Diffuse Soil Pollution

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Outline

- **LUCAS topsoil survey**
- **Copper**
- **Mercury**
- **Cadmium**
- **Phosphorus losses due to soil erosion**
- **Other: Radio-active contamination (Cs, Pu) / Manure**

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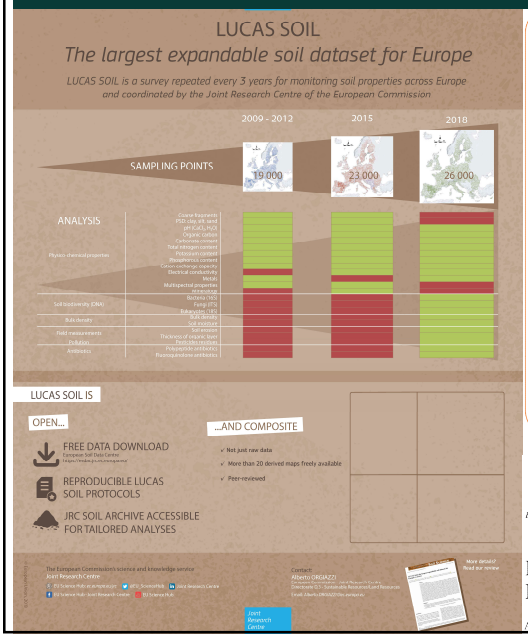
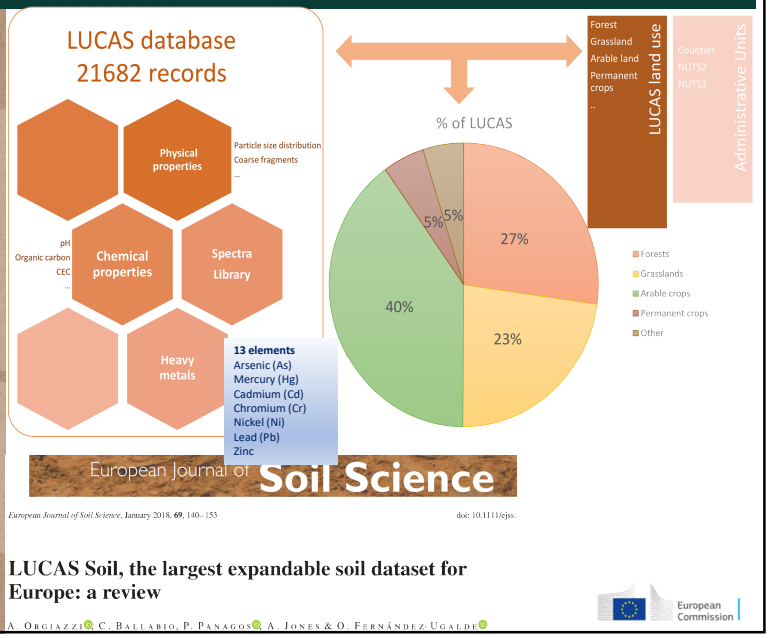
LUCAS: Land use / Land Cover Survey including soil





European Journal of Soil Science, January 2018, **69**, 140–153 doi: 10.1111/ejss.

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

A. Orgiazzi, C. Ballabio, P. Panagos, A. Jones & O. Fernández-Ugalde

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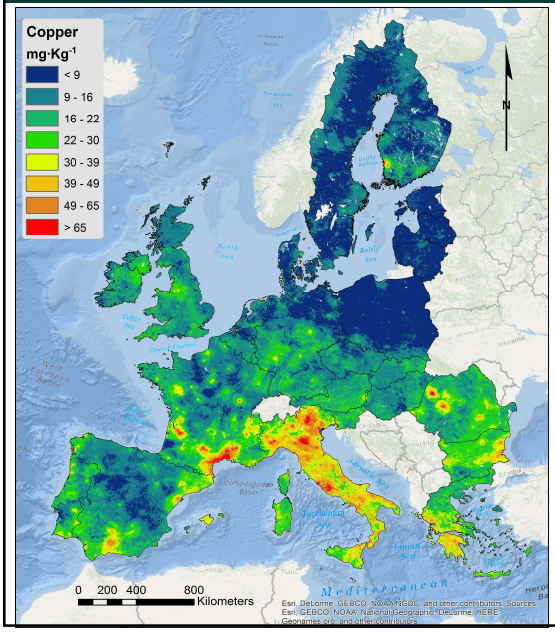
Copper distribution in European Union



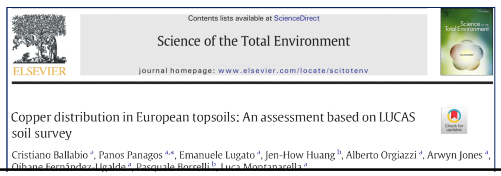
21,682 LUCAS soil samples for an analysis of copper(Cu) in EU

Cu excess may result in liver diseases, neurological effects and Alzheimer-disease, alter also the soil web food.

Copper (Cu) is **correlated** to soil properties(pH, texture, Organic Carbon), climate, geology and management.

Vineyards has the highest mean Cu concentration: 49.3 mg kg^{-1}. Cu is relatively high also in **olive groves**(33.5 mg kg^{-1}) and **orchards**(27.3 mg kg^{-1}) [**Threshold**: 100 mg kg^{-1}]

Cu highest concentration is found in **wet areas** due to frequent fungicide treatments



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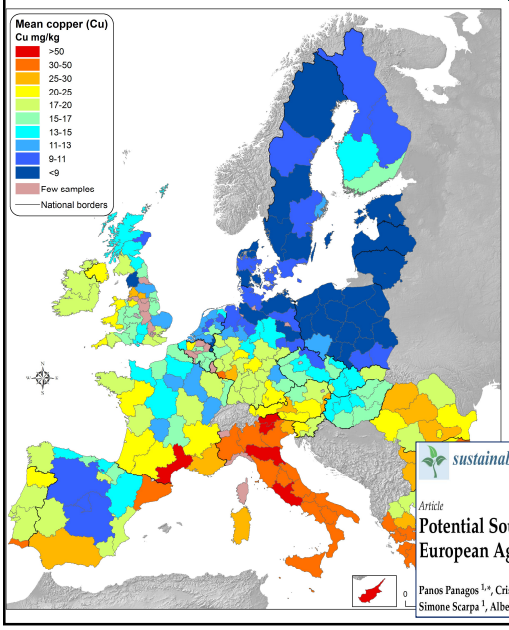
Main anthropogenic sources for Copper in EU

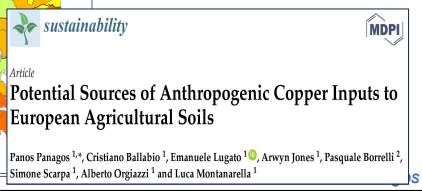


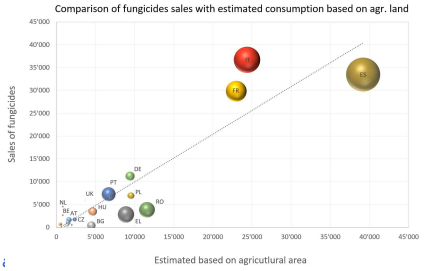
Anthropogenic sources of diffuse copper contamination include: fungicidal treatments, liquid manure, sewage sludge, atmospheric deposition, mining activities, local industries, and particles from car brakes

Sales of fungicides in the EU: c.a 158,000 tons annually, a large proportion of which are copper based and used extensively in vineyards and orchards.

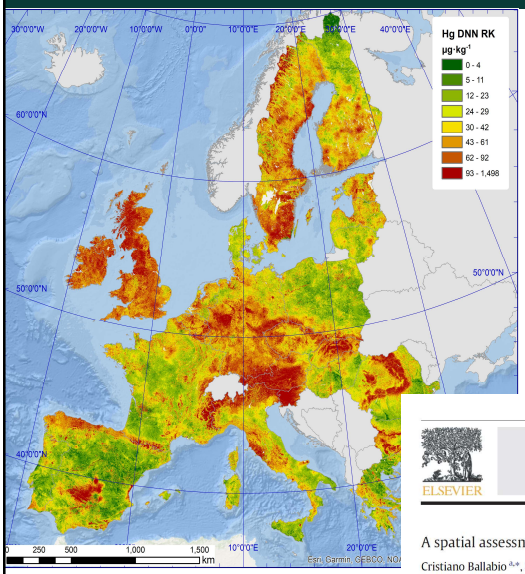
Sewage sludge: c.a 10 million tonnes of sewage sludge is treated annually (EU) & 40% of this (which has a high copper content) is fertilizer in agriculture

Pigs and liquid manure: In the EU, 150 million pigs consume more than 6.2 million tonnes of copper through additives in their feed, and most of their liquid manure


sustainability
MDPI
Article
Potential Sources of Anthropogenic Copper Inputs to European Agricultural Soils
Panos Panagos [1,*], Cristiano Ballabio [1], Emanuele Lugato [1], Arwyn Jones [1], Pasquale Borrelli [2], Simone Scarpa [1], Alberto Orgiazzi [1] and Luca Montanarella [1]



Mercury (Hg) distribution in EU soils

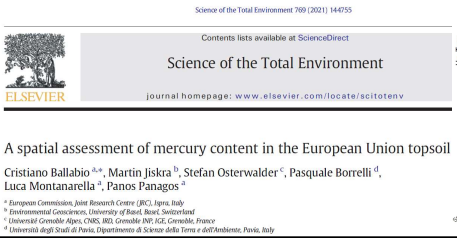


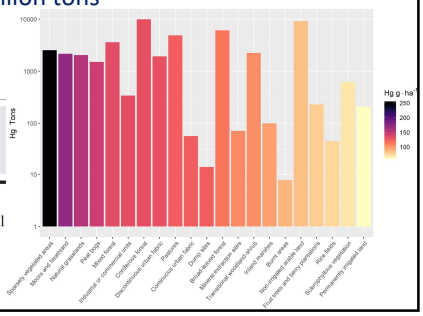
Toxic elements such as arsenic (As), lead (Pb) and mercury (Hg) poses a significant risk to **human health** The case of Minamata mercury contaminated fish (1950's).

Low levels in EU – only 0.8% higher than 0.5 mg Kg $^{-1}$ (Threshold)

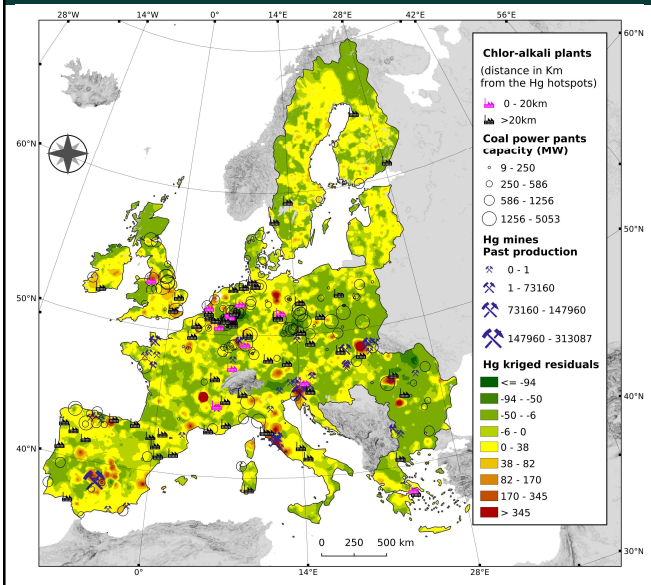
Mercury distribution in soils is linked to **soil organic carbon, temperature, NDVI and land cover.**

Hg pool in EU topsoils: 44.8 Million tons


Science of the Total Environment 769 (2021) 144755
Contents lists available at ScienceDirect
Science of the Total Environment
journal homepage: www.elsevier.com/locate/scitotenv
ELSEVIER
A spatial assessment of mercury content in the European Union topsoil
Cristiano Ballabio [a,*], Martin Jiskra [b], Stefan Osterwalder [c], Pasquale Borrelli [d], Luca Montanarella [a], Panos Panagos [a]



Mercury (Hg) hotspots in EU soils



Ballabio et al.(2021). Science of the Total Environment.

209 hotspots of Hg (1%)of the data (> 0.5 mg Kg $^{-1}$)

The main anthropogenic source is the mining activity:

- Almaden district (Spain)
- Asturias (Spain)
- Idrija mercury mine, (Slovenia)
- Mt. Amiata in Tuscany region (Italy)
- Rudnany iron ore mine (Slovakia)

High **concentrations** close to:

- Mines
- Coal power pants
- Chlor-Alkali industries
- Local diffuse contamination small-scale industries employing mercury (electrical equipment, dental amalgams, disinfectants)

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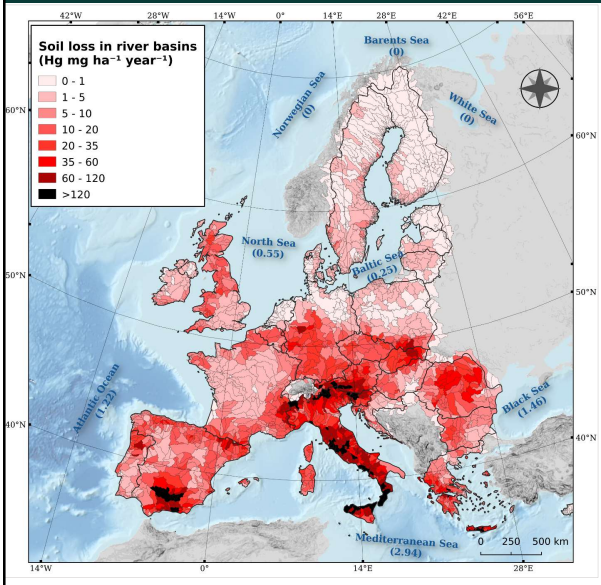
Mercury fluxes in river basin/sea



Panagos et al.(2021). Environmental Research

44.8 million tons Hg with mean concentration of 103 g ha^{-1}.

Coupling of Hg concentration with sediment fluxes: **43 tons** of Hg displaced per year (0.1% of stocks)

14% of displaced mercury (5.9 tons) is routed to river basins - the rest 86% is redistributed in the field

Data aggregated per 6,000 catchments in EU (source: CCM Catchment database)

Almost half of this Hg is potentially transported in river basins ending in the **Mediterranean Sea**

High risk: high erosion rates + high Hg stocks (Italy, Slovenia, parts of Spain)

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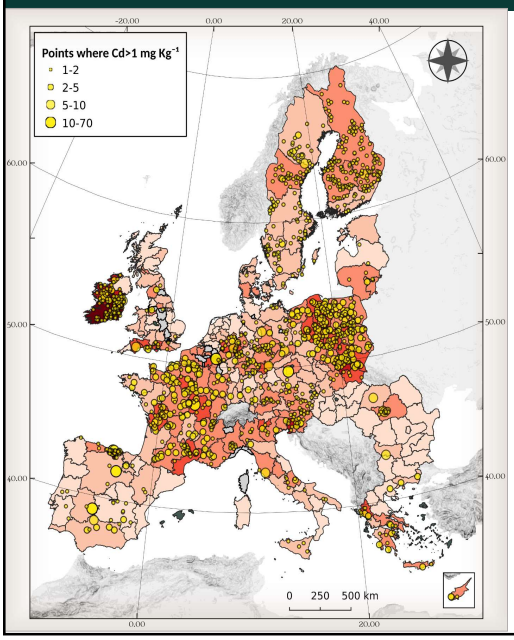
Cadmium and fertilizers use



Cadmium inputs to topsoil have **increased significantly** (+50%) during the 20th century mainly due to the application of fertilisers and sewage sludge.

> 70% of the samples had **very low concentration** (<0.07 mg Kg^{-1})

We found 1,191 samples **(5.5%)** with values higher than the threshold of 1 mg kg^{-1};

Cadmium distribution depends much on **pH** which is an important driver followed by **soil organic carbon content**.

Cadmium concentrations in soils is closely related to **agricultural uses of phosphate fertilizers**

Work under development

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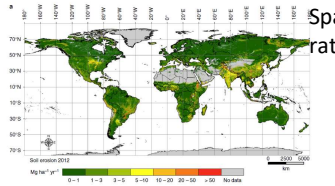
Phosphorus loss due to soil erosion on a global scale

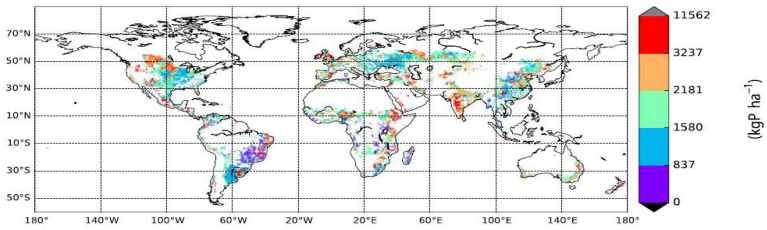


Spatially discrete soil erosion rates from Global erosion map

Borrelli et al. 2017. *Nature Communications*. 8(1): 2013

Spatially discrete soil P contents from Ringeval et al., 2017

P_{TOT} : mean of the simulations



Soil Phosphorus is...

- essential for plant growth and productive agriculture
- key limiting nutrient of future food & feed production (supply stems from non-renewable geological deposit)
- threat to ecosystem health due to eutrophication
- lost from ecosystems mostly due to soil erosion

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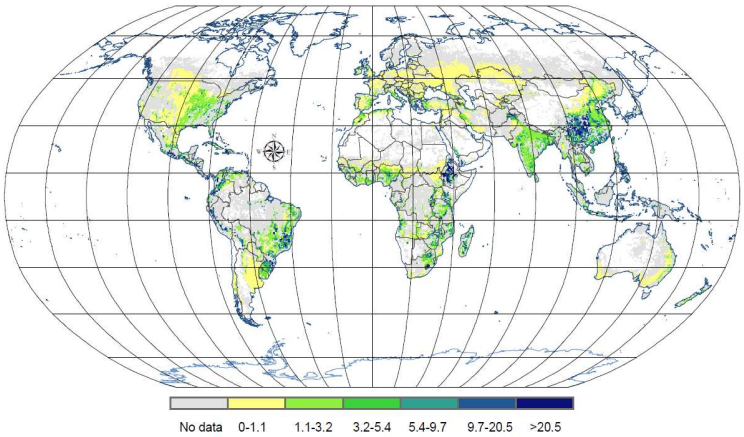
Spatially discrete global soil P losses due to erosion



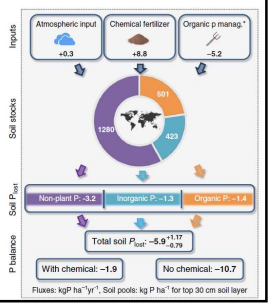
Global P losses due to soil erosion in kg P ha^{-1} yr^{-1}

Alewell et al., Nature Comm (2020)

P loss from agricultural systems due to erosion is substantial (dependent on region and continent between 1 – 12 kg $ha^{-1}yr^{-1}$)

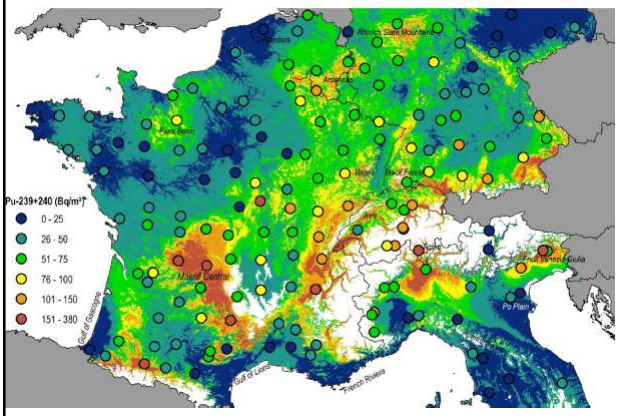
Very high losses: Eastern China, Indonesia, regions of south-eastern Africa, Central America and South America

High losses: most of India, regions of Southern Africa and South America



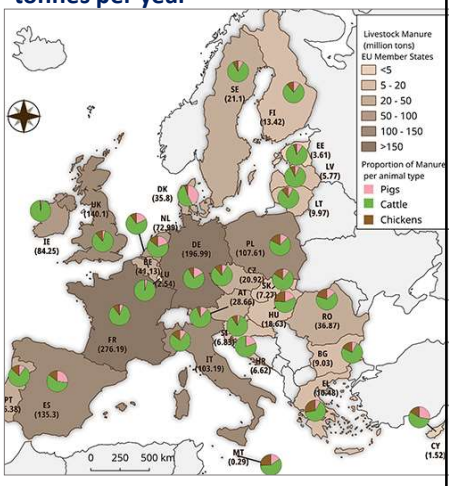
Other examples

Radio active contamination in soils:
an example for **Plutonium and Cesium**



Meusburger et al., 2020. Nature Sci. Reports

Livestock manure: 1.4 Billion tonnes per year



Koeninger et al., 2021. Agricultural Systems

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Concluding remarks

- **LUCAS database** is a major advancement for Diffuse pollution estimates
- JRC studies focus not only in **spatial distribution** but also explaining the **main reasons** behind the high concentrations
- As **Polluted sediments** can pose significant risks for aquatic organisms, important to **assess sediment fluxes**.
- **Modelling integration**: Soil pollution (Heavy metal, microplastic, pesticides, etc) → Sediment transport → water pollution (eutrophication)
- **Policy challenges (in the area of EU Green Deal)**: The Zero Pollution Action Plan, Farm to Fork (F2F), EU Soil Strategy