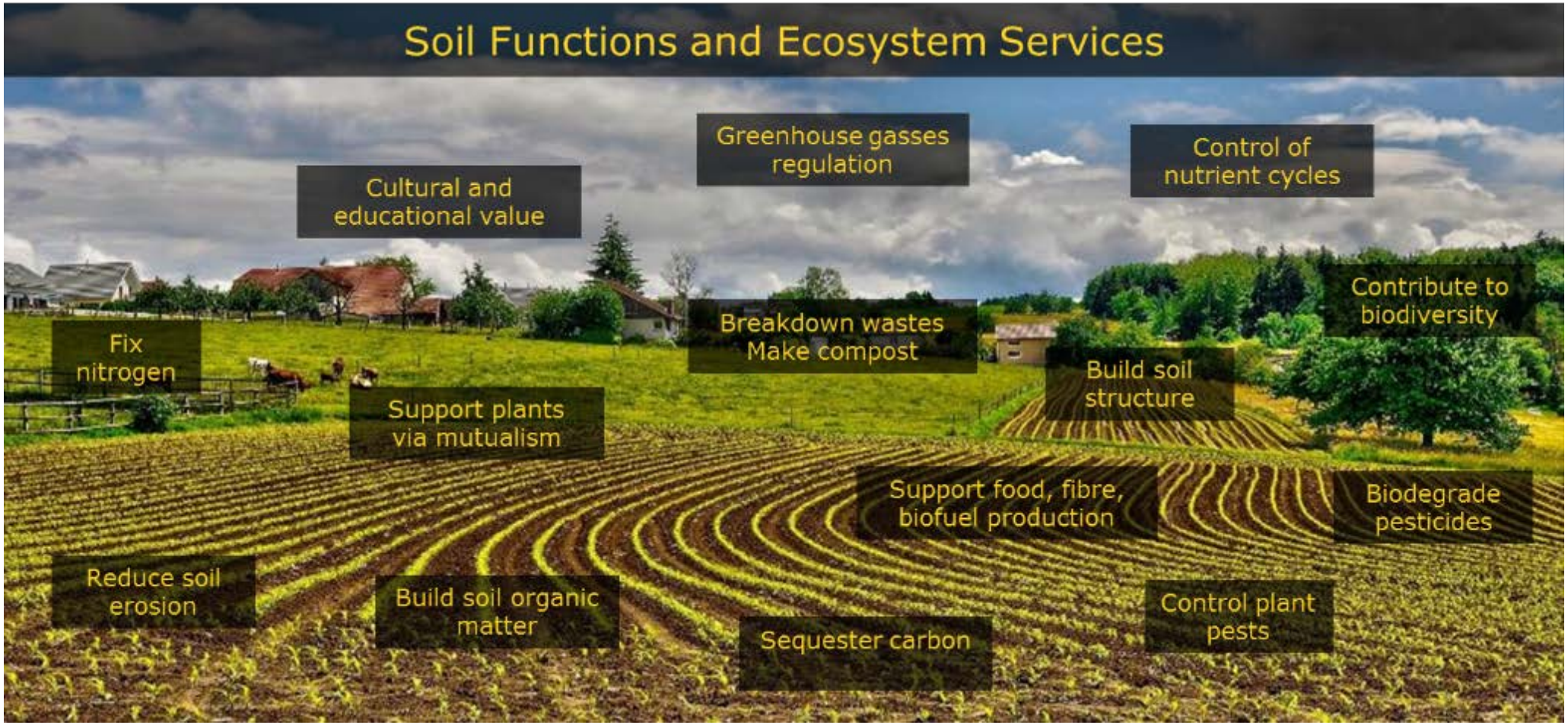
LUCAS Soil datain the context of Sweden-Finland soil monitoring

Webinar EJP SOIL
06/02/2024

Arwyn Jones EUSO

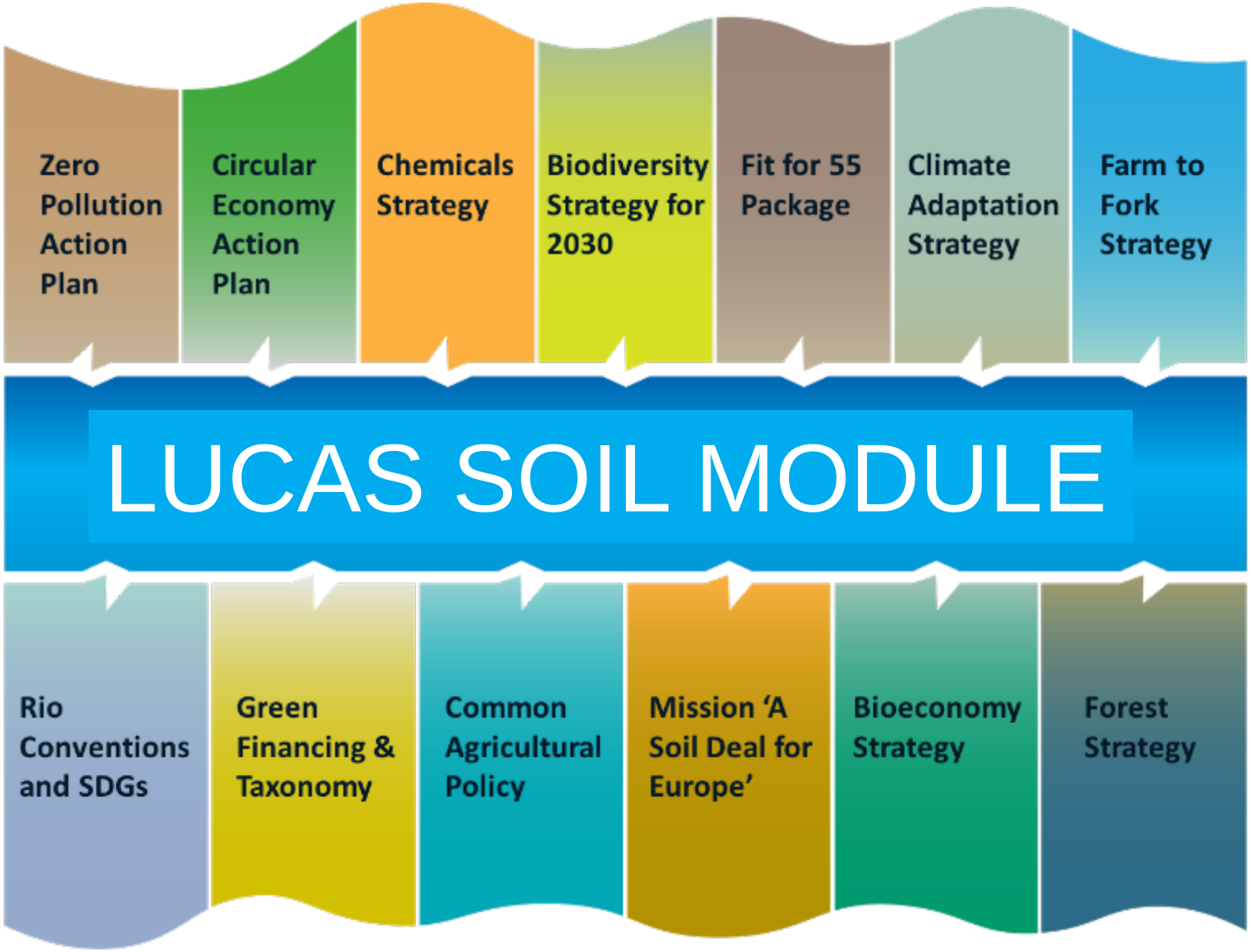
PDF: fawpixel

Scope of LUCAS Soil Module



European Commission

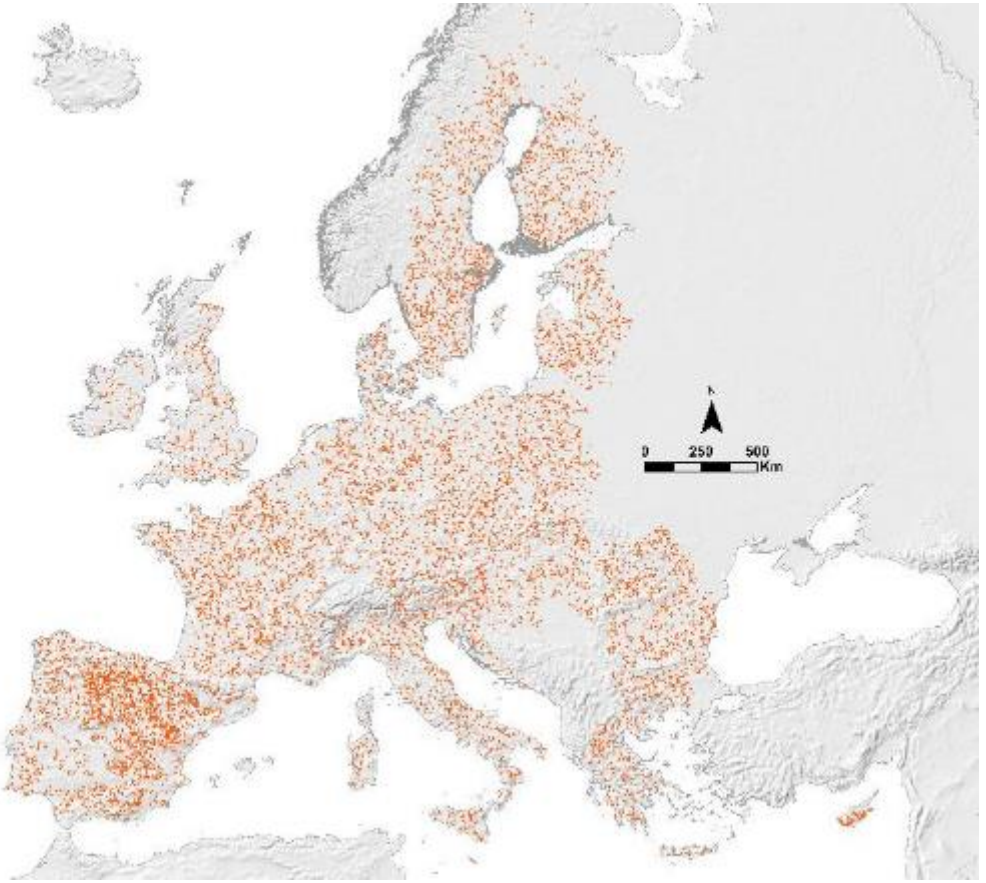
Soil and the European Green Deal



European Commission

LUCAS Soil Module

- Subset of LUCAS
- Previous: 2009/2012, 2015, 2018
- Only harmonized soil data collection programme for EU
- Extending in scope
- Increased policy relevance
- Samples from c. 22,000 locations across EU
- Stratified random samples from LUCAS Master Grid



NUTS 0	Points	Artificial land	Bareland	Cropland	Grassland	Shrubland	Water	Wetlands	Woodland
FI	1143	2	3	134	50	24	0	1	929
SE	1906	5	21	120	121	51	0	18	1570

European Commission

LUCAS Soil Module

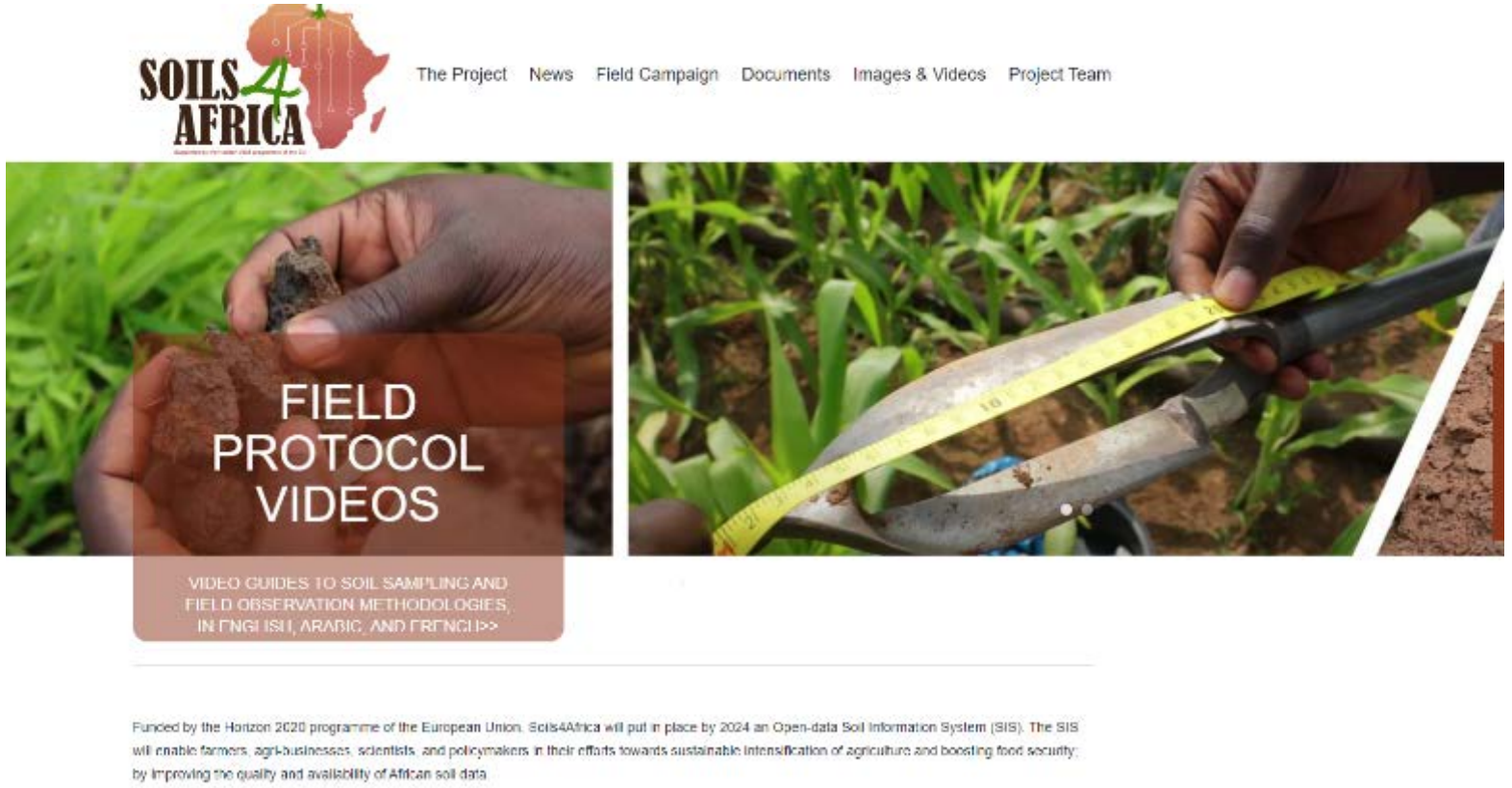
Methodology extended to

- Africa (Soils4Africa)
- Mediterranean (PRIMA)

Adopted by Norway in 2024

Applied for Western Balkans (2015)

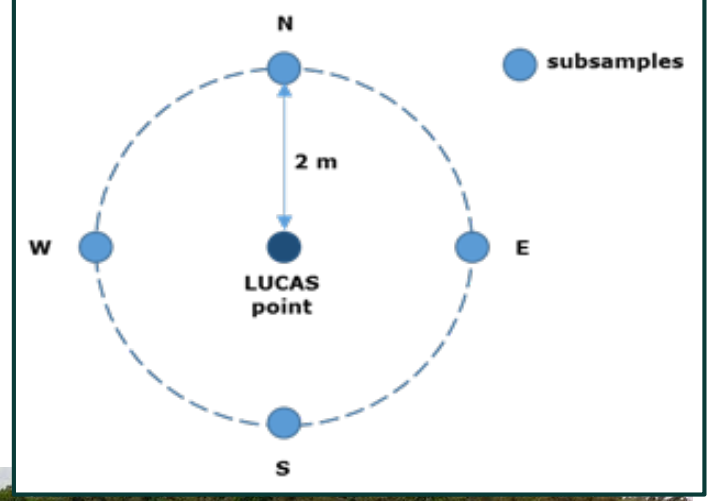
Used in Switzerland (2018/2022)

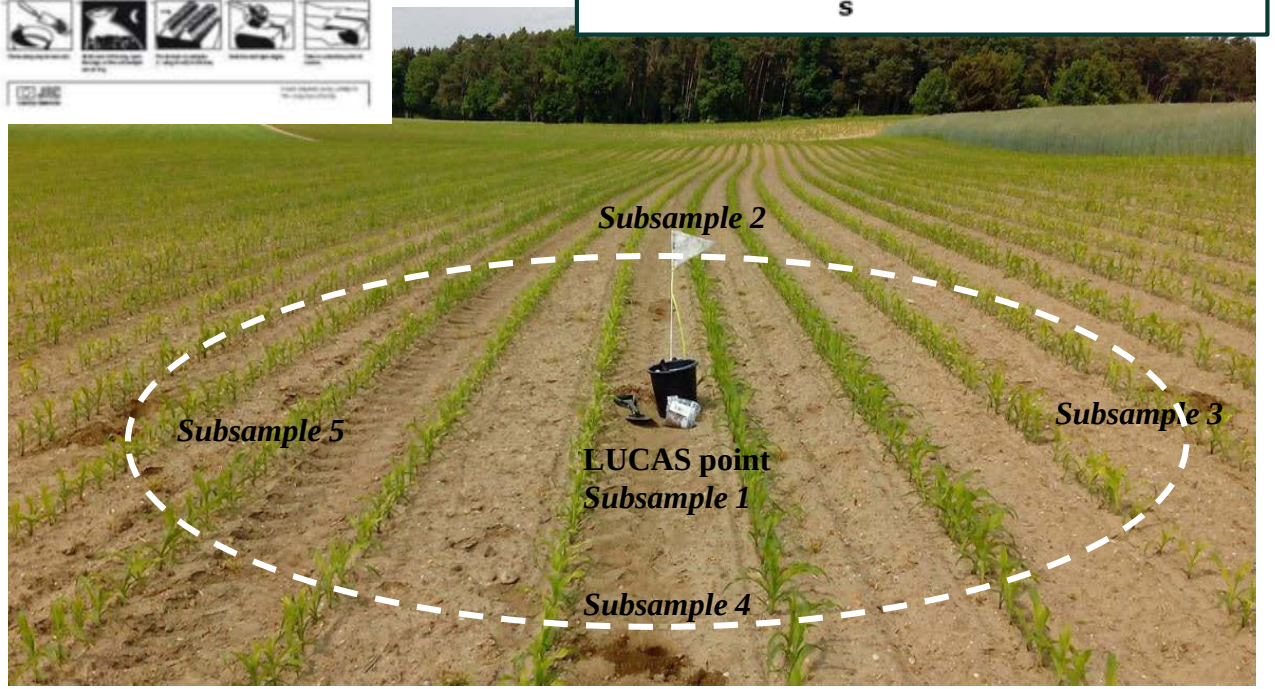


European Commission

LUCAS Soil Module (summary)

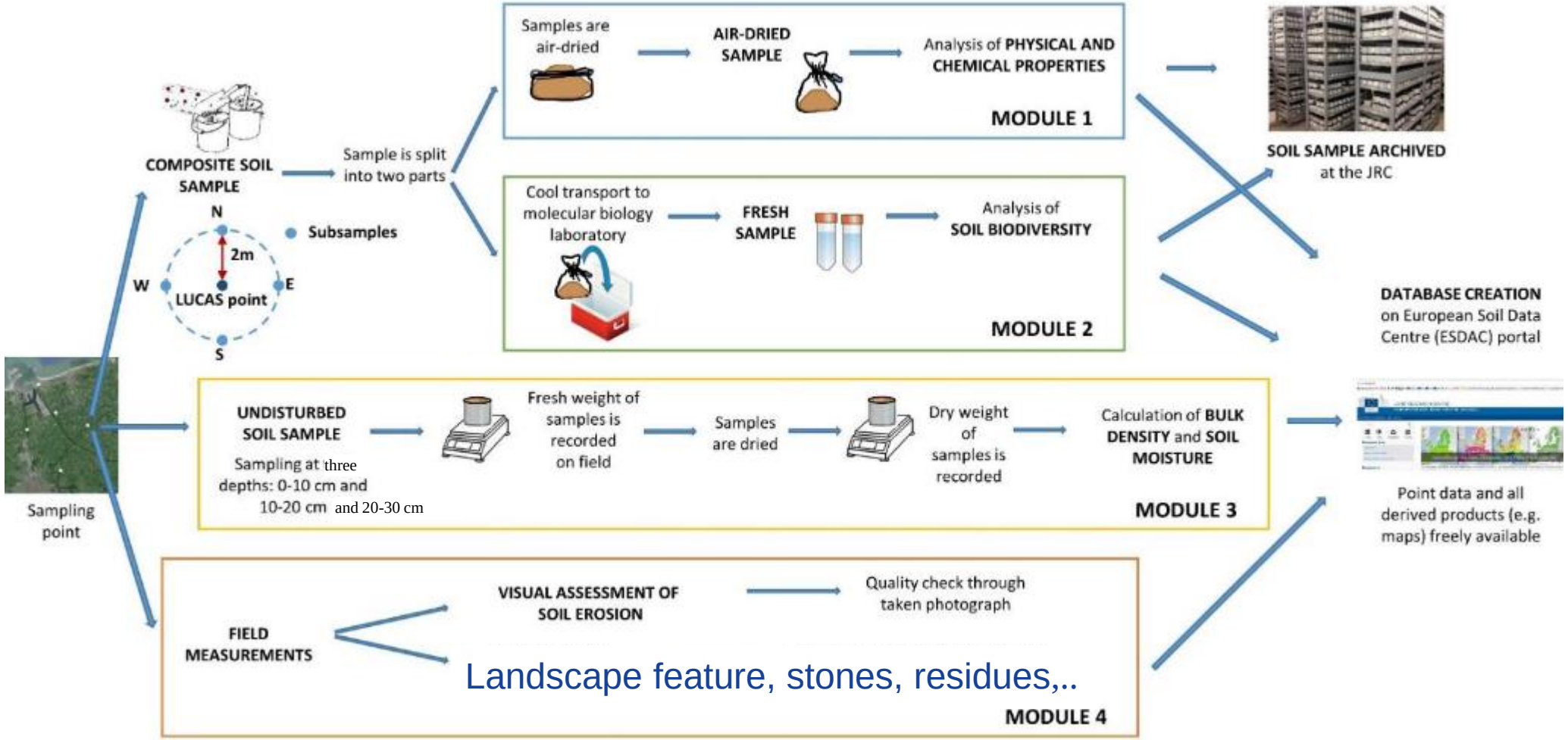
- A **topsoil sample**
- Composite of **5 subsamples – 30 cm depth**
- **c. 2m from point**
- Take out approx. weight: **500 g** (5 heaped trowels)
- Sampling equipment
  - Spade and trowel
  - Bucket
  - Meter stick
  - Plastic bags and ties
  - Labels
  - Box to store and transport samples





European Commission

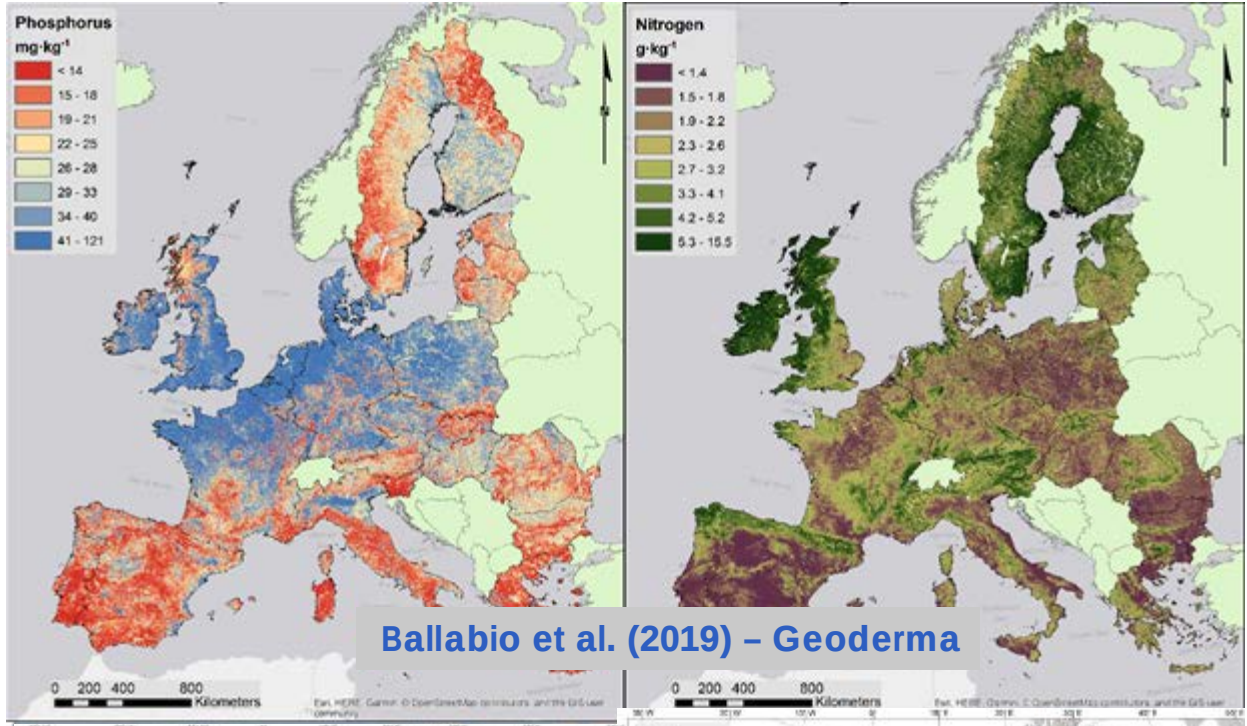
LUCAS-Soil: field sampling

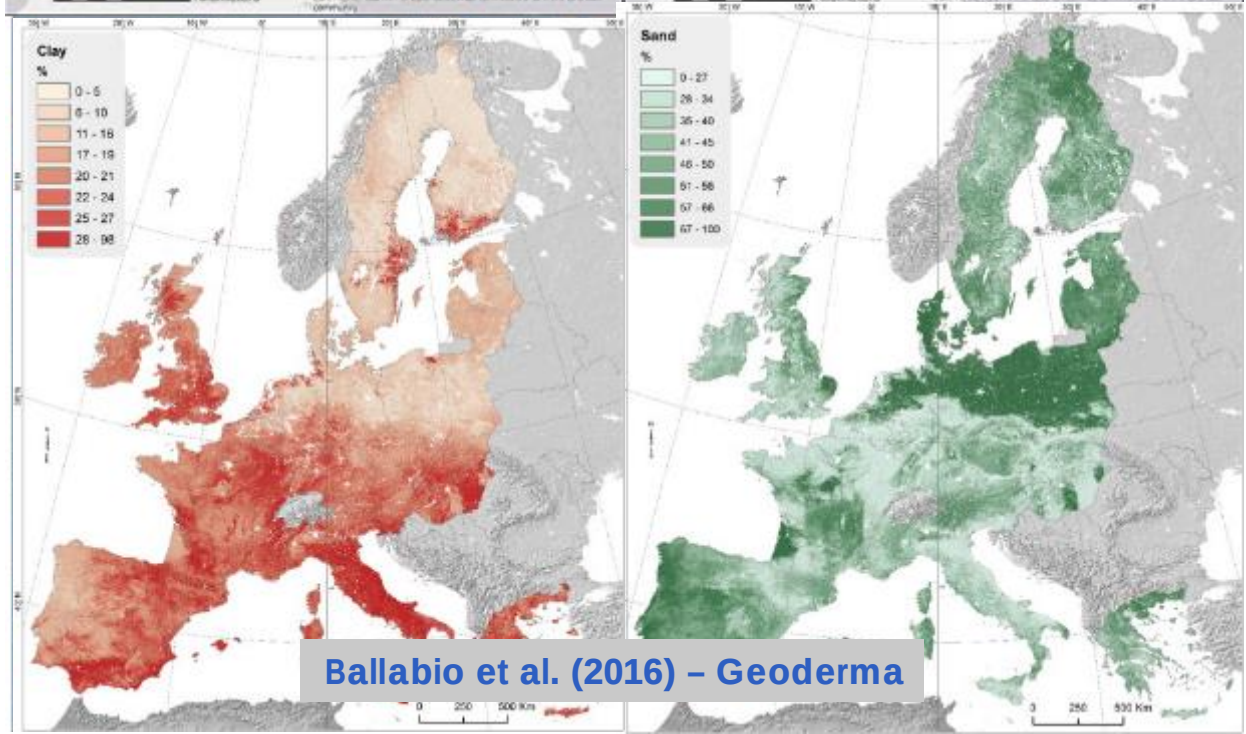


European Commission

Parameters measured by single laboratory

- 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
- Metals
- Multispectral properties
- Pesticides (90 substances)
- Antibiotic Resistance
- Soil Biodiversity





LUCAS 2022: new developments

- Sample increased to 41,000 locations (Cropland SOC stocks at NUTS 2, others NUTS 0)
- Fixed pool: 17,000 points (2009/2012-2015-2018)
- 24,000 new points
- New points selected on the basis of a soil organic carbon prediction

Estimates	Selected points
Cropland	23,185
Woodland	8,091
Grassland	9,166
Wetland	556

2022 Summary

	STN	BD	BIO	LIT
FI	1623	195	134	964
SE	2587	258	197	1513

European Commission

LUCAS 2022: new developments

- Sampling **depth = 30 cm** (compliant with IPCC reporting)

Soil biodiversity (fresh samples for genetic analysis)

- 1000 sites from 2018
- 1000 new random samples
  - 150 points within Alpine Zone
  - 50 in urban areas

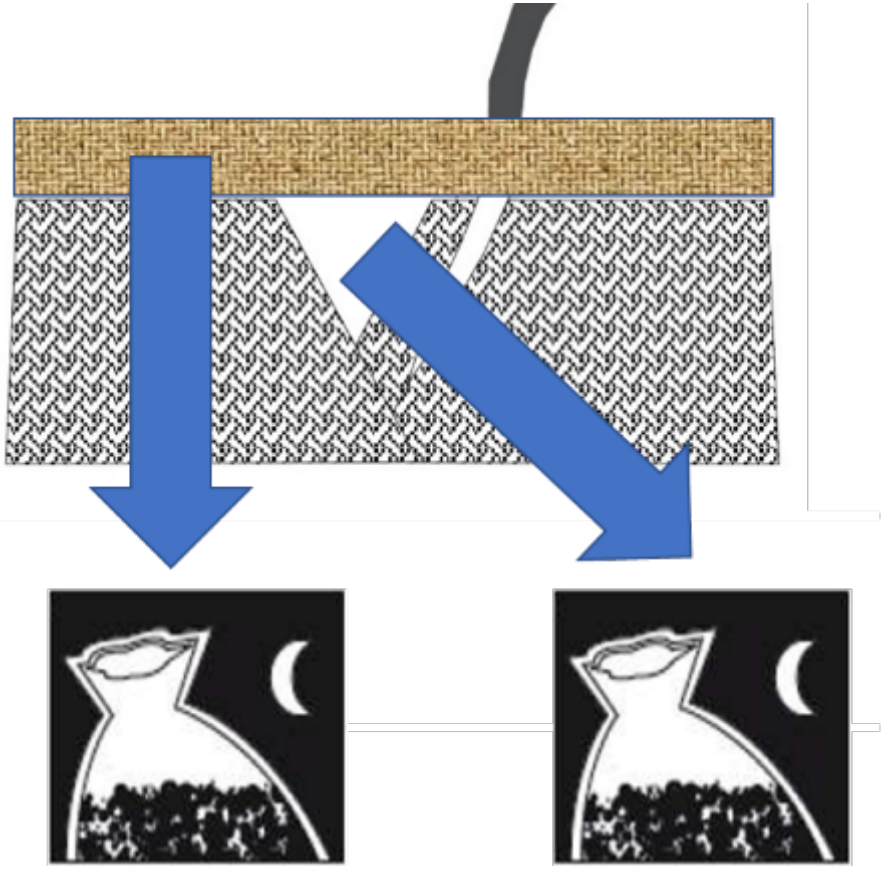
Bulk density

- 1000 on 2018 BD sites
- On all new biodiversity sites (1000)
- 2000 random selection (weighting x arable)

European Commission

Adapted sampling in woodland

- Litter layer can vary in thickness and type



European Commission

Core laboratory analysis in LUCAS 2022

(new)

Revisited locations

- Core parameters: pH, SOC, carbonates, N-$P_{extract}$-K, Base saturation, Electrical conductivity, Cation Exchange Capacity, Al-Fe-P Oxylate extractions
- Na, S plus micronutrients from CEC extract - sodium, (Na), boron (B), chloride (Cl), iron (Fe), manganese (Mn), Carbon in litter
- Carbon in litter

- Screening for pesticides
- Screening for PFAS, plastics, ?

New samples

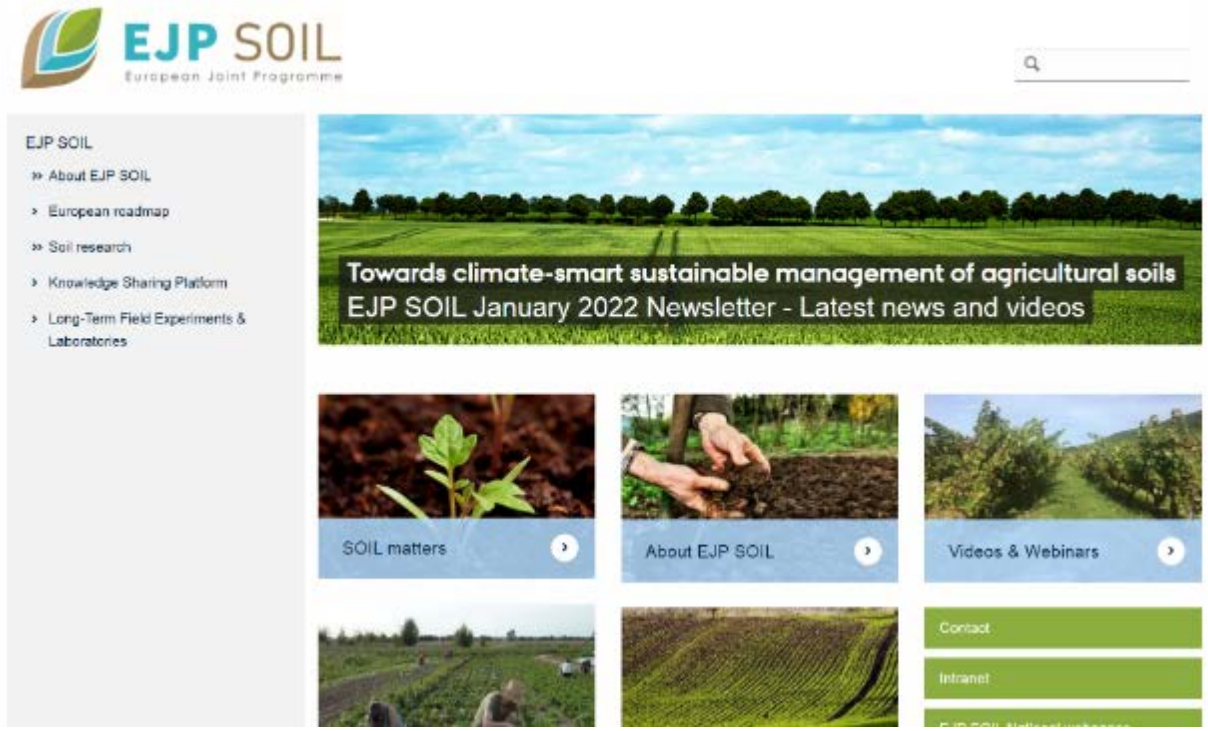
- Extended core (see above)
- Particle size distribution & coarse fragments
- Carbon in litter
- Metals from 2009 (including Total P, new extraction techniques)

European Commission

Collaboration with Member States

European Joint Programme on Agricultural Soils (EJP-Soil)

- H2020 co-funded by EC and MS (€80 million)
- Harmonise LUCAS with MS monitoring systems



- Invitation to propose some LUCAS GRID coordinates as part of the fixed pool
- No restrictions other than accessibility
- 13 MS engaged in co-sampling/analysis
- Transfer functions MS > LUCAS
- SHL Reporting / Monitoring

EU Soil Observatory

- Integrated soil monitoring system for EU

European Commission

What happens next?

LUCAS 2.0

EC contribution to reduce burden on MS (20% of samples)

Adapted to indicators of Soil Monitoring Law

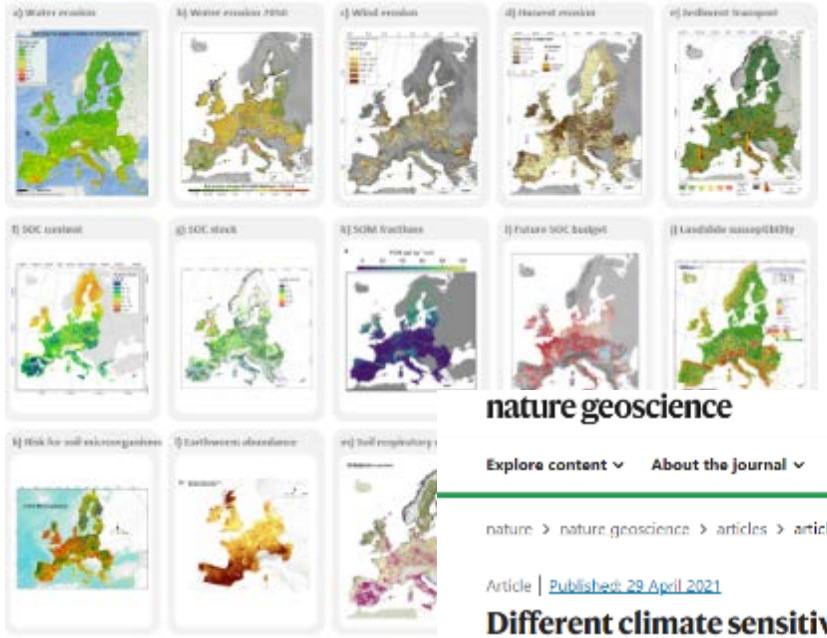
Fully integrate LUCAS Soil and MS monitoring programmes

- Facilitate harmonization of methodologies
- Sampling framework
- Transfer functions
- Standards

Provide support to MS for implementing the Directive

European Commission

How LUCAS data are used?



Science of The Total Environment
Volume 853, 20 December 2022, 158706

Improving the phosphorus budget of European agricultural soils

Panos Panagos, Julia Köningner, Cristiano Ballabio, Leonidas Liakos, Anna Muntwyler, Pasquale Borrelli, Emanuele Lugato

RESEARCH ARTICLE

Complementing the topsoil information of the Land Use/Land Cover Area Frame Survey (LUCAS) with modelled N_2O emissions

Emanuele Lugato[1]*, Lily Paniagua[1,2], Arwyn Jones[1], Wim de Vries[2,3], Adrian Leip[1]

1 European Commission, Joint Research Centre (JRC), Sustainable Resources Directorate, Ispra, Varese, Italy, 2 Wageningen University and Research, Environmental Systems Analysis Group, Wageningen, The Netherlands, 3 Wageningen University and Research, Environmental Research (Alterra), Wageningen, The Netherlands

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Article | Published: 29 April 2021

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

Emanuele Lugato, Jocelyn M. Lavallee, Michelle L. Haddix, Panos Panagos & M. Francesca Cotrufo

Nature Geoscience **14**, 295–300 (2021) | Cite this article

11k Accesses | **74** Citations | **197** Altmetric | Metrics

Science of The Total Environment
Volume 769, 15 May 2021, 144755

A spatial assessment of mercury content in the European Union topsoil

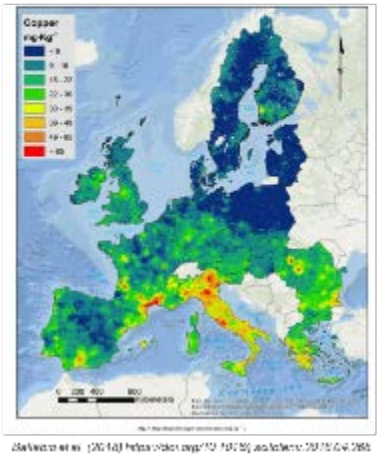
Cristiano Ballabio, Martin Jiskra, Stefan Osterwalder, Pasquale Borrelli, Luca Montanarella, Panos Panagos

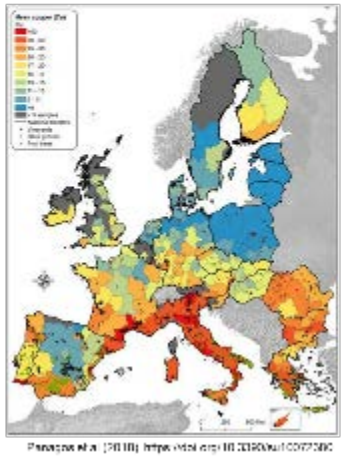
And, many more…

European Commission

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

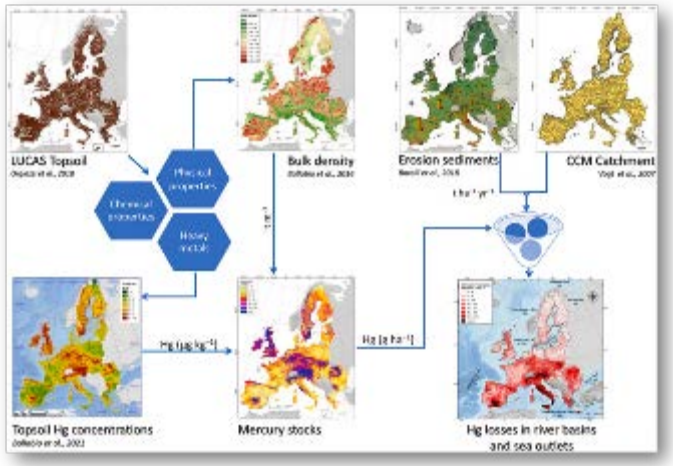
- Cu is correlated to soil properties (pH, texture, OC), climate, geology and management.
- Vineyards (49.3 mg kg^{-1}), olive groves (33.5 mg kg^{-1}) and orchards (27.3 mg kg^{-1}) show high [Cu] that may be affected by the application of Cu-based fungicides for controlling plant diseases





Mercury in European topsoils: Anthropogenic sources, stocks and fluxes

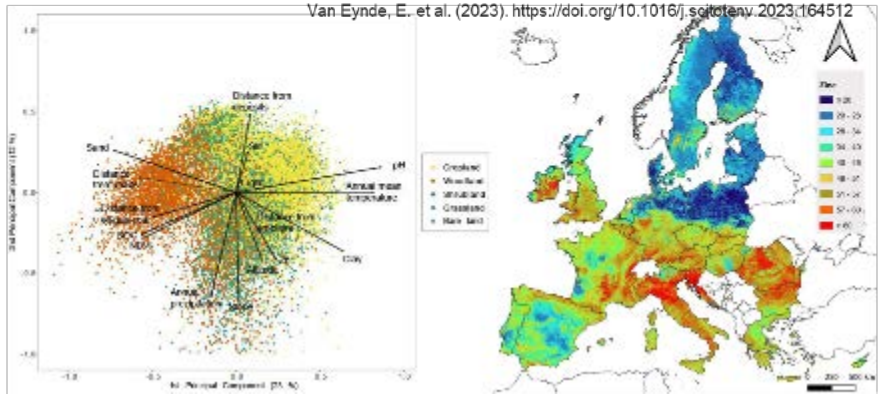
In the European Union and UK, about 43 Mg Hg yr^{-1} are displaced by water erosion and 6 Mg Hg yr^{-1} are transferred to river basins and to coastal Oceans.



Spatial assessment of topsoil zinc concentrations in Europe

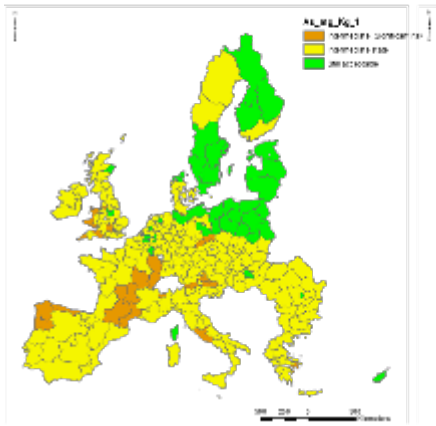
Based on LUCAS topsoil database, the mean Zn concentration in Europe is 47 mg kg-1 and median Zn concentration is 40 mg kg-1. Ninety nine percent of all samples have concentrations below 167 mg kg-1. Soil texture and pH are most important drivers for the variation in topsoil Zn ? High Zn concentrations are found near Zn deposits, and in grasslands

Van Eynde, E. et al. (2023). https://doi.org/10.1016/j.scitotenv.2023.164512



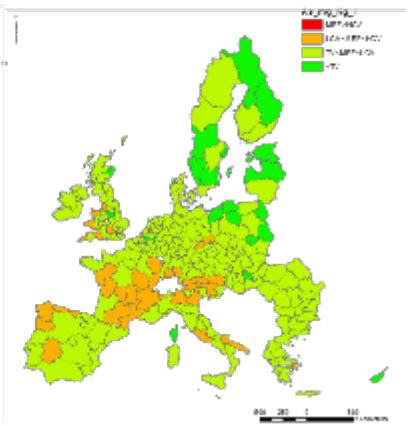
SOLACE project

Carcinogenic Factor (pCR)

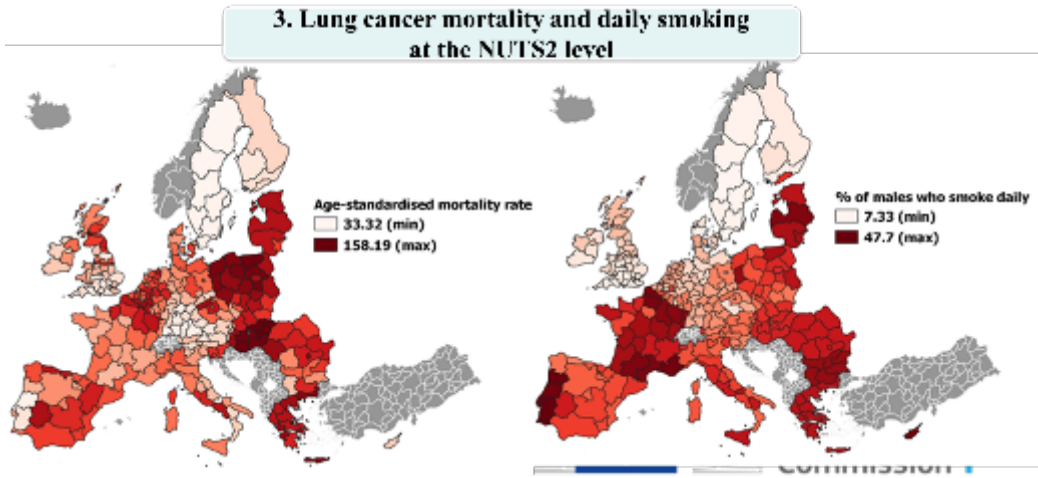


Non-Carcinogenic Factor (HI)

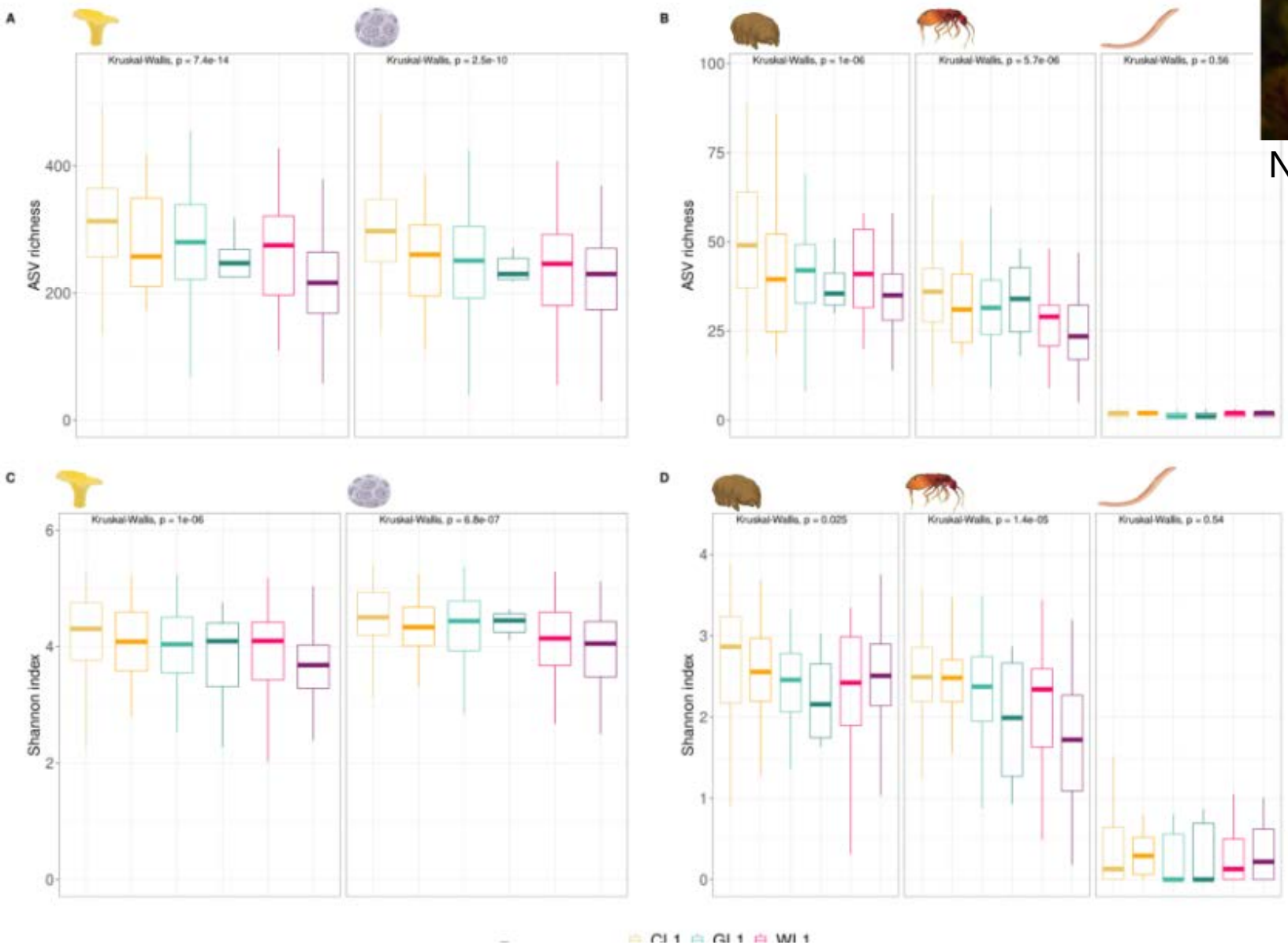
Risk Factor (MEF)



Exposure model



Soil biodiversity and land management



Nature Communications June 2023

Metagenomic barcoding

16S – Bacteria

16S Amplicon - Fungi

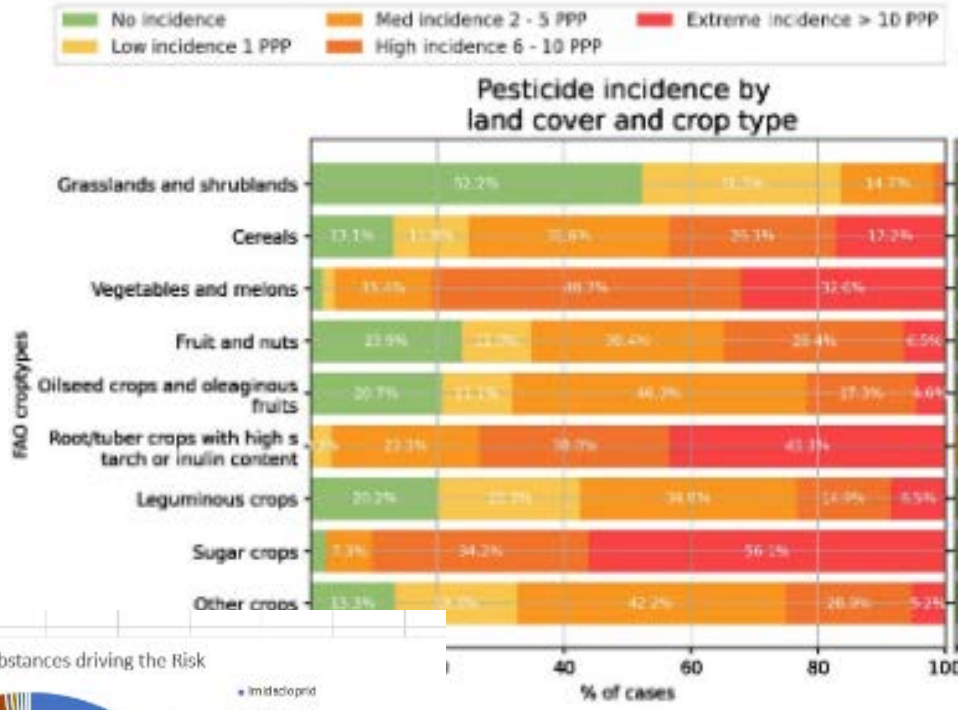
18S - Animals

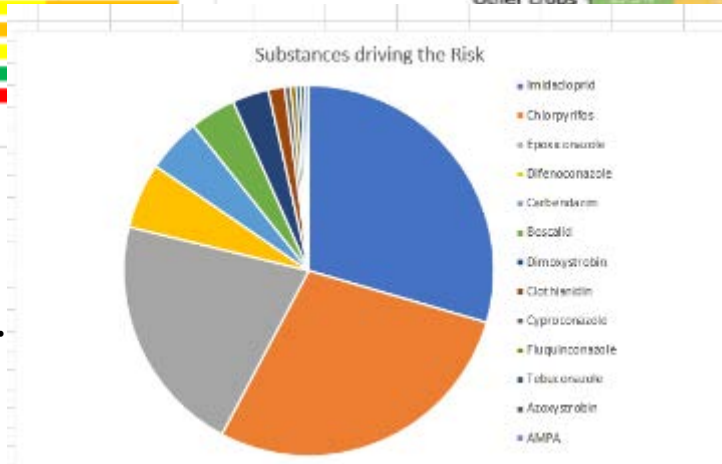
European Commission

Agro-ecosystem dynamics: Plant Protection Products

Figure 5 – Pesticide incidence (left panel) and content (right panel) distribution (%) for all soil samples (EU) and by Country. Note number of soil samples in parenthesis.

Source: Joint Research Centre.

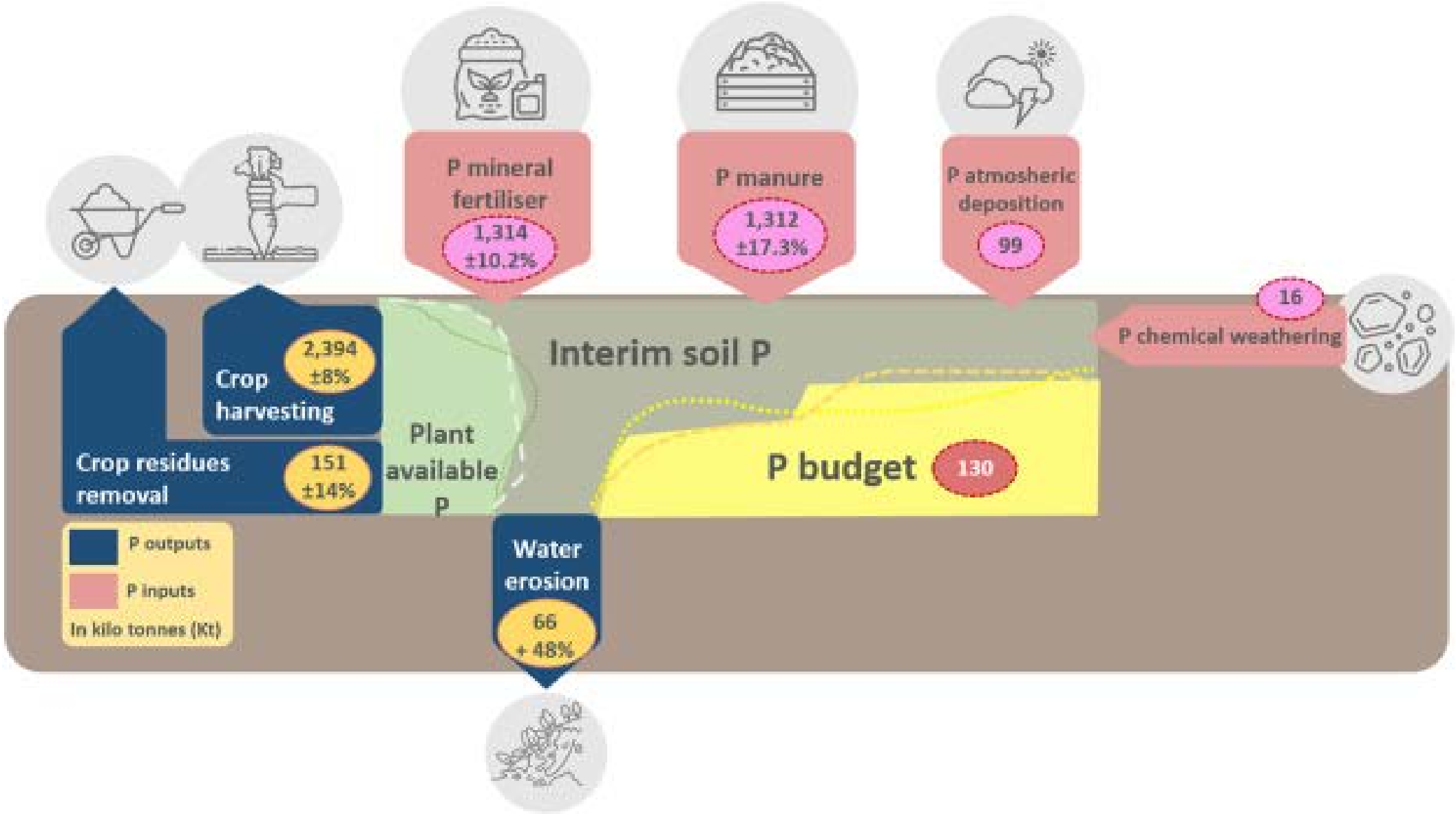




Study on risk assessment in press.

European Commission

Agro-ecosystem dynamics



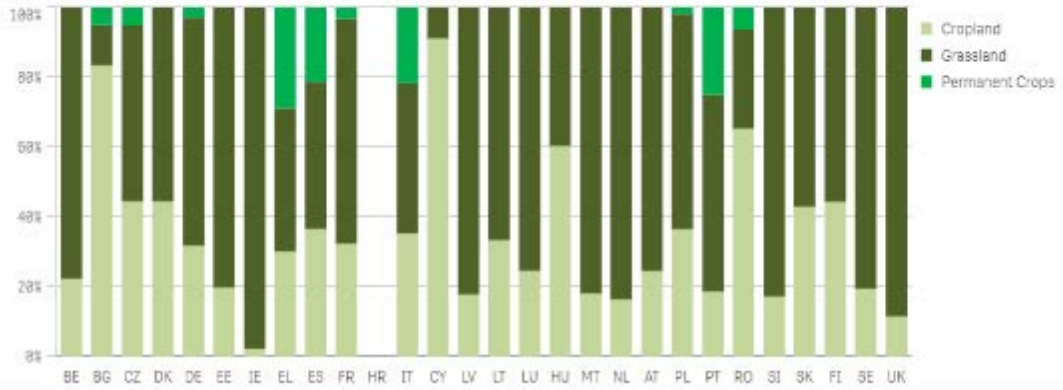
Soil carbon: state and dynamics

CONTEXT INDICATOR 41 : SOIL ORGANIC MATTER IN ARABLE LAND

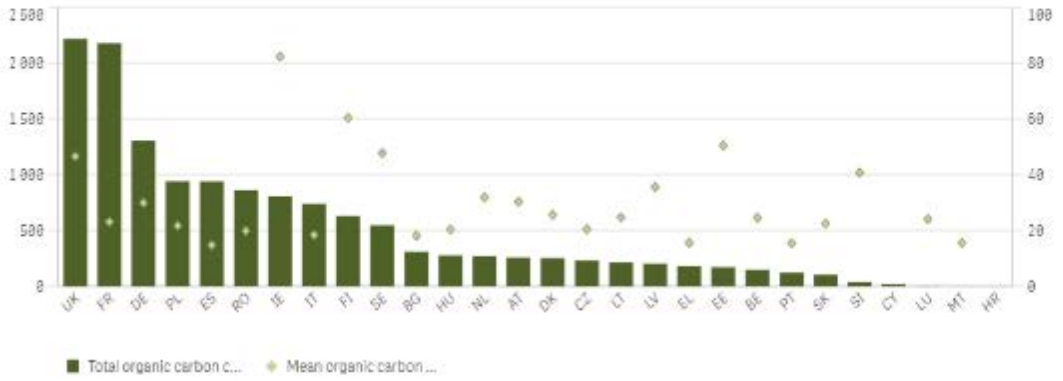
Tab1 | Map1 | Map2

Member State | Selections : Year: 2015 | Last data update : 2020

Estimate of organic carbon content in different category of arable land, 2015



Total estimates of organic carbon content in arable land, 2015



Total estimates of organic carbon content in arable land (Year - 2015)

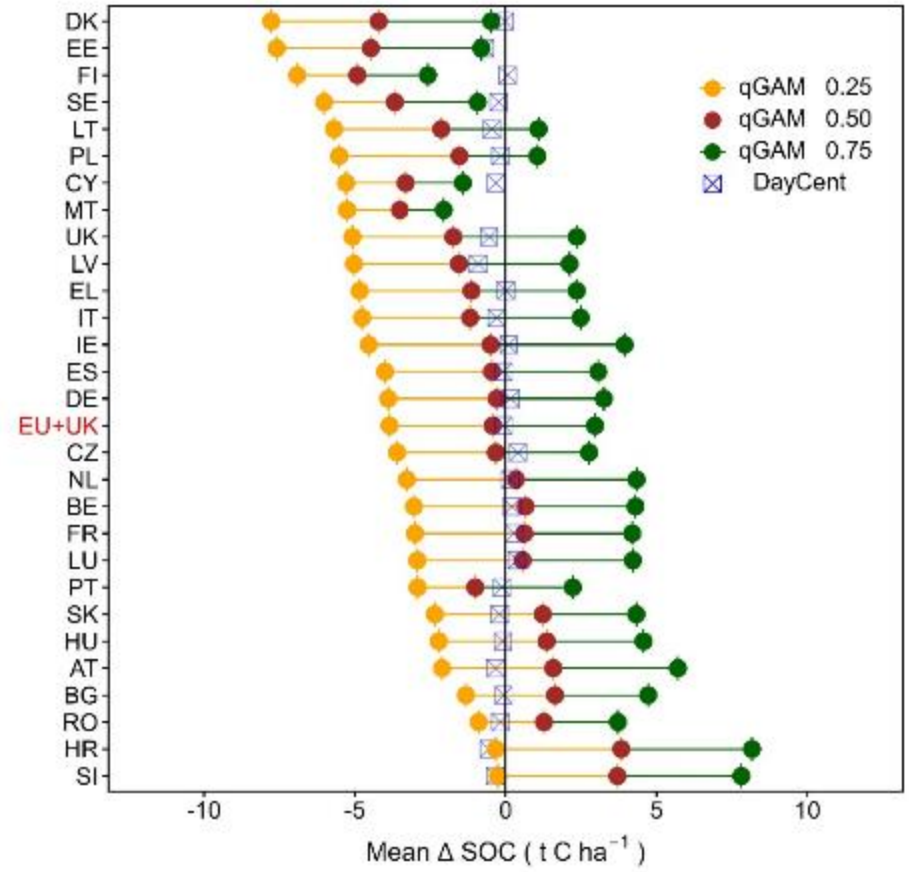
Member State	Total estimates of organic carbon content in arable land (Mega tons)	Mean organic carbon content (g kg-1)	Cropland (Mega tons)	Grassland (Mega tons)	Permanent crops (Mega tons)
Belgium	151.18	24.71	33.88	117.50	0.00
Bulgaria	312.43	18.31	260.69	36.05	15.69
Czechia	236.46	28.58	105.25	119.17	12.04
Denmark	258.02	25.77	114.73	143.29	0.00
Germany	1 305.99	30.09	415.52	851.70	38.77
Estonia	175.86	58.57	34.82	141.04	0.00
Ireland	887.01	82.41	17.93	769.09	0.00
Greece	182.66	15.77	84.96	75.01	82.71
Spain	944.01	14.91	345.70	398.24	200.07
France	2 178.89	23.23	703.65	1 406.02	69.22
Croatia	n.a	n.a	n.a	n.a	n.a
Italy	742.29	18.58	261.70	319.30	181.29
Cyprus	23.19	n.a	21.13	2.06	0.00
Latvia	207.78	35.73	37.14	170.64	0.00
Lithuania	215.73	24.89	71.94	143.79	0.00
Luxembourg	9.22	24.20	2.27	6.95	0.00
Hungary	280.04	20.52	168.91	111.13	0.00
Malta	0.70	15.70	0.13	0.57	0.00
Netherlands	273.85	32.03	44.78	229.07	0.00
Austria	263.15	30.43	64.53	198.62	0.00
Poland	945.44	21.88	345.10	582.53	17.81
Portugal	125.89	15.55	23.37	70.45	31.27
Romania	865.03	20.05	564.76	246.86	53.41
Slovenia	44.69	48.83	7.69	37.00	0.00
Slovakia	109.41	22.63	47.04	62.37	0.00
Finland	635.79	50.46	281.69	354.10	0.00

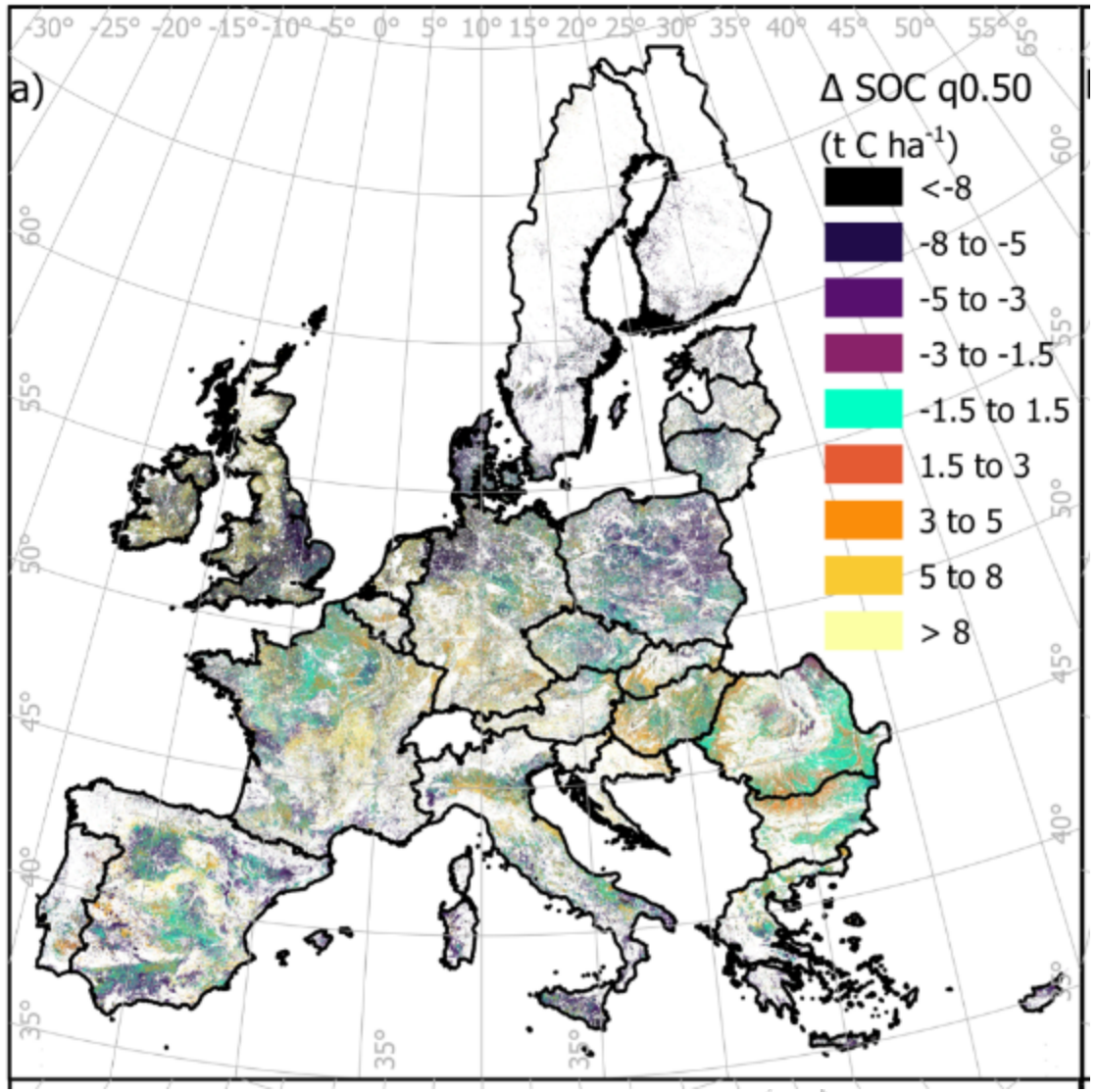
European Commission

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

-0.75% between 2009 and 2018

~ 70Mt C (0-0.2m depth)





European Commission

Land Use Change – Basic Scenarios

9 years
strategic scenarios of Land use Change

- Conversion of all Grassland to Cropland

$\Delta\ SOC$ up to **-4.8%** (~ 47 Mha)

- Conversion of all Cropland to Grassland

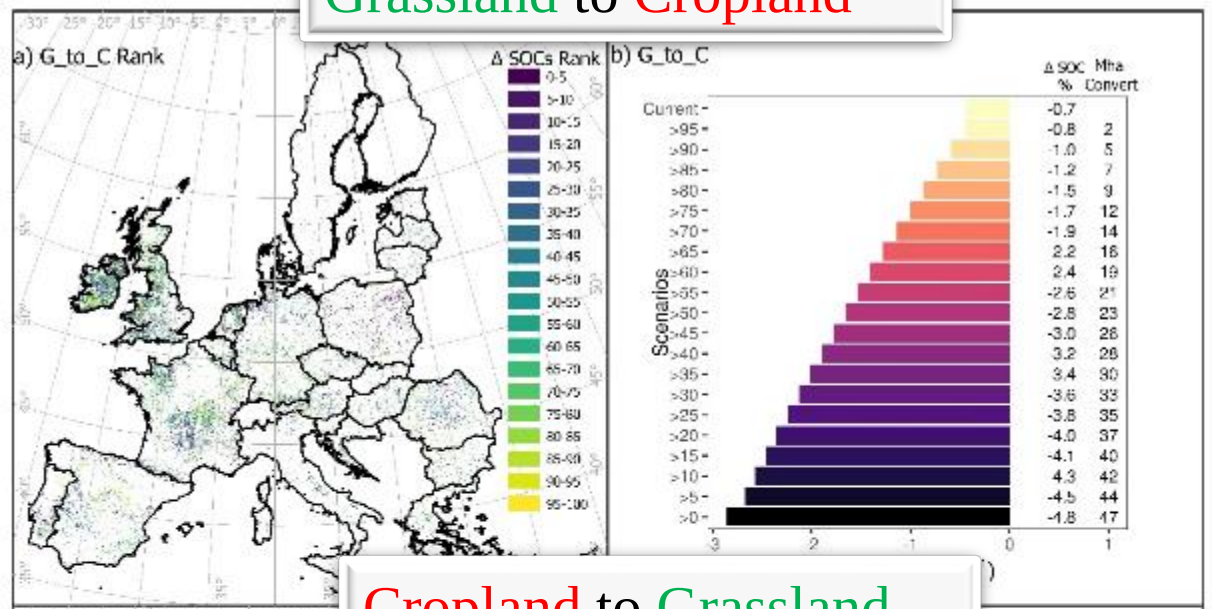
$\Delta\ SOC$ up to **+12.1%** (~ 116 Mha)

Conversion of the worst 7% performing Cropland to Grassland

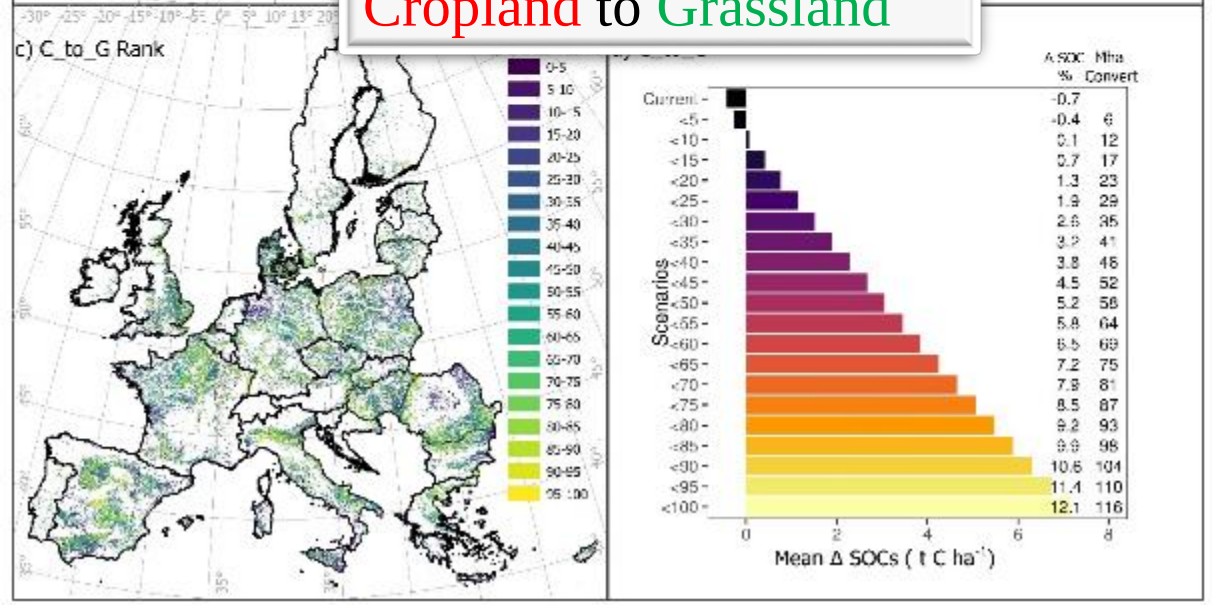
$\Delta\ SOC = 0$

NEUTRAL!

Grassland to Cropland



Cropland to Grassland

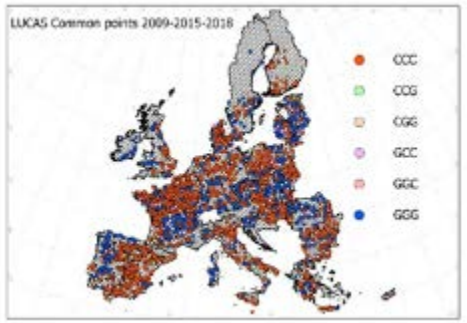


NEXT? Carbon Farming Baselines

Hybrid Approach

POINT DATASET

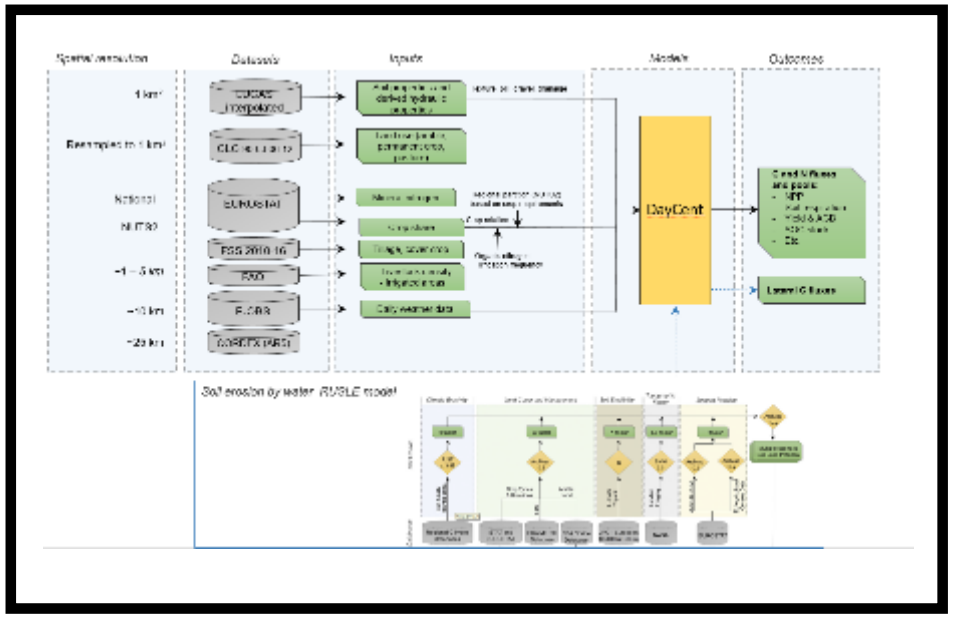
LUCAS



SPATIAL PREDICTIONS CONFIDENCE ↑

Bringing together the

JRC biogeochemical modelling *large-scale* framework



TEMPORAL PREDICTION CONFIDENCE ↑

European Commission

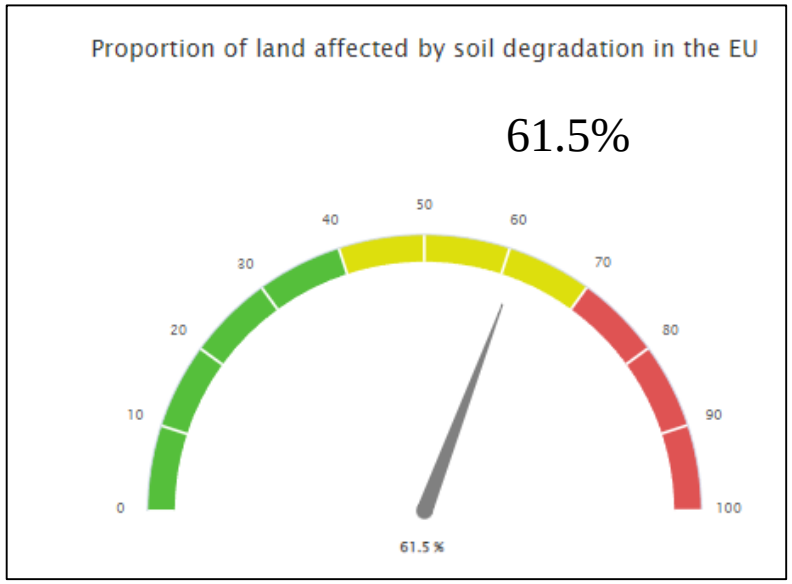
EUSO Soil Dashboard

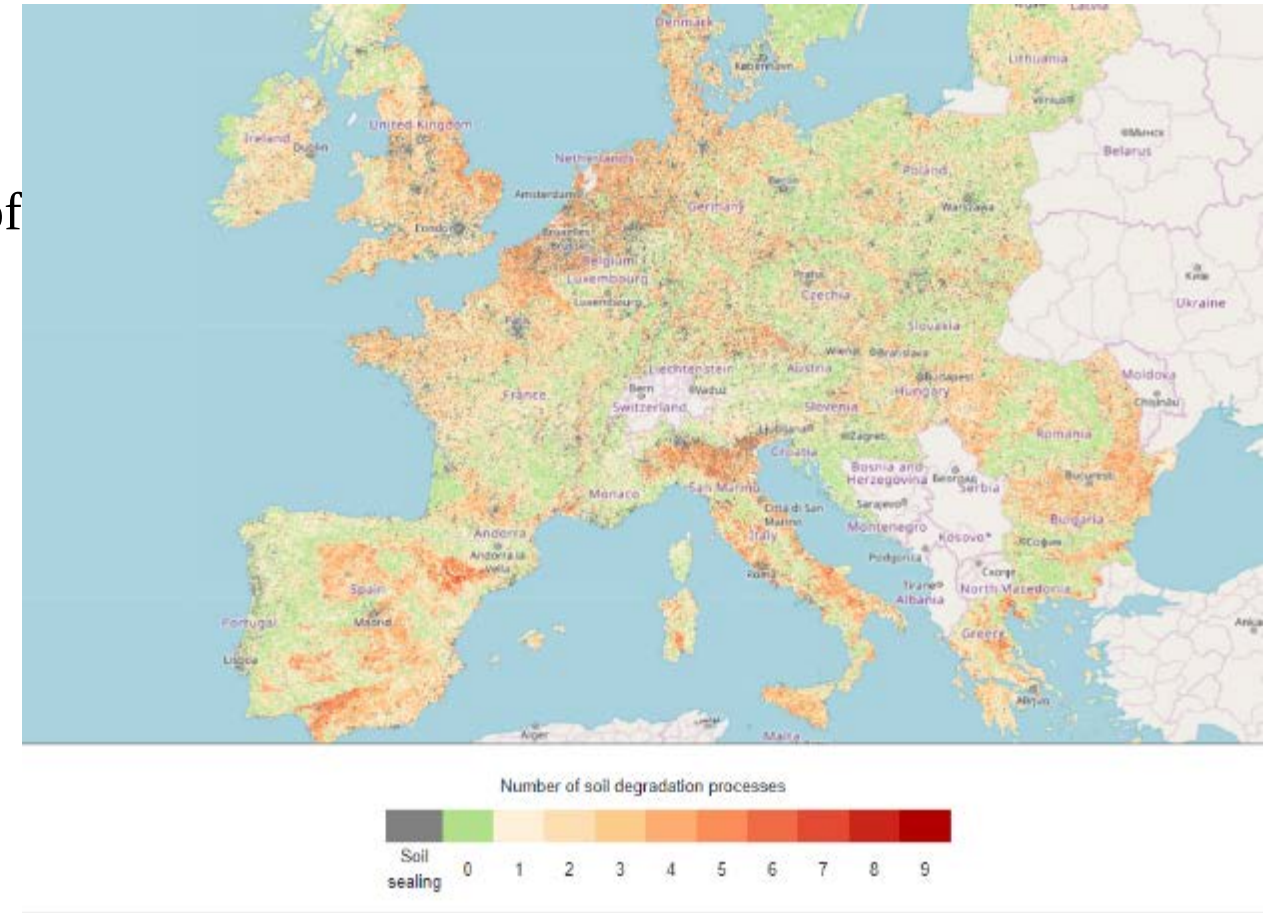
Convergence of scientific evidence

- 61.5 % of unhealthy soils

- Dashboard shows location and different types of soil degradation in the EU

→ Launch: **March 13th 2023**





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

European Commission

Thanks for your attention

Any questions?

arwyn.jones@ec.europa.eu for any issue

European Commission