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AI 4 Soil Health

DIALOGUE 4

From Soil Monitoring to Action across EU Policies

Soil Monitoring Law: the backbone for promoting soil health across policies

An estimated 60–70% of EU soils are degraded, at a cost of more than EUR 50 billion per year. Directive (EU) 2025/2360 on soil monitoring and resilience (Soil Monitoring Law, SML) is the EU's first law dedicated to soil health. It covers all soils, builds on existing monitoring systems, follows a staged approach and pursues an aspirational objective of healthy soils by 2050. It rests on a governance system (soil districts, soil units, competent authorities) and three pillars: monitoring and assessment of soil health and land take; soil resilience; and contaminated sites.
The SML does not require a "soil plan". Instead, soil-health data and assessments must inform the 16 programmes, plans, targets and measures listed in Annex III — including CAP Strategic Plans, National Restoration Plans, nitrates, water and flood plans, and LULUCF targets. Its impact therefore depends on how well its data are used by other policies: the core question of the Cross-Policy Soil Dialogues.

Policy framework and timeline: from adoption to an operational monitoring system



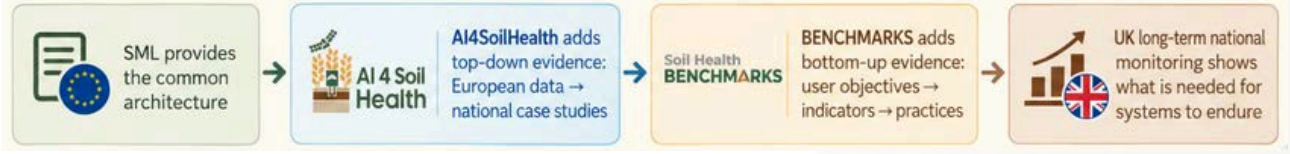
Source: Art. 24 roadmap presented by DG ENV; Directive (EU) 2025/2360

A more detailed overview of the Directive and of AI4SoilHealth's contribution is provided in the brief *Europe Adopts its First Soil Health Law (Annex 1).*

Webinar at a glance: takeaways and recommendations

The fourth and final AI4SoilHealth Cross-Policy Soil Dialogue moved from individual policy areas to the implementation of the Soil Monitoring Law itself. Choices made now, in the SML expert group and in national transposition, will decide whether the SML delivers only an assessment of soil condition or also information that supports action. The dialogue asked **which implementation challenges are emerging and how research and innovation can help address them.**
The dialogue brought together complementary perspectives from four speakers. **Esther Goidts (DG ENV, European Commission)** spoke on SML implementation and the Commission's support to Member States. **Lucas de Carvalho Gomes (Aarhus University)** presented AI4SoilHealth results on harmonised European soil data and national case studies, on behalf of **Professor Mogens H. Greve**. **Fenny van Egmond (Wageningen Environmental Research / ISRIC)** presented the BENCHMARKS framework and tools for user-driven indicator selection. **Laura Bentley (UKCEH)** spoke on fifty years of national soil monitoring in the UK and the conditions needed to sustain it.
The cross-cutting theme of the webinar was a **transition from monitoring that describes soil condition towards monitoring that supports action**, sheding light on a monitoring that is question-led, rich in context, interoperable across policies and sustained over time.

The SML already provides the common architecture called for in the previous dialogues. Its soil units, descriptors, target and trigger values and assessment classes create a shared language for soil condition. It also introduces a new form of multi-level governance in which data are designed to be reused rather than duplicated. For example, the same data on soil organic carbon should serve the CAP, the NRR and climate policy.



The research projects offer complementary building blocks. AI4SoilHealth works largely top-down, from harmonised European data to national case studies. BENCHMARKS works bottom-up, from users' objectives to indicator selection and practices. The UK experience shows what such systems can deliver over decades, and what they need to survive.

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From Soil Monitoring to Action across EU Policies

Key Takeaways

Monitoring must be question-led and record context. Knowing what changed, whether it matters and when and why it requires data on management, schemes and biodiversity alongside soil data.

Outcomes must be read at the right scale. A measure can have a positive impact on local soil condition but not be visible at national level soil condition assessment, and averages can hide growing threshold exceedances. Different users also need information at different scales and with different levels of uncertainty.

SML data should be comparable and reusable across policies. Well-designed soil units, soft harmonisation and machine-readable shared terminology make data comparable across scales and borders. They also make the data reusable for e.g. the CAP, the NRR and climate policy.

Projects already work where the SML meets practice. Tools that adopt SML vocabulary can prepare land managers for the future knowledge repository on practices. The expert group roadmap and national transposition, up to 2028, are the window to embed them.

Research should also inform the SML review, not only its implementation. Mission Soil projects are testing indicators and methods that can improve descriptors over time.

Continuity needs political will, funding and champions. Long-term monitoring and project tools only survive policy cycles if someone owns and funds them.

Policy Recommendations

Design national monitoring around explicit policy questions. Co-locate soil sampling with data on management, CAP and agri-environment interventions, and biodiversity.

Align monitoring evaluation with SML condition monitoring. Report distributions and threshold exceedances, not only averages, and use neighbouring countries as counterfactuals.

Provide information adapted to users and uncertainty: aggregated maps for policy, and locally refined information for land managers.

Define data formats and access rules early, through the implementing act on data management and the data portal. This lets SML data inform Annex III programmes without parallel data collection.

Tag indicators in tools and guidance by the legislation they can serve (SML, CAP, NRR, CRCF). Develop expert-validated, multilingual vocabularies and strengthen cross-border data comparability.

Use the period up to transposition in 2028 to test and embed Mission Soil tools, indicators and protocols, through structured exchanges between projects and the SML expert group.

Create a channel for research evidence to inform future SML revisions, on both descriptors and cost-effective methods.

Secure long-term funding and institutional ownership for monitoring infrastructures and project tools beyond project lifetimes.

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DIALOGUE 4

From Soil Monitoring to Action across EU Policies

Opening & Framing

ISINNOVA research innovation sustainability

Giovanna Giuffrè | ISINNOVA

"How can the experience of research projects and long-term monitoring help the SML deliver information that is used, not only collected?"

Giovanna Giuffrè introduced the fourth and final webinar in the AI4SoilHealth Cross-Policy Soil Dialogues series. She recalled the path of the series: after consulting project partners, the first three dialogues examined soil data needs for nature restoration, the Common Agricultural Policy, and climate and carbon policy. A clear message emerged. Other policies need the data the Soil Monitoring Law will produce, even though they operate with different governance cycles, authorities and scales. The analysis of the three dialogues identified recurring tensions and three priorities: making monitoring actionable, strengthening coherence across policies and scales, and ensuring that monitoring supports land managers in practice. To test them, the webinar brought together the European Commission, two complementary Mission Soil projects, AI4SoilHealth and BENCHMARKS, and long-term monitoring experience from the UK.

The dialogue sparked from a forward-looking question: *How can the experience of research projects and long-term monitoring help the SML deliver information that is used, not only collected?*

Scan the QR code or click here to watch the full webinar and listen to the complete contributions from the speakers.

AI4SoilHealth Cross-Policy Soil Dialogues

DIALOGUE 4

FROM SOIL MONITORING TO ACTION ACROSS EU POLICIES



Esther Goidts

Soil Protection and Sustainable Land Use, DG Environment, EC



Lucas de Carvalho Gomes

Assistant Professor, Department of Agroecology, Aarhus University



Fenny van Egmond

Researcher Wageningen Environmental Research / ISRIC



Laura Bentley

Environmental Data Scientist, Land Soil & Coast, UK Centre for Ecology & Hydrology (UKCEH)

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Soil Monitoring Law implementation: overview, challenges to overcome and European Commission support

Esther Goidts | DG Environment, European Commission

"This is a new approach: not adding a layer, but better integrating data in the system."

Goidts recalled the long road to the Directive on soil monitoring and resilience, from a first attempt in 2006 to its adoption on 12 November 2025, and noted that transposition by December 2028 is "quite soon" given the work ahead. The directive covers all soils in the EU and is designed as a flexible, proportionate instrument that builds on existing policies and monitoring systems through a staged approach. It is built around six building blocks, all serving an aspirational objective: healthy soils by 2050, able to provide the ecosystem services society needs. For each block, Goidts highlighted the main challenges for implementation (Table 1).

Building block	What the SML requires	Challenges to overcome
Governance	Soil districts, soil units and competent authorities.	**Transversality:** many authorities and actors act on soil and need to connect and build a shared understanding of soil health. **Scales of decision-making:** decisions taken at EU, national and local level must work together.
Monitoring and assessment	Monitoring and assessment of soil health and of soil sealing and soil removal (land take).	**Soft harmonisation:** gradually aligning existing national systems, without losing them. **Integrated assessment:** combining results across degradation aspects to decide on measures in practice. **Spatial coverage:** covering the whole territory requires aggregation, while land managers need field-level information.
Soil resilience	Support to landowners and land managers; land-take mitigation principles.	**Soil data for decision-making** and for related EU legislation (Annex III), relevant to land managers. **Link to ecosystem services:** assessing their loss, notably from land take.
Contaminated sites	Identify, investigate, register and remediate contaminated sites.	**Legacy sites and new contaminants;** defining unacceptable risks; applying the polluter-pays principle.
Information, funding and Commission support	Public information and transparency; funding, capacity building and facilitation by the Commission and EEA (Art. 24).	**Different starting points:** the system must be co-created with Member States and connect communities that rarely work together (raised in discussion).
Reporting and evaluation	Member State reporting every six years (first by June 2032); Commission evaluation by June 2033.	—

Source: DG ENV presentation and discussion, 20 October 2026; Directive (EU) 2025/2360.

Table 1 | SML building blocks and challenges for implementation, towards the aspirational objective of healthy soils by 2050

Monitoring and assessment rest on soil units, nested within soil districts (the administrative scale, also used for land take) and defined by soil type (WRB) and land use (the six LULUCF categories). This keeps the system coherent with other EU law. Member States may use more detailed data, provided the link to these classifications is kept. Soil-health descriptors and soil sealing and removal indicators (Annex I) are measured with common methods (Annex II).

Descriptors are compared with two sets of values: (i) non-binding sustainable target values, based on science, and (ii) operational trigger values, set by Member States to decide where action and support are needed. Soil health is assessed every six years at soil-unit scale, classifying areas in good, moderate or poor condition, and land take every three years at district scale. The Commission supports this through LUCAS campaigns agreed with each Member State, while the directive also requires sample archiving, laboratory quality assurance and a public digital soil health data portal.

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DIALOGUE 4

From Soil Monitoring to Action across EU Policies

Policy & Governance



Soil Monitoring Law implementation: overview, challenges to overcome and European Commission support

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"This is a new approach: not adding a layer, but better integrating data in the system."

The SML does not require a soil plan. Instead, its data must inform the 16 programmes, plans, targets and measures listed in Annex III and be relevant to land managers. Member States must support landowners and land managers through (i) independent science-based advice, training and capacity building, (ii) awareness raising, (iii) local information on suitable practices based on the soil-health assessment, (iv) research and (v) an overview of available funding, with involvement of the public concerned and explicit synergies with the NRR and the CAP. Land-take mitigation follows an avoid–reduce–compensate logic for the loss of ecosystem services caused by new sealing or removal; it is effort-based rather than result-based, reflecting the sensitivity of the topic and subsidiarity.



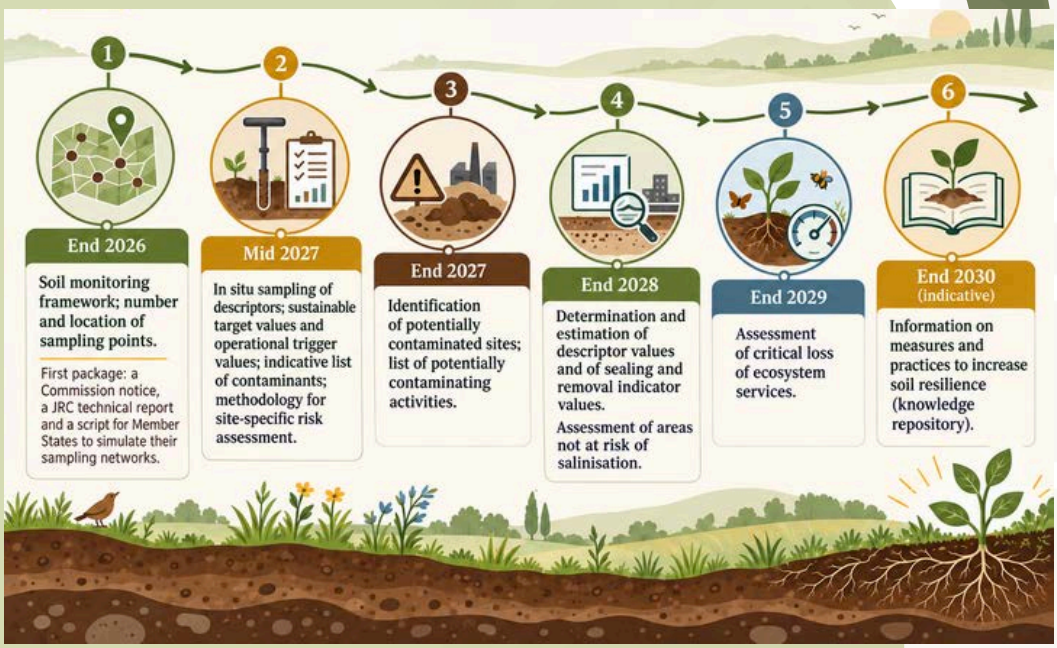
The contaminated-sites pillar covers point-source contamination from human activity, while diffuse contamination is addressed through soil-health monitoring.
It follows a risk-based, stepwise approach with a hierarchy of responsibility: (i) identification of potentially contaminated sites within ten years and investigation of the latter, (ii) site-specific risk assessment, (iii) risk-reduction measures where risks to human health or the environment are unacceptable, and (iv) a public register with public involvement.

Under Article 24, the Commission and the EEA must support Member States following a roadmap set by the directive (Table 2).

The SML expert group, set up in early 2026 with representatives of each Member State, brings policymakers and topic experts together to work through it.

Further support will come from (i) exchanges of experience and good practice among Member States and other stakeholders, (ii) transboundary cooperation, notably on soil units, (iii) secondary legislation, especially an implementing act on data management, (iv) EU programmes such as LUCAS, Copernicus and EU data legislation, and (v) Mission Soil and other research projects.

Table 2 | Expert group roadmap under Article 24



In discussion, Goidts described the SML as unusual because it requires the Commission to support Member States and co-create the system with them. Member States start from different points, with front-runners alongside countries that face more difficulties. The expert group connects communities that rarely meet, from contaminated sites to forest management, and some Member States are already setting up national coordination mechanisms.

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AI 4 Soil Health

DIALOGUE 4 From Soil Monitoring to Action across EU Policies

Research and innovation for implementation



AI4SoilHealth: key results and potential for policy use

Lucas de Carvalho Gomes* | Department of Agroecology, Aarhus University

** on behalf of Professor Mogens H. Greve*

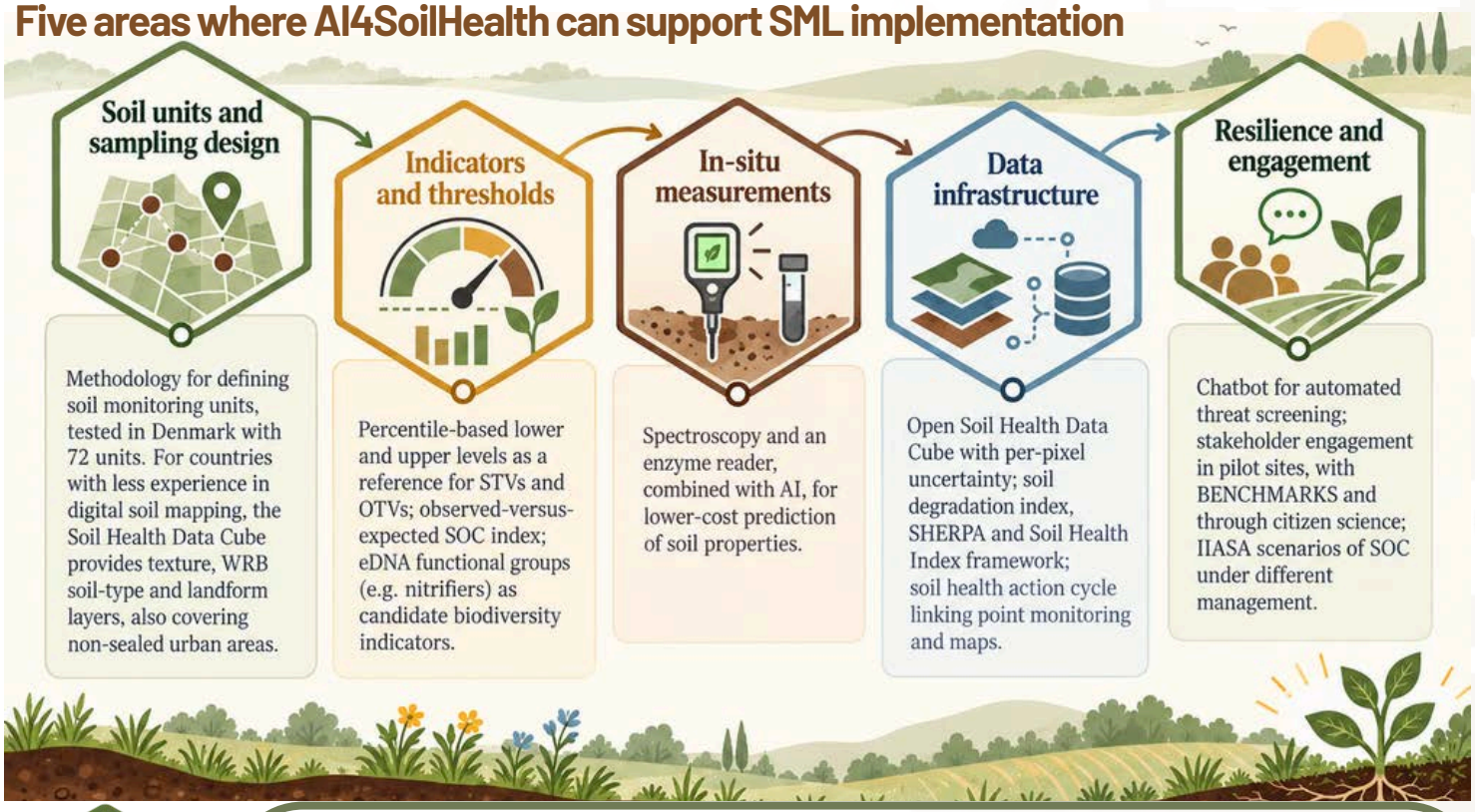
AARHUS UNIVERSITY

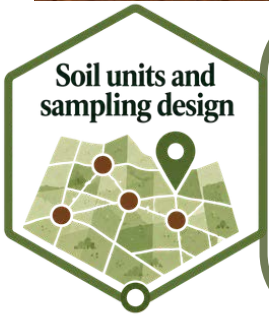
"Over the last three to four years we have been in close contact with the Commission, and we adapted the project to better support policy needs."

AI4SoilHealth started before the Soil Monitoring Law, but over the last three to four years it has worked in close contact with the Commission, in particular DG AGRI and the JRC, to support implementation. Working with 13 pilot sites in 11 pedoclimatic regions, the project harmonised more than 250,000 soil organic carbon samples into 30 m maps for 2000–2024. Its Soil Health Data Cube viewer has had more than 200,000 visitors, and its policy webinar series has reached participants from 68 countries. Among the project's many results, Gomes selected those most relevant to policy, grouped in five areas.



Five areas where AI4SoilHealth can support SML implementation





A 2024 Danish case study divided the country into 72 soil monitoring units, combining texture-based soil type, landform, wetland type and three cropping systems. This goes beyond the LULUCF classes to capture differences in management, especially in agricultural areas. For each unit, the 10th and 90th percentiles of properties such as soil organic carbon, bulk density, pH, erosion and nitrogen leaching provided lower and upper levels corresponding to the SML's sustainable target values and operational trigger values. On this basis, 44% of Denmark showed none of the soil threats assessed. Drawing on work by David Robinson, Gomes stressed that soil units should distinguish stable layers, such as texture, from changing ones, such as land use. For countries with less experience in digital soil mapping, the Data Cube could support the development of soil units by providing texture, WRB soil-type and landform layers, including non-sealed urban areas.

In discussion, Gomes confirmed that Denmark will have a single competent authority, while Giuffrè noted that countries such as Italy are likely to have several, which will require stronger coordination across regions.



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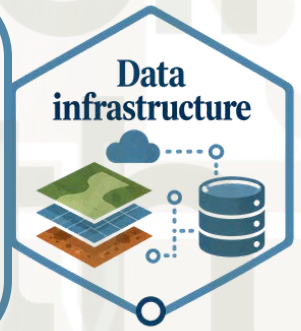
A second area where the project can offer support is soil health indicators, from developing new ones to setting sustainable target values and operational trigger values. As an example, the project brought to spatial scale an observed-versus-expected SOC index proposed in the UK by Feeney, showing that it discriminates between areas better than the SOC-to-clay ratio. The index has been discussed in the SML expert group as a suggestion for future revision. On soil biodiversity, the project is using a large Danish eDNA dataset of about 7,000 sampling points to identify meaningful indicators, analysing functional groups such as the relative abundance of nitrifiers.





While the SML sets strict requirements on methodology and reference methods, the project, which started before the SML, has focused on developing in-situ methods, in particular (i) spectroscopy to predict soil properties and (ii) an enzyme reader developed by one of the partners. Combined with AI technologies, these methods can significantly improve the prediction of many soil properties in a more cost-efficient way. This responds to a clear need expressed by Member State experts and policymakers, as soil analysis remains expensive

The Soil Health Data Cube provides open data on soil properties across Europe, together with other layers such as vegetation indices and a tillage index, with the uncertainty reported for each pixel and the possibility to filter data by country. The project is also assessing soil health and its trends through three complementary approaches: (i) a soil degradation index mapping changes in degradation across Europe between 2000 and 2022, (ii) SHERPA, and (iii) the Soil Health Index framework, conceived as a set of indices rather than a single one. The overall aim, described as the soil health action cycle, is to connect point-scale monitoring data with the maps produced by the project. Where uncertainty is low, this can provide farmers with low-cost information, while policymakers can use the maps for larger-scale assessments, where a higher level of uncertainty is acceptable.





Responding to the challenge raised by Goidts, the project can offer support in three ways: (i) automated threat screening, through a chatbot integrated in the Soil Health Data Cube that allows users to query and filter the data; (ii) stakeholder engagement, carried out in the pilot sites, with the sister project BENCHMARKS and through citizen science; and (iii) forecasting the effects of soil management, using a model developed by the partner IIASA to project future soil organic carbon under different management scenarios. The results show that sustainable management leads to significantly higher carbon storage over time than intensive management focused solely on agricultural production.

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Research and innovation for implementation



BENCHMARKS: key results and potential for policy use

Fenny van Egmond –Wageningen Environmental Research / ISRIC

WAGENINGEN UNIVERSITY & RESEARCH

ISRIC World Soil Information

"If you know your objective, you can be much more targeted in your land management practices and soil monitoring."

BENCHMARKS and the SML. Like AI4SoilHealth, BENCHMARKS started before the SML but has since adapted its work to ensure alignment with the law. Taking the SML into account, it refines the soil indicator framework at a more detailed scale and/or for (more) specific aims. The goal is to make it usable by land managers, national and regional stakeholders along withvalue-chain actors, and to encourage action on the ground.

BENCHMARKS is a Horizon Europe project working to develop a harmonised, transparent and cost-effective framework for assessing and monitoring soil health across Europe. Through a participatory approach involving scientists, policymakers, land managers and other stakeholders, the project develops and tests indicators, methods and practical tools tailored to different land uses, objectives and scales. By connecting scientific evidence with users' needs, BENCHMARKS aims to make soil-health monitoring more relevant, accessible and actionable, supporting better land management and the implementation of EU soil policies.



Soil Health BENCHMARKS

Purpose of monitoring

The SML is mainly a tool for policymakers, working with national and sometimes subnational actors. Industry, farmers, NGOs and consumers, however, monitor for other reasons: (i) to identify trends, (ii) as a warning system, (iii) to assess status, (iv) to check whether measures had an effect, (v) for certification, or (vi) to provide incentives. Complementing the SML with these perspectives can make it more useful.



Working across scales and land uses. From the outset, the project recognised that land uses, scales and actors differ. Land managers, national legislators, value-chain actors and European policymakers have different needs, so the same indicator cannot serve them all. The guiding principle is "as generic as possible and as specific as needed": indicators at regional and local level should fit together as building blocks of one coherent system. The information gathered can also serve the legislation listed in Annex III of the SML, related ecosystem services and several UN Sustainable Development Goals. This approach builds on 23 multi-stakeholder workshops in 17 countries on needs and barriers in improving and monitoring soil health.

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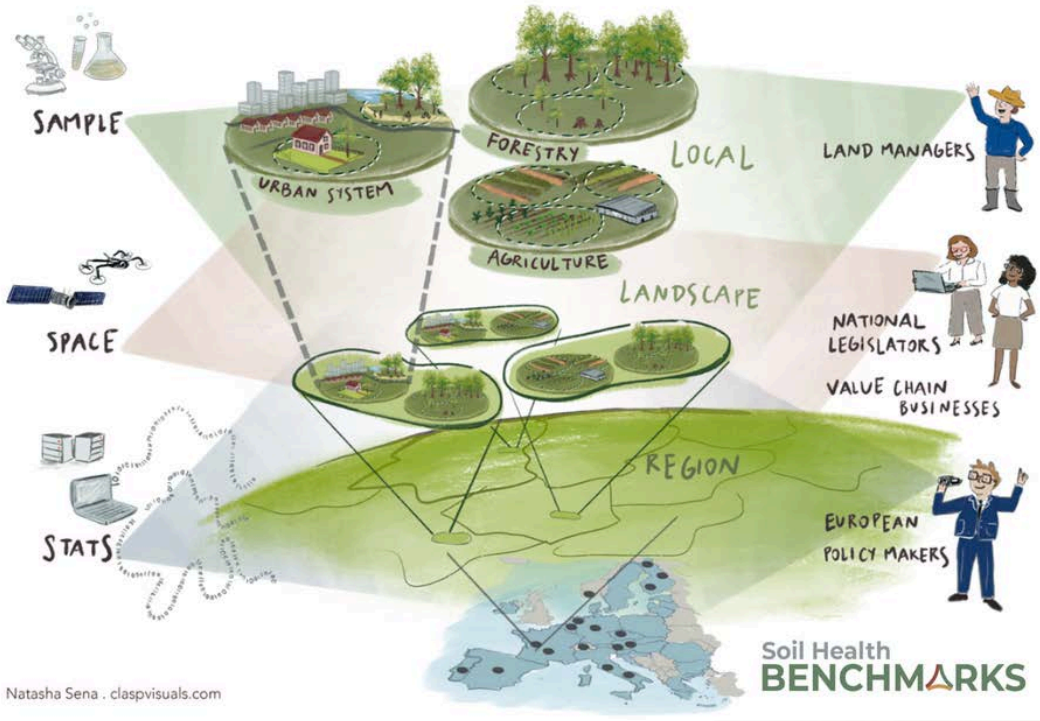
How do we monitor soil health?

BENCHMARKS defined five steps, within which the SML can be embedded: (i) identify the objective and context of the assessment; (ii) understand the drivers of soil functioning in that area; (iii) identify the soil functions, processes and parameters of interest; (iv) select indicator measurements that capture change over time; and (v) assess whether the methods are available and feasible in practice. For example, a goal such as reducing erosion or improving infiltration is linked to the soil functions that support it, then to the processes behind them, such as aggregation or bioturbation, and finally to the soil properties that underpin those processes. This chain shows what to measure, when and where.



Soil functions and purposes. Expert-based models were developed for four soil functions: (i) water regulation and purification, (ii) carbon and climate regulation, (iii) nutrient cycling and (iv) habitat provision. Each model breaks a function down into sub-functions and processes, with the most relevant processes identified by experts. It then proposes objectives by scale. For water, a land manager may aim to increase infiltration, a value chain to meet water stewardship standards, national policy to reduce flooding, and EU policy to serve laws such as the Water Framework Directive.

The logical sieve. To select methods, a "logical sieve" scores indicators on three criteria: (i) pertinence, meaning whether they provide the information needed; (ii) applicability to a given land use and scale; and (iii) technical feasibility and cost. This narrows the full list to a targeted set of methods and properties.

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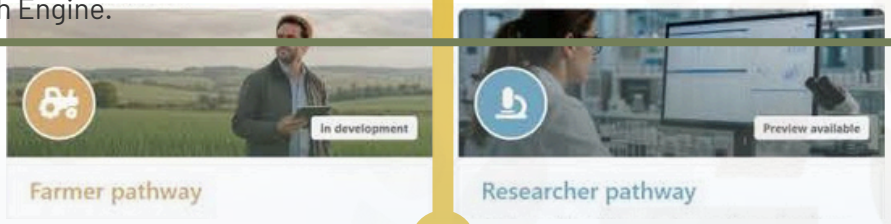
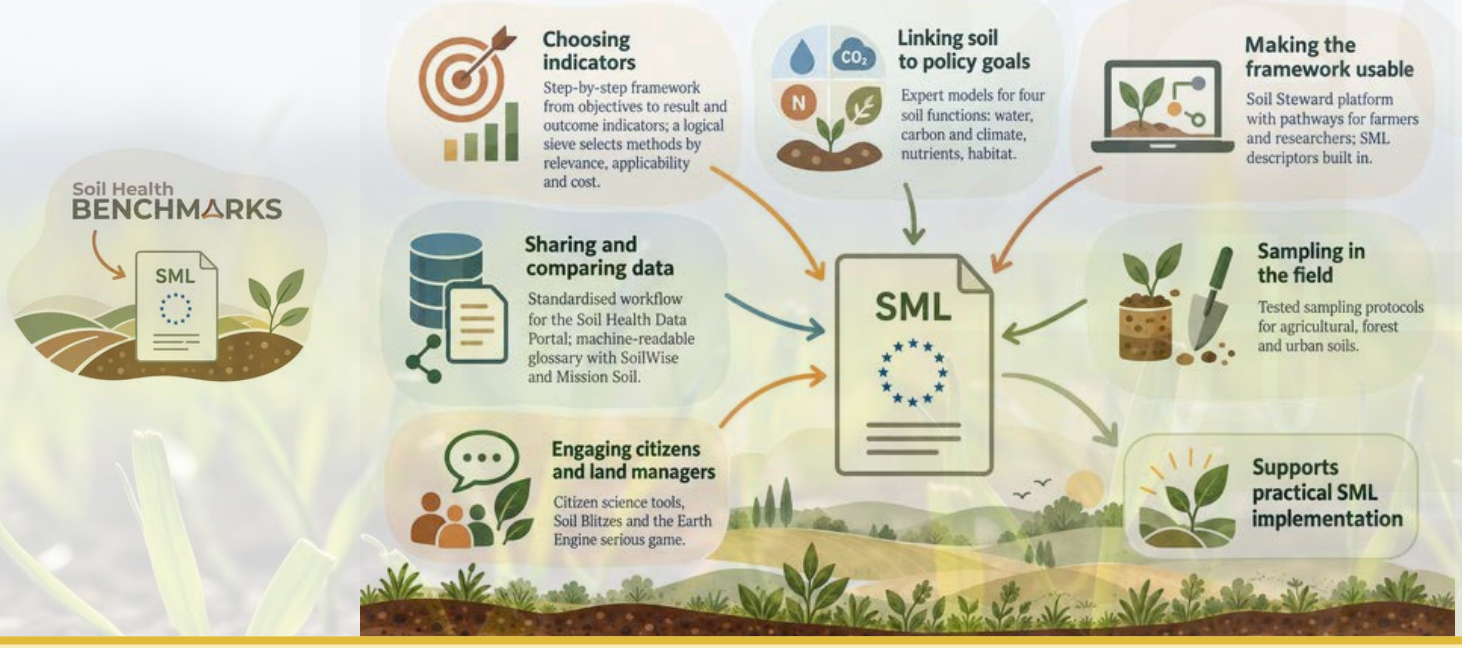
Tools and Data

These elements come together in the **Soil Steward platform**, developed by the Josef Stefan Institute. It offers pathways for farmers and researchers, with MRV for soil health to follow, and builds on the BIOSIS method selection tool for soil biology. SML descriptors are included and can be selected, and a first working version is expected in February 2027. An operational workflow standardises, checks, stores and shares soil data from simple CSV uploads, and can be mapped to reporting structures such as the Soil Health Data Portal. Because soil health terminology is not yet machine-readable, BENCHMARKS is making its glossary machine-readable together with SoilWise and the Mission Soil cluster on knowledge and data management. The project has also produced (i) inventories of stakeholder objectives and existing indicators, (ii) sampling protocols for agricultural, forest and urban systems, tested in a Europe-wide sampling campaign, and (iii) citizen science tools, including five Soil Blitzes with 467 measurements and the serious game Earth Engine.



How BENCHMARKS can support SML implementation



In discussion, asked about exchanging practices across regions with similar pedoclimatic conditions, van Egmond referred to an AI-supported literature review on how sustainable soil management practices affect soil health in different regions. She noted that language remains a barrier to uptake: vocabularies for practices, for example in AGROVOC, could be made multilingual, but translations need expert validation.

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Soil Monitoring Law implementation: overview, challenges to overcome and European Commission support

Laura Bentley | Environmental Data Scientist, UK Centre for Ecology & Hydrology (UKCEH)

UKCEH
Our planet. Decoded.

"It's the only way, really, at scale, to detect when things are starting to go wrong in a way we don't anticipate"



Background

Bentley presented the UK's experience of supporting evidence-based policy with soil monitoring, speaking on behalf of the many people involved in its programmes. The UK has 50 years of national-scale soil monitoring, and four programmes are currently active at different scales. Each provides evidence on soil condition to support decision-making; they share some design features and differ in others. UKCEH runs three of them and supported the design of the fourth. Bentley addressed two questions: what these experiences teach about translating soil evidence into policy and decisions, and what would make soil monitoring more useful. She answered from a scientist's perspective, stressing that the views of policymakers and land managers are equally needed.

Four UK monitoring programmes: different scopes, complementary approaches



Countryside Survey (Great Britain, since 1978)
led by Bentley at UKCEH. It reports on national soil condition; scheme evaluation is possible with its data but not routine.





ERAMMP (Wales, since 2012)
commissioned by the Welsh Government. It is fully compatible with the Countryside Survey but measures much more, including birds, pollinators and freshwater, and is designed to assess Glastir, the Welsh agri-environment scheme.





Countryside Survey of Northern Ireland (since the 1990s)
soils were added in 2023–24, so it has just established a soil baseline.





Natural Capital and Ecosystem Assessment (England, since 2024)
run by Natural England for Defra, and also designed to assess agri-environment schemes.



All four co-locate soil and vegetation monitoring and use stratified sampling. Their designs are similar enough to compare results, which will be valuable once the two newer datasets are available.

Question-driven soil monitoring. The programmes are designed around the questions policymakers and land managers need answered: (i) what has changed, (ii) does it matter, (iii) what is driving the change, and (iv) how this can inform future decisions. In practice, this means asking whether a previously detected decline has continued, whether changes exceed trigger points for action, and whether agri-environment measures are countering the trend, and where. Answers are provided both as evidence and as decision-support tools. One example is a UKCEH benchmarking tool that lets land managers compare their measurements with similar soils.

Emergent issues in soil pH. In 2007, the Countryside Survey provided the only national-scale evidence that 1983 UN legislation against acid rain had worked: soil pH and vegetation communities had recovered across Great Britain since 1978. In 2019, however, it detected significant new acidification in both low- and high-intensity systems, potentially linked to climate or nitrogen deposition. Plant communities are still stable but could decline in future, and research into the drivers is under way to inform policy. Because the UK programmes are independent but compatible, they can verify each other. In 2025, Welsh monitoring confirmed new pH declines in semi-natural habitats, while intensively managed systems showed a different pattern that indicates where to look next.

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Implications for monitoring

Bentley drew three lessons:



Long-term continuity is key to detecting the impacts of policy and management, so measurements should still be possible in 20 or 30 years.



Monitoring should scan for emerging risks and be resilient to annual climate extremes, to separate real trends from fluctuations.



Comparing results with neighbouring countries provides independent verification, and can supply counterfactuals for evaluating schemes where none exist within a country.

A closer look shows two further lessons:

- **Averages can hide extremes.** Phosphorus levels in improved grassland remained fairly stable on average, but more farms now exceed leaching thresholds than ten years ago. Refining such thresholds for different systems, as the benchmarking work in AI4SoilHealth will support, is also being considered.
- **Local success may not change national condition.** Woodland management significantly improved soil carbon where it was applied, but uptake was too low to shift the national average. Sites from earlier schemes had clearly benefited, but few moved into the new scheme, and many of those gains declined quickly.

Answering the "so what?" questions

Monitoring must also explain what changes mean, for example what declining pH means for biodiversity and production, and when it might become a problem. This requires resources and supporting structures within programmes, since the people doing the monitoring are often best placed to answer. It also requires enough samples to explore drivers and regional differences, and contextual data collected alongside soils. Because the UK programmes record biodiversity with soils, they can show directly what a change means for plant communities.

National trends and agri-environment scheme evaluation

NERAMMP, led by Bridget Emmett for the Welsh Government, tracks both national condition and scheme impact. Across many themes, positive trends have fallen and declining ones increased, and in soils declines clearly outnumber improvements. Glastir benefited birds but had no detectable impact on soils at scale.

Aligning scheme monitoring with national condition monitoring therefore separates two questions: whether a measure works, and whether uptake is enough to change national condition.

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DIALOGUE 4

From Soil Monitoring to Action across EU Policies

Research and innovation for implementation



Soil Monitoring Law implementation: overview, challenges to overcome and European Commission support

Laura Bentley | Environmental Data Scientist, UK Centre for Ecology & Hydrology (UKCEH)

UKCEH
Our planet. Decoded.

"It's the only way, really, at scale, to detect when things are starting to go wrong in a way we don't anticipate"



CHALLENGES

Management Data

Turning to what would make soil monitoring more useful, Bentley pointed first to the lack of contextual management data. The efficacy of many soil health practices depends on context. Yet the wider farming system, its history and its rotations are rarely known, and even scheme data give only part of the picture. Supporting data can help. ERAMMP's survey of 600 farmers found that Glastir participants had reduced their nutrient inputs, but so had farmers outside the scheme, for other reasons. This largely explains why soil nitrogen did not differ between the two groups.

Becoming More Agile

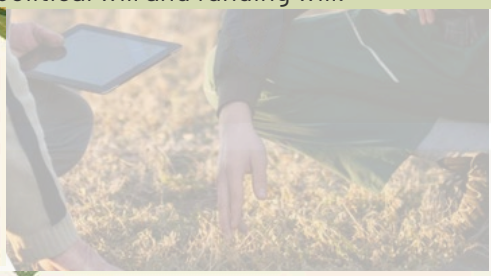
Long-term consistency remains essential, but policymakers and land managers also need prompt information on new threats. Traditional methods report change robustly, while new methods can unlock new information at the cost of continuity. Sample archives offer some flexibility, but not for every measurement. Bentley suggested that the answer may lie in monitoring design: (i) a minimum core of sites and indicators for long-term reporting and threat detection; (ii) agile sampling, deployed opportunistically to detect new threats or target areas of concern; and (iii) citizen science and farmer-led monitoring to fill gaps.

Communication

Finally, communication with diverse stakeholders must be maintained over time. Data to answer a question often exist, but the people asking it do not know, and links can be lost over long monitoring periods. Bentley urged programmes to keep asking: (i) who decides which questions monitoring addresses, how often this is reviewed and who contributes; (ii) whether data are presented only as reports and CSV files, or also as tools and decision-support systems; and (iii) who these tools are for, and whether they are fit for purpose.

In discussion, asked how UK monitoring began, Bentley traced the Countryside Survey back to Bob Bunce, who designed the approach and secured funding for it. The survey has since relied on changing funding models and partners and is now funded through UKRI National Capability. In 2012, the Welsh Government built on this legacy by setting up ERAMMP, whose baseline now allows it to track change, and work is under way to align long-term Countryside Survey data with the new programme in England. Continuity, she concluded, depends on champions who provide a through line across policy cycles, and on political will and funding will.









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Conclusions



Moderated discussion and looking ahead

Upscaling results

Asked what is needed to upscale their results, van Egmond said that BENCHMARKS is operationalising its tools and preparing policy briefs. It would like to test how its tools complement the SML with SML stakeholders, for example through the expert group, and to explain jointly with other Mission Soil projects and beyond how their tools fit together. Gomes explained that AI4SoilHealth, which closes at the end of 2026, is finalising around ten deliverables. Its priority is to reach users beyond European projects, for example with a tool that lets farmers and land managers add their own data to produce maps with lower uncertainty for their area.

Indicators and the SLM review

Panos Panagos (JRC) stressed that both projects were funded to develop indicators, including those proposed by the Soil Mission. He recalled AI4SoilHealth's joint work with the JRC on bulk density, the SOC-to-clay ratio and porosity, and asked how the projects can inform the next SML revision: which indicators work better, and which are missing. Van Egmond replied that in its remaining year BENCHMARKS will provide its framework, tooling and recommendations for supporting implementation and revision of the SML. As an easy first step, its tools could flag which indicators also serve the CAP, the NRR or the CRCF. She also proposed to check complementarity between indicator maps produced by BENCHMARKS and AI4SoilHealth. Gomes added that some indicators, such as porosity, have been upscaled to European level. In Denmark, the project has developed nitrifier-based biodiversity indicators, strongly linked to fertilisation, and water-retention curves at 10 m resolution, alongside European work on ponding and infiltration.

The Commission's view

Asked about short-term priorities for research, Goidts noted that the projects already work at a stage the SML reaches last: the knowledge repository on measures and practices. She encouraged them to use SML vocabulary, such as soil units and descriptors, with stakeholders and to help avoid redundancy across legislation, so that SML data such as soil organic carbon can be reused for the CAP, the NRR and climate policy. In this sense, the projects act as small-scale integration systems.

Emerging threats

Bentley explained that national trend reporting on emerging threats is carried out for the Countryside Survey under National Capability funding. Separately, the Welsh Government leads a work package with UKCEH on new indicators, trigger points and emerging threats that may require new monitoring.

Closing the series, Giovanna Giuffrè picked up Goidts' image of **bridges between policy and science**: policymakers need ecological evidence, and scientists need to understand policy language and user needs.

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Legal, scientific and project references

- Symanczik, S., Lori, M. et al. (2025). BENCHMARKS soil sampling protocol: Guidelines for agricultural and forest systems. Natural resources and bioeconomy studies 40/2025; companion protocols 39/2025 and 41/2025.
- Directive (EU) 2025/2360 of the European Parliament and of the Council of 12 November 2025 on soil monitoring and resilience (Soil Monitoring Law).
- Emmett, B. A. et al. (2010); Seaton, F. et al. (2022); Emmett, B. A. et al. (2025); Bentley, L. et al. (2025), as cited in the UKCEH presentation.
- Soil Health BENCHMARKS: https://soilhealthbenchmarks.eu/
- Soil Steward: https://ecoenvai.ijs.si/benchmarks/soil-steward/
- AI4SoilHealth: https://ai4soilhealth.eu/ | EcoDataCube: https://ecodatacube.eu/

Editorial note

*This Webinar Insight Brief has been prepared in the framework of the **AI4SoilHealth** Cross-Policy Soil Dialogues, a series of science–policy exchanges conceived and organised by **ISINNOVA** to foster dialogue across policy areas and explore how soil knowledge can better support policy implementation. This brief provides a concise summary of the webinar presentations and discussions, reflecting the main points raised by the speakers rather than providing verbatim records of their contributions.*

The key takeaways, cross-cutting insights and policy recommendations or implications presented in this brief are an interpretative synthesis developed by ISINNOVA, drawing on the webinar contributions and analysed within the project's science-for-policy framework. Unless explicitly attributed, these elements should not be understood as statements, recommendations or endorsements made by individual speakers or their organisations.



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