

Workshop on Cross-UK Soil Monitoring and Research

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SOILS
ALLIANCE



UK Centre for
Ecology & Hydrology

Introduction

The Sustainable Soils Alliance in collaboration with the UK Centre for Hydrology and Ecology hosted a workshop in February 2024 to identify, map and evaluate readiness of soil-assessment-focused research for policy delivery taking place across the UK. The objectives were to build greater understanding of the detail behind current and planned soil monitoring activities by the four governments, and lay the groundwork for a roadmap towards harmonisation of frameworks, methods and protocols.

The workshop was attended by two groups of stakeholders: policymakers in the soil and land use departments of each of the four governments who have developed (or are developing) soil monitoring programmes, and the suppliers of these programmes who worked on (or are working on) the technical detail.

The day was organised around a programme of presentations that included overviews of national schemes, an analysis of the technical content of these schemes, and an exploration of land-manager-led monitoring efforts currently being rolled out through industry. This was set within the context of the EU soil mission and soil law and the extensive monitoring and reporting plans associated with that.

The day was run interactively with feedback and observations invited throughout, providing varied discussion on a number of points including opportunities/needs for alignment, the strengths and weaknesses of methodologies, and priorities for future research.

This report summarises the presentations given at the workshop and includes the points raised by attendees in response, under Chatham House rules. First the rationale for the workshop is laid out, with an introduction to the LUNZ Hub and the international context. Following this is an in-depth analysis of the four nations monitoring schemes, based on [a shared spreadsheet](#) providing details of monitoring methodologies. The variety of land-manager-led approaches to soil data collection (including sustainable farming schemes) and related concerns are then covered, and lastly the group's hopes for future research and commissioned LUNZ work are explored.

Background

The origin of this workshop lies in conversations with policy makers, farmers and businesses, but it was given the necessary lift in urgency through the launch of the Land Use for Net Zero (LUNZ) Hub. This is a government-funded consortium of 34 organisations that aims to provide all four UK administrations with the rapid evidence they need to develop policies that will drive the land use transformation required to achieve Net Zero by 2050. Delivery partners include experts from research, farming and industry across issues including green finance, renewable energy, planning, soil health, afforestation and water management. LUNZ will play a pivotal role in supporting policymaker decision making and helping to communicate more widely the critical importance of land as a carbon sink or source.

Soil Health and Carbon Dynamics is one of the key cross-cutting themes within LUNZ, that is coordinated by a Topic Advisory Group (TAG) co-led by Ellen Fay (SSA) and Pete Smith (University of Aberdeen). The LUNZ Soil TAG will provide the bridge between policy, research and practice, and



this workshop is the first step in addressing the TAG's primary focus for this year: soil health assessment and monitoring.

Understanding the state of our soils is critical for both national targets and individual land managers (the term 'land managers' is used throughout this report in recognition of the need to avoid a narrow focus on farmer monitoring, and ensure coverage of non-agricultural soils). By knowing which soils are in need of what remediation, progress can be made on reversing degradation, and improving soils for the wealth of services they can provide.

Currently however, the growing number of inconsistent approaches to soil health assessment represent a barrier to better understanding. The different frameworks, metrics, thresholds, protocols and terminology that are in various stages of development from governments, industry and NGOs are generating inconsistent data, and ultimately different interpretations of soil health. This can have wider implications for agricultural and environmental policy development, and hamper future research and prioritisation by misalignment of data. This workshop was a first step in addressing this issue, by providing a more coherent picture of soil monitoring at the policy level across the UK, and identifying common challenges and priorities for future work.

Throughout the workshop the potential value of collaboration was noted, especially regarding the importance of avoiding duplication, sharing progress as schemes rapidly develop, and presenting a united vision to farmers, some of whom see lack of alignment in national schemes and guidance for measuring their own soil as preventative to them measuring soils effectively. However, the difficulty in shifting from one methodology to another once data collation is already progressing was raised as a critical barrier, especially when significant investment has been made in adopting particular monitoring approaches. Discussions were hence more focussed on identifying potential areas for 'harmonisation' rather than trying to forge 'standardisation' within the national schemes, with a specific window of opportunity available for supporting guidance for farmer-led monitoring which is still under development in all 4 nations. Throughout the day it became evident that there is a need for more government leadership given that without a 'one-stop shop' for farmer-led soil monitoring it is inevitable misaligned schemes will proliferate.

European Context

The first presentation covered EU monitoring efforts under the Soil Deal for Europe Mission. This highlighted the international importance of soil monitoring and the relevance of UK schemes to wider efforts to improve soil health that is degraded across the continent. The significant funding dedicated to monitoring in the EU gave weight to the importance of this workshop, but it was raised that the EU is experiencing similar difficulties around harmonisation: Only 6 countries have national monitoring schemes in place with varying levels of alignment, and some don't have any soil mapping to speak of. The extent to which each member state can monitor independently is being discussed, as there was pushback after the initial EU soil health law, but many are hoping it will be a coordinated approach centred around the ongoing pan-EU ongoing monitoring programme – LUCAS.

Here the important point was raised that the EU Join Research Centre and EU soil observatory has in the past collected soil data in the UK but is unlikely to continue this activity going forward since the UK left the EU. Ongoing analysis of the existing data is currently included the UK as and described as e.g. 'EU and UK soil trends' but how long this will continue is unknown. It was agreed among the group that it would be highly beneficial to remain part of EU-level research for a number of reasons:

- The UK is still part of Horizon funding program for research and innovation, so many future products will be available for UK researchers and may cover UK soils.



- Looking at comparable data over a larger scale can be extremely useful to contextualise national issues- something UK researchers have benefited from for a long time in understanding drivers and impacts.
 - By including UK data in EU machine learning schemes, our data can benefit from wider comparison and be more valuable for addressing degradation and the success of sustainable land management actions in reversing degradations and restoring soil health.
- Connecting land managers on the same soil type ‘horizontally’ across countries was seen as a valuable way to improve understanding of soil health and share successful practises.

Despite agreement that engagement with EU schemes is beneficial, attendees noted that political barriers might prevent working together, and that asking EU schemes to include the UK is not a simple request. Some attendees suggested that focussing on the value of resilience thinking can help sidestep such barriers, and all agreed that by working towards some national alignment the UK can both contribute to and benefit from the EU Mission.

Analysis of National Monitoring Schemes

Prior to the workshop, a spreadsheet was circulated to gather information on national monitoring schemes across the UK. The intention was to provide a simple resource to inform discussions on the day for anyone who is involved in soil policy and monitoring and who is interested in how to improve the link between soil research and monitoring. This spreadsheet built on past synthesis and analysis of soil monitoring schemes described in LQ09.

The sheet was laid out to allow comparison of the distinct aspects of each scheme (of which each government filled in more than one). This included background context such as the driving policy objective, and extensive detail on the technical methodology of each scheme, such as sampling framework; soil physical, chemical and biological qualities; archiving protocol; and other supporting information such as management practices. Several additional parameters were noted throughout the workshop, such as whether the scheme covered nematodes, and these rows were added and recirculated following the workshop for any final additions from attendees.

Overview of schemes

A total of 15 schemes were submitted, with the first eight of these in the list below currently with confirmed funding:

1. Soil Nutrient Health Scheme (SHNS)
2. Countryside Survey NI (CS/NI)
3. Countryside survey GB (CS)
4. Glastir Monitoring and Evaluation Programme / Environment and Rural Affairs Monitoring and Modelling Programme (GMEP / ERAMMP)
- 5a. England Ecosystem Survey/NCEA (EES/E)
- 5b. Fungal Health Survey - Natural Capital and Ecosystem Assessment Programme (Kew-NCEA)
6. BioSoil -soil and biodiversity network (FR)
7. Land Use Change Area-frame Survey Soil Module (LUCAS/EU)
8. ICP Forest Level I forest monitoring network (FR)
9. ICP Forest Level II Intensive forest monitoring network (FR)
10. National Soil Inventory (NSI/E&W)

Monitoring plans in Scotland are in preparation for a start date in 2027 and are likely to be based around the following schemes which were also submitted:



11. National Soil Inventory of Scotland (NSI/S)
12. Trends in pollution of Scottish Soils (TiPSS)
13. Birse and Robertson Survey soils
14. Afforested soils in Scotland
15. East of Scotland Farm Survey

All four governments had some level of coverage either through country specific schemes or by coverage from GB or UK schemes (this excluded any land-manger led monitoring programmes).

Across the UK we are already data-rich, and while some schemes covered much more than others, they could be broadly grouped into three categories:

- Seven schemes have funding and cover all habitats and soils nationally using a sampling design and number of samples to capture a national representative unbiased sample (EES/E, NSI/E&W, NSI/S, ERAMMP/W, CS/NI, CS/GB and LUCAS/EU)
- Three are large schemes designed to capture unbiased sample but target specific habitats:
 - Agriculture (SNHS/S)
 - Forestry (BioSoil & BioD/UK)
 - Non-arable soils (B&R survey/S)
- Five schemes are networks based on 'typical' sites along gradients or to capture a range of vegetation or geological / soil classes

Past schemes

Not all of these schemes are active- five previously funded schemes in Scotland, where work is ongoing to develop a new monitoring scheme, were submitted as well as one (NSI E&W) that covers England and Wales. It was also assumed that LUCAS/EU will not be continuing for the UK. Beyond these, there are a number of separate soil monitoring programmes which have no specific funding in place but represent a potential resource for future comparison, NSI E&W (Cranfield) being the most obvious and largest (also of note are the 29 schemes identified and reported in 2006 by Emmett *et al.*).

Live/funded schemes

The purpose of many of the funded schemes is to understand national trends of soil condition in either all habitats or a subset of specific habitats, while others are predominantly to provide a baseline for agri-environment schemes (CS/GB, ERAMMP/W, EES/E). Two are explicitly intended to also track agri-environment scheme outcomes at national level i.e. checking for displacement from in-scheme to outside (ERAMMP/W, SNHS/S).

The primary outcome from this collection of information is the comparative table that can act as an open resource for policymakers, researchers, and other interested stakeholders to learn about how different schemes operate. Beyond this, a number of key technical points stood out:

- A number of schemes have moved from Loss On Ignition (LOI) to **thermogravimetric (TGA) for analysis of organic matter**.
- Analysis of biodiversity components was more extensive than many realised but varied considerably, with metabarcoding generally used to identify bacteria and fungi, with some looking in more detail at mycorrhiza, eukaryotes, nematodes or roots themselves.
- Some schemes measure more specific soil processes such as nitrogen mineralisation and basal respiration, but it should be noted these techniques are especially costly.
- A range of contaminants are being identified, most commonly heavy metals, and some schemes looked into POPs / pesticides, but none currently include more recent contaminants e.g. plastics, AMR.



- Most schemes archived dried samples with only two additionally archiving frozen samples for potential use for molecular and contaminant work. A short discussion on the relative need for freezing samples highlighted the Edwards et al. 2024 paper questioning the need for frozen samples for some element of metabarcoding.
- Only a few schemes collected detail on aggregate stability, erosion, and peat depth.
- Depth measurements varied considerably, most including as a minimum 0-15cm but with only a subset extending sampling to deeper subsoil. It is useful to note LUCAS has now moved from 0-20cm to 0-30cm which is compliant with the needs of the IPCC LULUCF GHG inventory.

Land manager-led monitoring

No scheme information was submitted with respect to land manager-led monitoring e.g. the SFI scheme currently in play in England. It is possible it was not clear this would have been welcomed. See section below for further consideration of this topic.

Observations

In response to this analysis, attendees discussed the point that it can be very difficult to interpret data that is not attached to information regarding management decisions beyond that recorded on site during sampling. This is variable across scheme but can include, land use, evidence of recent management, vegetation composition etc. Monitoring schemes rarely collect information which have may have occurred between sampling periods as the cost of interviewing farmers would be high and there is a risk farmers could start changing management if data becomes more personalised risking bias in the monitoring data. Going forward, high-resolution EO data is likely to fill some of this gap as some management actions such as tillage, rotations and leys, crop type, woodland planting can all be identified at a field scale. Some gaps such as fertiliser and pesticide use though will remain unknown.

Attendees were keen to emphasise the different risks that each government faces, and how that informs monitoring priorities. Northern Ireland, for example, prioritises nutrient management in the face of extensive waterway pollution whilst England has prioritised soil organic matter in its SFI soil monitoring scheme. The most prominent risks were less immediately evident for other governments, although carbon management, peatland degradation and flooding were mentioned, and this variation should be considered when looking towards harmonisation.

Land Manager-Led Monitoring

Separate to national monitoring schemes, soil data is being collected across the UK either by or for individual land managers to support AES schemes and the uptake of sustainable land management practices. Two are driven by national governments – the SFI soil monitoring scheme in England and the Soil Nutrient Health Scheme in Northern Ireland. In the former, soil organic matter measurements by the land manager are needed to secure SFI funding. In the latter, professional surveyors are sampling every agricultural field for pH, nitrogen phosphorus with LiDAR being used to assess above ground biomass and carbon and a subset of farms being explored for soil C stock and sequestration. Both require repeat surveys every 5 years. We are aware both Wales and Scotland have plans to roll out AES soil monitoring schemes although whether these will be professional surveys as in NI, land manager-led as in England, or a combination is as yet unknown.

Beyond this there are numerous diverse players are involved in different initiatives, that are requesting soil measurement in order to better understand farm sustainability, for farming certification, to access agri-environment payments, or to calculate GHG fluxes. At each level, from those collecting the data to the investor in the scheme, there are numerous interested parties, that



includes the supply chain; banks; water, construction and insurance companies; as well as those less directly connected but interested in ecosystem markets and biodiversity net gain.

An overview of these various tools was outlined during the workshop. Some of these simply define metrics for data collection, others are 'baskets of indicators'. Some align on technical detail, others diverge considerably on methodology and rigor. This is often due to a lack of unifying technical frameworks behind each tool, which has implications for not only what data collected, but importantly how that data is interpreted. These can be broadly grouped into three categories:

- Soil measurement tools
- Sustainable farming assessment and certification schemes
- Farm GHG calculators and soil carbon schemes

National incentivisation

Beyond these tools, land-manager-led soil data collection is already or likely to be a requirement for National Sustainable Farming Incentives, with each devolved administration at a different stage of replacing outgoing European basic payments. These farming subsidy systems are still in development in most of the UK, although England's Environmental Land Management schemes (ELMs) has been live for several years now. Each of these is evolving independently, but all suggest to some extent a requirement for land managers to collect data on soil to access (certain) levels of payment. The purpose for collecting soil data in this case is not always clear- in those countries where it will be aggregated for national comparison there is obvious value for policymakers and research, but without that requirement it is generally indicated that understanding (and hopefully hence working to restore/maintain) soil health can be beneficial at the individual level, and ultimately contribute to national targets for restoration.

In discussions around these national sustainable farming schemes, there was agreement that the value to researchers of the data land managers are being asked to collect should not be overlooked. This echoes the recent EFRA Soil Health inquiry, which advises that Defra should be collecting data from ELM actions that already require soil testing as an option. Making this data available clearly involves recognising the importance of data sharing protections, and although policymakers were confident these could be put in place, there were questions about how to assure land managers about the security of sharing. A key point raised was that governments should require this information to demonstrate value for taxpayer money, but there was little clarity on whether this could in any way be aligned, given the freedom land managers have in approaching soil health data collection. In NI, the data collected from each field is only made available to the individual farmer. This approach of prioritising the data to support land-manager decisions and protect individual data is also common in the EU.

Soil Carbon

There was agreement among the group that it is necessary to avoid "*soil health being sacrificed at the altar of soil carbon*", and throughout the workshop the potential for practice change to drive significant changes in carbon sequestration in soil was questioned. Although more measurement of soil was seen as beneficial, there were concerns that carbon/SOM is being used as an indicator for other metrics without sufficient scientific grounding. When carbon stocks do change it is often on a small scale and takes significant time, so isn't always suitable for demonstrating more wide-scale change, especially given further concerns raised in the group that failure to accurately assess subsoil can hide cycling of carbon within the profile as opposed to overall stock change. On this theme one attendee was keen to highlight that biodiversity metrics often get forgotten in place of climate objectives, and there is a risk that land managers prioritise enhancing those metrics they can get paid for (e.g. carbon) at the expense of others. Increasingly though, this is being highlighted to companies fearful of greenwashing allegations. Some work is also needed to clarify when increases



in SOM is not an indication of enhanced soil health (e.g. when contaminants are introduced as an unintended consequence) or the use of manures and animal waste have increased eutrophication at the expense of organic matter / carbon inputs.

Land managers' perspective

The key message from this presentation was that the overwhelming abundance of tools, calculators and schemes available are not only generating inconsistent soil data, but are leading to confusion and indifference among land managers, and ultimately may even be counterproductive for progress on soil health. Without the buy-in from land managers there is little hope that schemes will produce results, and without meaningfully comparable data there will be no way to see an accurate picture of national soil health. While many land managers actively engage with these monitoring schemes to understand their soil better, there is a risk that supply chain demands for making this data collection obligatory will be seen as "*regulation by stealth*".

In many cases, land managers will already be closely involved in some of these toolkits based on their history, crops/livestock, supply chain buyer, catchment etc., but the information on which groups of farmers and supply chain actors are involved in each is scattered. One attendee even questioned whether the fact that uncoordinated farm monitoring platforms are so profuse is a deliberate technique buyers benefit from in preventing farmers from accessing other markets. Nevertheless, there is opportunity, as was noted by several researchers, for this data to ultimately feed into a national picture of soil health, adding value to top-down monitoring.

It was suggested that there is a particular opportunity now where collective government leadership can lead the way as to best practice for land manager-led monitoring with the hope that industry can fall in line, but the practicalities of this were not explored in depth during the workshop. However, the example of RB209 as a potential model which could be built on was repeatedly brought up as a standardised protocol supported by industry, policymakers and researchers, an equivalent of which is desperately needed for soil health assessment. Some tools already have this approach embedded.

Options for Commissioning LUNZ and Other Research

Following group discussions on the national schemes and land-manager-led monitoring, attendees were given the opportunity to distil pressing research questions into asks for the LUNZ soil TAG, as a means to address the points raised above. This was a unique opportunity for policymakers to highlight critical areas of interest where collaboration might be beneficial. Options for future work included covering the following key topics:

1. *Development of minimum set of metrics for soil health assessment*
 - The information provided on government monitoring schemes demonstrated the extensive variety of measurement categories and methods to assess soil health. For the data produced from these schemes to be meaningfully comparable there needs to be a certain degree of alignment.
 - This alignment could help contextualise risks and highlight opportunities where novel approaches to soil management are producing replicable results.
 - Approaching this could entail a refresh of the soil quality index SQUID (Soil Quality Indicator) that links a set of ten different soil functions to different ecosystem services, and/or a meeting of a smaller group of soil-leads from each of the four UK governments.
2. *Fostering a common approach to land manager-led / industry-supported soil monitoring*



- The profusion of independent monitoring schemes/toolkits are already producing data at scale, and there is little understanding of how any of it aligns.
 - To limit confusion in the community, an analysis of these schemes would be a valuable first step to understand what is out there already, what metrics they require, and what learnings there are from land managers.
 - This could lead to the development of a flowchart that indicates to land managers (and researchers and policymakers) which options there are for different purposes.
 - Appetite for changing methodologies is unlikely to be strong among toolkit providers, but bringing together the interested parties could help to identify key areas where harmonisation is possible. This could take the form of research interviews leading to a stakeholder workshop.
3. *Establishing minimum common requirements for national land management incentivisation schemes*
- All devolved administrations are in the process of developing sustainable farming incentivisation schemes. England and Northern Ireland have already released their approach or start to their approach. In England this rewards farmers for collecting data on soil health. In Northern Ireland, the government pays for the sampling of all agricultural fields and provides that data back to the farmer.
 - There is great potential value in working to ensure the data collected has a degree of consistency, to support wider targets and understanding of soil health. This could include: how to collect the sample; to what depth; frequency; minimum set of standardised measurements etc.
 - A workshop that engages policymakers involved in developing these schemes could harness this unique window of opportunity to create a level of harmonisation across the UK.
4. *Comparison of approaches to eDNA methods*
- The growth in different biological methods for soil health assessment was raised as an opportunity to share understanding across nations and monitoring providers.
 - This could take the form of a subgroup of the attendees, and would contribute towards a standardised library of biological methods. UKEOF have offered to host such a group to complement their working group on eDNA in waters.
5. *Briefing on emerging net-zero agricultural technologies*
- A number of approaches to net-zero farming were discussed (biochar, enhanced rock weathering etc.), with concern shared in the group that the evidence base behind them is not necessarily sufficiently robust enough to justify their use or support in sustainable farming incentivisation schemes.
 - These questions are highly relevant to the wider LUNZ Hub, and a research project or workshop could be proposed that includes the Land Use and Agricultural Systems working groups to better assess their application.

Next Steps

The presentations made during this workshop and the wide-ranging discussion in response constitutes an overview of the current soil monitoring situation in the UK, and the research priorities of those most closely involved in its development. This background document represents a starting point for more in-depth discussions on harmonisation, than can hopefully lead to clarity for farmers, more valuable data for researchers and the supply chain, and the delivery of policy priorities.



The day was an opportunity to share ideas and concerns between the four nations. We hope the spreadsheet detailing the various national monitoring schemes can be used in conjunction with developing work on understanding land-manager-led monitoring to form a valuable resource for policy makers and researchers, and foster a better understand of soil monitoring challenges and opportunities for the wider community. This work is a vital aspect of the LUNZ soil TAG's work, and ultimately should lead to universal appreciation of soil health across sectors.

Beyond the project priorities outlined above, there are a number of priority areas of interest where understating on soil monitoring is spread across stakeholders without sufficient join-up to make meaningful progress on soil health. This includes soil carbon measurement, green finance and soil data issues. The LUNZ soil TAG will continue to consult with the workshop attendees to identify priorities in this space.

