



EUROPEAN UNION

EUROPEAN MISSION SOIL WEEK

Welcome and opening

21-23 November 2023



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#MissionSoilWeek #MissionSoil #EUMissions





EUROPEAN UNION

EUROPEAN MISSION SOIL WEEK

Welcome and opening

Arwyn Jones

Deputy Head of Unit at the Land Resources and Supply
Chain Assessments Unit, Joint Research Centre,
European Commission

23 November 2023



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MINISTERIO
DE CIENCIA
E INNOVACIÓN

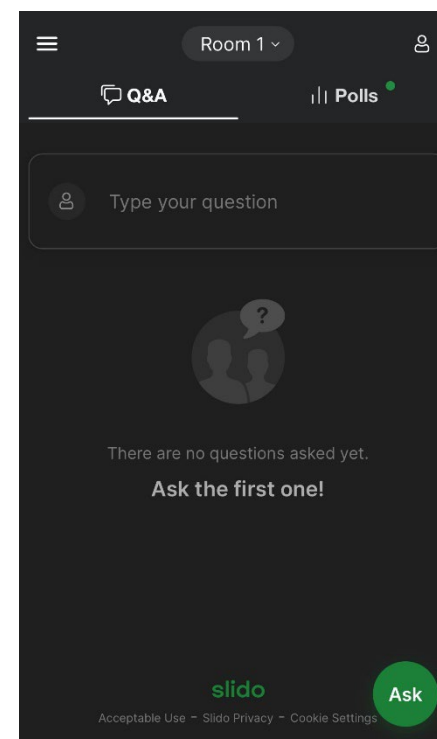


Housekeeping rules

- **WIFI**
 - Network : EMSW
 - Password : Mission.Soilw3ek2023
- **Questions**
 - Go to www.sli.do and enter event code **#ESMW2023** (or scan the QR code)
 - Select the 'room' of the session
 - Submit your questions



EUROPEAN
MISSION SOIL
WEEK



#MissionSoilWeek **#MissionSoil** **#EUMissions**



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EUROPEAN MISSION SOIL WEEK

Programme Day 3 - Thursday, 23 November

Time	Session Name	Building name
9:30 – 10:00	The EU Soil Observatory	<i>Main hall – Building A</i>
10:15 – 11:00	Assessing soil health at different scales across Europe	
11:00 – 11:30	<i>Coffee Break</i>	
11:30 – 13:00	Soil monitoring and indicators	
13:00 – 14:00	<i>Lunch Break</i>	
14:00 – 15:30	Outcomes of the EUSO Working Groups (WG)	
15:30 – 16:15	Closing ceremony	
16:15 – 17:15	<i>Cocktail & Networking</i>	



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**EU Soil Observatory (EUSO):
State of play, developments, and achievements**

Panos Panagos

Scientific Officer at the Land Resources and Supply
Chain Assessments Unit, Joint Research Centre,
European Commission

23 November 2023



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EU Soil Observatory – Second year

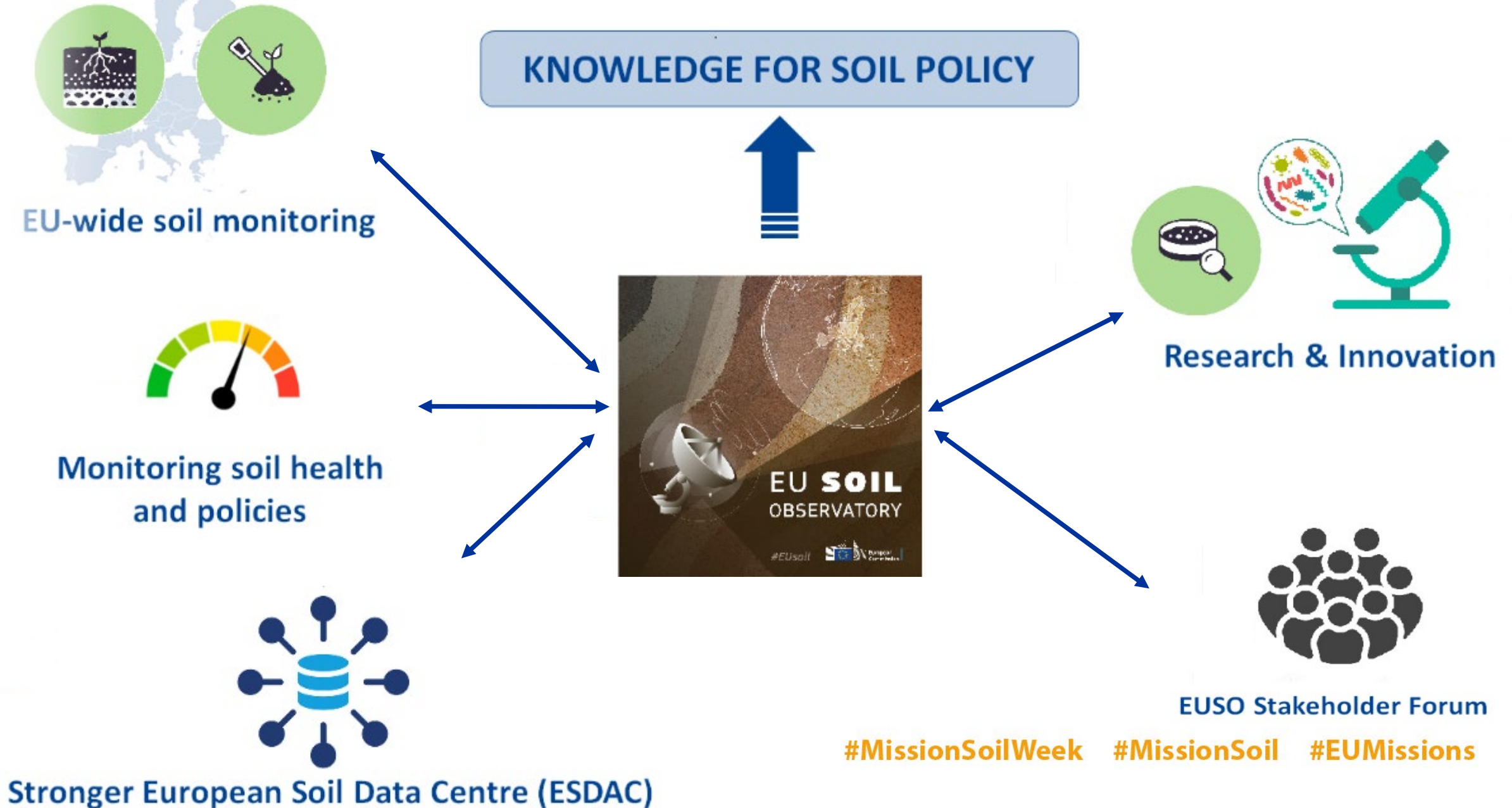


 #EUSO

<https://esdac.jrc.ec.europa.eu/euso>

**EU SOIL
OBSERVATORY**

The EU Soil Observatory (EUSO)



Framework for Soil Protection in the EU



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EU Soil Observatory – Second year



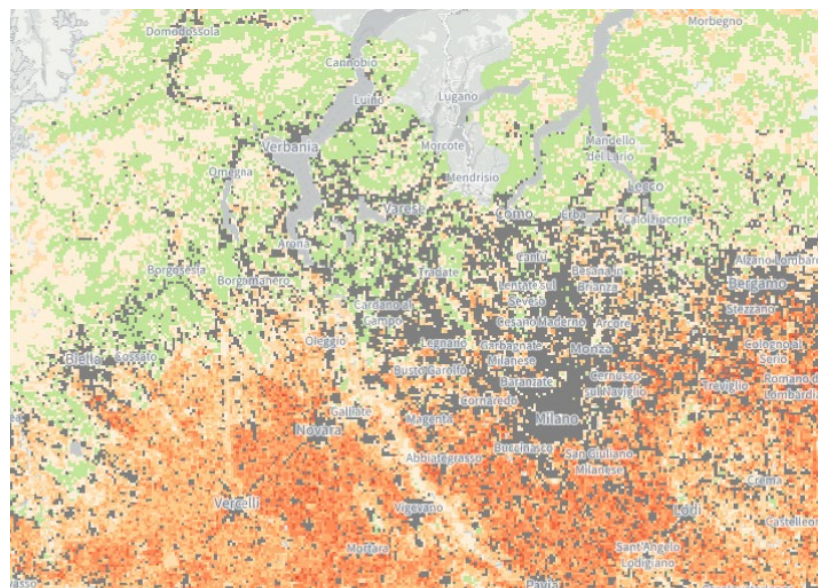
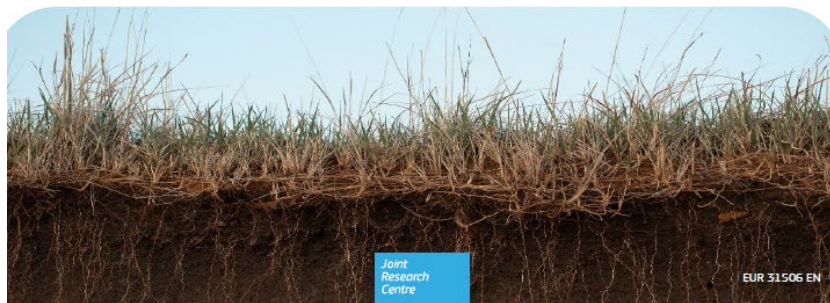
JRC Technical Report

EUSO Annual Bulletin

A review of 2022 activities

Maréchal, A; Panagos, P; Jones, A; Arias Navarro, C; Ballabio, C; Beltrandi, D; Breure, T.; De Medici, D.; De Rosa, D.; Fendrich, A.; Koeninger, J.; Labouyrie, M.; Liakos, L.; Martin Jimenez, J.; Matthews, F.; Montanarella, L.; Muntwyler, A.; Orgiazzi, A.; Scarpa, S.; Schillaci, C.; Simoes Vieira, D.; Van Eynde, E.; Van Liedekerke, M.; Wojda, P.; Yunta Mezquita, F.

2023



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<https://publications.jrc.ec.europa.eu/repository/handle/JRC133346>



Brussels, 5.7.2023
COM(2023) 416 final
2023/0232 (COD)

Proposal for a

DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

on Soil Monitoring and Resilience (Soil Monitoring Law)

{SEC(2023) 416 final} - {SWD(2023) 416 final} - {SWD(2023) 417 final} -
{SWD(2023) 418 final} - {SWD(2023) 423 final}



Brussels, 5.7.2023
COM(2023) 416 final
ANNEXES 1 to 7

ANNEXES

to the proposal for a Directive of the European Parliament and of the Council

on Soil Monitoring and Resilience (Soil Monitoring Law)

[...]

{SEC(2023) 416 final} - {SWD(2023) 416 final} - {SWD(2023) 417 final} -
{SWD(2023) 418 final} - {SWD(2023) 423 final}

Contribution to the Soil Monitoring Law

Brussels, 5.7.2023
COM(2023) 416 final
2023/0232 (COD)

- Close interaction with DG ENV and EEA in the context of the proposed **Soil Monitoring Law**

Proposal for a

DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

on Soil Monitoring and Resilience (Soil Monitoring Law)

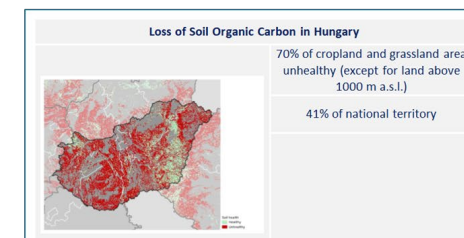
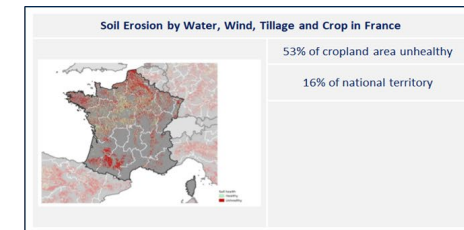
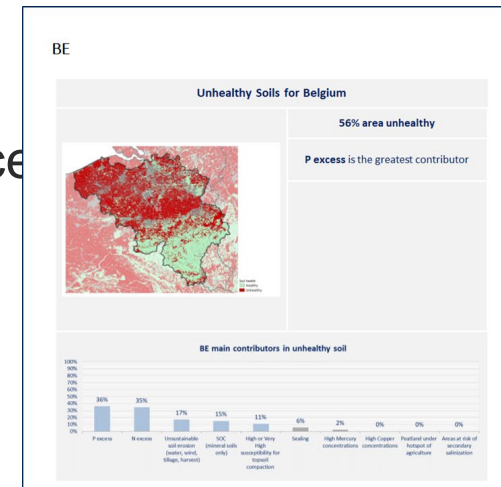
{SEC(2023) 416 final} - {SWD(2023) 416 final} - {SWD(2023) 417 final} -
{SWD(2023) 418 final} - {SWD(2023) 423 final}

- Responses to 100+ technical and conceptual questions

- Supporting the need for action on soil (scientific evidence)

- Support to the Impact Assessment

- Support to triilogue process



Contribution to soil related policies

- Assessment - evaluation of the **Soil Mission**
- Contribution to the **Nature Restoration Law**
- Coordination of **Clean Soil Outlook**
- Contribution to **Carbon Removal Certification**
- Contribution to the review of **CAP Performance indicators** (Soil Organic Carbon)
- **Farm2Fork**: pesticides & nutrient management indicators

#MissionSoilWeek **#Miss**



COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL,
THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE
REGIONS

EU Missions two years on: assessment of progress and way forward

{SWD(2023) 260 final}

COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL,
THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE
REGIONS

EU Missions two years on: assessment of progress and way forward





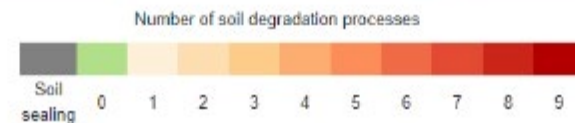
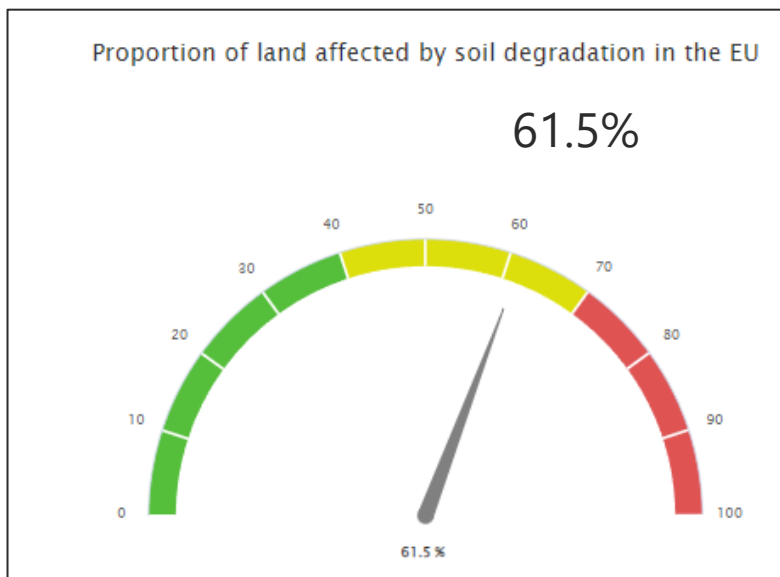
Monitoring soil health and policies

Assessing Policy Impact

EUSO Soil Dashboard

Convergence of scientific evidence

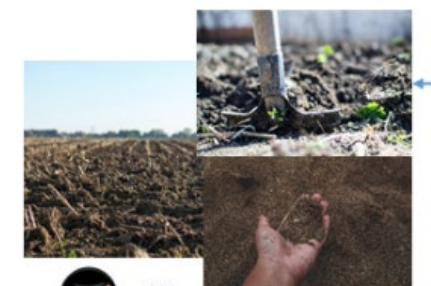
- At least 61.5 % of unhealthy soils
- Dashboard shows location and different types of soil degradation in the EU



[#MissionSoilWeek](#) [#MissionSoil](#) [#EUMissions](#)

EU-wide soil monitoring

- Conclusion of the **LUCAS 2022** campaign with EJP-Soil members
- Fine tuning of laboratory analysis to reflect needs of Soil Monitoring Law
- Contribution to EEA Zero Pollution Monitoring Report
- Publication of novel datasets
- LUCAS as a model for
 - Norway, NorForSoil, PRIMA Projects (Mediterranean)

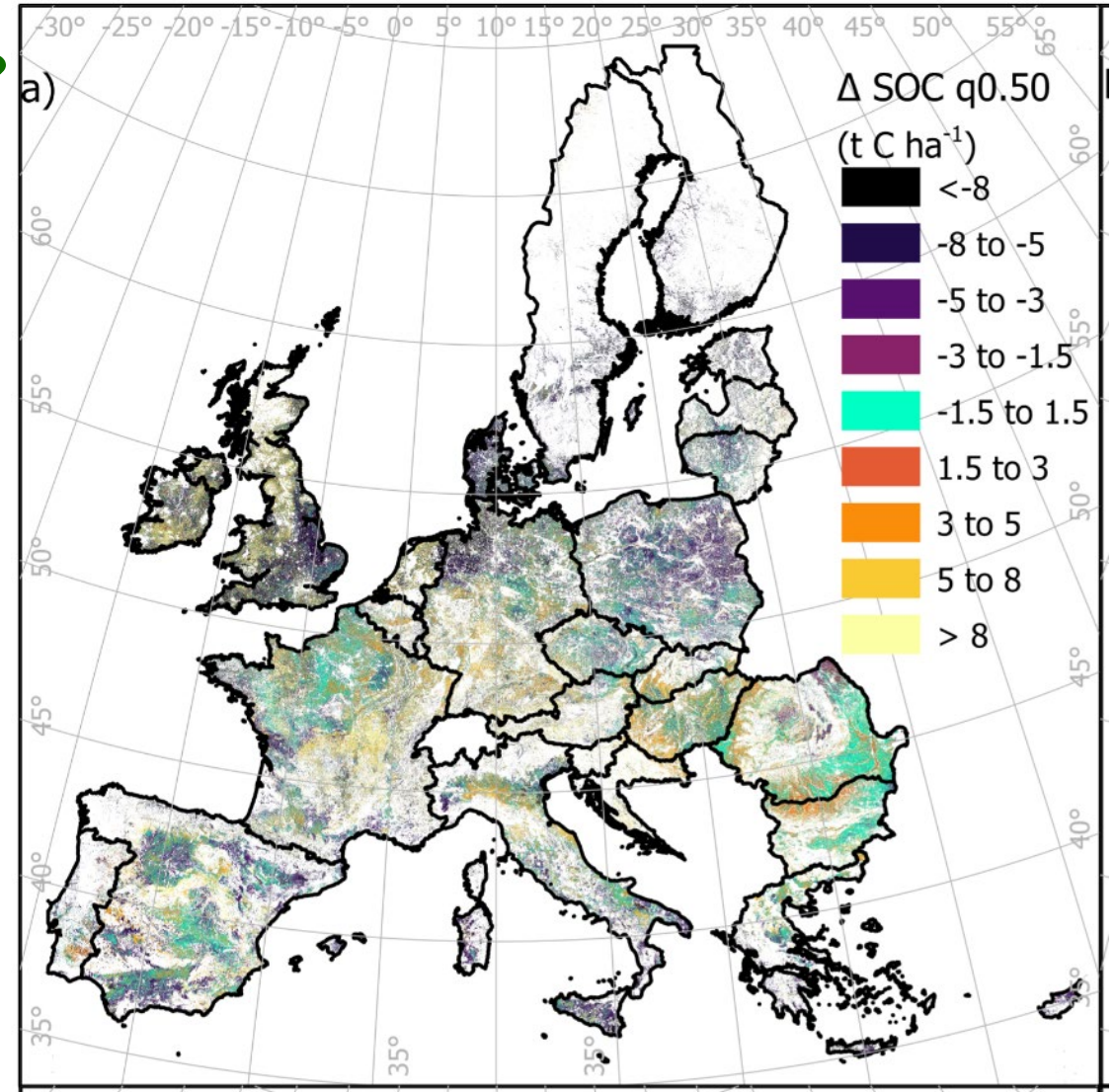
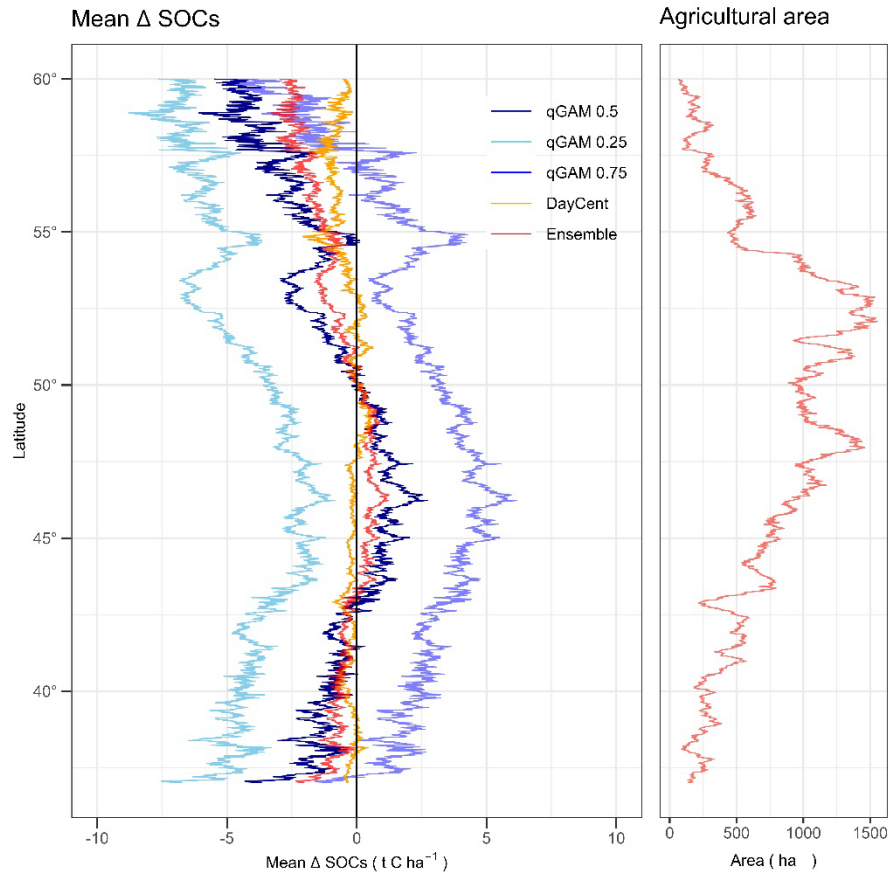


EU-wide Soil Monitoring

#MissionSoilWeek **#MissionSoil** **#EUmissions**

SOC, how much have we lost in the past decade?

-0.75% between 2009 and 2018
 ~ 70 Mt C (0-0.2m depth) =
28 MtCO₂e per year

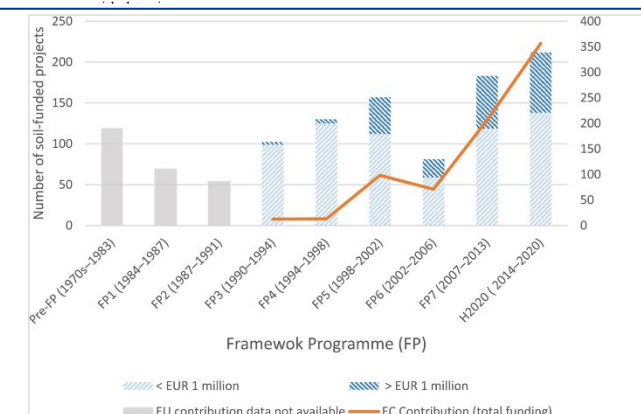


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Support to research and innovation



- Steering the research agenda, ensuring alignment between EUSO and the development of research on soils in the EU
- Contributing to the Mission annual work programme
- JRC responsible for the soil monitoring elements within the Soil Mission
- EUSO as a beneficiary of research activities in Soil Mission Projects
- Close collaboration with **SoilWise Mission Project** for the development of the Repository hosting Soil Mission data and knowledge
- Review of Soil-related projects in all Framework Programmes



Support to research and innovation

- Developing further the JRC in-house research and development capacity on soils (> 40 publications of EUSO group in peer review journals in 2022)

- Co-hosting and mentoring 6 Collaborative Doctoral Partnership PhD candidates.

First PhDs awarded

- Support the **implementation of Soil Mission** (novel approaches on soil monitoring, new methods for data acquisition, metrics for measuring indicators, etc)

- Close collaboration with **Soil Mission Projects** (such as AI4SoilHealth, BENCHMARKS, Soil-Olive, Prepsoil, ECHO, MARVIC, etc) – EUSO as a beneficiary of research activities in Soil Mission Projects



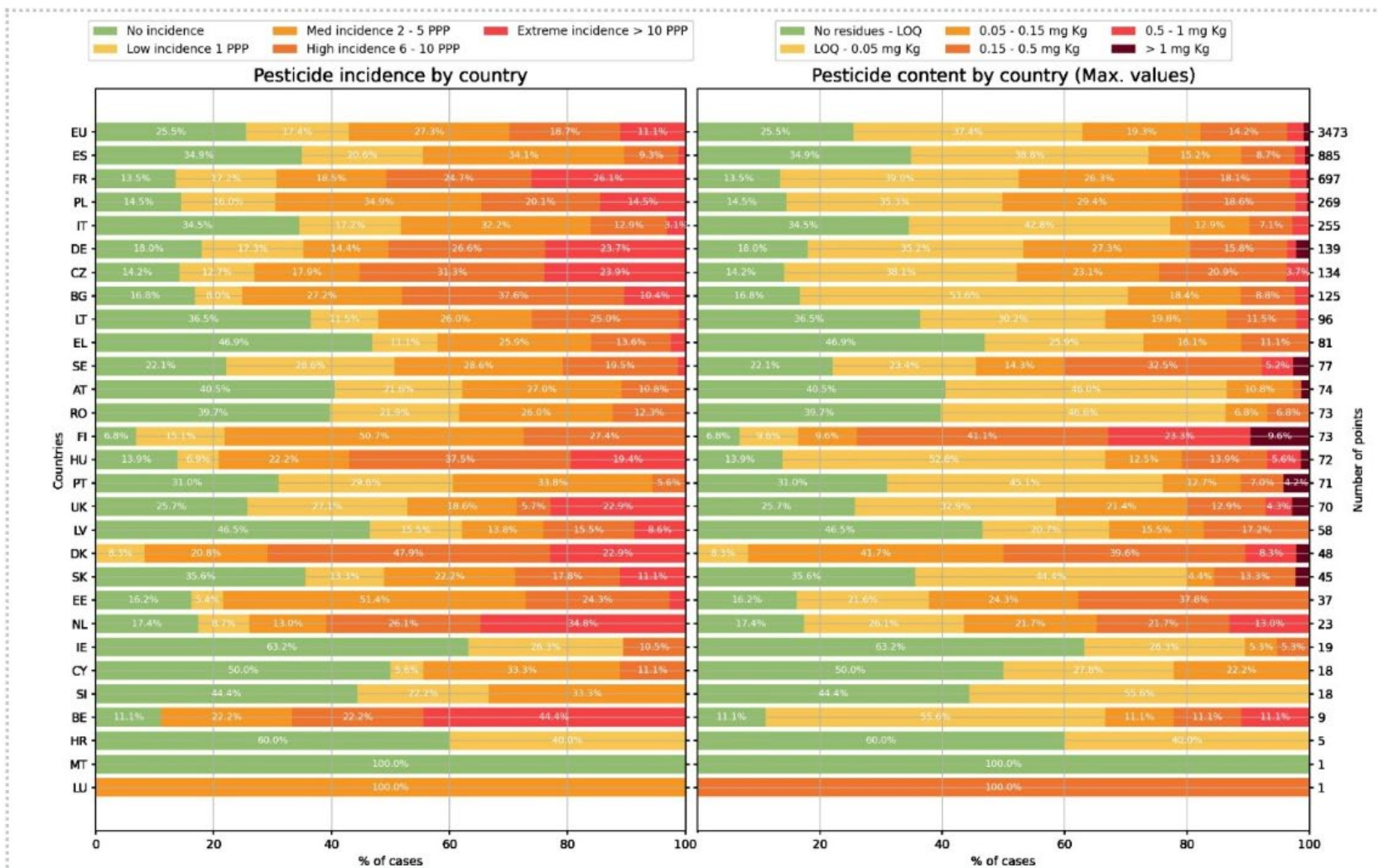
Research & Innovation

Novel assessments of Soil Health

New information
New Indicators

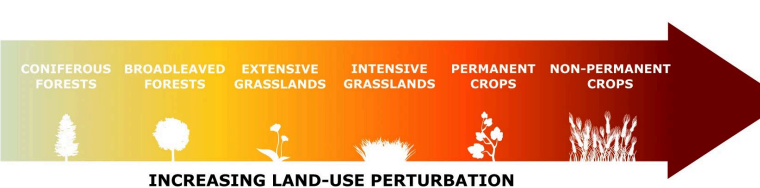
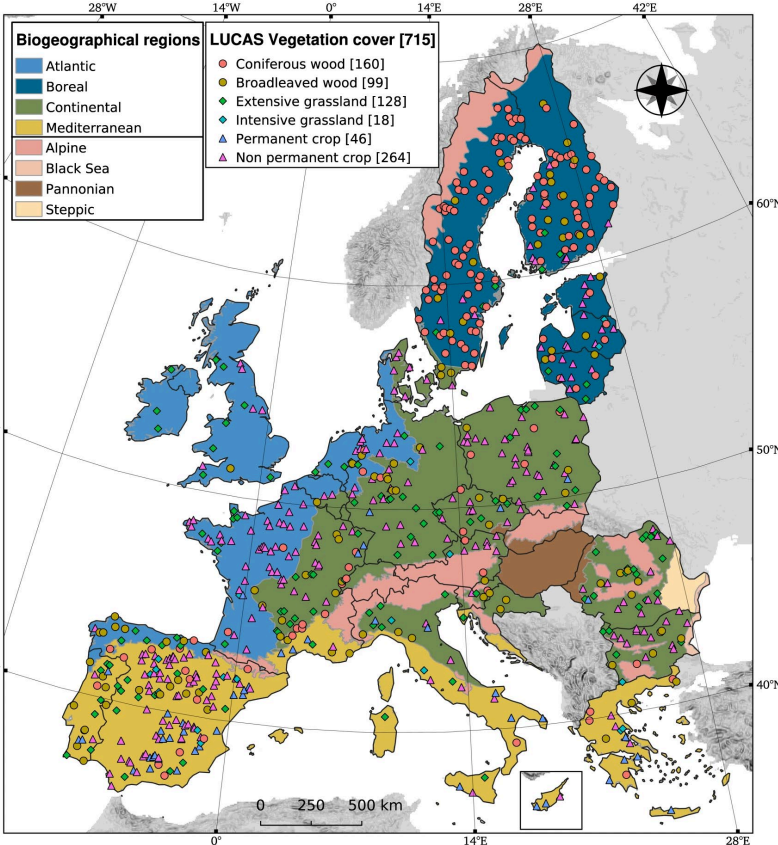


Research & Innovation



Novel assessments of Soil Biodiversity

- Diversity increases with land use intensification
- Increase in pathogens in agricultural soils
- Strong effect of soil properties on biodiversity
- pH is the strongest driver among soil properties
- Climate and Land cover are also relevant



nature communications

Received: 6 March 2023 | Revised: 5 June 2023 | Accepted: 12 June 2023

DOI: 10.1111/gcb.16871

Global Change Biology WILEY

Article

<https://doi.org/10.1038/s41467-023-28146-7>

RESEARCH ARTICLE

Patterns in soil microbial diversity across Europe

Ecosystem type drives soil eukaryotic diversity and composition in Europe

Received: 25 August 2022

Accepted: 6 April 2023

Published online: 08 June 2023

Maëva Labouyrie^{1,2,3}, Cristiano Ballabio², Ferran Romero³, Panos Panagos², Arwyn Jones², Marc W. Schmid⁴, Vladimir Mikr⁵, Olesya Dulya^{5,6}, Leho Tedersoo⁵, Mohammad Bahram^{5,7}, Emanuele Lugato², Marcel G. A. van der Heijden^{1,3} & Alberto Orgiazzi²

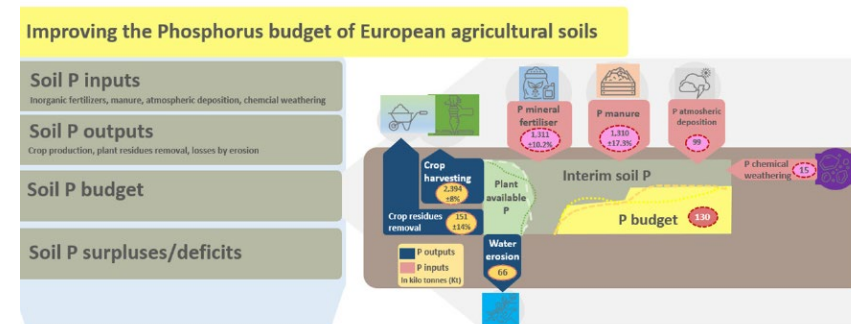
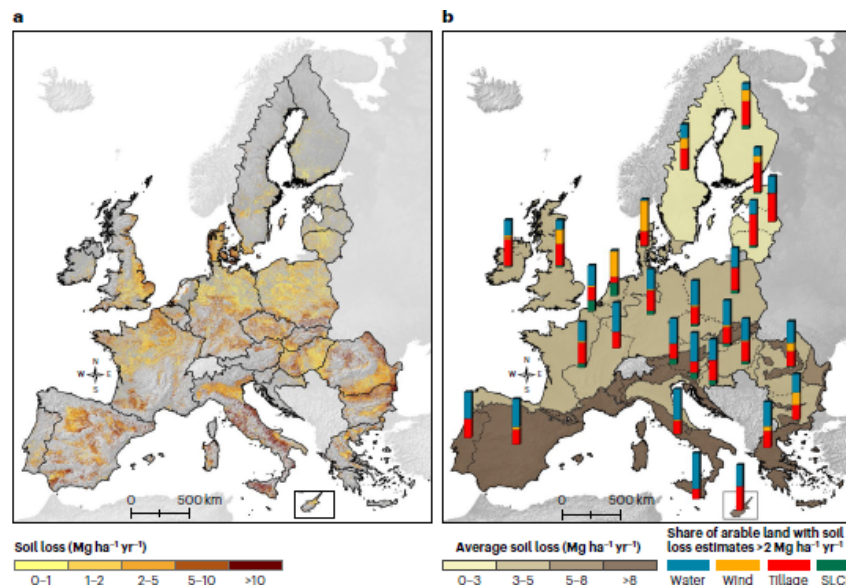
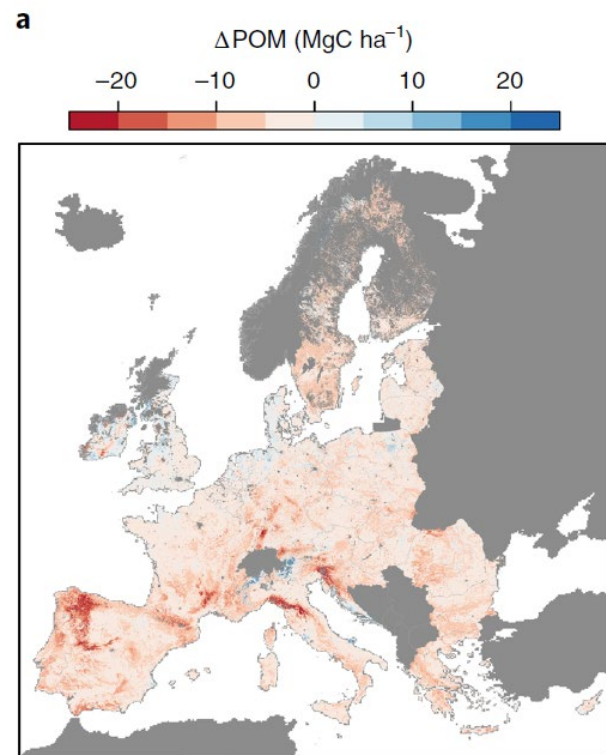
Julia Köninger^{1,2} | Cristiano Ballabio² | Panos Panagos² | Arwyn Jones² | Marc W. Schmid³ | Alberto Orgiazzi² | Maria J. I. Briones¹

Check for updates

Novel assessments of Soil Health



Research & Innovation



ELSEVIER

Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

Science of the Total Environment

nature sustainability

Analysis

<https://doi.org/10.1038/s41893-022-00988-4>

Policy implications of multiple concurrent soil erosion processes in European farmland

Received: 4 May 2022

Accepted: 27 September 2022

Published online: 27 October 2022

Check for updates

Pasquale Borrelli^{1,2}, Panos Panagos³, Christine Alewell⁴, Cristiano Ballabio⁵, Hugo de Oliveira Fagundes⁶, Nigusie Haregeweyn⁶, Emanuele Lugato³, Michael Maerker⁷, Jean Poesen^{8,9}, Matthias Vanmaercke⁸ and David A. Robinson¹⁰

Different climate sensitivity of particulate and mineral-associated soil organic matter

Emanuele Lugato^{1,2}, Jocelyn M. Lavallee², Michelle L. Haddix², Panos Panagos¹ and M. Francesca Cotrufo²

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From ESDAC to ESDAC 2.0

2012 – 2023

ESDAC at the core of EU soil policies

Increase an order of magnitude in data/users

New Data flows



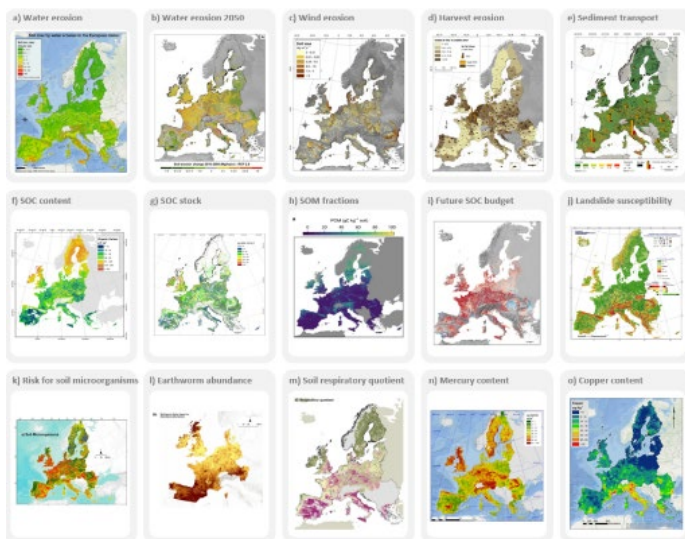
Land Use Policy

Volume 29, Issue 2, April 2012, Pages 329-338



European Soil Data Centre: Response to European policy support and public data requirements


Panos Panagos  , Marc Van Liedekerke, Arwyn Jones, Luca Montanarella



European Journal of **Soil Science**

DATA ARTICLE |  Full Access

European Soil Data Centre 2.0: Soil data and knowledge in support of the EU policies

Panos Panagos , Marc Van Liedekerke, Pasquale Borrelli, Julia Köninger, Cristiano Ballabio, Alberto Orgiazzi, Emanuele Lugato, Leonidas Liakos, Javier Hervas, Arwyn Jones, Luca Montanarella

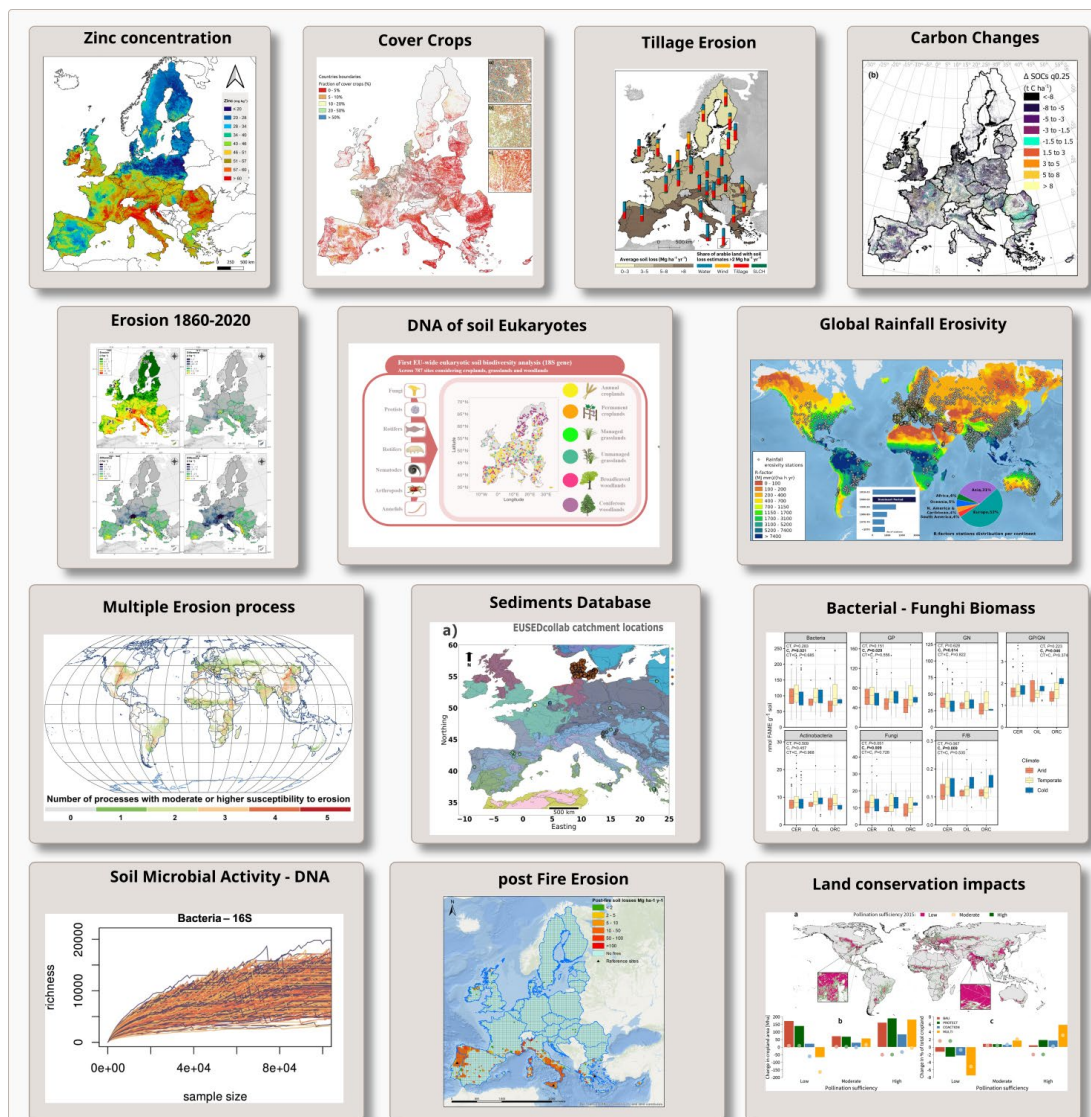
First published: 13 October 2022 | <https://doi.org/10.1111/ejss.13315>



European & global soil datasets

2023 Datasets published
In ESDAC

Focus on Soil Health
indicators



- *European Soil Database*
- *Soil point data (LUCAS) 2009-2015-2018*
- *Soil Physical properties*
- *Soil Chemical properties*
- *Soil functions*
- *Soil threats*

Supporting Citizen Engagement & Awareness Raising

- Support increased soil literacy and dialogue with stakeholders
- Fully supporting the objectives and actions of the Soil Strategy and Mission
- Participation in EU Green Week, REMTECH, Ecomondo
- Development of a **Repository with Citizen Science projects on soil** – collaboration with ECHO Mission project
- Further expansion of the range of awareness raising initiatives of the JRC e.g. **development of JRC Soil Atlas series**, educational material public communication events
- JRC Summer School on the evaluation of air, soil and water pollution in support to the European Green Deal



- Ecomondo

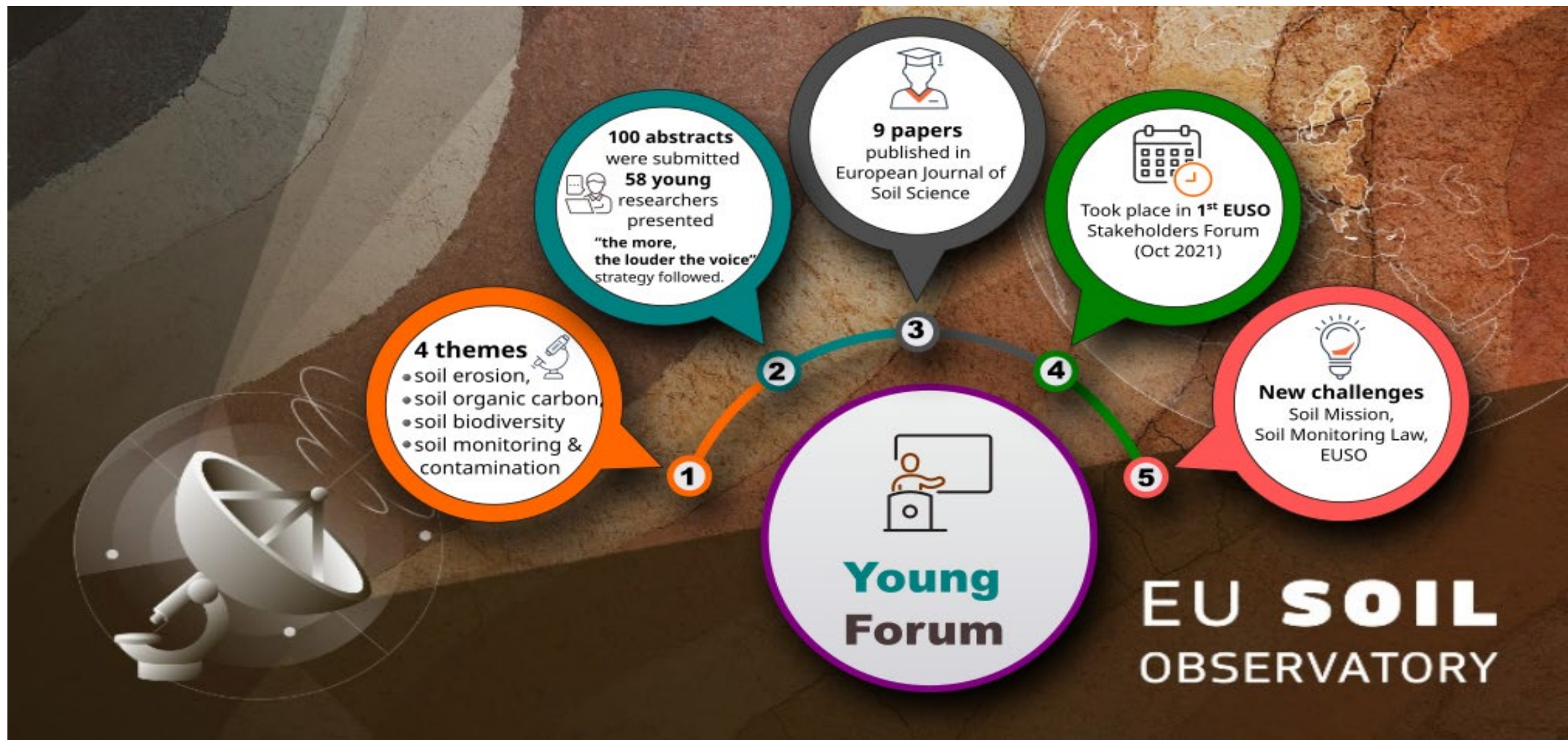


REMTECH
Europe



#MissionSoilWeek

Support Young Soil Researchers



EUSO Stakeholders Forum

- 3rd EUSO Stakeholder Forum online
 - 700 participants
 - 60+ presentations over three days
 - Emphasis to first results of Soil Mission funded projects
 - Six Technical Working Groups - Lead to a more complete knowledge base for policy
- Soil pollution
 - Soil monitoring
 - Soil data sharing
 - Soil erosion
 - Soil biodiversity
 - Soil Carbon MRV



European Soil Forum



Third EUSO Stakeholders Forum

 **15-17**
November 2023
Online Working groups meeting

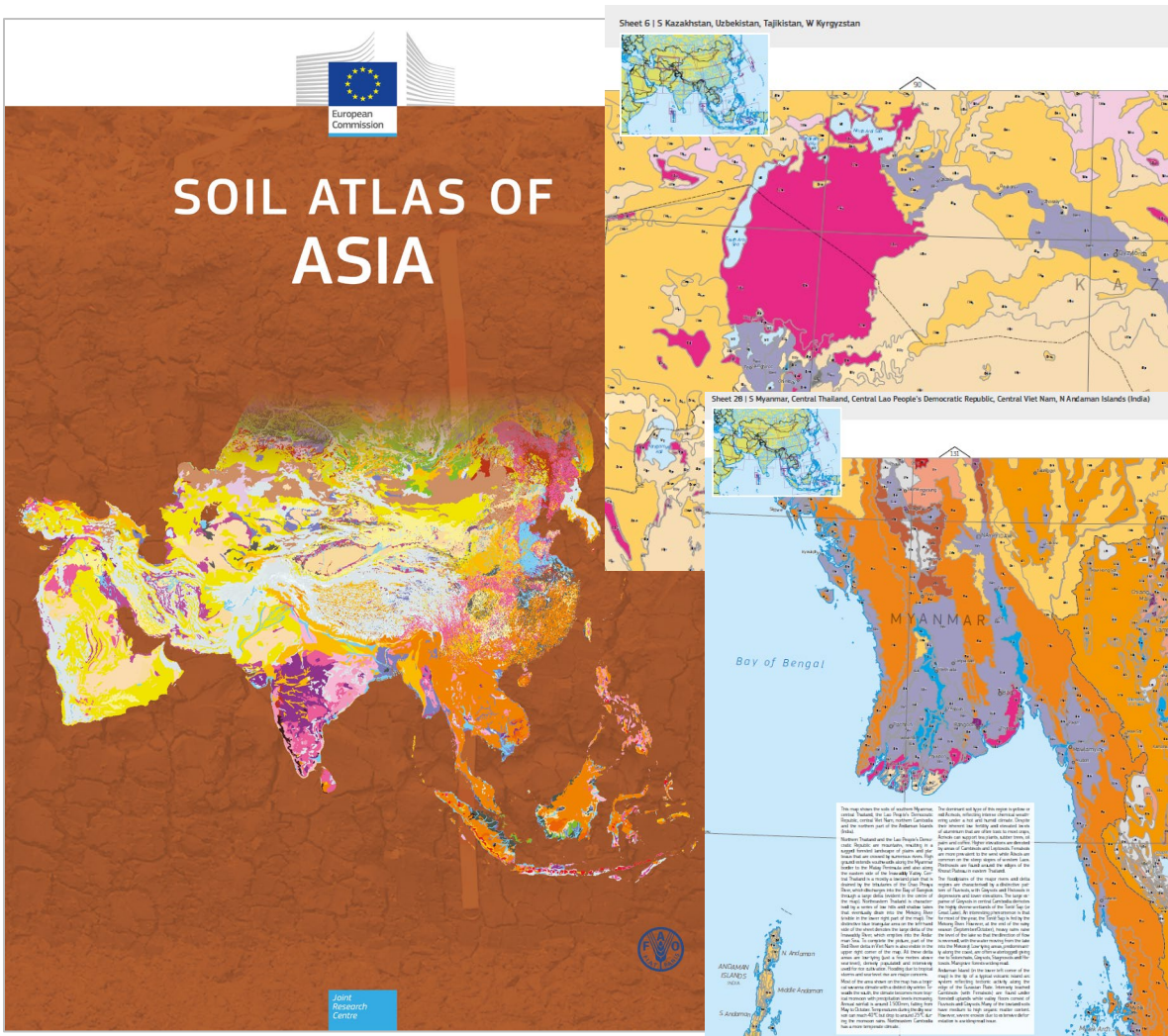
 **21-23**
November 2023
European Soil Mission Week
Madrid, Spain

 #EUSO

 <https://esdac.jrc.ec.europa.eu/euso>

EU SOIL
OBSERVATORY

EUSO beyond the EU



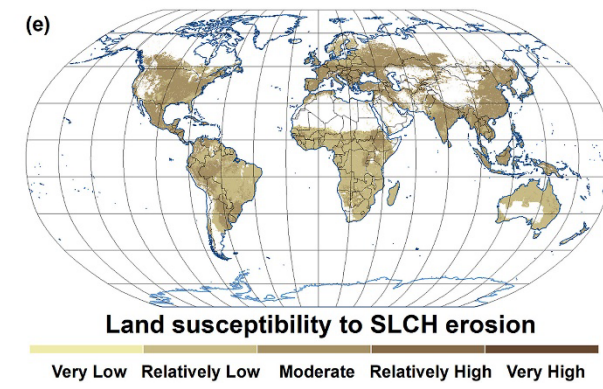
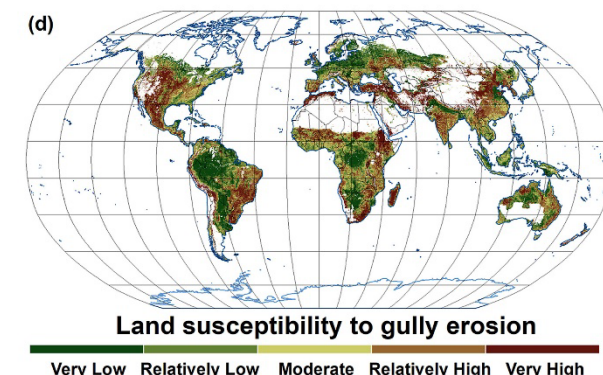
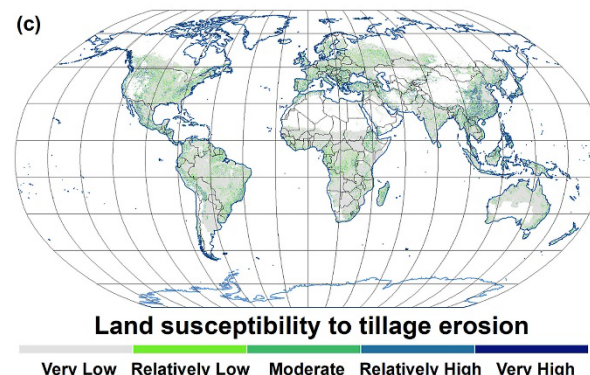
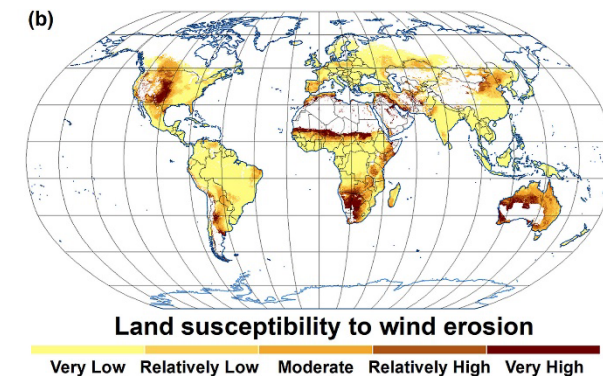
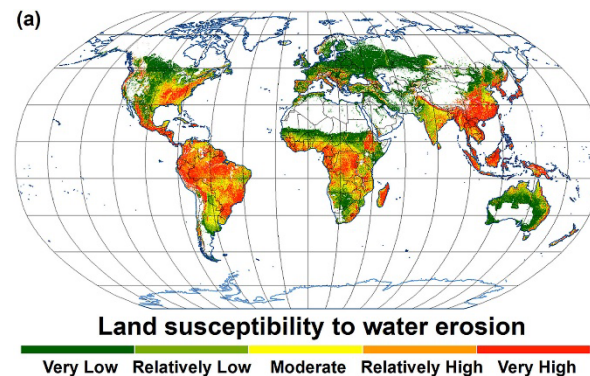
European Commission

SOIL ATLAS OF ASIA

Sheet G | 5 Kazakhstan, Uzbekistan, Tajikistan, W Kyrgyzstan

Sheet ZB | 5 Myanmar, Central Thailand, Central Lao People's Democratic Republic, Central Viet Nam, N Andaman Islands (India)

Joint Research Centre



What's next for EUSO

- LUCAS SOIL 2.0
- Updated EUSO Soil Health Dashboard – to mirror SML
- Updated ESDAC – increased data flows
- Improved knowledge management platform
- EUSO policy dashboard
 - Living Labs portal
 - Indicator development (AI4SoilHealth , Benchmarks)
- Increased integration with Soil Mission projects

What's next for EUSO

- State of European Soils Report
 - FAO State of World Soil Resources 2025
 - SOER 2025
- EU Biodiversity and Antimicrobial resistance (AMR) Assessments
- Soil Fertility Report (for Taxonomy)
- Land Degradation / Desertification methodology
- Soil organic carbon baselines for Carbon Farming
- IACS Data Sharing Platform
- Innovative Soil Health Assessments

Keep in touch



EU Science Hub: ec.europa.eu/jrc



@EU_ScienceHub & follow the forum **#EUSO on twitter**

Forum: <https://esdac.jrc.ec.europa.eu/euso/second-euso-stakeholders-forum>

Technical Working Groups: <https://esdac.jrc.ec.europa.eu/euso/technical-working-groups>

ESDAC Newsletter eu-soil-observatory@ec.europa.eu



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Plenary Session

Assessing soil health at different scales across Europe

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EUROPEAN UNION

EUROPEAN MISSION SOIL WEEK

Assessing soil health at different
scales across Europe

Teresa Pinto Correia

Mission Soil Board & MED/CHANGE, University of Évora

23 November 2023



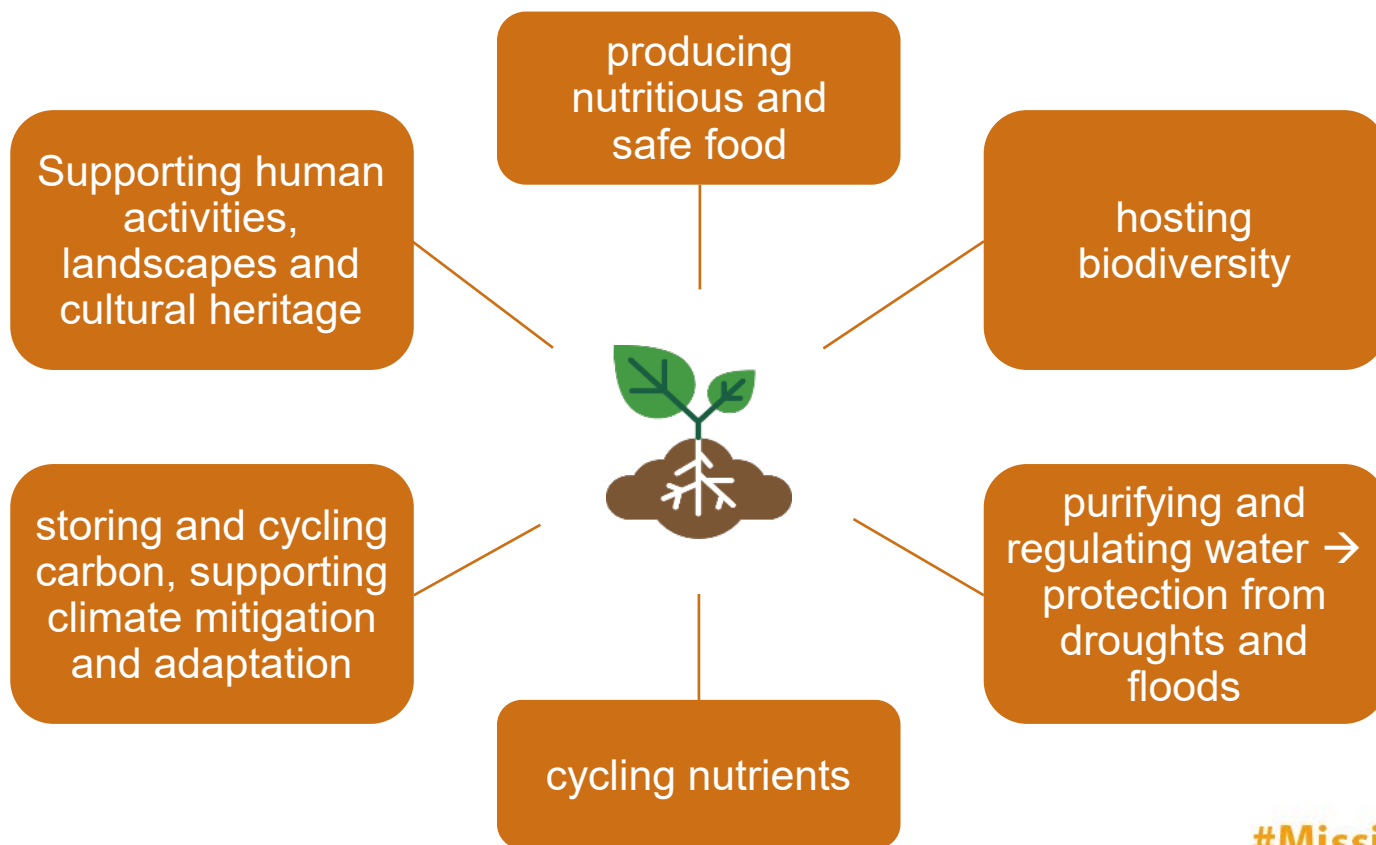
© European Union, 2023. Image - Yuri A. / Shutterstock.com

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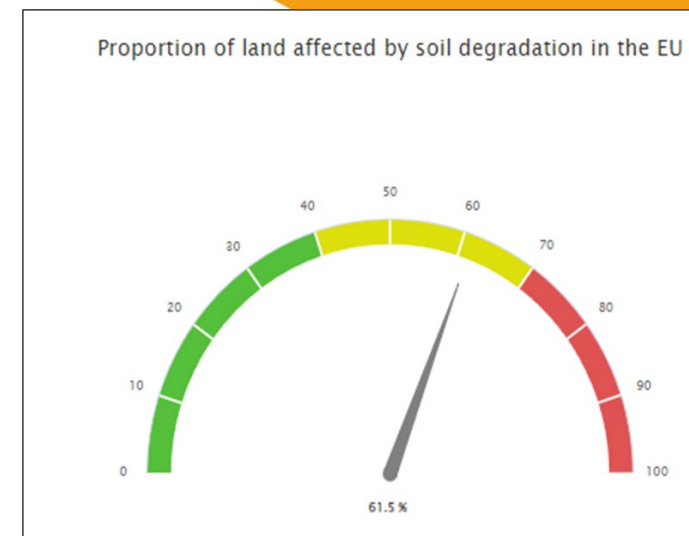
The Soil Mission: the right instrument at the right time

Soils support ecosystem services and provide vital functions:



EUROPEAN MISSION SOIL WEEK

Dashboard of the European Soil Observatory

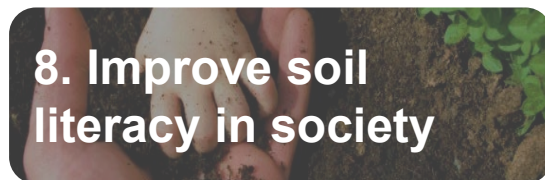
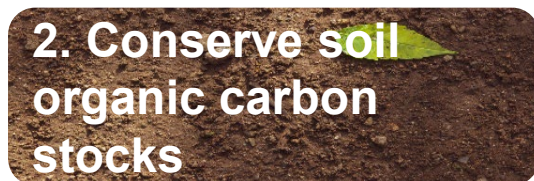


More than **60% of soils in Europe are considered to be unhealthy** due to current management practices, pollution, urbanisation and the effects of climate change

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Goal: 100 living labs and lighthouses to lead the transition towards healthy soils by 2030

Specific objectives:



Objectives apply to **all types of land use and all territories** and are relevant for a **range of sectors**.

Building blocks:



Main vehicle for addressing the diversity of conditions and generating locally adapted solutions

LIVING LABs

3 core principles



User-centred innovation

Activities focus on the users' needs and users are involved throughout the development process



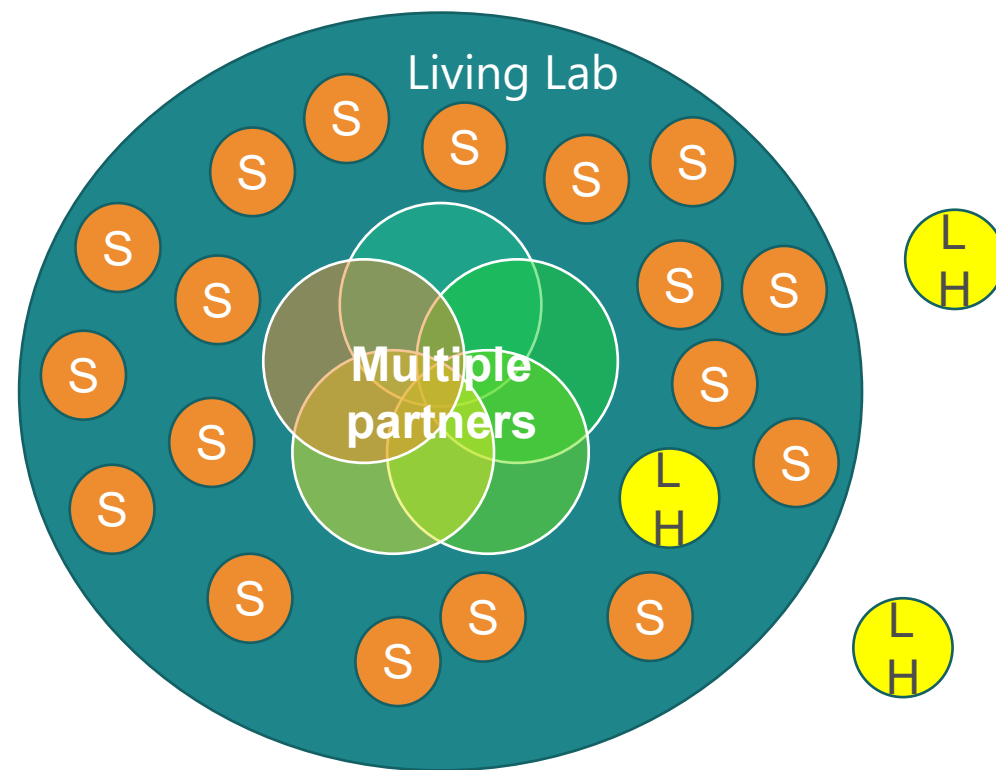
Working in partnership

Experts from various disciplines and backgrounds tackle a common issue



Real-life context

Testing takes place where the users would actually use the technology or practice



partners and construction
adapted to each regional context



The importance of the local / regional context:

SOIL health depends on land use management
SOIL needs are stakeholder and location specific



The importance of the socio-economic & cultural factors:

Soil health change depends on people

Social capital »» entrepreneurship, business models, business communities, SMEs, investors, entrepreneurs;

Potential for enlargement and empowerment of communities

»» meaningful long-term engagement, not just informing but involving;

Contribution to other societal challenges and European policies;



The Mission Board considers that the following Success Factors will help reach the 2030 targets:

- Building awareness and engagement of society at various levels, **connecting people with soils**.
- Co-creating activities with **as many land users and related actors** as possible to drive **collective experimentation and co-ownership** of solutions and results.
- Working under **adequate policy frameworks**, involving policy-makers and other governance authorities (including private businesses or influential associations) as co-design actors.
- Taking in consideration how **land use is related with social, cultural, and economic needs** and **local contexts** while paying specific attention to existing structures and values to understand **drivers and barriers**.
- Stimulating efforts to develop **economic models fit to circular and solidary economies** and the involvement of the actors from the wide value chain.
- Combining and **networking activities at local, regional, national and global scales** to ensure concerns regarding different land uses and up-scaling can be considered.

The needed integration of scales

Specific change to occur in different scales

Policy

**Sector Integration
Networking**

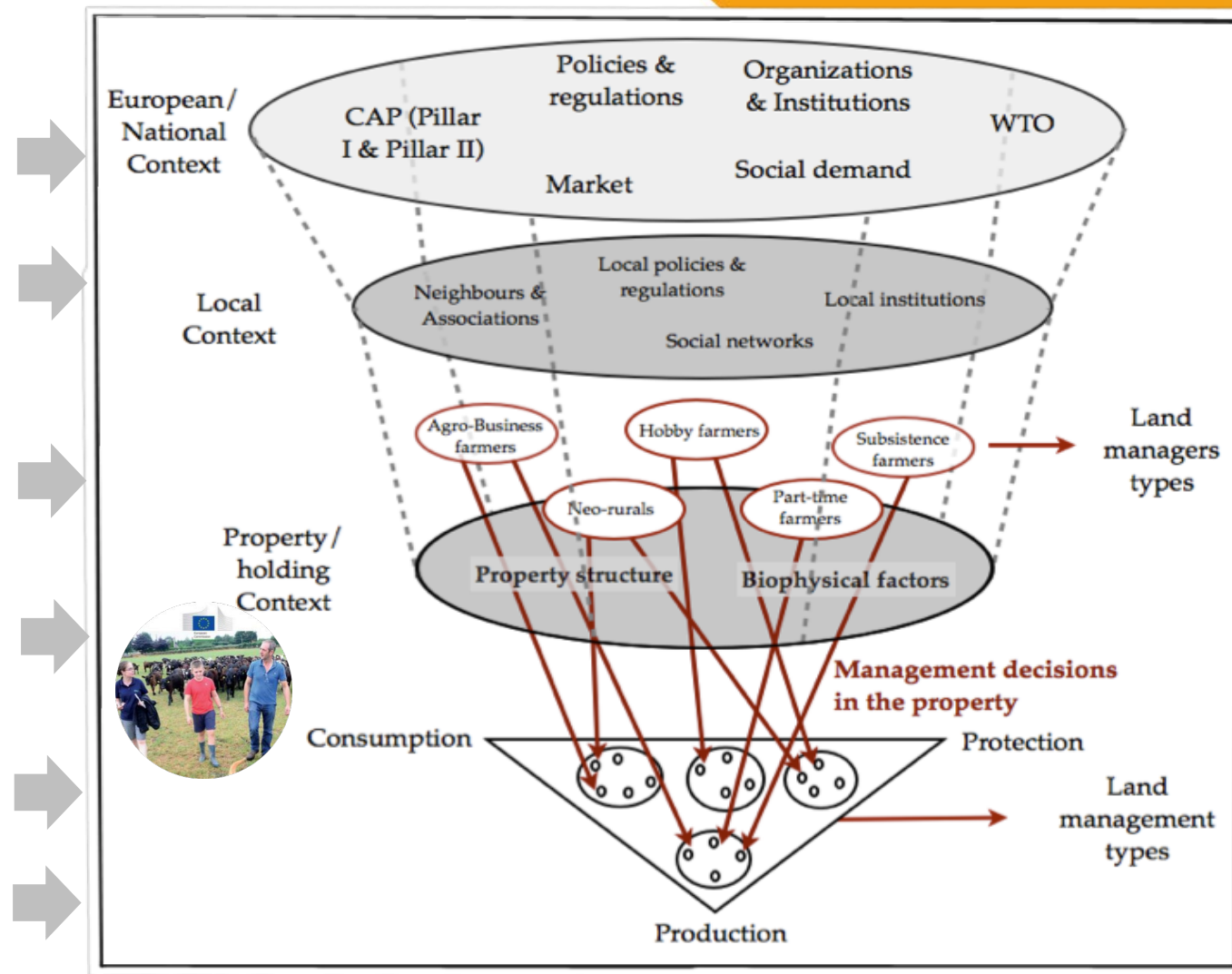
Collective experimentation

Connecting people and soil

Economic models

Soil health

Not all results can be achieved equally fast in all regions or contexts »
downscale and acknowledge differentiations



Specific changes to be detected at specific scales

Mapping socio-environmental pressures to assess soil vulnerability – Portugal

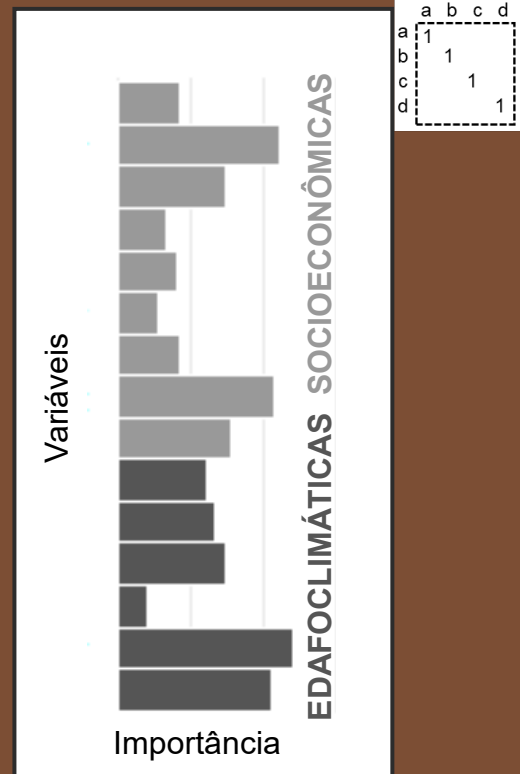
SoilReCon Project,
Portugal

THREATS

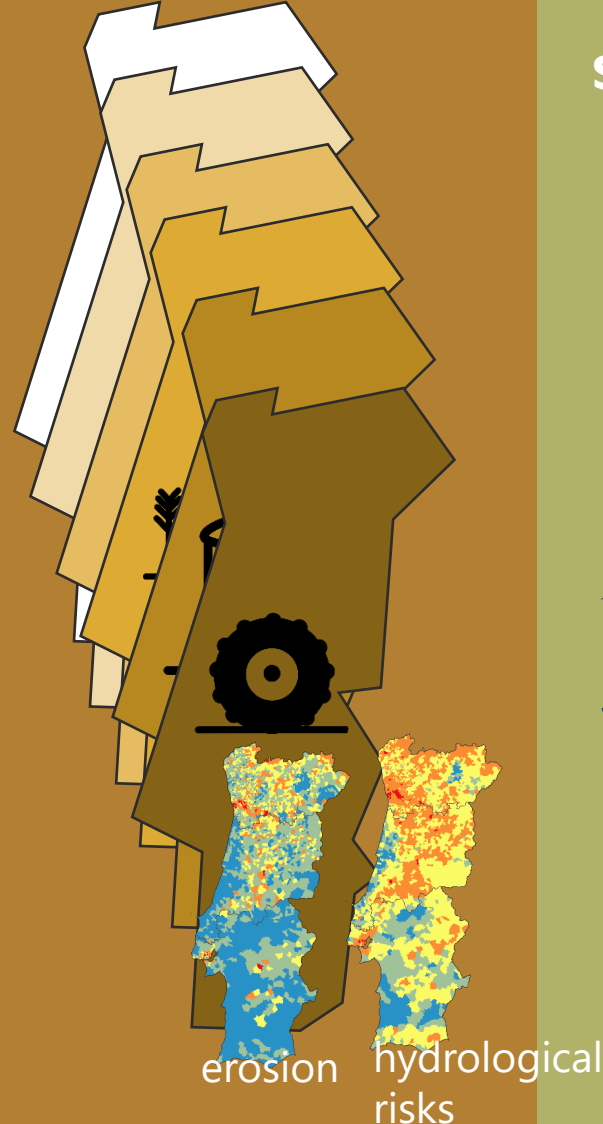
-  Loss of Organic Matter
-  Erosion
-  Compaction
-  Contamination
-  Desertification
-  Salinization
-  Soil sealing
-  Hidrologiac risks

EVALUATION

Analytic Hierarchy Process (AHP)
»» drivers

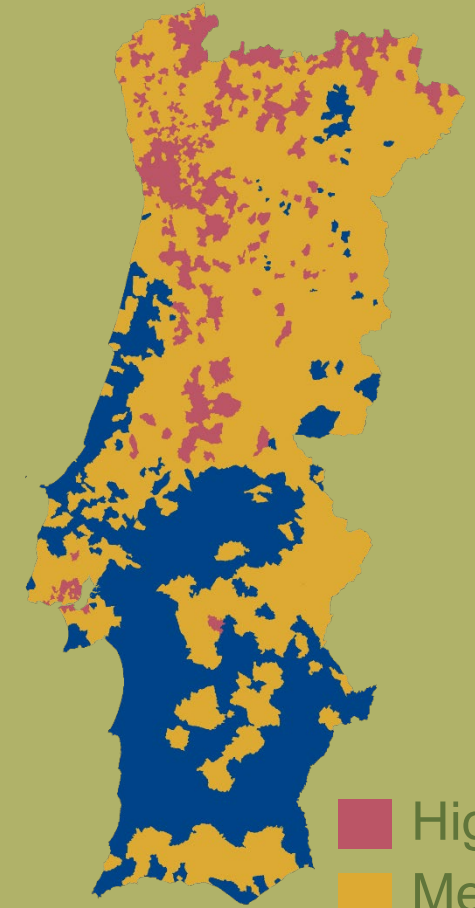





MAPPING



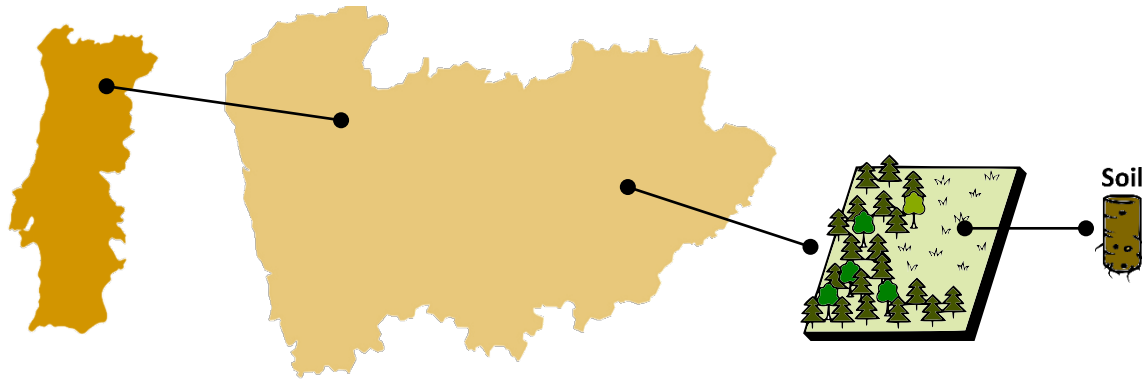
CLUSTERING

SOIL VULNERABILITY

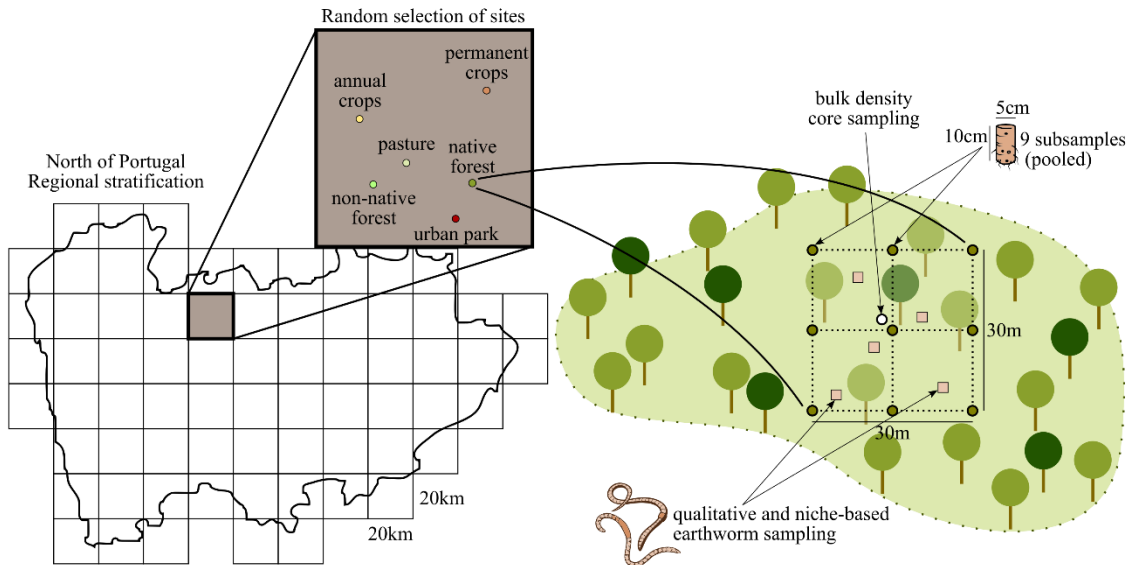


-  High
-  Medium
-  Low

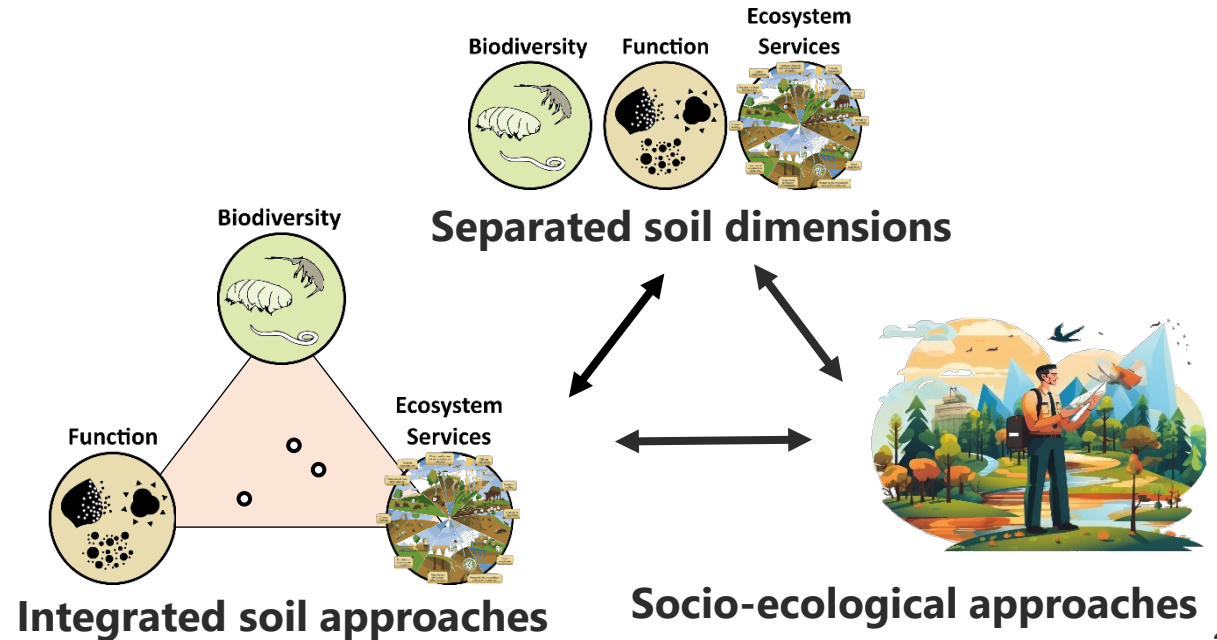
An integrated approach for soil health monitoring in Northern Portugal



Multiple analytical scales



Multiple analytical approaches



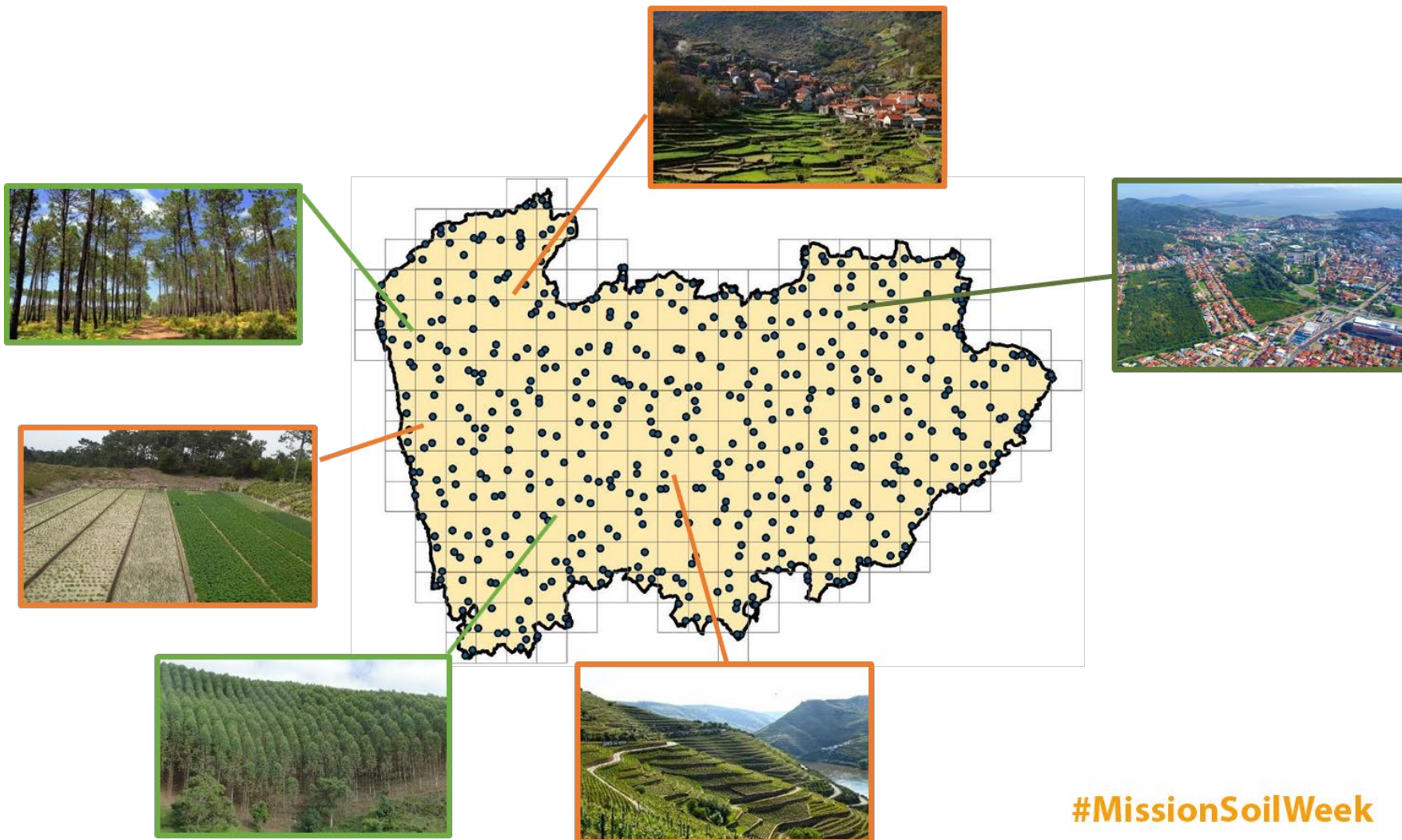
6 land use systems:

- * Pastures
- * Annual crops
- * Permanent Crops
- * Forest plantation
- * Endogenous Forest
- * Urban



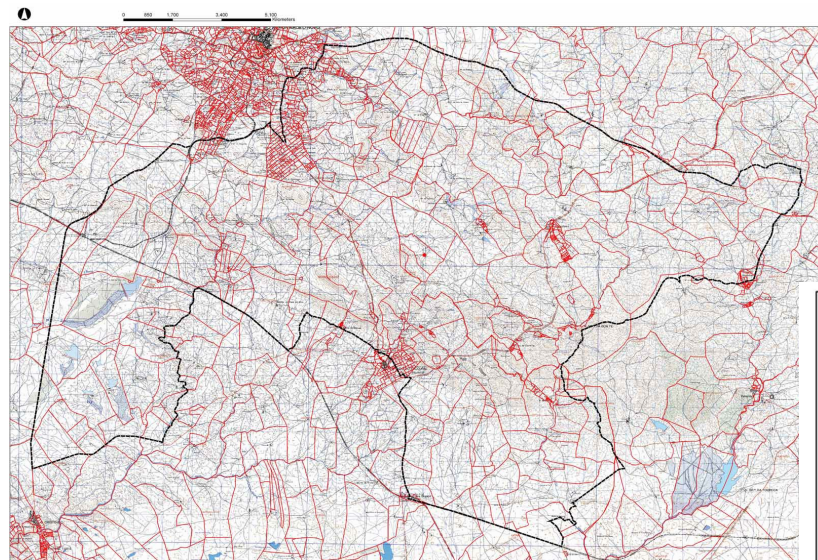
multiple actors and actor networks:

- farmers & land owners
- common's associations
- value chain actors
- planners
- agro & env administration
-

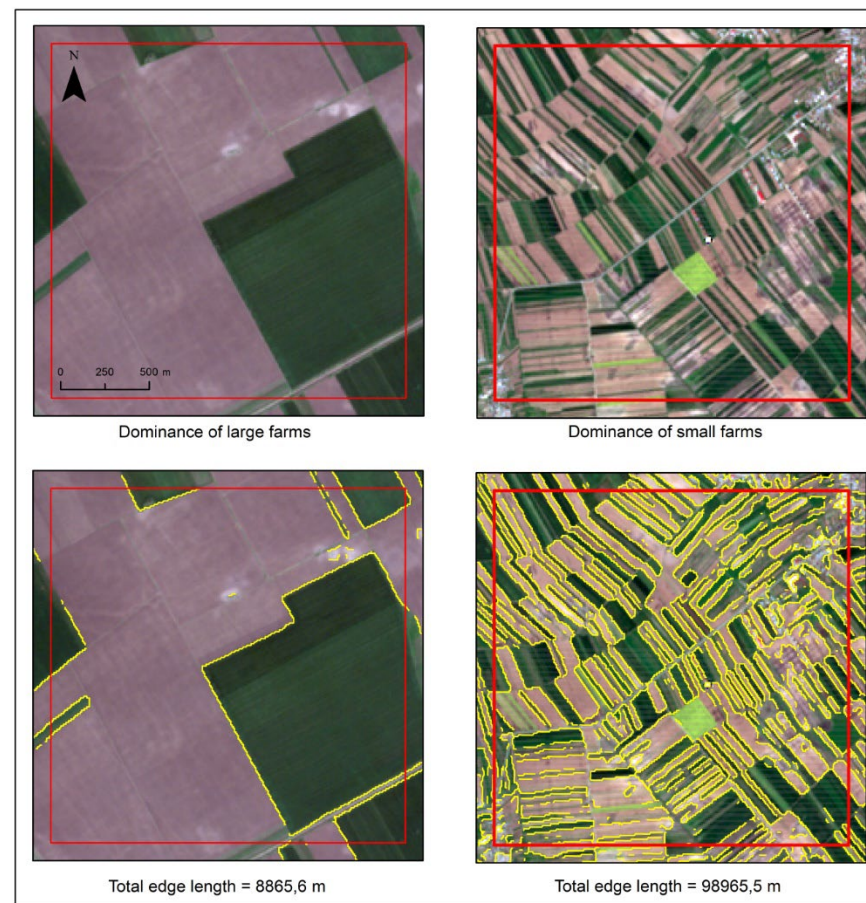


and multiple farm ownership types:

- small family farms
- large competitive family farms
- whole value chain companies
- investment funds
- nature stewardship farms
-



Not all have the same capacity to integrate knowledge, invest, monitor and adapt

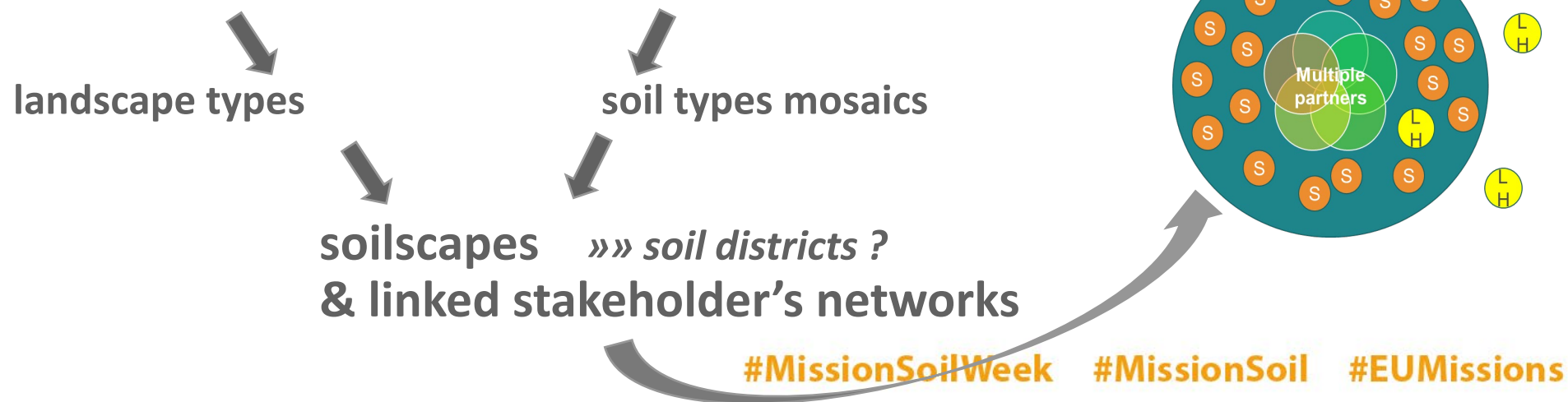


Scale matters

- not all soil questions can be addressed at the same scale
- if we want to involve those who manage soil, we need to address the local level
- thinking accross scales allows better management of expectations » reality check

BUT we also need to operationalise

regional land use/land cover patterns X soil heterogeneity





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Website: mission-soil-platform.ec.europa.eu



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**Assessing soil health at different
scales across Europe**

Rachel Creamer

Professor at Wageningen University, Coordinator of the
EU-funded project BENCHMARKS

23/11/2023



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Soil Health BENCHMARKS



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Building a European Network for the Characterisation and Harmonisation of Monitoring Approaches for Research and Knowledge on Soil



earthwatch EUROPE

UN WCMC environment programme

FiBL

INSTITUTE FOR APPLIED PLANT BIOLOGY

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The Soil Health and Food (SH&F) mission board has set the goal to have 75% of European soils healthy or significantly improved by 2030. This is in line with other important European initiatives such as the Green Deal and EU Farm-to-Fork Strategy. Soil Health Benchmarks aims to validate and further develop indicators for soil health and functions.

 60%

Currently in Europe we have a vast percentage of soils that are considered unhealthy

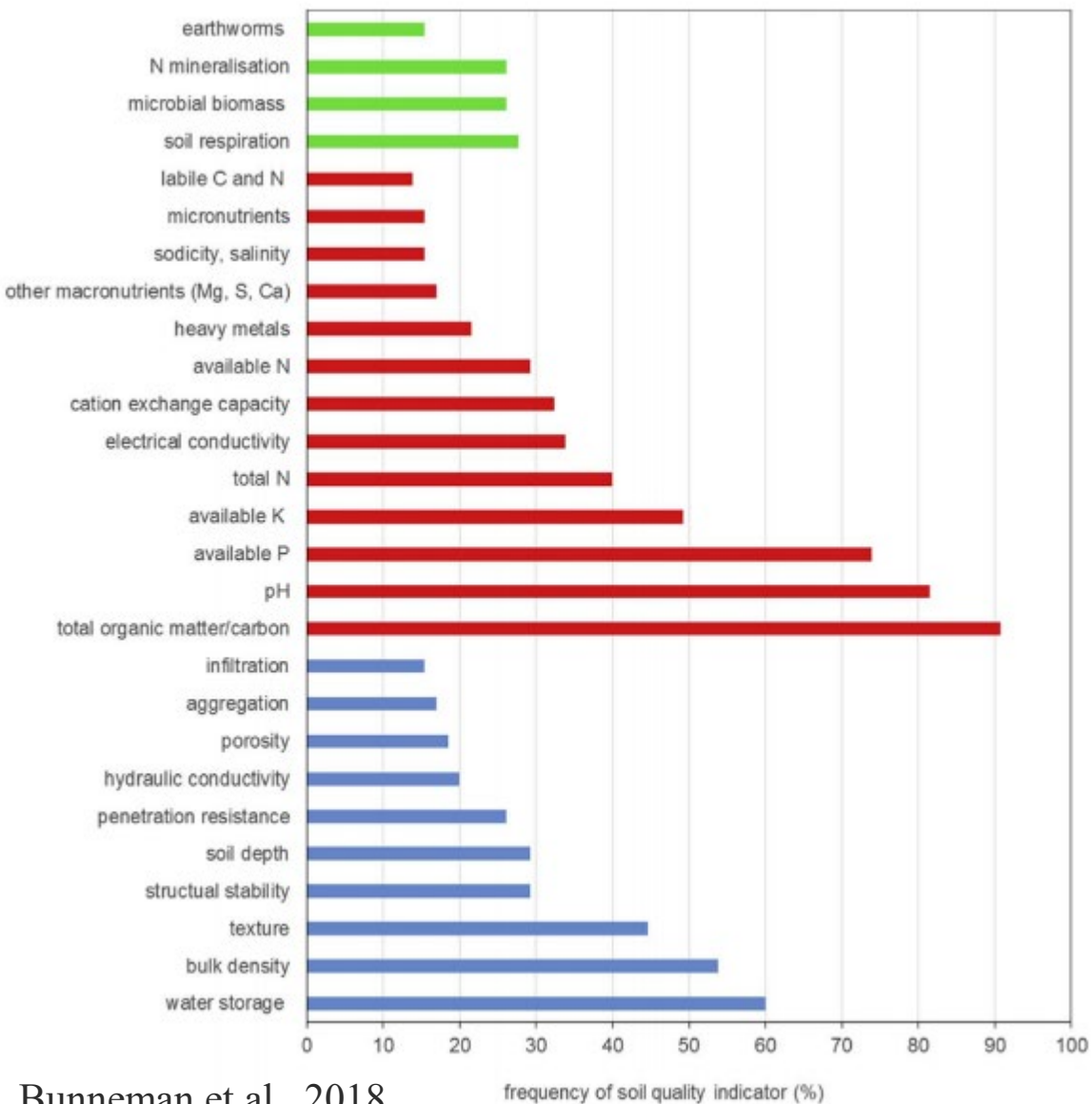
 75%

The goal is to increase the share of healthy or significantly improved soils by 2030

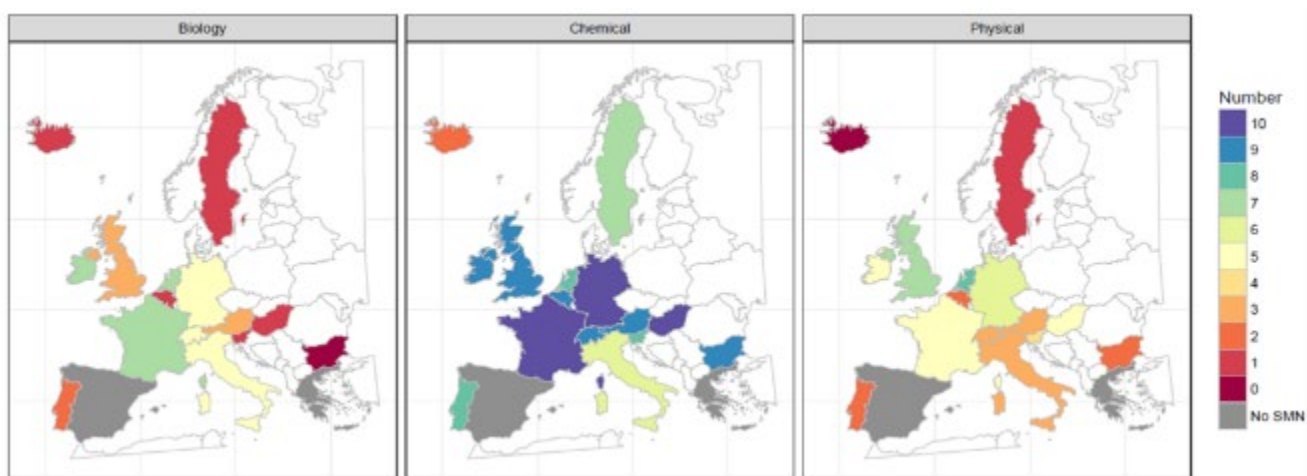
Private Public Partnerships

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Bunneman et al., 2018



Van Leeuwen et al., 2017



Brussels, 5.7.2023
COM(2023) 416 final
2023/0232 (COD)

Proposal for a

DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

on Soil Monitoring and Resilience (Soil Monitoring Law)

{SEC(2023) 416 final} - {SWD(2023) 416 final} - {SWD(2023) 417 final} -
{SWD(2023) 418 final} - {SWD(2023) 423 final}

Threat

Indicator

Salinisation

• Electrical Conductivity

Soil Erosion

• Soil Erosion Rate

Loss of SOM

• Soil Organic Carbon Concentration

Subsoil compaction

• Bulk Density in Subsoil

Excess nutrient content

• Extractable Phosphorous / Nitrogen

Soil Contamination

• Concentration of Heavy Metals

Reduction in capacity
to retain water

• Soil Water Holding Capacity

Acidification

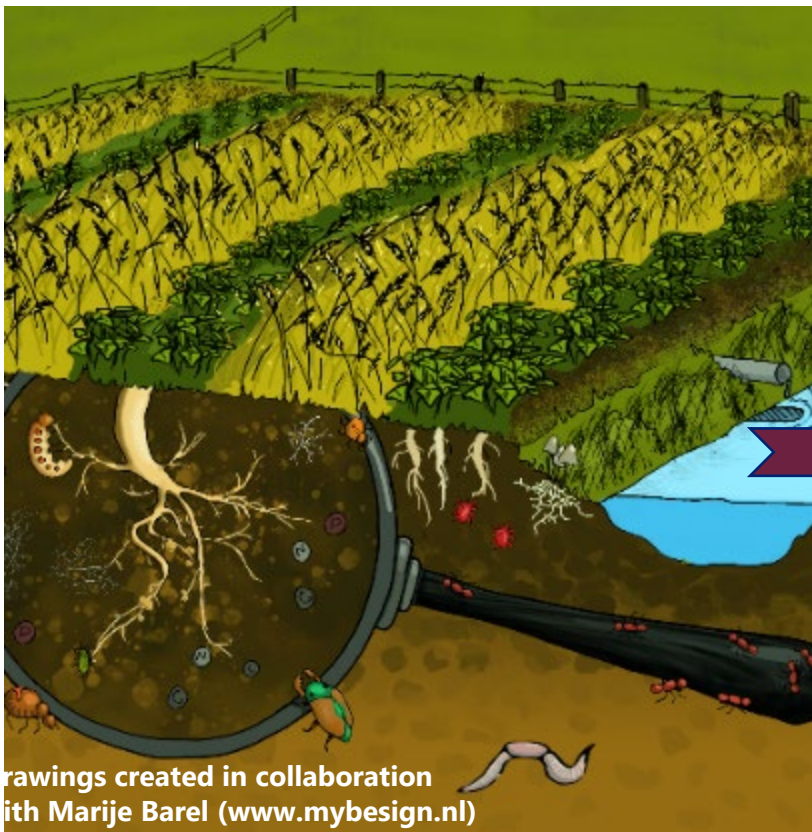
• Soil acidity (pH)

Topsoil compaction

• Bulk Density in Topsoil

Loss of Soil
Biodiversity

• Basal Soil Respiration

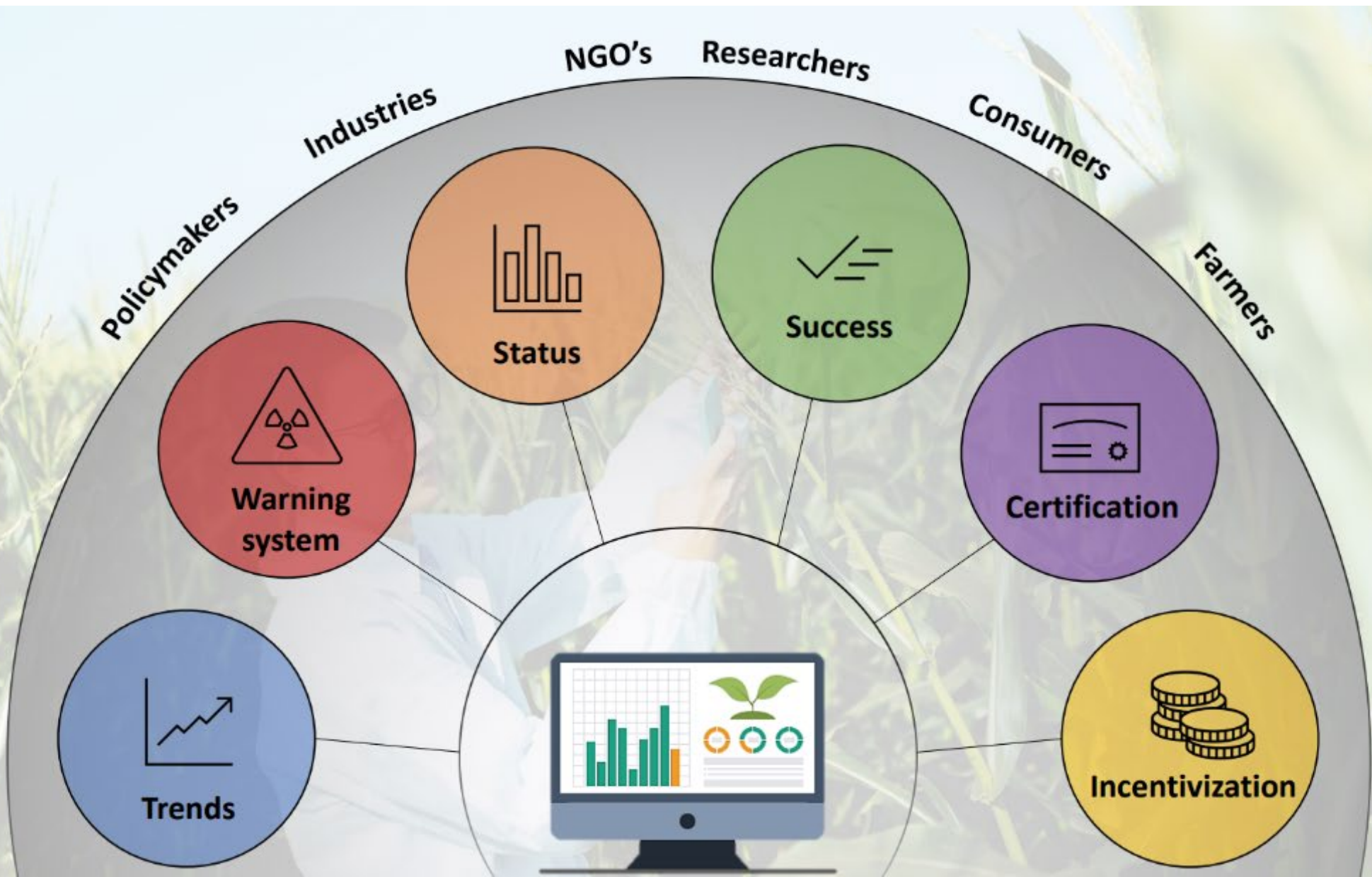


Drawings created in collaboration with Marije Barel (www.mybesign.nl)

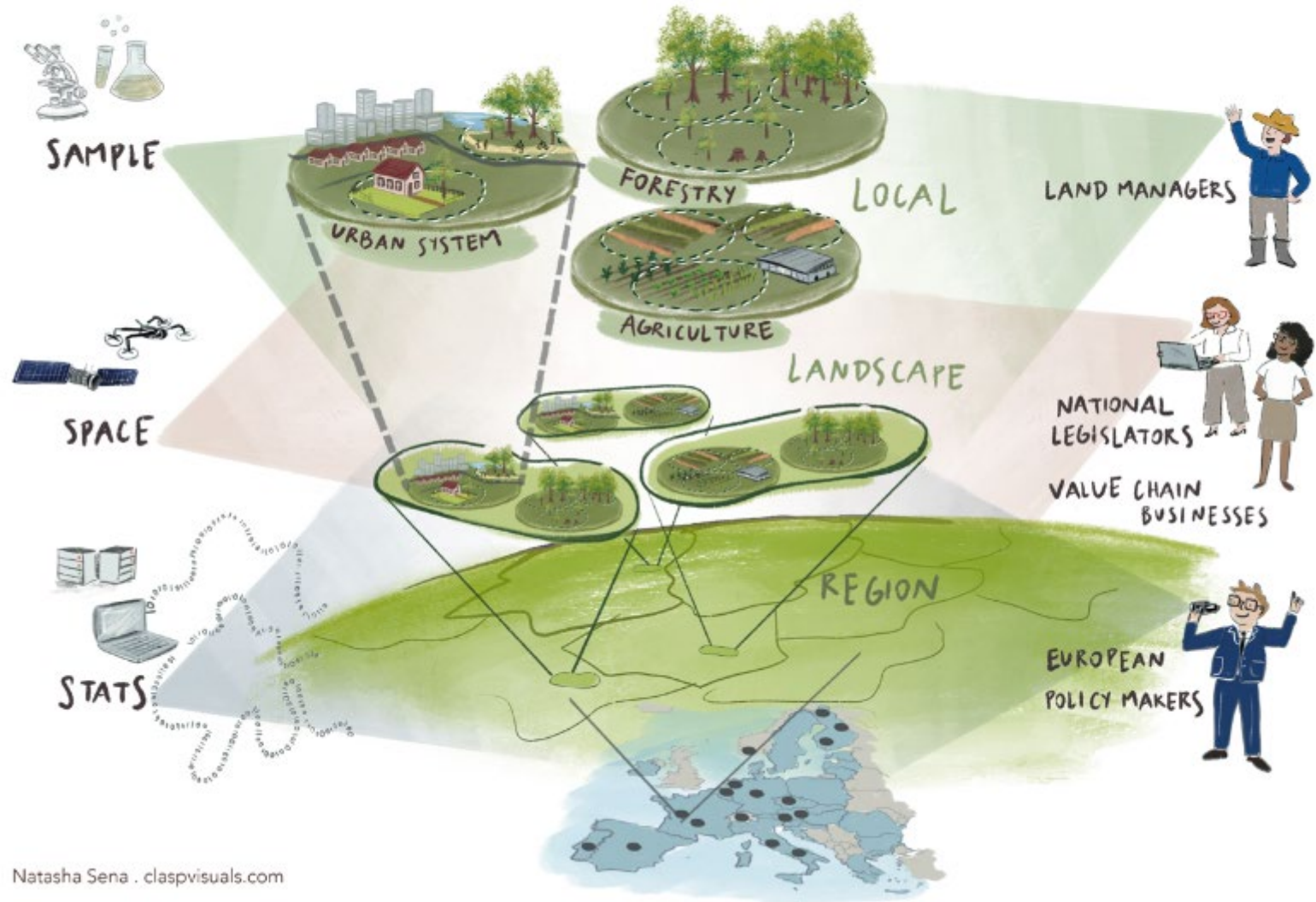


1. Identify the objective and contextualization of assessment
2. Understanding the drivers of soil functioning
3. Soil functions, processes and parameters of interest
4. Select indicator measurements to measure change in time
5. Assess logistical considerations for indicator selection

Purpose of Monitoring



Scale of Assessment



Land Use & Pedo-Climatic Region of Relevance

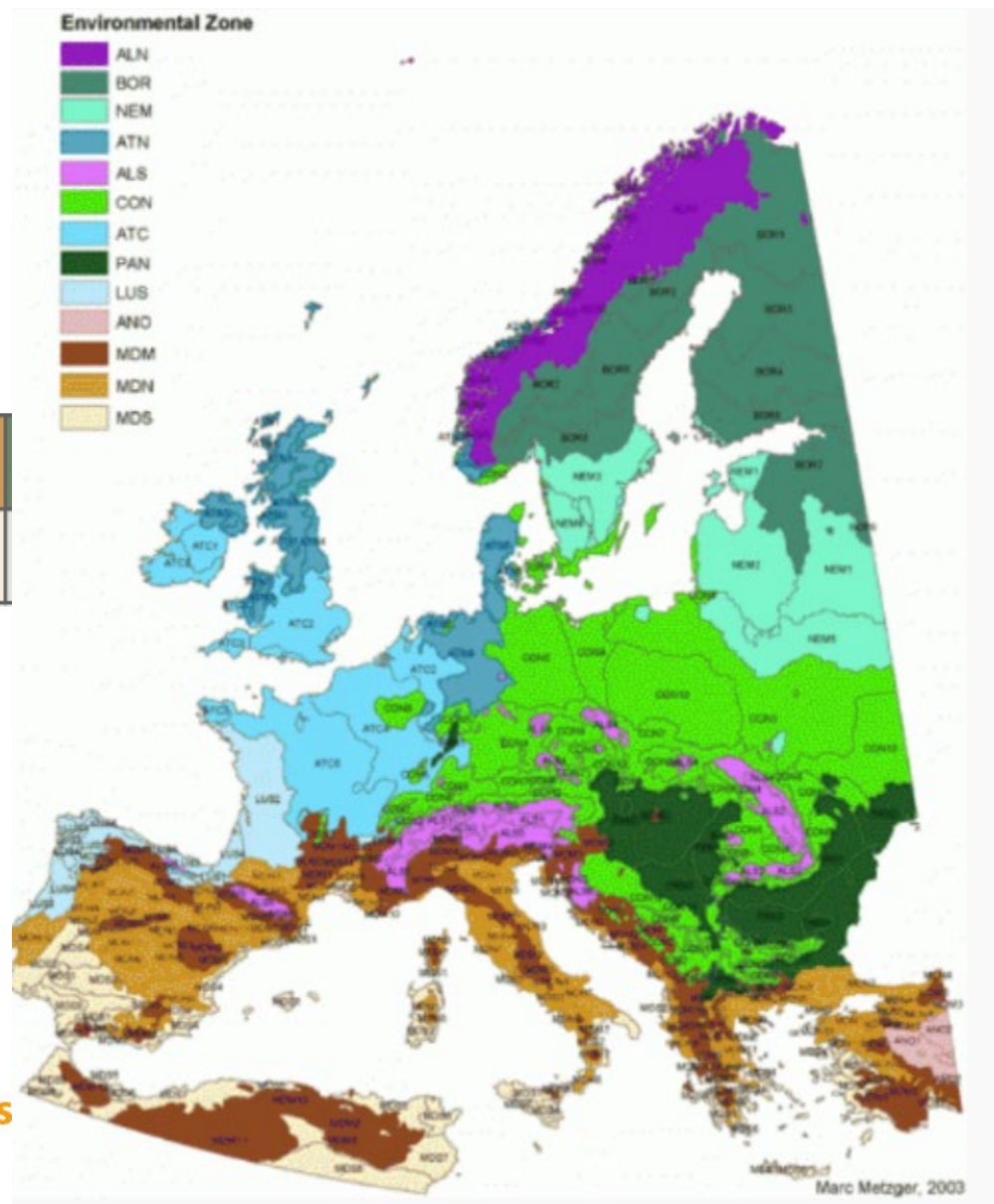
24 Landscape Case Studies

Agriculture
12

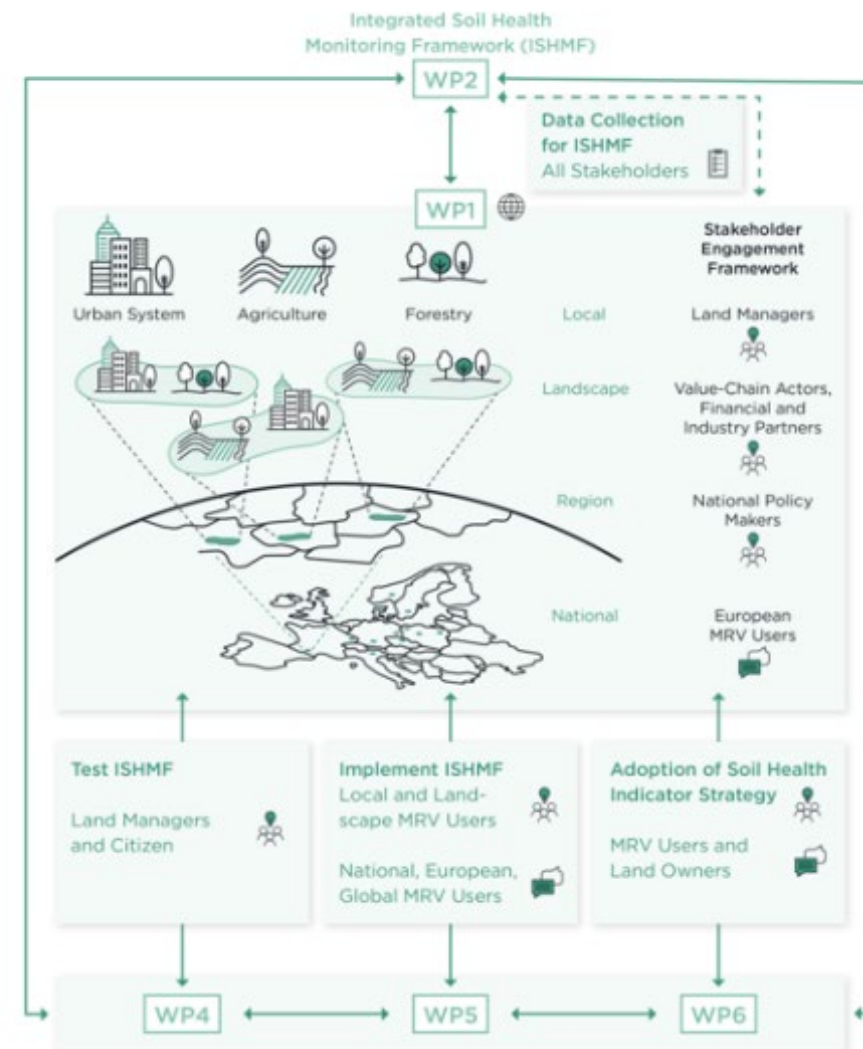
Forest
7

Urban
5

#Mis



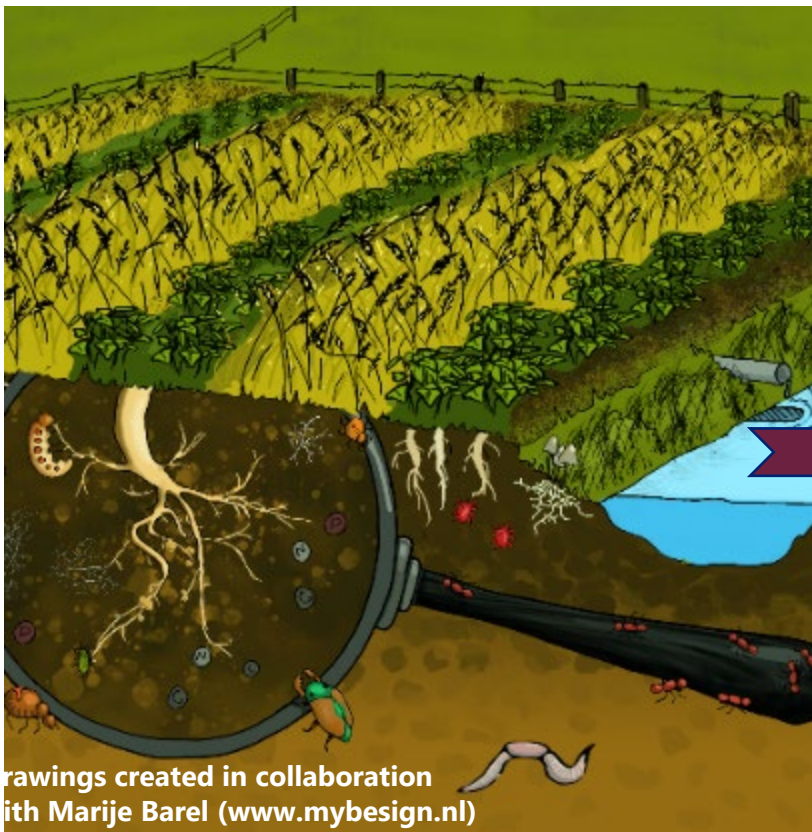
Multi-stakeholder Workshops



#Mi

Type and Method of Stakeholder Engagement:

-  Project Communication - Website, Social Media
-  Indirect - Surveys, Questionnaires
-  Direct - Meetings, Dialogues, Consultations
-  Active - Workshops, Site Visits



Drawings created in collaboration
with Marije Barel (www.mybesign.nl)



1. Identify the objective and contextualization of assessment
2. **Understanding the drivers of soil functioning**
3. Soil functions, processes and parameters of interest
4. Select indicator measurements to measure change in time
5. Assess logistical considerations for indicator selection

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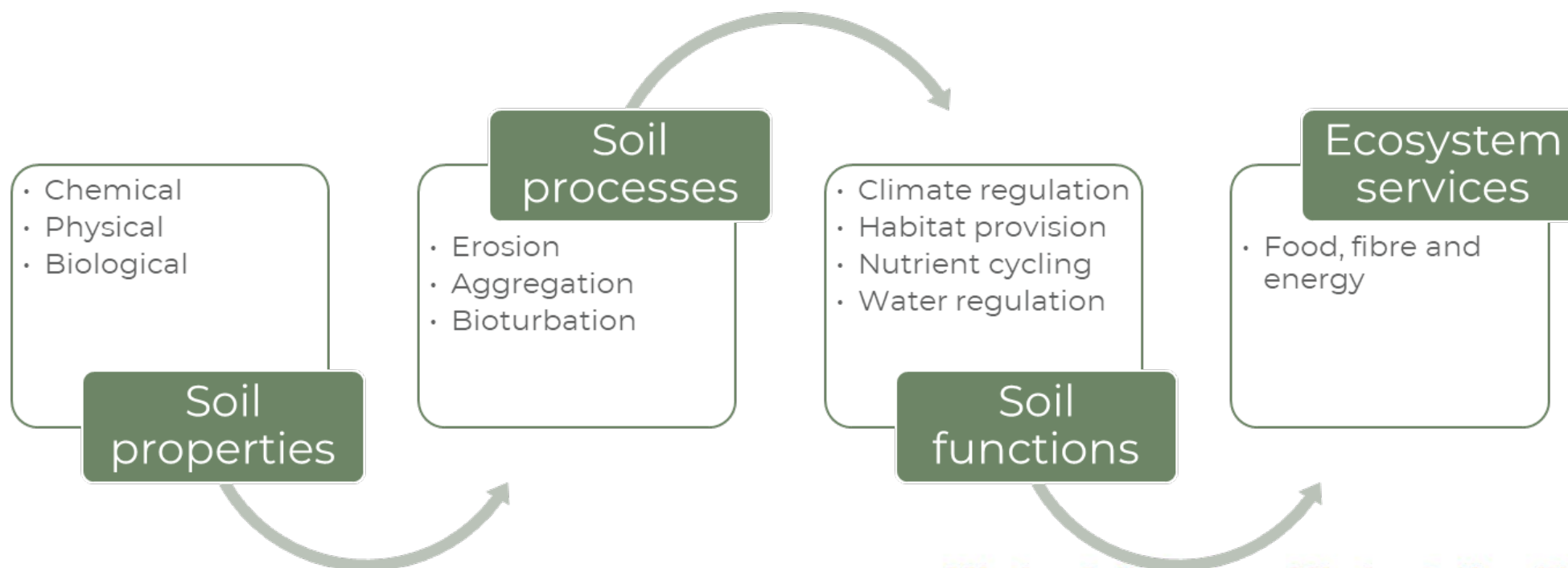
Understanding the drivers of soil functioning

Goal / Objective

i.e. reduce erosion, improve water infiltration, improve yield

Soil functions

Identify functions which support objective



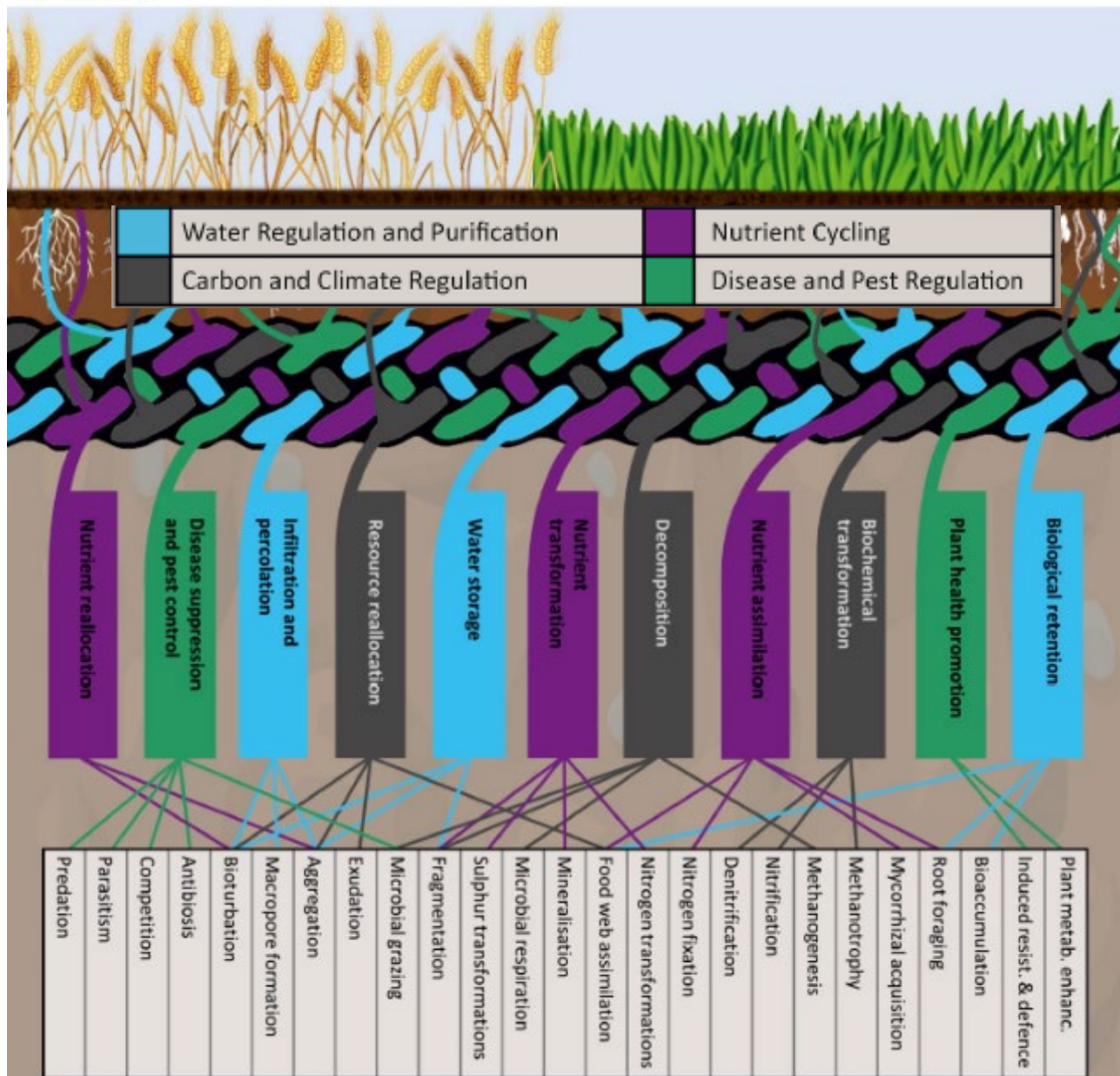


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Understanding the drivers of soil functioning



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Creamer et al., 2022

The life of soils: Integrating the who and how of multifunctionality

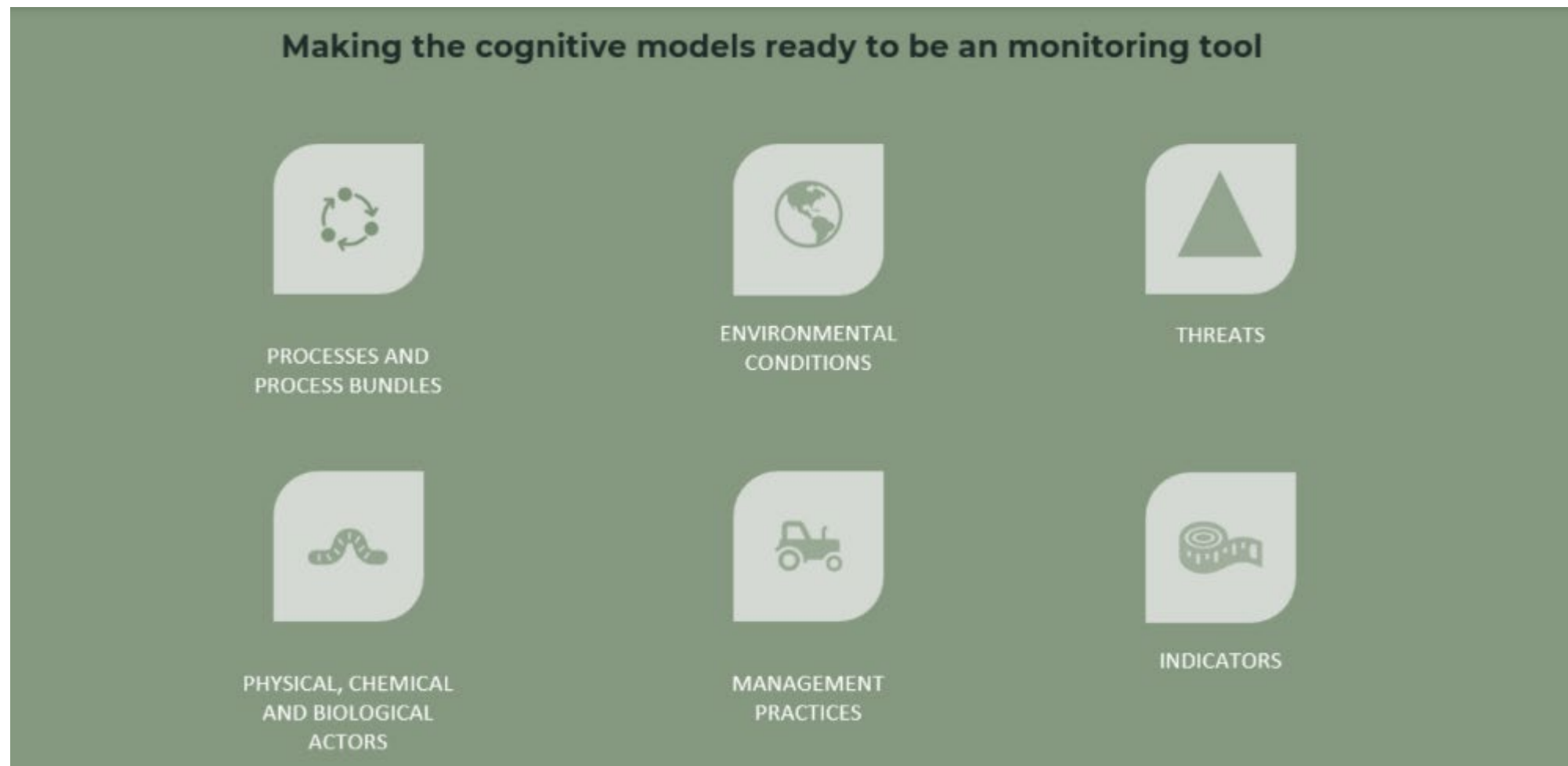
Soil Biology and Biochemistry 166 (108561)

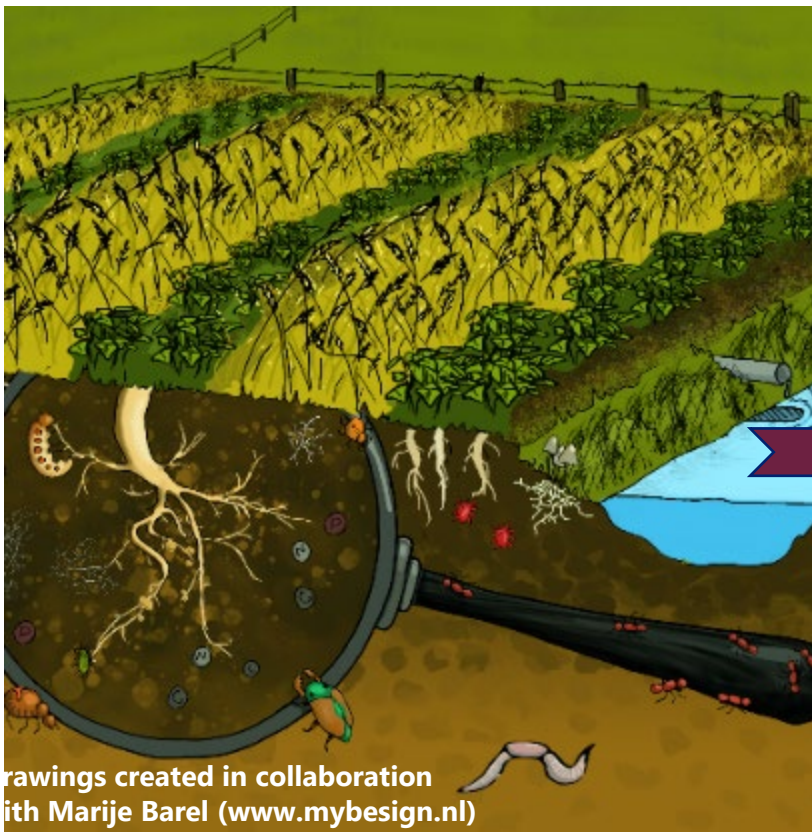
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Understanding the drivers of soil functioning



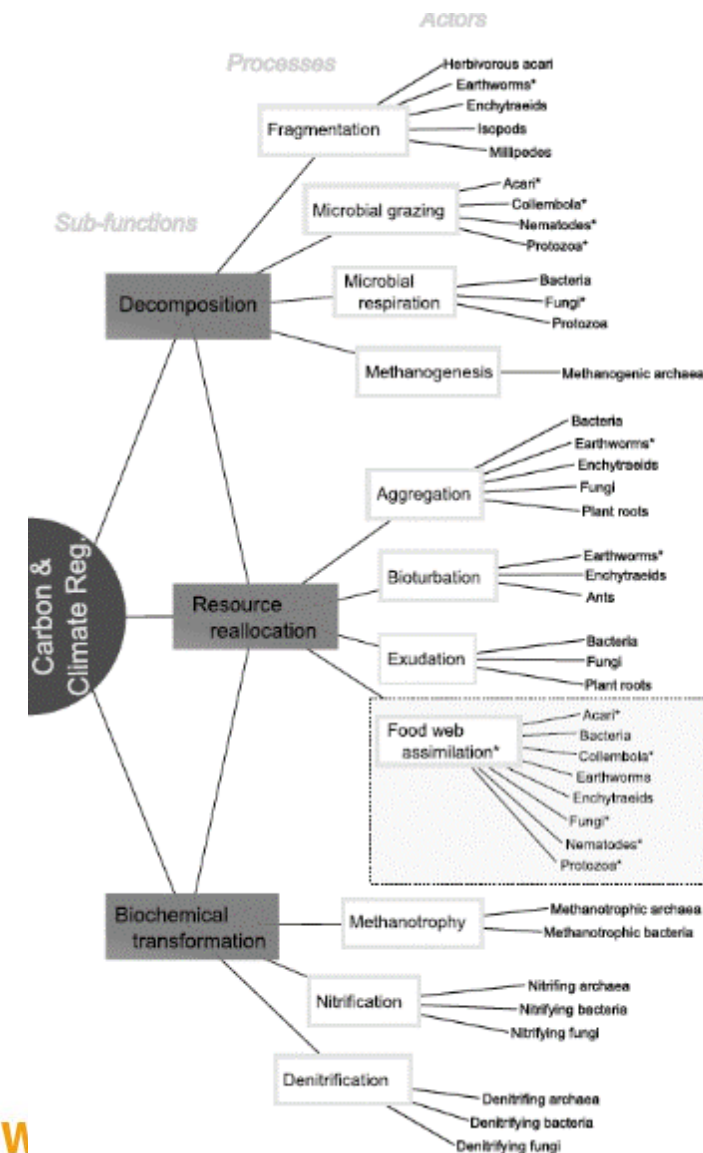
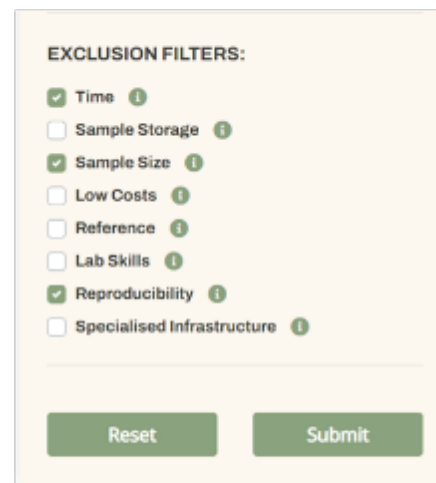
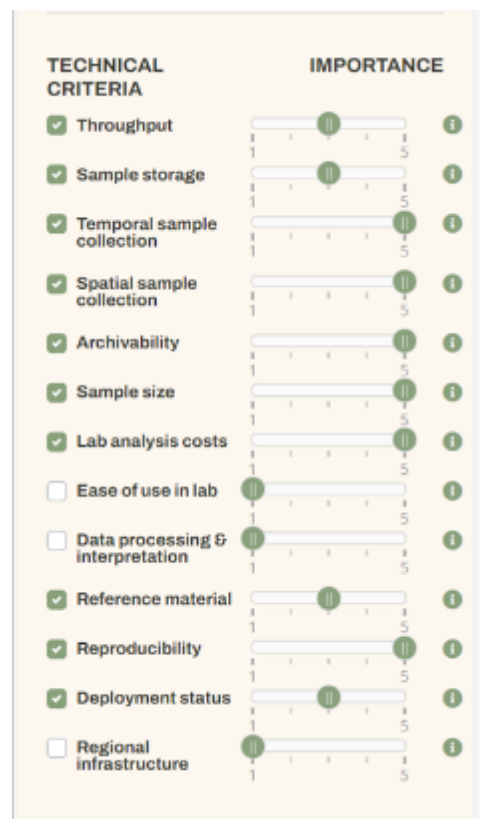


Drawings created in collaboration with Marije Barel (www.mybesign.nl)



1. Identify the objective and contextualization of assessment
2. Understanding the drivers of soil functioning
3. **Soil functions, processes and parameters of interest**
4. **Select indicator measurements to measure change in time**
5. **Assess logistical considerations for indicator selection**

Example on the role of biological actors



Zwetsloot et al., 2022

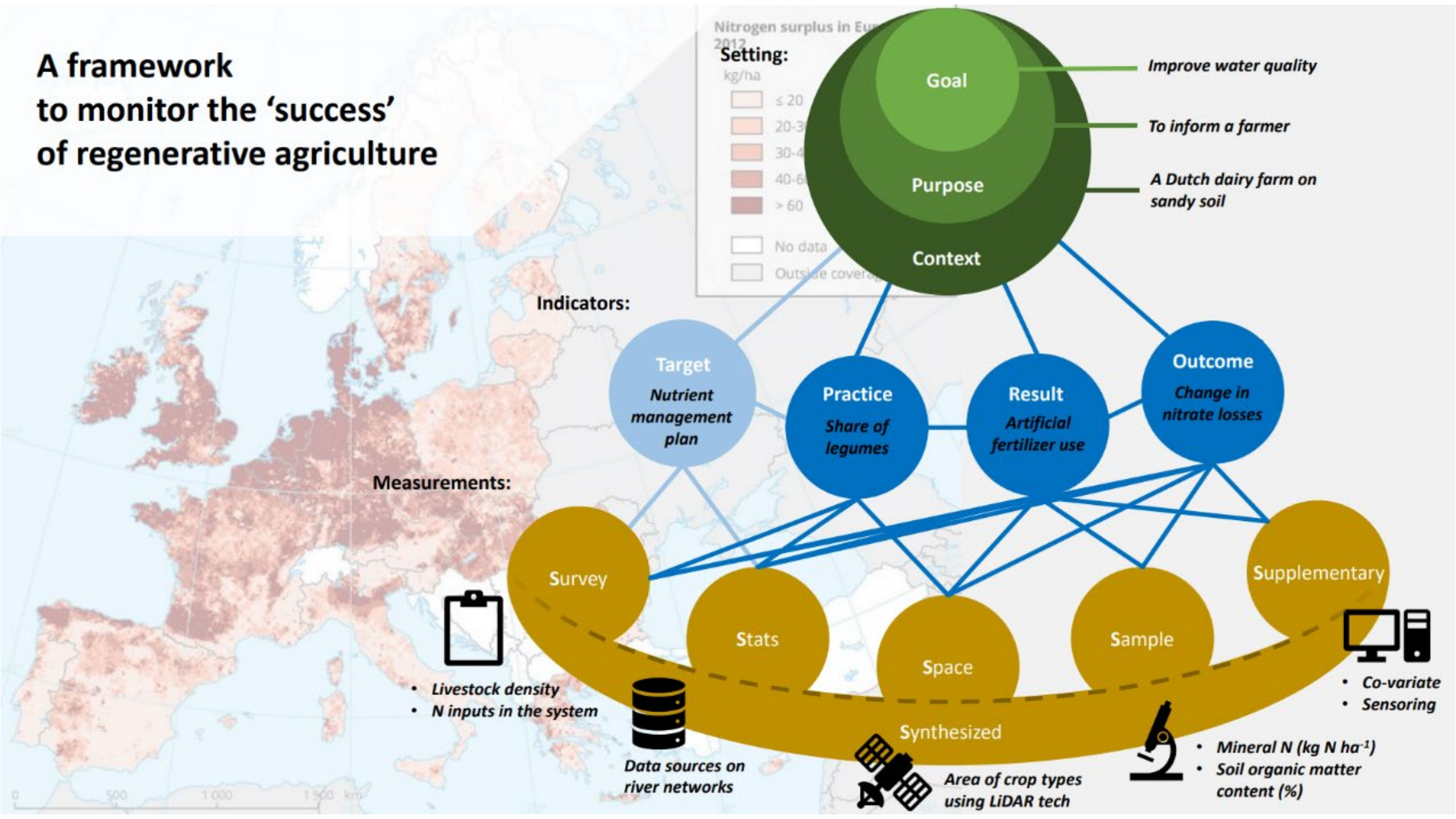
A flexible selection tool for the inclusion of soil biology methods in the assessment of soil multifunctionality

Soil Biology and Biochemistry 166 (108514)

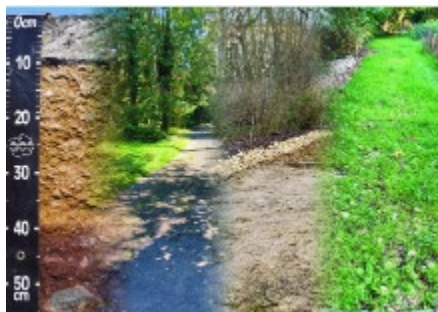
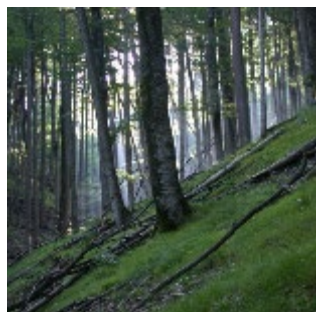
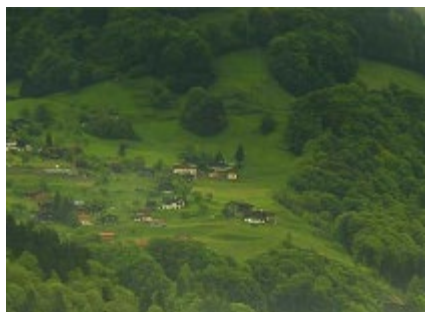
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Creamer et al., 2022

A framework to monitor the 'success' of regenerative agriculture



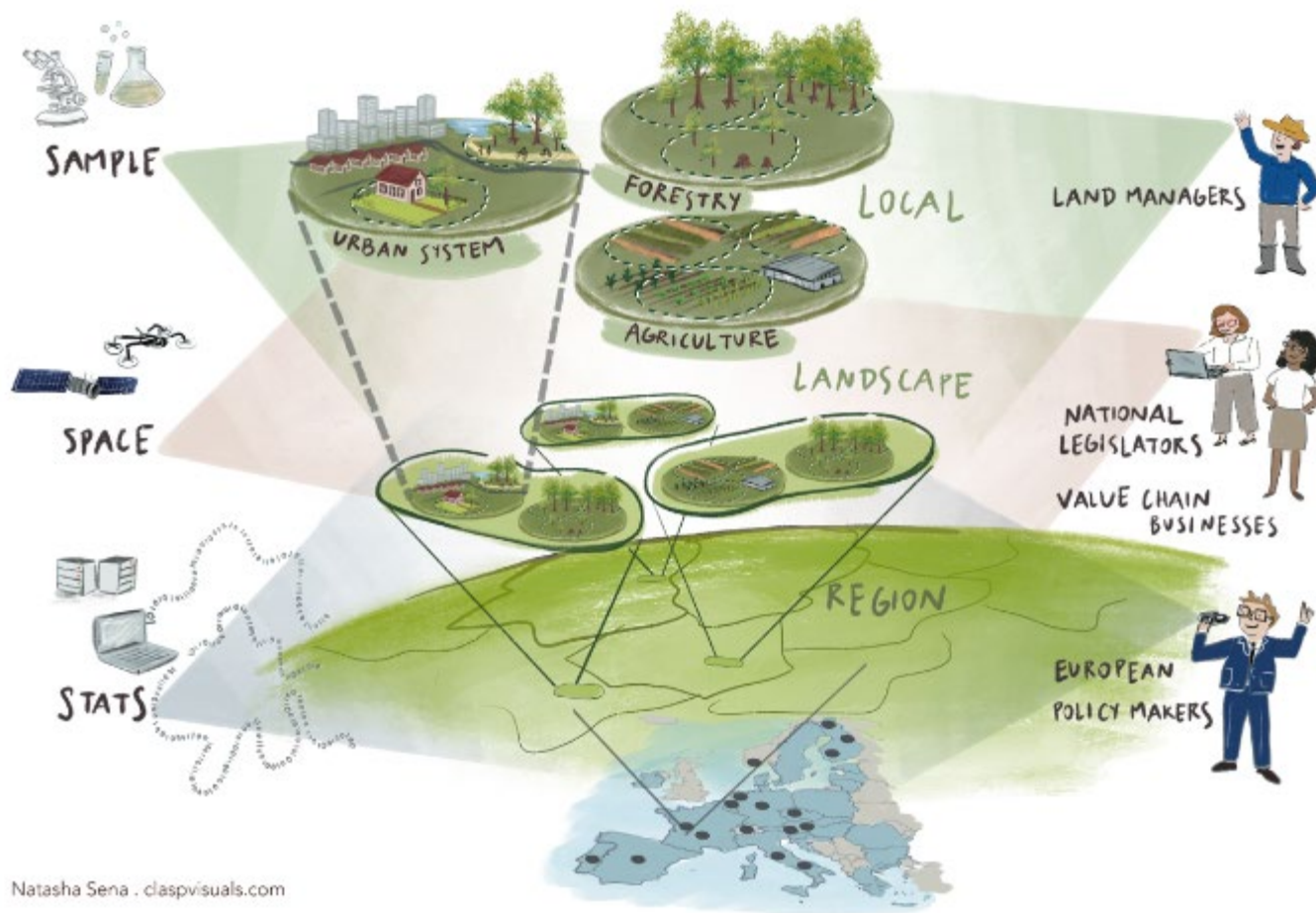
Testing of indicators across Europe



Defining Soil Health across Europe from the Local to European Scale of Assessment



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Natasha Sena . claspsvisuals.com



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Thank you!

Get in contact: Dr. Paolo Di Lonardo, Project
Manager paolo.dilonardo@wur.nl
soilhealthbenchmarks.eu

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INIA
Instituto Nacional de Investigación
y Tecnología Agraria y Alimentaria





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AI 4 Soil Health

Mogens H. Greve

Head of Research Section at Aarhus University

23 November 2023



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AI4SoilHealth, objective

This project will co-design, create, and maintain an **open access European-wide digital infrastructure**, termed “AI4SoilHealth”. The infrastructure will be used for assessing, and continuously monitoring, soil health metrics by land use and/or management



AI 4 Soil Health

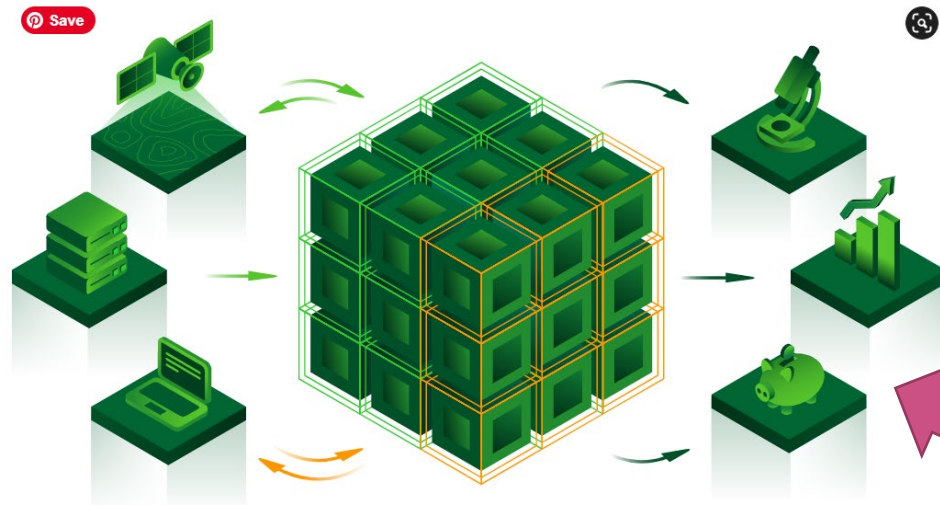
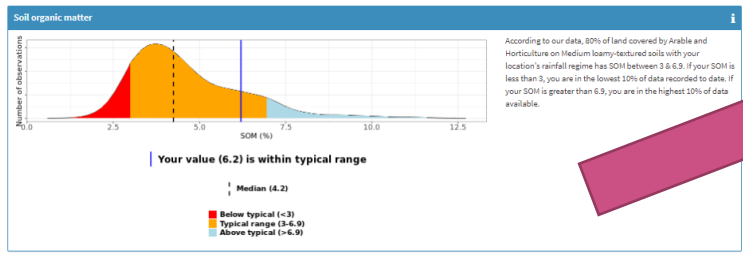
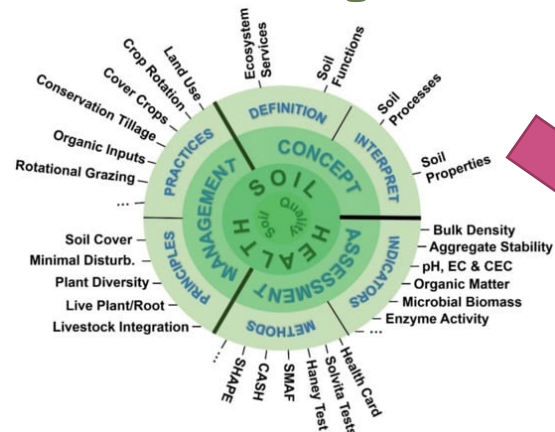


AI4SoilHealth, aim

- Identify robust & realistic **Soil Health Proxies** that can detect state and change in soil health relative to the desired soil ecosystem functions/services. **Soil district**
- Test **new proxies** based on emerging methods such as soil spectroscopy and molecular arrays that show high promise for characterizing both state and change in soil health;
- Create a digital infrastructure, foundation for a **“Soil Digital Twin”**



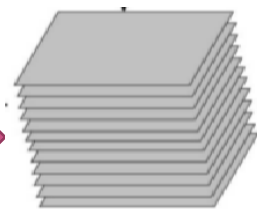
Main project outcome



Mobile APP



Data layers



Soil Health Tool



Coordination, AU

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Prof. Mogens H. Greve



Prof. Lis Wollesen de Jonge



Isabella Marie Leong
Project manager



Coordination, AU

WP4
Gustaf Hugelius



WP2
Giovanna Giuffrè



WP5
Tom Hengl



WP6
Katy Jo Stanton



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WP7
Julie Wilkins



Our partners:



Our partners

- 28 partners in 14 European countries



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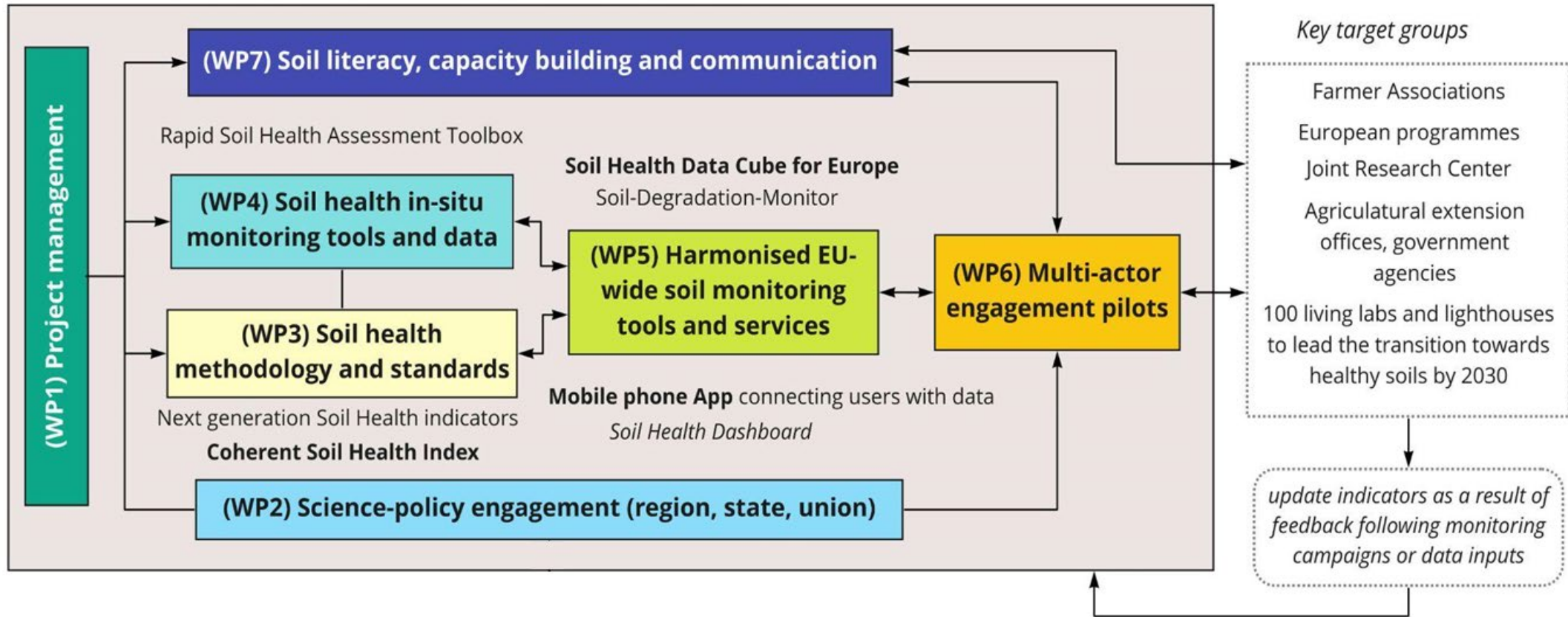


Our pilot sites

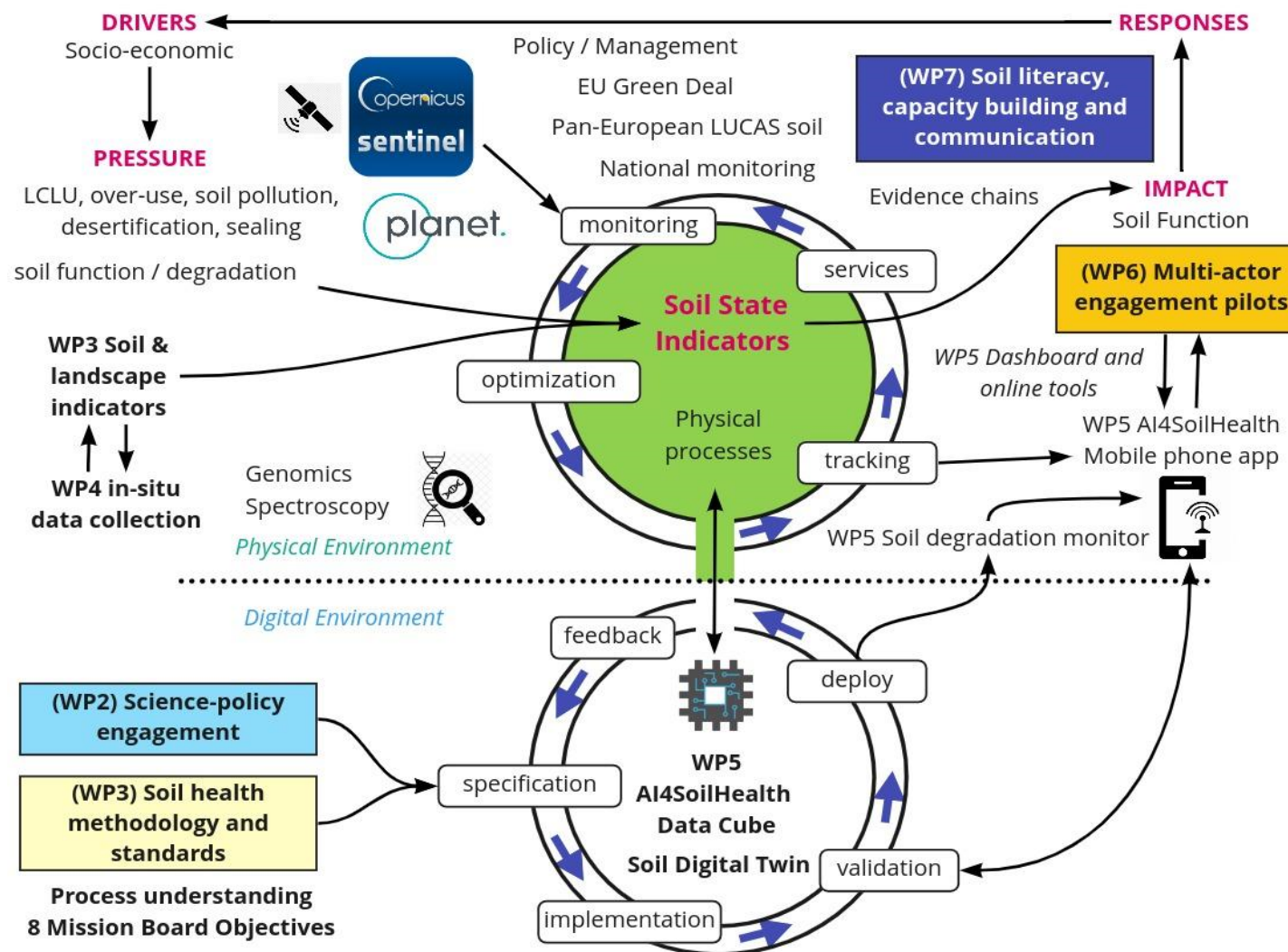
- AI4SoilHealth brings together a diverse range of stakeholders ‘on-the-ground’ across 13 pilots in 11 countries covering 11 of the 13 pedo-climatic regions in Europe.



Project overview



Soil Digital Twin



Soil health Indicators – selection procedure development

- Is it relevant to address a policy or stakeholder question of interest?
- Does it provide a good signal to noise ratio and the ability to detect change?
- How practical is it to measure?
- How efficient, or cost effective is it?

Typical robust soil change indicators that are widely used:

- Soil organic carbon
- pH
- Bulk density (topsoil and subsoil)
- Phosphorus (Olsen) and total nitrogen (TN)
- ...

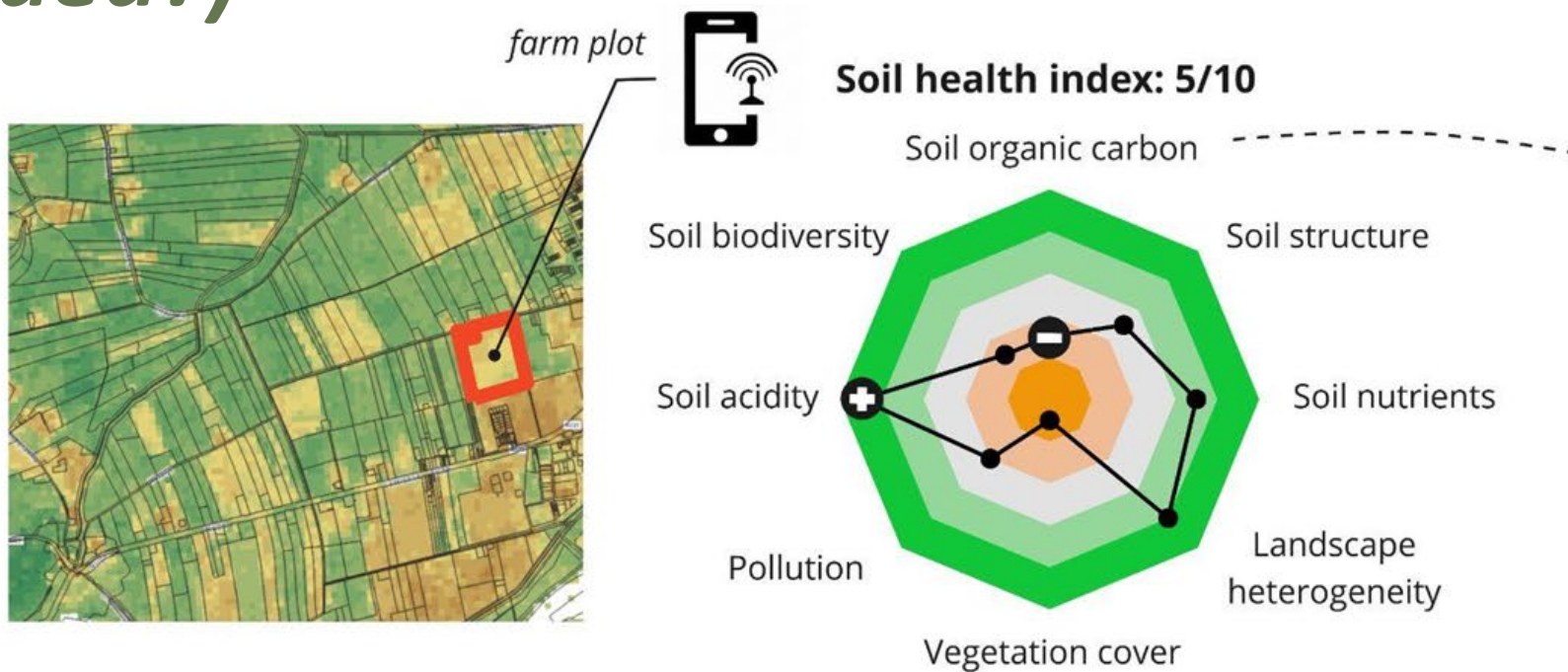


Novel Soil health indicators

- Relative and absolute abundance of class 1 integron-integrase gene as proxy for anthropogenic pollution
- Water repellency
- Specific surface area to soil organic carbon ratio
- NDVI change duration of land cover and turnover
- Characteristic times of soil water partitioning
- Soil air phase indicator
- Tree disease indicator of soil health
- Bare soil coverage change



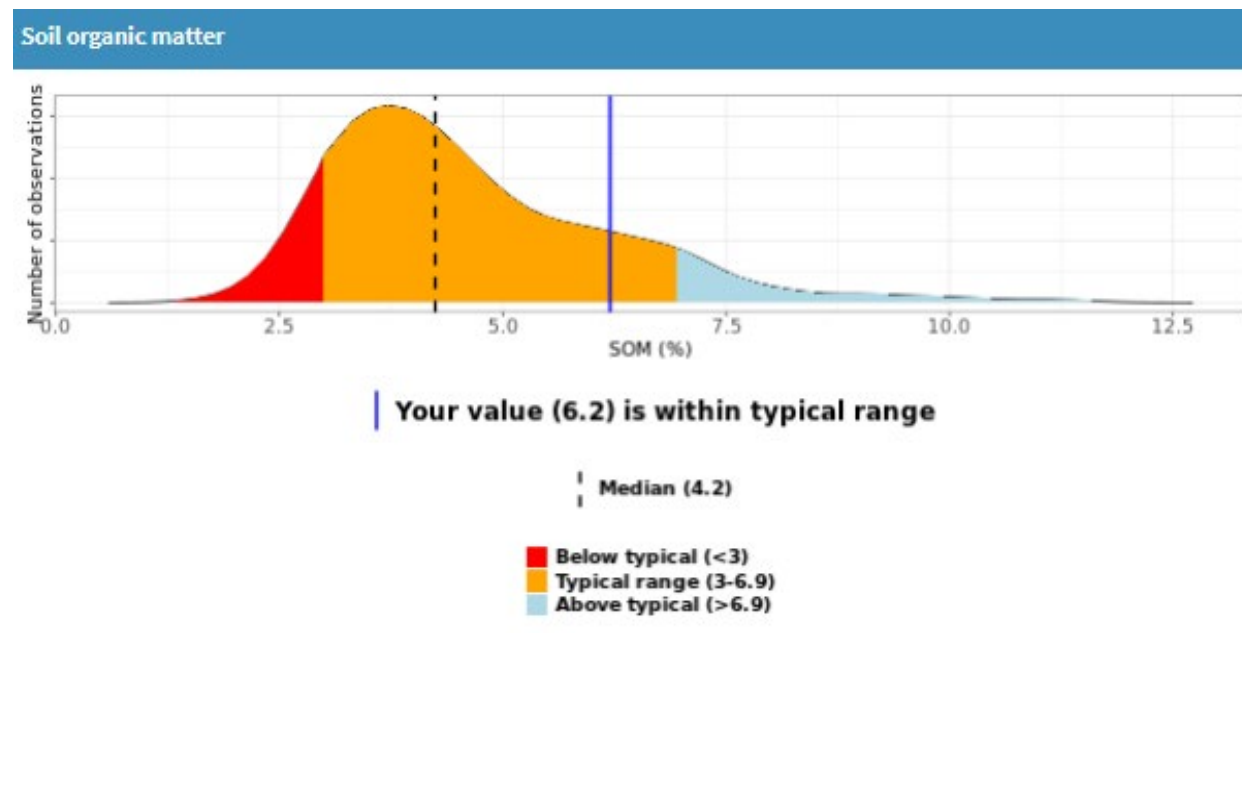
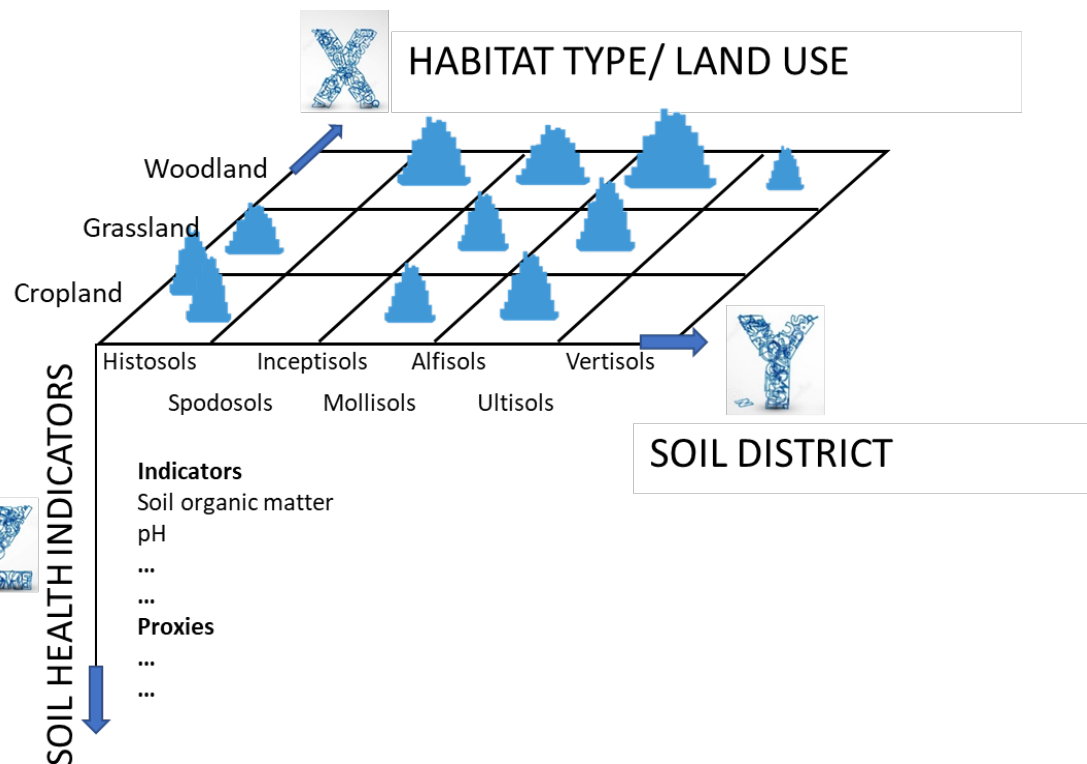
AI4SoilHealth, SHI (one possible idea?)



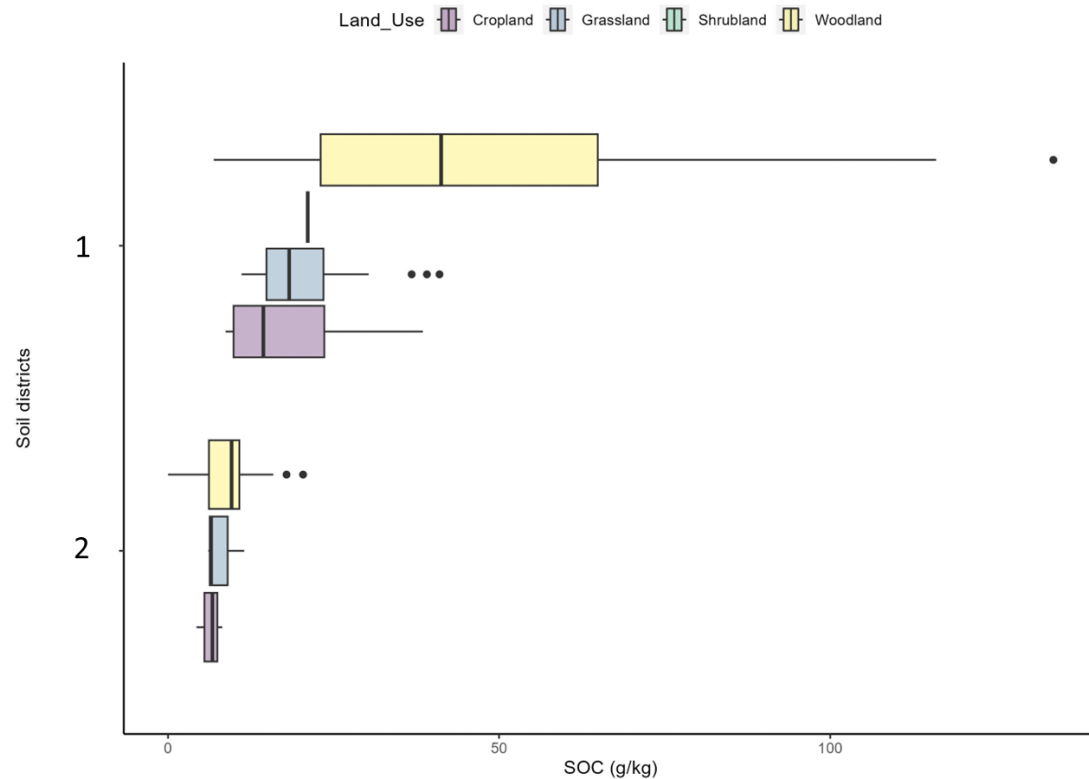
In the past 20 years, soil organic carbon stocks have decreased to sub-optimal levels. The following measures might help to counteract this trend ([External link to info sheet on SOC management in cropland by Dutch farmer association](#)).



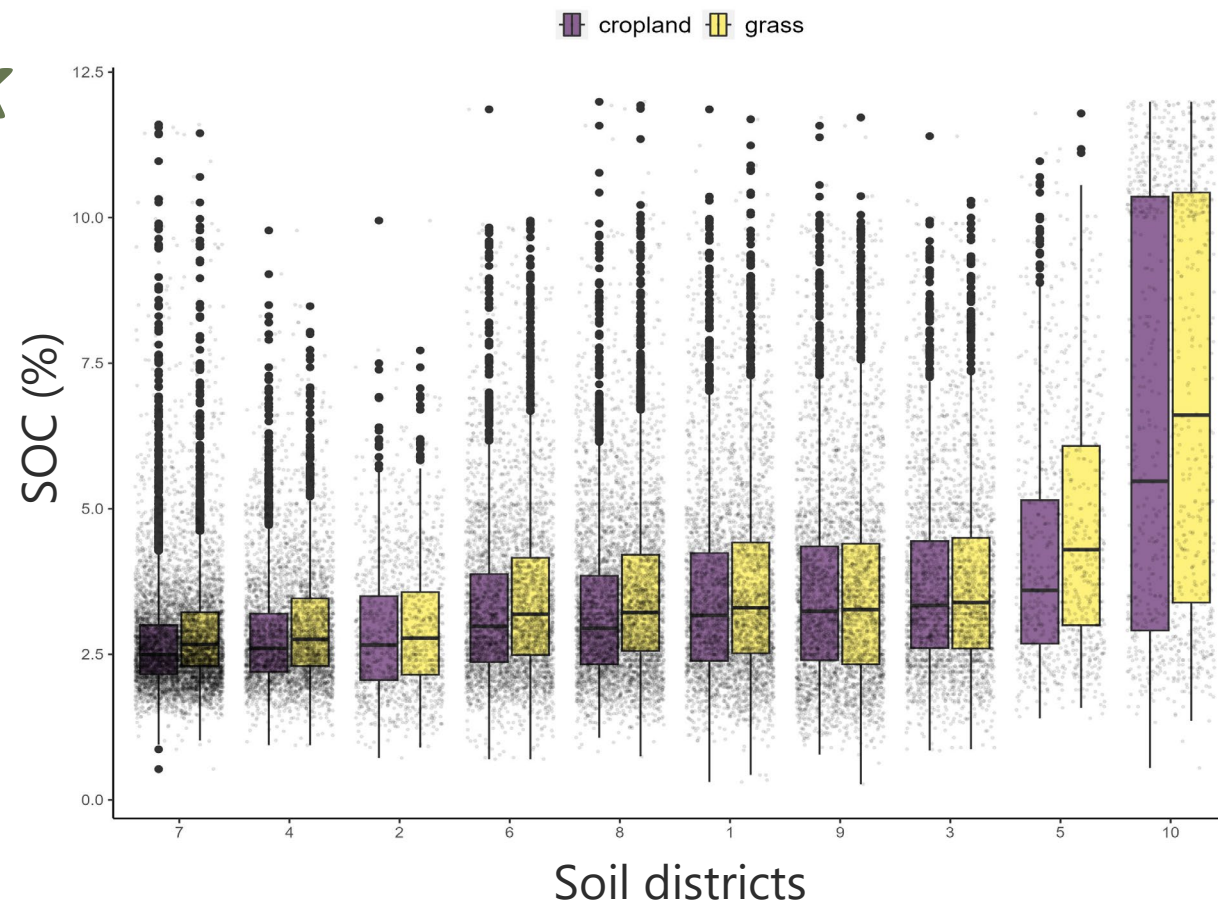
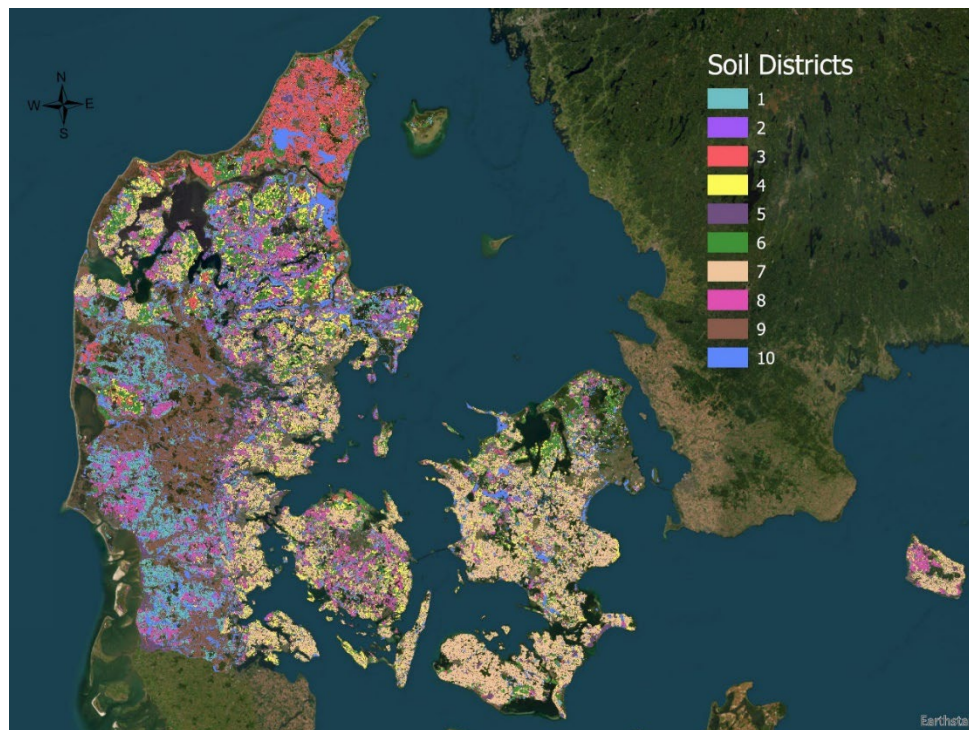
Soil Districts



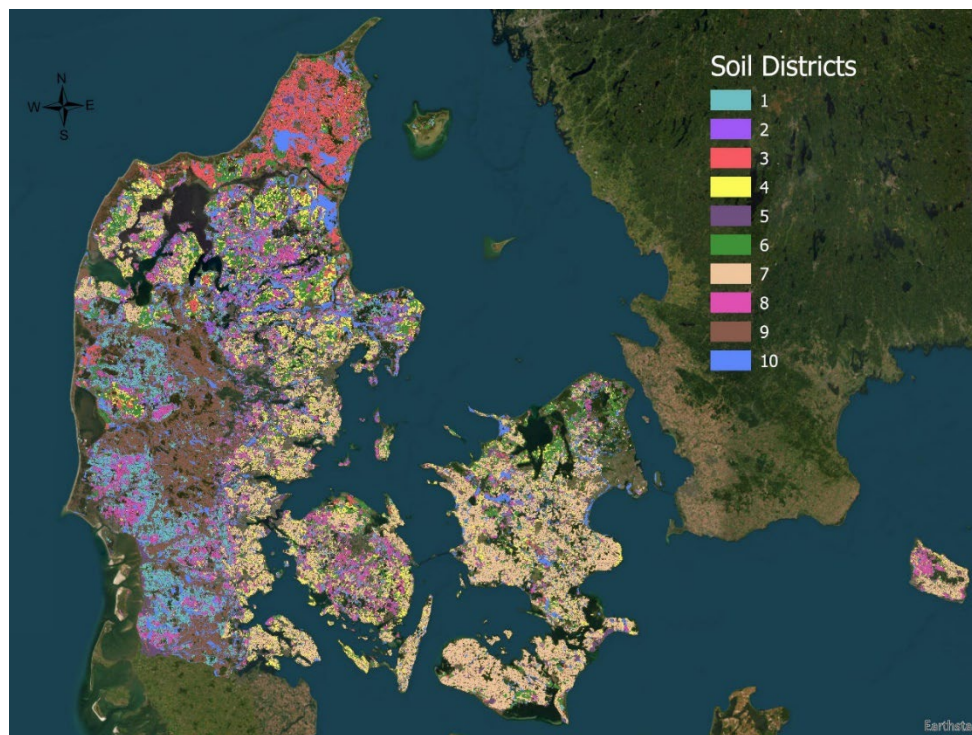
Soil Districts, a European example



Soil Districts in Denmark



Soil Districts in Denmark



Soil district	Number of samples (n)	
	SOC	CLAY/SOC
1	12	7
2	3	3
3	8	5
4	7	16
5	4	5
6	12	11
7	14	25
8	14	13
9	11	5
10	70	2
Mean	16	9
Sum	155	92





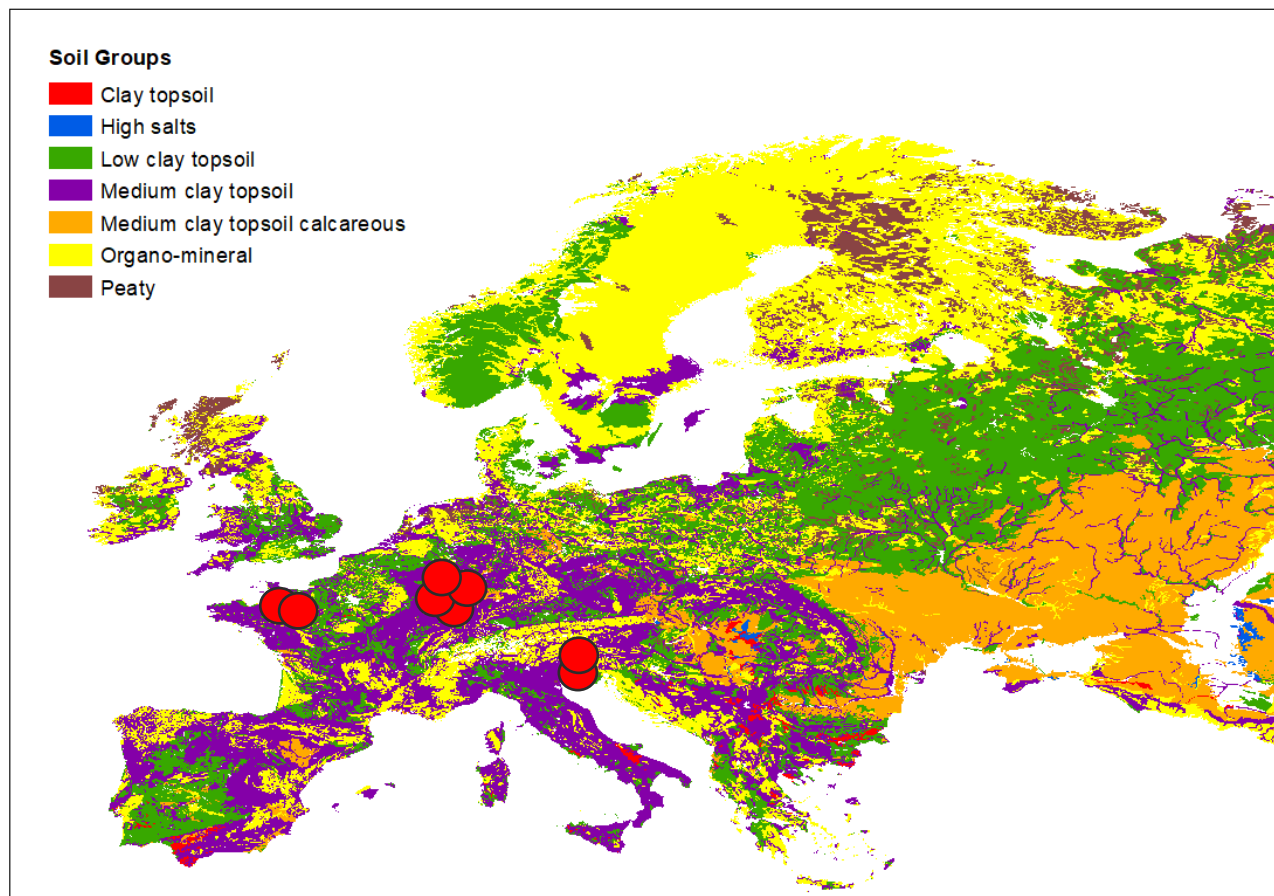
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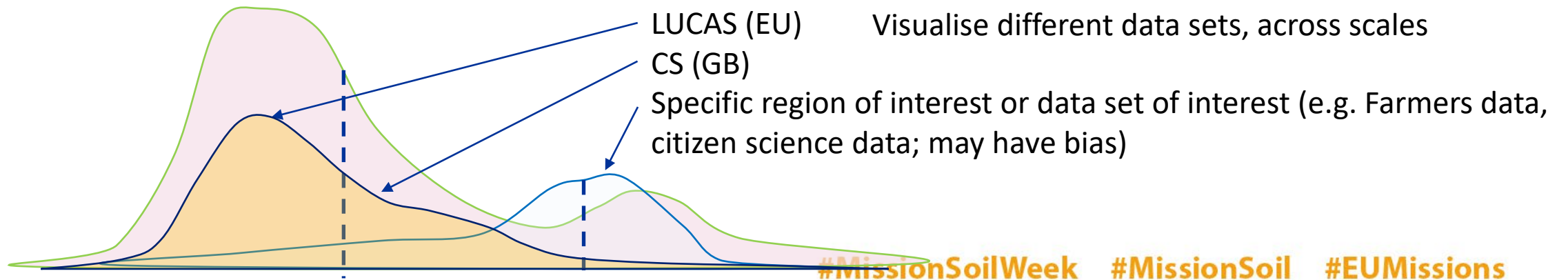
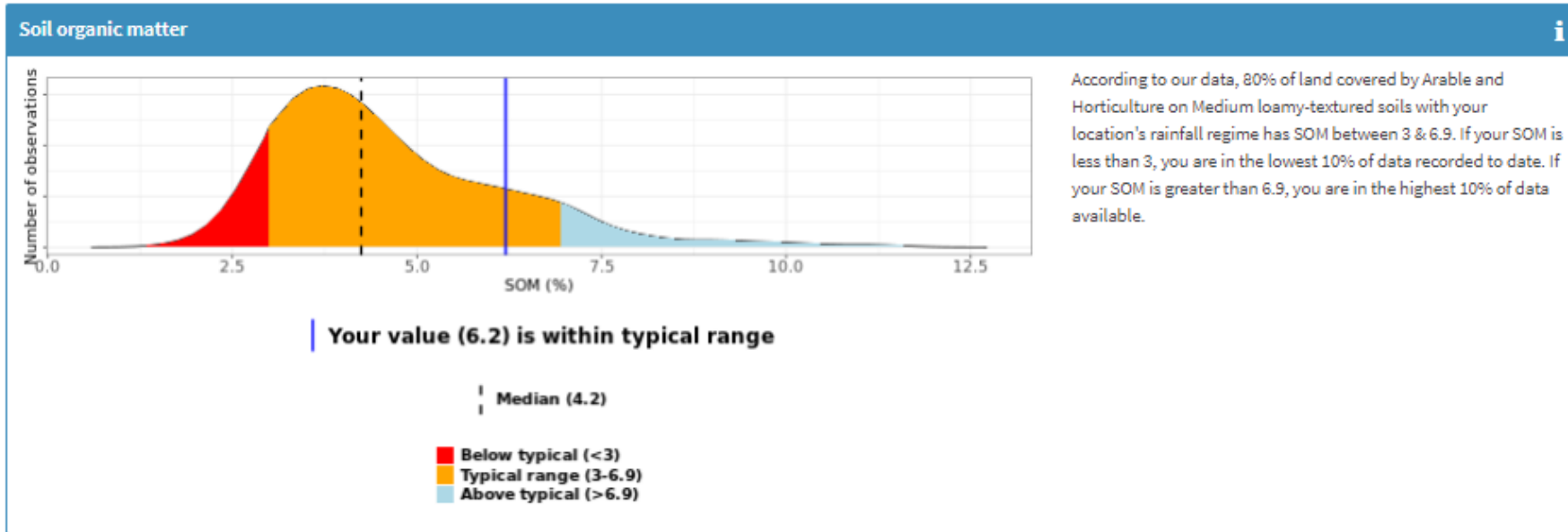


Extending the benchmark into space



- Identify where the habitat / soil type combination is located.
- Use dots to show the distribution of values above or below a threshold spatially
- Help to set the context as to whether an issue is local, management related or parent material related.

Benchmarking approach using different data sets for different scales or sampling populations





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INIA
Instituto Nacional de Investigación
y Tecnología Agraria y Alimentaria



Side activities – DAY 3

Meet the Projects



Photo exhibition

Knud Bay Smidt

Jacek Cislo

Božidar Grgošic

Diana Joca

Eniko Kelemen-Zobor

Dominika Koszowska

Eric Lucot

Cristina Mancini

Mariya Maslova

Sergio Ibáñez Pascual

Félix González Peñaloza

Marcin Switoniak



Side activities– DAY 3

**Poster Exhibition: Soil
needs in PREPSOIL regions**

Building E - Cloister





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Group picture

Please smile!



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Plenary Session

Soil monitoring and indicators

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Moderators



Rachel Creamer

Professor

*Wageningen University and
Research (Netherlands)*



David Robinson

Soil Scientist

*UK Centre for Ecology and
Hydrology*

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Diego Soto Gomez

Postdoctoral researcher
University of Vigo

Maria J. I. Briones

Professor of Zoology
University of Vigo

Anne-Catherine Dalcq

Farmer representative
*European Council of Young
Farmers*

Erwin Szlezak

Head of unit
*Agricultural District Authority,
Lower Austria, Department of
Rural Development, Section Soil
Protection*

Teresa Pinto Correia

Professor, Member of the Mission
Soil Board
University of Evora

Bridget Emmett

Head of Soils and Land Use
*UK Centre for Ecology and
Hydrology*

Arwyn Jones

Deputy Head of Unit / EUSO
Project Leader
*European Commission, Joint
Research Centre*

Luis Sanchez Alvarez

Head of Sector "New Research
and Innovation Concepts"
*European Commission, DG
Agriculture and rural
development, Research and
innovation unit*

Nina Koele

Senior Soil Scientist / Kaipūtaiao
One Matua
*Ministry for the Environment New
Zealand – Manatū Mō Te Taiao
Aotearoa*

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Plenary Session

Outcomes of the EUSO Working Groups (WG)

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Third EUSO Stakeholder Forum

15-17 November 2023

Summary

Arwyn Jones



EU SOIL
OBSERVATORY

The EU Soil Observatory (EUSO)

KNOWLEDGE FOR SOIL POLICY



EU-wide soil monitoring



Monitoring soil health and policies



Stronger European Soil Data Centre (ESDAC)



Research & Innovation



EUSO Stakeholder Forum

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Introduction

3rd EUSO Stakeholder Forum

Opportunity to engage with EUSO user community

Two-way communication

- Support EUSO developments
- Key objectives
- Underpinning knowledge base

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Overview

Three days

Six sessions addressing:

- Soil erosion
- Soil monitoring / Citizen science
- Soil biodiversity
- Soil pollution
- Soil data integration
- Soil carbon

Over 700 registrations

More than 60 presentations /
Interventions

EUSO TWG Soil data integration - ID:254240-20231117_0831-1



Collaboration with a specific group of stakeholders

Type of Stakeholders:

- Those who use the solution;
- Those who implement the solution;
- Those whose role or activity performance may change;
- Those who regulate;
- Those who support / sponsor;

Data user: means a natural or legal person who has lawful access to certain personal or non-personal data and has the right, including under Regulation (EU) 2016/679 in the case of personal data, to use that data for commercial or noncommercial purposes. [\(Data Governance Act Art. 3\)](#)

Who will implement SoilWise

Who will use (2 Groups)

Data users
Stakeholders that want to be able to discover data and knowledge.

Generation of data and knowledge

Ingestion
Storage
Discovery
Analytics

Funded by the European Union
This research has been funded by the Horizon Europe research and innovation programme under Grant Agreement No. 101019180

SoilWise
SoilWise is a joint effort

Third EUSO Stakeholder Forum

15-17 November 2023

Soil Biodiversity

Alberto Orgiazzi/Cristiano Ballabio



#EUSOforum

EU SOIL
OBSERVATORY

Work done



EU Soil Strategy for 2030: "...publishing the first assessment of EU soil biodiversity..."

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Article | [Open Access](#) | [Published: 08 June 2023](#)

Patterns in soil microbial diversity across Europe

[Maëva Labouyrie](#), [Cristiano Ballabio](#), [Ferran Romero](#), [Panos Panagos](#), [Arwyn Jones](#), [Marc W. Schmid](#),
[Vladimir Mikryukov](#), [Olesya Dulya](#), [Leho Tedersoo](#), [Mohammad Bahram](#), [Emanuele Lugato](#), [Marcel G. A.](#)
[van der Heijden](#) ✉ & [Alberto Orgiazzi](#) ✉

[Nature Communications](#) **14**, Article number: 3311 (2023) | [Cite this article](#)

Microorganisms



Animals



RESEARCH ARTICLE | [Open Access](#) |

Ecosystem type drives soil eukaryotic diversity and composition in Europe

[Julia Köninger](#), [Cristiano Ballabio](#), [Panos Panagos](#), [Arwyn Jones](#), [Marc W. Schmid](#), [Alberto Orgiazzi](#) ✉
[Maria J. I. Briones](#) ✉

First published: 14 July 2023 | <https://doi.org/10.1111/gcb.16871>

Analysis carried out and presented at EUSO forum by young scientists!!

#EUSOil

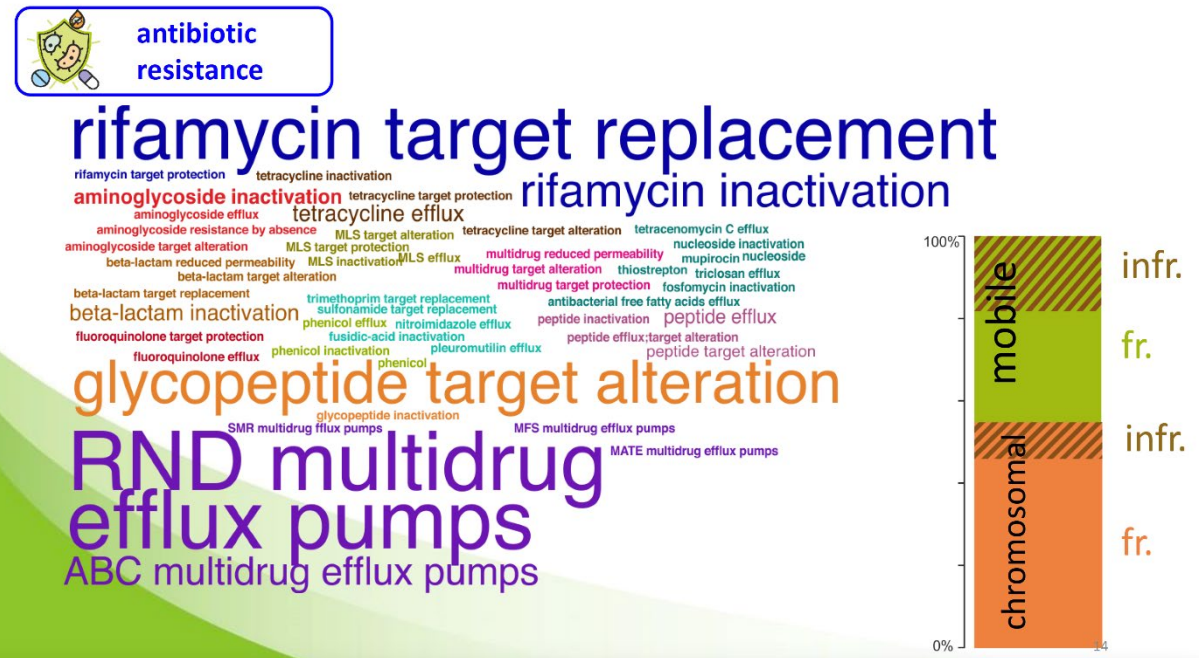
Work done



EU Soil Strategy for 2030: "... " ...publishing first assessment of antimicrobial resistance genes in agricultural soils..."

Results presented for the 1st time at the 2023 EUSO forum

Dulya et al., submitted



#EUSOil

Work in progress

ONGOING ANALYSES ON LUCAS SOIL BIODIVERSITY... MANY THINGS GOING ON!!

1. AMR genes and socio-economic factors
2. Soil biodiversity and pesticides
3. Metabarcoding of Archaea
4. Mapping soil biodiversity
5. Network analysis
6. Genes responsible for nutrient cycling (P, S, N, CH₄ biotransformations)
7. Genes encoding CAZymes responsible for carbohydrates biotransformations
8. Soil virome
9. Evaluating the bioindicator capabilities of genes
10. Taxonomic profiling based on shotgun data
11. Soil biodiversity conservation (Natura2000 effectiveness)
12. Design of Essential Biodiversity Variables
13. Soil biodiversity and primary productivity
14. Soil biodiversity and climate scenarios



#MissionSoilWeek #MissionSoil #EUMissions

Also contributing to the new EU Soil Health Report (released in 2024)

Future work



EUROPEAN
MISSION SOIL
WEEK

Loss of soil biodiversity

Soil basal respiration ($\text{mm}^3 \text{O}_2 \text{g}^{-1} \text{hr}^{-1}$) in dry soil

Member States may also select other optional soil descriptors for biodiversity such as:

- metabarcoding of bacteria, fungi, protists and animals;
- abundance and diversity of nematodes;
- microbial biomass;
- abundance and diversity of earthworms (in cropland);
- invasive alien species and plant pests

**EU Soil Monitoring and
Resilience Directive**

**Not much soil biodiversity
into it**

Waiting for outcomes from the discussion with European Parliament

#EUSOforum

#MissionSoilWeek #MissionSoil #EUMissions



Future work

How LUCAS soil biodiversity can tackle challenges posed by the directive proposal?

Open call for collaboration with JRC



Work with Soil Mission projects dealing with soil bio

LUCAS data and samples accessible



Goals:

1. Show that soil biodiversity can be better integrated into directive proposal
2. Offer methods/baselines to support the directive

[#MissionSoilWeek](#) [#MissionSoil](#) [#EUMissions](#)



Third EUSO Stakeholder Forum

15-17 November 2023

Soil Erosion

Panos Panagos



#EUSOforum

EU SOIL
OBSERVATORY

WG Soil erosion



Established in
2021

54 members

Volunteer participation
no funding



3 main objectives

- Support the needs of EU policies (EU Soil Strategy 2030, Biodiversity Strategy, Soil Mission, Common Agricultural Policy)
- Establish a soil erosion community
- Contribute to new data and integration of erosion data to other disciplines



EU SOIL OBSERVATORY



Costs of Soil Erosion

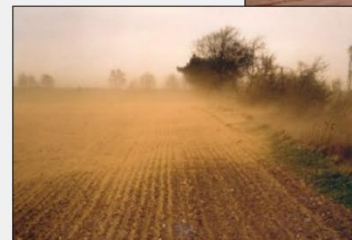
On site effects

- losses in agricultural production (yields and nutrients)
- damage to plantations
- reduction of the available planting area



Off site effects

- sedimentation
- flooding
- landslides
- water eutrophication
- siltation of reservoirs
- loss of biodiversity
- Loss of carbon sequestration
- land abandonment
- destruction of infrastructure such as roads, railways



Quantifiable costs of no-action gives the broad range of EUR 16.5 to 68.8 billion per year

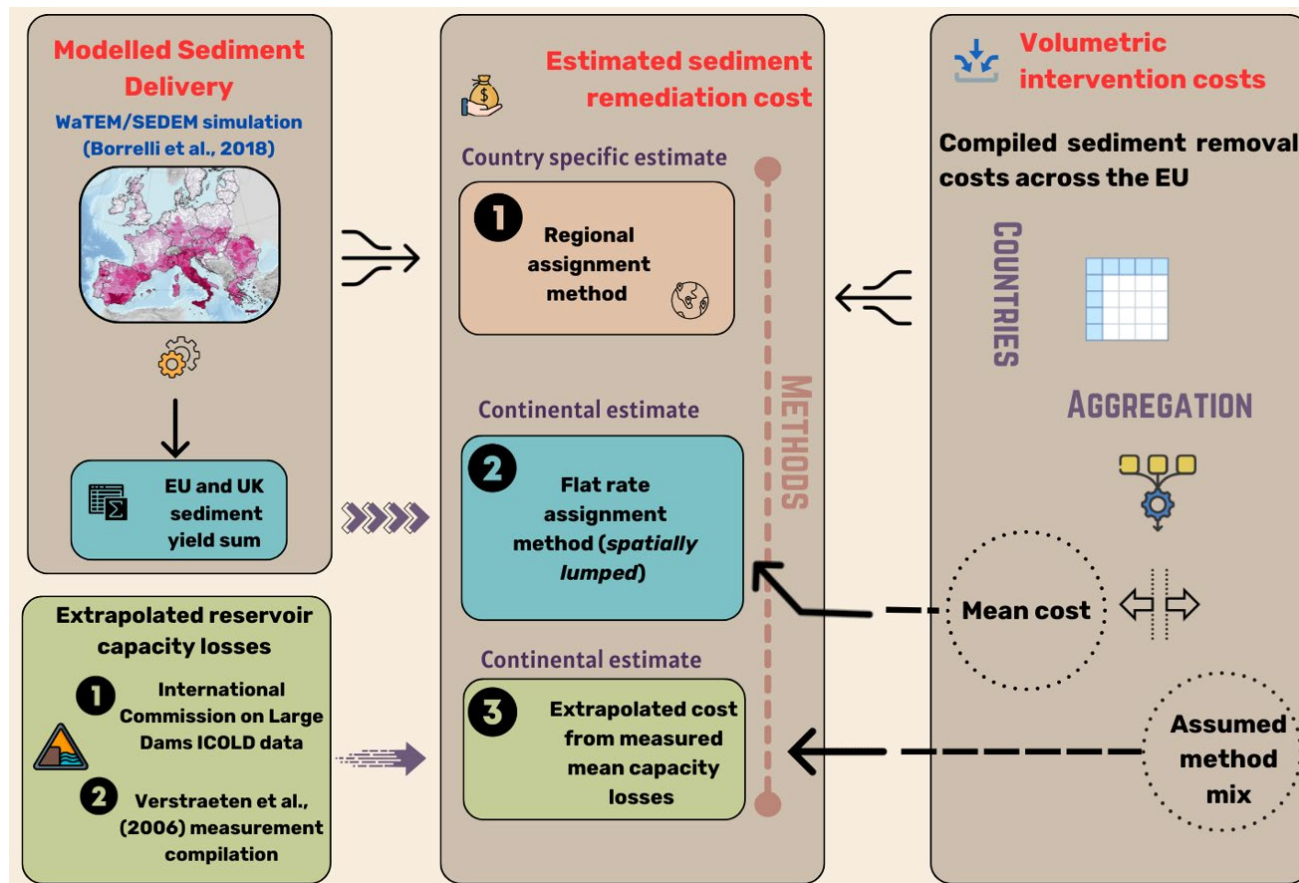
Lack of estimates (financial) for land degradation

Proposal for a
DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

on Soil Monitoring and Resilience (Soil Monitoring Law)

{SEC(2023) 416 final} - {SWD(2023) 416 final} - {SWD(2023) 417 final} -
{SWD(2023) 418 final} - {SWD(2023) 423 final}

How to estimate the costs?



15 experts within EUSO
WG Erosion

Data from 20 countries

Involvement of
International
Committee of Large
Dams (ICOLD)

Panagos et al., 2023.
In review

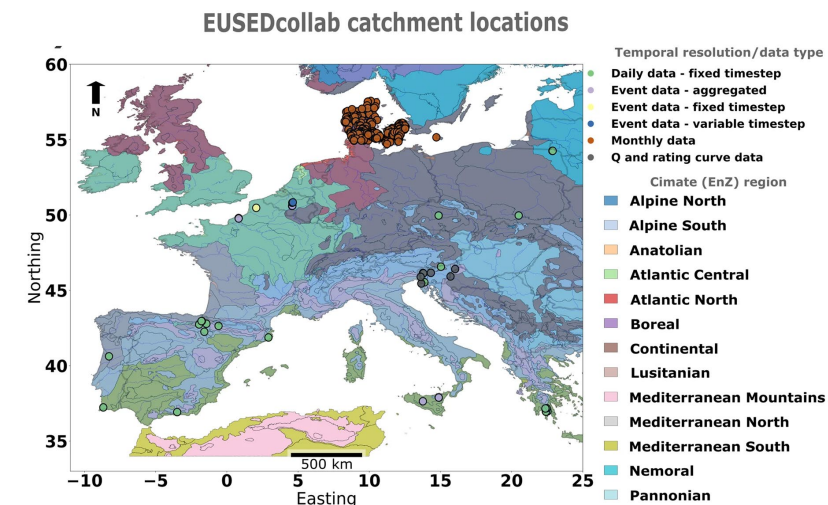
Costs of sediments removal - in a nutshell



- ▶ **01** **Cost of 2.3 bn. euro annually**
removing 135 million m³ of sediments (EU) due to water erosion
- ▶ **02** **5,000 reservoirs in EU**
estimation of the annual capacity losses
- ▶ **03** **2.5-8 bn. euro annually**
the potential cost of all sediments removal
- ▶ **04** **High variability of costs per country**
most common methods are mechanical dredging and flushing
- ▶ **05** **>1 billion m³ of sediments**
accounting all soil loss processes (gullies, landslides, quarrying, etc.)

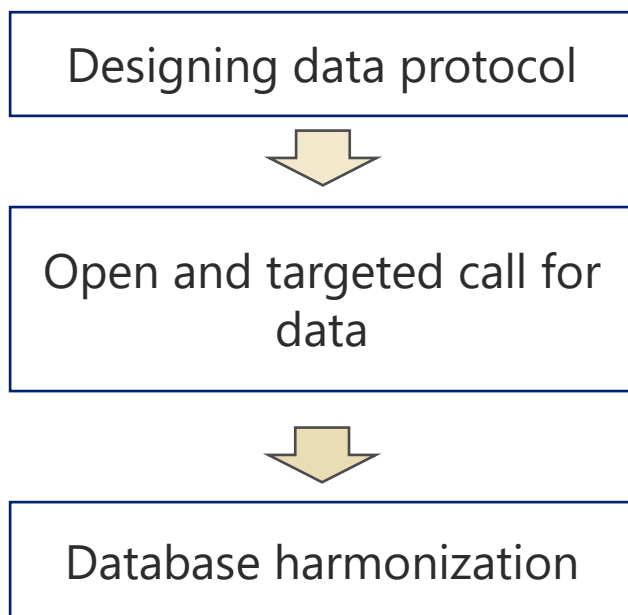
EU Sediments Database (EUSEDCollab)

- **Objective:** Compile data suitable for quantifying and understanding the delivery of eroded soils to river channels
- **EUSEDcollab** - Monitored catchments with measured **time series** of water discharge and suspended sediment load
- **Scientific insights** into how our understanding can **generalise** in different environments
- **Data opportunity:** from data-driven to process-driven models, **measurements are essential** for **development** and **validation**



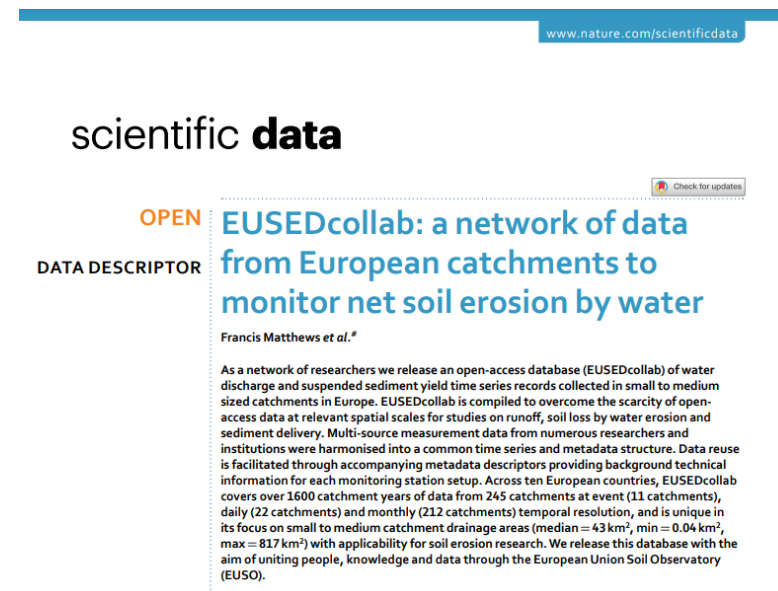
EU Sediments Database (EUSEDCollab)

Project launch: Winter 2020



- First significant effort to platform data from principally small catchments in Europe
- 245 catchments
- Over 1600 catchment years of data

- **EUSEDcollab.v1 publication: August 2023**
- **Data manuscript** as a **reference point** for users



www.nature.com/scientificdata

scientific **data**

OPEN DATA DESCRIPTOR

EUSEDcollab: a network of data from European catchments to monitor net soil erosion by water

Francis Matthews *et al.**

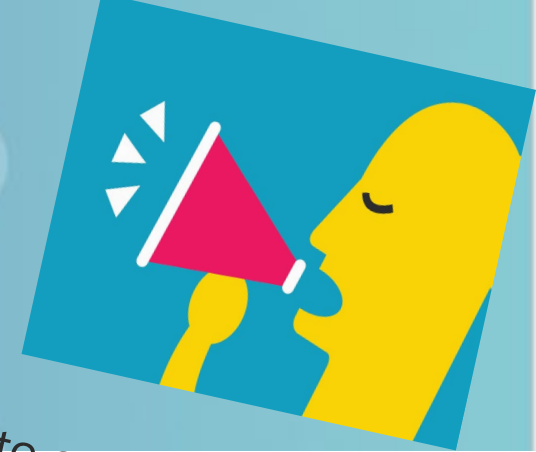
As a network of researchers we release an open-access database (EUSEDcollab) of water discharge and suspended sediment yield time series records collected in small to medium sized catchments in Europe. EUSEDcollab is compiled to overcome the scarcity of open-access data at relevant spatial scales for studies on runoff, soil loss by water erosion and sediment delivery. Multi-source measurement data from numerous researchers and institutions were harmonised into a common time series and metadata structure. Data reuse is facilitated through accompanying metadata descriptors providing background technical information for each monitoring station setup. Across ten European countries, EUSEDcollab covers over 1600 catchment years of data from 245 catchments at event (11 catchments), daily (22 catchments) and monthly (212 catchments) temporal resolution, and is unique in its focus on small to medium catchment drainage areas (median = 43 km², min = 0.04 km², max = 817 km²) with applicability for soil erosion research. We release this database with the aim of uniting people, knowledge and data through the European Union Soil Observatory (EUSO).

<https://www.nature.com/articles/s41597-023-02393-8>

#MissionSoilWeek #MissionSoil #EUMissions

Call for collaboration (Proposal)

Field soil erosion data in EU



- reach out to community
- prevent historical data loss
- update from previous data compilations
- model validation
- determine effectiveness of land management practices
- provide data access to the community for further scientific development

Compile

Soil erosion field data in European territory

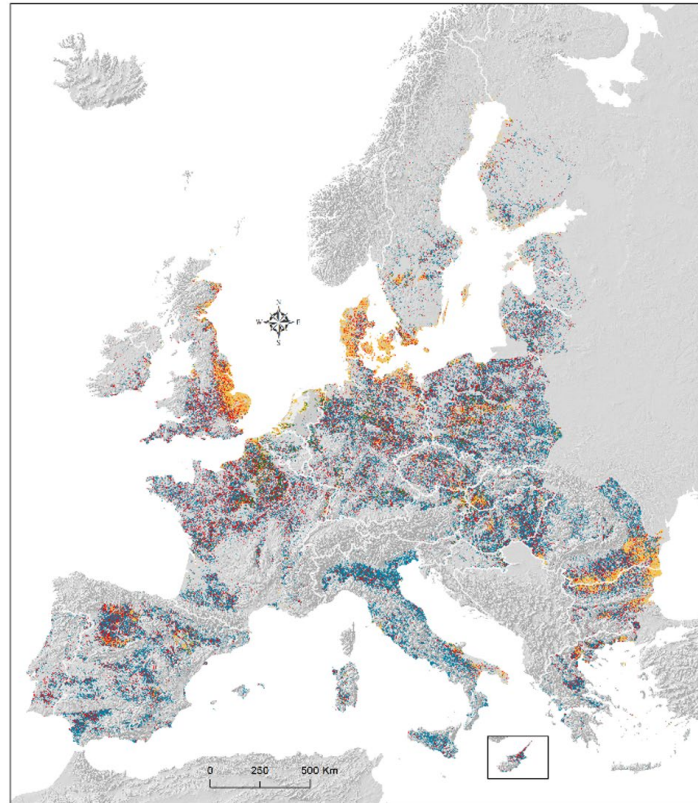
Process

Data Harmonization and quality assessment

Share

Data publication and accessibility to scientific community

Use



Dominant soil loss process (by cell)

Water Wind Tillage SLCH

nature sustainability

Analysis

<https://doi.org/10.1038/s41893-022-00988-4>

Policy implications of multiple concurrent soil erosion processes in European farmland

We aim at creating a new soil erosion indicator

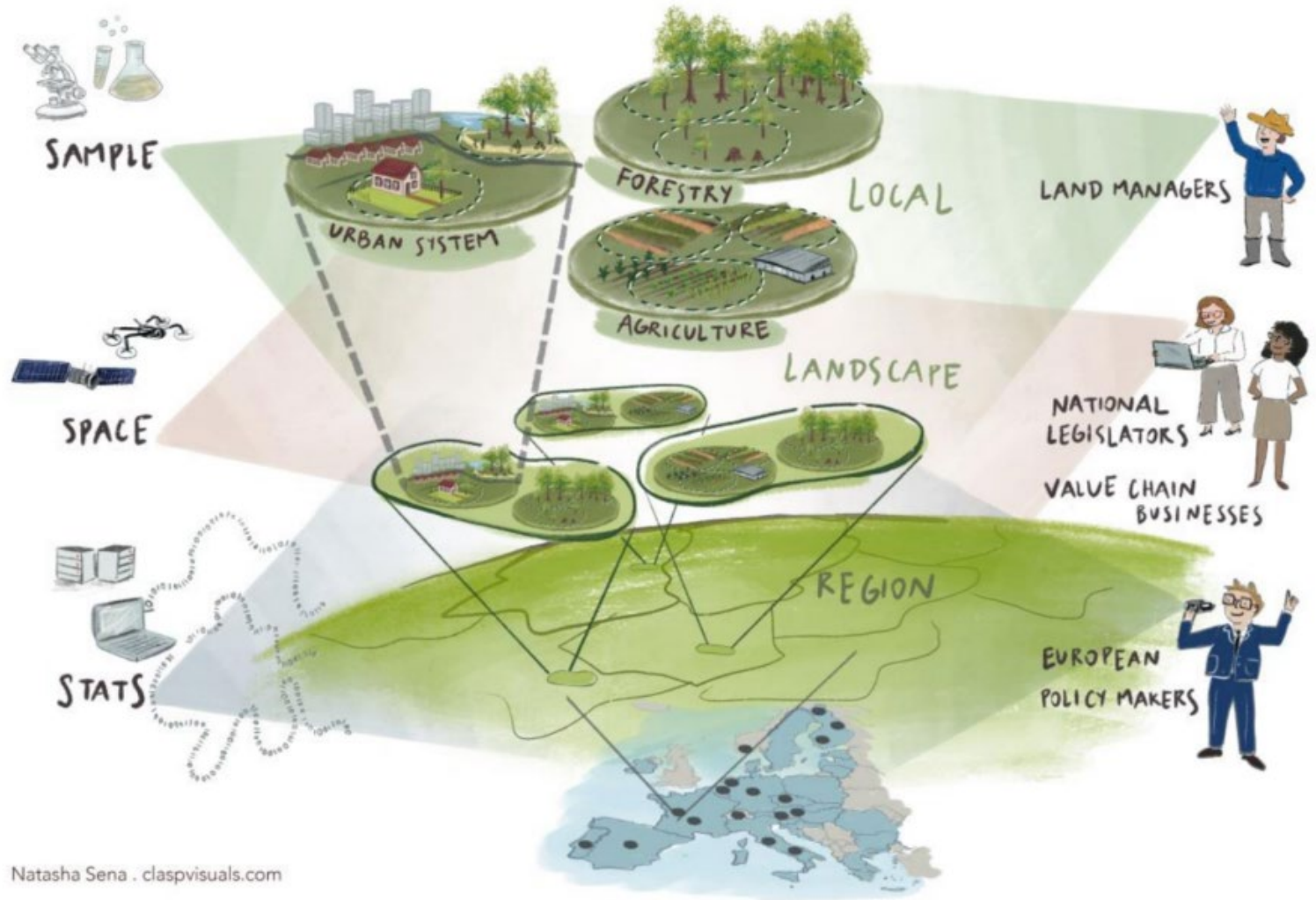


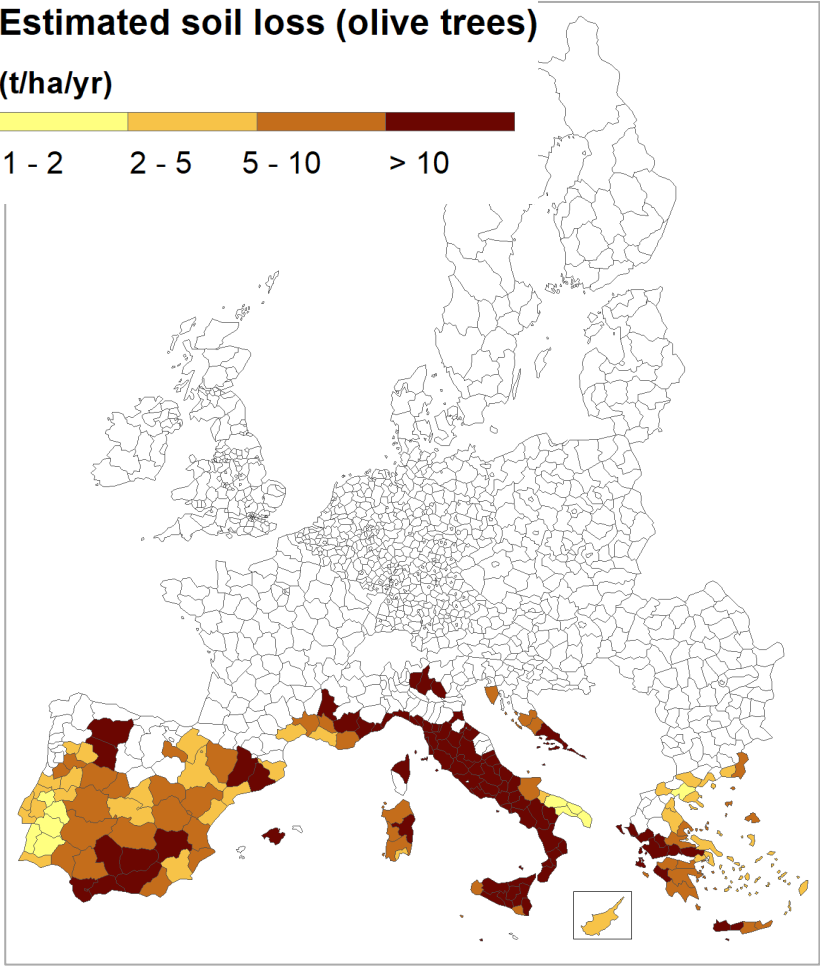
+ Soil stock + Crop economic value



Powered by  **ISRIC**
World Soil Information

- How do the drivers of erosion change as scale of assessment change?
- Which indicators of erosion are appropriate at which spatial scales?
- When are existing data, existing models, or remote sensing data sufficient for assessments of soil erosion?





Average slope = 5.5° (16% > 10° slope)
 Mean soil loss rate in arable land = 2.7 t/ha/yr
 Mean soil loss rate olive trees = 12.7 t/ha/yr

Goal 1. Pan-European assessment

- Grass cover
- Tillage operations
- Connectivity
- Mitigation strategies
- Stone walls
- Smart agriculture
- Contort farming

Goal 2. Networking. Integration with different topics and expertise of the project partners:

- Biodiversity
- Olive production
- Pollution
- Nutrients

Goal 3. Monitoring infrastructure. Build a large scale monitoring and modelling infrastructure - Collaborate with EUSO



Third EUSO Stakeholder Forum

15-17 November 2023

Soil Pollution

Piotr Wojda



#EUSOforum

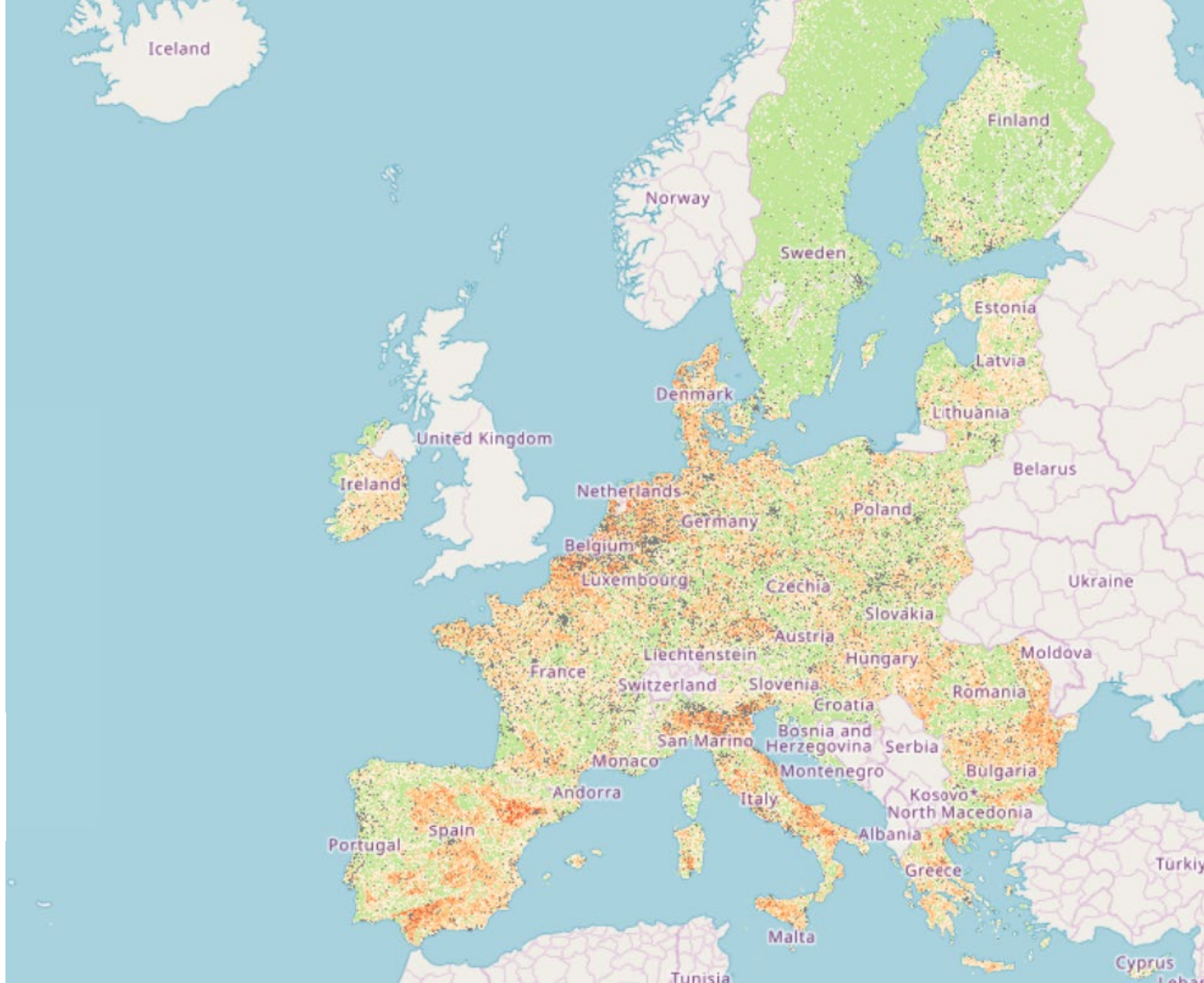
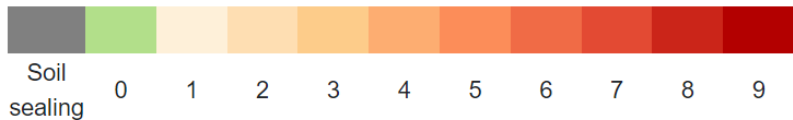
EU SOIL
OBSERVATORY

Contributors: citizens, academia, institutions, industry, policy makers,...



Where are healthy and unhealthy soils?

Number of soil degradation processes



Guiding questions as regards soil pollution

- **How would you improve the Soil Monitoring Law?**
 - Substances, thresholds, monitoring data sharing, watch list
- **What should be the Soil Health Dashboard priorities**
 - Contaminated land, contaminated sites, Risk assessment,
 - Antimicrobial resistance genes,
 - Organic pollutants: PFAS,
 - Pesticides,
- **LUCAS vs National Monitoring schemes?**
 - How to integrate: platform and data harmonisation

Chemical Soil Pollution
Need for effective soil protection

Definition of healthy soils

Define & implement suitable indicators

Identify substances with high priority

Implement environmental quality standards

Adapt regulatory framework for chemicals

Implement polluter pay's principle

Establish Europe wide monitoring program

Define restoration measures

Healthy Soils

The upcoming European Soil Monitoring Law: An effective instrument for the protection of terrestrial ecosystems?

Global Soil Partnership and its soil indicators in the assessment of soil pollution and sustainable soil management

Sergejus Ustinov
Land and Water Division, Global Soil Partnership secretariat (GSP)



Aim:

To navigate technicians, stakeholders, government representatives in the decision-making process to identify and assess the contaminated soils and take the best management decision. Advocate for a better understanding of national legal instruments on the prevention, monitoring and/or remediation of soil pollution

Justification

- Can be used to understand whether there is a soil pollution;
- To understand the behaviour of soil contaminants in the soil;
- Applicable to many soil conditions such as soil types, functions; and
- Widely developed and rely on internationally established and harmonized methodologies

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EU Soil Monitoring Law from an industry perspective

Meta van Heusden, Micha van den Boogerd, Elze-Lia Visser

Healthy industrial soils: fit for use

It is not clear in the proposal whether (all) soil health criteria also apply to industrial land (or to what extent).

- Due to the nature of an industrial site, it is often impossible to meet (all of) the soil health criteria.
- Halting land take also means repurposing industrial lands, potentially changing the applicable soil health criteria.
- A future use can only be taken into account when it is known.
- Make sure responsibilities in case a (sudden) change in land-use is decided are clearly defined.

Reuse and circularity of excavated soil

A missed opportunity regarding the re-use / circularity of excavated soil.

- reuse of soil strongly contributes to avoiding excavated soils being discarded as waste rather than becoming a resource (e.g. building materials)



The state of the management of contaminated sites in Slovakia and its public awareness

Elena Bradiaková, Katarína Paluchová. Slovak Environment Agency

5 pillars of Management of contaminated sites in Slovakia

1. The legal framework for addressing of contaminated sites – investigation and remediation

Adoption of the amendment of the Act No. 569/2007 Coll. on geological works (Geological Act) –

- defines new terms related to contaminated sites (November, 2009)
- fulfils conditions for using EU funds for investigation and remediation (through the Operational programmes – OP)

2. Identification and registration of contaminated sites

- Systematic identification of contaminated sites in the Slovak Republic (2006–2008)
- Regional Studies of Environmental Impacts of the contaminated sites in Selected Regions of the Slovak Republic (2010)
- Information System of Contaminated Sites (2009– till today)

3. Legal framework for determination of the obliged person (polluter):

- Adoption of the Act No. 409/2011 Coll. on certain measures in relation to contaminated sites (January 1st, 2012) – establishes the determination of the obliged person (mainly in private sector) and fulfils condition for using EU funds for remediation (through OP)
- Directive of the Ministry of the Environment of the Slovak Republic No. 1/2015 – 7 of January 28, 2015 for the Risk Analyses of Contaminated Sites (2015)
- Methodological guideline for environmental investigation in contaminated sites (2021)

4. State remediation programme of contaminated sites – priority action programme for management of contaminated sites:

- 1st 2010–2015
 - 2nd 2016–2021
 - 3rd 2022–2027
- strategic document on CS approved by the Slovak Government in May 2022

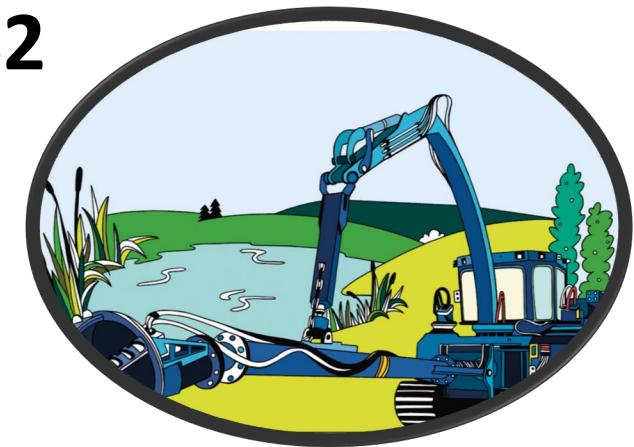
5. Public awareness on contaminated sites

3 information and education projects during 2 last EU programme periods

- 1st AWARENESS 2012–2015
- 2nd INTEGRATION 2014–2015
- 3rd INFOACTIVITIES 2018–2023

Registers of ISCS – include 1 782 contaminated sites in total in 11/2023

Interconnection with 14 public administration information systems



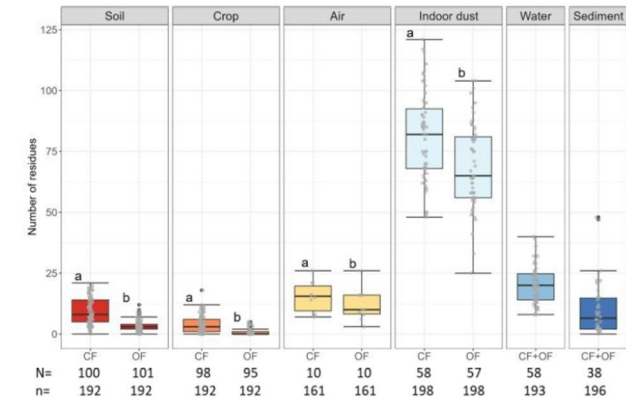
Mixtures of pesticide residues are omnipresent in the first results from the SPRINT field campaign



- **Mixtures of pesticide residues are omnipresent in European agricultural environments, and in farmers' households.**
- The number, levels and type of the pesticide residues found vary between Conventional Fields and Organic Fields
- Multi-matrix assessments provide further insights into pesticide fate, and impacts.
- Most of the pesticide residues detected are hazardous for non-target organisms
- Little is known about the health risks posed by environmentally relevant mixtures
- **More comprehensive approaches can be useful for decision-making concerning approved pesticides, and the development of transition plans towards more sustainable food production.**

WHAT did we find?

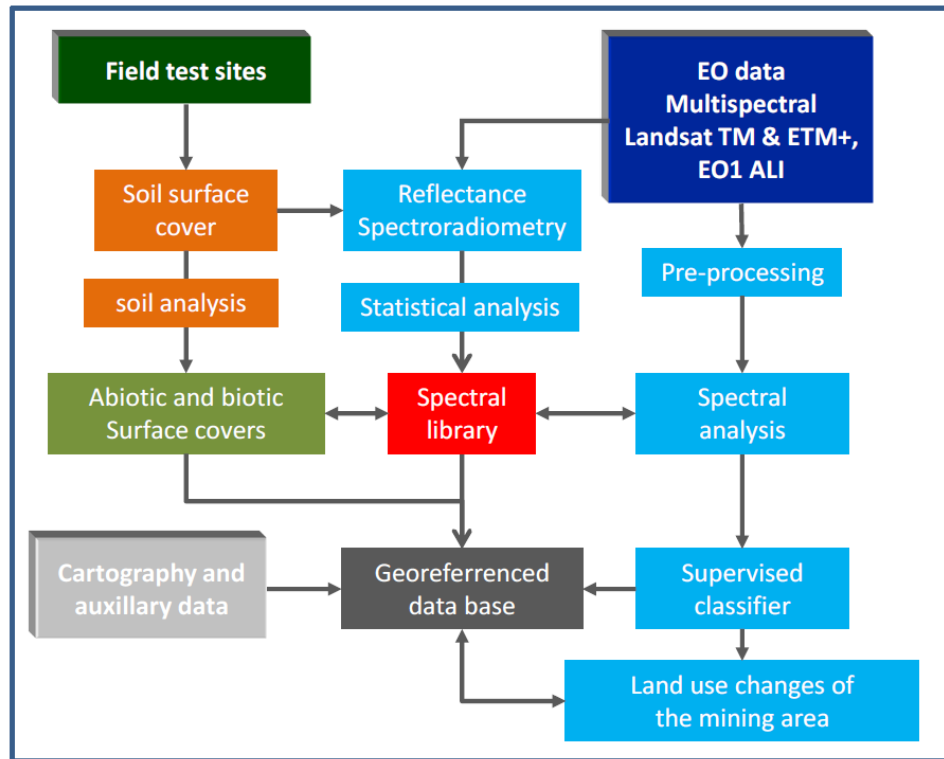
CF = conventional fields; OF = organic fields; N = number of samples; n = number of analytes (min161-max196)



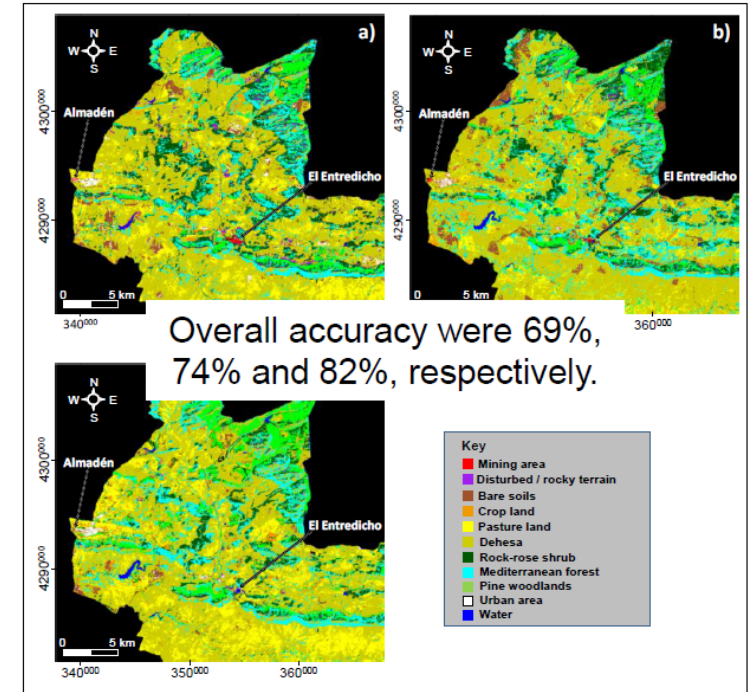
Overview env. matrices - Silva et al. 2023 - <https://doi.org/10.1016/j.envint.2023.108280>

Vera Silva, PhD

The use of remote sensing in soil pollution: Monitoring of the mercury mining site Almadén



Classification results (a) TM acquired 23 March 1989; (b) Landsat ETM+ acquired 22 April 2002 and (c) EO-ALI acquired 2 April 2008



□ Schmid, T., Rico, C., Rodríguez-Rastrero, M., Sierra, M.J., Díaz-Puente, F.J., Pelayo, P., Millán, R., 2013. Monitoring of the mercury mining site Almadén implementing remote sensing technologies. Environmental Research, 125, pp. 92-102..

Remote sensing techniques are recognized as a useful tool for both monitoring and management of mercury contaminated sites.

Hot discussion on the TWG on Soil Pollution

- **Soil Monitoring & Resilience Directive**
 - **Quality of indicators, groups of pollutants, polluter pays principle**
- **Methods used for soil monitoring**
 - **Heavy metals, ISO, pesticides, emerging contaminants**
- **Bioavailable fraction & Human health**
 - **For impact risk assessment**

LUCAS topsoil dataset

Sludge, treated biowaste and soil - Digestion of aqua regia soluble fractions of elements

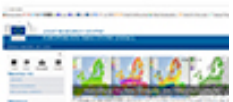


21,683 samples

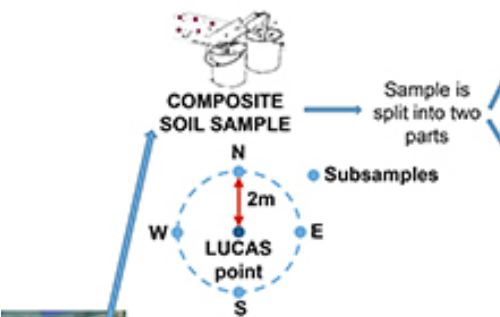
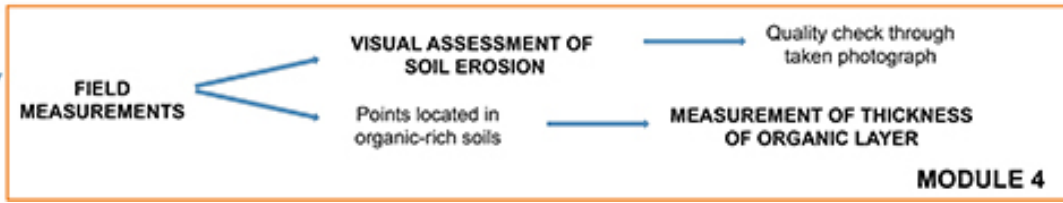
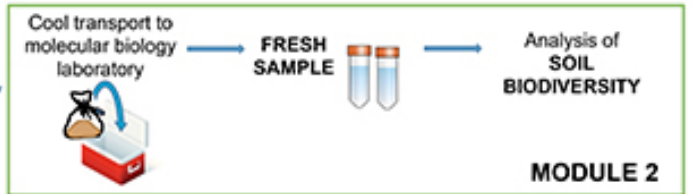


SOIL SAMPLE ARCHIVED at the JRC

DATABASE CREATION on European Soil Data Centre (ESDAC) portal

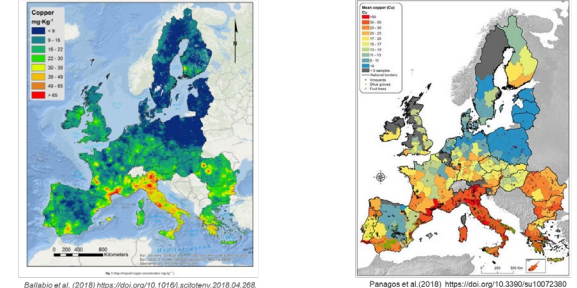


Point data and all derived products (e.g. maps) freely available



Copper distribution in European topsoils: An assessment based on LUCAS soil survey

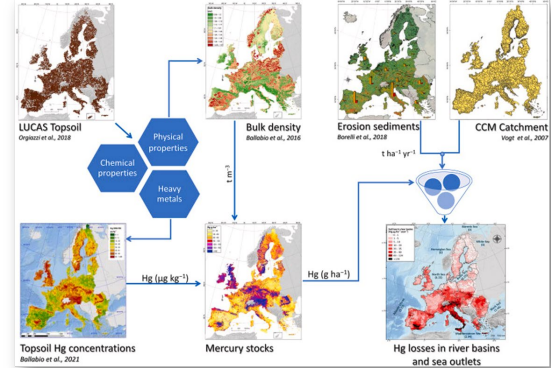
- Cu is correlated to soil properties (pH, texture, OC), climate, geology and management.
- Vineyards (49.3 mg kg⁻¹), olive groves (33.5 mg kg⁻¹) and orchards (27.3 mg kg⁻¹) show high [Cu] that may be affected by the application of Cu-based fungicides for controlling plant diseases



Balabac et al. (2018) <https://doi.org/10.1016/j.scitotenv.2018.04.268> Panagos et al. (2018) <https://doi.org/10.3390/ru10072380>

Mercury in European topsoils: Anthropogenic sources, stocks and fluxes

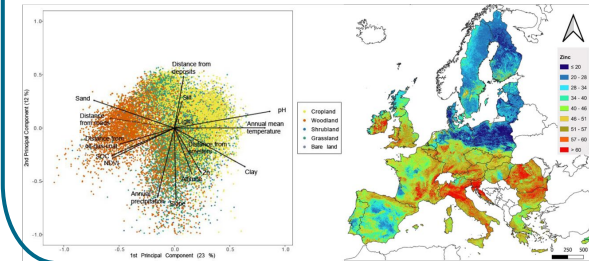
In the European Union and UK, about 43 Mg Hg yr⁻¹ are displaced by water erosion and 6 Mg Hg yr⁻¹ are transferred to river basins and to coastal Oceans.



Topsoil Hg concentrations Balabac et al., 2021 Mercury stocks Borrell et al., 2016 Hg losses in river basins and sea outlets Borrell et al., 2021

Spatial assessment of topsoil zinc concentrations in Europe

Based on LUCAS topsoil database, the mean Zn concentration in Europe is 47 mg kg⁻¹ and median Zn concentration is 40 mg kg⁻¹. Ninety nine percent of all samples have concentrations below 167 mg kg⁻¹. Soil texture and pH are most important drivers for the variation in topsoil Zn. High Zn concentrations are found near Zn deposits, and in grasslands Van Eynde, E. et al. (2023). <https://doi.org/10.1016/j.scitotenv.2023.164512>



EUSO Soil Health Dashboard

<https://esdac.jrc.ec.europa.eu/esdacviewer/euso-dashboard/>

Soil degradation indicators

Select a soil degradation indicator:

Copper

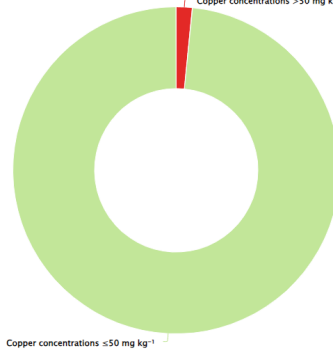
- Soil erosion
 - Water erosion
 - Wind erosion
 - Harvest erosion
 - Tillage erosion
 - Post-fire recovery
- Soil pollution
 - Copper
 - Mercury
 - Zinc
- Soil nutrients
 - Nitrogen surplus
 - Phosphorus deficiency
 - Phosphorus excess
- Loss of soil organic carbon
 - Distance to maximum SOC level
- Loss of soil biodiversity
 - Potential threat to biological functions
- Soil compaction
 - Susceptibility to soil compaction

Copper is both a micronutrient essential for environmental well-being. In soil, copper originates from agriculture (e.g. fungicides) or industrial and land use, this layer shows copper concentrations of more than 50 mg kg⁻¹. 50 mg kg⁻¹ is the lowest limit value for copper in the Sludge Directive. National critical limits may differ and could be used as more accurate thresholds in future iterations.

Areas with copper concentrations >50 mg kg⁻¹, in % (based on areas with data)



Webtools • © EC-GISCO • Leaflet | © OpenStreetMap contributors | Disclaimer



Copper concentrations ≤50 mg kg⁻¹

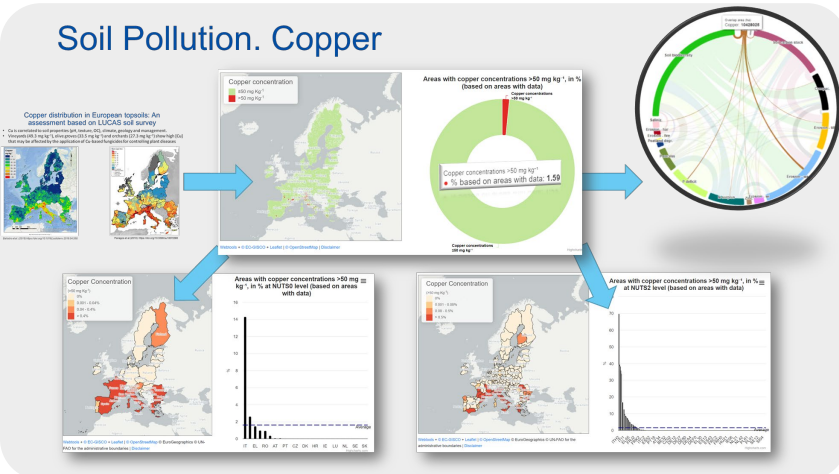
Highcharts.com

- Soil erosion (water, wind, harvest, tillage, fire)
- **Soil pollution (copper, mercury, zinc,...)**
- Nutrients balance (nitrogen, phosphorous)
- Loss of Soil Organic Carbon
- Loss of Biodiversity
- Soil Compaction
- Salinization
- Loss of organic soils
- Soil Sealing

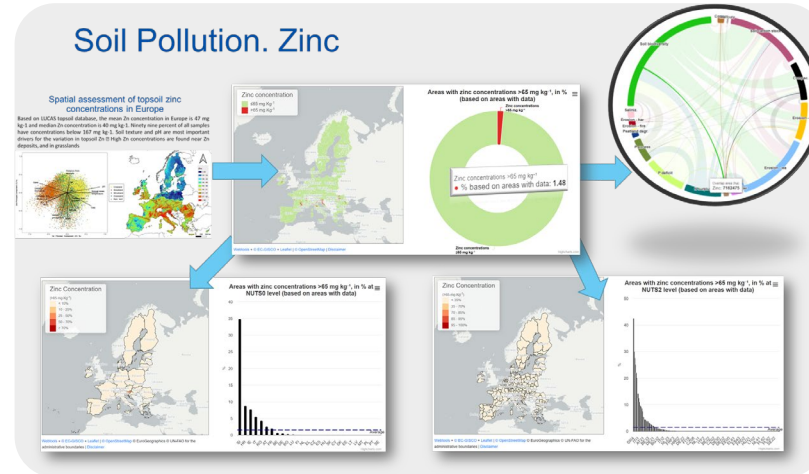
Convergence of evidence!

- Supported with peer-reviewed publications.
- Updates on current and additional indicators are foreseen.
- Support for the forthcoming Soil Monitoring Directive.

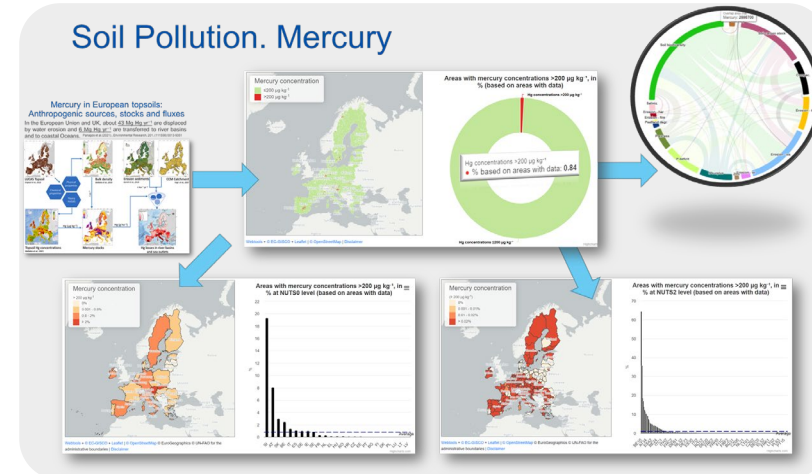
Soil Pollution. Copper



Soil Pollution. Zinc



Soil Pollution. Mercury



Highlights – Our TWG activities

- **Proposals for new advances in the Soil Health Dashboard**
 - Indicators, maps, new substances based on scientific evidence,
 - New methods, indices, treat holistically
 - Soil parameters and their change under certain pollution conditions
- **Proposals for new advances on the Monitoring on Soil Pollution**
 - Remote sensing, geographically,
 - Registration, databases, awareness, remediation
- **Multi-media (air, soil, water) pollution by pesticides residues (and others?)**
- **Soil Monitoring and Resilience Directive**
 - Definitions, characterisation, ...
 - Indicators, substances, monitoring, PPP, restauration
 - Priority list and emerging contaminants
 - Industrial land, holistic and circular approach, stakeholders engagement, future use
- **Global soil Partnership for Soil Pollution and Sustainable Management**
 - Worldwide approach, monitoring, legal questions

Bucket list for future work

- **Key-challenges**

- Best Platform/Chanel for interactions (e.g. EUSO TWG, INSOP, CF, NICOLE...)
- Strategic approach to tackle soil pollution out of academia towards policy.

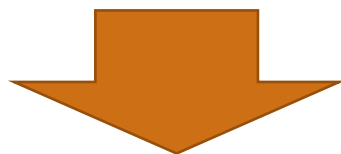
- **Collaborative project for data collection on a given topic**

- Bringing community together (e.g. Soil Mission, EJP Soil)
- Making data synthesis (e.g. Meta analysis)
- Call for evidence on next LUCAS Soil pollution module

- **Watch list / Priority list**

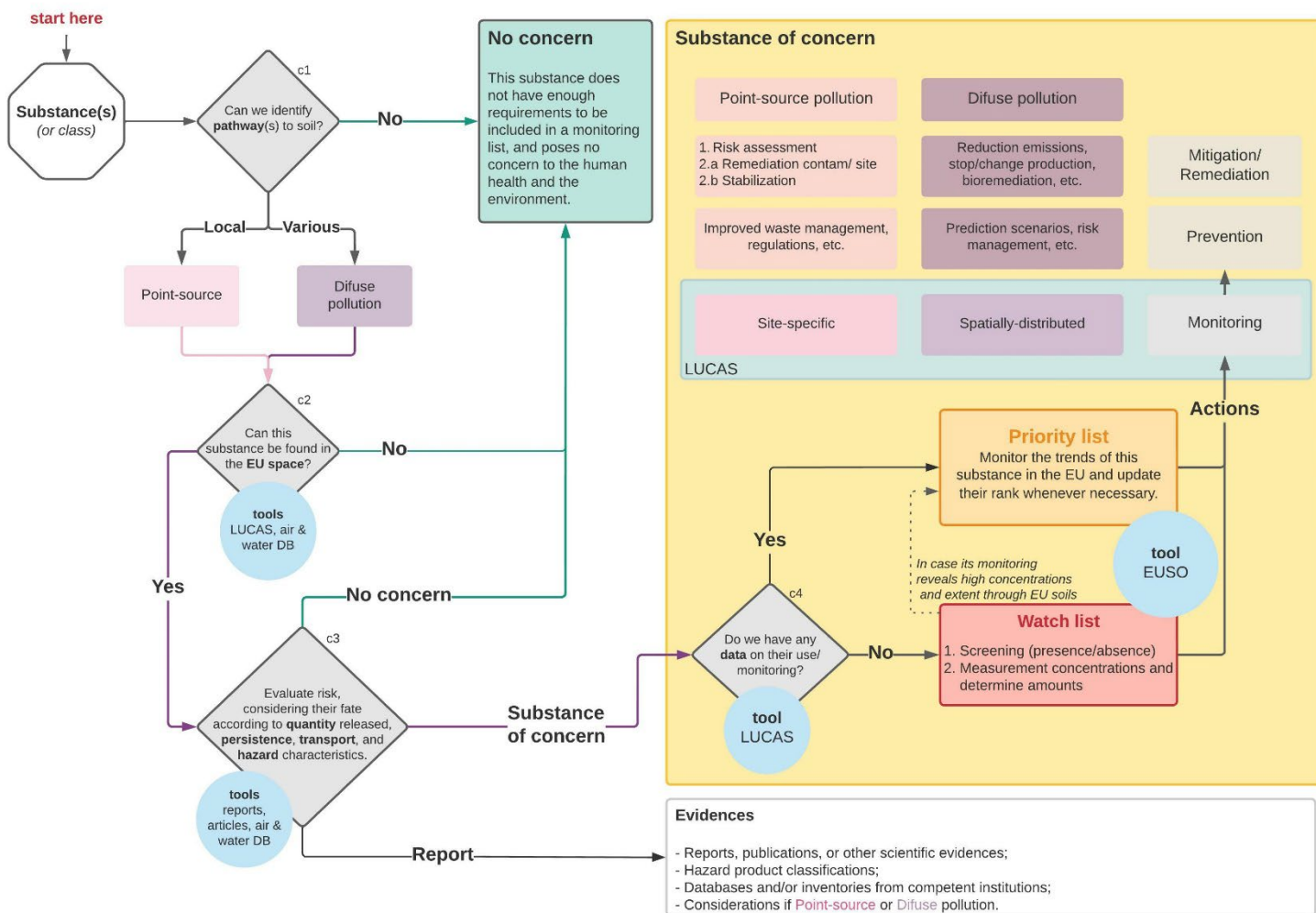
What has to be monitored?

- Proposal to develop a watch list, in order to capacitate the EU with the best knowledge to address soil pollution originated from emerging pollutants.
 - Target soil strategy by 2024, while SML + MS implementation ~ 2026-2027

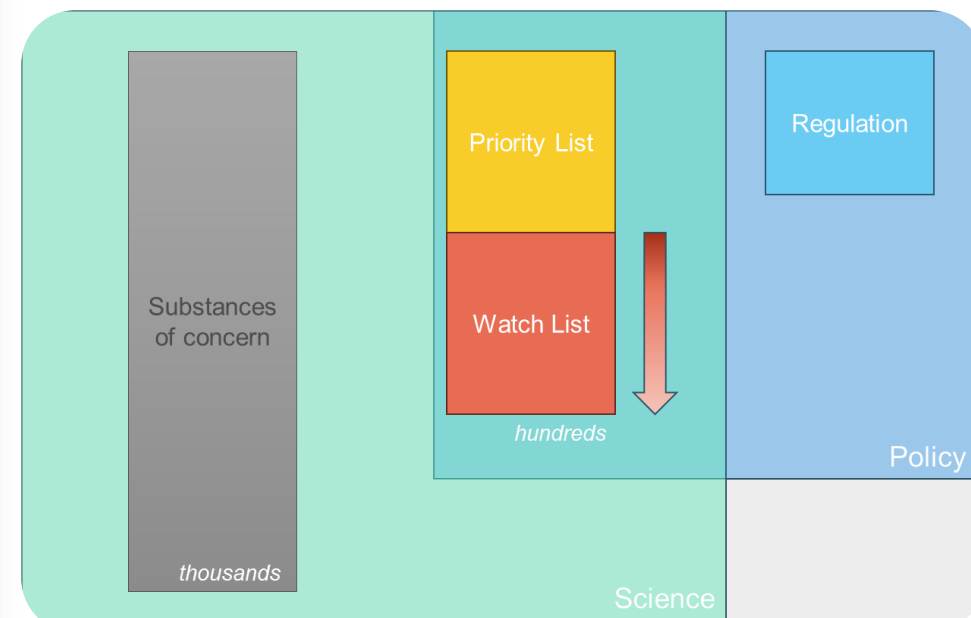


- The development of a procedure that aims to collect information for any emerging pollutant with a pathway to soil, regardless of their nature. This will be done by monitoring such compound at EU scale, by assessing their extent and impact.

Watch List



Watch list conceptual structure



Take-home message

- TWG contributes to closing the gap on Soil Pollution in EU
- Publish Soil Health Assessment in the EU (Q1 2024)
- Anticipate new developments:
 - Soil Monitoring and Resilience Directive
 - Soil Health Dashboard: new indicators
 - Collaborative initiatives on Soil Pollution

Third EUSO Stakeholder Forum

15-17 November 2023

Soil data Integration

Cristiano Ballabio



#EUSOforum

EU SOIL
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The EU Soil Observatory (EUSO)

KNOWLEDGE FOR SOIL POLICY

EU-wide soil monitoring



Monitoring soil health and policies



Stronger European Soil Data Centre (ESDAC)

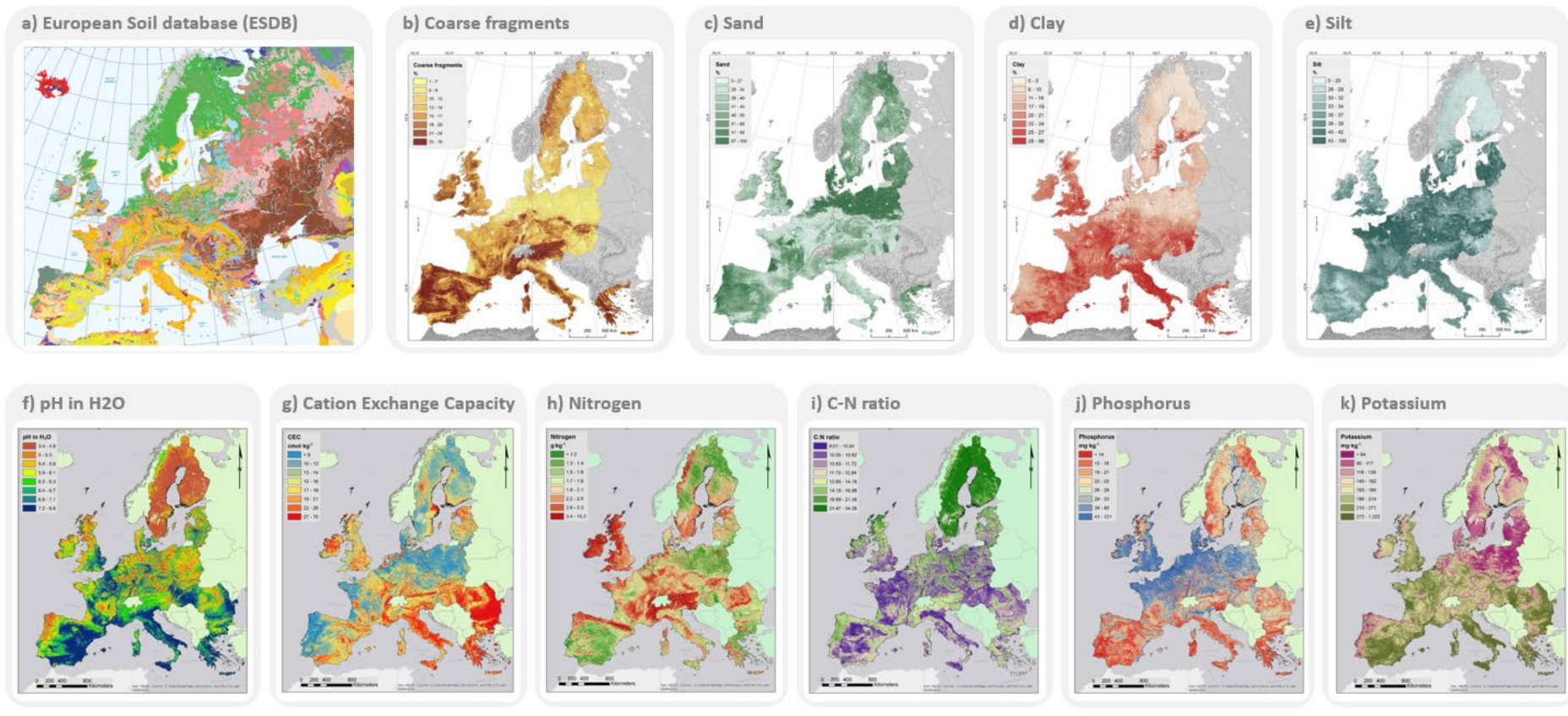


Research & Innovation



EUSO Stakeholder Forum

European & global soil datasets



- *European Soil Database*
- *Soil point data (LUCAS) 2009-2015-2018*
- *Soil Physical properties*
- *Soil Chemical properties*
- *Soil functions*
- *Soil threats*



From ESDAC to ESDAC 2.0



Land Use Policy

Volume 29, Issue 2, April 2012, Pages 329-338



2012 – 2023

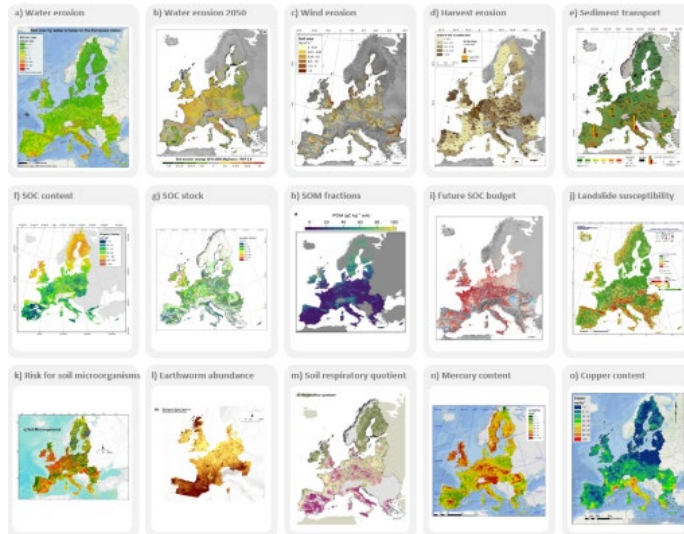
Immense progress

ESDAC at the core of EU soil policies


Order of magnitude in data/users

European Soil Data Centre: Response to European policy support and public data requirements


Panos Panagos , Marc Van Liedekerke, Arwyn Jones, Luca Montanarella



European Journal of **Soil Science**

DATA ARTICLE |  Full Access

European Soil Data Centre 2.0: Soil data and knowledge in support of the EU policies

Panos Panagos , Marc Van Liedekerke, Pasquale Borrelli, Julia Köninger, Cristiano Ballabio, Alberto Orgiazzi, Emanuele Lugato, Leonidas Liakos, Javier Hervas, Arwyn Jones, Luca Montanarella

First published: 13 October 2022 | <https://doi.org/10.1111/ejss.13315>

Mission Soil Projects





An open-access knowledge and data repository to safeguard soils

Panos ILIAS (project coordinator)

Tomáš ŘEZNÍK (scientific coordinator)

Fenny van EGMOND (user stories/stakeholder community)

EUSO Stakeholders Forum: WG on Data Harmonization, online

17 November, 2023



This project has received funding from the Horizon Europe research and innovation programme under Grant Agreement No 101112838



Soil-Wise

DEVELOP, TEST AND DELIVER A PROTOTYPE FOR LONG-TERM **KNOWLEDGE AND DATA** REPOSITORY.

Expected to become part of EUSO

4 years

1/9/2023

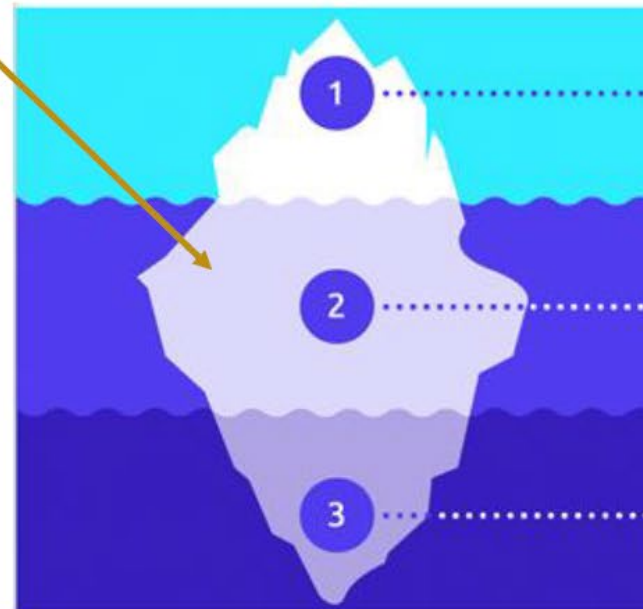
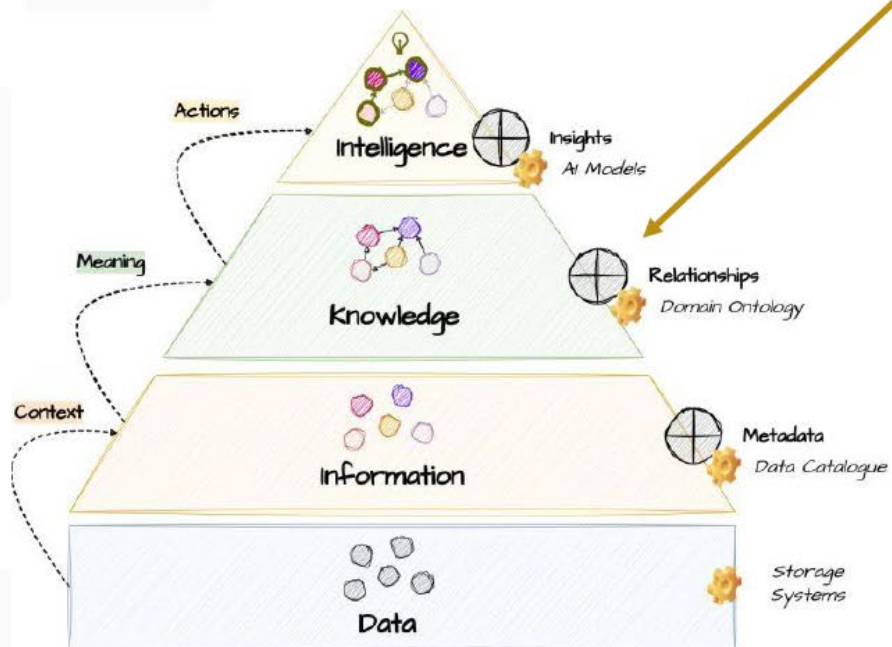
15 Project partners

Develop a solution

5 practice-oriented "user cases"

Domain ontology

How much inference do we need?



Explicit Knowledge – Knowing What

Sources

- ✓ Documents
- ✓ Manuals
- ✓ Videos
- ✓ Databases
- ✓ Historical Records
- ✓ Memos
- ✓ Notes
- ✓ How-to-Guides

Implicit Knowledge – Knowing How

Sources

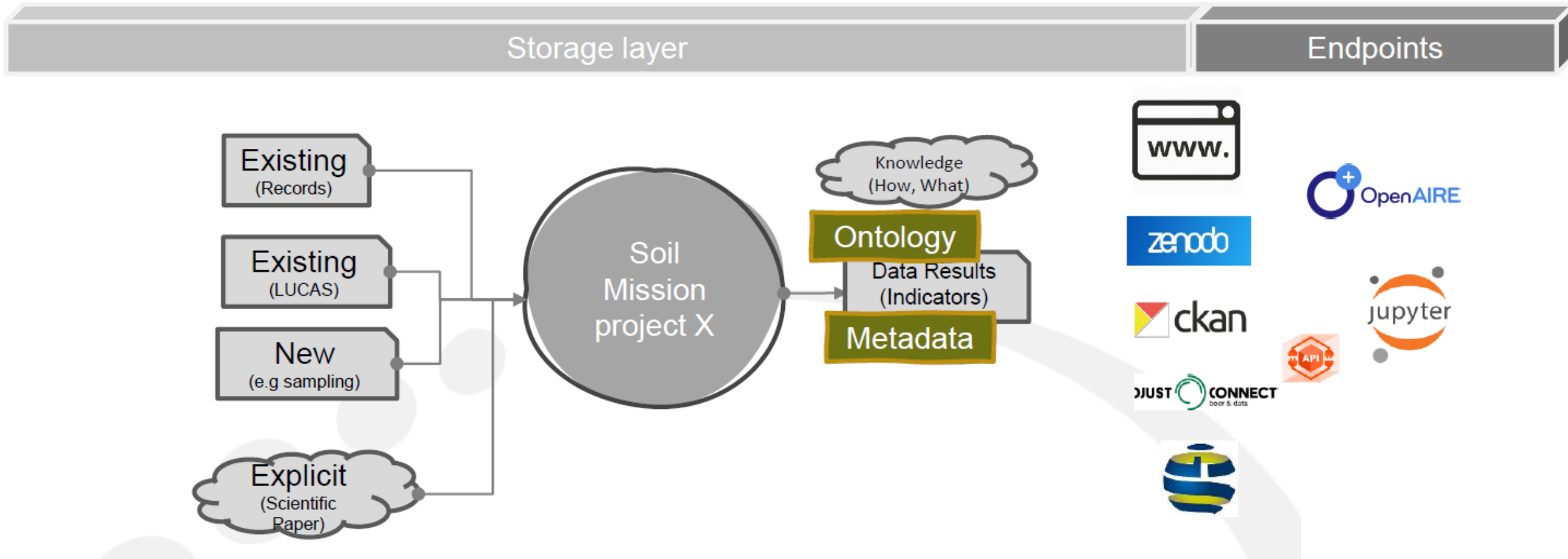
- ✓ Practice
- ✓ Shadowing
- ✓ Logic
- ✓ Representations
- ✓ Lesson Learned
- ✓ Generalized Rules
- ✓ Theorems
- ✓ Beliefs

Tacit Knowledge – Knowing in Action

Sources

- ✓ Experts
- ✓ Experience
- ✓ Education
- ✓ Insights
- ✓ Intuition
- ✓ Observation
- ✓ Cultural Legacy
- ✓ Organizational Values

Domain ontology



Data streams vs delivery at the end of the project



Data streams vs delivery at the end of the project

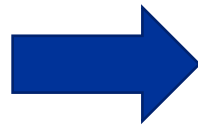


SOIL BIODIVERSITY AND FUNCTIONALITY
OF MEDITERRANEAN OLIVE GROVES

To analyze the impact of pollution and land degradation on soils from olive groves in terms of multi-biodiversity and ecological function at different levels of organization and scales.

Clear indication of:

- Data type
- Metadata format
- Metadata elements
- Licensing



Type of data	Metadata format	Elements	License
Biodiversity and Taxonomy	GBIF ⁶	Title, description, creator, contact information, license, dataset ID, geographic coverage, taxonomic coverage, temporal coverage, data quality, data format, data access details, and citation.	Creative Commons Attribution-NonComercial-ShareAlike 4.0 International
Ecological including land degradation	Ecological Metadata Language (EML)	Title, abstract, creator, temporal and spatial coverage, keywords, methods, variables, data quality, publications, data access, and usage.	Creative Commons Attribution-NonComercial-ShareAlike 4.0 International
Pollution	Ecological Metadata Language (EML)	Title, abstract, creator, temporal and spatial coverage, keywords, methods, variables, data quality, publications, data access, and usage.	Creative Commons Attribution-NonComercial-ShareAlike 4.0 International

Key outcomes

- Data management is a crucial for all projects
- Several possible approaches and different ontologies
- No harmonized framework for the end-node
- Several competing platforms

Key issues

- *Physical data storage*
- *Long term support for legacy data and software*
- *Paradigm shifting in data storage*
- *Reliance on external actors (i.e. CERN)*

Third EUSO Stakeholder Forum

15-17 November 2023

Soil Carbon

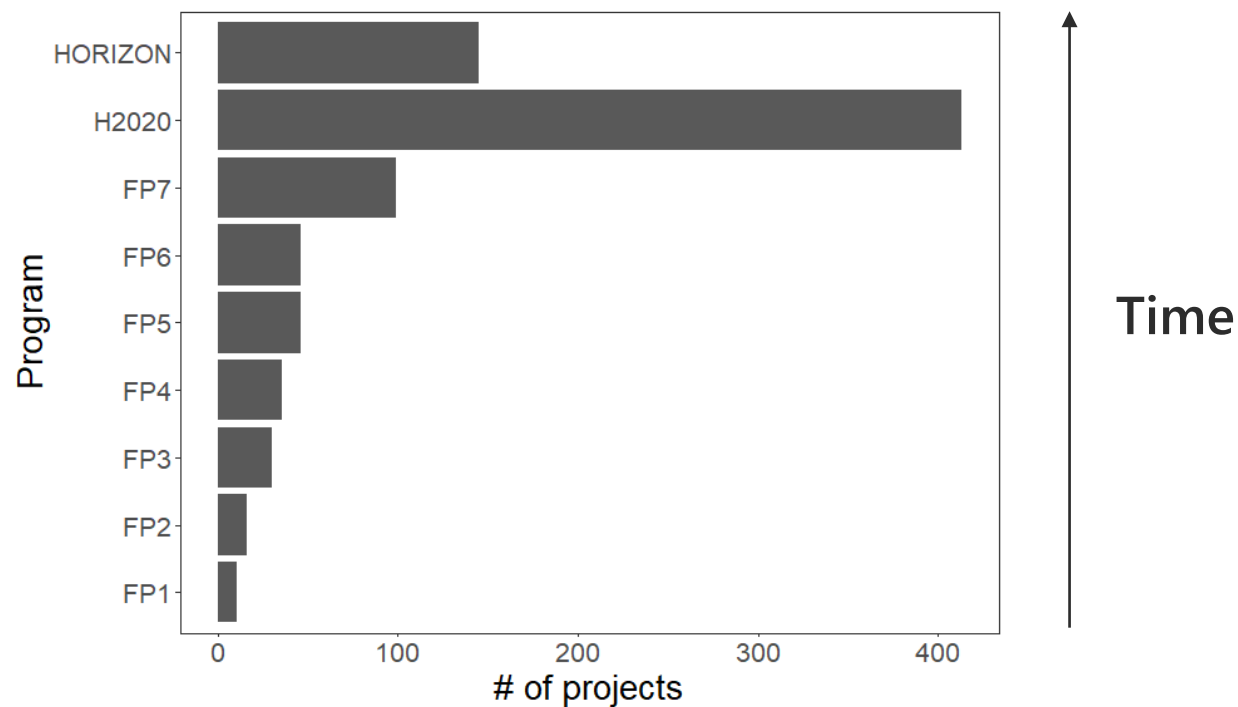
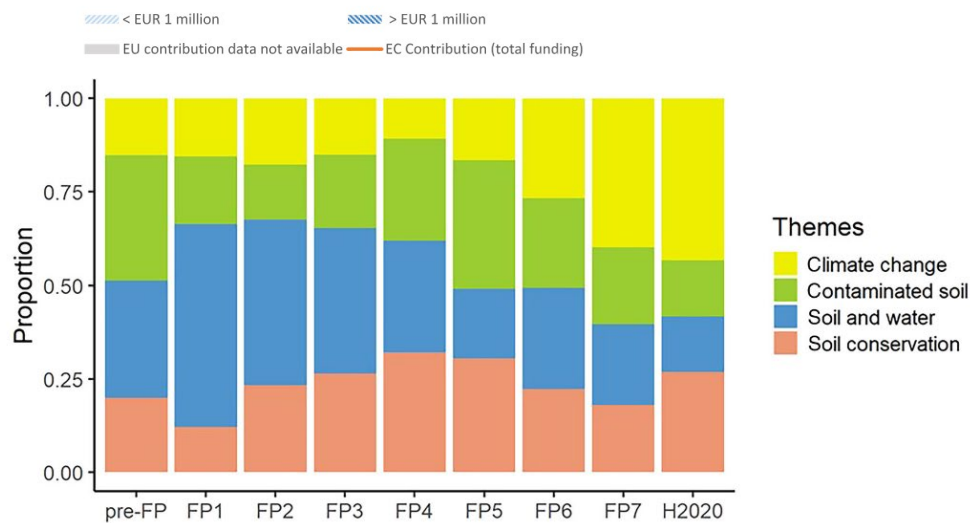
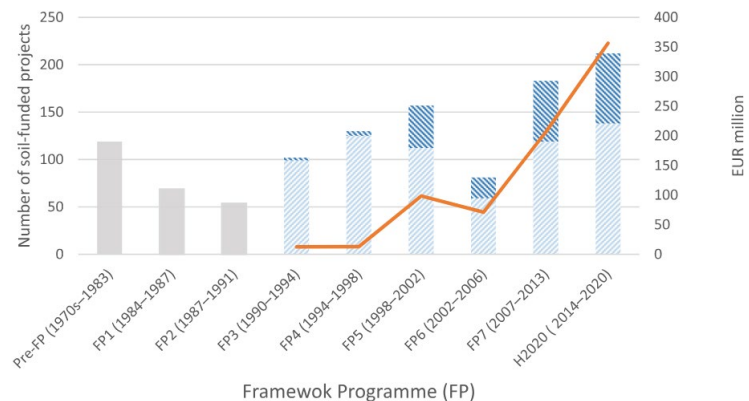
Cristina Arias Navarro



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Soil carbon research in the EU



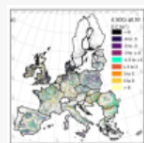
Source: CORDIS projects 'SOIL' and 'CARBON' (10/11/2023)

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EUSO *in-house* work on SOC

- [European Soil Data Centre \(ESDAC\)](#) - since 2006 the focal point for soil data, providing Open Access harmonised soil-related information including data and information on soil organic carbon both at European scale and Global scale



Title: **Changes in Soil Organic Carbon in Croplands and Grasslands between 2009 and 2018**

Resource Type: Datasets, Soil Threats Data **Continent:**
Theme/Sub-Theme: **Year:** 2023
Network/Cooperations: **Scale:**
Project/s: **Keywords:** SOC |
Registration requested: [Request Form](#)



Title: **Soil Organic Carbon (SOC) Projections for Europe**

Resource Type: Datasets **Continent:**
Theme/Sub-Theme: **Author:** Yusuf Yigini and Panos Panagos,
Network/Cooperations: European Commission
Project/s: **Year:** 2016
Registration requested: [Request Form](#) **Scale:**



Title: **Topsoil Soil Organic Carbon (LUCAS) for EU25**

Resource Type: Datasets, Soil Threats Data **Continent:**
Theme/Sub-Theme: **Year:** 2014
Network/Cooperations: **Publisher:** European Commission Joint
Project/s: Research Centre
Registration requested: [Request Form](#) **Scale:**
Keywords: SOC | , organic carbon | , content | , policy |



Title: **Pan-European SOC stock of agricultural soils**

Resource Type: Datasets, Soil Threats Data **Continent:**
Theme/Sub-Theme: **Year:** 2013
Network/Cooperations: **Publisher:** European Commission Joint
Project/s: Research Centre
Registration requested: [Request Form](#) **Scale:**
Keywords: SOC | , Stocvks | , CAPRESE | , CENTURY |



Title: **Soil GHG fluxes using LUCAS soil-DayCent (for EU)**

Resource Type: Datasets, Soil Functions **Continent:**
Theme/Sub-Theme: **Year:** 2018
Network/Cooperations: **Scale:**
Project/s: **Keywords:** Climate change |
Registration requested: [Request Form](#)



Title: **Global Soil Organic Carbon Estimates**

Resource Type: Datasets, Soil Threats Data **Continent:**
Theme/Sub-Theme: **Author:** R. Hiederer, M. Köchy
Network/Cooperations: **Year:** 2012
Project/s: **Publisher:** Joint Research Centre of the
Registration requested: [Request Form](#) European Commission
Scale:
Keywords: organic carbon | , Harmonized
World Soil Database | , Climate change |



Title: **OCTOP: Topsoil Organic Carbon Content for Europe**

Resource Type: Datasets, Soil Threats Data **Continent:**
Theme/Sub-Theme: **Author:** Jones, R.J.A., Hiederer, R., Rusco, E.,
Network/Cooperations: Loveland, P.J. and Montanarella, L.
Project/s: **Year:** 2004
Registration requested: [Request Form](#) **Language:** en
Scale:
Keywords: organic carbon | , SOC | , octop |

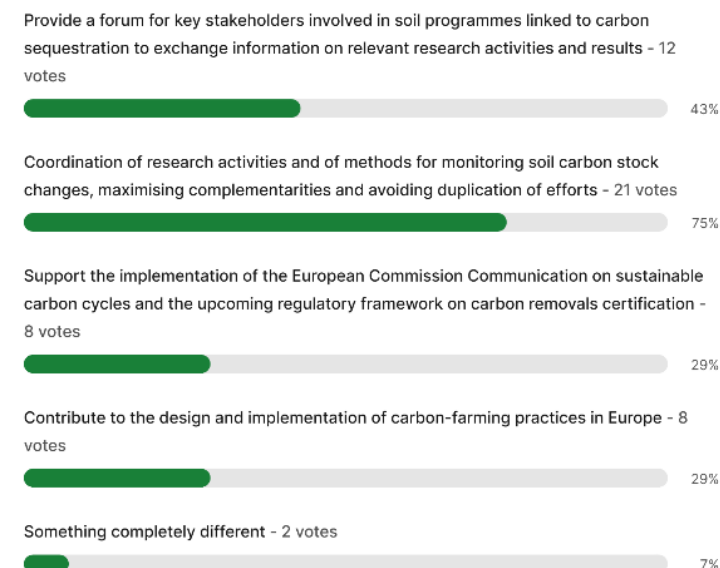
Attachments:  Topsoil Organic Carbon Content (%)

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oil #EUMissions

Overview – Launch of the TWG (October 2022)

- Coordination of research activities and of methods for monitoring soil carbon stock changes maximising complementarities and avoiding duplication of efforts;
- Provide a forum for key stakeholders involved in soil programmes linked to carbon sequestration to exchange information on relevant research activities and results concerning methodologies for soil carbon MRV;
- Support the European Commission Proposal for a regulation establishing a union certification framework for carbon removals.



Key outcomes – R&I Meeting (April 2023)

- Inform about upcoming and ongoing EU-funded research and innovation projects.
- Show synergies and potential collaborations among projects
 - Soil carbon MRV and carbon farming is a key area of research and innovation funded by the Soil Mission.
 - Important role of the EUSO TWG in bringing all projects together, to strengthen collaboration and avoid duplication of efforts.
 - MIP will lead and promote cluster groups (one on C farming). The added value of EUSO WG is to include non-mission projects and potentially reaching more stakeholders than the MIP



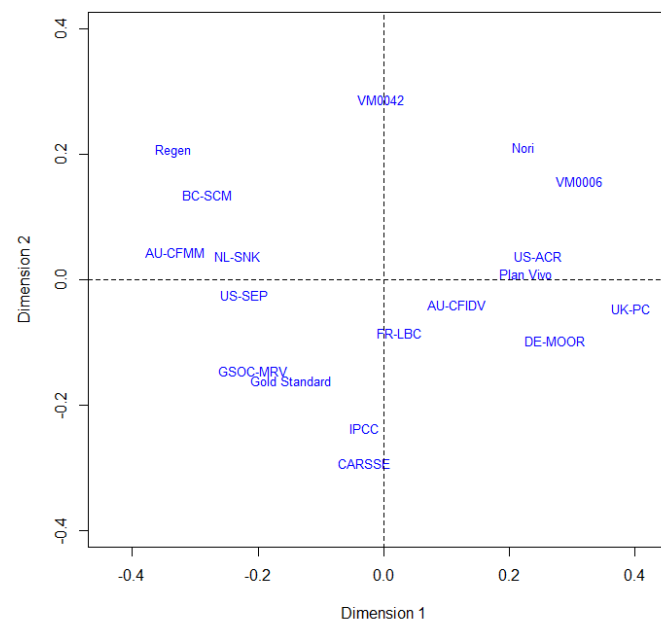
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Key outcomes – International review of current MRV initiatives

- Rapid expansion of the voluntary carbon market is evidenced by the number of carbon registries and private companies that have recently published measurement, reporting, and verification (MRV) protocols with important differences in their approaches to measurement and estimation of SOC and to key accounting issues.

Multidimensional scaling MRV guidelines



International review of current MRV initiatives for soil carbon stock change assessment and associated methodologies

Batjes et al 2023 (in prep)

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Overview – 3rd Stakeholder Forum

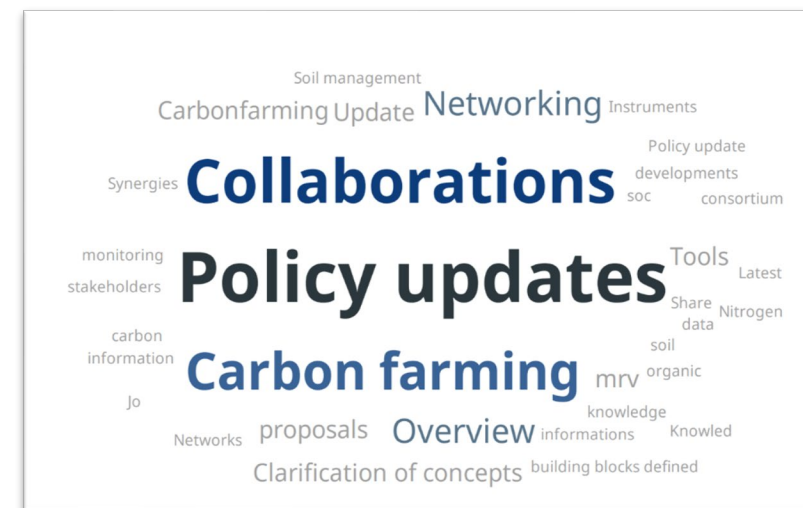
- How can R&I support the EU Commission's proposal for C removal certification?



- > 150 participants
- Updates DG-CLIMA
- MRV project's views
- Discussions:
 - Activity vs hybrid vs results based
 - Setting baselines
 - LPIS/GSAA data
 - ...

Key outcomes – WG Roadmap 2024

- Participation in and support to Horizon Europe projects (MARVIC, MRV4SOC, ORCASA...)
- Thematic mini-conferences to assess the state of knowledge on soil carbon for policy makers
 - Topics: peatlands and organic soils, young scientists (MSCA, ERC), inorganic carbon, remote sensing, monitoring schemes, carbon farming practices, business models, ..
 - Open call for abstracts coming soon
 - *Subscribe* to our mailing list to stay updated



Cristina.ARIAS-NAVARRO@ec.europa.eu
Elise.VAN-EYNDE@ec.europa.eu

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eu-soil-observatory@ec.europa.eu

Third EUSO Stakeholder Forum

15-17 November 2023

Soil Monitoring & Awareness

Arwyn Jones / Timo Breure



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Overview

Focus: overview of how citizen science (CS) can contribute to soil monitoring:

- Methodological aspects to consider
- Challenges associated with CS projects.

Content: presentations on CS by:

- Research foundation Ibercivis
- Horizon/Mission funded projects,
- Case-studies on local and national scales

> 100 participants

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Key outcomes

- CS projects can raise awareness amongst citizens on soils and facilitate environmental stewardship
- Existing CS generated soil databases can be integrated within EUSO

Key outcomes

- CS projects can raise awareness amongst citizens on soils and facilitate environmental stewardship
- Existing CS generated soil databases can be integrated within EUSO

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Key outcomes

Potential pitfalls are:

- GDPR complications
- Output maintenance is resource intensive

Future research should assess:

- Quality Control / Assurance of CS generated soil data
- How can CS projects and participation be scaled up?

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Next steps

- Strengthen linkages between EUSO and the CS community
 - Build on ECHO
 - Citizen Science for EU policies Platform (JRC)
 - Integrate past soil-CS data into EUSO
- Workshop in new year on presentations proposed for Forum
- Workshop in the spring on monitoring & SML (with EJP Soil)

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EUROPEAN UNION

EUROPEAN MISSION SOIL WEEK

Closing ceremony

23 November 2023



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EUROPEAN UNION

Speakers

EUROPEAN MISSION SOIL WEEK



Sala Saastamoinen

Deputy Director-General

*European Commission, Joint
Research Centre (video-
message)*



Maria Rodríguez de Sancho

Director General of Biodiversity,
Forests, and Desertification

*Ministry for Ecological Transition
of Spain*



Jose Antonio Sobrino

Deputy Director General of
Agricultural Means of Production
and Spanish Office of Plant
Varieties

Spanish Ministry of Agriculture



Diego Canga Fano

Director of quality policy, research
and innovation, outreach

*European Commission, DG
Agriculture and rural development
(video-message)*



Elena Cartea González

Vice President

*Spanish National Research
Council (CSIC)*

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DAY 1

WELCOME!

a VISUAL SUMMARY from the EUROPEAN MISSION SOIL WEEK

#MissionSoilWeek

21-23
NOVEMBER 2023

SETTING FOR THE MISSION
- THE STATUS OF SOIL IN
EU
the stage

RESEARCH & KNOWLEDGE
WILL SOLVE OUR SOIL
ANXIES?
HERE TO FIND
COMMON
GROUND

NOT A
NICHE
ANYMORE
it's EVERYWHERE

IN A NUTSHELL...

DAY 2

SOCIAL,
ECONOMIC &
CULTURAL
TRANSFORMATION FOR
SOIL HEALTH
CHANGING OUR
RELATIONSHIP TO SOIL

PHOTO
COMPETITION
awards
TELLING STORIES THROUGH
ART

launch
INTERNATIONAL
RESEARCH CONSORTIUM
ON SOIL CARBON

OUR
GOAL: MAKING EU CARBON NEUTRAL
BY 2050 BY EMPOWERING FARMERS
& FORESTERS TO CONTROL CO₂ BALANCE

PREP
SOIL
PROJECT
SUPPORTING
THE
MISSION SOIL
EST. 2022

SOIL LITERACY / SOCIETAL APPRECIATION
IMPROVING KNOWLEDGE BASE
INTERACTION SPACES

DAY 3

BREAKOUTS ON
living
labs
SOIL
BIODIVERSITY
& BUSINESS
MODELS
& EJP
SOIL

LOCAL & REGIONAL
DIMENSIONS
LOW
HIGH
AWARENESS

THE EU
Soils
OBSERVATORY
LUCAS
2022
EU SOIL DASHBOARD
says
AT LEAST 61.5% OF
UNHEALTHY SOILS

ASSESSING SOIL HEALTH at
DIFFERENT
SCALES
THINK
ACROSS
SCALES
HUGE
TINY
WHAT DO
YOU NEED?

AND INDICATORS
SOIL
MONITORING
PANEL
FARMERS
need
LIGHTHOUSES,
EXAMPLES TO
FOLLOW

HOW CAN WE
COMMUNICATE
IN A MORE UNDERSTANDABLE
LANGUAGE WITH
THEM?

OUTCOMES OF THE
EU
SO
WORKING
GROUPS

the
MANIFESTO
&
AMBASSADORS
Mission Soil Manifesto

CLOSING &
thank you!



EUROPEAN UNION

EUROPEAN
MISSION SOIL
WEEK

Thank you!

Website: mission-soil-platform.ec.europa.eu



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@EUAagri
@EUgreenresearch



@euagrifood



European Research
Executive Agency (REA)

#MissionSoilWeek #MissionSoil #EUMissions