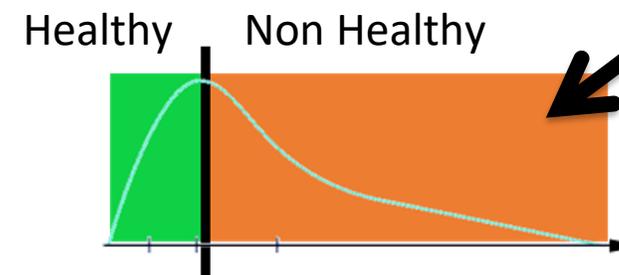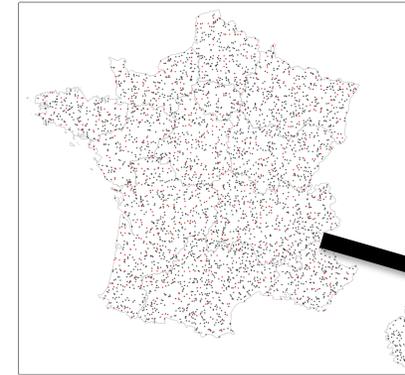# Navigating the Soil Monitoring Law: Practical Tools & Concepts for Soil Health Assessment regarding Contamination – What do we have – what do we need?

Antonio Bispo, INRAE, Orleans

Soil Health Monitoring – 3 main steps

- Setting a monitoring framework (based on existing networks)
  - Soil units (land use x soil type)
  - Soil districts (administrative)
  - # sampling points based on stratified random sampling to reach a maximum error percentage (or coefficient of variation) of 5%

- Sampling (0-30 cm) and characterizing soils
  - Trace elements
  - List of selected soil contaminants (e.g. pesticides, PFAs, microplastics…)

- Assessing Soil Health
  - National criteria
  - No Criteria

Healthy   Non Healthy
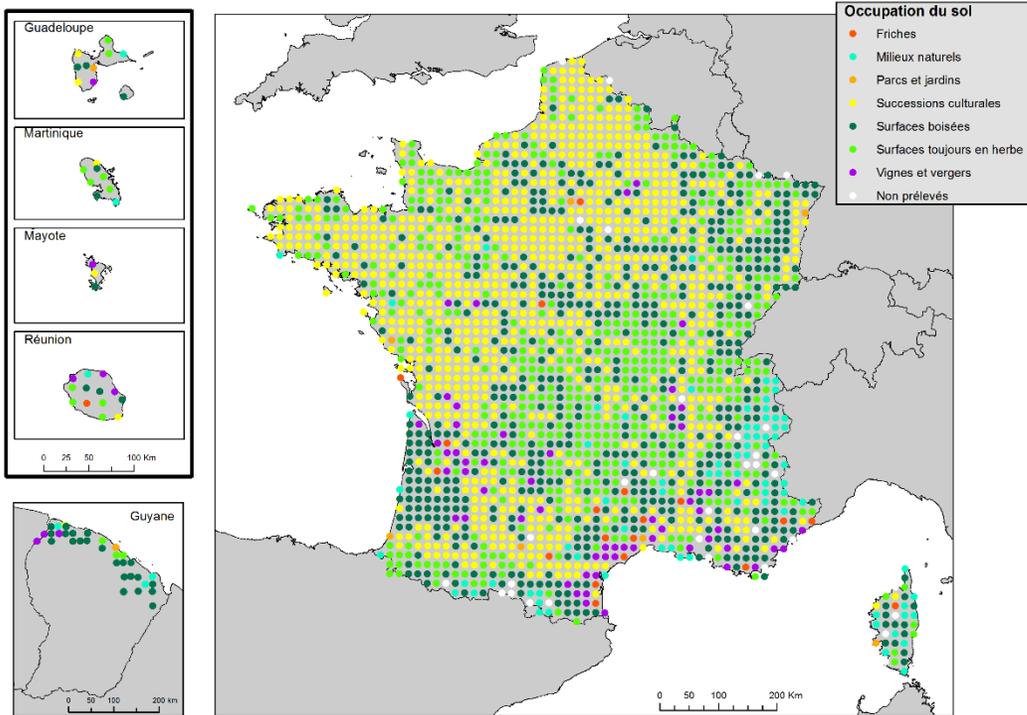
Setting a monitoring framework

- Soil units (land use x soil type)
- Soil districts (administrative)
- # sampling points based on stratified random sampling to reach a maximum error percentage (or coefficient of variation) of 5%
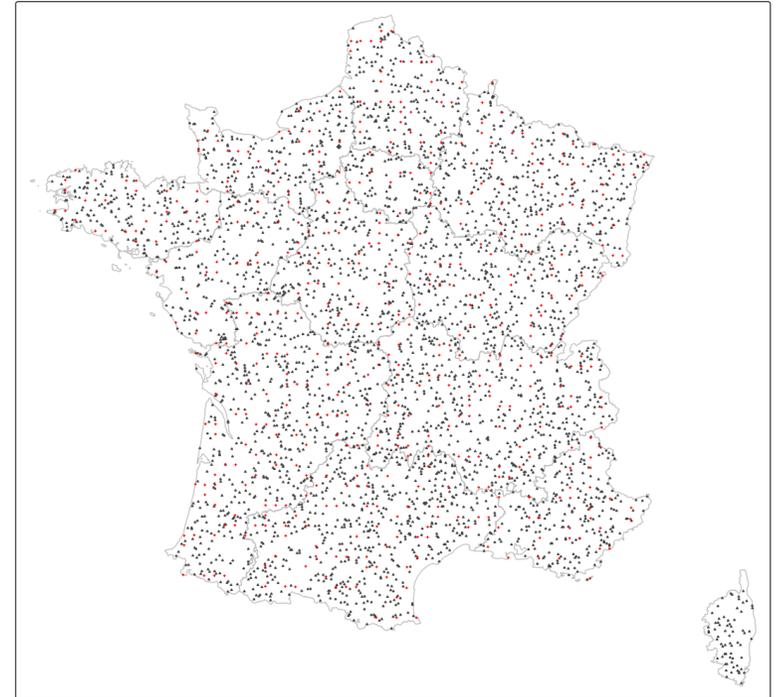
➡ MSs will have to adapt their existing monitoring systems (the sampling strategy)

EJP SOIL countries
- 🟧 1 to 3 SMSs
- 🔴 1 SMS
- 🔴 2 SMSs
- 🔴 3 SMSs
- Under installation
- No SMS
- No information
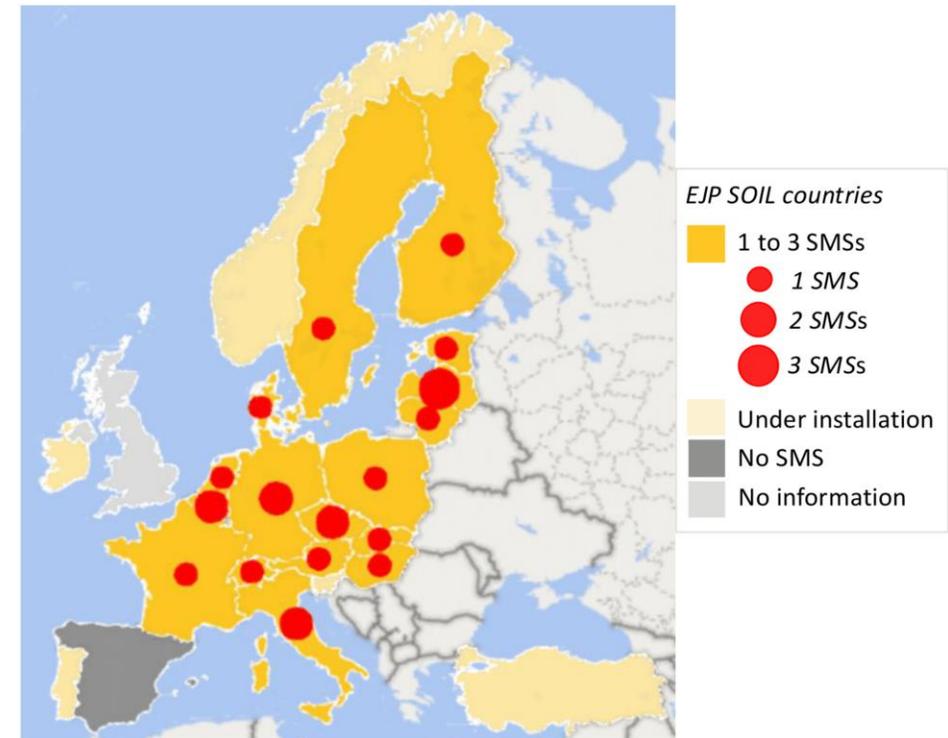
Example for France: can we combine a grid with a stratified design?

- Existing network
- LUCAS Soil
- New sampling sites

- Designed to report at national scale
- 2,240 sites, based on a 16 km x 16 km grid
- Representing all land-uses and soil types
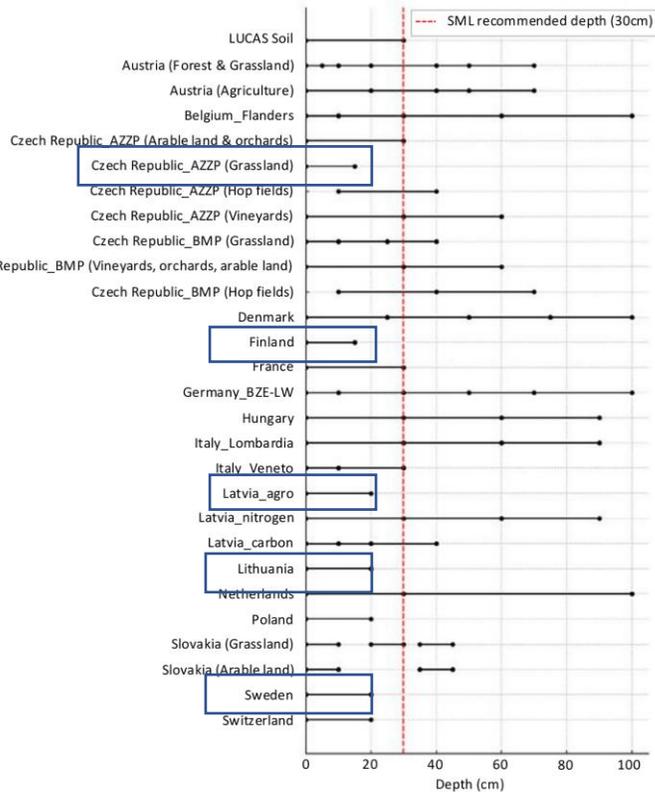- 1st campaign (2000-2015), 2nd campaign (2016-2030)

Sampling (0-30 cm) and characterizing

Sampling

List of parameters

Soil properties monitored	Number of SMSs measuring each parameter	Frequency of measurements
pH	Water: 13, KCl: 8, CaCl$_2$: 9	Moderately
Particle size distribution	20	Widely
Effective cation exchange capacity (ECEC)	16	Widely
Electrical conductivity	9	Moderately
Bulk density	Topsoil: 15, Subsoil: 16	Widely
Soil water holding capacity	2	Rarely
Saturated hydraulic conductivity (Ksat)	2	Rarely
Organic carbon	24	Widely
Carbonate content	16	Widely
Soil organisms	8	Moderately
Heavy metals	15	Widely
Organic contaminants	6	Moderately
Total nitrogen content	16	Widely
Extractable phosphorus	18	Widely

Methods

TABLE 3 | Overview of methodologies used to measure soil properties widely monitored across the SMSs, showing their alignment with ISO-recommended methods outlined in the SML. SMSs are categorized by ISO-recommended, comparable, or alternative methods, with parentheses indicating the number of SMSs per category.

| Properties monitored | ISO recommended methods | SMSs using | | |
		The recommended ISO methods	Comparable methods	Alternative methods
Particle size distribution	11277	BE[3], DE[1], DE[2], DK, EE, EU, SE	IT[2]	AT, BE[1], CH, CZ[2], FI, FR, HU, IT[1], LT, NL, PL, SK
ECEC	11260	DE[1], EU, SE	AT, CH, IT[2]	BE[3], CZ[1], CZ[2], DE[2], FR, HU, IT[1], NL, PL, SK
Bulk density (Topsoil)	11272	BE[1], BE[2], DE[1], DE[2], DK, EE, FR, IT[2], LT, LV[3]	EU	AT, CH, HU, NL
Bulk density (Subsoil)	11272	BE[1], BE[2], DE[1], DE[2], DK, FR, IT[2], LT, LV[3]	EU	AT, CH, CZ[2], HU, NL, SK
Organic carbon	10694	BE[1], BE[2], BE[3], CH, DE[1], DK, EE, EU, FR, LT, LV[3], NL, SE	IT[2]	AT, CZ[1], CZ[2], DE[2], FI, HU, IT[1], LV[1], PL, SK
Carbonate content	10693	BE[3], CH, EU, DE[2], FR, NL, SK	IT[2]	AT, BE[2], CZ[1], DE[1], DK, HU, PL, SE
Heavy metals	54321[a]	AT, BE[3], IT[2]		CH, CZ[2], DE[2], EE, EU, FI, FR, HU, IT[1], PL, SE, SK
Total nitrogen content	11261/13878	BE[1], BE[3], CH, DK, EU, FR, IT[2], SE	AT, DE[1], DE[2]	CZ[2], FI, HU, IT[1], NL
Extractable phosphorus	11263[b]	EU, FR, IT[2]		AT, BE[3], CH, CZ[1], CZ[2], DE[2], EE, FI, IT[1], LT, LV[1], NL, PL, SE, SK

Abbreviations: AT, Austria; BE[1], Belgium_Flanders; BE[2], Belgium_Wallonia; BE[3], Belgium_requa; CH, Switzerland; CZ[1], Czech Republic_AZZP; CZ[2], Czech Republic_BMP; DE[1], Germany_BZE-LW; DE[2], Germany_BD; DK, Denmark; EE, Estonia; EU, LUCAS Soil; FI, Finland; FR, France; HU, Hungary; IT[1], Italy_Lombardia; IT[2], Italy_Veneto; LT, Lithuania; LV[1], Latvia_agro; LV[2], Latvia_nitrogen; LV[3], Latvia_carbon; NL, Netherlands; PL, Poland; SE, Sweden; SK, Slovakia.
[a]Heavy metals (As, Sb, Cd, Co, Cr (total), Cu, Hg, Pb, Ni, Tl, V, and Zn) should be measured using ISO 54321 digestion (with Aqua Regia), with optional analysis of bioavailable fractions using ISO 17586 (dilute nitric acid).
[b]ISO 11263 is the preferred method; nevertheless, other methods can be used as an alternative.

> ## At a glance

From green (full compliance with SML) to red (not compliant at all)

MSs will have to adapt and/or develop transfer functions for sampling and analysis!

EJP SOIL
European Joint Programme

Transfer functions

'Transfer function' means a **mathematical rule** that enables the value of a measurement performed using a methodology different from a reference methodology to be converted into the value that would be obtained by performing the soil measurement using the reference methodology

Assessing soil health

Sewage sludge regulation

REFERENCE values
THRESHOLD values
TARGET values
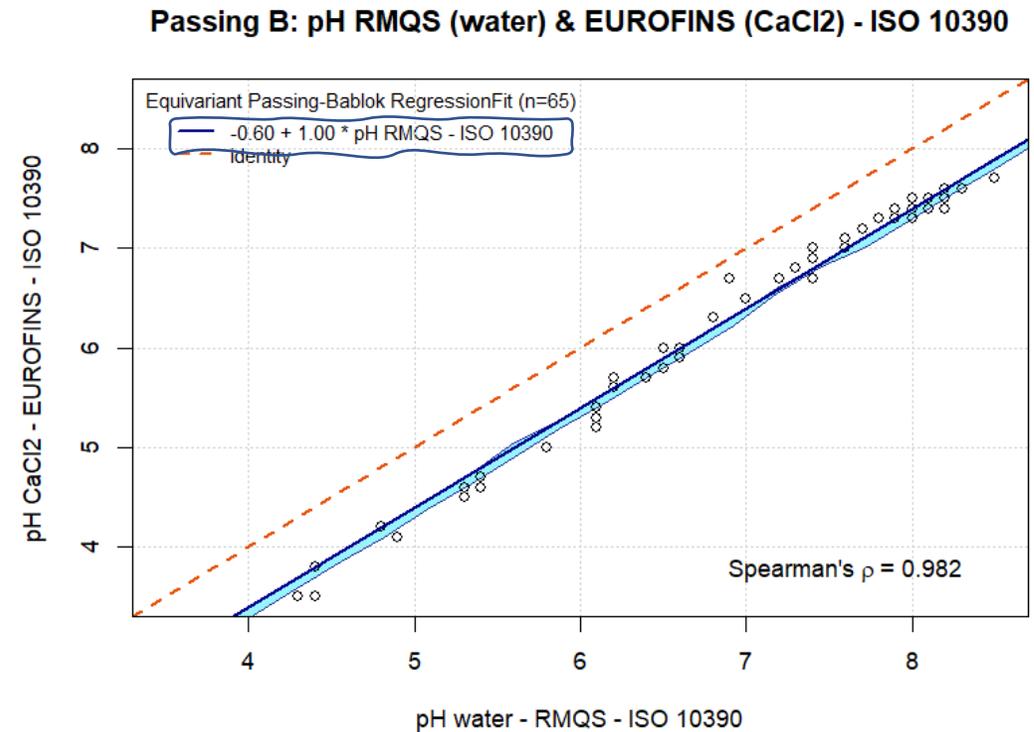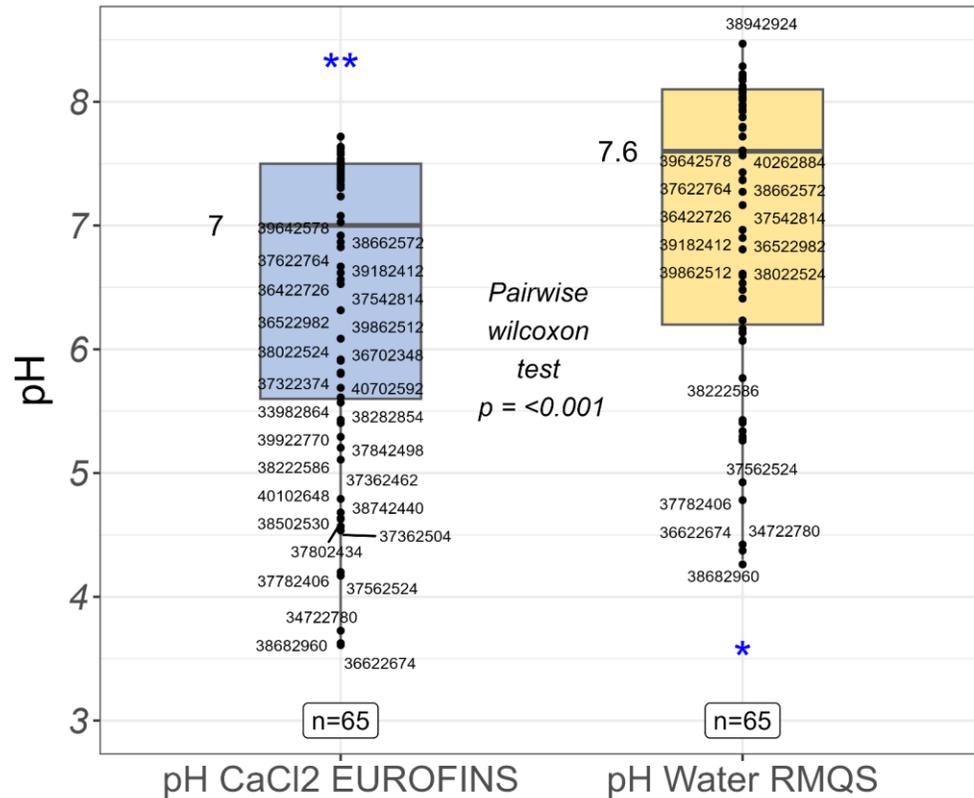
› Conclusions

• **We have**

- Existing monitoring systems in MSs
- Strong skills for sampling soil
- Experience in analysing trace elements and 'old' organic contaminants as PAHs, PCBs
- Few threshold values (mainly for trace elements)

• **What we need**

- Adapt the existings systems to comply with SML (e.g. combine grid systems with stratified ones, develop transfer functions)
- Identify new relevant contaminants to be monitored (e.g. microplastics, PFAs, pesticides)
- Develop and standardise proper protocols for sampling/preparation/analyse new contaminants
- Develop threshold values based on common rules

**The journey is just beginning!
We'll need your expertise on contaminated land**

INRAE