Eleven things we learned about Soil Carbon Mapping, with Dr Matt Aitkenhead

This conversation is the sixth instalment in a series of Talking Heads interviews with the LUNZ Hub Soil Health and Carbon Dynamics TAG community. Throughout this series we will explore the key themes that the community will be working on throughout the LUNZ project lifecycle. In this instalment, TAG co-lead Ellen Fay (Sustainable Soils Alliance) questions Dr Matt Aitkenhead (James Hutton Institute) on his project for peatland and soil carbon mapping in Scotland. The article below provides a summary of the key takeaways from the interview. The full interview can be viewed on the LUNZ YouTube channel.

1. Soil carbon mapping provides a vital baseline from which to track changes in peatland health

Soil carbon mapping is fundamental for understanding and managing peatland ecosystems, which serve as crucial carbon sinks. Without accurate baseline data, it is difficult to assess the impacts of land-use changes, restoration efforts, or climate change on soil carbon stocks. By combining traditional soil surveys with advanced digital soil mapping techniques, researchers at the James Hutton Institute (JHI) can produce highly detailed representations of carbon distribution and soil carbon stocks in peatlands. These maps help policymakers, conservationists, and land managers make informed decisions about protecting and restoring peatlands, providing essential data on where peatland conservation and restoration efforts should be focused and thus ensuring that efforts to sequester carbon are strategically placed and maximally effective. The ability to monitor changes in soil carbon over time also aids in assessing compliance with climate targets and guiding future land-use policies that prioritise soil carbon preservation.

2. High-resolution mapping is crucial for land management decision making and land use planning

Traditional soil mapping methods often rely on broad-scale, mixed mapping units, which provide only a general idea of soil types within a given area. This lack of specificity can lead to inefficiencies in land management and conservation planning, as small but significant pockets of peat or high-carbon soils may be overlooked. High-resolution digital soil mapping allows researchers to precisely locate variations in soil carbon content and peat thickness, offering an unprecedented level of detail. This refined approach enables more accurate carbon accounting, ensures better planning for restoration projects, and enhances the ability to identify areas at risk of degradation. For farmers and landowners, improved soil carbon maps provide insights that can inform sustainable agricultural practices, helping them optimise carbon sequestration while maintaining soil productivity.

3. Differing definitions of peatlands across the UK impacts upon data interpretation

A challenge in peatland mapping is the variation in how different regions define peat. Scotland and Northern Ireland classify peat as soil containing at least 30% carbon with a minimum depth of 50 cm, whereas England and Wales use a shallower threshold of 30 cm. This inconsistency in definitions can create discrepancies in soil carbon inventories and make cross-border comparisons difficult.

4. Standardisation of definitions for peat would enable more joined up climate policies and a holistic understanding of the UK carbon landscape

The lack of a unified definition affects land-use planning and carbon market mechanisms, as the same parcel of land might be classified differently depending on which definition is applied. Normalising these definitions would enable more consistent assessments of peatland extent and carbon storage potential, facilitating better coordination across national and regional policies. There have been some ongoing discussions about converging peatland classifications between regions and nations. However, changes to existing peatland classification systems must be approached cautiously to ensure that soil carbon mapping contributes to an accurate and reliable representation of the UK's carbon landscape.

5. Peatland condition mapping yields dynamic datasets

While traditional soil carbon maps provide a static snapshot of carbon stocks, they do not reflect ongoing environmental changes. To address this, Dr Aitkenhead's project incorporates condition mapping, which assesses key indicators such as erosion, hydrology, and vegetation cover. By analysing over 20 different spatial datasets, researchers can classify peatland condition more accurately and determine the degree of degradation or restoration potential across time. This approach makes it possible to update maps over time, ensuring that land managers and policymakers have access to the most relevant and up-to-date information. Long-term monitoring of peatland condition helps detect early signs of degradation, track the success of restoration efforts, and refine best practices for peatland conservation. The integration of condition mapping into soil carbon assessments represents a crucial step towards more adaptive and responsive land management strategies.

6. Using soil carbon and peat maps enables prioritisation of restoration leading to multiple benefits

Given the finite financial and logistical resources available for peatland restoration, prioritising restoration effort in peatland which bears the highest restoration potential is key to maximising a project's impact. Soil carbon mapping enables researchers to identify the most degraded peatlands, the areas with the highest carbon sequestration potential, and the sites that provide additional ecosystem services such as flood mitigation and biodiversity conservation. By ranking these areas based on ecological and economic criteria, policymakers can make data-driven decisions about where to allocate funding and restoration efforts. Additionally, mapping helps predict how different restoration techniques—such as re-wetting, re-vegetation, or sustainable land management—will impact carbon sequestration. By focusing resources on high-impact areas, this approach ensures that restoration efforts not only contribute to climate mitigation but also deliver broader environmental and social benefits.

7. Cross-border and broader research collaboration can strengthen UK-wide soil monitoring

Soil carbon mapping efforts are not limited to Scotland—similar initiatives are ongoing across England, Wales, and Northern Ireland. While methodologies differ, the underlying datasets used in these projects are often the same, as researchers rely on publicly available data to guide their work. This allows for some level of alignment and interoperability between different mapping initiatives. For example, mapping efforts in England and Wales have focused on determining the presence or absence of peat and measuring soil carbon stocks, similar to the work being done in Scotland.

A key challenge, however, is that many datasets were not originally designed for peatland condition mapping, meaning researchers must carefully interpret the available information. Land cover datasets, such as those produced by UKCEH, provide broad classifications—such as "bog"—without specifying the condition or level of degradation. This means additional work is required to refine the data, ensuring it accurately represents the reality on the ground.

Despite these challenges, increased collaboration between researchers across the UK could help streamline methodologies and improve the consistency of soil carbon assessments. By aligning data processing techniques and prioritisation frameworks, a more unified approach to peatland mapping could be developed, supporting policymakers to make informed, science-based decisions on land-use planning and carbon offset strategies.

8. Scotland's National Soil Monitoring Framework supports data integration

Scotland is at the forefront of national soil condition monitoring, with multiple projects feeding into a broader National Soil Monitoring Framework. This initiative brings together various research efforts, including the work being carried out by the James Hutton Institute under the Scottish Government's RESAS-funded strategic research program. Now in its third year of a five-year cycle, this framework provides an integrated approach to tracking soil health across Scotland.

The framework consolidates data from a wide range of sources and stakeholders, including government agencies, academic institutions, and environmental organisations. A key benefit of this approach is the ability to cross-reference datasets, ensuring a more holistic understanding of soil condition trends over time. This structured coordination enables researchers to refine soil carbon mapping methodologies, integrate new data as it becomes available, and enhance the accuracy of models predicting long-term soil changes.

Despite the complexity involved in managing such an extensive body of work, this collaborative effort is already driving meaningful progress in soil monitoring and conservation. The interconnected nature of the research means that findings from peatland and soil carbon mapping projects will directly contribute to the wider soil monitoring agenda, helping shape future land-use policy and climate action strategies.

By fostering collaboration among soil scientists, ecologists, and policymakers, the framework enhances the ability to make informed decisions about land management, restoration priorities, and climate adaptation strategies. The key stakeholders benefiting from this research include NatureScot, SEPA (Scottish Environment Protection Agency), Scottish Water, energy companies, large landowners, and conservation groups. The approach is not purely academic; rather, it is highly applied, ensuring that data collection and analysis are directly relevant to the people making on-the-ground decisions. Researchers actively engage with these stakeholders to understand their challenges, tailoring the work to provide meaningful insights that support practical decision-making.

Unlike isolated scientific studies, this project is designed to deliver actionable knowledge, supporting land use planning, conservation efforts, and resource management. The emphasis is on collaborative research—working alongside policy developers, businesses, and environmental groups to ensure that the research translates into real-world impact. By continuously refining methodologies and integrating stakeholder feedback, the research remains dynamic, adapting to new challenges and emerging policy needs.

9. Open access to data is a priority, but licensing remains a challenge

The research team at JHI follows an open science and open data philosophy, advocating for publicly funded data to be freely accessible. However, some datasets come with restrictions due to commercial licensing agreements, privacy concerns, or pre-existing legal arrangements with landowners. Balancing the need for transparency with these constraints requires ongoing dialogue among researchers, policymakers, and data providers. Increasing efforts to harmonise data-sharing agreements and establish open-access repositories would greatly enhance the usability of soil carbon data, enabling more widespread application in conservation and land management.

10. Soil carbon data benefits farmers and conservationists alike

Beyond its policy applications, soil carbon mapping plays a crucial role in supporting farmers, conservation organisations, and other land managers. Farmers frequently seek guidance on soil composition, carbon levels, and land capability to optimise agricultural practices and improve sustainability. The ability to access precise, site-specific soil data helps them make informed decisions about crop selection, fertilisation strategies, and potential involvement in carbon sequestration initiatives.

The demand for soil information is significant, with researchers regularly receiving inquiries from farmers who want to understand their land better. Many farmers are interested in how soil carbon affects productivity and whether their land might be eligible for funding linked to carbon offset schemes. Similarly, conservation organisations use soil carbon mapping to identify and protect high-value peatlands, ensuring that restoration efforts are focused where they will have the greatest ecological and climate benefits.

However, the project goes beyond simply providing raw data. The research team places a strong emphasis on ensuring that the information is accessible and useful. Instead of simply handing over datasets, they work directly with stakeholders to interpret the findings, explain data limitations, and provide practical guidance. This hands-on approach ensures that soil carbon mapping is not just a theoretical exercise but a valuable tool for real-world decision-making.

Collaboration is key. The team works closely with organisations such as the National Farmers Union of Scotland, levy boards, and environmental charities to tailor their research outputs to the needs of different users. By fostering these partnerships, they ensure that soil carbon mapping supports sustainable land management across multiple sectors, from agriculture to conservation.

11. The data is freely available for those who need it

Accessibility is a key priority of this project. The research team actively shares soil carbon data through public platforms and engages with stakeholders to ensure the data is properly understood and utilised. By providing technical support and interpretation guidance, JHI will help users — from policymakers to farmers — make the most of the information. This approach ensures that soil carbon mapping contributes to tangible environmental and economic benefits, supporting efforts to combat climate change and promote sustainable land use.

Soil carbon mapping is an indispensable tool for climate action, land-use planning, and ecosystem restoration. By improving the accuracy of carbon assessments, enhancing data accessibility, and integrating peatland condition monitoring, this project lays a strong foundation for informed decision-making. As collaboration and data-sharing efforts continue to evolve, soil carbon mapping will play an increasingly pivotal role in shaping policies that support sustainable land management and climate resilience.

UK Research and Innovation
Department for Environment Food & Rural Affairs
Department for Energy Security & Net Zero
Scottish Government Riaghaltas na h-Alba gov.scot
Llywodraeth Cymru Welsh Government
Department of Agriculture, Environment and Rural Affairs