European Joint Programme SOIL. Feedback and survey of information supporting/ enabling discussion on the Soil Monitoring Law proposal

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EJP SOIL is a European research programme, co-funded between the EU commission and 24 European countries, that aims to develop knowledge, share it and harmonize it towards climate-smart and sustainable management of agricultural soils. Work performed by the EJP SOIL is highly relevant for several of the chapters of the proposed Directive on Soil Monitoring and Resilience. EJP SOIL welcomes progress towards a better soil monitoring and thereby towards a better protection and sustainable management of soils.
We develop here a series of points, not commenting in a comprehensive way the different chapters of the Directive proposal, but identifying the supporting information from the EJP SOIL that is publicly available as Deliverables, policy briefs, webinars or scientific publications.

Chapter 1- General provisions.

Definitions. Soil health: the EJP SOIL endorsed the definition proposed by the Soil Mission Board, that soil health is the actual capacity of soils to provide ecosystem services. This definition is more precise than that in the current law proposal as it differentiates it from soil quality, which is the potential to provide ecosystem services. This has the merit to support a context-dependent evaluation of soil health as, intrinsically, different soils do not have the same ability to provide ecosystem services. Definitions can be found in: EJP SOIL policy brief.

Competent authorities: EJP SOIL inventoried whether competent authorities have been appointed at the national or regional scale for soil data, in 24 European countries. Mobilizing the existing competent authorities whenever possible should foster implementation of the directive (EJP SOIL deliverable 6.2).

Chapter 2. Monitoring and assessment of soil health

Article 6- Soil health and land take monitoring framework. The comma 6 of the article states the establishment by the Commission and the EEA of a digital soil health data portal that shall provide access in georeferenced spatial format to at least the available soil health data resulting from measurement carried out by the Commission itself and by Member States as foreseen in article 8(2). The EJP SOIL inventoried national regulations relative to soil data

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sharing in EJP SOIL deliverable 6.2. A conflict of interests between public and private rights was evidenced because soil is a natural resource providing services for the public benefit (INSPIRE regulation) but is often under private property (GDPR). The D6.2 chapter 5 - Draft agreement for soil data sharing suggests general best practices to overcome the soil data sharing constraints:

1) to get the consent from landowners for the open disclosure of point georeferenced soil data, with the only exception that the consent is not required for data on emissions of pollutants into the environment,
2) to respect the intellectual property rights of authors, and/or an economic payment to sustain the sharing service of soil data and maps, and
3) to adopt a country-driven approach for European soil mapping which would imply involving the national soil data officers/services and through them the national soil data owners, with a common European methodology, similarly to what is adopted by the INSII network of the Global Soil Partnership.

Tests with optimised European mapping (between country-driven and top-down are ongoing within EJP SOIL, results are expected in summer/autumn 2024.

Article 8 Measurement and methodologies

EJP SOIL delivered recently a report (EJP SOIL D6.5) presenting and discussing main indicators for accounting and mapping soil fertility and degradation that is currently under review. The following suggestions are from this document, and from the EJP SOIL deliverable 6.3 already approved and published.

The EJP SOIL inventoried and compared the existing National Soil Monitoring systems in Member States[1] including LUCAS SOIL and the technical options to harmonize them: EJP SOIL deliverable 6.3. Proposed steps include comparing the national and LUCAS SOIL datasets (results), designing ways to use national and European datasets together in a statistically sound manner to provide better and more detailed information on soils, and developing lab transfer functions (see also next point on transfer functions).

The inventory shows the diversity of monitoring systems and their soil indicators across European countries. This clearly shows that better harmonisation is needed, but also that it is challenging, inasmuch as national specificities of these systems can be related to specific national issues.
EJP SOIL deliverable 6.3 reports on the following issues:

Sampling design: The Directive aims to harmonize sampling systems, but the current prescription of stratified random sampling design (Annex II, Part A), although quite

[1] EJP SOIL reviewed existing soil monitoring systems (SMS) across EU and the number of sites per country is highly variable but most have at least 1 site representing 300 km². In the majority of SMS, the **monitoring sites were selected according to several criteria such as land use, soil type, main crop, climatic zone, but regular grids are also used**. On monitored sites, 50 to 60% of the countries also collect information on soil management and on the surroundings. The sampling protocol is quite variable as the sampling area ranges from less than 5 m² to 1 ha. The depths of sampling are also quite different as samples are taken according to soil horizons or just at one depth (0-20 or 0-30 cm) or at multiple depths (2 to 5).

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understandable, makes it difficult to use existing monitoring networks with a different sampling design that Member States will want to continue (EJP SOIL deliverable D6.3) and use as building blocks for the purpose of the Directive as well.

To achieve the same purpose as foreseen in the Directive but allow easier inclusion of existing monitoring designs, an alternative is to propose that the sampling scheme shall *preferably* be a stratified random sampling design but should at least overall (including national and LUCAS samples) be reasonably optimized for the (range in) soil health descriptors and their spatial variability.

For example, some national monitoring systems are grid-based and within countries the sampling design may vary per land use type/soil monitoring system (e.g. agricultural/forest monitoring systems). If overall the national and LUCAS monitoring systems, plus possibly additional locations, have a good coverage of the spatial and soil indicator diversity in a country and statistically sound conclusions can be drawn, this would be sufficient.

This does require methods to combine data resulting from different designs in a statistically sound manner, which is ongoing work in EJP SOIL, with results that will be available in 2024.

After the first baseline monitoring in the context of the Directive is performed, an evaluation of the design, frequency of sampling per land use type and indicator, and minimum indicator set will be needed.

Sampling conditions: The best period to sample (either for topsoil or subsoil) is not described in the Soil Monitoring Directive proposal. Of course, it depends both on EU regions (climate, land use) and on the indicators/parameters to be measured. While certain indicators may be sampled at any time during the year, others should be done under specific conditions (e.g. soil organisms should be sampled when they are active which is in spring or autumn). Other conditions should be considered such as moisture conditions and soil management practices: sampling should be avoided just after a treatment (e.g. application of a fertilizer or a pesticide, or a tillage operation) because it may drastically change the results. The owner and/or the farmer should be contacted before sampling to agree on the appropriate date and obtain his/her consent (see also previous point on the sharing of data).

Frequency of sampling: An option to reduce monitoring costs would be to reconsider the 5-year frequency proposed by the Soil Monitoring Law. As most soil indicators may not change that quickly due to soil management (e.g. SOC, trace elements content), we recommend not to measure all parameters every 5 years as a 10 y frequency would be sufficient for a number of indicators and land use types. For indicators for which a frequency of once every 10 years is sufficient, measurements could also be alternated (e.g. for contamination, measure trace elements during the 1st campaign, then organic contaminants during the second campaign, and trace elements again during the 3rd campaign).

Indicators: We reviewed the indicators currently used by Member states and identified a short list quite similar to the list proposed in Annex 1 of the proposal. Regarding biodiversity loss indicators, we disagree that basal respiration is an indicator of biodiversity. It informs

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on overall biological activity, and we propose a different set of biological indicators as Tier 1 (EJP SOIL Soil health indicators webinar).

Critical values: Different methods allow to set critical values for a soil health monitoring framework, both for threshold values and target values. Examples are fixed values, relative change (trends), regional distribution, values relative to potential. We inventoried them, compared their strengths and weaknesses (EJP SOIL Soil health indicators webinar), and designed a framework for choosing the most appropriate method depending on the aim of monitoring, the indicator and data availability. A scientific publication on this issue is currently under review.

Available soil databases. The EJP SOIL reviewed the soil information (databases and maps) available in different Member States (EJP SOIL Deliverable 6.1 chap 2, and Cornu et al. 2023). Metadata is available at https://catalogue.ejpsoil.eu/

Use of remote/proximal sensing: For some parameters/indicators (e.g. SOC, EC, texture) the use of proximal sensing techniques is fairly well developed for estimations and mapping at field scale, while for others their use is still in its infancy (e.g. for biodiversity), or will be difficult to use. For implementation in large scale monitoring systems and for detecting changes, remote/proximal sensing methods still need to be evaluated, to determine whether the detected changes in time are significant, given the error of proximal/remote sensing estimations. It should be recognised that the remote sensing techniques only give information on the surface layer.

Transfer functions
EJP SOIL in collaboration with JRC has facilitated and enabled the double sampling of a sub-set of LUCAS 2022 soil samples. The samples are sampled and analysed both by national soil laboratories and the European LUCAS laboratory, with the purpose to derive validated transfer functions among different analytical and sampling methods adopted. EJP SOIL proposes to define for the coming campaigns common monitoring sites between the EU-wide LUCAS soil monitoring and the national soil monitoring to facilitate harmonization.

Chapter 3. Sustainable soil management
The proposal is less developed regarding sustainable soil management than monitoring. We agree that identification of sustainable versus unsustainable soil management options must be context specific (land use, soil type, climate and agricultural/forestry systems. To this end, the amount of available information supporting the implementation of sustainable soil management is very different across EU member states and environmental regions. (EJP SOIL deliverable 2.1).

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