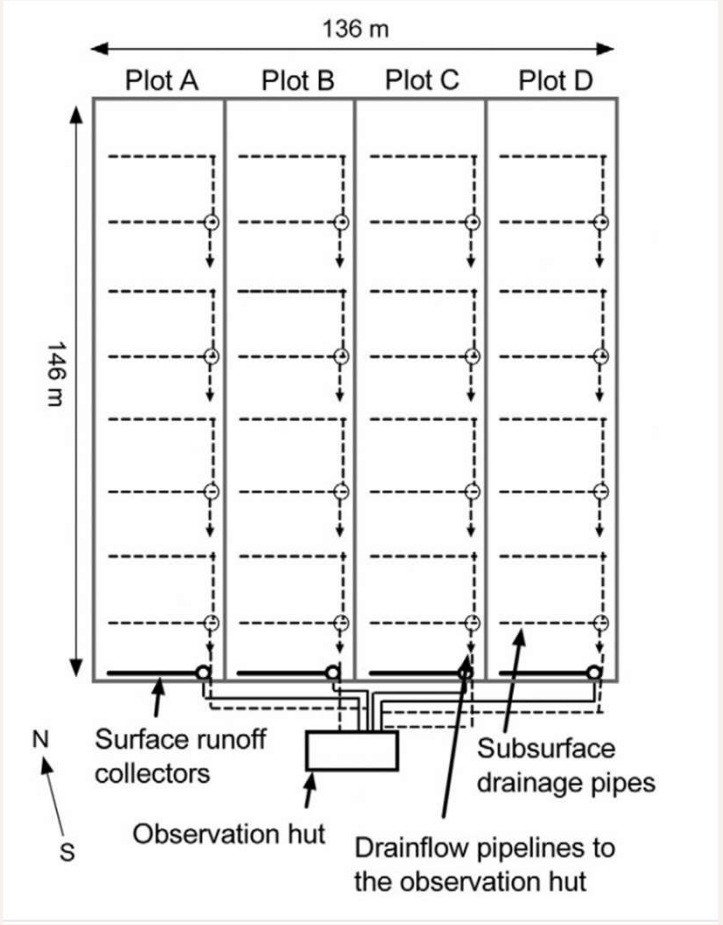


Heikkinen et al. 2022.
DOI: 10.1111/gcb.16164

Pilot site - Finland

Kotkanoja leaching field

- Four hydrologically isolated 0.5 ha plots in Jokioinen Southwest Finland on a clay soil
- The effects of different soil managements on erosion and nutrient leaching in surface runoff and subsurface drainage have been studied since autumn 1993
- Tillage treatments: moldboard ploughing vs. reduced tillage (no-tillage since 2008)
- Data available on discharge, soil properties, earthworm density, yield, records of cultivation measures
    - Amplicon sequence data of bacterial 16S and fungal ITS2 barcoding regions (Fritze et al. submitted ms)



Uusitalo et al. 2018
doi:10.2134/jeq2018.06.0242

Pilot site - Finland

Yöni leaching field

- Six 0.5 ha plots in Jokioinen Southwest Finland established progressively on a clay soil between 1990 and 1995
  - Since 2001 total discharge (surface runoff +subsurface drainage) collected and analysed from:
    - 2 plots under organic farming
    - 2 plots under conventional farming
    - 2 plots under natural grassland
- Additional plots not monitored for leaching losses
- Data available on discharge, erosion, N and P leaching, soil properties, yield levels, records of cultivation measures (all 14 plots: fertilization, tillage etc.)
  - GRSP (glomalin-related soil proteins) analyzed (Häkkinen et al, manuscript under preparation)

Pilot site - Finland

Toholampi leaching field

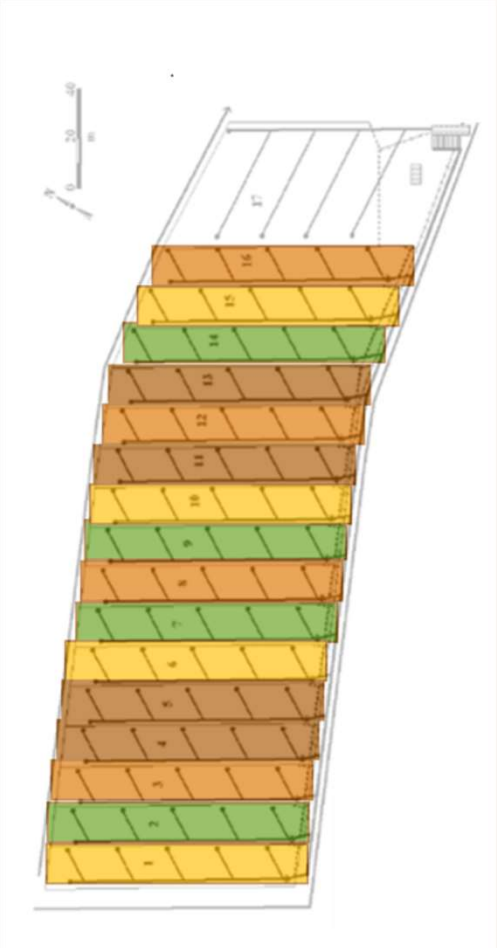
16 plots of 100 m × 16 m established on a sandy soil in Toholampi western Finland in 1997 for erosion and nutrient leaching studies

Comparing organic and conventional cropping systems between cereal and dairy farming

Data available: records of cultivation measures, yields, soil properties, discharge, erosion, N and P leaching

Begum et al. 2022: doi.org/10.3389/fenvs.2022.819162
Amplicon sequence data for arbuscular mycorrhiza, and soil bacteria, fungi, and fauna

Peltoniemi et al. 2021: doi.org/10.1016/j.ejsobi.2021.103314
Hagner et al. 2023: doi.org/10.1016/j.apsoil.2023.104944



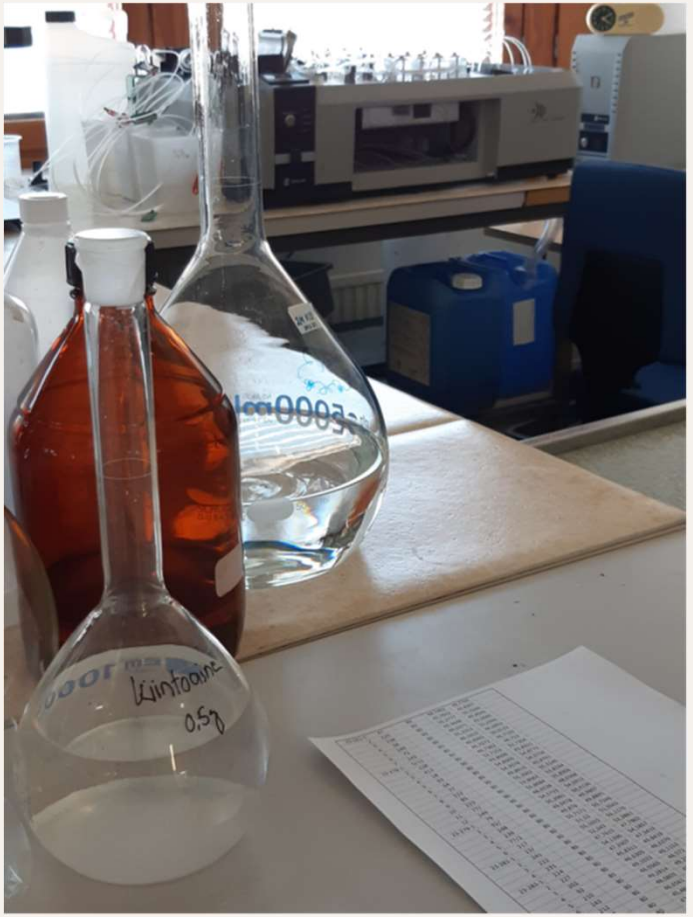
Hagner et al. 2023

Pilot site - Finland

Laboratory facilities at LUKE

- Soil-plant laboratory with basic equipment for analysing various soil extracts, plant material and fertilizer products
  - E.g., ICP-OES, ICP-MS, GC, FIA, Kjeldahl automatic distiller, TGA, CHNS element analyzer, DOC
  - Physical soil analyses
    - Water retention and conductivity, air permeability, rain simulation

- Spectral analysis:
  - NIR (800-2500 nm) BÜCHI NIRFlex N-500, Foss NIRS TM DS2500F
  - FTIR Shimadzu IRPrestige with ATR and PAS accessory

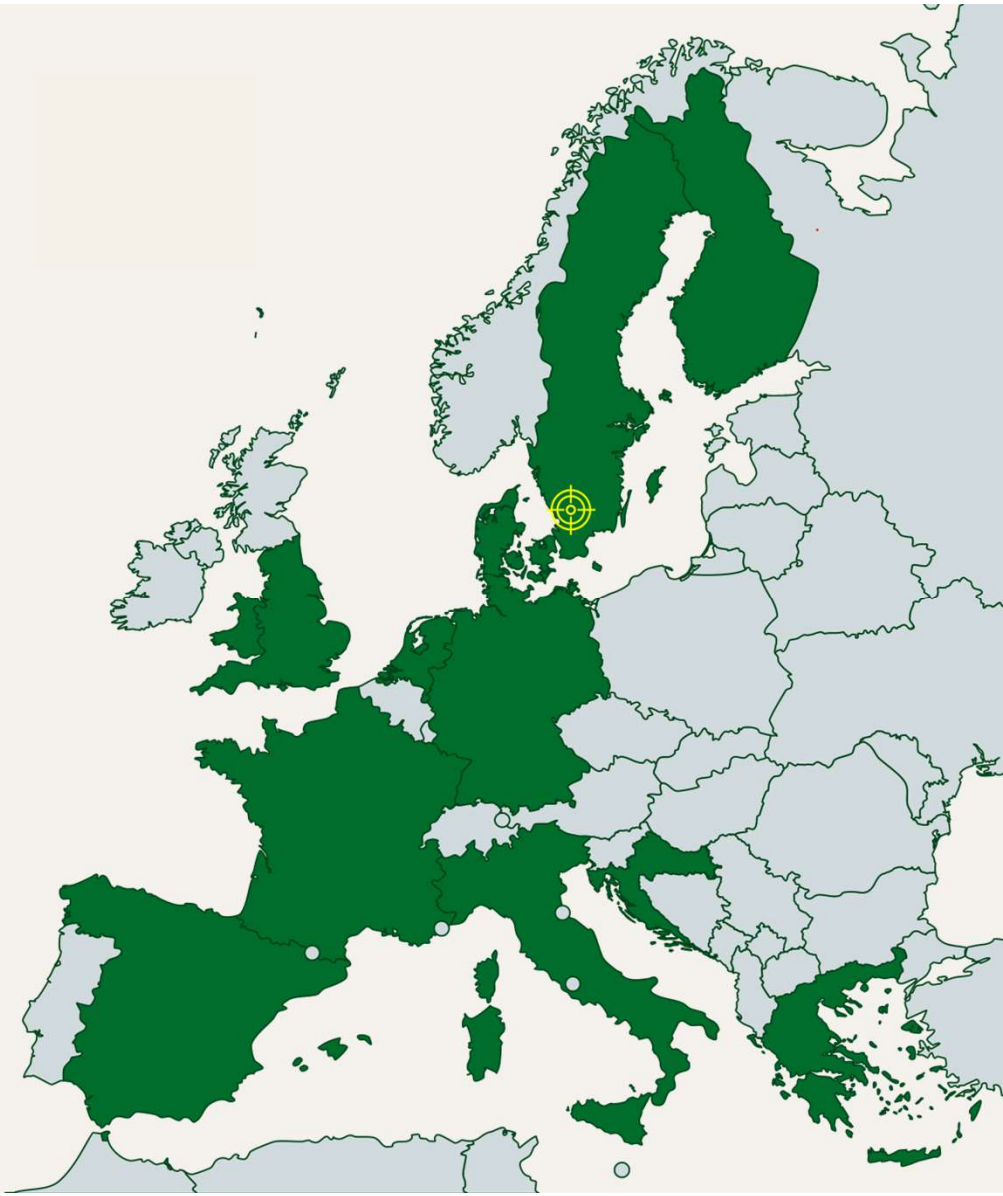


Pilot site - Sweden

Stockholm University

SLU
Swedish University of Agricultural Sciences

Location	Sweden, Lomma - Lönnstorp
Pedo-climatic region	Continental
Soil types	Clay soils
Management practices	Conventional (60 ha) and organic (18 ha) arable
Actors	Researchers, farmers, advisors
Type	Existing network of pilot sites, research station
Data / testing	Long term field monitoring, soil health properties, crop yields
Opportunity	Spectral parameters / monitoring – permanent spectral monitor installation



Pilot site - Sweden

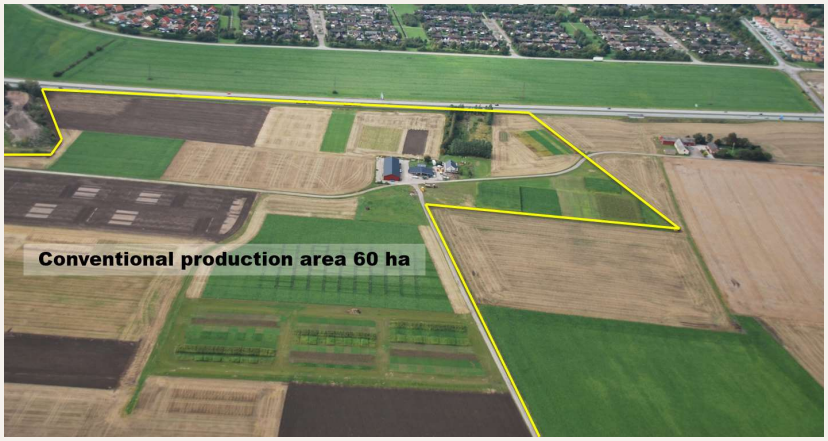
Open research sites run by the Swedish University of Agricultural Sciences in southern Sweden, situated in a periurban area east of Lomma between the E6/E20 motorway and the Södra stambanan railway.

Experimental research station established 1969, multiple experiments (open access). 60 ha conventional production area, 18ha organic farming area (certified organic in 1993, at the Alnarp campus), both with multiple plots.

There is a large number of on-going experiments at Lönnstorp, of which several are long-term. The SITES Agroecological Field Experiment (SAFE), a new large facility for research on future cropping systems, was established in 2015-2016. The facility is available for many types of studies, within for example plant and soil ecology, biogeochemistry and agroecology, and it is possible to establish smaller experiments within the facility.

https://www.slu.se/en/departments/biosystems-technology/research-facilites/lonnstorp/

Notes from surveys and online meetings and website provided



Pilot site - Sweden

Facts:

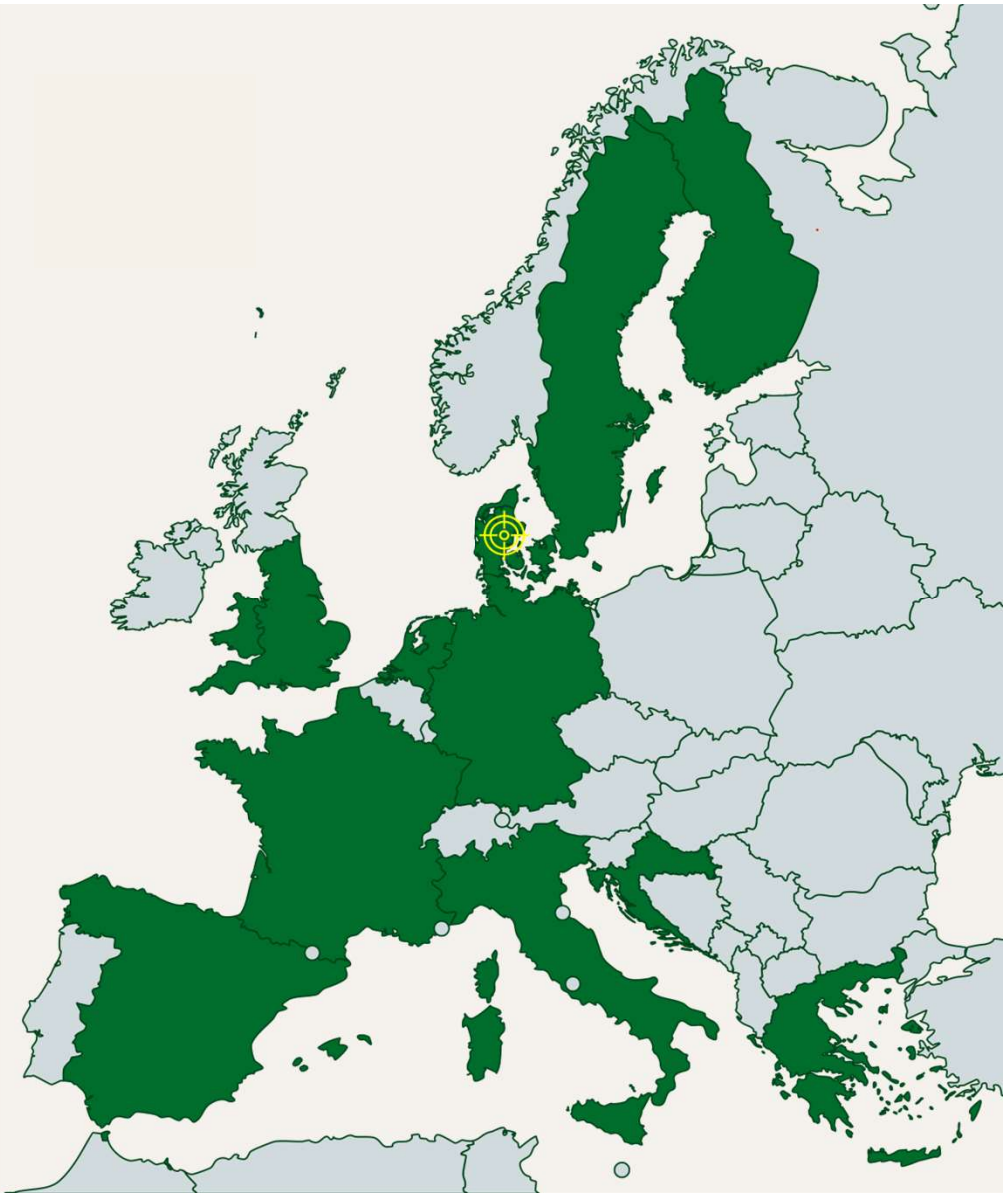
- *Main rotation on the 60ha conventionally farmed area:*
  winter wheat – sugar beets – spring barley – winter oilseed rape.
- *Rotation on the 18ha organically farmed area (certified by KRAV):*
  Spring wheat with undersown lucerne/grass mixture - Lucerne/grass ley – Winter oilseed rape – Winter wheat with undersown lucerne/grass mixture - Lucerne/grass ley – Faba bean intercropped with barley
- *Four systems on the 14ha SAFE experimental facility:*
  Perennial cereal, Agroecological intensification, Organic, Conventional
- The soil type is a loam with about 15 % clay and 3 % organic material

Notes from surveys and online meetings and website provided

Pilot region - Denmark

AARHUS UNIVERSITY

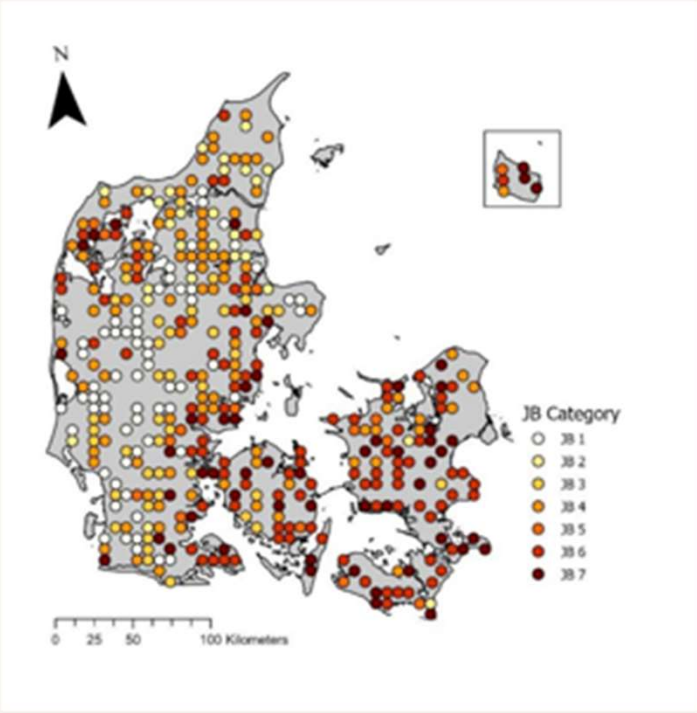
Location	Denmark
Pedo-climatic region	Atlantic North
Soil types	Sand, clay, peat soils
Management practices	7km grid monitoring Denmark, 250 sites on agricultural land
Actors	Farmers, advisors
Type	Existing network of pilot sites
Data / testing	Long term large dataset - soil health properties, subset peat areas c. 1000+ samples
Opportunity	Soil physical properties, new peat monitoring areas



Pilot region - Denmark

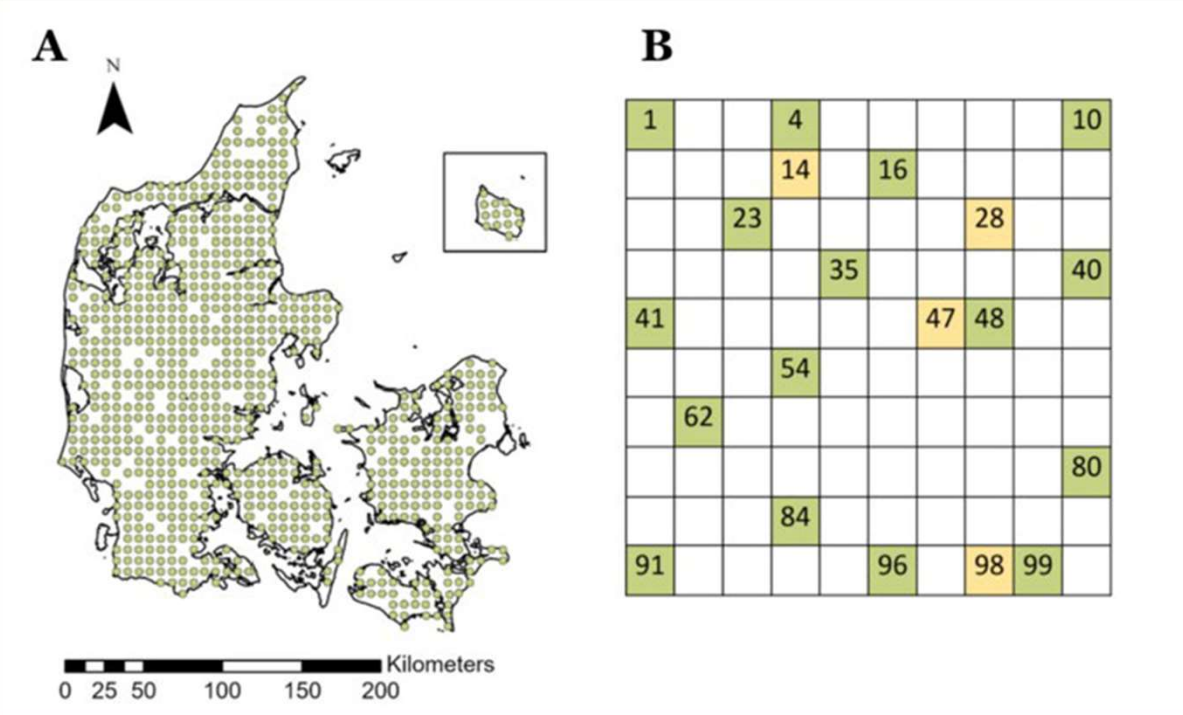
Danish national soil grid

Between 1987 and 1989, the Danish National Soil grid detailed soil profile investigations were based on the 7 km grid .This meant that exactly 7 km separated each site to be investigated, There were 835 sampling sites: 672 on arable land, 116 on woodland, and 47 on heathland or meadows. Hence, a comprehensive, national, soil profile database has been established. The Grid covers all soil types dominated by Luvisoil and Podsols. The domination landscape is Weischelian moraine.



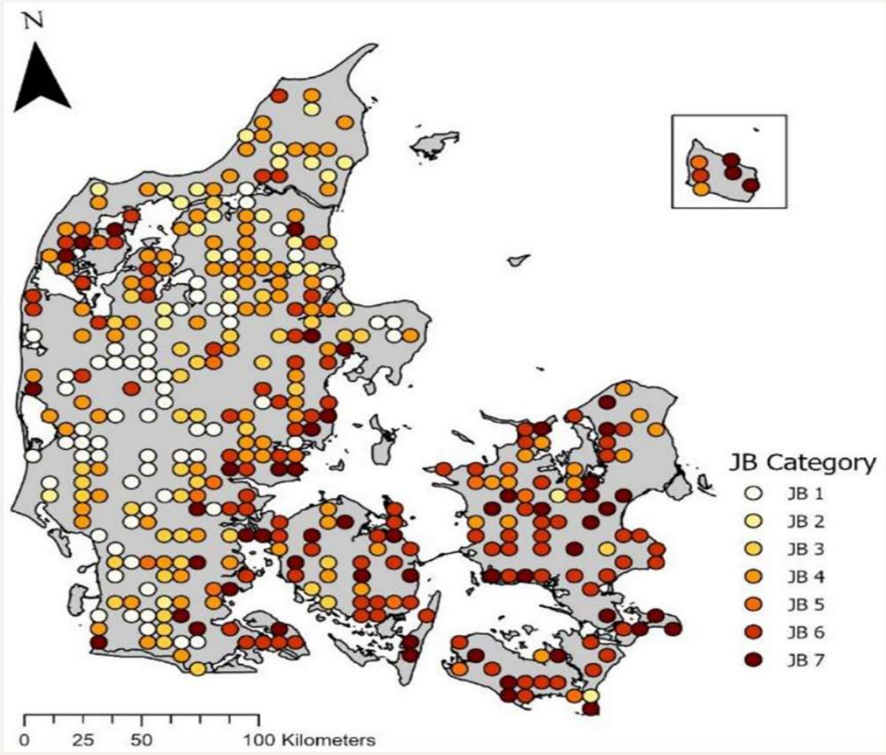
Pilot region - Denmark

- National soil monitoring network
- 7 km x 7 km
- 16 cores pooled together
  - Topsoil: 0-25 cm
  - Subsoil: 25-50 cm
  - Deep soil: 50-100 cm (not included)



Pilot region - Denmark

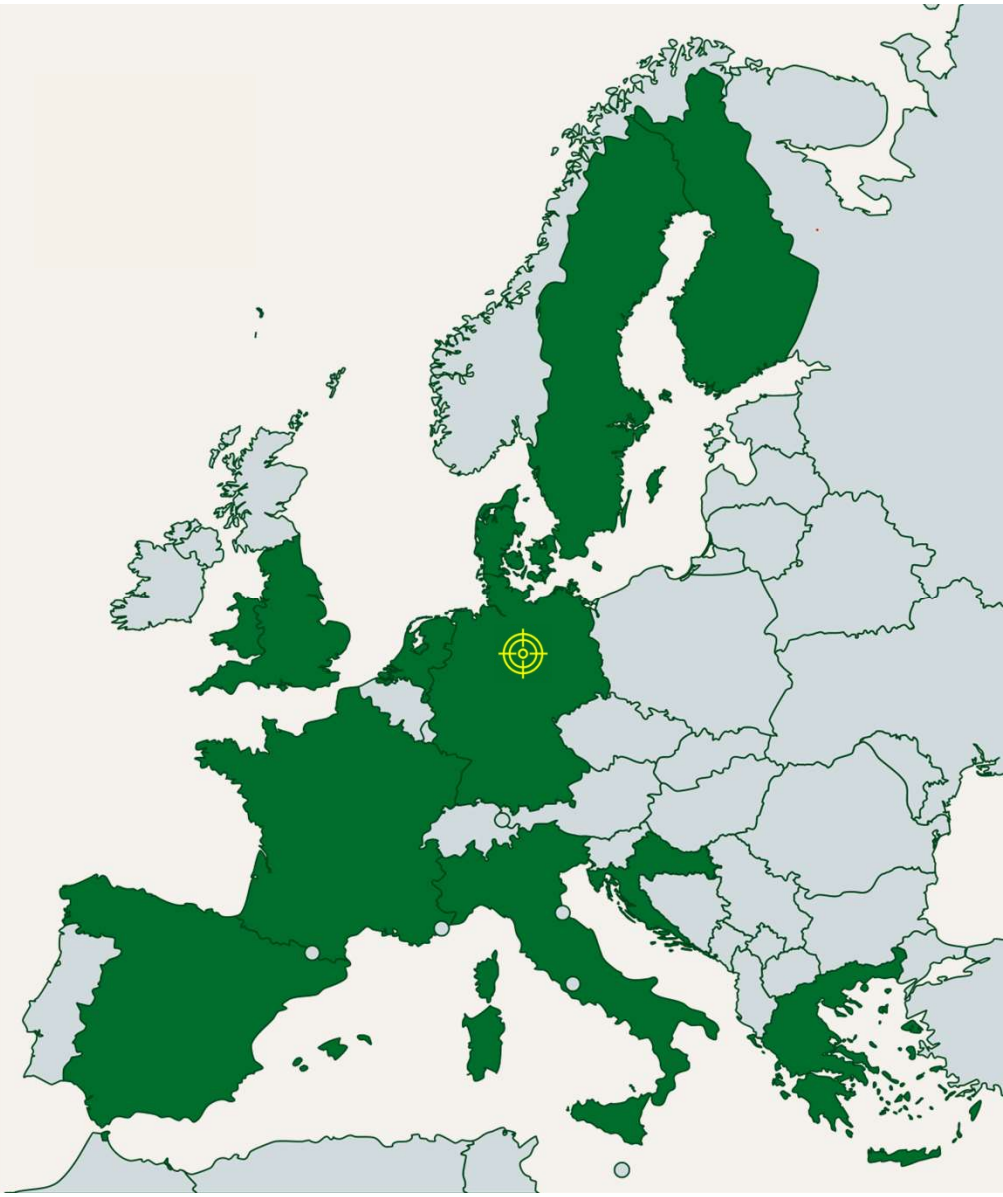
- National soil monitoring network
- 7 km x 7 km
- 16 cores pooled together
  - Topsoil: 0-25 cm
  - Subsoil: 25-50 cm
  - Deep soil: 50-100 cm (not included)
- JB categories 1-7
- 1985: 700 sites
- 2009: 507 sites
- 2019: 406 sites
- All years: 352 sites



Pilot region - Germany

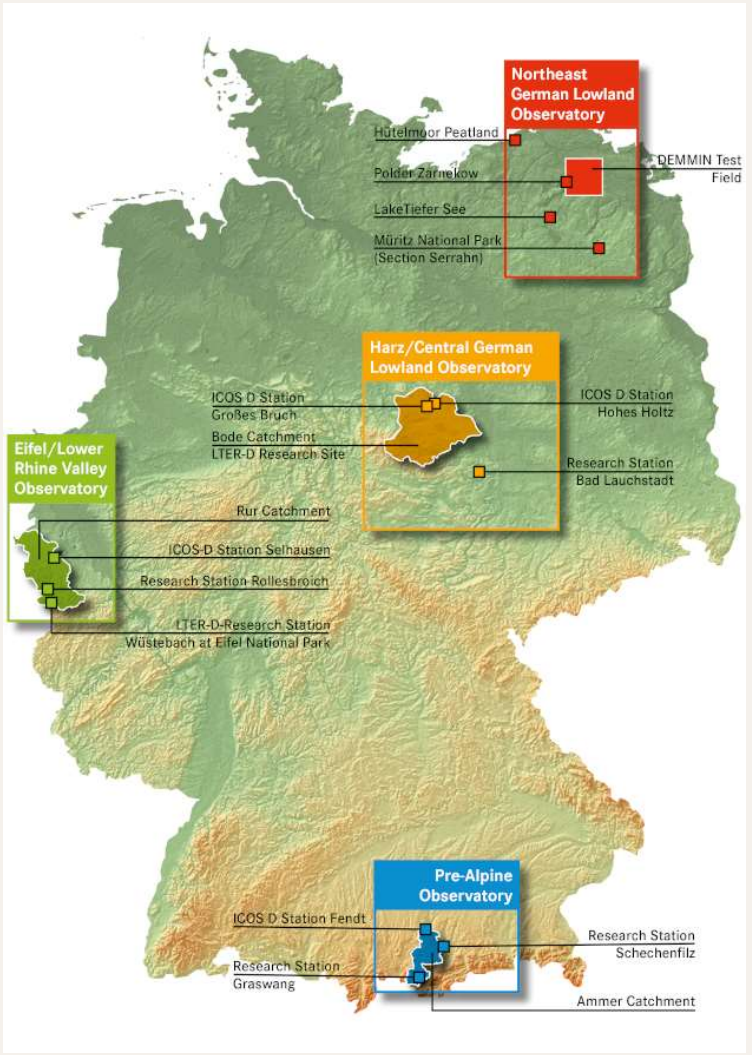
TERENO
TERRESTRIAL ENVIRONMENTAL OBSERVATORIES

Location	Germany, region - North German lowlands to Bavarian alps
Pedo-climatic region	Atlantic north, Continental, Alpine South
Soil types	Temperate brown and deep brown soils, sandy soils – mainly podsols
Management practices	Multiple regional; agriculture, urban, peri-urban, forest etc
Actors	Multiple; scientists, researchers, land owners, policy makers, coordination teams
Type	Earth observation network across Germany
Data / testing	Data Management, environmental testing, atmosphere, pedosphere, hydrosphere, biosphere, urban system, paleo climate
Opportunity	Large data sets and national scale, integrative modelling



Pilot region - Germany

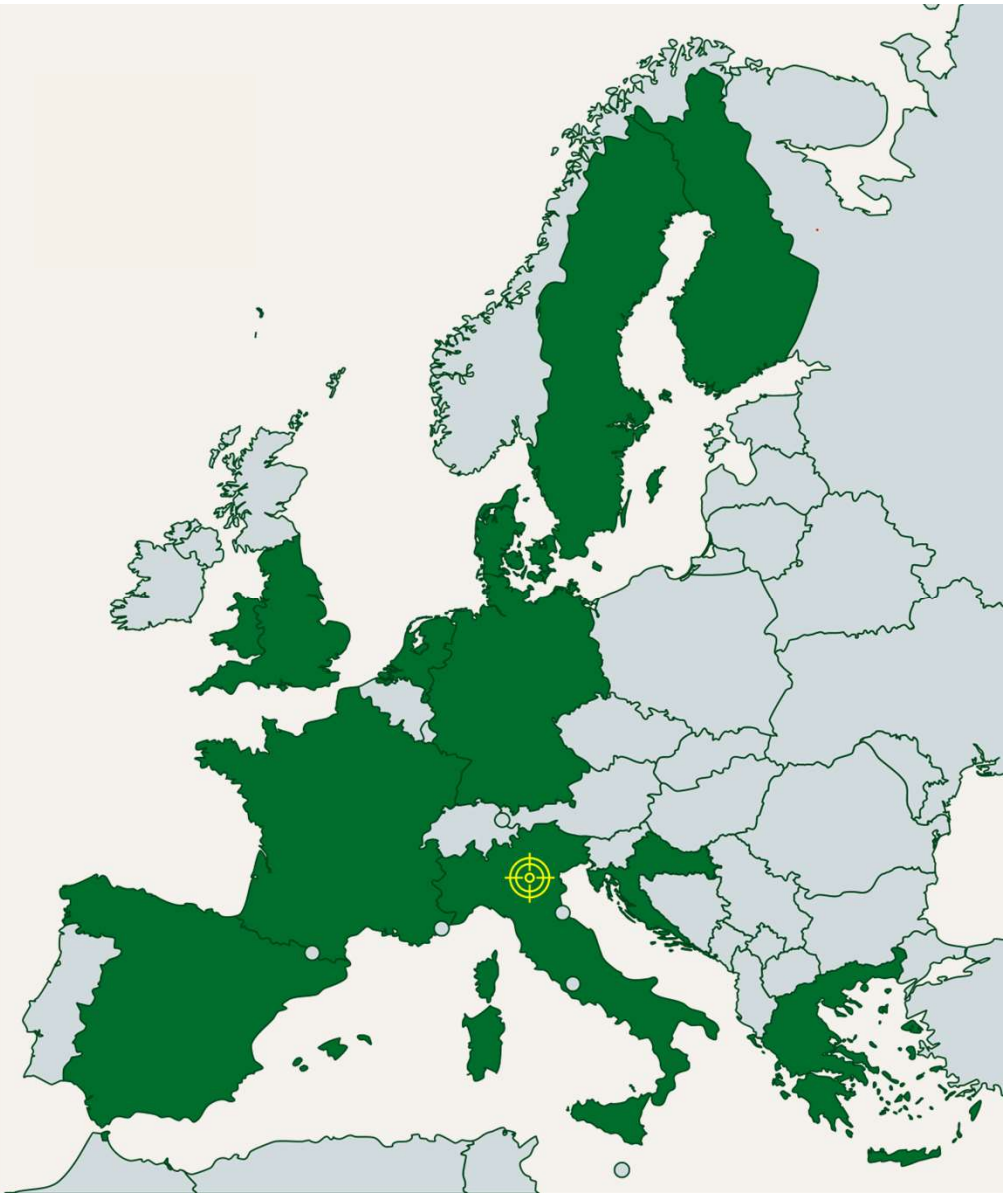
AI4SoilHealth project (WP6 / WP5) are exploring a potential relationship with TERENO for data and collaboration.
This activity is ongoing.



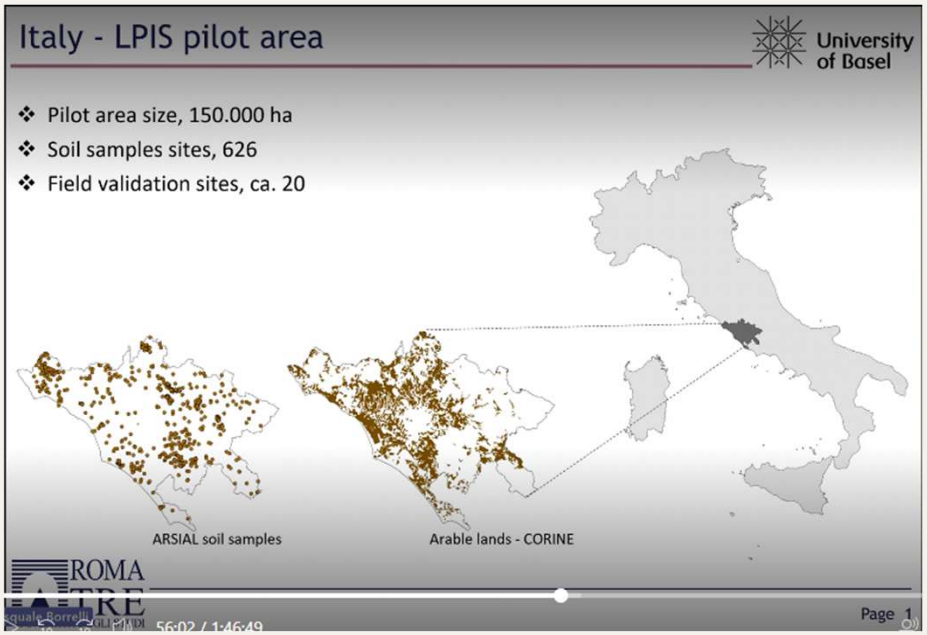
Pilot region - Italy

ROMA TRE
UNIVERSITÀ DEGLI STUDI

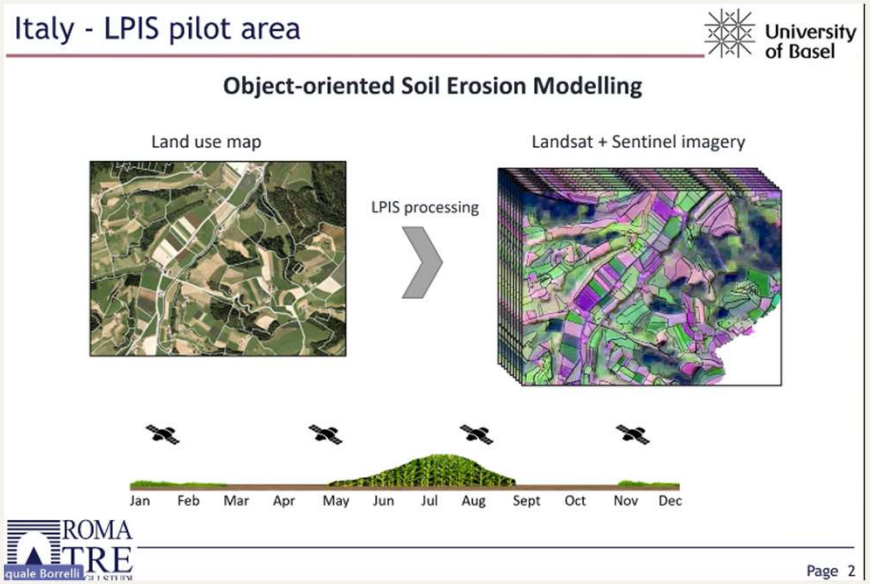
Location	Italy, regional (Lombardy)
Pedo-climatic region	Mediterranean North, Mediterranean mountains
Soil types	Cambisols, luvisols, podzols
Management practices	Varied across regions – national data sets and validation of erosion modelling approaches
Actors	Land owners, farmers, policy makers, water catchments, citizens – for erosion mapping / drones
Type	New regional areas – focus on soil erosion but potential in future for other variables e.g. carbon and nutrients
Data / testing	Use of Copernicus and LUCAS – enhanced land cover and management factors, revised universal soil loss equation (RUSLE)
Opportunity	Soil erosion modelling (LPIS), JRC collaborator



Pilot region - Italy



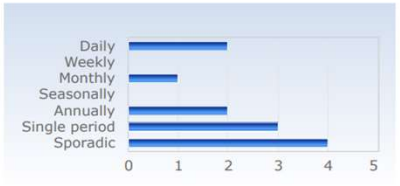
Note: Slides screenshots from internal presentation recording



Work package synergies

18. Approximate frequency of historical data collection (for active datasets collected as part of AI4SoilHealth, the planned frequency will be given separately):

Approximate frequency of historical data collection (for active datasets collected as part of AI4SoilHealth, the planned frequency will be given separately):	Number of responses
Daily	2 (16,7%)
Weekly	0 (0,0%)
Monthly	1 (8,3%)
Seasonally	0 (0,0%)
Annually	2 (16,7%)
Single period	3 (25,0%)
Sporadic	4 (33,3%)
Total	12 (100,0%)



Part 4. Spatial resolution of all in-situ datasets (legacy, ongoing, upcoming)

19. Representative horisontal spatial scale for single sample/grid cell:

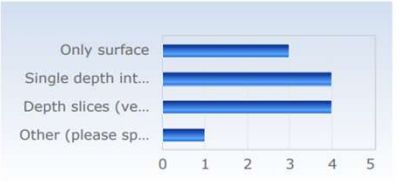
Representative horisontal spatial scale for single sample/grid cell:	Number of responses
cm	0 (0,0%)
dm	0 (0,0%)
m	3 (30,0%)
m*10	0 (0,0%)
m*100	2 (20,0%)
km	5 (50,0%)
Total	10 (100,0%)

WP4 in-situ / data survey

WP6 collaborated with feeding into questions of survey and pilots' completed survey and provided information needed

20. Vertical resolution of single sample point/grid cell:

Vertical resolution of single sample point/grid cell:	Number of responses
Only surface	3 (25,0%)
Single depth integrated sample (depth given in pop-up)	4 (33,3%)
Depth slices (vertical slices given in pop-up)	4 (33,3%)
Other (please specificy in comment)	1 (8,3%)
Total	12 (100,0%)



Comment
The idea is to use the same depth as LUCAS
Sensors that monitored soil temperature, moisture and ECa were installed at four depths, every 25 cm up to 100 cm of the soil profile
differs per variable
different depth increments (usually 4), most down to 1m, fewer down to more than 2m

Work package synergies

WP3 soil health indicators

WP6 collaborating with pilot site information matrix, including soil health indicators and existing and future potential mapping

			Indicator channels							
	Pilot site contribution	Spatial variation?	1. Pollutants, nutrients and salts	2. Soil organic carbon	3.Soil structure, bulk density, erosion	4. Soil biodiversity (WP4)	5. Soil nutrients and pH (WP5 link)	6. Vegetation cover	7. Landscape heterogeneity	8. Area of forest and other woodland
Country	Pilot site name									
Finland	National soil monitoring programme			x		x				
	Long-term leaching fields		x		x					
Croatia	5815 ha river delta		x				x			
France	Field-plot trials									
Netherlands	1200 ha farmland		x					x		x
	Continuous monitoring pof parcels									
Spain	Rotational grazing experiment in blocks									
	Farmlands (x4)- 5-20 plots each									
	18.000 already samples?			x		x				
UK	UK long-term monitoring		x	x						
	Research catchment areas									
	Sheep catchment area									
Italy	Pilot site area				x			x?	x?	
Greece	1 ha parcell									
	60 ha pine yards									
	… soil spectroscopy?									
Sweden	Conventional versus organic plots			x	x					
Denmark	7 km square grid			x	x	x	x			
	Sinks			x						
	MFD			x		x	x	x		


AI
DATA
CUBE