

# EU SOIL DAY

#EUsoilDay

Título: The EU Soil Observatory contribution  
towards healthy soils  
Ponente: Panos PANAGOS, JRC

U  
23

PRESIDENCIA  
ESPAÑOLA  
CONSEJO DE LA  
UNIÓN EUROPEA

BRUSSELS  
6 NOV 23

#EUsoilDay



# EU Soil Observatory (EUSO) contribution towards healthy soils

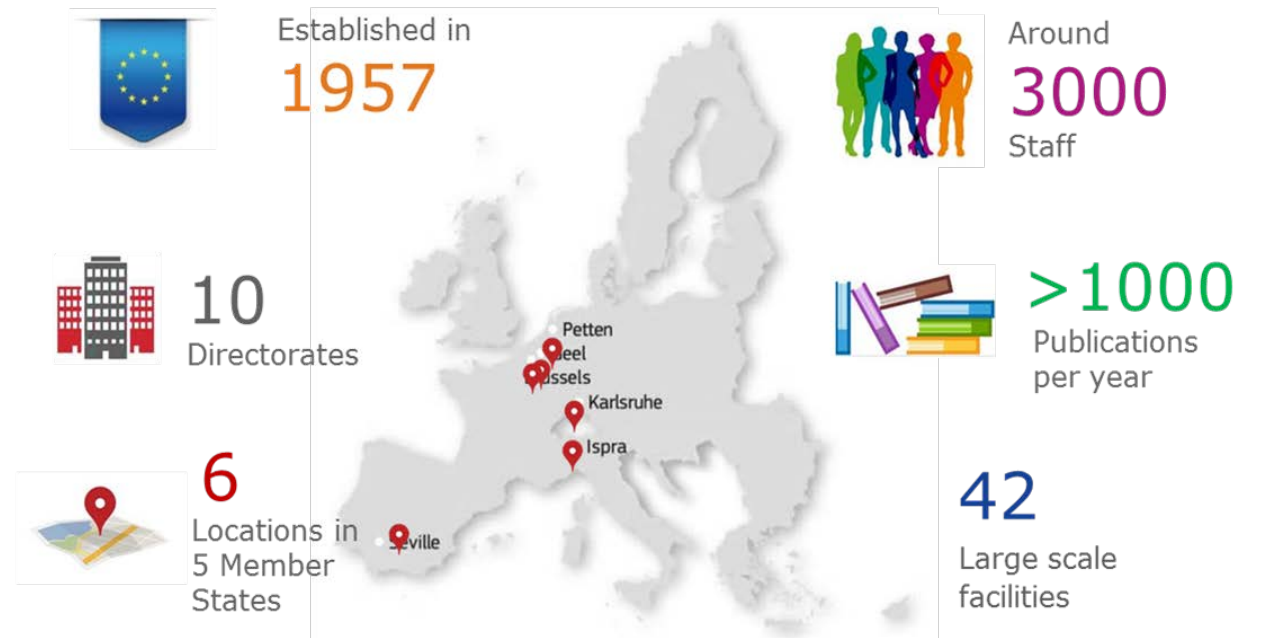
*Dr. Panos Panagos*

European Commission  
Joint Research Centre (JRC)  
Directorate D Sustainable Resources

# Joint Research Centre – European Commission



As the **science and knowledge service of the European Commission**, the Joint Research Centre's mission is to support EU policies with independent evidence throughout the whole policy cycle.



# Contents

Soil within the Green Deal: knowledge needs and knowledge gaps

New Soil Monitoring Law

The European Soil Observatory

Links with the Soil Mission

Towards a holistic approach of soil health

# SOIL DEGRADATION IN THE EU: why do we need to act?

**60-70%**  
of soils are not healthy

**13%**  
of EU soils suffer from high erosion with 1.25 bEUR yearly losses in crop yield

**78%**  
of land take takes place in agricultural land

**7.4 million tonnes**  
of CO<sub>2</sub> lost yearly by mineral soils under cropland

**25%**  
of land in Southern, central and Eastern Europe at high or very high risk of desertification

**200 – 800 k**  
deaths globally per year due to soil contamination

**390.000**  
contaminated sites to be remediated

**SOIL THREATS: Erosion, compaction, organic matter decline, pollution, loss of biodiversity, salinization, desertification, land take & sealing**

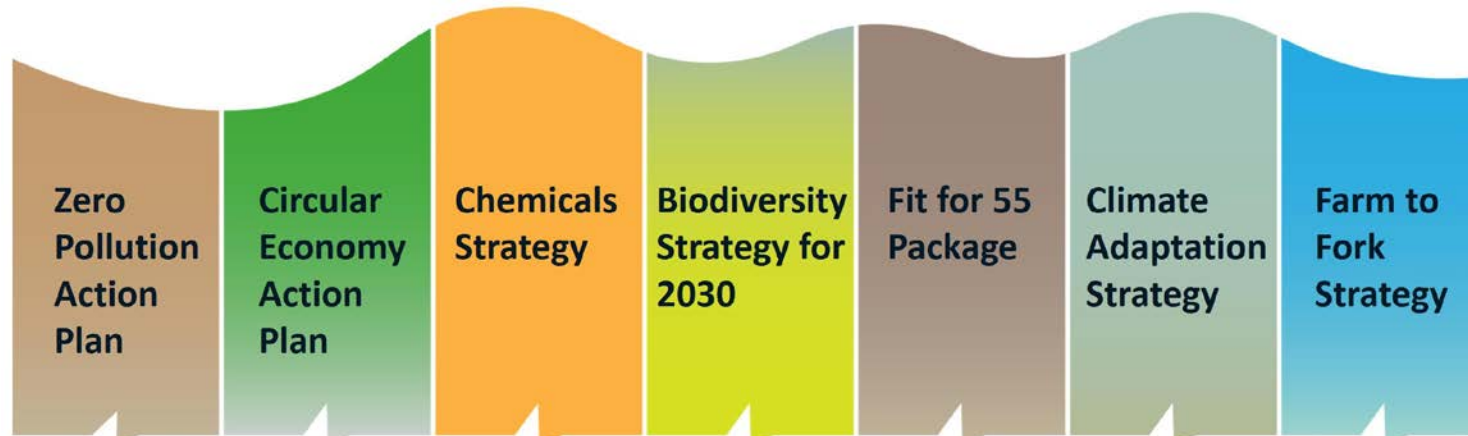


# Soils in the EU Green Deal



**Soils are a cross-cutting theme within the European Green Deal**

# Soil is cross cutting within many policy initiatives



## EU Soil Strategy

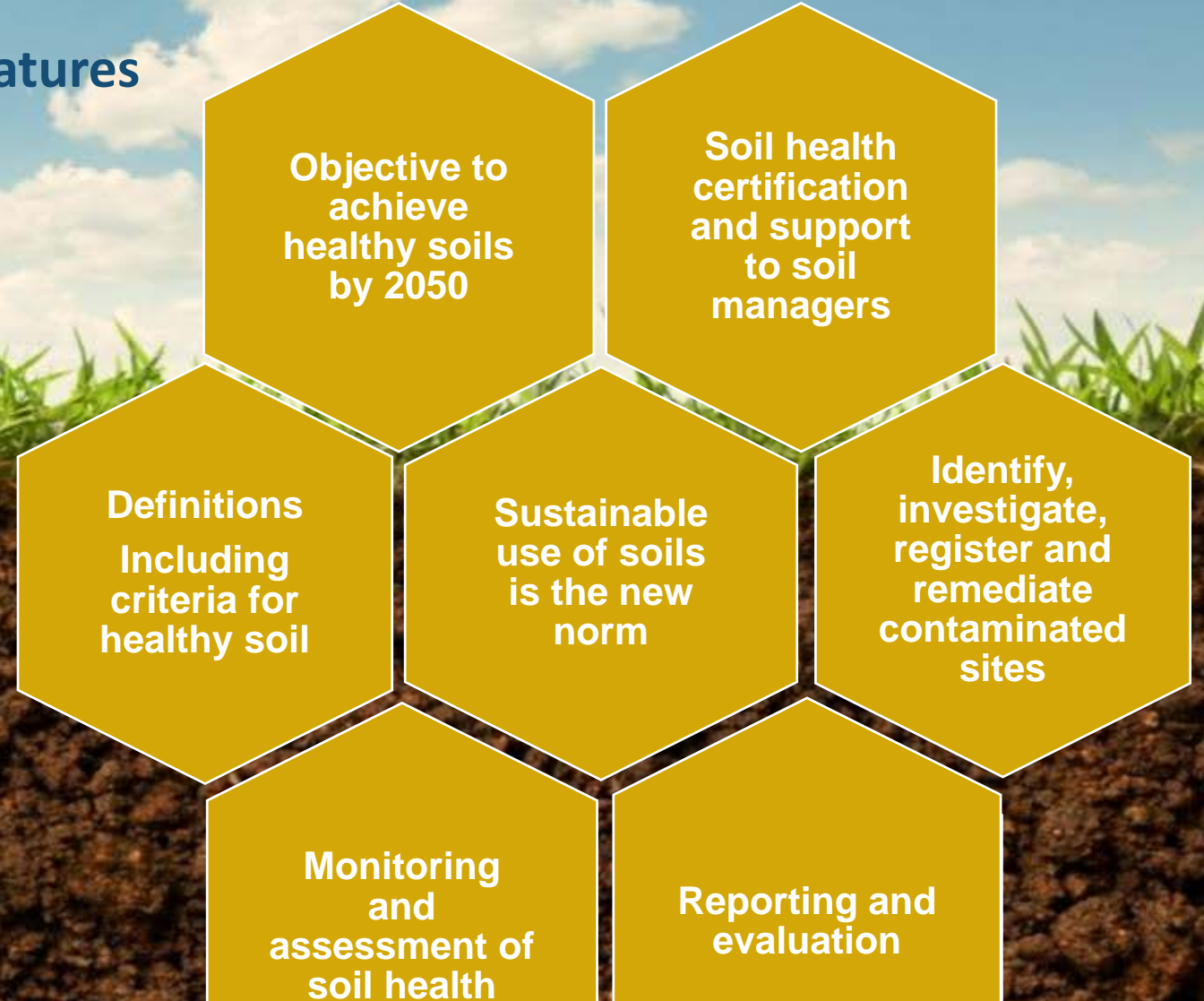


# Soil Monitoring Law proposal



## Key features

### Scope



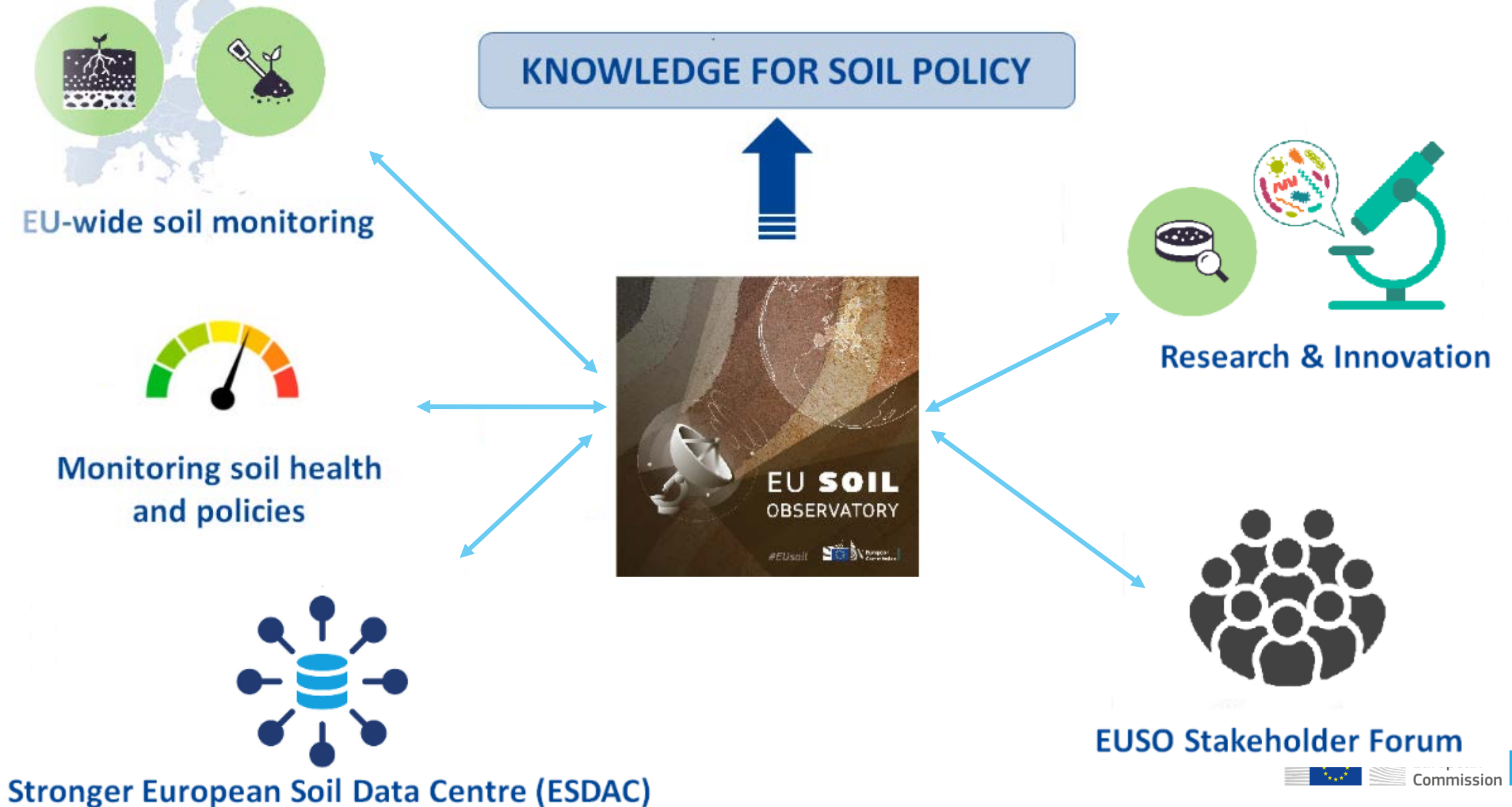


# Overarching objectives

Objective  
to achieve  
healthy  
soils by  
2050

- to establish a coherent **soil monitoring framework for all soils (including contaminated sites)** that will provide **data on soil health** in all Member States
- to continuously improve soil health to achieve **healthy soils by 2050** and maintain soils in healthy condition, so that they can **supply multiple services** at a scale sufficient to meet **environmental, societal and economic** needs,

# The EU Soil Observatory (EUSO)

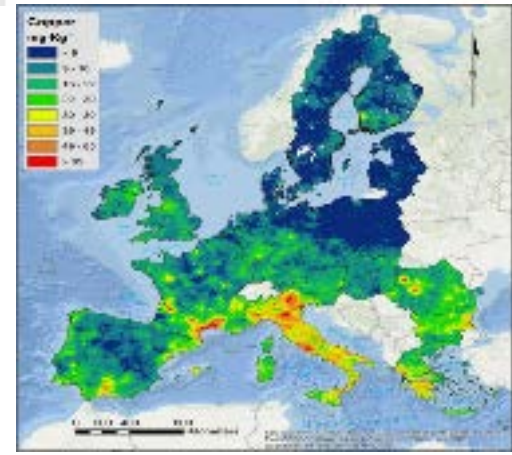
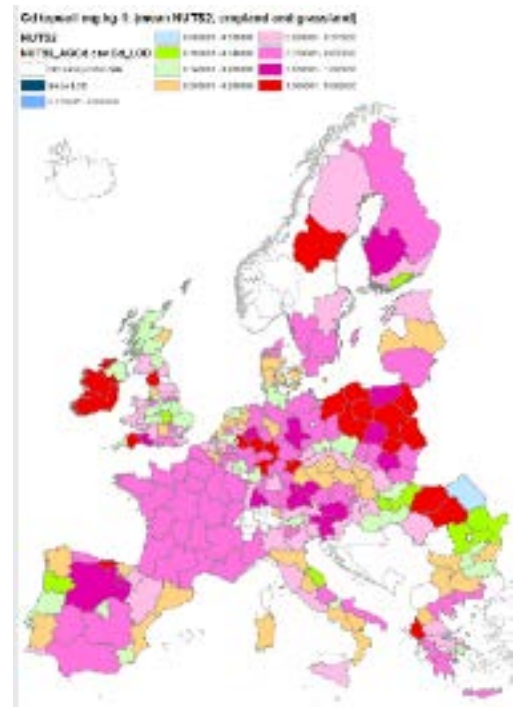
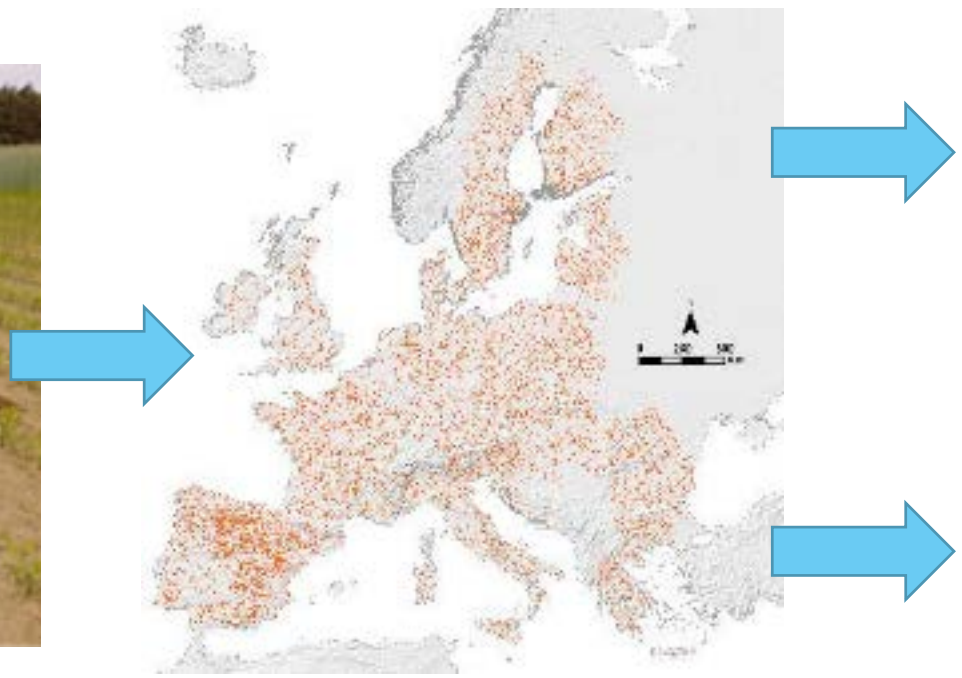




# LUCAS SOIL survey

The JRC manages the LUCAS SOIL survey: sample design, measurement protocols through integrated analysis and monitoring, training of surveyors

## EU-wide soil monitoring



- Surveys (and the resulting data) span multiple years 2009, 2015, 2018, 2022
- 42,000 observations
- Soil archive at the JRC premises in Ispra (IT)
- Close cooperation with MSs

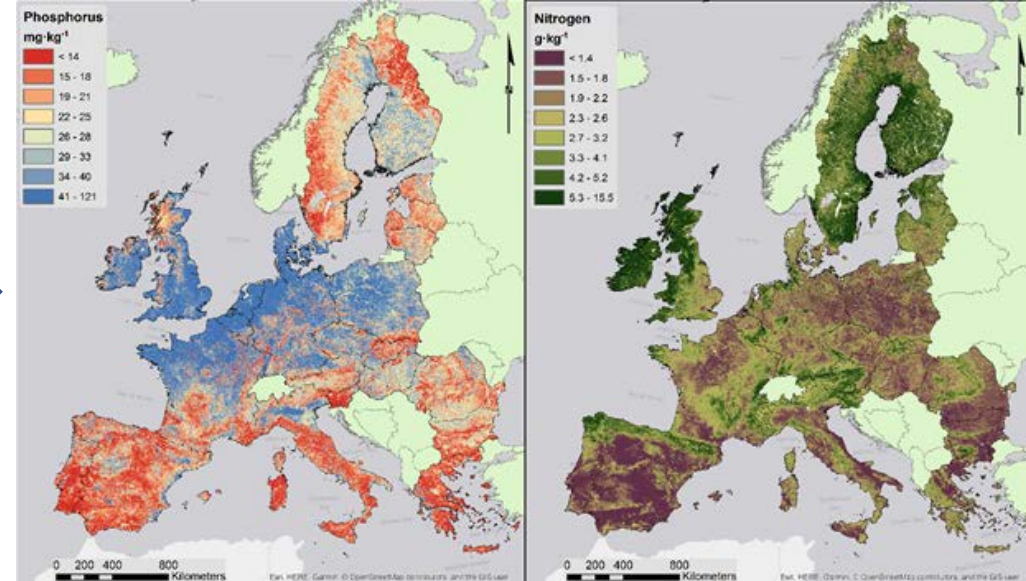
# LUCAS Contributes to EU-Wide Soil Monitoring

From monitoring chemical, physical and biological soil properties to modelling the spatial distribution of soil properties in the EU



EU-wide soil monitoring

- Coarse fragments
- Particle-size distribution (clay, silt, sand)
- pH
- Organic carbon
- Carbonate content
- Total nitrogen content
- Extractable potassium content
- Phosphorous content
- Cation exchange capacity
- Electrical conductivity
- Heavy Metals
- Multispectral properties
- Pesticides (90 substances)
- Neonicotinoid insecticides
- Fungicides (e.g. copper in soils)
- Herbicides
- Antibiotics
- Soil Biodiversity



Ballabio et al. (2019) – Geoderma

2024+



## LUCAS 2.0

Better integrated in MS programmes

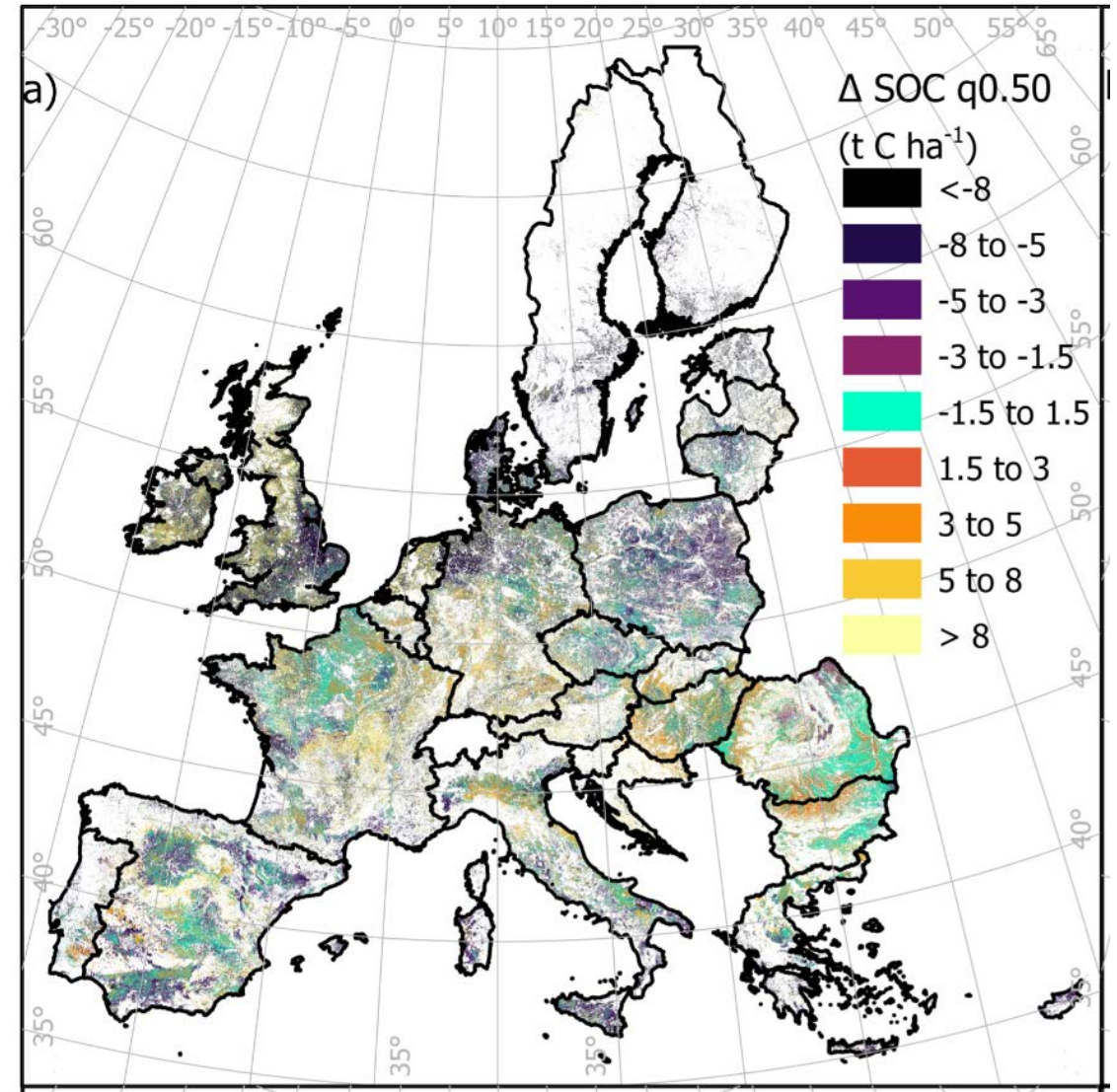
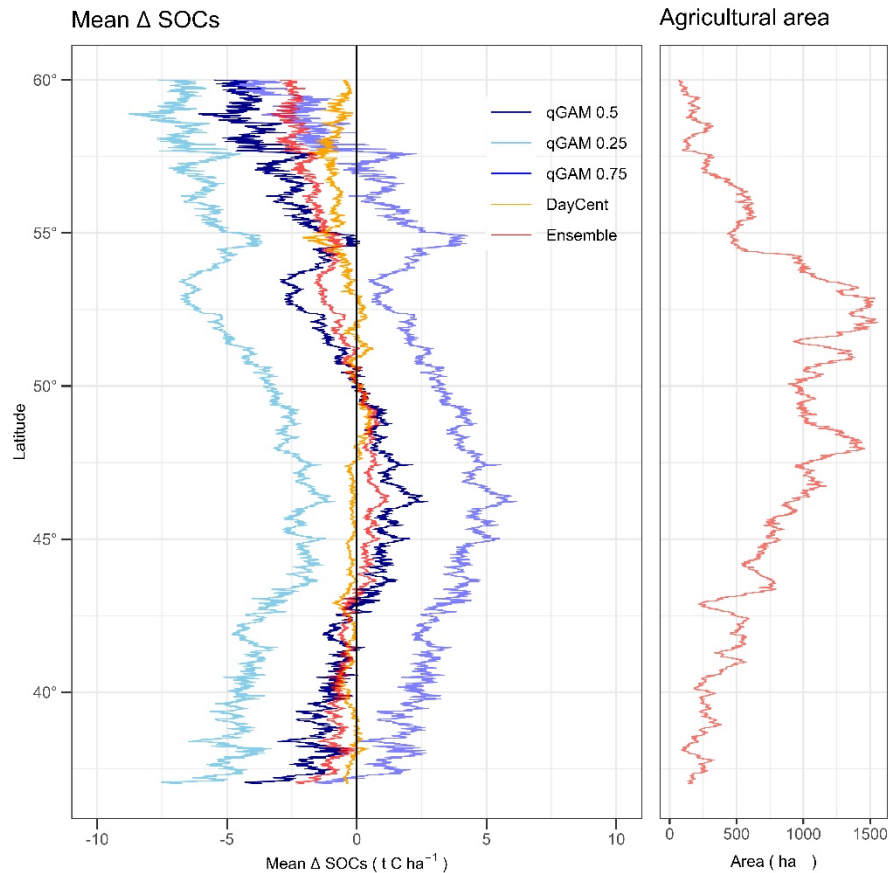
New parameters

Depth aspects

Harmonisation with MS laboratories

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

-0.75% between 2009 and 2018  
~ 70 Mt C (0-0.2m depth) =  
**28 MtCO<sub>2</sub>e per year**





# European Soil Data Centre



[Privacy statement](#) | [Legal notice](#) | [Cookies](#) | [Search](#)



JOINT RESEARCH CENTRE

EUROPEAN SOIL DATA CENTRE (ESDAC)

EUROPEAN COMMISSION > JRC > ESDAC

Search

## EU SOIL OBSERVATORY

EUSO

## SOIL DATA

DATASETS

MAPS & DOCUMENTS

APPLICATIONS & SERVICES

## SOIL KNOWLEDGE

THEMES

NETWORKS & COOPERATIONS

PROJECTS

## UPCOMING EVENTS

06/Sep/2023 Joint conference on trace to elements and heavy metals  
10/Sep/2023

13/Sep/2023 European Healthy Soils to Conference Series  
15/Sep/2023

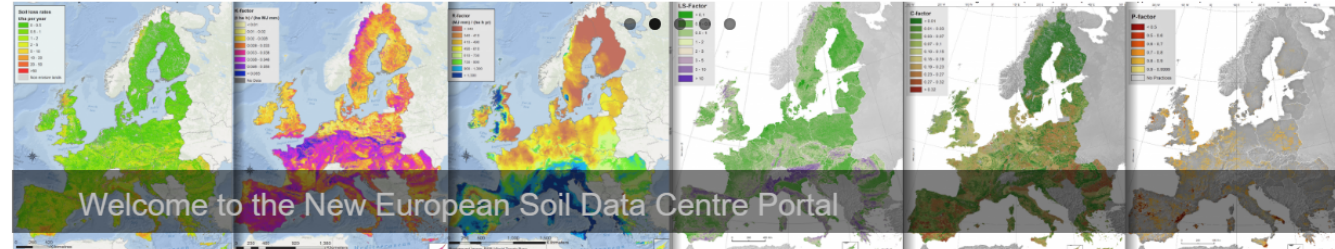
## HIGHLIGHTS

**24 Aug 2023** 40 publications in peer-review journals (Scopus Indexed) produced by EUSO team in JRC during 2022.

**18 Aug 2023** Report on Pesticides residues in European agricultural soils.

**16 Aug 2023** New dataset on Soil biodiversity - DNA eukaryotes and relevant publication in Global Change

[Home](#) [About Us](#) [Newsletters](#) [Atlases](#) [Events](#) [Vacancies](#)



Welcome to the New European Soil Data Centre Portal  
The **European Soil Data Centre (ESDAC)** is the thematic centre for soil related data in Europe. Its ambition is to be the single reference point for and to host all relevant soil data and information at European level. It contains a number of resources that are organized and presented in various ways: datasets, services/applications, maps, documents, events, projects and external links. We hope you can find your way in this site. When in doubt or for any question, you may contact [ec-esdac@ec.europa.eu](mailto:ec-esdac@ec.europa.eu)



## Dataset Highlights

### GloREDA

The data collection started in 2013 with the objective to develop a pan-European assessment of soil erosion. After the successful release of the pan European Rainfall Erosivity database and the derived R-factor map, we extended the data collection to a global scale. The first version of...  
[Read more](#)

[More Datasets](#)



One year after the First EU Soil Observatory Stakeholders Forum, the Second EUSO Stakeholders Forum was held from 24 to 26 October 2022.

This **three-day event** covered the following topics:

- The first day dealt with "Recent EU policy developments in soil".
- The second day discussed the concept of Soil Health Districts, and the EUSO engagement with the Mission "A Soil Deal for Europe".
- The third day was dedicated to look at the work done in the EUSO Technical Working Groups.

The agenda is available from [here](#), which also publishes all presentations and recordings of the various sessions.



## Scientific-Technical Reports

### EUSO Annual Bulletin - 2022 activities

### EU Soil Observatory 2022

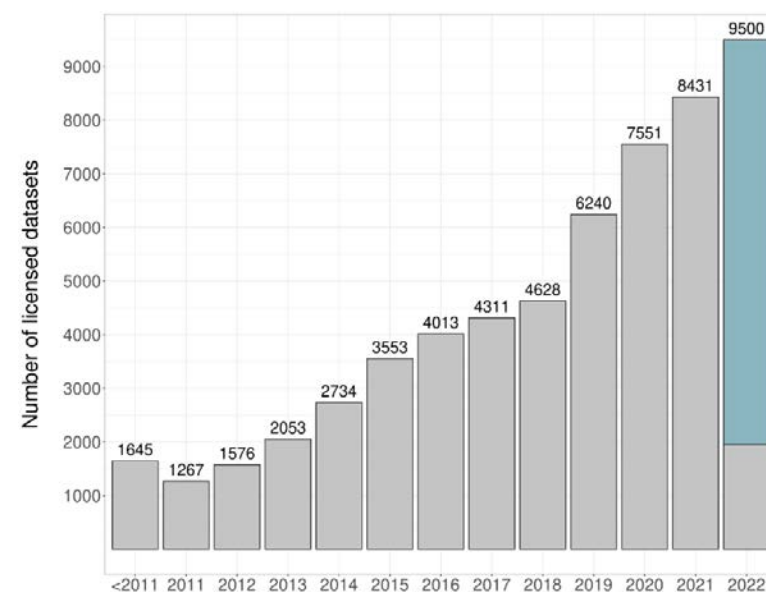
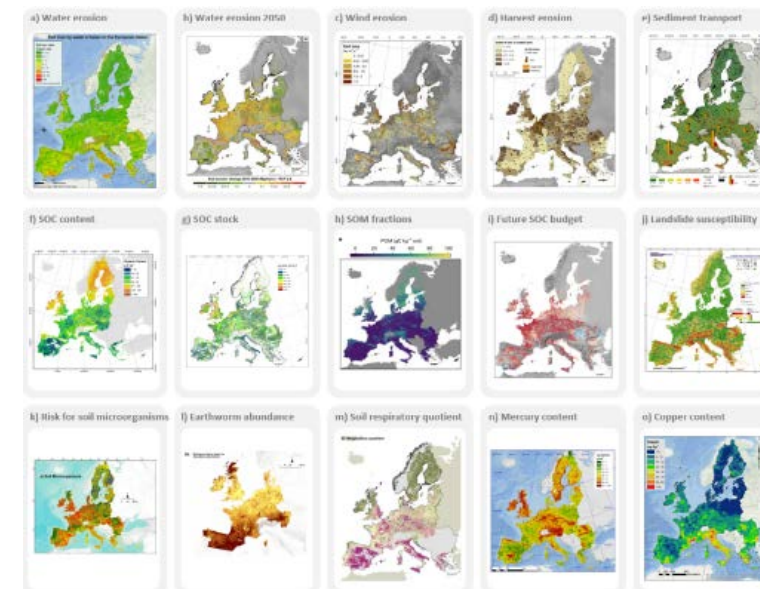
This report presents the activities of the EU Soil Observatory (EUSO) that took place during 2022. Through its five main objectives, the EUSO...  
[Read more](#)

DG AGRI is currently supporting under Horizon 2020 an European Joint Programming Initiative (JPI) on agricultural soil management to overcome current fragmentation in national research programmes and unleash the potential of agricultural soils to contribute to climate change mitigation/adaptation, while...  
[Read more](#)



# ESDAC: Towards v2.0

- 100 blocks of data
- 300,000 visitors per year
- > 65,000 total data downloads since the start
- One of the most visited JRC websites



2024+



Accommodate data flows from MS  
Outcomes of Soil Mission  
Enhanced functionality



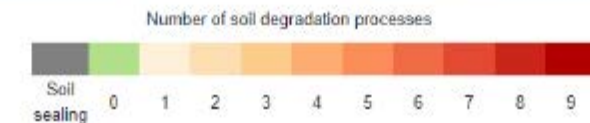
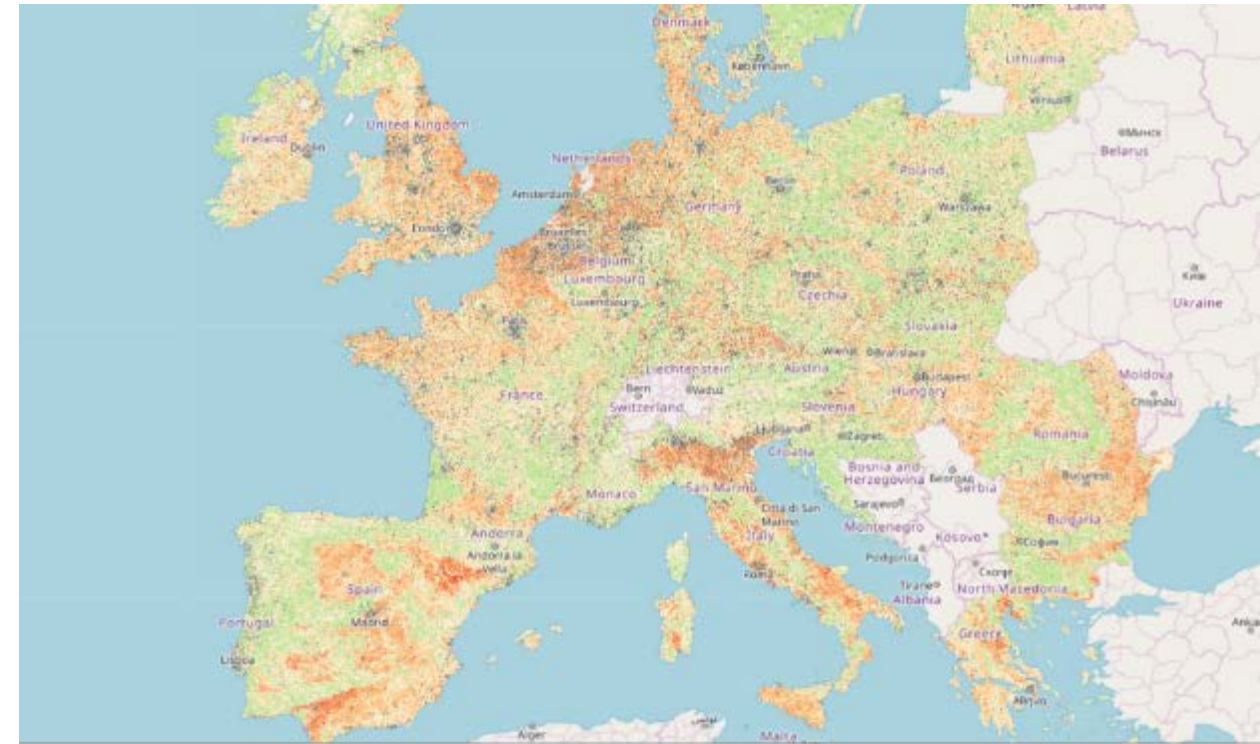
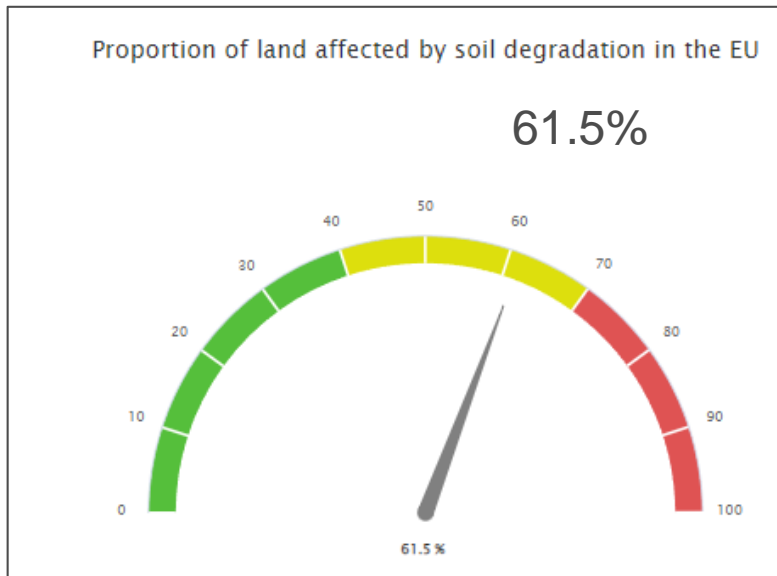
Monitoring soil health  
and policies

# Assessing Policy Impact

## EUSO Soil Dashboard

### Convergence of scientific evidence

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



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





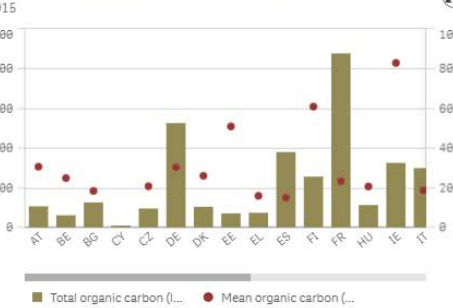
# CAP Performance indicators

## Monitoring soil health and policies

2020

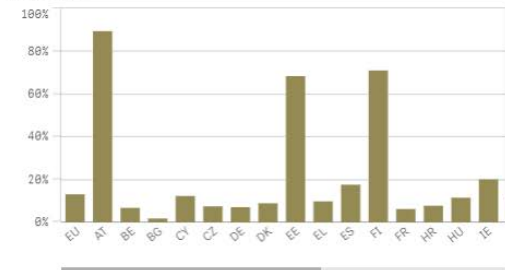
↓ B

organic matter in arable land (Mega t & g/kg)



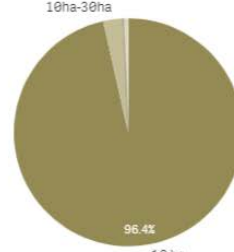
Share of agricultural land under contracts to improve soil (%)

In 2020 (soil management and/or prevent soil erosion, focus area 4C, rural development programmes)



Farms with 1 arable crop by size class (%)

In 2016



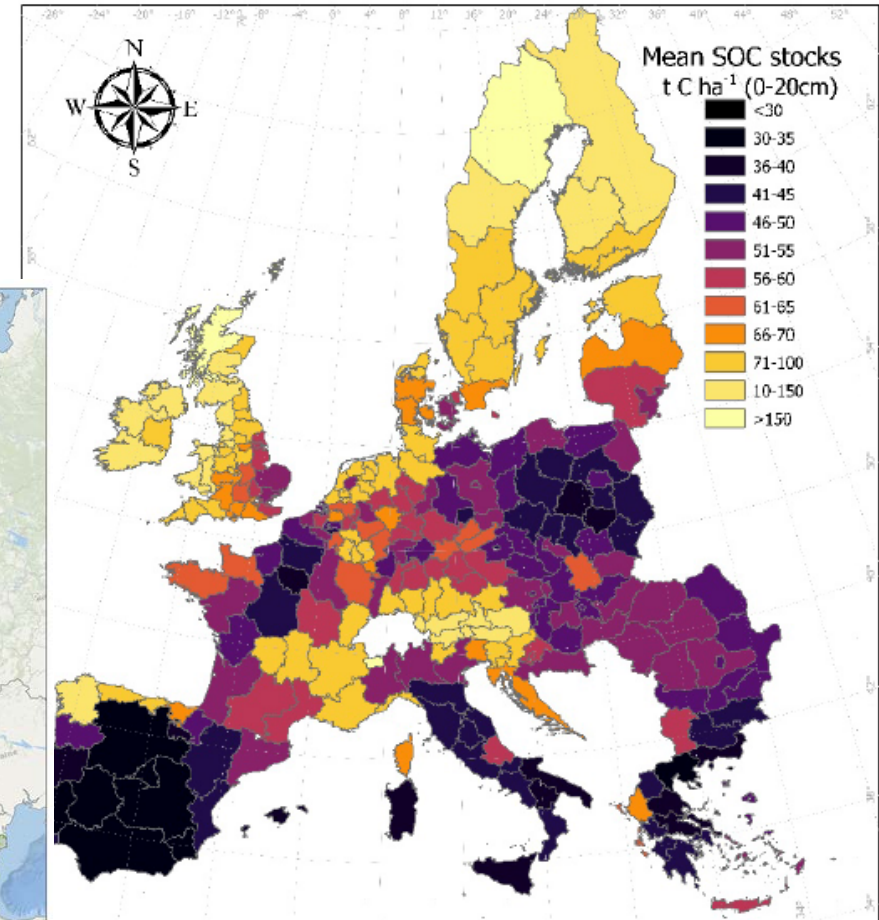
Crop diversity on EU farms (%)

In 2016 (Share of farms classified by number of arable crops)

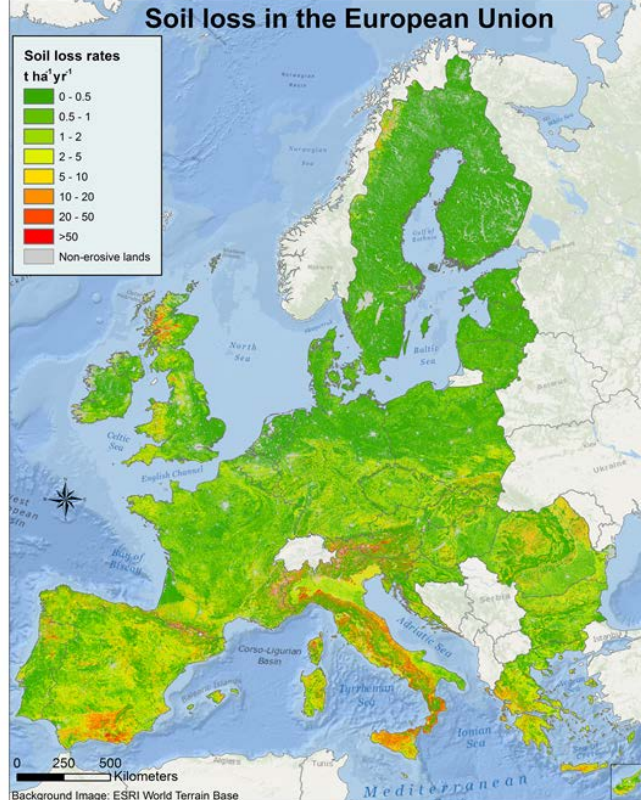
Sh

In 2

Figure 2. Mean soil organic carbon (SOC) rates of 2018 aggregated data at NUTs2



Soil loss in the European Union



Thematic Indicators Context Indicators

Data up to 2019



### Socio-economic indicators

- C01 Population
- C02 Age structure
- C03 Territory
- C04 Population density
- C05 Employment rate (\*)
- C06 Self-employment rate
- C07 Unemployment rate
- C08 GDP per capita (\*)
- C09 Poverty rate (\*)
- C10 Structure of the economy
- C11 Structure of the employment
- C12 Labour productivity by economic sector



### Sectoral indicators

- C13 Employment by economic activity
- C14 Labour productivity in agriculture
- C15 Labour productivity in forestry
- C16 Labour productivity in the food industry
- C17 Agricultural holdings (farms)
- C18 Agricultural area
- C19 Agricultural area under organic farming
- C20 Irrigated / Irrigable land **NEW**
- C21 Livestock units
- C22 Farm labour force
- C23 Age structure of farm managers
- C24 Agricultural training of farm managers
- C25 Agricultural factor income (\*)
- C26 Agricultural entrepreneurial income (\*)
- C27 Total factor productivity in agriculture (\*)
- C28 Gross fixed capital formation in agriculture
- C29 Forest and other wooded land (FOWL)
- C30 Tourism infrastructure



### Environmental indicators

- C31 Land cover
- C32 Areas facing natural and other specific constraints (ANCs)
- C33 Farming intensity
- C34 Natura 2000 areas
- C35 Farmland birds index (FBI) (\*)
- C36 Conservation status of agricultural habitats (grassland)
- C37 HNV (high nature value) farming (\*)
- C38 Protected forest
- C39 Water abstraction in agriculture /WEI+ (\*) **NEW**
- C40 Water quality (\*)
- C41 Soil organic matter in arable land (\*)
- C42 Soil erosion by water (\*)
- C43 Production of renewable energy from agriculture and forestry
- C44 Energy use in agriculture, forestry and food industry
- C45 Emissions from agriculture / GHG per LSU & GHG per ha (\*) **NEW**
- C47 Sales/Use of antimicrobials in food production



# 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)

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

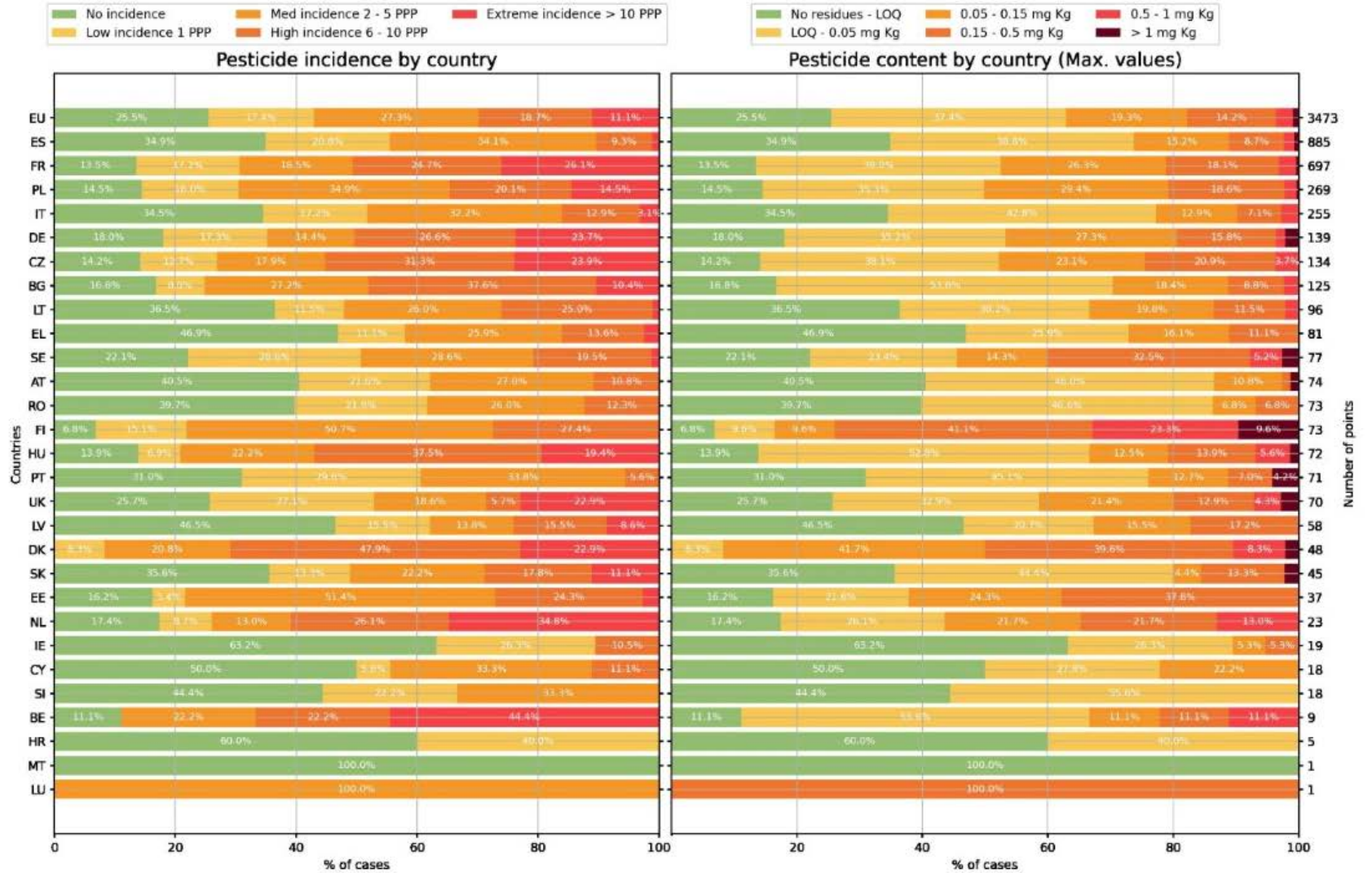
Close collaboration with **Soil Mission Projects** (such as AI4SoilHealth, BENCHMARKS, Soil-Olive, Prepsoil, ECHO, MARVIC, etc) – EUSO as a beneficiary of research activities in Soil Mission Projects



# Novel assessments of Soil Health

Research & Innovation

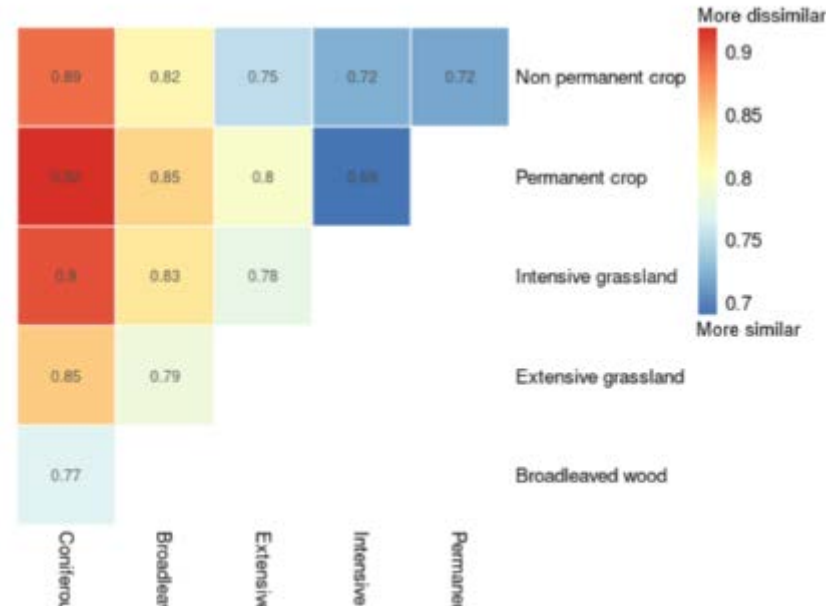
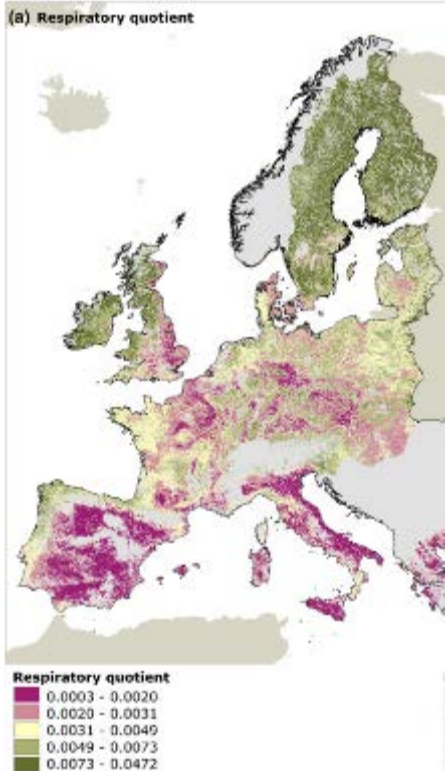
New information  
New Indicators





Research & Innovation

# Novel assessments of Soil Health



nature communications



Article

<https://doi.org/10.1038/s41467-023-37937-4>

## Patterns in soil microbial diversity across Europe

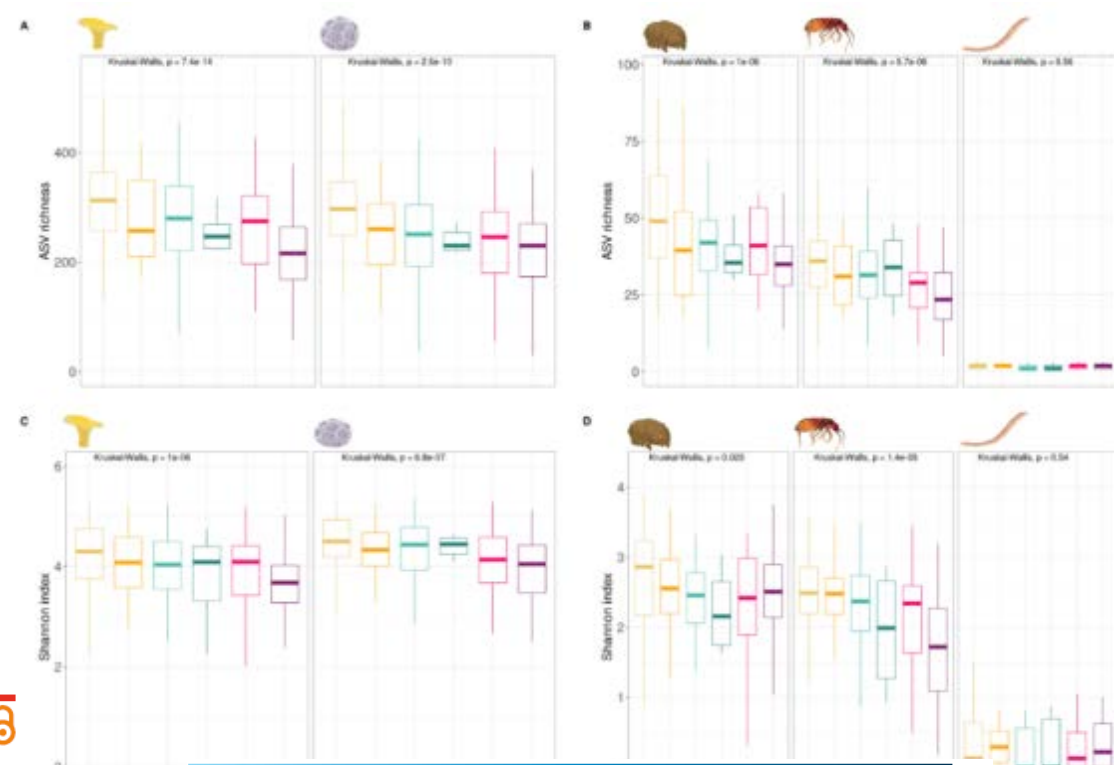
Received: 25 August 2022

Accepted: 6 April 2023

Published online: 08 June 2023

Check for updates

Maëva Labouyrie<sup>1,2,3</sup>, Cristiano Ballabio<sup>2</sup>, Ferran Romero<sup>3</sup>, Panos Panagos<sup>4</sup>, Arwyn Jones<sup>5</sup>, Marc W. Schmid<sup>4</sup>, Vladimir Mikryukov<sup>5,6</sup>, Olesya Dulya<sup>5,6</sup>, Leho Tedersoo<sup>5</sup>, Mohammad Bahram<sup>6,7</sup>, Emanuele Lugato<sup>2</sup>, Marcel G. A. van der Heijden<sup>1,2</sup> & Alberto Orgiazzi<sup>2</sup> ✉



Global Change Biology

RESEARCH ARTICLE | Open Access | CC BY

## Ecosystem type drives soil eukaryotic diversity and composition in Europe

Julia Königer, Cristiano Ballabio, Panos Panagos, Arwyn Jones, Marc W. Schmid, Alberto Orgiazzi ✉, Maria J. I. Briones ✉

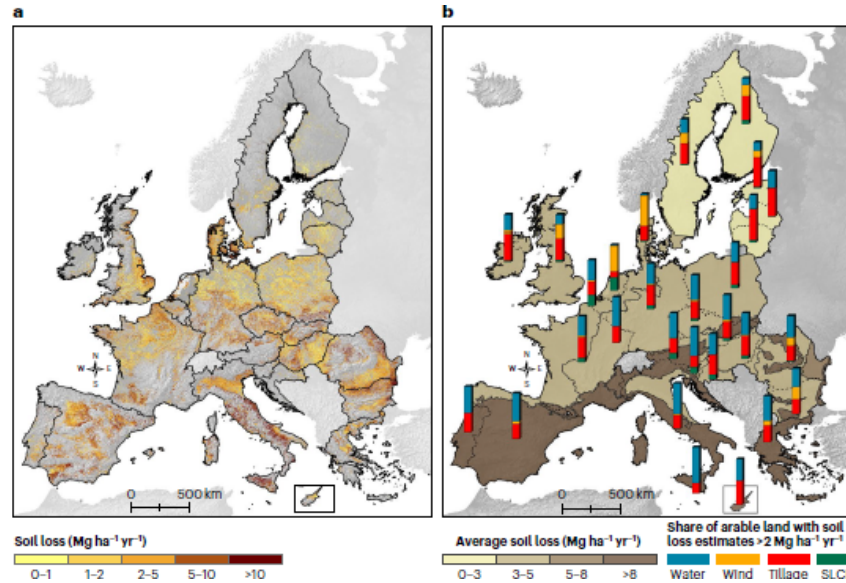
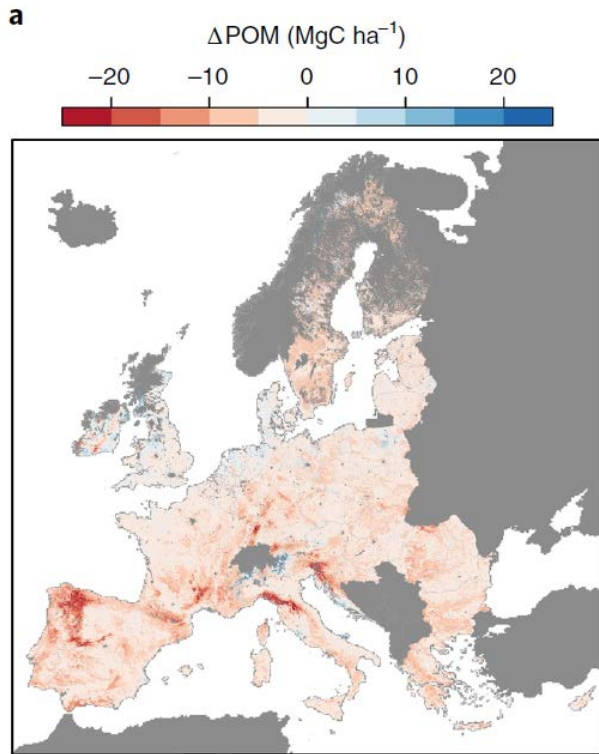
First published: 14 July 2023 | <https://doi.org/10.1111/gcb.16871>

Smith et al., 2021. Large-scale drivers of relationships between soil microbial properties and organic carbon across Europe. *Global Ecology and Biogeography*.

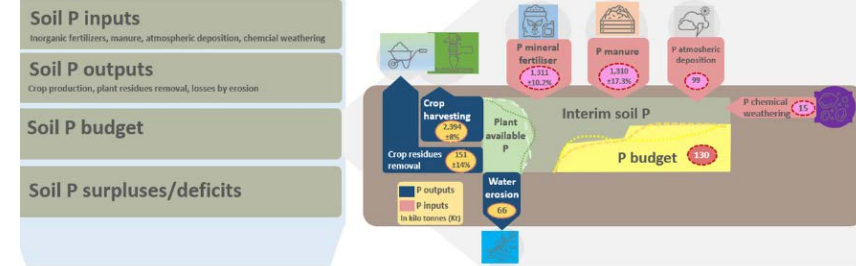


Research & Innovation

# Novel assessments of Soil Health



## Improving the Phosphorus budget of European agricultural soils



Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: [www.elsevier.com/locate/scitotenv](http://www.elsevier.com/locate/scitotenv)



## nature sustainability

Analysis

<https://doi.org/10.1038/s41893-022-00988-8>

# 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<sup>1,2</sup>, Panos Panagos<sup>3</sup>, Christine Alewell<sup>4</sup>, Cristiano Ballabio<sup>5</sup>, Hugo de Oliveira Fagundes<sup>6</sup>, Nigussie Haregeweyn<sup>6</sup>, Emanuele Lugato<sup>3</sup>, Michael Maerker<sup>7</sup>, Jean Poesen<sup>8,9</sup>, Matthias Vanmaercke<sup>8</sup> and David A. Robinson<sup>10</sup>

nature  
geoscience

ARTICLES

<https://doi.org/10.1038/s41561-021-00744-x>



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

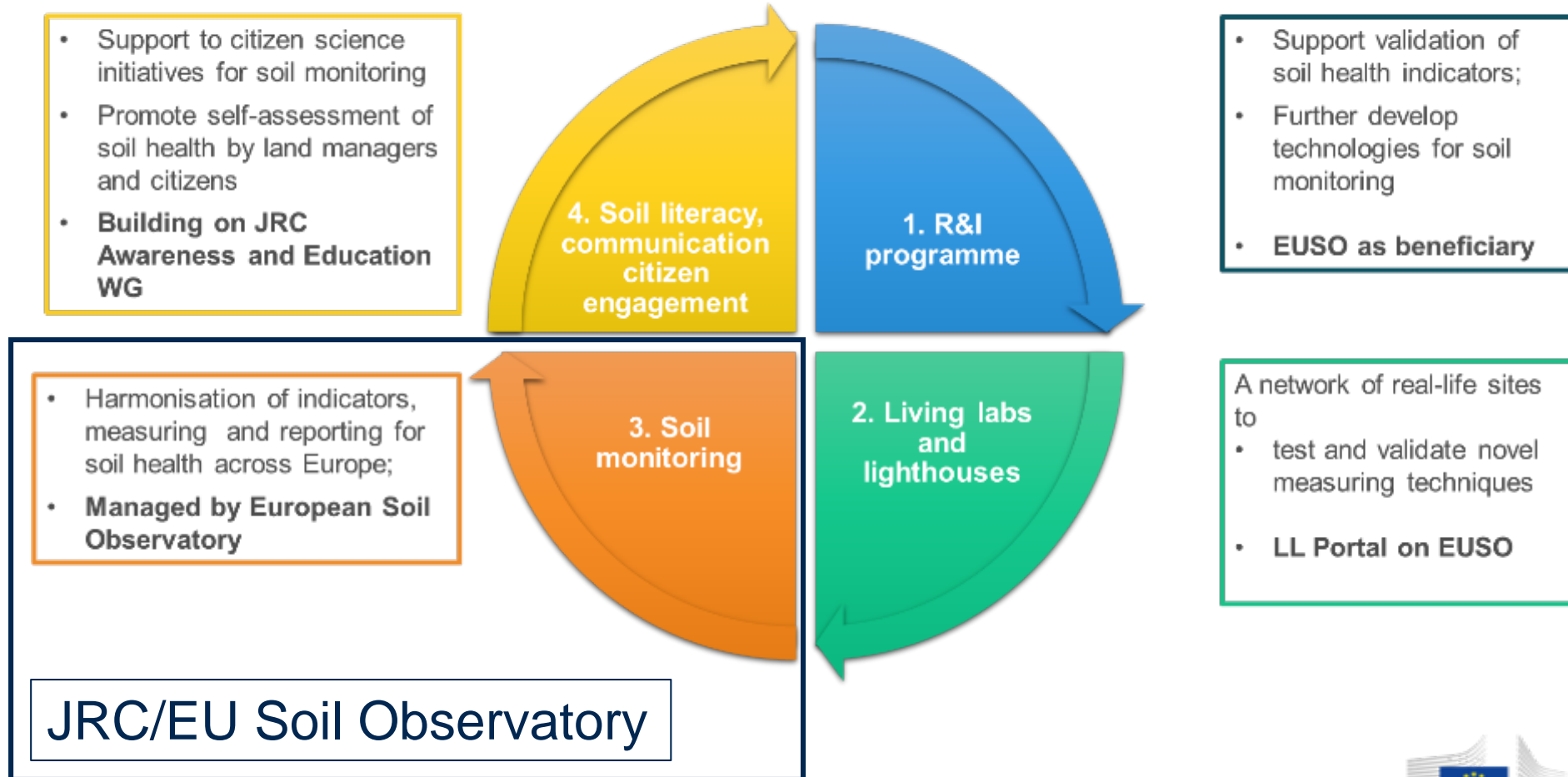
Emanuele Lugato<sup>1,5\*</sup>, Jocelyn M. Lavallee<sup>2</sup>, Michelle L. Haddix<sup>2</sup>, Panos Panagos<sup>1</sup> and M. Francesca Cotrufo<sup>6,2</sup>





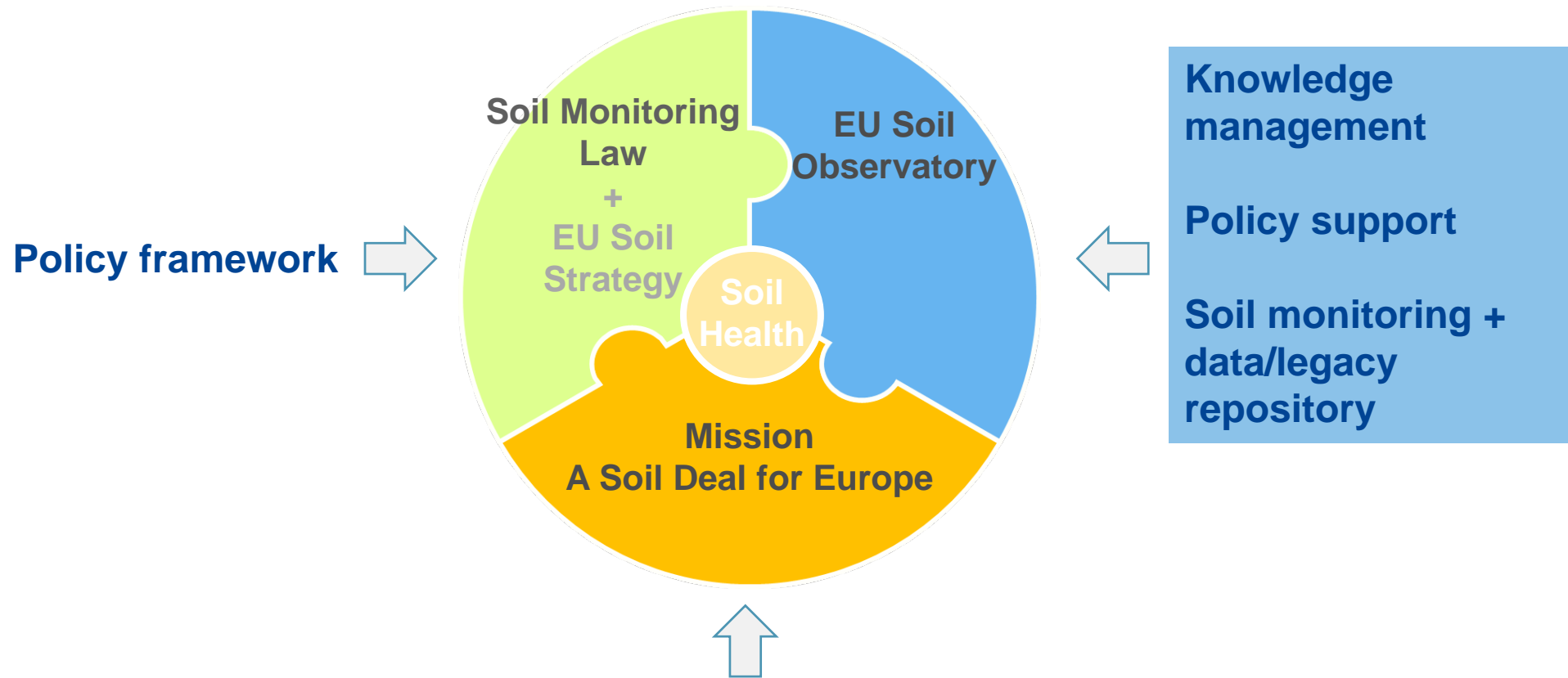
# JRC is part of the Horizon Europe Soil Mission: a major partnership that will fill knowledge gaps

## Soil Mission Building Blocks



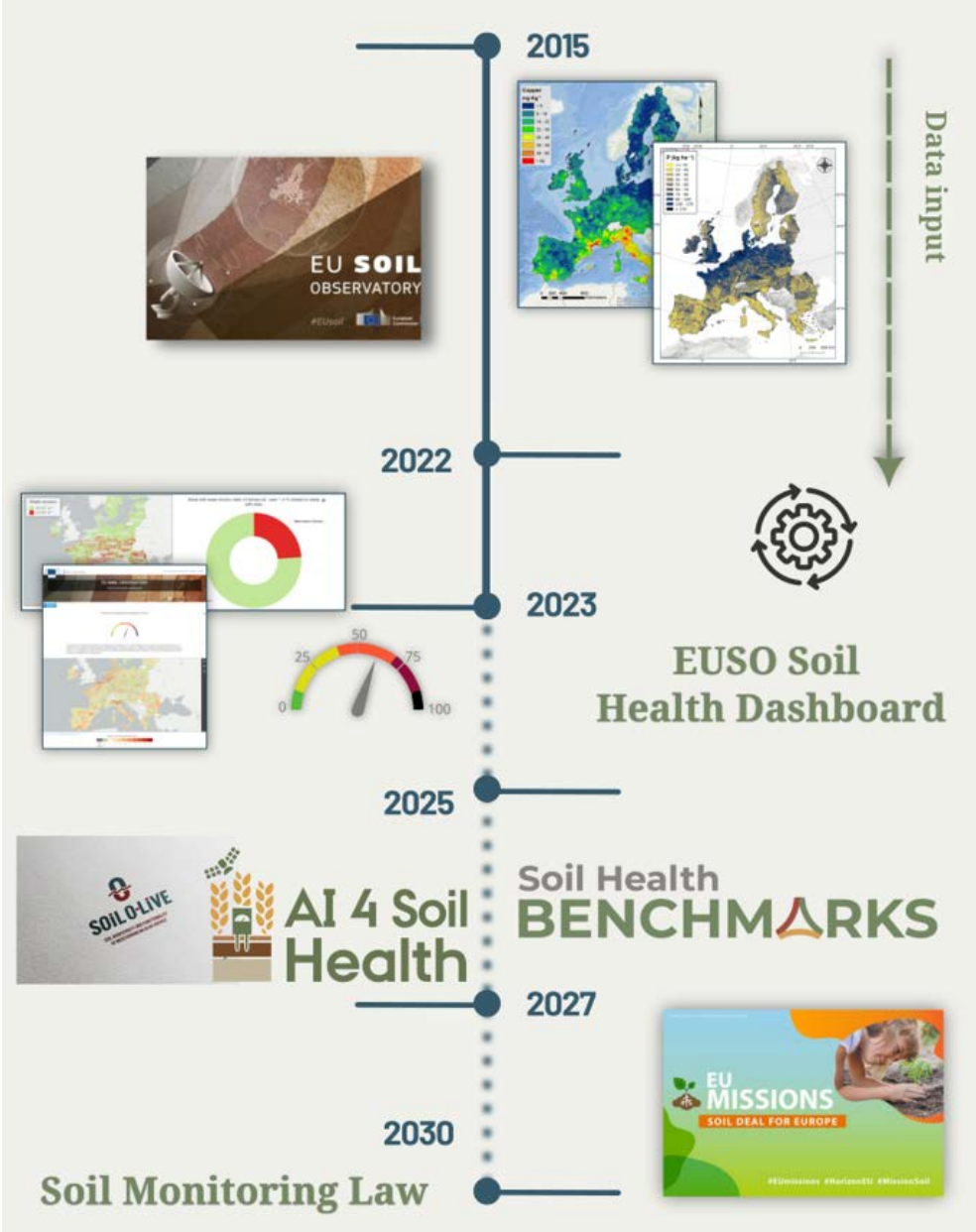
# A supportive framework for soil protection in the EU

The new EU Soil Strategy and Soil Monitoring Law (2023), European Soil Observatory and Mission A Soil Deal for Europe together are the main **framework for soil protection and restoration in the EU.**



**Mechanism for research and innovation, knowledge gaps, citizen engagement and wide outreach**

# ESDAC in 2015 – EUSO in 2030







# 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
- Promote outcomes of Living Labs and Lighthouse projects (knowledge management)
- 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





# EUSO Stakeholders Forum



- 1,000 participants in 2021 & 2022
- High-level participation
- 70+ presentations over three days
- 2022 Forum: first presentation of Soil Mission funded projects
- Establishment of 6 Technical Working Groups - Lead more complete knowledge base for policy
  - Soil pollution
  - Soil monitoring
  - Soil data sharing
  - Soil erosion
  - Soil biodiversity
  - Soil Carbon MRV



## European Soil Forum



## EUSO Annual Bulletin

A review of 2022 activities

Manichal, A., Pothigias, P., Jones, A., Ariza Navarro, C., Battaglia, C., Bellizzi, D., Birkens, T., De Heert, D., De Rosa, D., Fierich, A., Koeninger, J., Labourie, M., Llorens, L., Madori Jimenez, J., Matzner, F., Montanarella, L., Murtwyler, A., Orzi, A., Scarpa, S., Schillaci, C., Simoes Vieira, D., Van Eynde, E., Van Liedekerke, M., Wajda, P., Tuntal Mezquita, F.



## EU Soil Observatory 2021

Review and reflections

Manichal, A., Jones, A., Panagos, P., Beltrandi, D., De Medici, D., De Rosa, D., Jimenez, J.M., Koeninger, J., Labourie, M., Llorens, L., Lugato, F., Matthies, F., Montanarella, L., Murtwyler, A., Orzi, A., Scarpa, S., Schillaci, C., Wajda, P., Van Liedekerke, M., Vieira, D.





## 3<sup>rd</sup> EUSO 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

### 3<sup>rd</sup> EUSO Stakeholder Forum

- Working group meetings (15-17 November, online) – Join: <https://ec.europa.eu/eusurvey/runner/EUSOFORUM2023>
- European SOIL Mission Week (21-23 November, Madrid)

# Sustainability of soils requires an holistic assessment of all drivers of impact within production and consumption systems



For example, more resilient and sustainable food systems are possible but they require **integrated solutions at multiple scales and across the entire food chain** from field to table, to waste management

# What happens next?

## 10 years+ of work!

- *2 years for EP/MS agreement + 2 years for implementation + 6 years for first reporting + analysis*

Upgrading EUSO to accept **MS data flows** and Soil Health dashboard to report progress

Fully integrate **LUCAS Soil and MS monitoring programmes**

- *Facilitate harmonization of methodologies*

Provide support for transposing and implementing the **Directive**, in particular concerning land take and soil contamination

Facilitate filling in **the knowledge gaps** related to the directive, interfacing with research programmes (e.g. Mission) for any needed update of the directive's annexes.

Better linking drivers of impacts on soils (from production and consumption systems) to ensure a **coherent policy support**

# Thank you

## Contacts



EU Soil Observatory: <https://esdac.jrc.ec.europa.eu>

[Panos.Panagos@ec.europa.eu](mailto:Panos.Panagos@ec.europa.eu) @PanosPanagos33