Soil threats in Europe: Status, methods, drivers and effects on ecosystem services

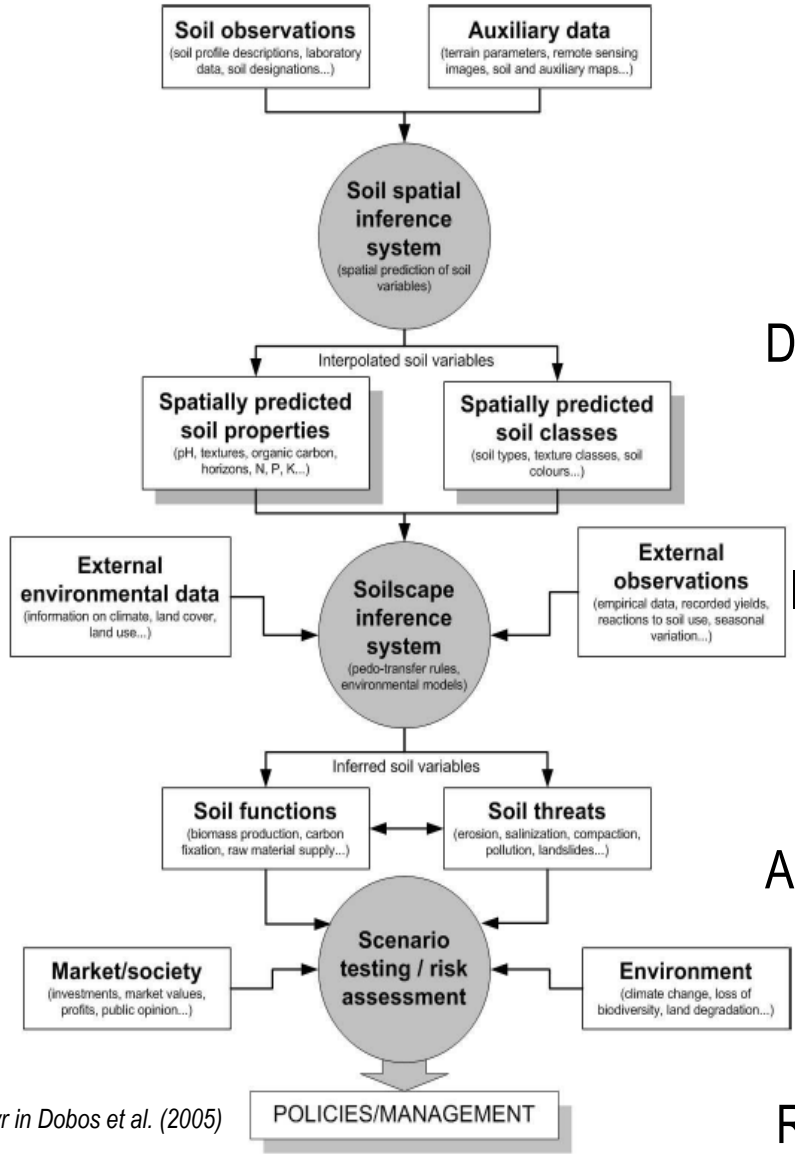
Luca Montanarella

Senior Expert

European Commission - JRC, Land Resource Unit, Ispra (VA), Italy
(luca.montanarella@ec.europa.eu)

From raw data to policy relevant information

European Commission



After Mayr in Dobos et al. (2005)

Raw data

Derived data

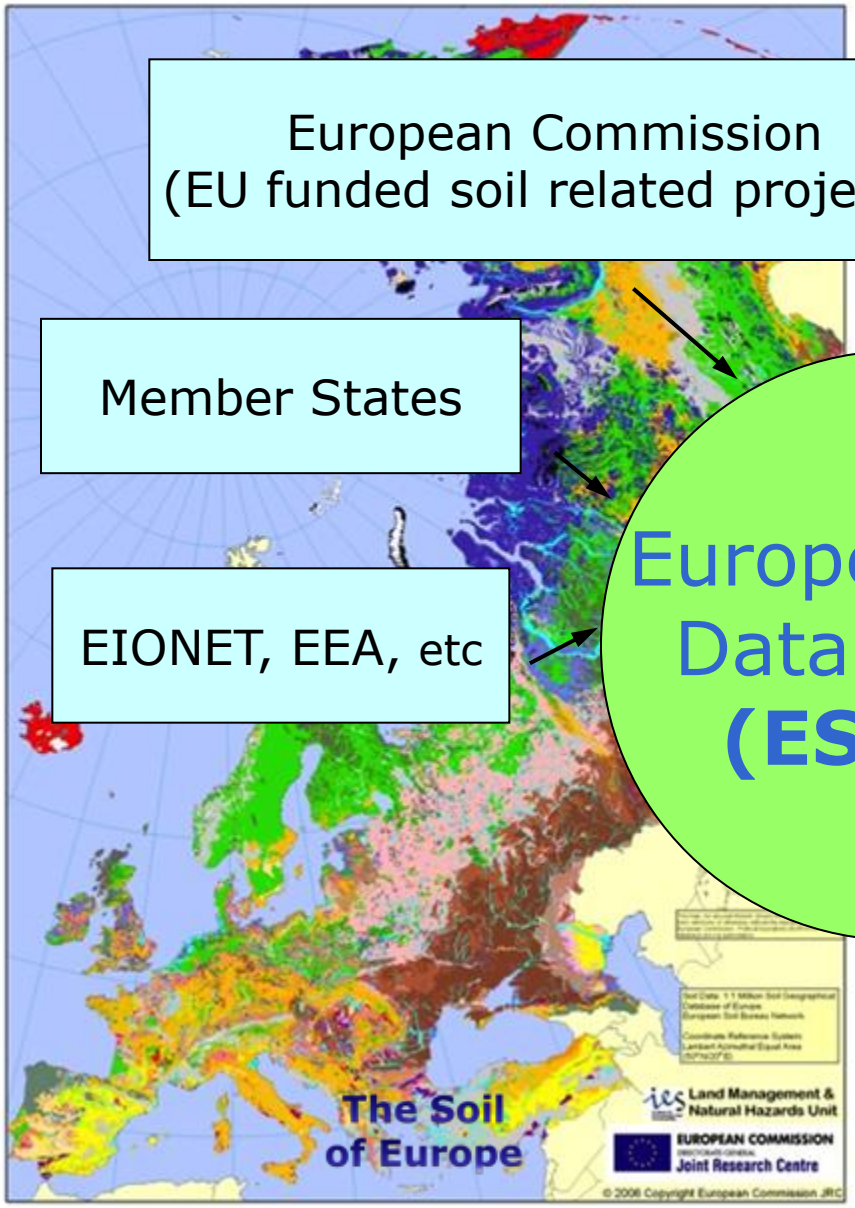
Information

Assessment

Reporting

http://esdac.jrc.ec.europa.eu

European Commission



European Commission
(EU funded soil related projects)

Member States

EIONET, EEA, etc

European Soil Data Centre **(ESDAC)**

Data from specific in-house JRC actions (e.g. ESDB, SOTER)

Data from related JRC and EC actions (e.g. LUCAS, BIOSOIL)

Network of soil centres (e.g. ESBN)

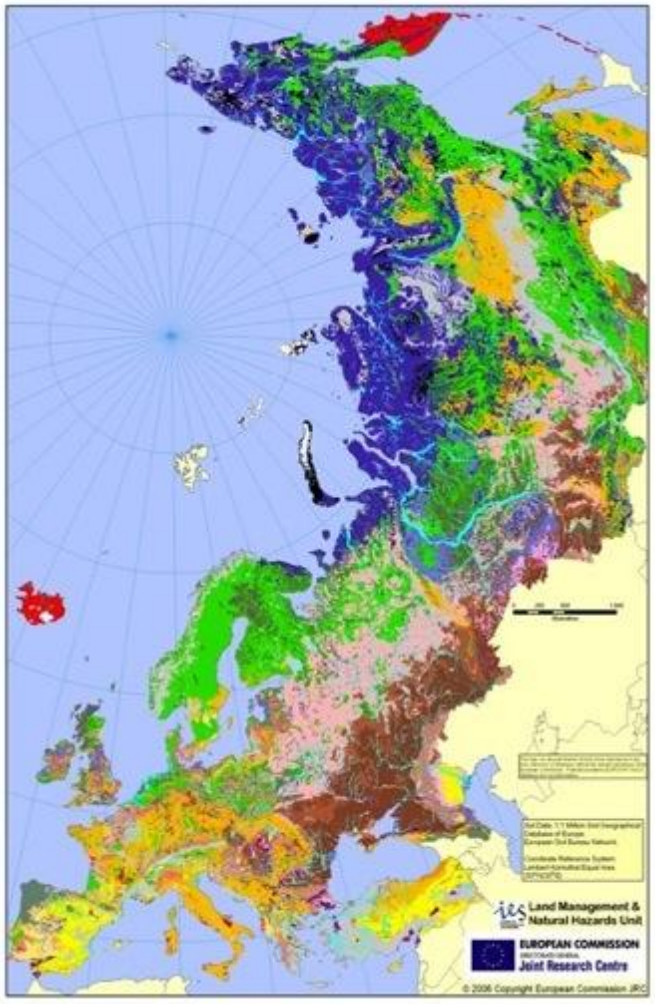
Collaborative research (e.g. EuroGeoSurveys, FAO, ISRIC)

Joint Research Centre

European Soil Information System

European Commission

The Soils of Eurasia



Main source from which most DATA, INFORMATION, DOCUMENTS and SERVICES are derived 1:1.000.000

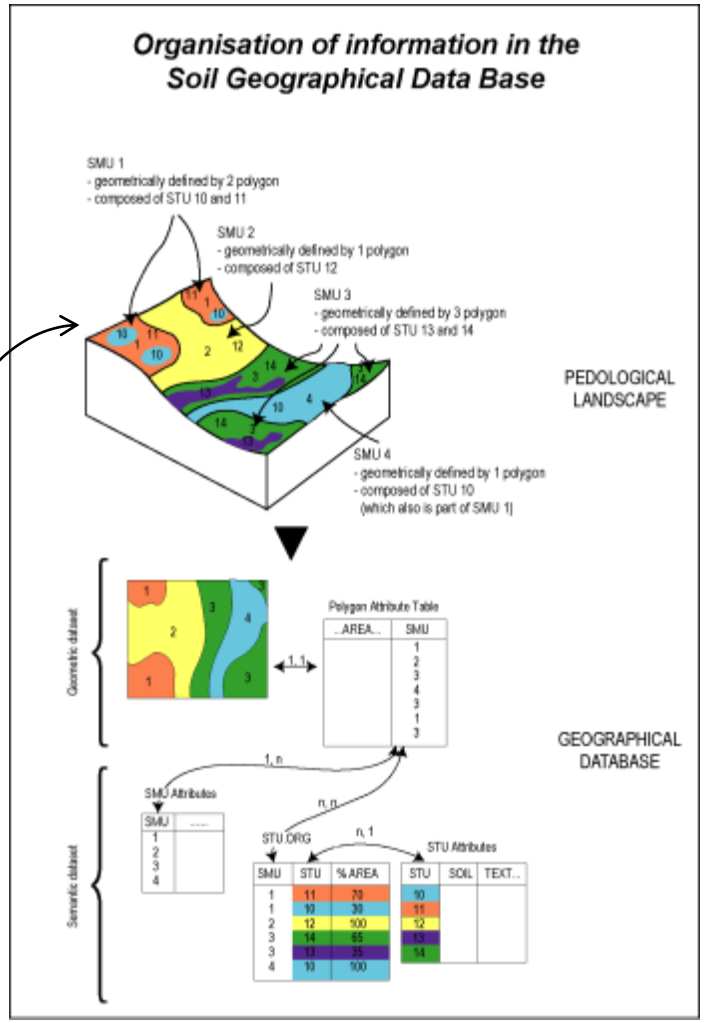
Vector (geometric) dataset:

> 50.000 polygons

9 ha minimum area

> 2.000.000 vertices (x,y)

73 parameters



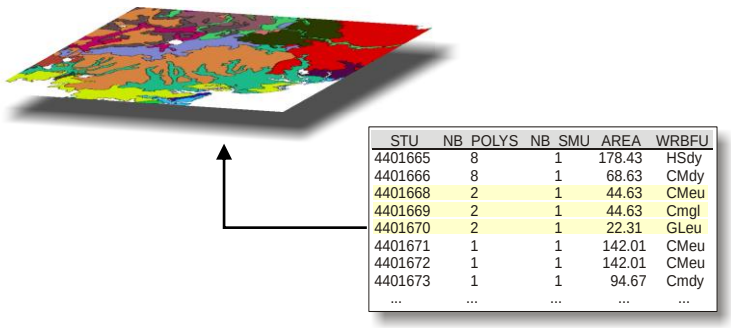
Joint Research Centre

Full database documentation is available in the Soil Portal
http://esdac.jrc.ec.europa.eu

Mapping vs. Monitoring

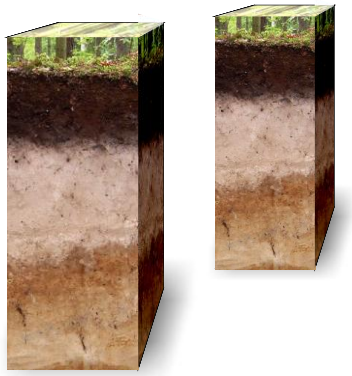
- **Mapping**
  symbolically represent the geographic distribution of an object on the Earth surface.

- **Monitoring**
  sample information on an object systematically and on a regular basis.



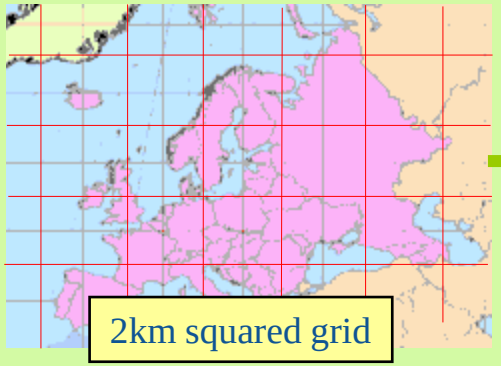
STU	NB_POLYS	NB_SMU	AREA	WRBFU
4401665	8	1	178.43	HSdy
4401666	8	1	68.63	CMdy
4401668	2	1	44.63	CMeu
4401669	2	1	44.63	Cmgl
4401670	2	1	22.31	GLeu
4401671	1	1	142.01	CMeu
4401672	1	1	142.01	CMeu
4401673	1	1	94.67	Cmdy
...	...	...	...	...

GIS Layer and Attribute



Field Survey

LUCAS: EUROPEAN LAND USE / COVER AREA FRAME STATISTICAL SURVEY



2km squared grid

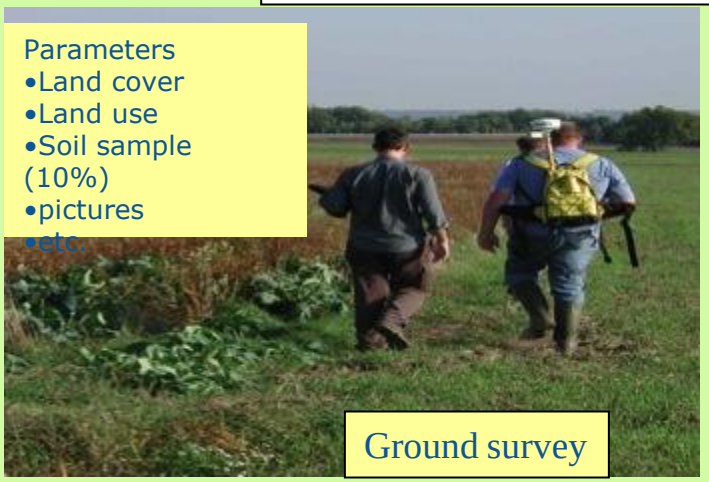
1 100 000 points

LAND COVER classes

1 ARABLE LAND
2 PERMANENT CROPS
3 GRASSLAND
4 WOODED AREAS AND SHRUBLAND
5 BARE LAND, RARE VEGET.
6 ARTIFICIAL LAND
7 WATER

Second phase sample: in-situ data collection

Parameters
- Land cover
- Land use
- Soil sample (10%)
- pictures
- etc.

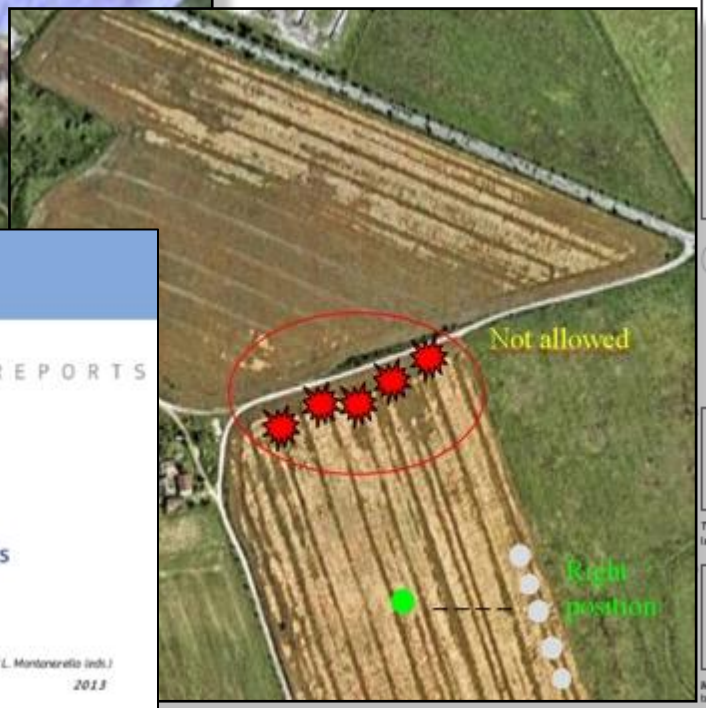


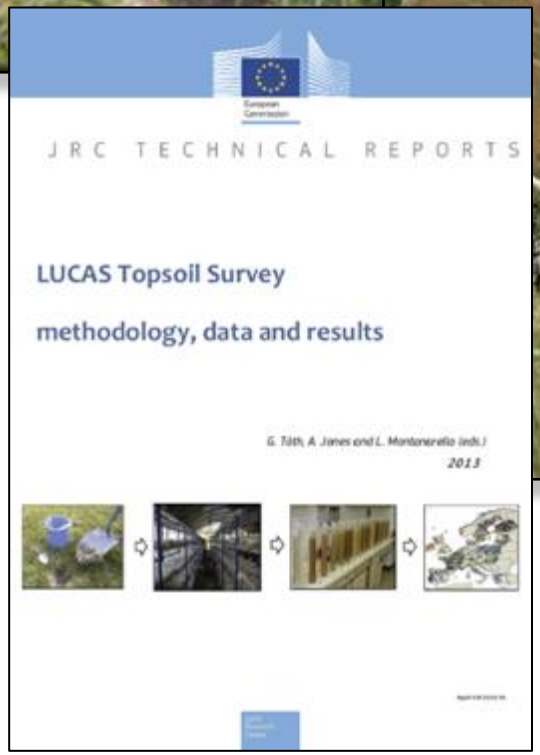
Ground survey

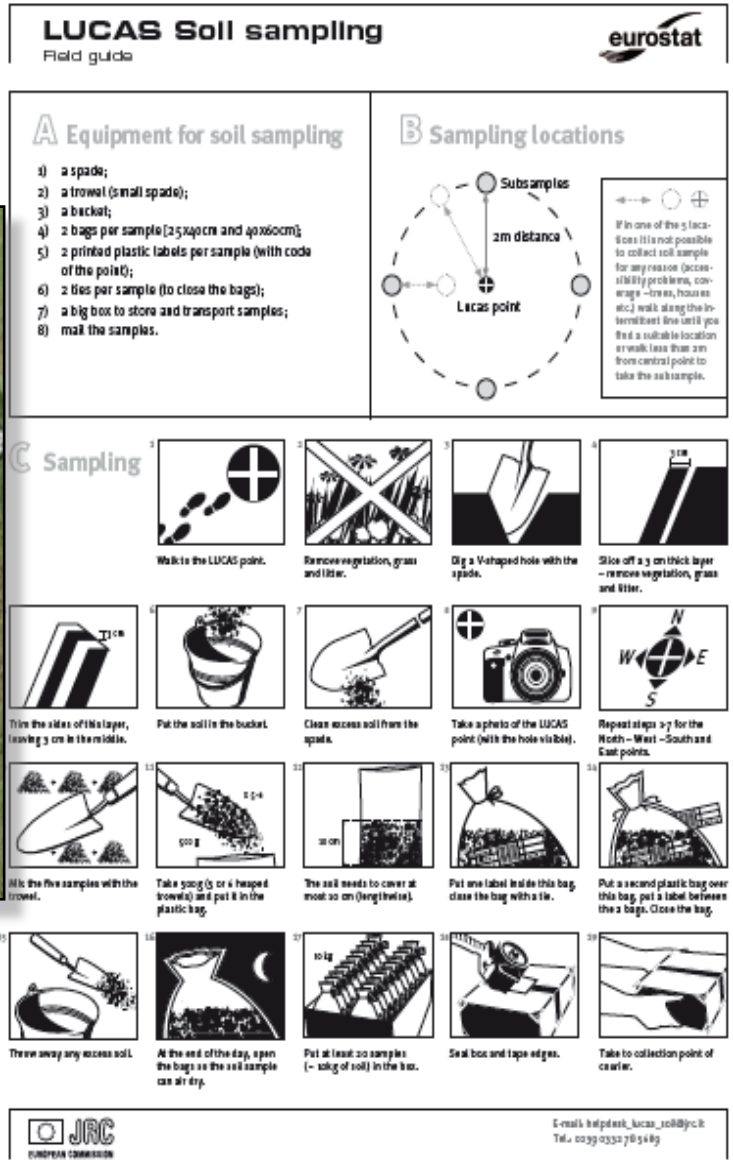
Sample of around 260,000 pts

LUCAS SOIL: TRAINING, SUPPORT MATERIAL, DATA AND RESULTS

European Commission

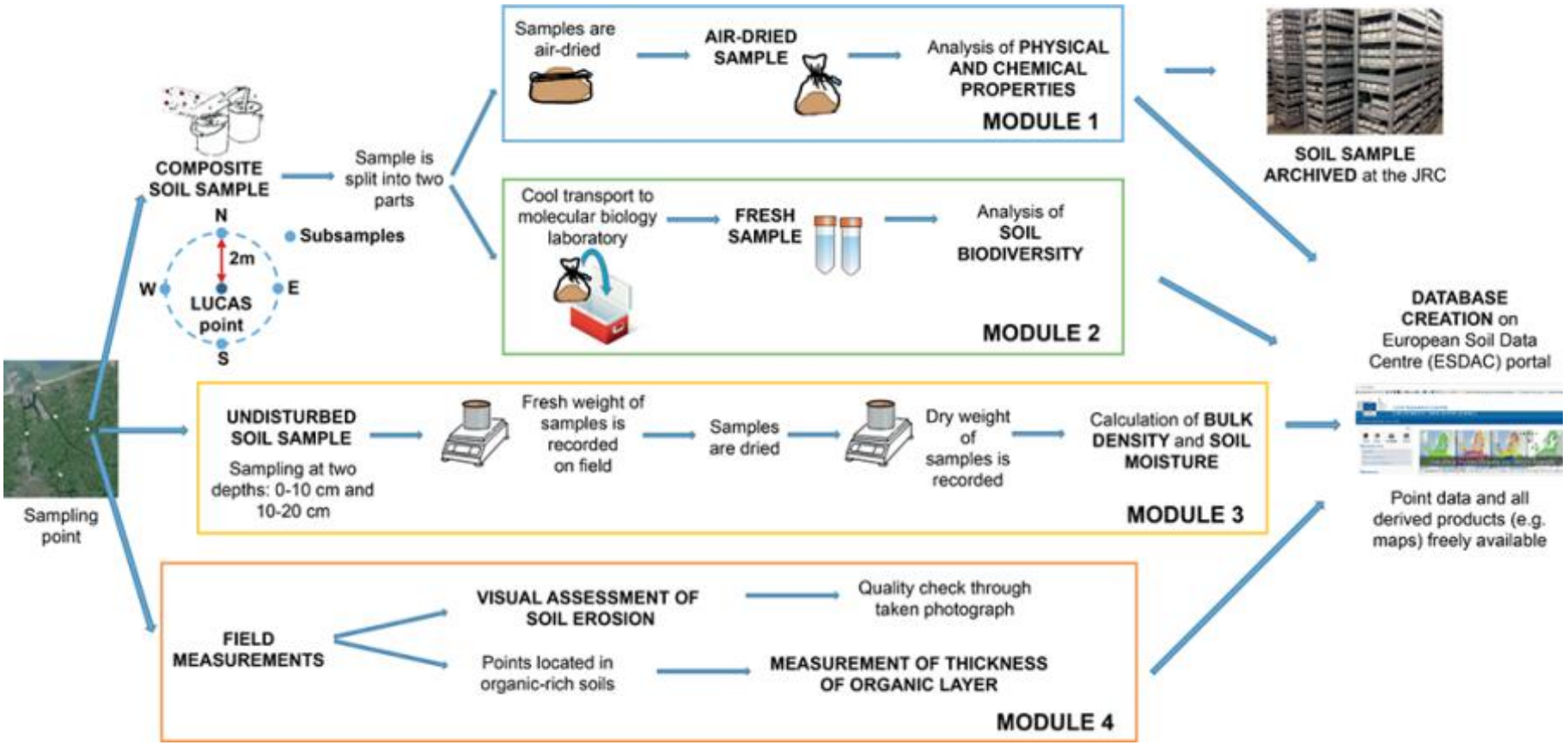




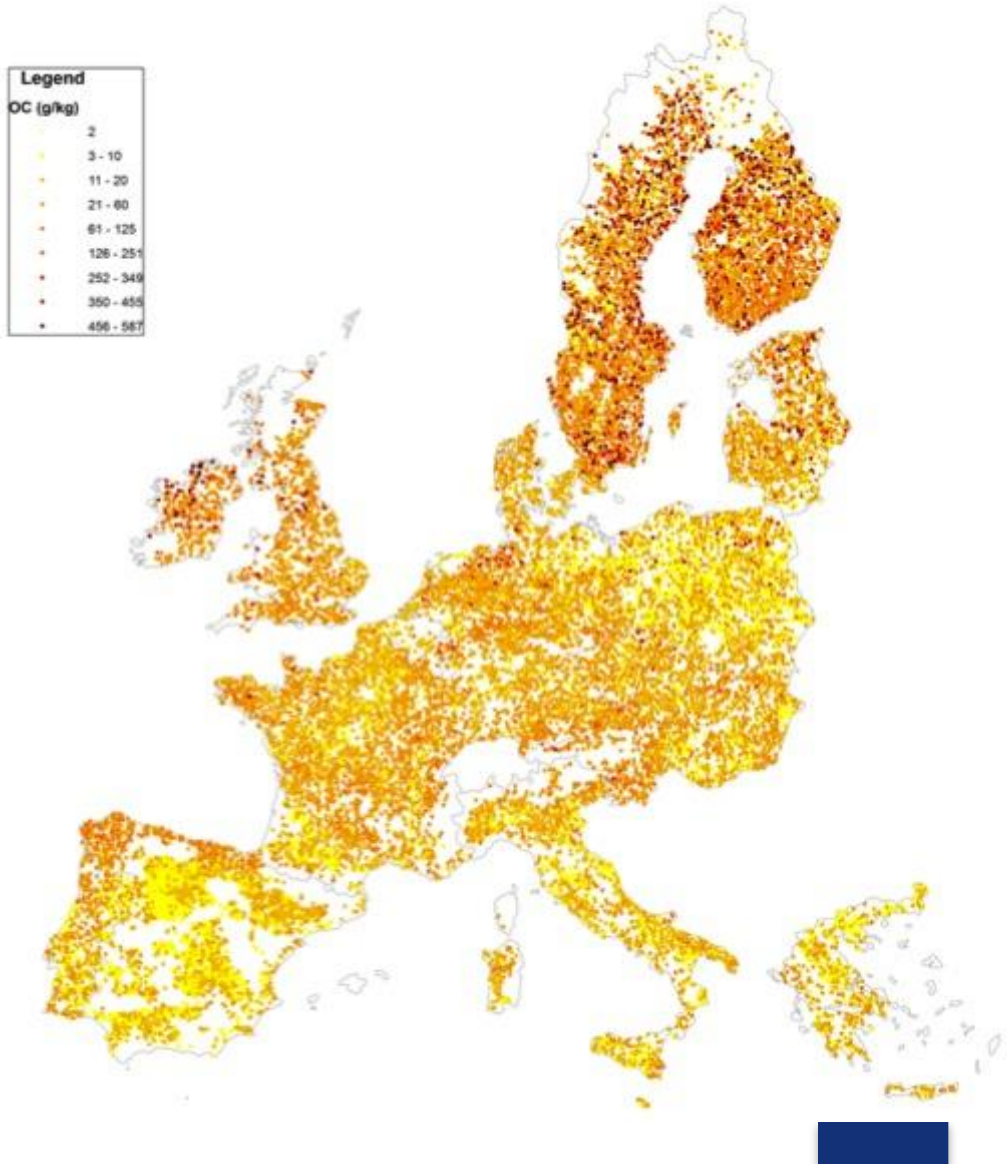


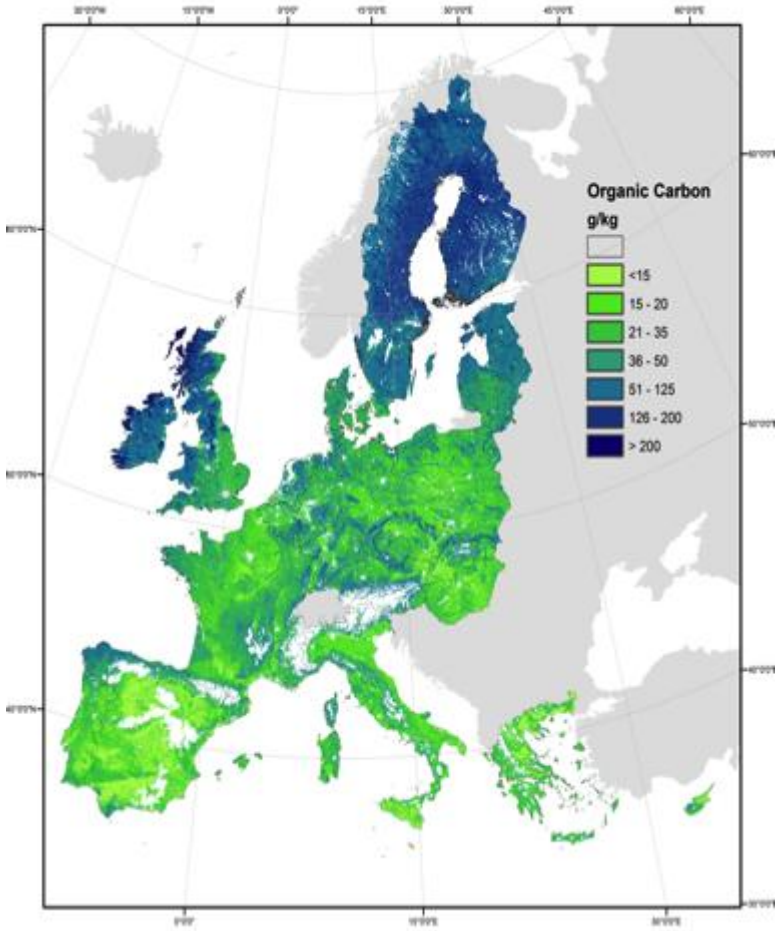
European Commission

LUCAS Soil, the largest expandable soil dataset for Europe: a review



European Journal of Soil Science
23 NOV 2017 DOI: 10.1111/ejss.12499
http://onlinelibrary.wiley.com/doi/10.1111/ejss.12499/full#ejss12499-fig-0002

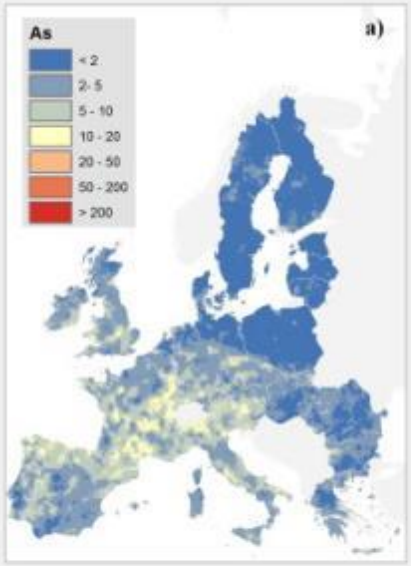


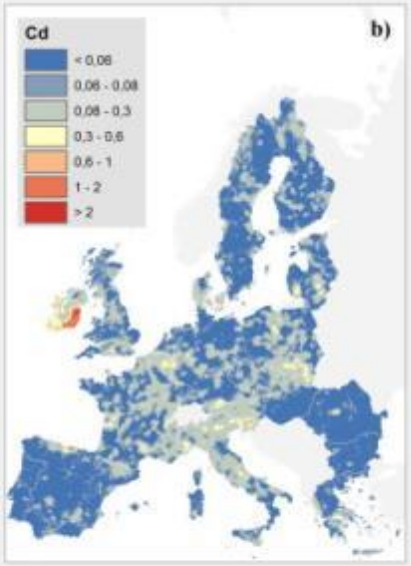


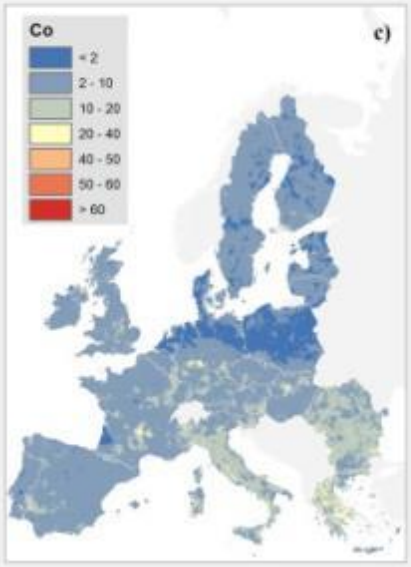
Distribution of 19,879 LUCAS land areas/points and their level of organic carbon (OC) content in the topsoil layer (0-30 cm).

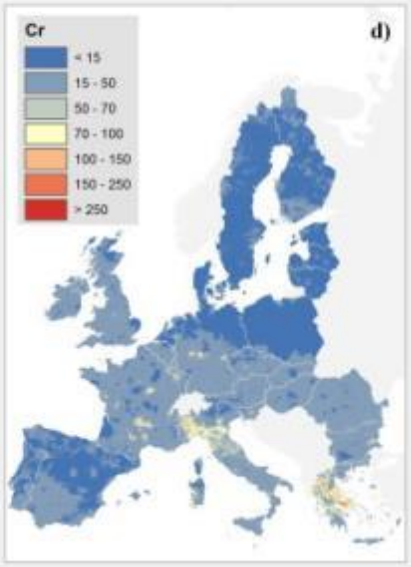
Heavy Metals in EU 27 Soils Data from LUCAS 2009 survey

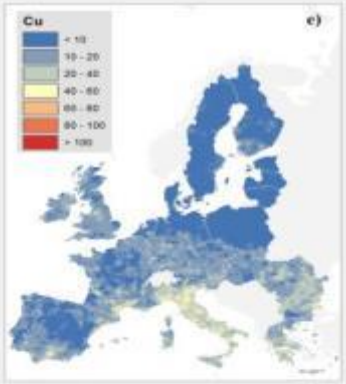
European Commission

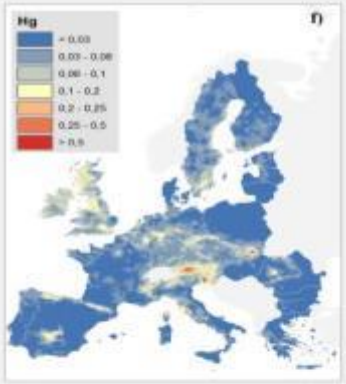


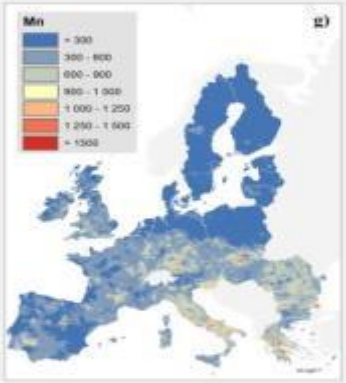


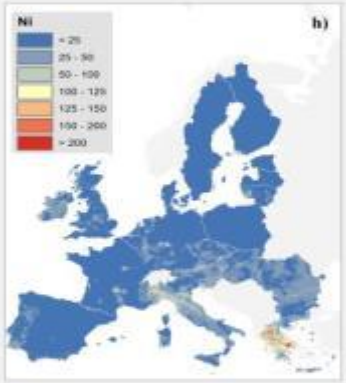


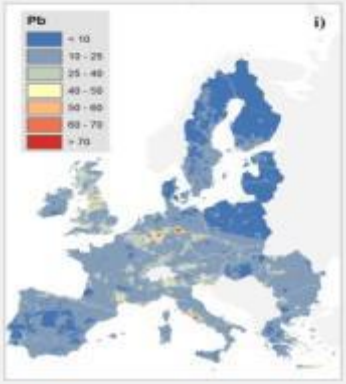


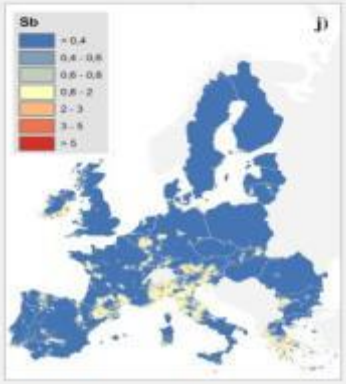




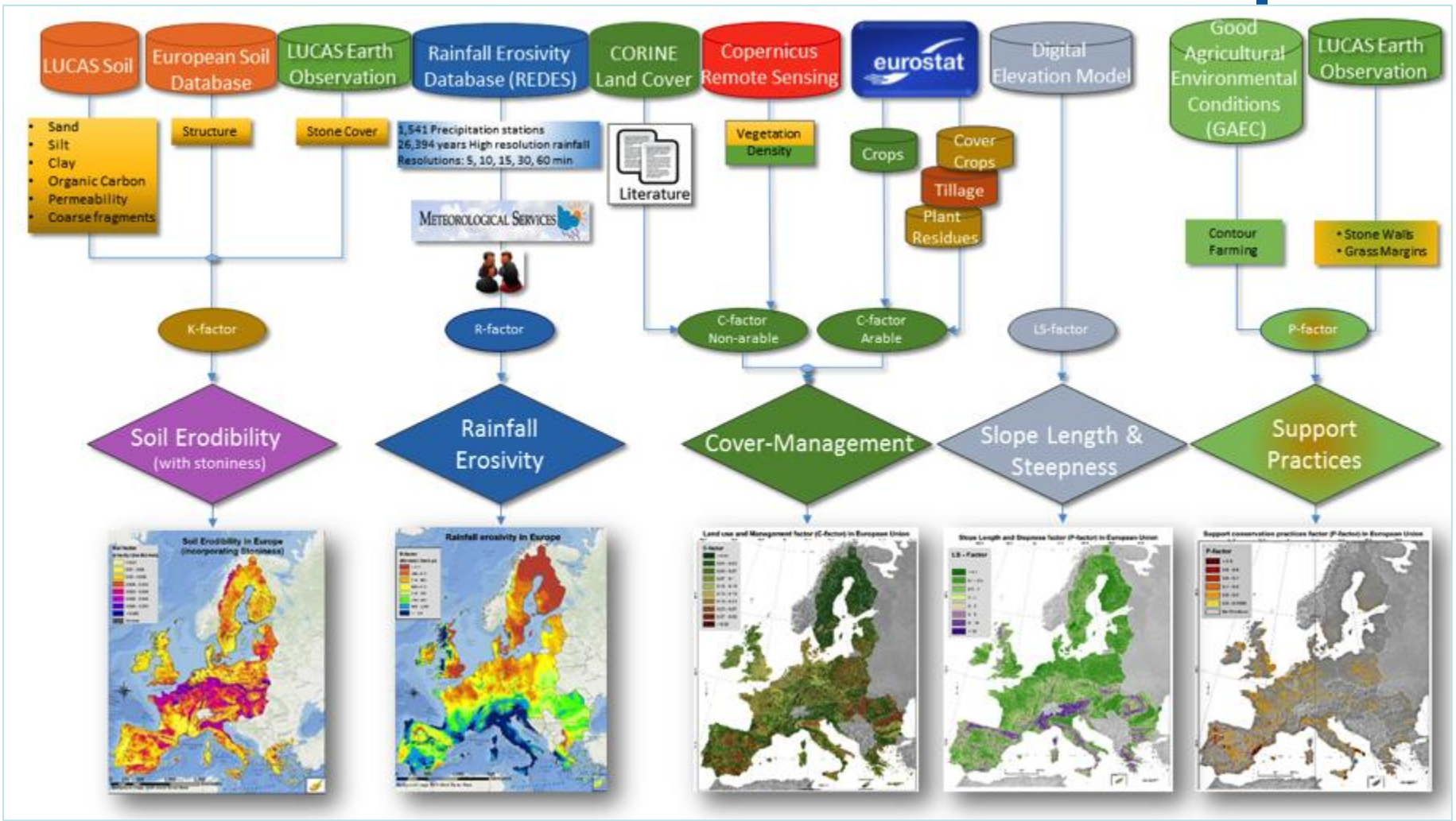




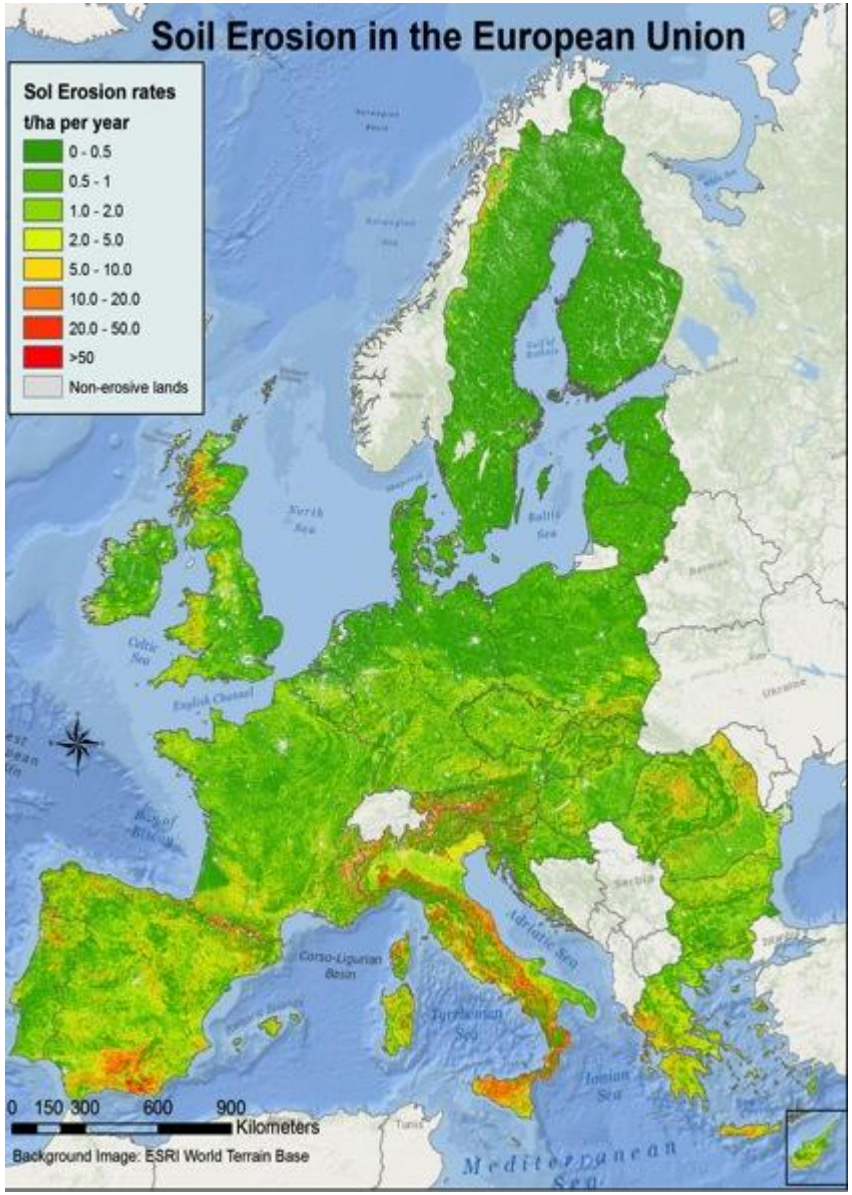


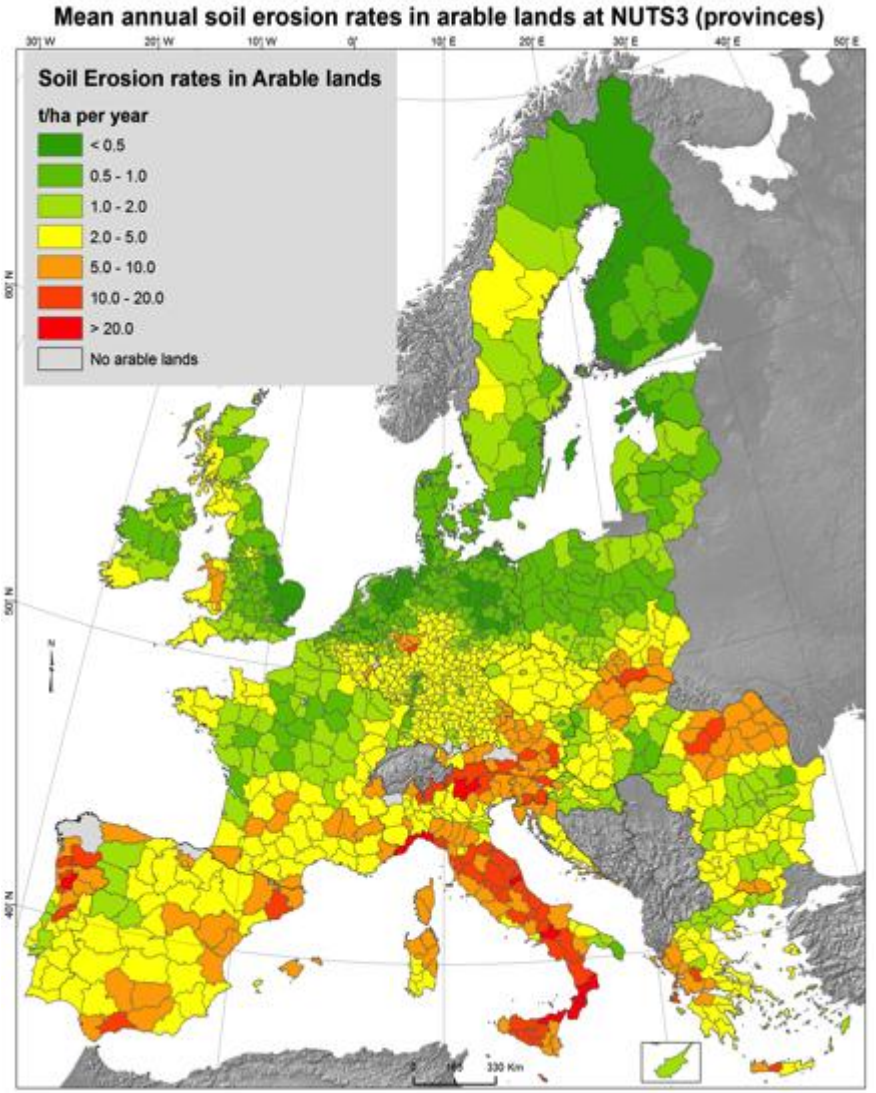


Soil erosion assessment in Europe



European Commission





Combining LUCAS Soil point observations with erosion estimates

Contents lists available at ScienceDirect

Science of the Total Environment

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

Distribution of glyphosate and aminomethylphosphonic acid (AMPA) in agricultural topsoils of the European Union

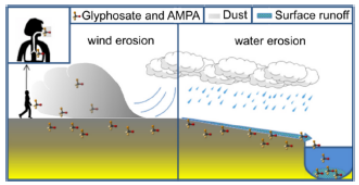
Vera Silva [a,*], Luca Montanarella [b], Arwyn Jones [b], Oihane Fernández-Ugalde [b], Hans G.J. Mol [c], Coen J. Ritsema [a], Violette Geissen [a]

[a] Soil Physics and Land Management Group, Wageningen University & Research, Droevendaalsesteeg 4, 6708 PB Wageningen, The Netherlands
[b] European Commission, Joint Research Centre (JRC), Directorate for Sustainable Resources, Land Resources Unit, Via E. Fermi 2749, I-21027 Ispra, VA, Italy
[c] RIKILT – Wageningen University & Research, P.O. Box 230, 6700 AE Wageningen, The Netherlands

HIGHLIGHTS

- Data on occurrence and levels of glyphosate residues in EU soils is very limited.
- Glyphosate and its metabolite AMPA were tested in 317 EU agricultural topsoils.
- 21% of the tested EU topsoils contained glyphosate, and 42% contained AMPA.
- Both glyphosate and AMPA had a maximum concentration in soil of 2 mg kg^{-1}.
- Some contaminated soils are in areas highly susceptible to water and wind erosion.

GRAPHICAL ABSTRACT



ARTICLE INFO

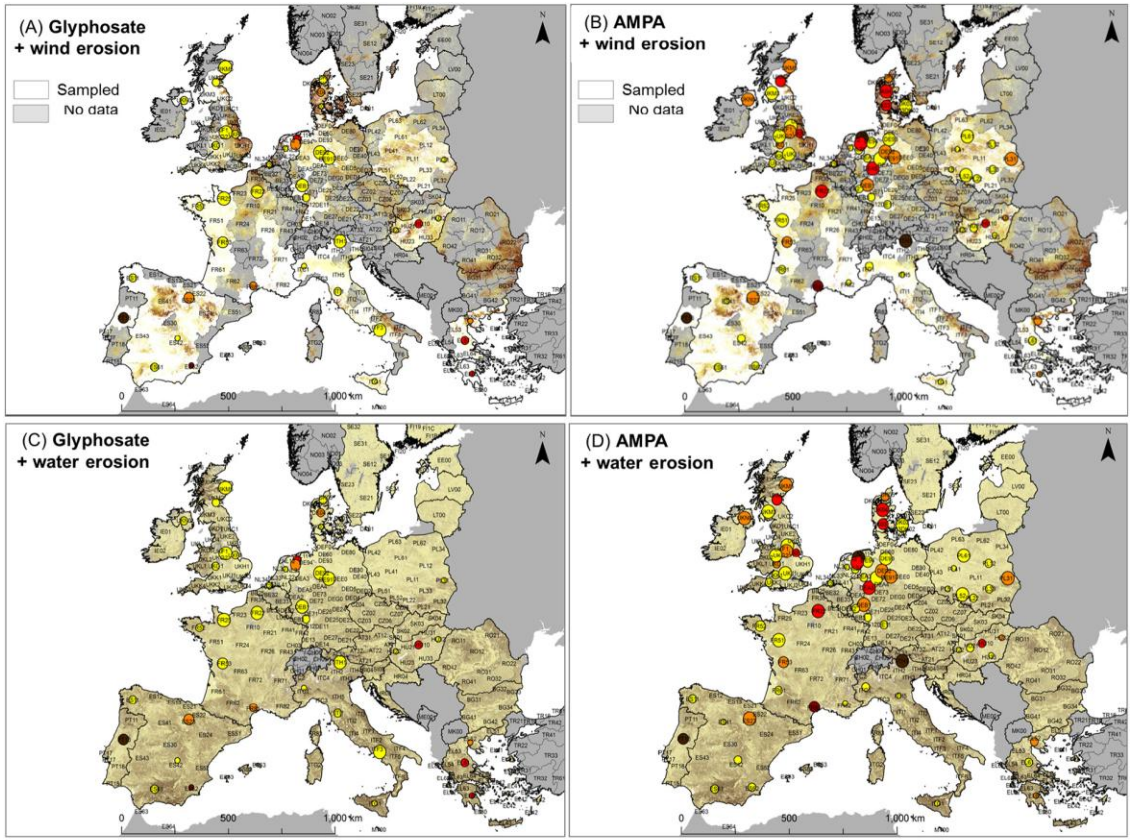
Article history:
Received 10 August 2017
Received in revised form 5 October 2017
Accepted 10 October 2017
Available online xxxx

Editor: J Jay Gan

Keywords:
Agricultural soils
European Union
Glyphosate
AMPA
Environmental exposure

ABSTRACT

Approval for glyphosate-based herbicides in the European Union (EU) is under intense debate due to concern about their effects on the environment and human health. The occurrence of glyphosate residues in European water bodies is rather well documented whereas only few, fragmented and outdated information is available for European soils. We provide the first large-scale assessment of distribution (occurrence and concentrations) of glyphosate and its main metabolite aminomethylphosphonic acid (AMPA) in EU agricultural topsoils, and estimate their potential spreading by wind and water erosion. Glyphosate and/or AMPA were present in 45% of the topsoils collected, originating from eleven countries and six crop systems, with a maximum concentration of 2 mg kg^{-1}. Several glyphosate and AMPA hotspots were identified across the EU. Soil loss rates (obtained from recently derived European maps) were used to estimate the potential export of glyphosate and AMPA by wind and water erosion. The estimated exports, result of a conceptually simple model, clearly indicate that particulate transport can contribute to human and environmental exposure to herbicide residues. Residue threshold values in soils are urgently needed to define potential risks for soil health and off site effects related to export by wind and water erosion.

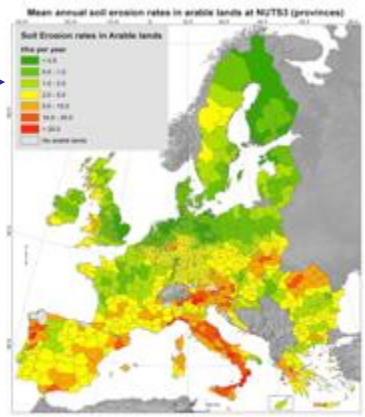


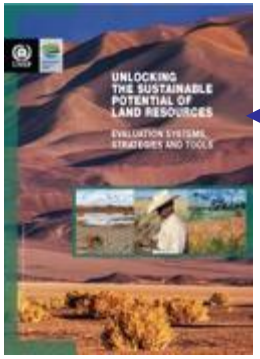
Soil erosion indicators & policy support

European Commission

European Parliament - Greens

ESTAT: Agro-Environmental





UNEP

DG AGRI

ENV-ESTAT: EUROPE 2020

EEA

ESTAT: Regional stats

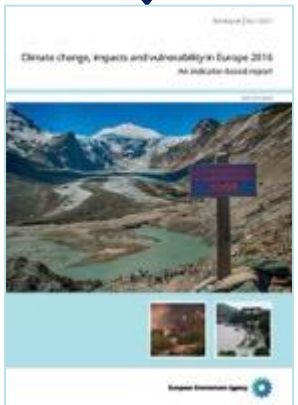
OECD

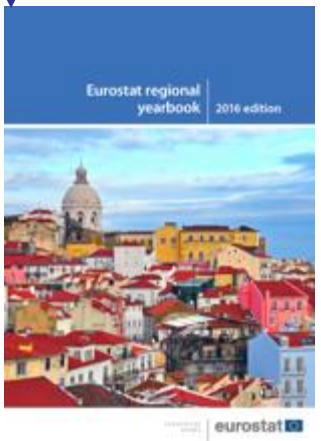
ipbes

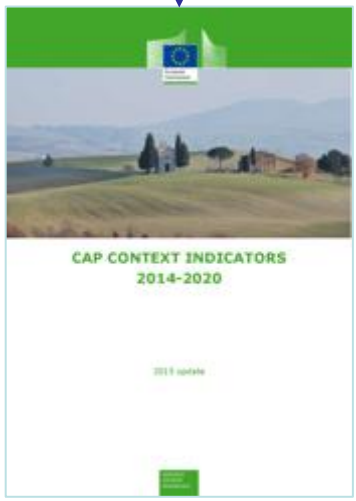
GLOBAL SOIL PARTNERSHIP

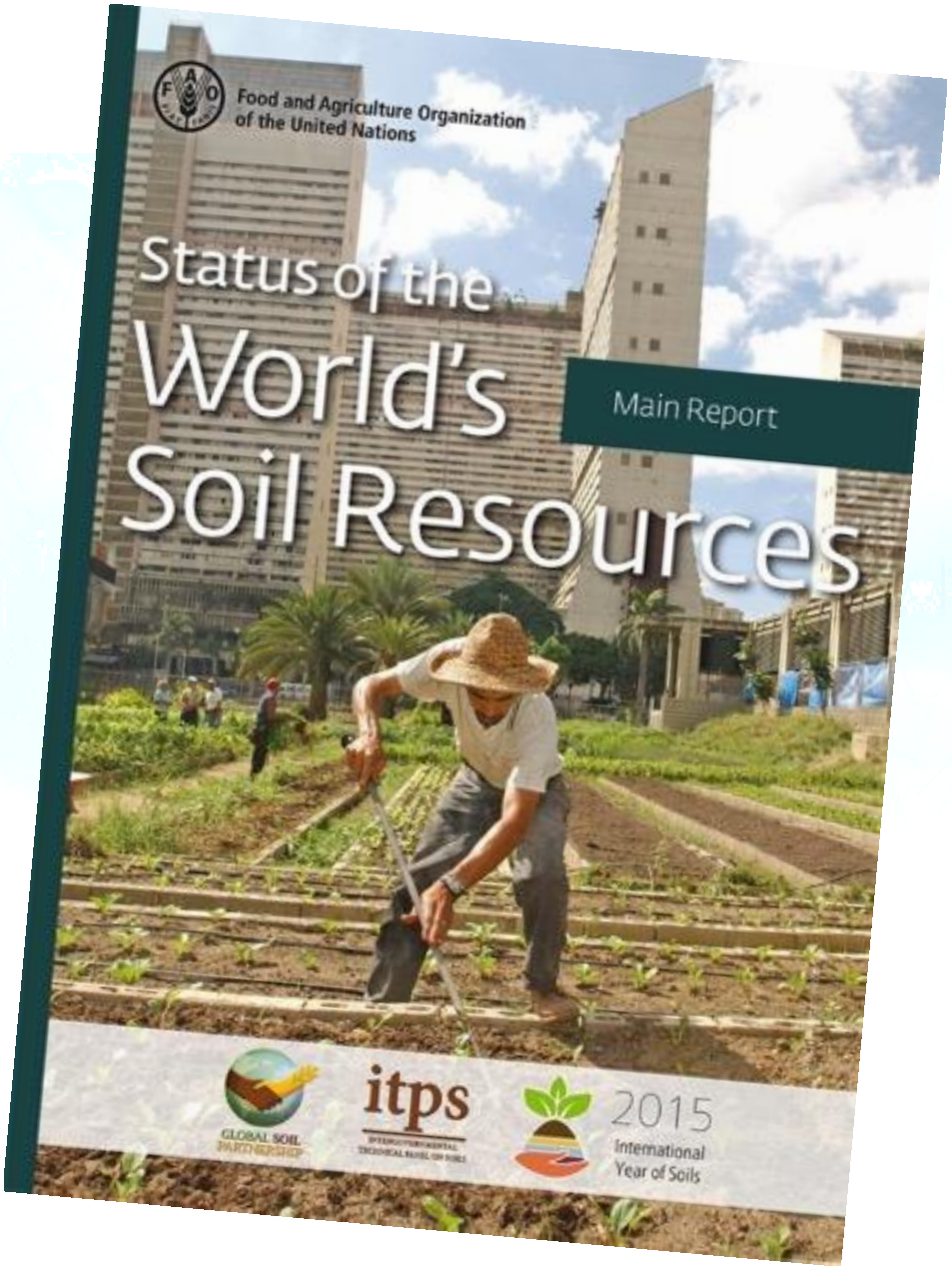
UNCCD

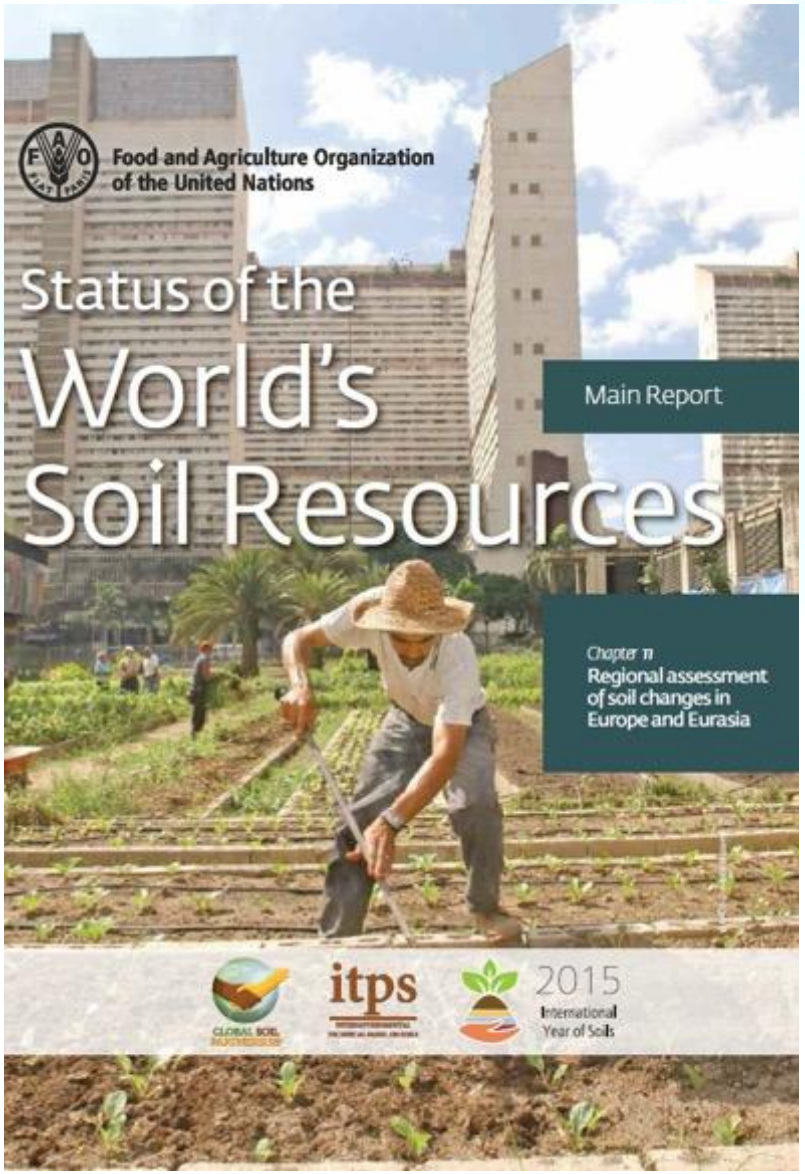
United Nations Convention to Combat Desertification








Food and Agriculture Organization of the United Nations
Status of the World's Soil Resources
Main Report
GLOBAL SOIL PARTNERSHIP
itps
2015 International Year of Soils


Food and Agriculture Organization of the United Nations
Status of the World's Soil Resources
Main Report
Chapter 11
Regional assessment of soil changes in Europe and Eurasia
GLOBAL SOIL PARTNERSHIP
itps
2015 International Year of Soils

Stable = Variable ↗↙ Improving ↗ Deteriorating ↙

Evidence and consensus is **low** | Evidence and consensus are **limited** | **Adequate** high-quality evidence and **high level** of consensus

Threat to soil function	Summary	Condition and Trend					Confidence	
		Very poor	Poor	Fair	Good	Very good	In condition	In trend
Soil sealing and land take	In densely populated Western Europe soil sealing is one of the most threatening phenomena.		↙					
Salinization and sodification	Salinization is a widespread threat in Central Asia, and it is challenging in some areas in Spain, Hungary, Turkey, and Russia.		↙					
Contamination	Soil contamination is a widespread problem in Europe. The most frequent contaminants are heavy metals and mineral oil. The situation is improving in most regions.		↗					
Organic carbon change	The loss of organic carbon is evident in most agricultural soils. Peatland drainage in northern countries also leads to rapid organic carbon loss. In Russia, extensive areas of agricultural lands were abandoned that resulted in quick organic mater accumulation; however, some of these areas are now again used for agriculture.		↗↙					
Nutrient imbalance	In the western part of the region the loss of nutrients is compensated by application of high doses of fertilizers. In the eastern part the use of fertilizers is insufficient, and in most soils nutrient mining results in intensive mineral weathering.		↗↙					
Soil erosion	Water erosion is active in all the cultivated mountainous and rolling areas; the worst situation is observed in Turkey, Tajikistan and Kyrgyzstan. Due to the attention paid to this threat it is controlled in most areas, especially in the EU.			↗				
Loss of soil biodiversity	Loss of biodiversity is expected in the most urbanized and contaminated areas of the region. However, there are almost no qualitative estimations of the biodiversity loss in soils.			↙				
Soil acidification	Acidification due to acid rain was a challenge in Northern and Western Europe. The situation is now improving, though several decades will be needed for complete soil recovery.			↗				
Waterlogging	Waterlogging is mostly associated with irrigation in Central Asian countries. Most cultivated irrigated soils there are waterlogged. This phenomena in Central Asia is commonly associated with salinization.			↗↙				
Compaction	The use of heavy machinery and overgrazing are threatening in almost all the agricultural areas.			↗↙				

Soil

SYNTHESIS REPORT | GLOBAL MEGATRENDS

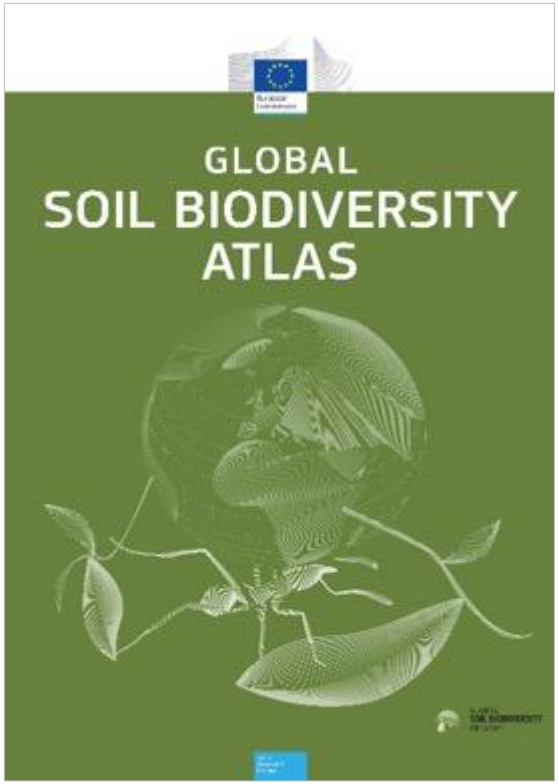
- The ability of soil to deliver ecosystem services — in terms of food production, as biodiversity pools and as a regulator of gasses, water and nutrients — is under increasing pressure.
- Observed rates of soil sealing, erosion, contamination and decline in organic matter all reduce soil capability.
- Organic carbon stocks in agricultural soil may have been overestimated by 25 %.
- A coherent soil policy at EU level would provide the framework to coordinate efforts to survey soil status adequately.

Related content

Land use and soil functions | Industrial pollution to air, soil and water | Urban systems and grey infrastructure

Relating ecosystem services to soils

ECOSYSTEM SERVICES	ECOSYSTEM FUNCTIONS	SOIL BIOTA
PROVISIONING Plant production (food) Biotechnology	Decomposition and carbon cycling	Macrofauna Mesofauna Microfauna Bacteria, fungi and archaea
REGULATING Climate regulation Atmospheric composition Hydrological services	Nutrient cycling	Microfauna Bacteria Mycorrhizal fungi Other microorganisms
SUPPORTING Habitat Biodiversity conservation	Soil structure and maintenance	Roots Earthworms Macroarthropods Fungi
CULTURAL Natural capital	Biological population regulation	Macrofauna Mesofauna Microfauna Bacteria and fungi



Soil-based ecosystem services, ecosystem functions and soil organisms that support them. The terms 'functions' and 'services' can be confusing. Usually, functions are considered as the biological processes underpinning and maintaining the ecosystem, while ecosystem services are defined as the direct and indirect contributions of an ecosystem to human well-being (derived from Brussaard, 2012). [119]

http://www.fao.org/global-soil-partnership/en/

European Commission

Thank you for your attention!