

Monitoring Systems of Agricultural Soils Across Europe regarding the Upcoming European Soil Monitoring Law

Eloïse Mason, Sophie Cornu, Dominique Arrouays, Maria Fantappiè, Arwyn Jones, Sophia Götzinger, Heide Spiegel, Katrien Oorts, Caroline Chartin, Luboš Borůvka, Evelin Pihlap, Elsa Putku, Jaakko Heikkinen, Line Boulonne, Christopher Poeplau, Marc Marx, Elisa Tagliaferri, Ialina Vinci, Lauris Leitāns, Kęstutis Armolaitis, Fenny van Egmond, Jozef Kobza, Johanna Wetterlind, Thomas Drobnik, Juliane Hirte, József Hefler, Božena Smreczak, Lucas Carvalho Gomes, Mogens Humlekrog Greve and Antonio Bispo

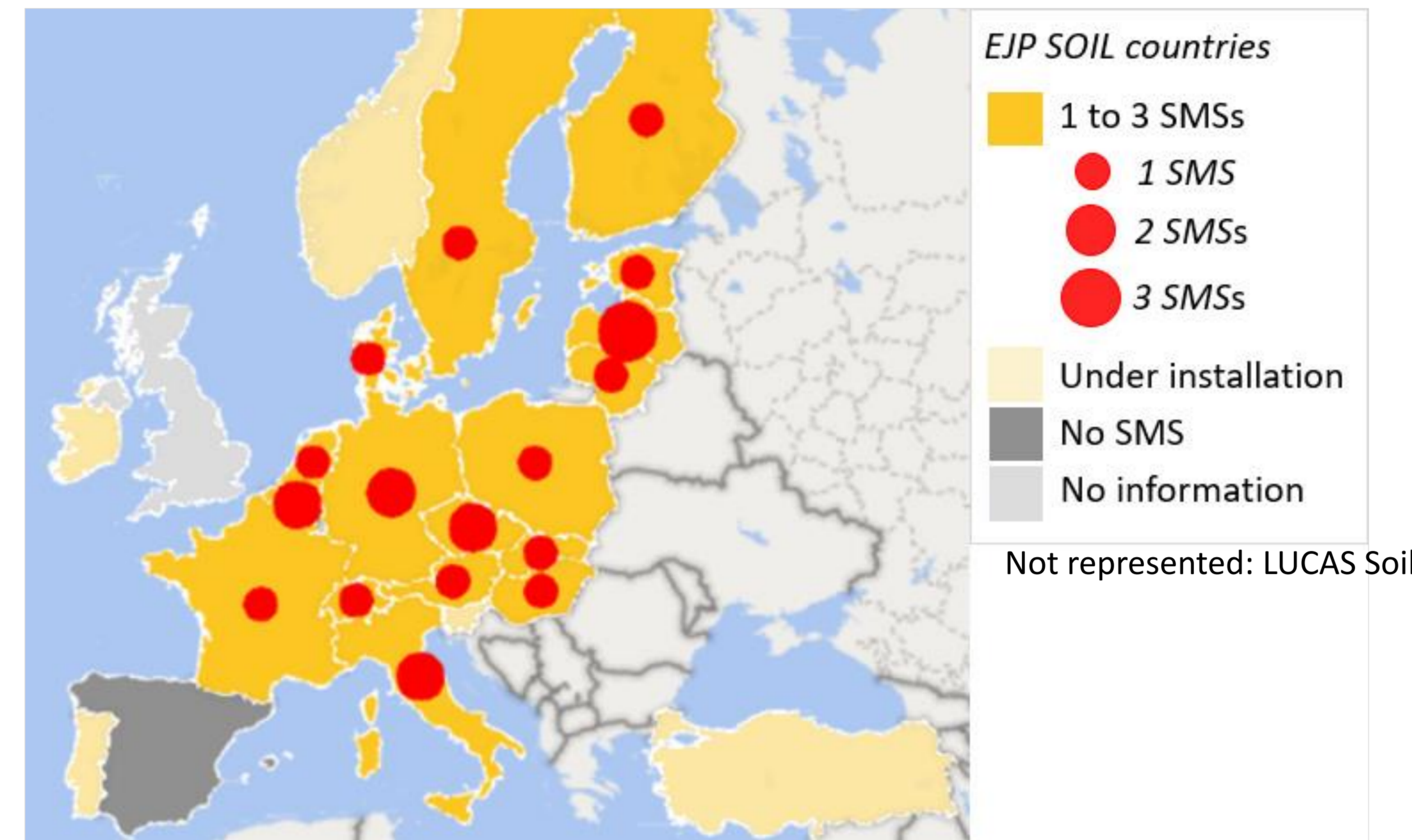
Context

- The **EU directive on soil monitoring and resilience (SML)** requires Member States to monitor their soils using a harmonised approach.
- In Europe, **several national soil monitoring networks (SMN) already exist**.
- We made an **overview** of these networks and **examines their differences and potential ways for harmonisation**.

Method

- **Development of an online questionnaire to identify:**
 - ✓ The national coordinator(s) of the network(s)
 - ✓ The information collected at the sites (e.g. land use, management, practices)
 - ✓ The sampling strategy and protocols (for soil and/or litter collection, bulk density)
 - ✓ The description of the soils (e.g. pit, taxonomy)
 - ✓ The sample preparation and storage
 - ✓ The analytical methods
 - ✓ The possible approaches to harmonization
- **Widespread dissemination across EU countries**
- **Analysis of all answers and contact with the coordinators** for further details (when needed)

Results at a glance



Geographical distribution of the countries surveyed and soil monitoring (SMN) networks identified

- **29 networks identified** (including LUCAS Soil)
- Not all countries have a SMN, and some have several (by region, by objective, land use etc.)
- The longest-running ones **started in the 1980s...** and have now completed over 10 campaigns!
- Networks differ in terms of:
 - their **sampling strategies** (spatially and temporally)
 - the **soil properties analysed**
 - the **methods** used to carry out these analyses
 - the way in which the **data is made available** to the public

The colours in the table indicate levels of similarity: green (very high similarity), yellow (high similarity), orange (moderate similarity), red (low similarity) and grey (no information)

Similarities between all existing networks and the requirements of SML

- **No network fully meets the requirements of the SML**
- **LUCAS Soil**, which partly inspired the SML, **remains the most closely aligned**
- Countries have agreed to **start inter-comparison exercises** with LUCAS Soil
- **Harmonisation approaches are needed**, as existing systems cannot be significantly modified (due to the need for temporal continuity)

		Austria	Belgium_Flanders	Belgium_Wallonia	Belgium_requa	Czech_agro	Czech_BMP	Denmark	Estonia	Finland	France	Germany_BZE-LW	Germany_BD	Hungary	Italy_Lombardia	Italy_Veneto	Latvia_agro	Latvia_nitrogen	Latvia_carbon	Lithuania	Netherlands	Poland	Slovakia	Sweden	Switzerland	LUCAS Soil
Sampling strategies	Stratified	Red	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
	Sampling depths ≥ 30 cm	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
	Composite / Number of samples	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
	Geolocation	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
	Interval ≤ 6 years	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
	Soil management data	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
Parameters monitored and methods	Soil type recording	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
	pH (Water)	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
	pH (KCl)	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
	pH (CaCl2)	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
	Particle size distribution	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
	ECEC	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
	Electrical conductivity	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
	Bulk density (topsoil)	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
	Bulk density (subsoil)	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
	Water retention capacity	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
	Ksat	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
	Organic carbon	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
	Carbonate content	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
	Soil organisms	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
	Heavy metals	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
Organic contaminants	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	
Total nitrogen content	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	
Extractable phosphorus	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	
Accessibility	Aggregated data accessibility	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	

Recommendations: harmonise or standardise

1

If an SMN is already in place

- Develop monitoring sites to compare protocols (e.g. with LUCAS Soil)
- Develop and apply transfer functions
- Introduce scoring systems

2

When new parameters need to be measured

- e.g. PFAS, biodiversity, etc.
- Use standard protocols from the outset

3

No SMN in place

- Use the SML framework as a standard to develop your SMN

References

Mason, E., Cornu, S., Arrouays, D., Fantappiè, M., Jones, A., Götzinger, S., Spiegel, H., Oorts, K., Chartin, C., Borůvka, L., Pihlap, E., Putku, E., Heikkinen, J., Boulonne, L., Poeplau, C., Marx, M., Tagliaferri, E., Vinci, I., Leitāns, L., ... Bispo, A. (2025). Monitoring Systems of Agricultural Soils Across Europe Regarding the Upcoming European Soil Monitoring Law. *European Journal of Soil Science*, 76(4). <https://doi.org/10.1111/ejss.70163>

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