BRITISH SOCIETY OF SOIL SCIENCE

Annual Conference 2025

Resilient Soils for a Sustainable Future

Wednesday 3 - Friday 5 December 2025

King's House Conference Centre, Manchester, UK

Thank you to our headline sponsors:
Soil Use and Management, Elementar, Leco and Manchester Accommodation BID

Contents:

Day 1 Itinerary

Time	Main Auditorium	Parallel Room
9:00am	Registration	
10:00am	Welcome *BSSS President, Prof. Paul Hallet*	
10:05am	Opening Remarks *Tony Juniper, Chair of Natural England*	
10:15am	Placing soil health on a global stage – bridging the international gap • William Blake – University of Plymouth • Diana Mangalagiu – University of Oxford • Bruce Lascelles – IUSS President-Elect *[Chair – Paul Hallett]*	
11:15am	Break	
11:45am	Oral Presentation Session – Soils For Climate [1] 1. *Soil and microbial carbon dynamics following conversion of grassland to cropland: stocks, persistence, and susceptibility to extreme heat* – **Christopher Taylor** 2. *Utilising a 15N2O isotope pool dilution approach to quantify gross production and consumption of N2O in UK saltmarsh sediments* – **Karina Marsden** 3. *Soil amendments for greenhouse gas removal: a holistic assessment of biochar and enhanced rock weathering in an agricultural cropping system* – **Elisabeth Appleton** 4. *From Coal to Carbon Sinks: Recovery and Climate Mitigation in UK Restored Mining Landscapes* – **Kaydee Barker** *[Chair – Marta Cattin]*	Launching the LandIS Open Access National Soils Portal – Cranfield University • Dr. Dan Evans • Professor Ron Corstanje *[Chair – Khalid Mahmood]*
12:45pm	Lunch	
1:35pm	BSSS EGM *[Chair – Paul Hallett]*	

1:45pm	EU Mission Soil: Leading the transition towards healthy soils through innovative research • Dr. Panos Panagos, Project Leader of the EU Soil Observatory • Dr. Nils Broothaerts, Scientific Project Officer at the Joint Research Centre of the European Commission. *[Chair – Paul Hallett]*	40@40: Insights from Forty Papers Across Forty Years of Soil Use and Management Fiona Nicholson *[Chair – Andy Morris]*
2:15pm	Oral Presentation Session – Soils for People [1] 1. *First Signs that National Cropland Organic Carbon Loss is Reversing in British Topsoils* – **Laura Bentley** 2. *Factors influencing soil carbon stocks and sequestration rates in Northern Irish grasslands* – **Chris Chagumaira** 3. *Translocation of organic carbon in the soil profile of a longterm experiment: scale and implications* – **Stephan Haefele** 4. *Continental Scale Soil Monitoring: A Proposed Multi-Scale Framing of Soil Quality* – **Grant Campbell** *[Chair – Jack Hannam]*	Oral Presentation Session – Advances for Soils 1. *Evaluating influence of moisture in controlling release of nutrients in novel green fertilisers using neutron imaging and muonic X-Rays* – **Ruben Sakrabani** 2. *Soil bulk density, ultra-high frequency, non-invasive seismic soil analysis* – **Simon Jeffery** 3. *Development and testing of a predictive approach to Agricultural Land Classification and potential applications* – **Liv Hoyland** 4. *Monitoring soil health for the evaluation of Agri-Environment Scheme outcomes* –**John Langley-Randall** *[Chair – Christina van Midden]*
3:15pm	Break	
3:30pm	Poster Session 1 – Soils for People	A New Standard for Soil Ecosystem Services and Functional Biodiversity: Measuring nematode with automated microscopy and AI – Royal Eijkelkamp Bob Klein Lankhorst *[Chair – Khalid Mahmood]* Engaging Youths in Climate Change response: Role of Climate Smart Agriculture Youth Global

		• Wansi Ulrich • Divine Ntiokam *[Chair – Khalid Mahmood]*
4:30pm	Regenerative Agriculture – Putting Research into Practice • Professor Pippa Chapman, University of Leeds • Dr Ruth Wade, University of Leeds • Dr Hannah Cooper, University of Nottingham • Philip Wright, Wright Resolutions Ltd *[Chair – Lizzie Sagoo]*	An overview of the AMAST (AMR in Agrifood Systems Transdisciplinary) Network and opportunities to engage with its members Professor Ruben Sakrabani *[Chair – Khalid Mahmood]*
5:15pm	Summary and Day 1 Close *[Chair – Paul Hallett]*	
7:00pm	Gala Dinner (separate event)	

Day 2 Itinerary

Time	Main Auditorium	Parallel Room
9:00am	Registration	
9:30am	How to measure, report and verify soil carbon change to realize the potential of soil carbon sequestration for atmospheric greenhouse gas removal Prof. Pete Smith, Professor of Soils & Global Change at the University of Aberdeen *[Chair – Lizzie Sagoo]*	
10:00am	Oral Presentation Session – Soils for Life 1. *Boosting Soil Health literacy in Europe through Innovative tools and resources* – **Saurabh Singh** 2. *The Language of Soil: Learning the Lessons from Climate Change* – **Karolina Trdlicova** 3. *Co-designing citizen science for monitoring soil health?* – **Charlotte Chivers** 4. *You Can't Always Get What You Want – Negotiating Soil Literacy with Stakeholders* –**Emma McKenna** *[Chair – Liv Hoyland]*	An Introduction to Soil Organic Carbon Content – Van Walt Vincent Van Walt, Director responsible for Marketing and R&D *[Chair – Khalid Mahmood]* Constructing in a contaminated urban landscape – effective approaches to regenerating soil health • Prof. Frederic Coulon, Cranfield University • Jonathan Atkinson – CL:AIRE *[Chair – Andy Morris]*
11:00am	Break	
11:15am	Pecha Kucha Session – Soil Science Across Boundaries **Carbon and Soil Health** • *A Pan-Wales study of management intensity effects on Soil Organic Carbon* – **Non Williams** • *Insights into the effects of varying biochar C:N ratios on greenhouse gas emissions and soil carbon pools across contrasting soil types* – **Muhammad Tauseef Jaffar** • *Exploring the Potential of Underutilised Plant Species to Improve Soil Health in Sub-Saharan Africa* – **Grant Campbell**	Does soil matter? Emerging approaches to social science, humanities and art in soil health • Jo Pearl • Daro Montag • Dr. Paul Granjon *[Chair – Jack Hannam]*

	Archaeology • *Digging soil: Collaboration potential between soil science and archaeology* – **Meike van Lit** • *Archaeological Investigations – Planning for Sustainable Soil Management* – **Bruce Lascelles** **Machine Learning** • *Reconstructing soil acidity neutralization curves using Machine 2 Learning and chemical or spectral soil signatures* – **Ismail Kouera** • *Identifying Arsenic Mobility Control Zones in Soils Using the Global Dataset: Machine Learning Insights from pH–OC Interactions Across Textural Classes* – **Jajati Mandal** *[Chair – Paul Hallett]*	
12:00pm	Poster Session 2 – Soils for Climate	How soil microbiology can unlock new frontiers in crop protection and crop nutrition - Society of Chemical Industry (SCI) • Dr Ben Jackson, University of Edinburgh • Dr Angela de Manzanos, CEO and Co-Founder of Fa Bio • Dr Chris Quince, Earlham Institute *[Chair – Andy Morris]*
12:45pm	Lunch	
1:45pm	The role of soils in flood mitigation • Prof. David A. Robinson, UKCEH • Dr. David Tompkins, WSP *[Chair – Lizzie Sagoo]*	Rooted in Data: Natural England's Drive to Embed Soil Knowledge in Every Decision – Natural England • Dr. Eleanor Reed • Dr Matthew Shepherd • James Hughes • Jonny Griffiths *[Chair – Khalid Mahmood]*
2:15pm	Evaluating Biodiversity Net Gain Using Long-term Ecological Field Experiments - Ecological Continuity Trust	Oral Presentation Session – Soils for Water

	• Ben Sykes, ECT • Jade Hatton, UKCEH • Jonathan Silvertown, University of Edinburgh • Cicely Marshall, University of Cambridge • Kairsty Topp, SRUC *[Chair – Paul Hallett]*	1. *Signatures of soil structural degradation: exploring stable water isotopes in soil pores* – **Jessica Brook** 2. *Resilient soils for a sustainable future in Scotland – using soil data to inform improved recovery of waste material on land* – **Alan Cundill** 3. *Predicting Soil Erosion through Plant–Soil Interactions in Wheat under Different Agronomic and Water Regimes* – **Sophia Bahddou** 4. *Genotypic variation in wheat root architecture, soil pore structure and hydraulic properties* – **Bartolo Giuseppe Dimattia** *[Chair – Chris Cantle]*
3:15pm	Poster Session 3 - Soils for Water, Soils for Life, and Advances for Soils	Recommendations for measuring organic carbon – comparison of loss-on-ignition, and elemental analysis methods – Elementar Dr Rob Sparkes *[Chair – Khalid Mahmood]*
4:00pm	Break	
4:15pm	Oral Presentation Session – Soils for Climate [2] 1. *Climate-Smart Nitrogen Management: Sensor-based Insights into Legume-based Crop Rotations* – **Emily Guest** 2. *Are soil carbon MRV methodologies meeting the needs of "Carbon Farming" in the transition to net zero farming and beyond? Insights from five years of commercial soil carbon MRV across UK and Europe* – **Helaina Black** 3. *Navigating trade-offs between food security, carbon storage and farm profitability* – **Albert Muleke** 4. Maintaining soil health in an arable rotation – **Delana Davies** *[Chair – Jess Potts]*	*Oral Presentation Session – Soils for People [2]* 1. *A proposed national "Soil Health Alert Indicator" for agricultural landscapes* – ***Christopher Feeney*** 2. *An integrated soil health index for the monitoring, reporting and verification of regenerative management options* – ***Stephan Haefele*** 3. *Regenerating arable soil health for people and the planet- how to do it and monitor it* – ***Jonathan Leake*** 4. *DeepHorizon: DEploying Ecosystemic solutions to imProve soil Health and uncOveRing subsoil functIons in the critical ZONe* – ***Daniel Wardak*** *[Chair – Jess Brook]*
5:15pm	Closing Remarks	

Day 3 Itinerary/Tour Information

Scientific Tour (Bold Moss)

9:00am	Meet at King's House Conference Centre and collect packed lunch
9:30am	Leave on coach
10:30am	Arrive at Bold Moss for Tour
12:30pm	Finish tour and return on coach
1:30pm	Approximate finish at King's House Conference Centre

Cultural Walking Tour

9:30am	Meet at King's House Conference Centre and collect packed lunch
10:00am	Leave on walking tour
12:00pm	Finish tour at King's House Conference Centre

Manchester City Stadium and Pitch Tour

10:00am	Meet at King's House Conference Centre and collect packed lunch
10:30am	Leave on bus
11:00am	Arrive at Manchester City and do stadium tour
12:30pm	Return on bus
1:00pm	Approximate finish at King's House Conference Centre

Speaker Biographies

Tony Juniper CBE - Natural England

Tony Juniper CBE is a prominent environmental figure, active in the defence of Nature for 40 years. He has led major organisations, run global campaigns, written many books and advised at the highest levels. He began his career as an ornithologist and went on to join Friends of the Earth, initially leading the tropical rainforest campaign and then was appointed as Executive Director. He worked as an advisor to HRH The Prince of Wales, was President of the Royal Society of Wildlife Trusts and was an Executive Director at WWF-UK. He is now the Chair of the British Government's official conservation agency Natural England and a Fellow with the University of Cambridge Institute for Sustainability Leadership. He has advised many global businesses on their environmental strategies. His books include the multi-award winning What has Nature ever done for us? and Harmony, which was co-authored with The Prince of Wales. Tony Juniper is a frequent contributor to TV and radio broadcasts and is a prolific speaker on environmental themes. He has received many awards and widespread recognition for his environmental work and in 2017 he was appointed Commander of the British Empire (CBE) for services to conservation.

Prof. Will Blake - Sustainable Earth Institute at University of Plymouth

Will Blake is Professor of River Basin Science and Director of the Sustainable Earth Institute at University of Plymouth with expertise in applying environmental diagnostic tools to support sustainable land & water management. Current work with farmers in UK and the global south explores impacts of land management on soil hydrological processes and use of sensor technology to assess soil composition, supporting the evidencing of Climate-Smart Agriculture and regenerative practices. He is an Advisory Board member of the UNESCO International Sediment Initiative and expert member of Joint UN Food and Agricultural Organization and International Atomic Energy Agency (FAO/IAEA) programmes on nuclear techniques in food and agriculture.

Diana Mangalagiu – University of Oxford

Diana Mangalagiu is Professor at the University of Oxford.

With a dual background in natural sciences, her interdisciplinary research encompasses sustainability transitions, long-term planning, and integrated risk governance in public policy and corporate settings, addressed through modelling, stakeholder-based inquiry and foresight approaches.

Over the past two decades, she has led international projects on environmental policy – including the co-chairing of the Sixth Global Environment Outlook for the pan-European region and the Coordinating Lead Author role for the IPBES Nexus Assessment of the interlinkages among biodiversity, water, food, health and climate change. She has published widely on sustainability, and the integration of environmental and economic policies across corporate and public sectors, co-founded the Initiative for Science, Society and Policy Dialogue, is a scientific board member of the Global Climate Forum and High-Level Group for the International Science Council.

Dr Bruce Lascelles - Arcadis

Bruce is a Chartered Soil and Environmental Scientist with 35 years' technical and business management expertise and is currently Director of Sustainable Land Management at Arcadis, a Past President of the British Society of Soil Science and President Elect of the International Union of Soil Sciences. Bruce focuses on the survey and understanding of soils and on the interaction of the physical and biological worlds in relation to land use change. Bruce is a strong and active advocate for soils and the physical environment as a whole and supports a number of organisations around engagement and knowledge in this area.

Dr Dan Evans – Cranfield University

Dan is a Senior Lecturer in Soil Formation at Cranfield University. He leads both fundamental and applied research on soil formation and the parent materials from which soil is formed. His work focuses on the interactions between parent materials and soils, how soil parent materials support soil ecosystem services, and the natural and anthropogenic threats to the parent material zone. He also studies how soil formation can be accelerated, such as the manufacturing of new soils for urban green infrastructure.

Dan's passion for soils research germinated in 2012 when he studied mobile debris lobes in Alaska during a Royal Geographical Society Scholarship. Following his return, he obtained a first-class degree in Physical Geography at the Royal Holloway, with prize-winning research on root architecture and soil erodibility. During his PhD at Lancaster University, he conducted the first isotopic measurements of UK arable soil formation, and the first globally-relevant estimates of soil lifespans.

Dan is the Early Career Scientist representative for the European Geoscience Union, representing >20,000 Early Career Scientists from more than 20 geoscience disciplines across the Union. Previously, he was former ECS Representative for the Union's Soil System Science division and the National ECS Officer for BSSS.

Professor Ron Corstanje – Cranfield University

Ron is Professor of Data Sciences at Cranfield and Head of the Cranfield Environment Centre. He specialises in the application of spatio-temporal models to understand the nature and behaviour of natural systems and processes. He is interested in the application of (spatial) modelling tools to understand the structure and function of environmental systems and processes. A key area in which these techniques have proven invaluable is in the area of resilience as applied to ecological functions, allowing significant insights into the nature and functioning of resilience. Both these areas have significant societal significance, in helping inform how to infer resilience in the natural and man-made systems on which we depend, but also in how to design and plan the built environment to retain the benefits from the natural capital inherent in our greenspaces.

Dr Panos Panagos - EU Soil Observatory (EUSO

Panos Panagos is the project leader of the EU Soil Observatory (EUSO). Panos has a PhD in soil erosion modelling from University of Basel, and Master in Business Administration from Patras University and an Information Technology degree from Athens University of Economics & Business. Panos lead the European and Global soil erosion assessments and contributes to modelling assessments of soil organic carbon, diffuse pollution and nutrients in soil. He has more than 230 publications in peer-review journals and he has been awarded the Web Of Science highly cited award in the last 6 years 2019-2024. He is coordinating the Working Group on "Soil erosion in relation to land degradation, climate change & food security" in the European Soil Observatory. Panos is also responsible for the scientific and technical support of the JRC to the HORIZON Europe Mission "A Soil Deal for Europe".

Dr. Nils Broothaerts

Dr. Nils Broothaerts is a Scientific Project Officer at the Joint Research Centre of the European Commission. Nils has a PhD in Geography from the KU Leuven (Belgium) and the VU Amsterdam (Netherlands). He has a broad experience in various fields of earth and environmental sciences, including soil monitoring, human-climate environment interactions in the past, geo-archaeology and geo-ecohydrology. At the EU Soil Observatory, Nils is dedicated to soil health monitoring at the EU scale and is working on the monitoring building blocks of the Mission Soil. His works includes the development of the various EUSO Soil Dashboards.

Fiona Nicholson – Soil Use and Management

Fiona is a soil scientist who has worked for over 25 years with ADAS studying the impacts of agricultural practices on soils and the wider environment. Particular research interests include heavy metal fate and behaviour in agro-ecosystems, and the environmental effects and nutrient value of organic material applications to agricultural land.

She was a deputy editor for Soil Use and Management from 2014 to 2019, and now acts as social media coordinator.

Bob Klein Lankhorst – Royal Eijkelkamp B.V.

Expert in soil health and sustainability, with a focus on innovative technologies that help land managers better understand and improve soil health.

Ulriche Wansi – Global Climate Smart Agriculture Youth Network

Ulriche Wansi is a development practitioner dedicated to advancing community resilience, poverty reduction, and sustainable agriculture through knowledge sharing and evidence-based action. With a background in Agricultural Engineering and a Master's in Development Project Management, his work bridges research and practice to improve the lives of vulnerable communities. Ulriche has engaged extensively with local farmers and community groups across Cameroon and Nepal, supporting them to strengthen their

livelihoods through improved agricultural practices, soil stewardship, and climate-resilient solutions. Ulriche's engagement in global platforms, such as the UN Food Systems Summit 2021, UN COY16, and the IUCN Global Youth Summit, reinforces his commitment to connecting local realities with global dialogues. In his role at GCSAYN, he contributes to strengthening a global youth network across more than 170 countries, championing soil health, climate-smart agriculture, and inclusive development.

Prof. Pippa Chapman

Professor Pippa Chapman is a soil scientist working in the interdisciplinary field of land and water management. Her expertise focusses on sustainable agriculture, soil health, water quality, and climate change. Her research includes measuring and demonstrating the impacts of regenerative agriculture on soil health, crop health and yield, greenhouse fluxes and water quality at a trial on the University of Leeds research farm.

She is the co-champion for the Natural Environment Research Councils research programme on Freshwater Quality (2022-2026), and working with colleagues at the University of Leeds, AFBI and University of Ulster to monitor and evaluate the impact of the Soil Nutrient and Health Scheme in Northern Ireland.

Pippa serves on national and international advisory, funding and strategy groups, including NERC, BBSRC, Defra, Northern Ireland's Department of Agriculture, Environment and Rural Affairs Water Quality Science Advisory Group, and Yorkshire Agriculture Society Farmer-Scientist Network. She is regularly invited to present at national agricultural events e.g., Groundswell, Down to Earth, Agroforestry Show, Great Yorkshire Show, AHDB Monitor & Strategic Farms, Gren Farm Collective Open Day, and other Farm Clusters. She also recently gave oral evidence to the House of Commons Environment, Food and Rural Affairs Committee inquiry on soil health.

Dr Hannah Cooper – University of Nottingham

Dr Hannah Cooper is currently an Assistant Professor in Agronomy (2023-present) after receiving her PhD in Environmental Science from the University of Nottingham. Her research focuses on enhancing sustainable crop production and evaluating agri-food climate resilience. Her research spans a range of management and land use gradients, including arable soils and peatlands in temperate and tropical regions. One of her main interests is assessing the sustainable management of crop production systems through a variety of techniques, such as measuring greenhouse gas emissions, quantifying soil architecture through X-ray Computed Tomography and assessing the carbon thermostability through Rock Eval pyrolysis.

Dr Ruth Wade – University of Leeds

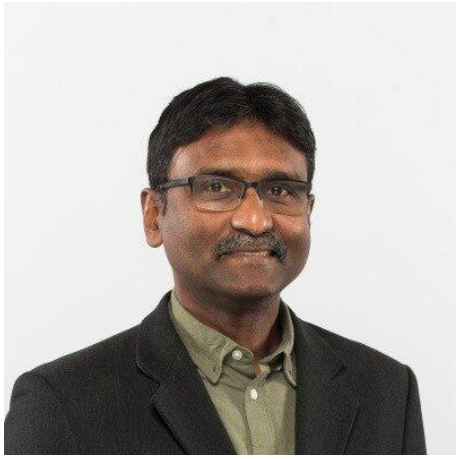
Dr Ruth Wade is a Lecturer in Sustainable Agriculture in the School of Biology at the University of Leeds. An ecologist at heart, her passion is to use knowledge and ideas from ecological systems in agricultural systems, working towards sustainable farming whilst maintaining a resilient and productive farming system.

She uses combinations of novel laboratory, small plot and field scale trials to investigate the impact of different land management decisions and changes in rainfall patterns on plant growth, plant chemical composition, soil structure and fertility as well as interacting organisms such as insects and their natural enemies. For the last three years, she has been investigating different strategies to transition to a regenerative farming system, measuring the impact of following different combinations of regenerative agriculture principles on soil functioning, hydrological properties, pests, disease and weed incidence, crop production and greenhouse gas emissions.

Phillip Wright - Wright Resolutions Limited

Philip Wright trained at Silsoe in the late 1970's gaining an honours degree in Agricultural Engineering. He became Technical Director of machinery manufacturer Simba where he worked for 28 years before becoming an independent advisor to the Agricultural Industry on soils and cultivations in 2007. Philip's company, Wright Resolutions Limited, provides independent, cost effective and environmentally friendly solutions for the agricultural industry. Such advice allows Clients to make better informed decisions on topics such as soils and cultivations, systems and machinery selection and setting, and to progress towards a regenerative approach to farming. This includes training for Farmers, Operators, Agronomists and Students. Philip is also an Associate Lecturer on the BASIS Soil and Water Management Courses run by Lincoln University. Machine design and stress analysis services have also been provided to a number of manufacturers in this sector over many years. The Client base also includes bodies such as the Environment Agency, Catchment Sensitive Farming, and the AHDB, together with Machinery Manufacturers and suppliers both within and outside the Agricultural Industry in the UK, Eastern and Western Europe, and the Southern Hemisphere. Philip is a Member of the Institution of Agricultural Engineers, the American Society of Agricultural and Biological Engineers, the British Society of Soil Science and is a Chartered Engineer.

Prof Ruben Sakrabani – Cranfield University



Professor Sakrabani is a soil chemist with more than 20 years of experience in determining nutrient dynamics in soils associated with application of organic amendments such as compost, manure, slurry, sewage sludge, biochar and digestates. His work explores the resource efficiency and reliability of organic amendments as alternative sources of fertilisers to reduce demand on inorganic fertilisers to promote regenerative agriculture. His interest is AMR is related to use of manure and crop residue as part of OMF and its potential pathways to have antibiotic resistance genes which can contribute to AMR through interactions with selected soil properties. His research covers use of novel approaches using muonic X-Rays and neutron computerised tomography to characterise OMF for its physical and chemical properties.

Prof Pete Smith - University of Aberdeen/ Scottish Climate Change Centre of Expertise (ClimateXChange)

Pete Smith is Professor of Soils and Global Change at the Institute of Biological and Environmental Sciences at the University of Aberdeen and Science Director of the Scottish Climate Change Centre of Expertise (ClimateXChange). His interests include climate change mitigation, soils, agriculture, food systems, ecosystem services modelling and nature-based solutions.

He is a Fellow of the Royal Society of Biology, a Fellow of the Institute of Soil Scientists, a Fellow of the Royal Society of Edinburgh, a Foreign Fellow of the Indian National Science Academy, a Fellow of the European Science Academy, and a Fellow of the Royal Society (London).

Vincent Van Walt - Van Walt

Vincent has many years' experience in the environmental field – more than he is prepared to admit to! More than 30 years ago he and Kaja, his wife, established Van Walt to fill a gap in the market for equipment that provides consistent, accurate results – equipment that sets the standard for soil and groundwater monitoring and research. Today he remains equally as committed and still spends the majority of his time sharing his expertise on groundwater field techniques, percussion drilling, soil moisture measurement and mineral exploration with customers at home and abroad. As an enthusiastic sailor he has learnt to appreciate the combination of quality and craftsmanship to create something that is both functional and beautiful.

Prof Frederic Coulon – Cranfield University

Professor Frederic Coulon holds the Chair in Environmental Chemistry and Microbiology at Cranfield University and is internationally recognised for his leadership in pollution control and remediation across contaminated land, waste, and wastewater systems. He has pioneered risk-based management strategies and biotechnological solutions that have shaped environmental policy and practice across the UK, Europe, Africa, Singapore, and China.

As the Director of the UKRI Engineering Biology Hub's Environmental Biotechnology Innovation Centre (EBIC), he leads pioneering research in engineering biological applications and environmental biotechnology to develop innovative environmental solutions. His work drives sustainable solutions within the Water-Soil-Waste nexus, addressing global environmental challenges across industries and scales. His contribution was featured in Cranfield University's 2014 REF Impact Case Studies for advancing hydrocarbon bioremediation. Prof. Coulon is the Chairman of the European Conference AquaConSoil and the NICOLE Academic Group. He serves as Co-Editor-in-Chief for Environment International and Heliyon Environment, and as Associate Editor for Science of the Total Environment.

Jonathan Atkinson - CLAIRE

After 34 years in the Environment Agency and the KCC Waste reg team Jonathan has recently moved to work with CLAIRE, an industry leading organisation dealing with best practice guidance and frameworks for positive materials management on sustainable development sites, enabling land contamination issues to be dealt with comprehensively.

He has worked on risk assessment of developed closed landfill sites, landfill engineering and environmental controls enforcement on permitted sites, and a variety of land contamination projects. He was part of a team of GW&CL specialists and a national advisor on a number of specific projects related to soil remediation and waste management, including DoWCoP and emerging substances like PFAS.

Jo Pearl – Multi-disciplinary Artist, Soil and Climate Activist:

London-based artist Jo Pearl is member of the Royal Society of Sculptors, and a former PR whose work has a campaigning edge. Her soil-focused work has been exhibited at the Royal Geographical Society's Earth Photo 2024, Somerset House's SOIL: The World At Our Feet, Dialoghi Del Suolo, in Florence accompanying the UISS's Centenary Congress in 2024, as well as the forthcoming Soil Art Tales, in 7 museums around the EU from November 2025.

Artist and soil activist Jo Pearl shares her most recent work, imbued with wonder about the biodiversity in healthy soil, to playfully make visible the invisible biome beneath our feet. From clay stop frame animation, to kinetic sculpture, Pearl shares how she uses clay and ceramics to speak about soil health, enchanting viewers so that they fall in love with this material. She will be presenting *Dirty Secret*, her most recent commission for the EU's Soil Art Tales travelling exhibition that opens in Venice in November 2025, as well as *Oddkin* and *Unearthed Mycelium* exhibited at Somerset House's landmark exhibition SOIL : The World at our Feet in Spring 2025.

Dr Paul Granjon – Cardiff School of Art and Design

Paul Granjon is an artist and educator whose self-made machines explored the co-evolution of humans and machines with a humorous and critical perspective. The work questioned the validity of a creeping digitization that tends to replace living beings with digital programs and creatures, supporting a society based on economic profit, surveillance and extraction.

His interest in vital issues of resilience and ecological implication grew over the years, based on the conviction that a renewed relationship with plant, animal and mineral beings and environments, combined with a radically re-imagined use of technology are crucial pre-requisites for a good life on earth.

Current practice-based research includes the design and delivery of participative art activities and artworks that combine creative technologies and bio-life with a joyful dimension. The work aims to alleviate eco-anxiety and to stimulate an ecosophical approach

to everyday life. Paul currently teaches Fine-Art at Cardiff School of Art and Design and is a member of the Art and Ecology research group at Goldsmiths University.

Daro Montag - Artist

Daro Montag is a visual artist and Associate Professor of Art & Environment at Falmouth University. His art practice has, for over thirty years, been involved with environmental and ecological issues – he is particularly interested in the inherent creativity of the organic world.

He is probably best known for the technique he developed for generating images through the activities of soil micro-organisms, known as 'bioglyphs'. These works reveal and make visible the microscopic life within soil that would otherwise be impossible to see. It is hoped that these bioglyphs will contribute to a deeper understanding of soil as a living organism.

Daro's artworks have been exhibited at galleries in the UK, Europe, USA, Australia, China and the UAE, and have been published widely.

Between 2013-16 he co-produced *Soil Culture*, a series of exhibitions, projects and publications, in collaboration with the Centre for Contemporary Art and the Natural World. This was the UK's most significant cultural contribution to the 2015 International Year of Soil.

Ben Jackson - Specialist Research Technician at University of Edinburgh

Ben Jackson is a postdoctoral Research Fellow in the Global Academy of Agriculture and Food Systems working with Prof. Liz Baggs on the BBSRC funded LegumeSELECT project. Ben's research is aimed at better understanding how legume crops differ in their contributions to soil fertility in smallholder farming systems in Sub-Saharan Africa. To do this he is using stable isotope labelling techniques combined with 3D imaging of root systems to understand the links between plant phenotypic responses to management (e.g. intercropping vs. rotation), interactions between legume and maize root systems, and soil C and N dynamics.

Dr Angela de Manzanos – FA Bio

As CEO, Angela leads the scientific direction of FA Bio, nurturing and evolving the business process design and strategy, defining its innovation pipeline and growth. With more than 19 years experience in agriculture and using innovation to solve the challenges of sustainability, Angela has a strong background in leadership, biotechnology, and agriculture.

Angela studied for her Bachelor's degree and Master of Science at the Universidad Politecnica de Valencia. She went on to complete her Master Research in Chemical Biology of Crop Protection and Sustainability and was awarded the Lord Porter Prize, and her PhD in Chemical Biology at Imperial College London.

Since completing her PhD Angela has focused on developing her leadership skills, undertaking a Women in Leadership programme by IESE, Business Process Design for Strategic Management by MIT Sloane School, and a course on Dynamic Negotiations by INSEAD Business School.

Dr Chris Quince – Earlham Institute

Chris Quince has pioneered techniques to reduce sequencing noise and the application of methods such as shotgun metagenomics to microbial communities. This cutting-edge approach fragments and sequences all of the genomes in a microbiome – quite literally taking a shotgun approach – and these are then reconstructed using sophisticated computational approaches. The methods to reconstruct sequence fragments back into metagenome assembled genomes (MAGs) have been significantly advanced by Quince.

He has used these metagenome techniques and analysis methods, in conjunction with his wide network of collaborators, to address urgent clinical questions, such as trialling new treatments for paediatric Crohn's disease and understanding what drives antimicrobial resistance (AMR) in the gut microbiome.

Prof. David A Robinson – UKCEH/Utah State University, USA

Prof David Robinson, a graduate of soil science from Reading University, has a passion for soils research which has taken him around the globe. In the USA he served as Operations Director for the CUASHI Hydrological Measurement Facility at Stanford, while in his current role at UKCEH his focus is on national and EU soil monitoring, especially regarding indicators and the application of AI and modelling to better understand and predict soil function. He is an Adjunct Professor at Utah State University, USA and a Visiting Scientist at the Hamburg University of Technology in Germany.

Dr David Tompkins – Associate Director at WSP

Dr David Tompkins is an Environmental Scientist with a multi-disciplinary background encompassing horticulture, soil science, composting, anaerobic digestion, wastewater treatment, biowaste valorisation, sustainability, and the Circular Economy.

David is currently an Associate Director in WSP's Water Strategic Advisory team, where he focusses on bringing the Circular Economy to life within the UK's regulated water sector. This draws on previous experience as a technical consultant working on 'end of pipe' treatment options for commercial digestates and sewage sludges, wrestling with challenging regulatory frameworks and engaging with a broad range of stakeholders to deliver positive, evidence-based and consensus-driven commercial outcomes.

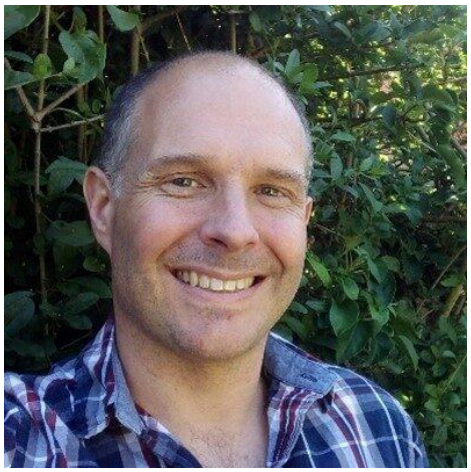
In addition to his role as a Board member, David is Chair of the BSSS Professional Practice and Development Committee.

Dr Eleanor Reed – Principal Soil Specialist at Natural England

Eleanor is an experienced, Chartered soil scientist and Fellow of the British Society of Soil Science (BSSS). She provides a strategic and scientific lead to promote and influence the integration of soils into projects and programmes delivered by Natural England. Working closely with DEFRA and other agencies, and developing trusting partnerships externally, to deliver evidence, tools and guidance to better understand and improve the health of soils and contribute to nature recovery, climate change resilience and food security.

Eleanor has a research background and over 10 years' experience working with the Agricultural Land Classification (ALC) system; including undertaking field surveys; providing internal training on ALC; and providing advice to Government departments on the ALC system, data and mapping.

Dr Matthew Shepherd – Natural England



Matthew Shepherd is Natural England's Senior Specialist for Soil Biodiversity, with 23 years of experience in working in soil science and longer experience in ecology and conservation. He manages research to improve soil management for ecosystem services, by working in harmony with soil organisms. Matthew engages with farmers, industry, and the public, partnering with farm outreach advisors, but also promoting soil biology and its importance among the general public through events, videos and television. He also manages and delivers soil monitoring and is an expert on soil mesofauna, particularly soil mites, for which he runs the UK national recording scheme and provides training for students, researchers, and naturalists. With a background in Ecology and a PhD on grazing effects on soil in semi-natural ecosystems, he has contributed to evidence on upland overgrazing, the state of our peatlands and how to restore them, and developed approaches to understand and improve soil health.

James Hughes – Natural England

James serves as a Senior Soil Specialist at Natural England, where he plays a pivotal role in advising area teams on the methodology employed by consultants for ALC across England. His expertise is particularly crucial for Nationally Significant Infrastructure Projects (NSIPs), as well as mineral and waste applications and other development management planning proposals.

A dedicated professional in his field, James holds Full Membership with the BSSS. With 7 years of experience in validating ALC surveys, James has consistently upheld rigorous standards in his work. Through his role, James significantly contributes to ensuring sustainable land management and informed decision-making in development and environmental planning.

Johnny Griffiths – Natural England

Jonathan, a Senior Soil Specialist, focusing on Land Management, supports the delivery and development of research and development, tools, guidance and training to further our understanding of soil health and its contribution to ensuring nature recovery, climate change resilience and food security.

Prior to joining Natural England, Jonathan worked within Environmental Consultancy with 7 years' experience as a Contaminated Land Specialist and has a wealth of experience managing and handling large soils data sets. Jonathan has a good understanding of the Natural England ALC and soil datasets and their potential use and application to inform future land use planning.

Jade Hatton – UK Centre for Ecology and Hydrology

Jade is a Landscape Biogeochemist, at the UK Centre for Ecology & Hydrology. She is interested in understanding the interplay between soils and sediments, waters, and the atmosphere, using geochemistry to trace the impact of climatic and land use changes on biogeochemical cycles. She oversees the Plynlimon Research Catchments, a multi-disciplinary, long-term paired catchment study for hydrogeochemical research, and also manages the first large-scale UK field trials of enhanced rock weathering at the site, improving our understanding into the viability of this cutting-edge greenhouse gas removal technology in UK upland environments.

Jonathan Silvertown – University of Edinburgh / Botanical Society of Scotland

Jonathan is an honorary Professor in the Institute of Ecology and Evolution at the University of Edinburgh and president of the Botanical Society of Scotland. He was the first chair of the Ecological Continuity Trust upon its foundation and continues to be an active trustee of the charity. His research covers many topics from plant behaviour to plant communities, population dynamics, evolutionary ecology and long-term experiments. He has written ten books, including a successful textbook on plant population biology. He now focusses on popular science and his most recent title is *Selfish Genes to Social Beings: A cooperative history of life* from OUP, which was a 2024 *New Scientist* Book of the Year.

Dr Cicely Marshall - University of Gloucestershire / University of Cambridge

Dr Cicely Marshall is botanist, ecologist and conservationist working on sustainable development and nature finance models in west Africa and the UK. She is a Research Fellow at the University of Gloucestershire and Course Director and visiting research staff with the University of Cambridge.

Kairsty Topp – Agricultural Systems Modeller at SRUC

Kairsty Topp is an agricultural systems modeller at SRUC. She works on the synthesis and analysis of data from cropping and livestock systems, with a focus on improving the sustainability of agriculture and understanding its environmental impacts. Her research interests include nitrous oxide emissions and their mitigation, the role of legumes in sustainable cropping systems, crop rotation management, nutrient flows and budgets, and the influence of climate on agricultural systems.

Dr Rob Sparkes – Manchester Metropolitan University

Robert Sparkes is a Senior Lecturer in Environmental Science, with research and teaching interests spanning Environmental Science, Geography, Geology, Chemistry, and Material Science, with expertise in a broad range of chemistry techinques, including chromatography, spectroscopy, and elemental/isopic analysis.

He researches many aspects of the global carbon system, from the continent scale to the molecular scale, and from the deep sea to meteorites. At the moment, he is particularly focussed on the burial and long-term storage of carbon in saltmarshes, and the role that coastal wetlands can play in mitigating climate change. This work, in collaboration with collegues at MMU, academics around the world, government agencies, businesses and charities, has been published in a wide range of academic journals and technical reports.

Robert is an environmental geochemist, tracing carbon as it moves around our planet. He is particularly interested in working out how burying carbon in coastal sediments can help mitigate climate change.

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Advances For Soils:

Oral Abstracts

Development and testing of a predictive approach to Agricultural Land Classification and potential applications.

By **Liv Hoyland,** Dr Bruce Lascelles, Dr Zhigang Liu, Dr Jess Potts

Arcadis

Soils are a critical and finite resource, yet their role in planning and infrastructure delivery is often underrepresented. Robust assessments of land grade are critical requirements of the planning process. In England, provisional Agricultural Land Classification (ALC) mapping is available; however, this is at a 1:250,000 scale and does not distinguish between Grades 3a and 3b, making them unsuitable for site-specific assessments. Detailed ALC surveys should be undertaken, but are sometimes infeasible due to factors such as access restrictions.

Using the assessment within the Environmental Statement (ES) of a recent nationally significant infrastructure project, we explore the application of a predictive mapping approach used to fill gaps where detailed surveys were not possible. The model developed follows the approach used within the Welsh Government's (2019) Predictive ALC Map, using best-available desk-based information.

The predictive approach was applied to the entire project area, including the 1011ha where detailed surveys had been undertaken, to enable both predictive gap filling and the testing of the predictive approach against actual survey data. This allowed an assessment of whether the predicted data points were underestimating or overestimating effects on Best and Most Versatile (BMV) land. Stage 1 of the approach (desk-based data only) showed 43% of predictions accurately matched surveyed grades, with 27% resulting in a downgrading of surveyed BMV land. Stage 2 of the approach incorporated refinements by integrating field data, national survey database information, and professional judgement, to better account for variability and natural complexity.

The outcome demonstrates the potential of predictive mapping to enhance environmental assessments. Whilst surveys should always be a priority (as required by policy), the testing of this approach offers valuable insights, particularly for early siting / routing stages to enable better reflection of likely BMV land distribution, driving more informed decision-making and sustainable development practices.

Keywords: Predictive Mapping, Modelling, Agricultural Land Classification, Best and Most Versatile.

Determining soil bulk density spatially with non-invasive seismology.

By **Simon Jeffery**[1], Maria Tsekhmistrenko[1], Joe Collin[1], Hugo Bloem[1], Tina Fallah[1], Jeroen Ritsema[2], Tarje Nissen-Meyer[1,3]

1. Earth Rover Program

2. Department of Earth and Environmental Sciences, University of Michigan, US

3. UK and Department of Mathematics & Statistics, University of Exeter

Soil is a critical resource for global food security, yet traditional physical analyses and geophysical imaging techniques remain labour-intensive and time-consuming. This study evaluates the potential of ultra-high frequency (>500 Hz) hammer-source seismology to characterise soil physical properties at decimetre resolution.

Experiments were conducted within a long-term field trial at Harper Adams University (UK), comparing Conservation and Conventional agriculture. Two 1.5 m sections of each treatment were surveyed using 16 geophones, with soil samples collected at matching 10 cm intervals. Estimates of P-wave velocity (vp) and bulk density in the upper 40 cm of the soil profile revealed a strong and statistically significant correlation. Depth-resolved comparisons between seismic images and interpolated bulk density data from physical samples further confirmed the robustness of this relationship.

These results demonstrate that ultra-high frequency seismic analysis provides a fast, non-invasive, and cost-effective method for estimating soil bulk density. The approach offers sufficient resolution to support agronomic and land-management decisions and has potential as an input for improving soil carbon stock quantification. With further validation across soil types, textures, and moisture regimes, this method could become a scalable alternative to conventional sampling.

Funded by: Bezos Earth Fund

Keywords: Soil bulk density, ultra-high frequency, non-invasive seismic soil analysis.

Monitoring soil health for the evaluation of Agri-Environment Scheme outcomes.

By **John Langley-Randall**

ADAS

The UK government's Environmental Improvement Plan aims to have "at least 40% of England's agricultural soil into sustainable management by 2028, and increase this to 60% by 2030". The baselining and monitoring of soil health within agri-environment schemes is an important part of this plan; and is a substantial undertaking that will require high quality data, while providing value for money. Soil sampling has traditionally relied on a suite of soil health indicators such as dry bulk density, soil pH, extractable phosphorus, earthworm biomass, and visual evaluation of soil structure. These are often time consuming, relying on field sampling and lab analysis, and costly when implemented as part of large-scale sampling strategies. Currently, there is no agreed framework for systematically integrating soil as a parameter into agri-environment monitoring and evaluation schemes to determine sustainable soil management.

A Rapid Evidence Assessment into novel soil sampling techniques, e.g. seismology, eDNA, ecoacoustics, volatilomics, remote sensing and image processing using artificial intelligence (AI), was carried out prior to assessing the potential for these techniques to replace and support traditional sampling methods to assess soil health. Results were presented to an expert panel for elicitation, who ranked the new technologies based on: Reliability, Cost, Applicability, Timescale, Data availability, and Practicability. To allow for comparison, traditional soil sampling methods used for soil health monitoring were also scored using the same criteria. The outcomes of the scoring highlighted where novel technologies could be utilised for augmentation within a national scale sampling strategy of agri-environment schemes.

Funded By: Natural England

Keywords: Remote sensing, Metabolomics, Ecoacoustics, Seismology, AI, Review.

Evaluating influence of moisture in controlling release of nutrients in novel green fertilisers using neutron imaging and muonic X-Rays.

By **Ruben Sakrabani**[1], Sayani Biswas[2], Adrian Hillier[2], Ranggi Ramadhan[2], Sylvia Britto[2], Alexander Liptak[3], Genoveva Burca[3]

1. Cranfield University, Cranfield

2. ISIS Neutron and Muon Source, STFC Rutherford Appleton Laboratory, Harwell Campus

3. Diamond Light Source Ltd, Harwell Science and Innovation Campus

In the UK, agriculture is responsible for 9% of all greenhouse gas emissions, and over 50% are due to the manufacture and use of nitrogen (N) based fertilisers to maintain yields. Organo-mineral fertiliser (OMF), which combines organic amendments with reduced amounts of mineral fertiliser, can partly be a solution to tackle this challenge. This works aims to exploit a novel approach for this application, using non-destructive combination of neutron and X-ray computed tomography (NCT and XCT) to assess the physical characteristics of fertiliser pellets such as porosity distribution.

NCT was performed on the IMAT beamline at the ISIS Neutron and Muon Source, while XCT was performed on the I12-JEEP beamline at Diamond Light Source, representing the first attempt to study the structure of OMF pellets with combined neutron and X-ray imaging techniques.

The neutron radiographies and the reconstructed NCT slices show that the distribution of the dense matter within a pellet is not uniform along the vertical axis. The variations of material packing density within the pellet is important to link the heterogeneity of nutrient distribution when released into soil. Additionally, XCT provides valuable information on the internal structure, texture, and porosity, as important indicators of the pellet's quality and performance. XCT and NCT are complimentary techniques with regards to pellet imaging.

When using the muonic X-Rays the results indicated that it is possible to determine key elements such as C, N, P, K, Mg within OMF pellets. The data showed that the distribution of these elements was rather uniform within each pellet.

Funded by: STFC Food Network +

Keywords: organo-mineral fertilisers, muonic X-rays, neutron tomography, imaging, traceability, pellets.

Advances For Soils:

Poster Abstracts

Assessing the impact of nature-based solutions on soil health in sub-Saharan Africa with AI-powered, farmer-focused methods.

By **Dominik Bittner**[1,2,*], Jo Smith[1], Georgios Leontidis[2], Grant A. Campbell[1], Pete Smith[1], Jeanne Biegel[3], Paul Hallett[1]

1. School of Biological Sciences, University of Aberdeen, Aberdeen, UK

2. Interdisciplinary Institute, University of Aberdeen, Aberdeen, UK

3. University of Burgundy, Institut Agro, Dijon, France

Soils underpin many ecosystem services, including food production, through important soil functions, such as the cycling of organic matter. Yet, these functions are increasingly threatened by soil degradation, especially in climate-vulnerable regions, such as Sub-Saharan Africa. In these regions, unstable soils are prone to intense erosion and farmers often lack adequate financial resources, so there is a pressing need for accessible tools to assess, restore and improve soil health. However, the tools available for assessing soil health are challenged by the availability of data, transferability across local communities with varying knowledge, and socio-economic challenges of the food, fuel and water nexus that affect rural livelihoods. In this poster we will showcase a novel hybrid approach using smartphones to assess soil health. Smartphones are becoming increasingly available in Sub-Saharan Africa to agricultural advisors, as well as to farmers themselves. The approach integrates a) user-friendly, Artificial Intelligence (AI)-supported, field-ready soil health tests to estimate key indicators, such as soil organic carbon, and b) modelling of the impacts of nature-based practices. The modelling combines: i) the realism of process-based soil models, ii) the scale and adaptability of data-driven AI, and iii) and indigenous knowledge via knowledge-based AI, all integrated into a systems model. The platform also utilises remote sensing data to enhance soil health assessments. Together, this approach aims to empower farmers with actionable insights, boosting soil health and securing sustainable livelihoods.

Funded by: UKRI AI Centre for Doctoral Training in Sustainable Understandable agri-food Systems Transformed by Artificial INtelligence (SUSTAIN).

Keywords: Soil health, Soil quality, LMICs, Ethiopia, Nature-based solutions, Artificial Intelligence.

Link to Poster

Equivalent soil mass correction and error propagation to quantify changes in soil organic carbon stocks accurately.

By **Leonard N. K. Döhl**[1], Sofia Biffi[1,2], Helaina Black[3,4], Pippa J. Chapman[1], Guy Ziv[1]

1. Faculty of Environment, School of Geography, University of Leeds

2. Århus Institut for Agroøkologi, Århus Universitet, Denmark

3. The James Hutton Institute, Invergowrie, Dundee, United Kingdom

4. Agricarbon UK Limited, Muirloch Farm, Liff, Dundee, United Kingdom

Transitions to sustainable soil management practices can improve soil health, address climate change and influence the future of farming through sequestering carbon. The resultant changes in soil organic carbon stocks requires accurate quantification that the well-known fixed-depth (FD) method is limited to achieve. The equivalent soil mass (ESM) correction has been praised to overcome the shortcomings of the FD method, yet it is rarely adopted. How to use the ESM correction remains unclear, and it requires a rigorous assessment of the accuracy and uncertainties of the ESM-corrected SOC stocks estimates. For this purpose, we have developed an ESM correction package in R that will be available on Github by late-2025/early-2026.

The package integrates visual assessments to evaluate ESM correction accuracy, the three regression functions – linear approximation (LIN), monotonic cubic spline (MCS) and cumulative exponential distribution function (CEDF) – used so far in ESM correction, and error propagation analysis that accounts for uncertainties of direct measurements, regression functions and between sampling horizons. We tested its performance and accuracy using data from hedgerow cultivation.

Our results show that using the MCS previously recommended for ESM correction predicts significantly inconsistent extrapolated SOC stocks as well as predicts too small propagation errors, making it inaccurate. In contrast, LIN and CEDF predict more precise propagation errors. However, LIN can risk overestimating extrapolated SOC stocks if total soil mineral mass of the treatment site is much smaller than of the control site compared to. CEDF avoids overestimation, but it requires more samples across a soil profile for greater accuracy. Hence, both regression functions have trade-offs and assumptions to consider when used. We encourage using our ESM correction package in future work that contribute developing a set of standard guidelines of quantifying changes in SOC stocks and scale its application from local to global assessments.

Funded by: European Union's Horizon Europe (HORIZON) NOVASOIL Grant 10191268; MARVIC project by European Union's Mission Soil Grant 101112942; CAFAMORE project by the European Union's Mission Soil Grant 101219027

Keywords: soil carbon stocks; equivalent soil mass; accuracy; error propagation; regression.

Link to Poster

Global Soil Phosphorus Response Prediction Using Random Forests: Implications for Precision Agriculture.

By **Amine Kassam,** Lotfi Khiari

Mohammed VI Polytechnic University

Conventional phosphorus (P) fertilizer recommendations for wheat are often derived from single-factor soil test phosphorus (STP) classifications and fixed-rate application grids. While widely used, these approaches fail to capture field-level variability and the complex, site-specific responses of soils and crops to fertilization. This study introduces a data-driven, multifactorial approach using machine learning, specifically the Random Forest (RF) algorithm, to model soil responses to P fertilization and P fixation under diverse agroecological conditions.

A global dataset was assembled from 15 countries, comprising 1,156 soil samples. Each soil was characterized for Mehlich III extractable nutrients (MIII), texture, pH and pH-SMP, and organic matter, alongside five phosphorus-related variables: plant-available P in water (Pw), short- and long-term responses to fertilization (24 h and 6 months), and short- and long-term fixed P (24 h and 6 months). These variables were incorporated as both predictors and targets, enabling a comprehensive analysis of soil capabilities and responses to fertilization.

The RF models achieved robust predictive performance, with accuracies ranging from 75–84% when using phosphorus-specific variables and 65–70% when relying solely on general soil characterization. Beyond prediction, the analysis revealed the relative contribution of different soil properties to fertilization outcomes, offering new insights into the drivers of soil–P interactions.

This machine learning framework represents a paradigm shift in P management. By replacing static fertilizer recommendations with dynamic, site-specific models, it enables adaptive nutrient strategies that enhance efficiency, reduce environmental risks, and align with the goals of precision agriculture and sustainable intensification.

Funded by: OCP Morocco

Keywords: Phosphorus fertilization, Random Forest, Machine learning, Precision agriculture, Nutrient management.

Radionuclide proxies for soil organic carbon: Evaluating the potential of portable gamma spectrometry for high-resolution soil mapping.

By **Nicola C. Mansfield**[1], Alex Taylor[1], Robin Jackson[2], Rupert Goddard[1], William H. Blake[1]

1. University of Plymouth

2. Duchy College

Soil organic carbon (SOC) is a key indicator of soil health and a vital component in climate change mitigation strategies. However, traditional soil sampling methods are often labour-intensive and costly, limiting the spatial and temporal resolution of SOC data required for informed land management. Portable proximal sensing technologies, such as gamma spectrometry, offer a promising alternative by enabling rapid, in situ data acquisition at high spatial resolution. This study investigated the potential of portable gamma spectrometry to support SOC mapping through radionuclide proxies. Soil samples were collected from two fields, one arable and one permanent pasture, on an estate in Southwest England. Radionuclide activity concentrations were measured at sample locations, and continuous walking surveys were conducted to generate spatial maps of measured radionuclide activity across both fields.

Correlation analysis and principal component analysis (PCA) were used to explore relationships between radionuclides and SOC. Results show that radionuclide activity concentrations are consistently and negatively associated with SOC, particularly thorium-232 (-0.77) and potassium-40 (-0.69). Elastic net regression and partial least squares regression (PLSR) identified thorium-232, potassium-40/uranium-238, potassium-40, and thorium-232/uranium-238 as consistently important variables (PLSR VIP scores 1.21, 1.12, 1.08, 1.07 respectively), emerging as strong indicators of SOC variation. These findings highlight the potential for radionuclide proxies to describe SOC distribution and offer insight into broader soil health dynamics across contrasting land uses.

The results support the adoption of portable gamma spectrometry as a transparent digital soil mapping tool, offering a scalable and efficient approach to generating high-resolution soil data that is accessible to land managers and practitioners. As a decision support tool, this approach contributes meaningfully to the development of sustainable land management strategies aligned with Climate-Smart agriculture.

Keywords: soil organic carbon, gamma spectrometry, soil mapping, decision support tool.

Link to Poster

Developing a holistic soil biological health assessment.

By **Flora O'Brian**[1], Matevz Papp-Rupar[1], Natasha Shomali[2], Frank Gollins[2], David Gollins[2]

1. Niab

2. Verdant Carbon

In this project, Verdant Carbon Ltd and Niab are looking to develop a novel testing protocol for soil biological health by combining phospholipid fatty acid (PLFA) analysis and quantitative polymerase chain reaction (qPCR) analysis of key microbial functional genes, to create a single measure of soil microbial abundance and diversity, or soil biological health. Through multivariable statistical analysis of the PLFA/qPCR results, crop yield data, and soil physicochemical measurements including total carbon/nitrogen, pH and texture, we aim to generate a metric to give an indication of soil health in terms of crop biomass production. The metric will be simple and both applicable and accessible to any farming setting. We aim to give further details on the status of soil nitrogen and carbon cycling since the health of both will be key in supporting the agricultural industry to achieve environmentally sustainable production.

PLFA is a valuable tool for measuring total active microbial biomass and quantifying fungal/bacterial ratios, however it lacks the specificity to identify specific microbial genera or fully capture microbial diversity. The molecular technique qPCR is a more targeted approach that can quantify the abundance of specific genes, however, does not give a reliable measure of the active microbial community as a whole. We will be testing the value of these results individually, exploring their potential to synergistically produce a valuable dataset and generate a metric that accurately and robustly indicates biological soil health. Soil health measurement is a vital ongoing area of development, the biology of which is often difficult to quantify. The combined approach of PLFA and qPCR have the potential to provide valuable insights into soil biological health.

(Please note experimental results are pending.)

Funded by: Innovate UK

Keywords: Soil health; soil microbiology; soil functioning.

Precision pesticide application and the risk to soil organisms.

By **Emma Tilston***, James Garratt

Enviresearch Ltd

As part of the HSE's work to develop a robust independent pesticides regulatory regime for Great Britain this desk study investigated the change in risk profile of soil-dwelling organisms, under conditions of precision application, compared with whole-field application.

Precision application practices will result in field-scale heterogenous exposure where exposure frequency, duration and intensity will vary in ways which may, or may not, influence the spatial distribution of non-target organisms. This differs from the current approach to risk assessment for soil organisms which assumes uniform application across the whole field. Spatial and temporal variability are largely ignored, as are chemical and organismal traits that enable recolonisation.

A simple precision application scenario was considered: band spraying over crop rows, i.e. a consistent pattern of spray distribution, on a spatial scale of ~1 m. For earthworms and micro-arthropods, recolonisation is a plausible refinement option. It would need to be shown that the population in the untreated bands (where there will be some pesticide deposition) will not be affected. For microorganisms, in the absence of soil disturbance (tillage) natural recolonisation is unlikely to be fast enough to lead to recovery within regulatory acceptable timescales.

The continued use of the present risk assessments for soil organisms would be conservative. Calculations based on reduced average application rates are not considered to provide an adequate level of protection. The development of alternative risk assessments for soil organisms would be a significant undertaking. Ideally, an expert working group should be formed to develop standard scenarios and identify appropriate endpoints for risk assessment. In order to (re)define protection goals and to specify acceptable recolonisation endpoints for target taxa new, bespoke studies on the spatial variation of soil physico-chemical properties, soil organism distributions and recolonisation timescales are required to address knowledge gaps.

Funded by: Health and Safety Executive

Keywords: Precision application, pesticides, soil organisms, soil microorganisms.

Link to Poster

Mineralogy of PFAS containing soils in Scotland: Correlations with clay minerals and Fe-oxides.

By **Stuart M. R. Turner,** Nia Gray-Wannell, Urmi Ghosh, Zulin Zhang, Stephen Hillier

The James Hutton Institute

Per- and polyfluroralkyl substances (PFAS) are a group of ~15,000 endocrine-disrupting synthetic compounds, used in a variety of every-day products including kitchenware non-stick coatings, surfactants and fire-fighting foams. The strong C-F bonds of these emerging soil contaminants make them resistant to chemical attack and high temperatures, and their terminal transformation products are pervasive in the natural environment. Studies have shown a direct correlation between PFAS concentrations in soil and bioaccumulation in agricultural plants, such as grains, fruits, and potatoes. Human exposure to these 'forever chemicals' leads to negative health effects including increased cholesterol levels, cancers, and developmental effects in unborn children.

Clay minerals are being considered for environmental remediation of PFAS primarily due to their small particle size, exchangeable cations and pH dependent surface charge sites. However, we have been unable to find robust experiments and datasets that consider mineralogy as a factor for PFAS levels in soils. Rather, soil studies tend to focus on soil organic matter, pH, cation exchange capacity and land use type to explain the presence of PFAS. Where these factors are unable to explain PFAS levels there exists a gap to consider whether changes in mineralogy explain variations, by acting as a sink and a subsequent potential source for PFAS, hence, affecting their fate, transport, and retention in soils.

Making use of the National Soils Archive at The James Hutton Institute, on-going work, led by Zulin Zhang, has determined changes in PFAS concentrations of 30 soil sample sites across Scotland over a 30-year time period. Using X-ray diffraction (XRD) to determine the quantitative mineralogy of NSIS (National Soil Inventory of Scotland, 1978-1988) soil samples, we are investigating possible correlations with PFAS levels with the aim to ascertain if there is a mineral component to PFAS mobility in Scottish soils.

Funded by: Scottish Government and James Hutton Institute Seedcorn Funding

Keywords: Scottish soils, NSIS, PFAS, Mineralogy, Clays, Fe-oxides, XRPD

Soil For Climate:

Oral Abstracts

Soil amendments for greenhouse gas removal: A holistic assessment of biochar and enhanced rock weathering in an agricultural cropping system.

By **Elisabeth Appleton,** Stella Linnekogel, Nadine Mitschunas, Morag McCraken, Tim Goodall, Simon Oakley, Pete Levy, Dafydd Elias, Richard Pywell & Niall McNamara

UK Centre for Ecology and Hydrology

Greenhouse gas removal (GGR) technologies are essential for meeting net zero targets. Among soil-based GGR technologies, biochar and enhanced rock weathering (ERW) offer promising opportunities for integration into existing agricultural practices, with potential co-benefits such as improved soil nutrient status, enhanced crop yield, and the suppression of soil nitrous oxide (N2O) emissions—a particularly potent greenhouse gas (GHG). Through a holistic study of these two GGR technologies, we assess the wider value of these strategies beyond their GGR potential in a spring barley crop system. Conducting a plot-scale field experiment using a robotic greenhouse gas chamber system (Skyline2D) in conjunction with a high frequency GHG analyser we measured CO2 and N2O emissions, soil nutrient and metal availability, soil moisture, and crop productivity. Our results show biochar application reduces heavy metal availability in soil and can suppress soil N2O emissions by ~33 % when applied at a rate of 10 t ha-1. However, biochar applied at a higher rate of 30 t ha-1 was associated with an increase in N2O emissions under dry soil conditions and a ~2 t ha-1 reduction in crop yield. In contrast, ERW through a single rockdust application of 20 t ha-1 had no significant effect on soil N2O emissions or any other metric measured. Overall, our findings support the integration of biochar and ERW as GGR strategies into cropping systems, but they also highlight possible trade-offs and limitations that must be considered in their implementation.

Funded by: NERC and BBSRC joint research program AgZero+ and NERC project Diurnal Variation in Soil Nitrous oxide Emissions (DIVINE): drivers and mechanisms.

Keywords: Net Zero, rockdust, N2O, crop productivity, nutrient availability, heavy metals.

From Coal to Carbon Sinks: Recovery and Climate Mitigation in UK Restored Mining Landscapes.

By **Kaydee S. Barker**[1], Jonathan P. Ritson[2], Yue Sun[1], Dael Sassoon[3], Rebecca Self[2], Henry Birt[1], Richard D. Bardgett[4], Clare H. Robinson (1), David Johnson[4]

1. School of Natural Sciences, University of Manchester, Manchester, UK.

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3. GEO3BCN-CSIC Geoscience Barcelona, Spain.

4. Lancaster Environment Centre, Lancaster University, Lancaster, UK.

Although estimates of total abandoned mines in the UK vary widely, over 1,500 UK coal mines have closed within the last 78 years, leaving more than 25,000 square kilometers affected by coal mining operations. Restoring these sites could enhance biodiversity, create habitats for vulnerable species, increase carbon sequestration, and help meet the UK's biodiversity and climate targets. We investigated plant and soil biodiversity and carbon dynamics across four former colliery spoil sites in Wigan, UK. Each site received an application of 10 cm of topsoil and a native meadow seed mixture, but three have been managed with an annual autumn hay cutting since 2000, 2008, and 2019 respectively, while one site was left to recover without further intervention since 2019. Our results revealed that sites with longer restoration periods demonstrated greater plant functional diversity, increased arbuscular mycorrhizal fungal association, and distinct fungal community assemblages compared to the unmanaged site. Older restoration sites also had accelerated root litter decomposition rates, indicating improved soil ecosystem functioning. All sites functioned as carbon sinks over a 9-month period, with soil carbon concentrations meeting or exceeding typical UK grassland values. However, the oldest restoration site exhibited the highest soil carbon sequestration, suggesting a positive relationship between plant and soil functional diversity recovery and carbon storage capacity. Our findings provide compelling evidence that grassland restoration of post-mining landscapes can simultaneously enhance biodiversity and contribute significantly to climate mitigation efforts if implemented across abandoned coal mines in the UK.

Funded by: Lancashire Wildlife Trust, BBSRC DTP

Keywords: Ecosystem restoration, biodiversity, soil carbon, climate migitation, fungi.

Are soil carbon MRV methodologies meeting the needs of "Carbon Farming" in the transition to net zero farming and beyond? Insights from five years of commercial soil carbon MRV across UK and Europe.

By **Helaina Black**

Agricarbon - The James Hutton Institute

The demand for soil carbon MRV (measurement/monitoring/reporting and verification) continues to expand around the world, aligned with the adoption of regenerative farming practices, as a transition to low carbon farming, and largely financed by businesses reporting greenhouse gas emissions reductions and soil carbon removals for insetting or offsetting.

In this talk, I will outline some of the key decisions and challenges around the practical deployment of soil carbon MRV at the spatial and temporal scales necessary for diverse commercial interests. This will include examples of R&D that has helped improve methods in soil sampling design, field sampling, laboratory analysis and soil carbon quantification e.g. using measure and model or measure – remeasure approaches in reporting soil carbon removals and reductions.

This insight has been drawn from data, knowledge and experience gained since 2020, working with farmers to multi-nationals in generating 650,000+ soil carbon stock baseline measurements for soil carbon projects using VCM (Voluntary Carbon Market) and Scope 3 reporting methodologies across UK and Europe. The talk will conclude with a perspective on the soil science research and expertise now needed to support the delivery of reliable and affordable soil C MRV at scale, and to maintain the transition of farming to net zero and beyond.

Funded by: Agricarbon, EU CAFAMORE

Keywords: commercial MRV, soil carbon, quantification, methods, spatial and temporal scale

Maintaining soil health in an arable rotation.

By Davies, Delana

Mentera - Farming Connect

The farming system in west Wales is famously diverse, incorporating beef, sheep, dairy, arable, horticulture, potatoes and root crop systems within the agricultural landscape. South Pembrokeshire in particular holds significant importance as a main cereal and potato growing region within Wales and provides most of the potatoes sold annually into Welsh supermarkets through local storage and packing facilities.

This project brings together 12 arable farmers in a focussed trial to provide information on the effect of soil management practices on soil health outcomes. Soil samples across multiple fields in arable rotations (n=96) have been collected and submitted for the soil health suite laboratory analysis incorporating soil physical, chemical and biological characteristics. Information has also been recorded on cultivation methods used for crop establishment, previous field cropping, animal manure applications, fertiliser amount and type applied, any trace element applications and field yield potential; all this information will be subject to statistical analysis to help define correlations with specific actions that might contribute to maintaining and improving soil health. Of particular interest in this context is what management practices provide the most benefit in remediating soil health in the intervening five-year period between two potato crops.

Dissemination of results through the Farming Connect programme will reflect on the local and national challenges of a changing climate and will focus on knowledge sharing, innovation and collaboration to support the future productivity, profitability and resilience of agriculture for the wider community. This trial correlates with Sustainable Land Management objectives in Wales through aligning with actions to meet Net Zero 2050, improve water and air quality, maximise resource efficiency, mitigate flood and drought risk, maintain and enhance the resilience of ecosystems, reduce emissions of greenhouse gases and maximise carbon sequestration, all for the greater resilience of both the environment, agricultural systems and wider communities.

Funded by: Mentera -Farming Connect programme.

Keywords: Soil health indicators, soil management outcomes, Welsh agriculture, farmer participation.

Climate-Smart Nitrogen Management: Sensor-based Insights into Legume-based Crop Rotations.

By **Emily Guest**[1], Jack Hannam[2], Wilfred Otten[1], Nicholas Girkin[3]

1. Cranfield University

2. University of Greenwich

3. Nottingham University

The 'Nitrogen Climate Smart' (NCS) project is a four-year initiative aiming to increase pulse and legume cropping in UK arable rotations from 5% to 20% (one in five years). This shift could reduce greenhouse gas (GHG) emissions by 3.4 Mt CO2e annually, equivalent to 7% of UK agricultural emissions, mainly through reducing nitrogen (N) fertiliser usage and replacing imported soybean meal in livestock feed.

This presentation reports initial findings from a glasshouse experiment using large soil modules with root cameras to study soil-plant-atmosphere interactions in legume-based crop rotations in greater detail than possible under field conditions.

Early results indicate that higher bean yields are associated with increased nodulation and more extensive root systems, providing insights into below-ground N contributions. Bean crops also enhanced soil N availability, particularly in upper soil profiles, and data from novel nitrate-ion-sensing blades will provide further information on the temporal and spatial availability of this soil N.

In the following wheat, a bean previous crop supported deeper and more prolific rooting, with ongoing analyses quantifying how these benefits will impact wheat grain and protein yields.

Gantry-based imagery is being evaluated alongside 15N isotope analysis to assess whether plant physiological and canopy-level indicators (i.e., yield, biomass, NDVI) can act as low-cost proxies for better estimating biological N fixation, enabling more precise fertiliser recommendations in crops following legumes, rather than the current blanket minimal reduction suggested in the RB209 nutrient management guide.

Future experiments will investigate the mechanisms underpinning prolonged wheat greenness following legumes observed in NCS field trials, exploring whether

legumes alter soil physical, chemical and biological properties to improve nutrient retention and water holding capacity.

Collectively, this research provides actionable insights for optimising legume-based rotations to improve N management and deliver meaningful GHG mitigation to reduce the impact of UK agriculture on the climate.

Funded by: Defra's Farming Innovation Programme, delivered by Innovate UK.

Keywords: Legumes, crop rotations, nitrogen fixation, greenhouse gas, nitrate sensing, roots.

Utilising a 15N2O isotope pool dilution approach to quantify gross production and consumption of N2O in UK saltmarsh sediments.

By **Karina A. Marsden**[*1], Wanyu Wen[1,2], Anthony Gunning[1], Joseph Cotton[1], Emily Stuchiner[3], Joe von Fischer[4], Dan Aberg[1], Christian Dunn[1], Mike Perring[5], Annette Burden[5], Angus Garbutt[5], Dave Chadwick[1]

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Saltmarsh ecosystems provide critical services including flood defence, biodiversity conservation, carbon storage and nutrient remediation. These systems filter terrestrial nutrients, including nitrate (NO3-), which can trigger harmful algal blooms and hypoxic conditions when entering coastal waters. Under the anaerobic conditions present in saltmarsh sediments, NO3- undergoes complete denitrification to environmentally benign N2, safely returning it to the stable atmospheric pool. However, the powerful greenhouse gas nitrous oxide (N2O) can be released as an intermediate product during this denitrification process. Therefore, the balance between N2O production vs. consumption (i.e. conversion to N2) in saltmarsh sediments is critical for determining the climate impacts of NO3- attenuation within these ecosystems. This study quantified gross N2O production and consumption rates in sediments from two contrasting saltmarsh sites: the Blackwater Estuary (Essex) and Ribble Estuary (Lancashire). Sediments were exposed to increasing NO3- concentrations (0, 20 and 200 μmol NO3--N above background levels) to simulate pollution events, and maintained at different moisture contents (30%, 60% and 100% of sediment saturation) to simulate wetting and drying cycles. We employed a novel 15N2O isotope pool dilution approach coupled with laser-based N2O isotopomer analysis to quantify gross N2O production and consumption within the sediments. Provisional results indicate rapid denitrification of the NO3--N pool in wetter

sediments (60% and 100% saturation), with up to 100% of the applied NO3- disappearing from the extractable pool over a 48-hour incubation period. In contrast, only ca. 10% of the NO3- was depleted from the extractable pool in at 30% saturation. The balance between N2O production and consumption from this depleted NO3- is essential for calculating the carbon balance in saltmarshes (with N2O considered on a CO2-equivalent basis) and elucidating potential trade-offs between pollutant attenuation, greenhouse gas emissions, and carbon storage potential.

Funded by: Bangor University, Taith Welsh Government, Dr Perrin Research Award

Keywords: Nitrous oxide, complete denitrification, saltmarsh, sediment, isotopomers, isotope pool dilution.

Navigating trade-offs between food security, carbon storage and farm profitability.

By **Albert Muleke**, Michelle Cain, Paul Burgess, Katy Wiltshire, Georgios Pexas, Matthew Tom Harrison, Karen Christie-Whitehead, Ke Liu, Maria Yanotti

Cranfield University

While practices for reducing greenhouse gas (GHG) emissions abound, less is known of economic co-benefits and trade-offs associated with carbon farming. Here, we examine how cropping systems interventions (irrigation, fertiliser, crop type and rotations) impact on profit associated with soil organic carbon (SOC) accrual and income at net-zero GHG emissions. Using whole farm systems approaches, we show that initial SOC levels strongly influenced economic returns from SOC accrual, while net-zero farm income was primarily governed by management. Diversified interventions – implemented through inclusion of grain legumes within wheat/canola crop rotations – were the most economically sustainable option for maximising SOC returns and net-zero farm income. Intensified adaptations (implemented through greater rates of irrigation, farm areas under irrigation, nitrogen fertiliser and inclusion of rice and maize in crop rotations) incurred significant abatement costs that counterbalanced financial gains associated with reducing GHG emissions. Interventions that Simplified farm systems by reducing irrigation and fertiliser use resulted in the lowest SOC revenue and income at net-zero emissions.

We revealed that (1) adaptations integrating water-efficient irrigation infrastructure (Drip) improved net-zero profits compared with less water-efficient irrigation infrastructure (e.g., Gravity), (2) crop rotations including wheat, canola and faba beans were more conducive to improving financial returns from soil carbon and net-zero farm income, (3) direct GHG costs were a function of the quantity of nitrogenous fertiliser, while indirect emission costs are driven by pumping energy, and (4) SOC financial benefits are more pronounced for clays compared with sandy soils.

We conclude that (i) Diversified interventions integrating water-efficient irrigation infrastructure with winter crops with low initial SOC hold greatest potential for improving net-zero farm income, and (ii) Intensified cropping systems have greater net present value but lower carbon income than Diversified cropping systems, highlighting tensions between management priorities aimed at carbon storage versus enterprise profitability

Funded by: Grains Research and Development Corporation

Keywords: Soil organic carbon, Net-zero, Profitability, Intervention, Climate change, Offsetting, Accrual.

Soil and microbial carbon dynamics following conversion of grassland to cropland: stocks, persistence, and susceptibility to extreme heat.

By **Christopher Taylor,** Adam Bilton, Deon Lum, Kaydee Barker, Ainara Leizeaga, Deborah Ashworth, Georgiana Păun, Richard Bardgett

Lancaster University

The conversion of grasslands into arable agriculture can lead to considerable losses of soil organic carbon (SOC) stocks, with much of this lost carbon irrecoverable on timescales relevant to climate change mitigation. Yet, through changes to soil biological and physicochemical properties, grassland to cropland conversion may also reduce the stability of remaining SOC, potentially increasing its susceptibility to degradation by soil microorganisms and extreme climate events that may exacerbate microbial catabolism (e.g. heatwaves).

Here we use grassland and cropland sites from rural Transylvania, Romania, to explore how the conversion of species-rich grassland to arable agriculture affects soil carbon dynamics. We quantified changes in SOC stocks (to 30 cm depth) using an equivalent soil mass approach for 68 paired grassland and arable sites (n = 272 cores) that shared the same soil type and underlying geology. Soils were then fractionated into mineral associated organic carbon (MAOC) and particulate organic carbon (POC) to provide an estimate of the stability of soil carbon forms (MAOC:POC ratio). Finally, we conducted a lab-based incubation experiment on separate fresh samples to assess how microbial carbon cycling was affected by heatwave conditions (+15 oC for 1 week).

Across sites, SOC stocks in arable soils were approximately 20% less than their grassland counterparts, equivalent to a loss of 18.7 tonnes of C per hectare. Microbial functioning differed significantly between arable and grassland soils, with arable soils being characterised by lower microbial biomass but a relatively greater potential for carbon catabolism, particularly of more labile forms. Responses of carbon cycle functions to heatwave conditions were similar between grassland and arable soils.

Our work suggests that in addition to significant and substantial losses of carbon stocks, converting grassland to arable agriculture may also increase the susceptibility of soil carbon to decomposition by microbes, which could be worsened by climate extremes.

Funded by: British Ecological Society

Keywords: Soil organic carbon, grasslands, arable agriculture, heatwave, microbial functioning.

Soils for Climate:

Poster Abstracts

Is soil carbon sequestration driven by burial depth rather than litter type

By **Daisy Alston,** Mengmeng Xie, Charlie Davies, Emily C. Cooledge, David R. Chadwick, Davey L. Jones

Bangor University

The subsoil (>0.2 m depth) holds between 45-65% of the soil's total carbon (C), representing a substantial portion of the terrestrial C reservoir. There is significant opportunity to enhance these C stocks, yet our understanding of how deep C will respond to management interventions is uncertain. Here, we investigated the effectiveness of organic matter burial (wheat straw, sycamore woodchip) on soil C sequestration in mineral soils across contrasting burial depths and its effect on soil biogeochemistry. We hypothesised that woodchip would be more effective for long term C storage than wheat straw due to differences in its physical properties and composition which affect decomposition rate and subsequent C storage. To investigate this, we buried known quantities of straw and woodchip in mesh bags at different burial depths (5 cm, 25 cm, 50 cm). After 2 years, the plots were excavated and the mesh bags retrieved, alongside soil samples for biogeochemical analysis. Contrary to our hypothesis, based on ash-free mass loss (%) (AFML), we found that the type of organic matter added had no effect on decomposition rate, with mean AFML % 58.6 % and 57.3% in straw and woodchip treatments, respectively. Burial depth had a significant effect on decomposition rate, with organic matter incorporated in the 5 cm depth experiencing 43 % and 12.5 % greater AFML % than burial depths of 25 cm and 50 cm, respectively. Soil C fractions including SOM %, CN ratio, TOC (mg kg-1), MBC (mg kg-1) were not significantly affected by litter burial depth, but saw significantly declines within the soil profile, excluding MBC which increased with depth. We conclude that the burial of organic matter, specifically cereal straw and hardwood woodchips do not enhance C sequestration after 2 years of burial. However, other types of organic material with different CN ratios when buried at optimal depths may offer greater potential.

Funded by: Bangor University sponsored student

Keywords: straw, woodchip, subsoil, decomposition, intervention.

Link to Poster

Global Nitrogen Innovation Centre for Clean Energy and the Environment.

By **Saoirse Sheehy Ariff**, Laura Cardenas, Alison Carswell, Brighton Chatindo, Yafei Guo, Asma Jebari, Saul Wood, Yusheng Zhang, Adie Collins

Rothamsted Research

Synthetic N fertilisers are an integral part of the global food system and are estimated to be responsible for just under half of all food produced today. Agricultural demand accounts for approximately 80% of industrially produced ammonia (NH3). Conventional NH3 production relies on fossil fuels both as an energy source and for supplying the hydrogen used in the conversion of nitrogen gas (N2) to NH3. Producing one tonne of NH3 typically requires 8 MWh of energy. Given that NH3 production contributes an estimated 1–3% of global CO_2 emissions, its decarbonisation could play a significant role in reducing greenhouse gas emissions. Green NH3, a promising alternative to conventional NH3, uses water (hydrolysis) to provide the necessary hydrogen and renewable energy to power the reaction. Specialised farm machinery can be used to inject anhydrous green NH3 into the soil at a depth of 15-20cm. The Global Nitrogen Innovation Center for Clean Energy and the Environment (NICCEE), is a project that employs use-inspired, data driven approaches to focus on the challenges, innovations, opportunities and socioeconomic impacts associated with green NH3 and climate smart N management. The UK partner of the NICCEE Global Centre project is involved in modelling and field-based experimental research. The modelling component examines the life cycle assessment of both conventional, green ammonia and derivative low-carbon fertilisers, focusing on their environmental impacts, N use efficiency and energy consumption on farms. The feasibility of adopting the new green ammonia technology in different farming contexts will also be examined. In tandem, the field trials investigate the mitigation of potential of nitrification inhibitors on NH3 and N2O soil emissions resulted from the availability of low-carbon fertilisers in UK agricultural system. This poster presents an introduction to green ammonia production, its application in agriculture, and an overview of the Rothamsted NICCEE team's ongoing research.

Funded by: UKRI

Keywords: Nitrogen, Green ammonia, Nitrification Inhibitor, Field-Trial, Modelling, Life cycle assessment.

Designing Field Trials to Assess Nitrification Inhibitor Impacts on Soil N_2O and NH_3 Emissions in UK Agricultural Systems.

By **Saoirse Sheehy Ariff**, Adie Collins, Alison Carswell, Brighton Chatindo, Yafei Guo, Saul Wood, Laura Cardenas

Rothamsted Research

Nitrogen fertilisers play a vital role in global food production. Managing N2O and NH3 emissions associated with N fertiliser use is key to improving agricultural sustainability. Nitrification inhibitors (NI) slow the transformation of NH4+ to NO3- and therefore N2O production and are thus predicted to reduce gaseous nitrogen emissions associated with fertiliser use. Previous studies have found NIs to be affective at reducing N2O; however, results are affected by soil characteristics, climate and fertiliser type. Urease inhibitors (UI) in contrast, slow down the hydrolysis of urea to produce NH3 and NH4+ also resulting in delay in further N transformations. In our experiment, it was hypothesised that the application of these inhibitors with N fertilisers would affect N2O and NH3 emissions and that these effects would vary with crop type and their inherent management as well as the form of N fertiliser. To test this hypothesis two field experiments, one growing wheat (Triticum aestivum; KWS Extase variety) and the other permanent pasture (Lolium perenne), were set up in Southwest England. Five treatments with four replicates each were applied: control (No N), calcium ammonium nitrate (CAN), CAN + NI Vibelsol (DMPP), Urea, Urea + UI (1,2,4-triazol) + NI (3-methylpyrazole)). Nitrogen fertilisers were applied as pellets with application rates of 160 kg N ha-1 (2 splits) and 200 kg N ha-1 (3 splits) for the arable and pasture sites, respectively. After each fertilisation event, soil greenhouse gas emissions were measured with decreasing frequency for 12 months using a static chamber (0.48m x 0.48m) method. Wind tunnels with phosphoric acid traps were used to measure NH3 volatilisation during three weeks after fertilisation. Wheat plants were harvested at maturity and grass was harvested three times over the growing period to mimic silage cutting. This poster describes the experimental methods used in this field study.

Funded by: UKRI

Keywords: Nitrogen, Nitrification Inhibitor, Urease Inhibitor, N2O, Ammonia, Pasture, Arable.

Development of a Decision Support Tool for China to Improve Nutrient Utilization from Manures (Biowaste Nutrient Management Tool, BNM-Tool).

By **Shidi Ba**[1], Zhaohai Bai[2], Lin Ma[2,3], Davey L. Jones[1], Dave Chadwick[1]

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Nitrogen (N) losses from cropland fertilization, including nitrous oxide (N2O), ammonia (NH3), and nitrate (NO3-), have significantly degraded environmental quality in China, making this sector a priority for multi-pollutant mitigation. Substituting mineral fertilizers with manure, termed 'manure substitution', has emerged as a promising solution to alleviate agricultural N pollution. However, its adoption has been limited by insufficient quantification of N losses and a lack of region-specific mitigation strategies under different combinations of manure and chemical fertilizer use. To address this, a novel modeling framework, the Biowaste Nutrient Management Tool (BNM-Tool), was developed to enhance manure substitution while minimizing N losses. The BNM-Tool integrates high-resolution estimates of N2O-N, NH3-N, and NO3--N losses with zoning-based synergistic mitigation strategies and consists of four modules: N2O-N, NH3-N, and NO3--N, and mitigation.

In 2019, total cropland N loss in China was estimated at 10.0 Tg N, with NO3--N leaching as the largest contributor. Northcentral China was identified as the common hotspot for N2O-N, NH3-N, and NO3--N losses, highlighting this region as a priority for policy intervention. While total N input remained the overarching driver across all N loss pathways, secondary factors varied: N2O-N was influenced by manure-N:total-N ratios, NH3-N by temperature, and NO3--N by precipitation. By 2050, merely pursuing 100% manure recycling without improving manure-N use

efficiency could almost double N2O-N emissions and increase NH3-N volatilization by 60% relative to 2019, emphaizing the need for concurrent improvements in manure recycling and nutrient management. An innovative zoning method was also developed to classify croplands into eight mitigation zones with region-specific strategies for synergistic reduction of N2O-N, NH3-N, and NO3--N losses.

Overall, our BNM-Tool offers both a transferable framework for cleaner fertilization in croplands and a scientific foundation for advancing China's green transformation toward sustainable agriculture.

Funded by: China Scholarship Council (CSC)

Keywords: N2O, NH3, NO3, Chinese cropland, manure, fertilization, model, mitigation.

Link to Poster

Quantifying Soil Organic Carbon at Scale: Insights from the UK's Largest Farm Survey to Inform SOC Monitoring Protocols.

By **Sofia Biffi**[1], Pippa Chapman[2], Helaina Black[3,4], Lars Munkholm[1], Iris Vogeler[1], Guy Ziv[2]

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Agricultural soils are increasingly recognised for their potential to mitigate climate change, but the promise of carbon farming relies on two assumptions: that management practices can increase soil organic carbon (SOC), and that these changes can be measured and verified with confidence. In practice, both remain challenging. SOC stocks are highly heterogeneous across soils, climates, and management systems, but our understanding of their variability across scales remains limited. We used the largest farm survey field-level SOC and bulk density (BD) dataset in the UK to date, consisting of 21,000 soil cores collected from 1,954 fields sampled at multiple depths (over 62,000 samples) across 75 farms in western Great Britain. Fields spanned through a land-use intensity gradient, from arable to seminatural grassland, and represented soil types typical of temperate dairy production areas. Our study provides robust estimates of SOC stock and BD at 0–100 cm (or bedrock), quantification of field- and strata-level variability in BD and SOC, and an estimation of expected SOC stock change following land use transitions. Moreover, we identified four sampling protocols that are commonly used to measure SOC stock and evaluated how simplified sampling performs relative to intensive protocols using a bootstrap framework simulating field selection and compositing strategies. Results show that BD measurements are critical for accurate SOC stock estimation, and that compositing SOC samples results in low accuracy up to ±30 Mg C ha^{-1} error thresholds, with important implications for the detectability of SOC stock change at different spatial scales. Our results clarify some of the trade-offs between sampling effort and accuracy, providing a data-driven basis for improving the transparency of SOC monitoring and verification, and for strengthening the role of agricultural soils in climate mitigation.

Funded by: BBSRC (Resilient Dairy Landscapes BB/R005664/1); Mission Soil (MARVIC 101112942)

Keywords: SOC stock; sampling; landuse change; sequestration; farm monitoring; bulk density.

Link to Poster

Soil CO_2 Fluxes and Carbon Balance in coffee agroforestry and full-sun coffee in Costa Rica.

By **Cristina Chinchilla-Soto**[1], Mayea Monge-Muñoz[1], Juan Chin-Pampillo[1], Ana María Durán-Quesada[2], Marco Vinicio Gutiérrez-Soto[3], Luis Villalobos-Villalobos[4], Gabriela Soto-Muñoz[5]

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Soil CO2 fluxes serve as a proxy for microbial and root respiration, offering insight into ecosystem function under varying land-use systems. The soil CO2 fluxes are affected by environmental factors and by crop management practices. In this study soil CO2 fluxes were measured in a coffee field under agroforestry (AFS) and full sun (FSS), in the Central Valley of Costa Rica, from 2021 to 2023. Twenty sampling points were randomly selected in each field and fluxes were measured once or twice a month. The CO2 fluxes followed the rainfall pattern throughout the measuring period, with the first peak in fluxes occurring between April and May, with the onset of the rainy season and a corresponding soil water content increment. CO2 fluxes tended to be greater in AFS than in FSS, although no significant difference was observed ($p < 0.05$). Differences within sites among years were more evident, thus the maximum CO2 values were registered in 2023, in AFS in March (5.2±0.2 µmol CO2 m-2 s-1) and in FSS in May (5.2±0.1 µmol CO2 m-2 s-1) and the lowest values were registered in January 2022 (AFS, 2.3±0.1 µmol CO2 m-2 s-1). Although no statistical differences were observed in CO_2 fluxes between systems, the agroforestry system maintained higher soil moisture levels, highlighting a key agroecological benefit that supports soil resilience and water regulation. Additionally, a partial carbon balance (considering soil C stock, cumulative CO2 fluxes and potential C

entry by litterfall) estimated for 2022–2023 revealed net carbon losses in both systems, though slightly lower in AFS. These findings emphasize the importance of comprehensive carbon accounting in evaluating the climate mitigation potential of coffee agroforestry systems, particularly in tropical regions where land use decisions can have major implications for global carbon emissions and climate regulation.

Funded by: Universida de Costa Rica, CONARE

Keywords: coffee, agroforestry, tropics, carbon balance, ecosystem function, greenhouse, ENSO, fluxes

Link to Poster

Does size matter? Biochar particle size and nitrogen addition drives mineralisation and soil organic matter turnover.

By **Charlie J. Davis**, David R. Chadwick, Davey L. Jones, Robert W. Brown

School of Environmental and Natural Sciences, Bangor University

Biochar represents a promising greenhouse gas removal (GGR) tool due to its recalcitrant nature and resistance to decomposition, with soil application one of the most common storage environments. However, the introduction of organic or mineral substrates can trigger priming effects (PE), leading to microbially-mediated mineralisation of native soil organic C (positive PE) or preferential degradation of added material (negative PE). The magnitude and direction of PE significantly impacts short- and long-term C storage. To examine how biochar characteristics influence C dynamics, we conducted a 30-week mesocosm study combining grassland soil and ammonium-nitrate fertiliser with biochar produced at 450°C and 600°C, separated into three size fractions: small (<355 μm), medium (355 μm–2 mm), and large (2–9.5 mm). 14C labelling enabled direct measurement of soil and biochar C mineralisation. Biochar mineralisation was significantly higher with small particle sizes, independent of pyrolysis temperature or N addition. PE was unaffected by biochar particle size or pyrolysis temperature. However, N addition significantly increased the PE and altered soil microbial community structure. Results indicate that larger biochar particles demonstrate greater soil durability, being less accessible to microorganisms and more resistant to degradation. These findings suggest that biochar particle size critically influences C sequestration potential.

Funded by: UK Biotechnology and Biological Sciences Research Council (BBSRC) funded Greenhouse Gas Removal Biochar Demonstrator project (BB/V011596/1).

Keywords: Biochar, priming effect, pyrolysis, inorganic nitrogen, 14C, soil microbial community

Link to Poster

AI enabled climate smart fertiliser practice.

By **Max Davis**, Yu Zhang, Gaoshan Bi, Yang Li, Qing Xue, Po Yang, Simon Jeffery

Harper Adams University

Fertilisers are an important component of highly productive arable production systems. However, they are linked to the production of Nitrous oxide (N2O) a potent greenhouse gas (GHG) with 273 times the global warming potential of carbon dioxide (CO2). Agricultural soils and the application of fertiliser contribute 68% of N2O from the agricultural sector. Optimising fertiliser inputs to improve agricultural sustainability is therefore necessary. AI has enhanced management in arable systems, but approaches to balance fertiliser input and GHG emissions have been constrained by the availability of suitable data. Cutting edge research methods utilising tensor multi task learning, agricultural process-based models and graph neural networks aim to bridge this gap and provide AI enabled fertiliser recommendations.

To validate this AI approach and compare it to conventional fertiliser practice (RB209), field trials in winter wheat systems across three different soil textures were undertaken. During periods of fertilisation GHG emissions were captured using a static chamber approach and cumulative emissions of CO2, CH4, and N2O were calculated. Data were collected on yield and grain protein following harvest to compare NUE and cumulative GHG emissions. Results from this study will aim to identify where fertiliser application can be optimised using AI-enabled tools.

Funded by: Innovate UK (UKRI)

Keywords: GHG, Nitrous oxide, AI, Fertiliser, Arable, Yield, Agriculture, Sustainability, Wheat

Growing soil microbial biomass for improved carbon storage.

By **Fiona C. Fraser**[1], Kairsty Topp[1], Eleanor Reed[2], Matthew Shepherd[2], Christine Watson[1]

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2. Natural England

Microbial biproducts and necromass are recognised as major contributors to soil carbon. The accumulation and subsequent storage of this is dependent on the living soil microbial population. Logically, the larger the microbial population the more exudates and necromass should be produced allowing increased scope for storage. Farmers and land managers are encouraged to use methods to conserve and build stocks of soil carbon; actively trying to grow the size of the soil biomass via soil amendments could be an option which would mutually benefit soil carbon and crop nutrition. We carried out a literature review to assess the evidence for different types of organic matter as feed stocks to grow soil microbial biomass. This suggested that incorporation of mixed species residues resulted in the biggest increase in microbial biomass carbon (MBC). Information on the stoichiometry of amendments was sparse and suggested the highest MBC accrued using amendments with C:N ratios between 7 and 10. We further tested this in an incubation experiment using 3 soils (sandy, silty and clay textures) and a range of materials commonly available to UK farmers. Our experimental results support the finding that mixed species residues result in the greatest increase in MBC although this was achieved with a C:N ratio of approximately 16. We also found that straw incorporation did not significantly change the soil MBC compared to the unamended control. These results suggest that whilst returning straw to cereal fields will put some C back into the topsoil this is unlikely to be stored long term via the microbial necromass pathway whereas terminating mixed species swards, cover crops or green manures may result in longer term storage.

Funded by: Natural England

Keywords: carbon, microbial, necromass, C:N ratio, residues.

The responses of topsoil organic carbon stocks in urban greenspaces to climate change and the urban heat island effect.

By **Charlie Goulbourne**, Jessica Davies, John Quinton

Lancaster University

Urban greenspaces are increasingly recognised as important soil organic carbon (SOC) stores, yet their future dynamics remain uncertain due to unique interactions between climate change, management, and local urban drivers. To date, no studies have modelled the responses of urban greenspace soil carbon to climate change.

The N14CP process-based nutrient cycling model, extended to represent urban parkland management, was applied to simulate SOC trajectories in 12 temperate and boreal urban greenspace sites from 2023 to 2100 under four SSP-based temperature scenarios, three nitrogen deposition trajectories, and three levels of urban heat island (UHI) intensity (+0, +1, +2.5 °C). Across sites, the model projected that SOC stocks declined by 6.5% on average under SSP2-4.5 with medium nitrogen deposition, with losses amplified by an additional ~2.5% per +1 °C UHI increment. Nitrogen deposition partially offset declines, but gains were modest and occurred only under low-to-moderate warming in a minority of sites. Site trajectories were heterogeneous, with some sites continuing to accumulate SOC under moderate warming, while others exhibited consistent decline, however, no sites exhibited resilience to warming, and SOC stock sensitivity to warming was consistently negative.

The findings of this study also highlight that UHI effects could be of comparable magnitude to differences between global climate scenarios, underscoring the importance of urban cooling strategies to limit SOC stock loss in urban greenspaces. While nitrogen inputs can buffer declines, limited sequestration potential under continued warming and falling nitrogen deposition suggests that urban greenspaces should not be regarded primarily as a mitigation lever but rather integrated into wider carbon budgets and adaptation planning with explicit attention to site history, management, and local thermal regimes.

Funded by: Self-funded MSc by Research

Keywords: Soil carbon, climate change, urban heat island, nitrogen deposition, greenspaces.

Link to Poster

Dual impacts of flooding and metal contaminations on soil greenhouse gas emissions.

By **Mahmuda Islam**[1], Mark E. Hodson[1], Ben Keane[1], Niall McNamara[2], David Spurgeon[2], and Rob Collins[3]

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Flooding represents a major global threat, severely affecting ecosystems, infrastructure, agriculture, and human livelihoods. Flood frequency and intensity are increasing due to climate change and anthropogenic activities. Floodwater often transports and deposits metals and metalloids across downstream environments, particularly floodplains, thereby altering soil chemistry and microbial dynamics. Under flooded conditions, soil oxygen concentration is rapidly depleted, leading to anoxic environments where facultative and obligate anaerobic microbes perform dissimilatory reduction reactions using alternative electron acceptors. These redox processes not only drive the production of key greenhouse gases (GHGs), such as nitrous oxide (N_2O) and methane (CH_4), but also modify the solubility and bioavailability of metals through reductive dissolution. Consequently, changes in metal mobility can influence soil microbial diversity and function. While the individual effects of metal contamination and flooding on soils are well documented, the combined influence of these stressors on microbial community structure and GHG emissions remains poorly understood. This study aims to reveal how flooding and metal bioavailability jointly regulate soil microbial diversity, functional gene abundance, and redox-associated processes that control GHG fluxes. We hypothesise that 1) flooding will alter bioavailable metal concentration in soil, which will reduce soil microbial diversity and the abundance of functional genes relevant to redox reactions, including those that result in GHG emissions (e.g., N_2O and CH_4), and 2) frequently flooded, contaminated sites will show greater resilience in microbial diversity and functional gene abundance, whereas rarely flooded sites will show reduced microbial diversity and functional gene abundance due to flood-induced changes in metal mobility, ultimately influencing soil GHG emissions. This project advances the understanding of the interactions between two major stressors on

floodplain ecosystems (flooding and metal contamination) and how they relate to soil microbial ecology and their contribution to GHG emissions.

Funded by: NERC

Keywords: Flooding, soil microbiology, metal mobility, greenhouse gases, biogeochemistry, climate change.

Capturing Soil Organic Carbon Heterogeneity: Insights from Hyperlocal and Field-Scale Sampling.

By **Christopher Lakey**[1], Nichola Knox[2], Jacqueline McGlade[3]

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3. Downforce Technologies, University College London, Strathmore University

Understanding the spatial variability of soil organic carbon (SOC) is critical for accurately monitoring and managing soil carbon stocks. Field-scale soil sampling is widely used to estimate SOC and infer its spatial distribution; however, SOC can vary markedly over short distances, leading to challenges in characterising within-field heterogeneity.

This study compared hyperlocal (samples taken within a 10 m × 10 m area) and field-scale soil datasets collected from an organic farm in Devon, UK. Statistical analyses were applied to evaluate SOC variability across different spatial scales and to assess the significance of hyperlocal soil carbon variability.

Results show that hyperlocal variability can closely reflect that observed at the field scale, indicating why spatial patterns may not be effectively captured by coarse-scale sampling. These findings have important implications for the reliability of low-density sampling and interpolation methods, which may underestimate local extremes and mask critical spatial trends. Consequently, reliance on field-scale averages alone may lead to inaccurate carbon stock estimates and misinformed management decisions.

This study highlights the value of incorporating hyperlocal sampling into soil carbon assessments to better represent spatial heterogeneity and improve the accuracy of carbon monitoring frameworks.

Funded by: N/A

Keywords: SOC, Soil Carbon, Sampling, Hyperlocal, Spatial, Variability, Measurement.

Exploiter no more: Root metabolites driving denitrification inhibition from diverse plants.

By **Jincheng Li**[1,2], Roland Bol[3], Davey L. Jones[2], David R. Chadwick[2], Xiaotang Ju[4], Chuihua Kong[5], Yunting Fang[1], Di Wu[1]

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Soil denitrifiers can profoundly benefit from plant root activities by utilizing the released labile carbon (C) in root exudates, though the plants may not receive direct benefits in return. However, the role of root metabolites in promoting or suppressing denitrification remains poorly understood across a wide range of plant species. Additionally, the underlying mechanisms driving these effects are still elusive. We used an optimized hydroponic-based approach to collect root metabolites in hydroponic solution from 100 plant species. We then assessed their differential effects on soil denitrification potential, microbial activity and the abundance of denitrification genes. Out of the 100 plant species tested, the root metabolites of 21 exhibited biological denitrification inhibition (BDI), while 51 stimulated denitrification under conditions of sufficient C supply. Some of the collected BDI root solutions inhibited soil denitrifying activity within the heterotrophic community and reduced the abundance of key denitrification genes, including nirK, nirS and nosZ. Several potential BDI-related secondary metabolites, such as flavonoids, were identified using untargeted LC–MS metabolomics. Our findings suggest that the inhibition of denitrification through root metabolites may be a widespread strategy among plant species, offering new insights for developing effective strategies to mitigate plant-mediated N losses in the rhizosphere.

Funded by: National Natural Science Foundation of China and Bangor university

Keywords: biological inhibition, soil denitrification, root metabolites, rhizosphere, soil microbes

Link to Poster

Investigating the influence of biochar and basalt rock dust on soil carbon cycling in urban cover crop agroecosystems

By **Jennifer Newell**, Rory Doherty, Siobhan F. Cox

School of Natural and Built Environment, Queen's University Belfast, Belfast, UK

Urban spaces are estimated hold around 10% of total global terrestrial carbon storage, and comparably, up to 5x more than rural/natural spaces1,2. If appropriately managed, poor quality urban soils then have significant potential for carbon offsetting that could aid climate change mitigation practices. Soil amendments such as biochar3 and basaltic rock dusts4 have been explored as effective methods to enhance carbon sequestration and storage, though less is known of their efficacy in heterogeneous contaminated urban soils. This study set out to compare the carbon storage potential of 33 t/ha digestate biochar and 40 t/ha Antrim basalt in urban soils under cover and forage crops (Brassica juncea; Trifolium pratense), by measuring LOI organic carbon stock, total carbon and nitrogen, and isotope signatures, and determining soil CO2 emissions (SCE) using an in-field analyser. Results showed immediate increases in Soil Organic Matter (SOM), Soil Organic Carbon Concentrations and Density (SOCC and SOCD) for biochar treatments, though no other significant differences across treatments at 6- and 12- months post-application. No significant differences in δ13C and C:N were observed between treatments. Interestingly, average cumulative SCE was significantly higher in basalt-treated soil, compared to control soil. This may be attributed to the complex interactions between local soil mineralogy and geochemistry, soil amendment properties, land use, biota, and local meteorology and hydrology. Further current research now considers quantifying inorganic carbon species using TGA and XRD, and the influence of biotic factors such as microbe populations to better understand carbon storage under the present study conditions. These investigations then support the potential use of urban soils as key carbon sinks to counter urban carbon emissions.

Funded by: Engineering and Physical Sciences Research Council (EPSRC) Studentship

Keywords: Carbon, urban, biochar, basalt, isotopes, emissions, carbon stock

Link to Poster

Impacts of flooding on earthworm populations.

By **Ben Pile**[1], Mark Hodson[1], Tristian Daly[2], Michael Berenbrink[2]

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Climate change is leading to increased frequency and intensity of extreme weather events such as flooding. When soils flood they rapidly become anoxic, which could significantly impact soil macroinvertebrate communities. Earthworms rely on passive gaseous exchange across their skin for respiration. Anoxic environments could negatively impact earthworm populations, reducing both abundance and diversity.

In choice chamber experiments using a range of soil types the earthworms Lumbricus terrestris, Allolobophora chlorotica, Aporrectodea caliginosa and Octolasion cyaneum typically avoided waterlogged or dry soils. Oxygen concentrations in these soils decreased within hours from 1.55 to 0 mg / l as moisture content increased from 20 to 30 wt%. In laboratory experiments in which earthworms were kept in solutions of differing oxygen levels, we found that the concentration of oxygen at which earthworms are able to survive can vary greatly between different species.

The concentration of haemoglobin in blood coupled with haemoglobin oxygen affinity are critical elements for earthworm respiration. We hypothesised that one or both of these factors may contribute to the variations observed in species survival at low oxygen levels.

Our results indicate significant differences in haemoglobin levels/ and oxygen affinity between species and suggest that these differences may indeed contribute to increased species survival under oxygen-restricted conditions in flooded soils." Our results suggest that flooding negatively impacts earthworm populations and diversity in soils. Increased frequency of flooding due to climate change will have a negative impact on earthworm population viability and their delivery of ecosystem services.

Funded by: Leverhulme Trust

Keywords: earthworm; moisture; flooding; haemoglobin; oxygen; suffocation.

Link to Poster

Compaction-induced losses in soil services in Europe under future climate.

By **Alejandro Romero-Ruiz**[1], Olivier Heller[2], Alice Milne[3], Kevin Coleman[3], Andrew Whitmore[3], Lorena Chagas Torres[4], Michael Kuhwald[6], Mathieu Lamandé[5], Thomas Keller[2,4,#], Landon Halloran[1,#]

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Soil compaction is an agricultural threat that is known to have negative impacts on crop yield and soil ecosystem services such as food production and climate regulation (by nitrogen and carbon cycling). European agricultural land is particularly vulnerable to soil compaction and related soil function loss under climate change, although the spatio-temporal variability of the impacts remain poorly understood. In this study, we address this knowledge gap by coupling a soil-compaction-agroecosystem model with climate projections from the Coupled Model Intercomparison Project (CMIP6) to systematically predict changes and associated economic losses in crop yield, nitrogen and carbon from compacted agricultural land across Europe under the high emissions Shared Socioeconomic Pathway (SSP585). We compared compaction-induced losses for the Near Future (NF, centred in year 2030) and End of Century time horizons (EOC, centred in 2090). In the NF, annual continental losses by soil compaction were predicted for crop yield (4%), soil organic carbon (2%), nitrous oxide emissions (20%), and nitrate leaching (3%). Crop yield and carbon losses peaked at latitudes of 47°, while losses by nitrous oxide emissions and nitrate leaching followed a general increasing and decreasing trend with increasing latitude, respectively. In the EOC horizon, we predicted losses in crop

yield, soil carbon and nitrous oxide emissions (2%, 4%, and 15%) and gains in nitrate leaching (15%). We estimated compaction-related economic losses to be 20 and 7 billion USD/year for the NF and EOC, respectively. Soil compaction is expected to remain a significant concern for soil services and to exacerbate climate-induced losses in agroecosystems in future climates.

Funded by: N/A

Keywords: soil compaction, climate change, function loss, soil degradation.

Mitigating Peat Decomposition with the Acrotelm Harvesting Method: The Role of Phenolic Additions Under Increased pH.

By **Takara Simpson-Jenkins**[1], Eléonor Bergeron-de Pani[2], Mélina Guêné-Nanche[2], Line Rochefort[2], Dan Aberg[1], Professor Chris Freeman[1], Professor Christian Dunn[1]

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Traditional peat extraction methods involve draining the land and drawing up its viable seed bank, exacerbating water loss, oxygenation, decomposition, and greenhouse gas emissions. This study works alongside the development of an acrotelm harvesting method, where the vegetative layer of the peatland is lifted before peat is removed from underneath and placed back down unharmed. To enhance the geoengineering capabilities of this method, this study harnesses the Enzymic Latch mechanism, whereby the addition of phenolic compounds inhibits hydrolase enzymes, mitigating the breakdown of carbon and subsequent release of carbon dioxide. To test this theory in-situ, three types of phenolic treatment were added to an acrotelm harvested commercial peatland in Quebec, (these include dry biochar and biochar and woodchips soaked in calcium lignosulphonate). Unexpectedly, it was found that the after 1 year of treatment some enzyme activity had increased, with the overall average activity of B-Glucosidase coming out at 7.93 nmol g-1 min-1 per gram of dry peat in the harvested areas and 8.17 nmol g-1 min-1 in the treated areas. This was found to correspond with an increase in pH within the treated areas, especially when the treatments involved soaking solution, (harvested:4.22, dry treated average: 4.48, soaked treated average: 4.83). Studies show that an increase in pH of peat often corresponds with a significant increase of enzyme activity. The current study indicates that elevated pH prevents the inhibitory effects of phenolics on enzyme activity, while also suggesting that phenolic supplementation can mitigate the severity of the effect of high pH on peatland decomposition.

Funded by: Premier Tech Horticulture, Bangor University and Laval University.

Keywords: 'Enzymic Latch' 'Peatland' 'Phenolics' 'Harvesting' 'Biochar' 'Enzyme activity' 'pH'

Link to Poster

Assessment of Carbon Carrying Capacity of Vertisols Under Long-Term Fertilization and Manuring.

By **Suvana Sukumaran**[1], Purakayastha T J[2], Bidisha Chakrabarti [2], K.K. Bandyopadhyay[3]

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SOC plays a pivotal role in regulating GHG emissions and sustaining food production systems. The balance between C inputs and outputs governs SOC dynamics. Designing optimal carbon input strategies requires an understanding of soil C saturation level, which varies with soil type, texture, clay minerology, C inputs and climate. Long term fertilizer experiments established across diverse agro-climatic zones and soil types in India, offer a valuable platform for assessing carbon saturation deficit (CSd). However, limited information is available on the CSd of Vertisols-one of key soil orders in India. This study aims to evaluate the C carrying capacity of Vertisols under different management practices and agro-climatic conditions, focusing on the role of soil texture, clay minerology, crop management and climate in shaping SOC sequestration potential. The study was conducted at two different ongoing LTFE sites (Junagadh, Gujarat and Parbhani, Maharashtra) in India. Groundnut-wheat at Junagadh and soybean –safflower at Parbhani were the major cropping systems. The mean annual estimated return of C (MAERC) across the soil types followed the order 100%NPK + FYM> 150%NPK = 100%NPK +Lime> 100%NPK > 50%NPK > control. The Maximum C Carrying Capacity (Cm) at 0–30 cm soil depth was 47.6 and 25.0 Mg ha-1, respectively for Junagadh and Parbhani. The Sd value was the highest in the control treatment and lowest in 100% NPK + FYM treatment, signifying a higher CSP of the former soil than the later. The estimated minimum threshold limit of annual C input to preserve the existing SOC level was 1.57 and 0.90 Mg ha-1yr-1 for soils at Junagadh and Parbhani, respectively. The MAERC, climate, soil texture and clay mineralogy largely influenced the SOC sequestration and Cm values. An integrated application of 100%NPK with either

lime or FYM is recommended to maintain the sequestration and stabilization of SOC in the studied soils.

Funded by: NICRA

Keywords: C saturation deficit, Maximum C carrying capacity, Vertisols

Resistance and resilience of the grassland soil microbiome to drought.

By **Christopher Taylor**[1,2], Ainara Leizeaga[1,2], Louison Dumond[1,2], Deon Lum[2], Katie Journeaux[2], The Nutrient Network[3], Richard Bardgett[1]

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Soil microorganisms underpin ecosystem functioning, and dictate the direction and magnitude of carbon and nutrient fluxes both within and between ecosystems. Soil microbiomes face concomitant threats from anthropogenic activities and increasingly frequent and intense climate extremes. Nutrient enrichment, for example, may shift soil microbial communities toward less stress-tolerant states, potentially rendering them more susceptible to climate extremes (e.g. drought).

We know little about the characteristics of an ecosystem or the communities therein that may determine the ability of soil microorganisms to resist and recover from climate extremes, or how other anthropogenic stressors, such as nutrient addition, modify their response.

As part of the 'SoilResist' project, we utilised a coordinated global-scale grassland experiment (Nutrient Network) to investigate the responses of soil microbial communities and their functioning to drought and test how responses are modified by nutrient enrichment. We exposed nutrient-enriched (NPK+ micronutrients) and unfertilised soils from 30 grasslands worldwide to a laboratory dry-wet cycle, and quantified changes in soil microbial communities and their functioning.

Responses to drought varied considerably across sites, and nutrient enrichment modified the resistance and resilience of microbial communities across grasslands. We further explored how responses were moderated by vegetation, edaphic and climatic attributes across wide environmental gradients.

Funded by: European Research Council

Keywords: Drought, Grasslands, Microbial functions, Nutrient enrichment, NutNet, Resistance, Resilience.

The Effect of Spatial Factors and Vegetation Types on Soil Organic Carbon from Bamen Bay Mangrove Forests in Southern China.

By **Wanyu Wen**[1,2,3], Julan Guo[1], Yaojun Zhu[1], Yanru Guo[1], Minghao Gong[1], Karina A. Marsden[2,3]

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Mangrove forests are large pools of soil organic carbon (SOC) found across the world, and play a vital role in global carbon (C) cycling. In this study, to investigate the effects of spatial factors and vegetation types on SOC in mangrove forests, soil samples at different depth layers from upper estuary (UE), lower estuary (LE), and tidal inlet (TI) in the Qinglangang (Bamen Bay) mangrove forest in Southern China were collected and the differences in SOC among the layers and geomorphological settings were compared. The mean SOC content showed a pattern of LE (4.63 ± 1.28%) > UE (2.94 ± 0.73%) > TI (1.44 ± 0.33%). SOC content and storage decreased with soil depth in TI, but increased in UE. The total SOC storages (0–80 cm) of sites TU, UE, and LE, were 104.41 ± 16.63, 207.14 ± 44.83, and 228.78 ± 19.37 Mg/ha, respectively. The results suggested that top- and subsoil organic C content and storage were largely dependent on their specific location, which underwent different river-sea interactions and human activities. We also found that soil C storage increased with soil depth in Lumnitzera racemosa plots but decreased in Sonneratia alba plots. In Bruguiera sexangula plots, soil C storage first increased with soil depth and then decreased. At UE and LE, soil C storage was greatest in the Sonneratia caseolaris plots, less in the Lumnitzera racemosa and the least in the Sonneratia alba. In this study, the soil carbon storage (0–100cm) ranged from 91.28 to 362.45 Mg/ha. Our study showed that soil C storage in a mangrove wetland varied with both soil depth and plant community type and differed significantly from landward (UE) to seaward (TI) sites. Our results provide a crucial scientific basis for the mangrove restoration aimed at enhancing carbon sequestration.

Funded by: N/A

Keywords: SOC, soil C storage, tidal, mangrove wetland, spatial pattern, vegetation type.

Impact of extreme heat events on soil microbial carbon metabolism.

By **Jinhua Yin**[1,2], Di Wu[1,*], Emily C. Cooledge[2], Chao Wang[1], Yue Li[1], Jincheng Li[2], Qiqi Wang[3], Roland Bol[4], David R. Chadwick[2], Davey L. Jones[2]

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Climate change has increased the frequency and intensity of extreme heat events with severe detrimental impacts on soil nutrient cycling globally. Here, we conducted a mechanistic study to assess the impact of a single 3-day extreme heat event (30, 40, or 50 °C) on C cycling in an agricultural soil relative to ambient conditions (20 °C), exploring potential legacy effects and shifts in microbial community structure. Compared with 20 ℃, warming to 30 or 40 ℃ did not change how microbes broke down 14C-glucose or microbial carbon utilization efficiency (CUE), whereas at 50 ℃, 14C-glucose breakdown rose by 48% and the growth share roughly halved. Molecular analyses showed that this singular 50 °C heat event decreased microbial diversity, microbial network complexity and community evenness compared with ambient conditions (20 °C). In contrast to these effects on labile C processing, extreme heat events had no legacy impact on the decomposition rate of native 14C-labelled SOM. The legacy effect on microbial C cycling was then monitored over a 200-day period following four times additions of 14C-glucose, revealing that microbial metabolism returned to a quasi-stable state after approximately six months. Despite the introduction of a microbial inoculum from a non-stressed (20 °C) community, this did not accelerate the recovery of microbial C metabolism in soil heated to 50 °C during the 16-day assay. In conclusion, we

demonstrate that short-term extreme heat events have a great detrimental impact on the turnover of labile C rather than native SOM, with its legacy effects on soil microbial C processing lasting for over six months. This study provides novel insights into the response mechanisms of microbial C metabolism following extreme heat events, helping to inform future C models in a rapidly changing global climate.

Funded by: Bangor University

Keywords: extreme heat events, microbial thermotolerance, organic matter priming, thermal adaption.

Link to Poster

Soil For Life:

Oral Abstracts

Co-designing citizen science for monitoring soil health?

By **Charlotte-Anne Chivers**[1], Anne Daykin[1], Lucy Barkley[1], Kirsten Mills[2], Rob Iddeson[3], Bethany Fairley[3]

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2. Western Sussex Rivers Trust

3. Southern Water

Citizen science is increasingly used in environmental monitoring, but its role in soil health assessment is still developing. The Soil SmART project, part of the CaSTCo programme, has worked with farmers and stakeholders to co-design soil monitoring approaches that are both practical and scientifically sound. This talk will show how co-design was embedded across the project, including decisions about which soil tests to use, when and where to sample, how to record results, and how validation and feedback are managed. We will report on findings from interviews and workshops with farmers, scientists and stakeholders that explored what motivates people to take part, ranging from stewardship and curiosity to the value of generating evidence that informs local decision-making. Using Self-Determination Theory, we will reflect on how autonomy, competence and relatedness can be supported to encourage sustained involvement. The talk will also foster a discussion about the applicability of citizen science for agricultural soil monitoring. While it can generate extensive and locally relevant datasets, challenges remain around perceived reliability, comparability and integration into policy frameworks. We will highlight the importance of clear purpose, inclusive recruitment, robust training and strong feedback loops if projects are to have lasting impact. Finally, we will report on a "time travel" exercise where citizen scientists, scientists and stakeholders considered what citizen science might look like ten years from now. Visions ranged from integrated monitoring networks feeding directly into policy, to concerns about funding, ownership and recognition. We will also reflect on how citizen science can support the UN Sustainable Development Goals and the EU's Mission Soil, by boosting soil literacy, strengthening nature connectedness, and delivering wider benefits that extend beyond data gathering to include community engagement, awareness and wellbeing.

Funded by: Ofwat innovation fund, Southern Water

Keywords: Citizen science, social science, farmers, co-design, participatory, collaborative monitoring, farmer-led.

Boosting Soil Health literacy in Europe through Innovative tools and resources.

By **Dr. Saurabh Singh**[1,2], Dr. Claire McDonnell[2]

1. Technological University Dublin

2. School of Chemical and BioPharmaceutical Sciences, Technological University Dublin

Soil health is one of the most important issues we face, and it needs an immediate response as more than half of European soils are degraded. The LOESS project (Literacy boost through an Operational Educational Ecosystem of Societal actors on Soil health) funded by Horizon Europe, has 15 partner countries. We have developed tools and resources to address gaps identified in soil health education during the initial scoping phase of the project.

Primary, secondary and university education as well as vocational education and training (VET) and awareness raising for the general public are all within the scope of the project. In response to the identified needs, a range of educational resources and tools have been co-created and piloted;

- A collection of over 60 case studies demonstrating exemplary existing soil education initiatives.

- A Massive Open Online Course (MOOC) on soil education for teachers – all learning materials are free to access.

- Four learning scenarios for upper primary and secondary school level

- Augmented Reality app called Soil: A universe beneath your feet for immersive experiential learning

- Crowdmapping tool to allow users to collaboratively build a local database by adding information about soil conditions in their areas

- Soil health glossary

- Guidelines on applying community engaged research and learning (CERL) to soil health topics

- Training modules for university students on future skills needed for professionals working in soil health co-created by students

We are now in the campaigning phase which involves implementing these tools widely and promoting their use among stakeholders. This presentation will provide an overview of what has been learned from the piloting phase and from the current campaigning phase as well as information on how to access and use the resources.

More information is available on the LOESS website; https://loess-project.eu/

Funded by: European Union

Keywords: Soil health literacy, Educational tools & resources, STEM education, Educational innovation.

You Can't Always Get What You Want – Negotiating Soil Literacy with Stakeholders.

By **Dr Karolina Trdlicova**[1], Dr Emma McKenna[2]

1. Social, Economic and Geographical Science, The James Hutton Institute

2. Dr Emma McKenna - Science Shop, The Queen's University Belfast

Building on last year's poster presentation at BSSS, in our oral presentation session we want to share practical lesson and aspects of engaging with stakeholders and communities based on the presenters' experience across two EU Mission Soil projects, LOESS and ECHO. ECHO engages citizens directly as citizen scientists through 28 tailored citizen-science initiatives across Europe and Scotland—empowering them to collect soil health data, foster soil stewardship, and contribute to a shared open-access soil monitoring repository. The LOESS project builds transdisciplinary Communities of Practice across 15 European countries—connecting educators, students, community organizations, and policy makers to co-create soil literacy tools, curricula, and learning ecosystems grounded in real-world experiences. As such both projects have a significant element of engaging with different stakeholders.

We will draw practical lessons from the 'citizen science' and the 'communities of practice' approaches embedded in these projects, and discuss how these can be utilised effectively. Lastly, we will share our practical reflections on how to include stakeholder engagement within EU Mission Soil proposals. These include – why stakeholder engagement is hard, why it matters and principles to keep in mind for good stakeholder engagement. Attendees will take away practical ideas for moving beyond "token engagement" in proposals, examples to strengthen the stakeholder sections of applications, and practical resources they can follow up with.

Funded by: THE EUROPEAN UNION, UK RESEARCH AND INNOVATION

Keywords: Stakeholder engagement, Soil literacy, Citizen Science, Communities of Practice

The Language of Soil: Learning the Lessons from Climate Change.

By **Dr. Karolina Trdlicova**, Dr Roy Neilson

The James Hutton Institute

This presentation will draw on a recently published opinion piece in the European Journal of Soil Science titled "The Language of Soil: Learning the Lessons from Climate Change" (Trdlicova and Neilson, 2025). In this piece we discuss that both the issue of soil health and of climate change can be characterised as a so called 'wicked problem.' We adopt this shared characteristic as a rationale for applying lessons from climate change communications to suggest an appropriate 'language of soil' that should be deployed to effectively communicate the pertinent issue(s) of soil health. In this presentation I will point to six recognised examples of climate change communication pitfalls. Firstly, I will point out why it is paramount to avoid inciting feelings of dread when communicating soil, especially when the desired outcome of communication is to inspire action. Secondly, I will discuss why setting 'soil health' deadlines similar to climate change deadlines or tipping points is not a helpful strategy. One of the reasons is because 'soil health' needs to be continuously addressed and re-addressed. Fourthly, I will make the point that the value-action gap needs to be taken into account when communicating on soil health with the hopes of inspiring meaningful change and action. The penultimate point will focus on why it is important to avoid the 'trap' of the knowledge deficit model when engaging with the public on soil health as there are varying levels of soil health knowledge, and lastly, I will stress the importance of communicating actions rather than knowledge as well as the importance of 'credible' soil health communicators. This presentation then aligns well with Soil for Life theme and the focus on social science.

Funded by: UKRI, EU Mission Soil, RESAS

Keywords: climate communication, soil communication, soil education, soil health, soil literacy.

Soil For Life:

Poster Abstracts

In Collaboration for Restoration: The Intrinsic Role Artists Play in Developing Effective Scientific Soil Solutions.

By **Olivia Carye-Hallstein**

Edible Nest Studio

Many artists are increasingly acting as interlocutors between the Arts and Sciences to promote and develop real solutions to challenges including soil restoration through interdisciplinary collaboration. Individually and in collaboration, artists play an intrinsic role, unique to the 21st century, as contributors to effective environmental soil management solutions beyond visual representation. The broadened 21st century definitions of art have allowed the discipline to grow past awareness work, and into projects related to soil restoration, agricultural biodiversity and permaculture solutions, and nature-based-solutions. The projects that I will survey include both artists who are trained scientists as well as artists in collaboration with scientists specifically addressing soil replenishment and innovative solutions for arability. As an artist, writer, and chef, who has held a vertical integration practice related to ingredients and materials, interviewed many prominent contemporary environmental-artists, and contributed to academic work on contaminated vacant-land restoration through Nature-Based-Solutions, it is clear to me the relevance and effectivity of STEAM frameworks related to soil. Artists' role as innovators who base their work on a bottom-to-top process based on observation, acts in informative contrast to the scientific 'top-to-bottom' hypothesis approach, which like ying and yang complete each other in developing holistic solutions for soil and beyond. Faced with growing challenges from past contamination and malpractice, these frameworks will be pertinent in resolving climate and soil solutions. This oral presentation will be participatory for interested parties to promote an active solution-oriented space.

Keywords: Art, STEAM, Collaboration, Soil, Restoration, Interdisciplinary, Creative, Solutions, Participatory, Innovation.

Link to Poster

A co-developed model policy for integrating soil sustainability into local planning.

By **Jess Davies**[1], Mirian Calvo[2], John Quinton[1], Susanna Dart[3], Paul Hatch[3], Birgit Höntzsch[4], Sejal Changede[2], Shuning Feng[2], Emelye Gill[1]

1. Lancaster Environment Centre, Lancaster University

2. Imagination Lancaster, School of Architecture, Lancaster University

3. Lancaster City Council

4. Cornwall Council

Soils are a vital yet often overlooked component of sustainable and resilient urban environments, frequently missing in planning policy. Recognising soils as living systems and finite, non-renewable resources – rather than merely construction substrates or 'muck' to be disposed of – is essential for climate resilience, environmental health, and community well-being.

Local Planning Authorities (LPAs) are well-positioned to lead this change. Through their local plans, LPAs can emphasise the importance of effective soil management and provide clear direction on protecting and managing soils throughout the development process - from design to use.

Building on the work of the Soils in Planning and Construction Task Force, the Local Soils Project, led by Lancaster University in collaboration with Lancaster City Council and Cornwall Council, sought to support the integration of soil sustainability into local planning. The project produced a co-developed model policy designed to embed soil sustainability across all stages of spatial and urban planning, influencing how places, spaces, and buildings are designed and delivered. This model policy can assist LPAs across England in integrating soil protection, enhancement, and management into policy frameworks and decision-making.

The project involved extensive cross-sector engagement, drawing insights from over 50 experts spanning science, policy, and practice. Through participatory design workshops, we created adaptable model policies that reflect both scientific insights and practical realities, combining scientific understanding with planning expertise

and on-the-ground experience from diverse actors engaging with soils throughout development.

This poster will share highlights from the resulting Local Soils Model Policy, outline the interdisciplinary co-design process, and present key insights from this collaborative approach.

Funded by: EPSRC and AHRC IAA; Lancaster City Council; Cornwall Council

Keywords: Planning, policy, soil, sustainability, urban development, built environment, construction.

Soils for Life: Interdisciplinary Understanding.

By **Rebecca Hearn**

Midlands Land Events and Society for the Environment

Soil is a multi-functional resource defined and valued differently across disciplines. This creates both opportunities for cross-sector learning and challenges in navigating the multitude of soil guidance.

Together, the authors have developed a tool to support people to navigate organisations and guidance spanning the spectrum of soil and land types. This presentation will explore the dual component tool:

• Component one, Mapping: a clickable PDF summarising selected disciplines engaged with soils, providing a snapshot of the breadth of activity that exists to safeguard this most valuable resource.

• Component two, Database: A catalogue of soil related guidance.

In our presentation, we will explore how to use the tool to identify organisations, what they do and the discipline they operate within. We will also highlight how to search for guidance using different search criteria, turning scattered resources into an accessible, interdisciplinary knowledge base.

No single management approach can meet the needs of a multi-functional soil resource. The presenter will explore how the tool can support the development of interdisciplinary hierarchies of use and management. In providing an overarching framework, the tool accommodates discipline-specific guidance while setting a clear agenda for the protection of soil. Such an approach challenges definitions, broadens thinking, and pushes knowledge boundaries.

Disciplines must understand each other's contexts to share resources, unlock opportunities, and avoid degradation and environmental harm. The presenter will outline the need for long-term and holistic interdisciplinary collaboration, as well as discussing the possibility to harness AI to boost the tool's comprehensiveness whilst ensuring it highlights only trusted, science-based sources.

Delegates will gain an understanding of how to use the tool, the ways in which it can be used to facilitate interdisciplinary collaboration and how they may contribute to its future development.

Funded by: N/A

Keywords: Soil, Interdisciplinary, Guidance, Regulation, Collaboration, Stakeholder, Knowledge.

Link to Poster

Sustainable Forestry: The Imperative of Soil Mapping in Forest Resource Inventory, Modelling and Management in Scotland, UK.

By **R L Hewison**[1], A J Nolan[1], D J Riach[1], S Addy[1], D Donnelly[1], D Miller1, L Beesley[2], J Haufe[3], J Gardiner[4], Hamish Mackintosh[4]

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2. Former members of James Hutton Institute, Aberdeen, Scotland, UK

3. Forest Research

4. Forestry and Land Scotland

Site specific knowledge of soil resources is essential to understanding their potential contribution to silvicultural management as well as wider ecological and aspects of forests. This is particularly important in Scotland, UK, where there is a complex pattern of climatic, geologic, and topographic factors that effect soil processes and their development often within a very small area. An approach based on soil classification and mapping has been devised to incorporate detailed soils information into decision support for silvicultural management. Detailed soil surveys are a vital component in the decision-making process whether to grow trees andif so, what species and how best to manage stands. Scotland's landscape has been radically changed by human influence, with forest cover reduced to 4% by the early 1900s. Re-establishing woodland cover was identified as a national priority and during the 20th Century, extensive planting took place to create a largely state-owned forest estate. Forest cover is now approximately 18% with a vision of around 25% for mid-late 21st Century. Expansion of native woodland is also underway to meet nature conservation, biodiversity and Habitat Action Plan targets. Detailed soil mapping is now deemed as an essential aspect of forest inventory planning. Over the last 16 years, detailed soil survey maps and peat depths have been produced for around 1200 km2 at a detailed scale of 1:10,000.

Funded by: Forestry and Land Scotland

Keywords: Sustainable Forestry, Soil Survey, Soil Mapping, Peatlands, Scotland.

Planning at a Crossroads Reconciling Development, Nature Recovery, and Agricultural Land.

By **James Hughes**

Natural England

Over recent decades UK land-use policy has prioritised development and economic growth, frequently at the expense of agricultural land, biodiversity, and greenfield spaces. Despite protective frameworks, the planning system's emphasis on housebuilding and infrastructure, and the presumption in favour of sustainable development, often overrides environmental constraints. Independent assessments have highlighted this divergence: long-term biodiversity declines persist and calls to create "more, bigger, better and joined" habitats have seen limited delivery, leaving landscapes increasingly fragmented and ecological resilience weakened.

Agricultural land, including Best and Most Versatile soils, continues to be lost incrementally, with greenfield development progressing in the absence of a clear national threshold to safeguard productive soils. The Environment Act 2021's mandatory Biodiversity Net Gain (BNG) requirement, delivering a minimum measurable 10% uplift, represents a major policy shift that embeds nature recovery into planning decisions and has the potential to deliver long-term ecological benefits. At the same time, BNG intensifies competition for land, frequently requiring habitat set-asides that add pressure on agricultural and limited greenfield resources.

Without a coherent national land-use framework (Further briefings and stakeholder materials circulated through spring 2025 indicate the Framework and associated guidance are being progressed during 2025), BNG risks creating unintended trade-offs: productive land may be repurposed, habitats can become fragmented through piecemeal off-site provision, and soil health and food production goals may be sidelined. Effective implementation of BNG therefore requires alignment with a strategic Land Use Framework that explicitly recognises soil protection, food security, and climate resilience. Integrating soil health monitoring, prioritising on-site gains where feasible, and ensuring BNG complements rather than substitutes for landscape-scale conservation will be essential to secure balanced, durable outcomes for nature and agriculture.

Keywords: Policy; BMV; BNG; trade-offs; resilience; framework; health; food; conservation; agriculture.

Link to Poster

Encouraging and supporting curiosity in our living soils.

By **Eleanor Reed[1], Jonny Griffiths[2], James Hughes[3], Matthew Shepherd[4]**

1. Natural England, Newcastle, United Kingdom

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Natural England is the Government's statutory adviser on the natural environment established under the Natural Environment and Rural Communities Act 2006. Natural England's purpose is to ensure that the natural environment is conserved, enhanced, and managed for the benefit of present and future generations thereby contributing to sustainable development.

Natural England has been delivering a range of soil health focused projects in recent years. In addition to this essential scientific evidence and guidance, it was identified that the awareness of soils and their role in ecosystem function needs to be encouraged from a young age.

"Our Living Soils" was commissioned by Natural England to explore soil health in a way that appeals to four to seven-year-old children. The illustrated book highlights just how much is going on in our soil and focuses on the creatures that make it their home. It was written by author and schoolteacher Emma Rosen, and illustrated by fine artist and illustrator, Rhiannon Thomas.

The book was launched during the Open Farm Sunday event at Springwater Farm in Exeter, UK. The team hosted a series of activities including round the campfire storytelling; soil minibeast drawing and writing activities; and the very popular exploration of soil dwelling organisms through the microscope.

From soil formation to soil function, this visually engaging book aims to raise the awareness of soils to young children and their parents alike. We hope it engages young children and develops their curiosity about the fascinating, but hidden, world beneath their feet.

This poster explores the process of preparing a scientifically accurate, yet engaging book, and the subsequent engagement with members of the public.

Funded by: Department of Environment, Food and Rural Affairs (Defra)

Keywords: soil literature, engagement, soil health, education.

Soils For People:

Oral Abstracts

First Signs that National Cropland Organic Carbon Loss is Reversing in British Topsoils.

By **Laura Bentley**[1], A. Thomas[1], A. Garbutt[1], B. Williams[1], S. Reinsch[1], I. Lebron[1], M. Brentegani[1], P. Keenan[2], C. Wood[2], S.M. Smart[2], P. A. Henrys[2], B.J. Cosby[1], B.A. Emmett[1], D.A. Robinson[1]

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High historic rates of soil organic carbon (SOC) loss from cropland soils are well known, contributing to climate change and compromising soil and ecosystem health. Stabilizing and reversing the loss of organic matter from cropland soils is a challenge for all nations to meet under the United Nations Sustainable Development Goals, including for sustainable food production. Sustainable land management (SLM) has been promoted as a mechanism of achieving this, but to date, there is no evidence of positive impacts at scale. Here we show the first signs of the reversal of soil carbon loss in cropland topsoils in Great Britain, following a period of reported SLM uptake, using 40+ years of national soil monitoring from the UKCEH Countryside Survey. Following a prolonged historic decline at rates of -0.16 t ha-1 yr-1 from 1978 to 2007, there was a significant increase in cropland topsoil SOC stocks (0-15 cm) from 2007 to 2019-22 with an accrual rate of 0.17 t ha-1 yr-1, approximately 0.74 MtC yr -1 nationally. Both carbon concentration and stock increase over this period, alongside a significant reduction in bulk density. The drivers of this change have not been established, and will likely be challenging, in part because management data at the scale of the national monitoring program is not available, despite coinciding with a period of reported SLM uptake. The increase in topsoil SOC could represent net carbon sequestration or carbon redistribution (geographic or vertical) but nevertheless demonstrates that topsoil properties that support soil health can be restored at scale and offers hope that a concerted effort by land managers may be halting, and reversing, SOC loss from cropland soils.

Funded by: NE/R016429/1 as part of the UK Status, Change and Projections of the Environment (UK–ScaPE).

Keywords: agriculture, arable, monitoring, organic matter, soil carbon, soil health.

Factors influencing soil carbon stocks and sequestration rates in Northern Irish grasslands.

By **Chris Chagumaira,** Alex Higgins, Rachel Cassidy, Gareth Ridgeway, Natasha Crumlish and Selva Dhandapani

Agri-Food & Biosciences Institute

Understanding the variation in soil carbon (C) stocks in grasslands is crucial for promoting sustainable management practices that support climate change mitigation. As part of Soil Nutrient Health Scheme, we aim to understand the environmental and management factors influencing C storage and sequestration in Northern Irish grasslands. Soil C stocks to a depth of 30 cm were measured in 257 fields spread across Northern Ireland. We are currently sampling full depth of soil in these fields going up to a metre depth. These selected 257 sites were also used for country wide soil survey projects in the 2004, with carbon stocks measures for the surface layers. Our results show significant increase in C ($p=0.000497$) and nitrogen (N) ($p=0.0001$) content from the year 2004 to 2024, indicating C sequestration in NI farms over the last two decades. Linear mixed models were used to determine the factors (soil type, grassland management & field topography) influencing carbon stocks and sequestration in grasslands. Field topography ($p=0.008947$) and depth ($p = 0.00000000000000022$) had significant effect on carbon stocks. Fields which were "flat and uniform" had more carbon stocks (63.68 Mg C/ha) and undulating fields had less (54.66 Mg C/ha). Our preliminary results from full soil depth analyses shows decrease in C stocks with depth as follows 0-15 cm (62.18 Mg C/ha), 15-30 cm (41.67 Mg C/ha), 30-45 cm (38.44 Mg C/ha) and > 45 cm (21.01 Mg C/ha). We are further measuring several related soil biogeochemical parameters and using modelling approaches to identify ideal management strategies for C sequestration and estimate soil C sequestration potential of NI grasslands.

Funded by: Department of Agriculture, Environment and Rural Affairs (DAERA)

Keywords: Soil carbon stocks, grasslands, sequestration.

Continental Scale Soil Monitoring: A Proposed Multi-Scale Framing of Soil Quality.

By **Grant Campbell**[1], Pete Smith[1], Nils Broothaerts[13], Panos Panagos[13], Arwyn Jones[13], Cristiano Ballabio[13], Daniele De Rosa[12], Lis Wollesen de Jonge[11], Emmanuel Arthur[11], Lucas Gomes[11], Nima Shokri[9], Mehdi Afshar[9], Gergely Toth[10], Peter Lehmann[8], Pasquale Borrelli[7], Christine Alewell[6], Robert Minarik[5], Tomislav Heng[l5], Ichsani Wheeler[5], Lindsay Maskell[4], Madlene Nussbaum[3], Laurence Jones[2], Christopher J. Feeney[2], David A. Robinson[2]

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Globally, soils are subjected to various management practices and stressors which can lead to degradation. This makes their protection essential for sustaining many functions and services as well as maintaining the overall life support of the Earth's system.

National monitoring programmes are increasingly being implemented to evaluate the state and trend of soils, a move which has been advocated by the Mission Soil in Europe.

In soil science, frameworks have been established to interpret and communicate soil monitoring results, concentrating on the concept of "quality", a term which can be interpreted in many ways.

This research explores the multifaceted meaning of soil quality, addressing its implications for future soil health assessments. It achieves this by focusing on the context of the Mission Soil.

The concept of quality is assessed through indicators where the choice of framework significantly influences selection and interpretation. However, selecting appropriate soil indicators across Europe is challenging due to diverse climate, topography, geology and soil types, resulting in varied soil processes. Therefore, establishing clear principles and criteria for soil indicator selection is essential. This work identifies four distinct frameworks for soil quality assessment: ‘Fitness for Purpose’, ‘Free from Degradation’, ‘External Benchmarking’ and ‘Value Assessment’, each possessing a unique role and application.

Notably, the ‘Free from Degradation’ framework is emphasised for its alignment with soil protection efforts and its relevance to soil threats, making it particularly suitable for pan-European assessments conducted by the European Union Soil Observatory (EUSO).

Funded by: European Union's Horizon Europe research and innovation Programme, 101086179; UK Research and Innovation (UKRI) under the UK government's Horizon Europe funding Guarantee, 10053484; UKCEH National Capability for UK Challenges Programme, NE/Y006208/1

Keywords: Degradation, Europe, Mission Soil, Quality, Soil health, Soil Monitoring Law.

A proposed national "Soil Health Alert Indicator" for agricultural landscapes.

By **Christopher Feeney,** Laura Bentley, James Lucas, Sabine Reinsch, David Robinson, Bridget Emmett

UK Centre for Ecology & Hydrology

We propose a "Soil Health Alert Indicator" to support national monitoring of, and continuous improvements to, soil health in agricultural landscapes. The proposed indicator follows the same design principles as applied by the EU, with 3 important advantages: (i) reporting the percentage of soils which cross trigger points, capturing changes in extreme cases that are otherwise unrepresented by national averages alone; (ii) recognising that soil condition reflects management practices to deliver different functions by land-use context, bespoke trigger points are developed for all major habitats; (iii) summarising the scale of soils where at least one potential issue requires further investigation through an integrated "one-out; all-out" assessment. Wales is unique in having continued to collect soil monitoring data over the last decade and provides an excellent test case here. We used nationally representative topsoil (0-15 cm) samples collected in 2021-23 from the Environment & Rural Affairs Monitoring & Modelling Programme (ERAMMP) across Wales to assess the current condition of agricultural soils. Five topsoil properties – soil organic matter, soil pH in water, carbon to nitrogen ratio, bulk density, and Olsen phosphorus (for arable & horticulture and improved grassland habitats only) – were selected, with a soil that crosses at least one trigger point flagged as requiring investigation. Bespoke, habitat-specific trigger points were established from topsoil samples collected during the 2013-16 Glastir Monitoring & Evaluation Programme (GMEP) survey, taking the most extreme 20% of values for each soil property per habitat as the basis. Applying this framework indicates that 79.9% of agricultural topsoils sampled under ERAMMP are under-performing relative to one or more trigger points, higher than the 75.1% recorded under GMEP. New results can be published with future surveys, allowing policymakers to set (and track progress towards) targets for improving soil health nationwide, potentially overcoming the current lack of a nationally agreed approach.

Keywords: Agriculture; Trigger points; SOM; pH; Bulk density; C:N; Olsen phosphorus

Translocation of organic carbon in the soil profile of a longterm experiment: scale and implications.

By **Stephan Haefele**[1], Cathy L Thomas[1], Yan Zhang[2]

1. Rothamsted Research

2. Northeast Institute of Geography and Agroecology, PR China

The Fosters Amendment Experiment at Rothamsted Research was established in 2013 to study the interaction of organic and inorganic N sources on crop performance and soil characteristics. Substantial SOC accumulations were observed in the topsoil when organic amendments with a low C/N ratio were used (farmyard manure, compost, anaerobic digest), SOC gains were small with straw applications. In 2023, we evaluated the soil organic carbon development in the profile down to one meter. Surprisingly, we found considerable organic carbon accumulation in the subsoil (23-46 cm), almost matching the accumulation in the topsoil (0-23 cm). SOC fractionation showed that around 75% of SOC is found in the mineral associated organic carbon pool (MAOC), less than 2% is in the dissolved organic carbon (DOC) pool. However, the DOC pool is increasing with soil depth and must be the main mechanism of SOC translocation to subsoil horizons. This has important implications for the understanding of the carbon and nitrogen cycle at the field, landscape and global level.

Funded by: UKRI

Keywords: carbon sequestration, SOC fractionation, vertical transport, soil C&N cycle.

An integrated soil health index for the monitoring, reporting and verification of regenerative management options.

By **Stephan Haefele**[1], Louis Ferchaud[2], Jon Storkey[1], Ian Shield[1]

1. Rothamsted Research

2. TERRENA Coopérative Angers, France

Modern agriculture faces the dual challenge of ensuring productivity while minimizing environmental impacts and preserving natural resources. Regenerative management practices are intended to achieve these goals, but their effects depend on the environment and are often small and difficult to measure. We tested an integrated soil health index, including a range of soil physical, chemical and biological indicators for its power to detect the effect of regenerative management practices on soils. For this purpose, we used soil samples from the Large-Scale Rotation Experiment (LSRE), established by Rothamsted Research in 2017-2018 at Harpenden and Brooms Barn. The trials were designed to explore how combinations of management practices namely crop rotation, tillage, fertilization, and crop protection affect a wide range of agronomic, environmental, and economic outcomes.

The top-soil samples were taken in 2023 and 2024, so seven years after the introduction of the new management options. At Brooms Barn, characterized by a Moulton series sandy loam soil type, the index could clearly detect the effects of regenerative options for tillage and fertilization, and found also interaction effects of rotation by nutrition and cultivation by nutrition. The effects were less clear at Harpenden, where the soil type was a Batscombe series silty clay loam, indicating only significant effects of regenerative options for tillage and fertilization.

These results indicate that the effect of some regenerative management options is similar across sites whilst others might not work on all soil types (or take much longer to show an effect). We conclude that the proposed integrated soil health index could be a quantitative tool for the monitoring and evaluation of regenerative management options at the field, farm and landscape scale in the UK.

Funded by: UKRI

Keywords: regenerative farming, monitoring reporting and verification, soil health.

Regenerating arable soil health for people and the planet- how to do it and monitor it.

By **Jonathan Leake**[1], Ruby Woollard[1], Dr Alastair Leake[2]

1. The University of Sheffield

2. Game and Wildlife Conservation Trust Allerton Project, Loddington Leicestershire.

Soil health in arable soil is vitally important for supporting food production, resistance to erosion, hydrological services, carbon storage and biodiversity, but intensively tilled and cropped arable soils have suffered some of the greatest impacts on these core services and functions. The regenerative farming movement, which seeks to minimize tillage, diversity rotations, maintain living roots all year, keep soil covered with plants or crop residues, and integrate livestock, is exemplified by integrating diverse leys into arable rotations for 2-3 years, followed by direct drilling of crops. However, the effects of herbal leys compared to grass-clover leys for improving soil health remain unclear in modern farming systems, especially on the large areas of intensively cultivated arable land that has been structurally and biologically degraded. We report the results of the first modern 7-year trial comparing the effects of introducing 2-3 year grass-clover versus diverse herbal ley both grazed by sheep, into a long-term arable rotation, returning to cropping by ploughing versus direct drilling, in research commissioned by the agricultural industry and research councils. Using an established simple wet-sieving method to quantify the proportion of the soil mass in water-stable aggregates > 2 mm we show dramatic improvements in this key measure of soil health due to leys in arable rotations. Importantly, this metric correlates with increased earthworm numbers, improved soil infiltration, water, nutrient and carbon storage reflecting soil health improvements that deliver societal and environmental benefits justifying paying farmers to incentivise this land use management. The grass-clover ley generally out-performed the herbal ley in improving soil water stable macro-aggregates, and both gave better crop yields with less N fertilizer. The white clover in leys that are direct-drilled can persist as living mulches that continue to deliver better soil structure 4 years post-ley showing long-term soil health improvement benefits to society.

Funded by: BBSRC, Game and Wildlife Conservation Trust; Sustainab le Agriculture Research and Innovation Club.

Keywords: Regenerative agriculture, Leys in arable rotations, Herbal leys.

DeepHorizon: DEploying Ecosystemic solutions to imProve soil Health and uncOveRing subsoil functIons in the critical ZONe.

By **Danieal Wardak**[1], Mathieu Javaux[1], Alexandre Wadoux[2], Abad Chabbi[3], Marcello DiBonito[4], Gloria Falsone[4], Sara Koenig[5], Hans-Yoeerg Vogel[5], Victor Burgeon[6], Anastasios Michaiidis[7], Ester Miglio[8], Francisco Jose Blanco Velazquez[9]

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DeepHorizon is a Horizon Europe Soil Mission project which aims to uncover hidden potential of European subsoils, an overlooked but vital component in soil functioning. Knowledge of subsoil dynamics, functions and degradation remains limited, and the pressure of unsustainable land management practices (LMPs) and climate change are increasing. To address this, DeepHorizon is leveraging multi-disciplinary collaborations across 19 international institutions to i) map subsoil properties, ii) identify sustainable subsoil management practices, and iii) develop and refine user-oriented tools to monitor and improve subsoil health.

The initial sampling campaign is underway, with 19 of our 40 sites sampled, which will be completed by the end of Autumn this year. Excavating a soil trench up to 2-

meters provides comprehensive physical, chemical and biological data to capture subsoil properties including soil texture, pH, Carbon, Nitrogen and other nutrients, X-ray CT, hydraulics, root length density, fauna, microbiology and more. These data will contribute to a better representation of subsoils in existing databases and calibrate two process-based models, BODIUM and ECOSYS, to improve representation of subsoil functions.

These models will be validated across 100+ test sites and 3 regional case-study areas (CSA), then adapted to suit the needs of end-users through farmer- and manager-friendly tools (BODIUM for farmers, ECOSYS for managers). The project will also assess the socio-economic impact and environmental trade-offs of LMPs to generate policy recommendations and incentives to propose the sustainable management and restoration of European subsoil.

To ensure widespread impact, DeepHorizon engages land managers, researchers and policymakers through Community of Practice (CoP) and targeted outreach and communication activities. To facilitate the work planned on future test sites and case study areas, we are looking for constructive feedback, synergies, and collaborations that may be available across existing projects, institutions or individuals.

Project: https://doi.org/10.3030/101156701

Funded by: European Commission under the Horizon Europe programme, Grant Agreement No. 101156701

Keywords: Subsoil, sustainability, ecosystem services, land management practices, community of practice.

Soils For People:

Poster Abstracts

Understanding variations in soil carbon dynamics from Mid-Infrared spectroscopy.

By **Ernest Afriyie**, Nikki Baggaley, Eric Paterson

James Hutton Institute

The chemical characteristics of soil organic carbon (OC) play a pivotal role in regulating microbial metabolism and the degradation processes that underpin soil carbon cycling. While the total amount of soil organic carbon (SOC) is commonly used as an indicator of soil health, its composition (specifically the molecular forms and chemical associations of carbon) may ultimately determine how SOC influences soil functioning. However, limitations in current analytical techniques have constrained our ability to elucidate how variations in OC composition affect soil processes and ecosystem functioning. Mid-infrared (MIR) spectroscopy offers a powerful, rapid, and cost-effective approach for investigating these compositional dynamics, as the MIR region of the soil spectrum contains rich qualitative and semi-quantitative information on both organic and mineral components.

In this study, Fourier Transform Infrared (FTIR) spectra from three organo-mineral soils, with comparable topsoil total SOC contents, selected from the National Soil Inventory of Scotland (NSIS 2) dataset were analysed across multiple horizons to evaluate the potential of MIR spectroscopy for resolving depth-related and spatial variations in OC molecular composition. The results revealed both shared and unique absorption features in topsoil spectra between points, as well as distinct variations across horizons. These findings demonstrate the sensitivity of MIR spectroscopy to subtle compositional variations in soil OC and provide a strong basis for its application for future studies linking molecular-level carbon dynamics to soil biogeochemical functioning.

Funded by: Scottish Governement: RESAS Healthy Soils project

Keywords: Mid-Infrared spectroscopy, Biogeochemisty, Soil Organic Carbon.

Maximising value from investment in soils data resources.

By **Nikki Baggaley**[1], Ernest Afriyie[1], Urmi Ghosh[1], Jackie Potts[2], Nia Gray-Wannell[1], Zisis Gagkas[1], Eric Paterson[1]

1. James Hutton Institute

2. Biomathematics and Statistics Scotland

The National Soil Archive and Scottish Soils Database represent valuable physical and digital resources underpinning our understanding of the diversity of soils in Scotland. Within this, the National Soil Inventory of Scotland is a systematic grid sampling of soils across Scotland (NSIS 1978-87; NSIS2 2007-9).

A current challenge is to make optimal use of this point-data in the context of the need to understand impacts of climate and land management on dynamic soil functions that underpin essential soil ecosystem services. Advanced statistical and machine learning approaches are being applied to complex multivariate NSIS2 datasets of chemical, physical and biological characteristics (e.g., infrared spectra, X-ray diffraction, phospholipid profiles). This is being used to identify metrics of soil status; and improve understanding of the context-specificity of soil functions and their sensitivity to change.

Combining these with legacy soil maps and new probabilistic soil maps, containing data on soil classes provides the basis for the development of tools underpinned by the rich sources of soils data in Scotland. The vision is to expand these 'big data' approaches to integrate these and other big data sources such as eDNA archives.

Funded by: Scottish Government

Keywords: National Soil Inventory, Soil Indicators, Legacy Soil Maps, Scotland

Link to Poster

A Soil Route Map for Scotland.

By **Sarah Buckingham**

Scottish Government

There is increasing awareness of the important role soils play for our communities, economy and environment in terms of their ability to contribute to climate regulation, flood resilience, food security, support forestry and assist biodiversity. Soils underpin all nature-based systems and are vital for our communities and economy.

There are many risks threatening Scottish soils across different soil types and land covers with soil degradation impacts affecting landscape-scale ecosystem services leading to varied socio-economic repercussions. However, unlike air and water, there is no overarching policy providing security and governance for Scottish soils with actions to support soils sitting across different policy divisions, which focus on different environmental challenges at different scales.

The climate resilience value of investing in healthy soils is recognised by the Climate Change Committee as a priority adaptation area for Scotland. Therefore, as part of the Scottish National Adaptation Plan the 'Soil Route Map for Scotland ' was developed to explore opportunities for Scotland to better protect, restore and enhance of soils through the mobilisation of an evidence-led strategy. The route map acknowledges the challenges of addressing soil security due to a lack of cohesive governance and leadership and highlights opportunities to gain value and effectiveness through better coordination of existing activities and policy delivery. The route map for Scotland provides initial recommendations across six core objectives to achieve the vision of 'thriving soils for Scotland's communities, economy and environment'. The six objectives are;

1. Lead: Inspire and collaborate to deliver the vision for Scottish soils

2. Protect: To prevent further damage to Scottish soils

3. Restore: Repair damaged soils

4. Enhance: Strengthen soil systems for the future

5. Mobilise: Communicate, engage and participate

6. Evidence: Data, information, knowledge and wisdom for evidence-led decision making

Funded by: ClimateXChange

Keywords: soil route map, soil governance, soil security, soil management.

Colne Valley Western Slopes: Resilient Soils for a Sustainable Future.

By **Chris Cantle**[1], Matthew Hobbs[1], James Rowson[1], Jane Rickson[2], Ceri Spears[3]

1. Jacobs

2. Cranfield University

3. Tim O'Hare Associates

Introduction and context:

The Colne Valley Western Slopes (CVWS) is a large-scale green infrastructure project, part of Section C1 of the HS2 Phase One Scheme. The design vision is to establish a 127ha biodiverse chalk downland mosaic, accessible to the public from over 4 km of new recreational routes.

Our presentation will demonstrate how putting soils at the centre of the design and delivery strategy helped maximise opportunities and value for biodiversity, public amenity and environmental improvement.

Design strategy – soil profiles:

The habitat creation designs were led by the inherent properties of the soil and substrate materials, following ecological succession and niche principles in the design of soil profiles to maximise the potential for biodiversity net gain.

Soil profile and landscaping trials:

A key technical challenge for the project was creating the optimum ground conditions to establish biodiverse calcareous grassland using the available site-won resources. A research project and landscaping trials were therefore undertaken to help resolve uncertainties and limit risks for the habitat creation.

Delivery – sustainable soil management:

Pre-construction planning, delivery phase support and verification protocols have all been critical to ensuring soils are sustainably managed. This has involved close collaboration between design and construction teams together with surveys, modelling and inspections to help meet the project objectives.

Outcomes:

The CVWS habitat creation is currently ~50% complete, and will ultimately provide:

- ~127 ha of high-value habitats and a 81% gain in biodiversity units
- high public amenity value through its accessibility to recreational users
- enhanced soil carbon storage potential, with an additional 54,317 tCO2e predicted to be sequestered over a 40-year period (vs. baseline conditions)
- circular economy and carbon footprint benefits through the retention of site-won materials and minimisation of off-site exports.

Funded by: HS2 Ltd and Align JV

Keywords: habitat creation, soil management, circular economy, biodiversity, carbon, calcareous grassland.

Link to Poster

How soil type influences the contribution hedgerows can make to natural flood management.

By **Pippa Chapman**[1], Sofia Biff[2], Richard Grayson[1], Guy Ziv[1]

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Woody features can regulate the hydraulic properties of a landscape by influencing water flow paths during rainfall events and reducing runoff. Hence hedgerow planting is often encouraged as a natural flood management solution. However, very little empirical evidence exists on the effect of hedgerows on soil hydrological properties, particularly when considering different soil groups. This study quantified the soil physical and hydrological properties that may affect the flood risk mitigation potential of hedges, such as bulk density, porosity, saturated hydraulic conductivity (Ksat), proportion of flow through different soil pore classes, and water-stable aggregates. We investigated 32 hedges of different age classes (new, 10 year old, and old) in the River Eden catchment in north-west England, comparing them to adjacent predominantly grassland fields. We assessed how soil properties varied under hedges on two widespread reference soil groups; cambisols and stagnosols. The soil group did affect hydrological properties, but, overall, soil under hedges had a larger proportion of smaller soil pores and a better soil structure, with increased soil organic matter and larger soil aggregates, increased soil porosity, and improved infiltration rates compared to the grassland soils. Soil porosity under hedges was ~ 17% greater than in grasslands in both soil groups but remained significant at 0–50 cm depth for cambisols and at 0–30 cm only for stagnosols. Ksat under hedges was 52 times greater than in adjacent grass fields on cambisols and 45 times on stagnosols, and changes in Ksat under hedges on stagnosols occurred over a longer timeframe. Our results show that hedge planting has the potential to contribute to flood risk alleviation, but we found that the magnitude is larger and quicker on well-draining soils than on poorly draining soils. These results will aid future natural flood mitigation modelling.

Funded by: UKRI

Keywords: natural flood management, hydraulic conductivity, permeability, macropores, nature based solutions.

Link to Poster

Monitoring the Impact of Plastic and Non-Plastic Microfibre degradation on Soil.

By **Emily Donaghy**[1], Geoffrey D. Abbott[2], Anh Phan[3], Kelly Sheridan[1], Jakub Olewski[4], Miranda Prendergast-Miller[1]

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One of the main pathways of microfibre pollution release into the environment is from textile laundering into waterways via waste-water treatment plants [1]. In these waste-water treatment plants, microfibres also make their way into sewage sludge [2]. Sewage sludge is then applied to agricultural land as fertiliser, introducing microfibres to terrestrial environments. Microfibre pollution is often categorised as part of the microplastic problem, however, studies have shown that cotton microfibres are more prevalent in the environment than plastic microfibres [3]. Non-plastic microfibres often have chemical dyes and finishes applied so pose a potential risk to soil environments.

The aim of this project is to investigate the impact that degradation of plastic and non-plastic microfibres, dyed and undyed, have on soil environments. A soil degradation experiment has been set up comparing dyed and undyed swatches of cotton and wool (examples of non-plastic textile microfibres) with virgin polyester, recycled polyester from PET bottles and recycled polyester from sea waste (examples of plastic textile microfibres). These fabric swatches and soil samples will be monitored over 18 months using pyrolysis-GC-MS and LC-MS to trace chemical changes over time, as well as monitoring impacts of fibre degradation to soil properties and soil function. Here we present preliminary data from the first 6 months of the experiment, focussing on the changes to fabric and soil properties.

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Keywords: Degradation, Microfibre, Pollution, Soil, Agriculture.

Link to Poster

The evidence for impacts of regenerative agriculture practices on greenhouse gas emissions and yield under UK conditions: a systematic mapping exercise.

By **Fiona C. Fraser**[1], Richard M. Francksen[2], Samuel Eze[3], Steven Jacobs[5], Jennifer Hodbod[4], Nicola Noble[6], Alex Playford[2], Leonidas Rempelos[7], Patrick Tarbuck[8], Payton T. O. Yau[1,9], Nicola P. Randall[3]

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Regenerative agriculture has been proposed as a pathway to achieve the twin goals or increasing food production whilst decreasing greenhouse gas emissions. However, the evidence base remains fragmented, particularly in terms of specific outcomes such as GHG emissions and agricultural yield. We conducted a systematic evidence mapping process using comprehensive searches across two academic databases and four organisational websites. Eligible studies reported outcome data on greenhouse gas emissions and/or agricultural yield associated with at least one of five representative regenerative practices: minimum or no tillage, cover cropping, undersowing, intercropping, and livestock reintegration. Studies were limited to those relevant to temperate-oceanic climates. A narrative synthesis and visualisation (heatmaps and descriptive statistics) approach was used to describe patterns in the evidence base. No critical appraisal of study quality was undertaken. A total of 117 articles met our inclusion criteria, providing 150 independent study comparisons. The distribution of evidence was uneven across practices and outcomes. Intercropping and tillage (particularly no-till) were the most frequently studied

practices, while undersowing and livestock reintegration were notably underrepresented. Most studies evaluated practices in isolation rather than in combination, despite multi-practice integration being central to regenerative agriculture. Outcome reporting was also uneven: 61% of studies focused on yield while 39% addressed emissions, most frequently nitrous oxide (N2O). Studies were typically short, with over half running for one or two years and fewer than 10% extending beyond five years. This systematic map reveals an uneven and fragmented evidence base for the effects of regenerative agriculture practices on greenhouse gas emissions and agricultural yield in temperate-oceanic systems. This limits generalisable conclusions, underscoring both opportunities for synthesis and priority gaps meriting investigation. There is a clear need for more integrative research that assesses the interactions among multiple practices and monitors outcomes over longer timeframes.

Funded by: AFN Network+

Keywords: sustainable; agriculture; farming; net-zero; production.

Hidden communities of afforestation: Revealing the mycorrhizal fungal communities of natural colonisation and plantations using a space for time chrono-sequence of post-agricultural sites in lowland England.

By **Rosemary Gooda1, Dr Laura Martinez-Suz2, Prof Martin Bidartondo3, Dr Elena Vanguelova[4]**

1. Imperial College London

2. Kew Gardens

3. Imperial Collage London

4. Forest research

Background: Mycorrhizal fungi (MF) play important roles in the creation and maintenance of biodiversity, above-ground productivity and health, carbon and nutrient cycling and ecosystem resilience to perturbation. UK afforestation programs engineer the transition from agricultural ecosystems into woodland. This transition involves a shift from an ecosystem dominated by arbuscular-mycorrhiza forming plants to one dominated by ectomycorrhiza forming trees. While tree planting is most widely used, there is growing interest in the use of natural successional processes (natural colonisation) to generate woodland. UK afforestation guidelines incorporate both tree planting and natural colonisation and EWCO financial incentives to landowners are provided for both. However, an understanding of how these practices influence the development of MF communities belowground throughout afforestation is lacking. Furthermore, subsequent effects on the resilience and belowground biodiversity of resulting woodlands are poorly understood and difficult to predict.

Aims: Here, we address the question of how mycorrhizal fungal communities develop under natural colonisation and plantations across eleven sites in lowland England ranging in age from 18 to over 100 years of afforestation, using local mature woodlands as a reference and potential source community. We incorporate both EcM and AM fungi, distinct functional groups often studied separately, in order to capture the breadth of mycorrhizal diversity and function in these successional habitats.

Methods: We generated MF community data through PacBio sequencing of soil, and both Sanger and PacBio sequencing of roots to identify EcM and AM fungal taxa. We examine impacts of afforestation practice, host plant community and soil physical-chemical properties on MF community composition, functional and taxonomic diversity across woodland age.

Impact: Our findings will help to inform policy guidelines on afforestation practices, shed light on the role of MF communities in natural colonisation of UK agricultural land and develop mycorrhizal diversity metrics inclusive of EcM and AM fungi.

Funded by: Forest Research, DEFRA Nature for Climate Fund

Keywords: Mycorrhizal fungi, Natural colonisation, Regeneration, Afforestation, Policy, Community ecology, Plantation.

Assessing regenerative agricultural practices in mineral-rich soils using carbon and nitrogen stable isotopes.

By **Flora Gray, Professor Darren Gröcke, Dr Catherine Hirst**

Durham University

Agriculture produced ~15% of global greenhouse gas emissions in 2021, despite being one of the most at-risk sectors to climate change. However, agriculture has the potential to mitigate climate warming through system-wide changes. Southwest England produces 29% of the UK's maize, despite sloping landscapes exacerbating its already harmful impact on soil health and regeneration. Trials in Europe have tried to counter ramifications by planting living mulches under maize to reduce soil respiration, fallow ground, increase soil carbon flux and improve soil structure. Elston Farm began farming regeneratively in 2021, implementing systems such as leguminous cover crops and silvopasture. Samples were collected from 16 different sites, including soil profiles up to 20cm in depth and individual plant species. Stable isotope ratios of carbon and nitrogen were measured in the Stable Isotope Biogeoeochemistry Laboratory (Durham); also producing wt% carbon and wt% nitrogen concentrations. Isotopic and elemental data was compared against land use. The iron-rich soils showed no statistical difference in soil carbon and nitrogen, indicating that regenerative agricultural practices had made little positive benefit to an agricultural soil that had previously been intensely used. Although there were some positive indications that regenerative agriculture was slightly improving the soil (e.g., leguminous N-fixation and/or silvopasture), more positive results in this mineral-rich soil system would require longer time to recover.

Keywords: Stable isotopes, Regenerative farming, Silvopasture, Nitrogen fixers, Cover cropping.

Improved plant performance and soil function via feremycorrhizal symbiosis under dual phosphorus and nitrogen deficiency in chickpea and faba bean.

By **Yasodhini Malika Liyanage**[1], Khalil Kariman[1], Saleh Rahimlou[2], Mahtab Omidvari[1], Zed Rengel[1]

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Sustainable agriculture depends on maintaining soil health and crop productivity without excessive chemical inputs, emphasising natural processes such as beneficial plant-microbe symbioses. This study examined the potential of the feremycorrhizal fungus Austroboletus occidentalis to enhance soil nutrient availability and growth of chickpea (Cicer arietinum) and faba bean (Vicia faba) under phosphorus (P) and nitrogen (N) deficiencies, with or without inoculation with the crop-specific rhizobial strains. A pot experiment was conducted using pasteurised soil, applying three microbial treatments (A. occidentalis, rhizobia, dual inoculation) and non-inoculated control. Inoculation with rhizobia or A. occidentalis increased shoot and root biomass after 7 weeks of growth for both crops, with dual inoculation resulting in the highest shoot biomass accumulation in chickpea. Enhanced shoot N and P contents were observed in some inoculation treatments, with the synergistic effects between rhizobia and the feremycorrhizal fungus evident in the highest shoot P content in dually inoculated chickpea. Rhizosphere soil Colwell P was elevated in the A. occidentalis and dual treatments compared with rhizobia and the control for chickpea, but in faba bean, the increase was only observed in the A. occidentalis treatment. Compared with the non-inoculated control, acid phosphatase activity in the rhizosphere soil of both crops was significantly greater in the A. occidentalis and dual treatments. The concentrations of citrate, malate and malonate in the rhizosphere soil of chickpea plants were highest in the dual treatment. In summary, inoculation with A. occidentalis improved plant growth, nutrient uptake, soil P availability, and acid phosphatase activity, with potential enhancement by

inoculation with the crop-specific rhizobial strains. These findings support the role of A. occidentalis as an effective biofertiliser compatible with commercial rhizobial inoculants, offering a low-input strategy to boost legume productivity and soil fertility in nutrient-limited agroecosystems.

Funded by: University of Western Australia

Keywords: Feremycorrhiza, Austroboletus occidentalis, Rhizobia, Colwell P, Soil nutrient bioavailability, Sustainability

Root soil binding capacity in the field: Rhizosheath formation and persistence in winter cover crop mixtures.

By **Cristina McBride-Serrano**[1,2], I. C. Dodd[1], J. N. Quinton[1], T. S. George[2], A. J. Karley[2]

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While much research has focused on the benefits of cover crop diversity for crop productivity, there is limited evidence on how root diversity and species selection stabilise soil. Although cover crops can potentially improve on-farm soil and water management, how they bind soil (through rhizosheath development) and whether multi-species cover crops offer additional benefits has attracted little attention. This study aimed to assess rhizosheath persistence in field-grown cover crops and their mixtures to understand the impact of species diversity on soil binding capacity.

Brassica juncea, Secale cereale and Vicia faba were sown as monocultures and mixtures in a winter cover crop field trial near Dundee, Scotland. Soil cores were collected three times during January-March 2023. Measurements included rhizosheath mass, root length, and root hair length and density.

While overall rhizosheath mass decreased by 27% with plant age, Secale cereale maintained the largest rhizosheath mass per unit root length (1.75 and 5.60 times greater than Vicia faba and Brassica juncea, respectively) regardless of time, diversity or species combination. The fibrous rooting system and long, dense root hairs of Secale cereale made this cover crop exceptionally effective at binding soil. Root hair length and density partially explained (42%) the variation in rhizosheath mass.

This field trial highlights that species selection is more important than diversity per se and indicates that Secale cereale is particularly effective at binding soil to the roots, suggesting it might be a particularly valuable cover crop over winter months.

Funded by: The James Hutton Institute and the Perry Foundation

Keywords: Rhizosheath, Cover crop mixtures, Root hairs, Root traits, Soil binding.

Defra's soil and peat research portfolio

By **Roisin O'Riordan,** David Smedley, Judith Stewart, Vittoria Lauretano, Cristina McBride-Serrano, Katherine Rothwell, Kriti Mukherjee, Munisath Khandoker.

Past contributors: Danielle Hunt, Rachael Osguthorpe, Catriona Willoughby, Katy Ross, Phil Shea, Martha Tabor.

DEFRA

The soil and peat science team commission and manage a range of research projects to support policy development. The aim of this poster is to illustrate the breadth and depth of research that the team is working on and to engage with the BSSS community. It will allow the team to show academics where the research focus is for soil and peat, potentially enable new connections with researchers, and support the development of future research to fill policy-relevant evidence gaps. Collectively, these projects represent a broad and impactful approach to advancing soil health, soil functions, ecosystem resilience, and sustainable land management. By gathering evidence that informs policy and practice, this research plays a critical role in delivering research and innovation across diverse soil habitats and land uses, helping people by supporting food security, flood and drought mitigation, climate resilience, and advancing our understanding of soil threats. The poster will include high level information and findings from research projects that have been completed in recent years, and the aims of current research projects that are ongoing.

The research projects will be grouped into the following broad topics:

- Soil health and ecosystem services
- Farming practices and sustainable soil management
- Soil data, mapping, measuring and monitoring
- Soil pollution and contamination
- Peatland restoration and management
- Paludiculture
- Peatland GHG Inventory research

Keywords: Soil health, Management, Regenerative Agriculture, GHGs, Pollution, Contamination, Peatland, Paludiculture

Calculating the cost of soil degradation in England and Wales.

By **William Pallier**, Isobel Lloyd, Fiona Nicholson, Kath Behrendt, Steven Anthony, Paul Newell-Price, Anne Bhogal

ADAS

Soil is the foundation of all terrestrial ecosystems, providing multiple ecosystem service benefits. However, the ability of soils to deliver these services is threatened by degradation processes such as erosion (by water and wind), compaction, loss of soil organic matter (SOM), contamination, disruption of the soil nutrient cycle, soil sealing (mainly in urban areas) and loss to development. Graves et al., (2011), estimated the cost of soil degradation to be £1.2 billion a year in 2011, and this figure is still widely used to communicate the importance of protecting and improving soil health.

The aim of this study is to review and revise previous estimates of the total economic cost of soil degradation in England and Wales (E&W), so that the Government can effectively prioritise the threats and risks to soils and identify areas where more research is needed. We have identified 8 main pressures of soil degradation in the UK: erosion; soil organic matter (SOM) loss; contamination; soil sealing/land take; compaction; nutrient imbalances; soil biodiversity loss and acidification. We have determined the most appropriate economic method(s) for assessing the cost of soil degradation. For each of these threats we attempted to assess where and to what degree these threats are occurring in England and Wales. The onsite and offsite economic costs associated with each degradation pressure have been identified. In addition the impact of future climate change and land use change have been considered. The poster will present an overview of these threats, what we know about the extent and rate at which they are occurring and the impacts of those threats. The outcomes of this work will improve our understanding and communication of the true cost of soil degradation and help to direct future policy measures to support sustainable development, climate change and sustainable soil management goals.

Funded by: DEFRA

Keywords: Soil degradation, Erosion, Compaction, SOM loss, Acidification, Nutrient imbalances, Biodiversity.

Banana pseudostem waste-derived biochar amendment revitalizes the tea garden soil health for sustainable cultivation.

By **Bhaskar Jyoti Parasar**[1], Ruby Woollard[2], Dr Alastair Leake[3]

1. Gauhati University

2. The University of Sheffield

3. Game and Wildlife Conservation Trust Allerton Project, Loddington Leicestershire.

Tea plantation overburdened with excessive and prolonged use of chemical fertilizers and pesticides has contributed to the degradation of soil health, including reduced functional microbes and nutrient imbalance. Two major challenges in long-term tea monoculture systems: nutrient depletion, particularly potassium loss due to continuous harvesting and progressive soil acidification can be effectively mitigated through green alternative such as application of banana pseudostem biochar (BPB), endowed with high potassium content. Further characterization revealed its microporous structure with particles ranging from micro to nanoscales, with high number of functional groups in its increased surface. Our study investigated concentration and duration dependent effects of BPB amendment on the physicochemical characteristics of tea garden soil properties and subsequently its impact on microbial diversity associated with it. Results have shown that BPB amendment induces key changes in soil health indicators such as pH, organic carbon, micro- and macro nutrient status, enzyme activities and nutrient availability. Improvement in soil condition subsequently aid in tea plants growth and increasing plant traits such as photosynthetic pigments, antioxidant activities and leaf enzyme activities. In conclusion, BPB amendment induces a distinct temporal and concentration dependent changes in soil physicochemical responses and improves tea plant health, affirming BPB as a promising green alternative for sustainable tea cultivation. Further, this study attempts to tackle challenges in sustainable agriculture and mitigate environmental issues to achieve carbon sequestration and nutrient retention, envisaging healthy tea garden soil ecosystem.

Funded by: ANRF INDIA

Keywords: Soil, degradation, nutrient, acidification, microbes, enzymes, genes, sustainable, carbon, health.

Sustainable Fertiliser Scheduling in Practice: Synchronising Organo-Mineral Nutrient Release with Wheat Growth Stages.

By **Parveen Fatemeh Rupani,** Ruben Sakrabani

Faculty of Engineering and Applied Sciences, Cranfield University, UK

Organo-mineral fertilisers (OMFs) offer a promising route to reduce reliance on mineral fertilisers (MFs), yet practical guidelines for their timing and formulation remain elusive. Most fertiliser schedules are still tailored to MF dynamics, overlooking the apparent nutrient release profiles of OMFs. This research aims to identify when OMFs should be applied to best match nutrient release with crop demand, providing evidence-based recommendations for OMF fertiliser timing.

A controlled glasshouse pot experiment was conducted using three OMF types (1) Straw-derived, (2) Anaerobic digestate (AD) blended with coco shell, and (3) AD-derived, compared against an unfertilised control. Non-destructive sampling was performed at five key growth stages: tillering, stem elongation, flag leaf, flowering, and harvest. This study combines soil nutrient profiling with biomass and yield assessments to evaluate how OMF timing influences spring wheat performance.

ANOVA results revealed that all three OMFs significantly influenced wheat growth ($P < 0.001$). Notably, stem elongation ($P < 0.001$), flag leaf, and flowering stages ($P < 0.05$) showed marked differences in available nitrate content, suggesting key windows for synchronising nutrient release with crop demand. While grain yield varied across treatments, differences were not statistically significant ($P = 0.36$), indicating that timing and formulation may impact nutrient uptake more than final yield under controlled conditions.

These findings provide early stage evidence for tailoring OMF application to crop phenology, paving the way for more precise, climate-smart fertiliser strategies. Future work will expand this framework to field trials and mechanistic modelling to support scalable recommendations.

Funded by: CCm Technologies Ltd

Key words: Organo-mineral fertiliser (OMF), Spring wheat, Fertiliser timing strategies, Soil health.

Organo-mineral fertiliser (OMF), Spring wheat, Fertiliser timing strategies, Soil health.

By **David Shannon**, Alan Cundill

Scottish Environment Protection Agency

Sustainable waste recovery on land can lead to soil improvement, for example through providing organic matter, and also supports circular economy principles. However, this activity carries risks to soil from contamination and over-application of nutrients. These risks may be increased if soil data provided in association with waste spreading is misused or is of poor quality.

In Scotland, the Scottish Environment Protect Agency (SEPA) regulate waste recovery on land through general binding rules, notifications and permits, which aim to ensure that the right amount of the right material is spread at the right time and in the right place. Results from SEPA audits carried out to check operator compliance with regulations will be presented.

Audits of operator soil and waste analysis data associated with recovery on land indicate that waste spreading is generally compliant with regulatory requirements and good practice guidance, however compliance in some areas is more complete than in others.

SEPA audits of operator data-gathering activities in relation to waste recovery on land, such as soil sample collection, have demonstrated that sustainable waste spreading can be compromised by issues such as badly documented sampling methods. In turn, this may lead to poor quality data being produced and subsequent spreading at rates that are too high or in unsuitable locations. Wide variations in operator performance have been observed.

From November 2025, waste recovery on land in Scotland will be regulated under the Environmental Authorisations (Scotland) Regulations, which introduce improved requirements to protect soils and ensure that waste spreading activities are sustainable. SEPA will continue to carry out audits to ensure that these requirements are met and use outcomes from these audits to continually improve regulation of waste recovery on land in Scotland.

Key words: Waste recovery, sustainable, audits, soil improvement, regulation, Scotland.

Link to Poster

Biodegradation of wool and cotton textiles in soil.

By **Miranda T. Prendergast-Miller**[1], Phill Catton Yeung[1], Nicci James[2], Veronika Kapsali[2]

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Textile waste management is a global issue, and current disposal methods rely on landfill and incineration. Textile recycling is another alternative, favoured for its contribution to sustainable circular pathways. Another alternative being considered are “soil-to-soil textiles”, where natural-based textiles such as cotton and wool are composted and/or buried in soil, with the biodegradation of the natural fibres over time replenishing soil nutrients. However, the environmental impact of biodegradation of natural textiles needs to be fully tested because of the intense fibre processing during textile manufacture and the diverse range of textile finishes that are often applied, such as dyes, flame retardants, waterproofing agents etc. We present our findings from a 3-month burial study where we assessed changes in wool and cotton textiles with different finishes and dyes, as well as the impact of biodegradation on soil properties. We also explore the implications for textile end-of-life options and soil management.

Funded by: "IMPACT+" UKRI NetworkPlus on Circular fashion and textile Network

Keywords: biodegradation, soil health, microfibres, textiles, soil function.

The missing pillar of functional soils.

By **Jade Prince**

Hutchinsons Ltd

Soil science is built on three pillars; physics, chemistry, and biology, yet soil biology remains the least understood and least applied in agricultural decision-making. While we routinely measure soil structure and nutrient levels, we rarely explore the living organisms that drive these processes. Increasingly, we recognise that biological processes are the missing link, driving nutrient cycling, resilience, and long-term soil health. This poster will explore how physical and chemical analysis are currently utilised to inform soil management decisions in agriculture and raises the critical question: how do we effectively understand and apply biological analysis?

Drawing on practical experience within a commercial soil services team, the poster will demonstrate how integrated testing helps farmers and agronomists make more informed decisions, while also highlighting the limitations of current biological metrics. It will consider the range of emerging biological testing methods, from microbial biomass and respiration to microscopy and question how these could complement traditional analysis to provide a more holistic picture of soil health.

This topic forms the foundation of my 2026 Nuffield Farming Scholarship study, which aims to explore how biological soil analysis can be more meaningfully interpreted and implemented in UK agriculture. The project seeks to identify global best practice, assess accessibility for farmers, and build an evidence base for practical application.

By engaging with the BSSS community, I hope to gather insights and generate discussion around how we can better connect biological understanding and analysis with on farm decision making and practical implementation.

Keywords: Biology, microbiology, microbial, microorganisms, communities, life, biodiversity, analysis, functionality, management.

Link to Poster

Soil Burial Experiment: Impact of Microplastics in U.K. Woodland Soil.

By **Abbie B. Rogers**, Miranda T. Prendergast-Miller, Matthew J. Pound

Department of Geography and Environmental Sciences, Northumbria University

Research on microplastics has focused heavily on aquatic environments, leaving a gap in understanding their presence and effects in terrestrial ecosystems, particularly woodlands which are crucial for the health of many species and ecological functions. One overlooked source of microplastic pollution is woodland management tools such as tree guards and cable ties. This research aims to address this gap by assessing the impact of microplastics from these sources on U.K. woodland soil to support the creation of policies to better regulate plastics use and waste management. This research is timely given the increase in tree planting initiatives to meet climate change mitigation targets.

To do this, a 15-month burial experiment is being conducted to explore how varying concentrations, types, sizes and shapes of microplastics affect woodland soil chemistry and microbial respiration. The impact of the soil on the microplastics physical and chemical properties is also being monitored. The findings will be shared with woodland management organisations and woodland management tool manufacturers to raise awareness of microplastics as a potential pollutant in woodland ecosystems.

Funded by: Natural Environment Research Council (NERC) funded One Planet Doctoral Training Partnership, and Northumbria University's Research Development Fund Studentship Scheme.

Keywords: Pollution, Terrestrial, Soil, Biota, Forest, Microplastic.

Link to Poster

England-Wide Soil Monitoring Scheme: Year 1 Progress Toward a National Soil Health Baseline.

By **Sonja Schmidt**[1], Kate Luckett[1], Jakub Olewski[1], Laura Hathaway-Jenkins[2]

1. Natural England

2. Environment Agency

Introduction

The UK Government is committed to protecting natural assets through initiatives such as the National Biodiversity Strategy and the 25 Year Environment Plan. To support these goals, the Defra-led Natural Capital and Ecosystem Assessment (NCEA) programme collects up-to-date environmental data across England to monitor natural capital's extent, condition and change.

A key component of NCEA, the England Ecosystem Survey (EES), is collecting field data on terrestrial ecosystems—including soils—at a national scale. This poster presents initial findings from Year 1 (2023/24) of the EES soil survey, which measured over 48 biological, chemical, and physical soil parameters. Data contribute to a developing soil health indicator model by JNCC. This poster will show an overview of the Soil Sampling and Assessment Survey conducted as part of the EES.

Methods

Surveys are carried out in randomly selected 1 km² monads, with up to six plots per monad. Soil and vegetation data are co-located, and soil samples are collected across three depth layers (0–15 cm, 15–30 cm, 30–40 cm). The survey follows a 5-year repeat cycle. Initial analyses explore the spread and correlation of earthworm counts, SOM, and bulk density across land use and soil types.

Results & Future Work.

In Year 1, 222 monads were surveyed. Soil data will be published in December 2025 as open government data. Environmental DNA, vegetation, and landscape data will follow in 2026. Year 2 data are currently being quality checked, and Year 3 soil

sampling is underway (Sep 2025–Mar 2026) to complement vegetation and landscape data collected during the summer.

Funded by: Department for Environment, Food & Rural Affairs.

Keywords: Long-term monitoring, Soil health, Natural capital, Ecosystems, England.

Ukrainian Soils as Carriers of the Geochemical Passport of War.

By **Anastasiia Splodytel**[1], Magdalena Sut-Lohmann[1], Naomi Rintoul-Hynes[2], Christopher Ferguson[2], Jannette Carey[3]

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War is a new factor in the formation of unique patterns of soil contamination, caused not only by the use of weapons and the nature of combat operations, but also by the specifics of pre-war contamination. The war in Ukraine, which has been ongoing since 2014 and has reached unprecedented intensity since 2022, has caused profound transformations in the functioning of natural landscapes and, in particular, soils.

Despite the scale of the military operations, there are no comprehensive studies of soils by land use type and level of military impact. Fragmentary assessments without standardised criteria for the ecological status of war-affected lands prevail. The lack of a unified typology of military impact and spatial analysis of sources and areas of contamination makes it impossible to develop effective reclamation strategies.

The aim of this study is to fill this gap by conducting a comprehensive geochemical assessment of soils with varying degrees of military impact in Ukraine. The study covers regions that have experienced different forms and durations of combat operations, from intense artillery shelling and tank battles to areas with localized destruction of industrial infrastructure.

The study uses the results of a number of analytical methods (ICP-MS, ICP-OES (PTEs), high-performance liquid chromatography (polycyclic aromatic hydrocarbons), gas chromatography with electron capture detection (polychlorinated biphenyls), and the gravimetric method (hydrocarbons)) for more than 1,000 soil samples, multiple linear regression analysis, geospatial mapping, and the Random Forest machine learning approach.

The results obtained allow spatial characterisation of the extent of soil contamination due to military operations over the last decade; establish links between types of impact and contamination profiles; and propose a classification of soil degradation levels for prioritising post-war remediation measures.

Funded by: Alexander von Humboldt Foundation; Global Food and Water Security (GFWS) Project

Keywords: military impact, soil contamination, geochemical assessment, spatial modelling, machine learning.

High-Resolution Nutrient and Isotopic Soil Mapping for Precision Agriculture in Westmorland and Furness.

By **Gabriel Yosafat Sanchez Vazquez**, Darren Grocke

Durham University

3D Spatial Resolution of Nutrient and Isotopic Soil Mapping: A Baseline for Precision Soil Management

Although there is a need to increase agricultural productivity, this must occur without compromising soil health and/or surrounding ecosystems and biodiversity. In Westmorland and Furness, a feasibility study is being developed to implement a scientific, collaborative, and interdisciplinary strategy involving farmers, scientists, and environmental authorities. The goal is to optimize nutrient management and promote climate-smart agriculture through evidence-based cooperation between farmers and scientists.

In this study we have generated high-resolution geospatial maps of nutrients on a dairy farm landscape; which we term nutrient landscapes or "nutriscapes". that characterize the distribution of macro- and micronutrients—primarily nitrogen, phosphorus, and potassium—in agricultural soils. To date, 107 soil cores have been collected across the farm area, with an average sampling depth of 40 cm. Isotopic ratios of $^{13}C/^{12}C$ ($\delta^{13}C$) and $^{15}N/^{14}N$ ($\delta^{15}N$), wt% C, N, P, K, along with soil pH, are produced from depths of 2, 5, 20, 15, 20, 30 and 40 cm; providing a detailed vertical and geospatial characterization of nutrient profiles.

We present a geospatial map of a dairy farm in Cumbria, that will advise and enable precision farming with respect to nutrient management. Although costly in terms of manpower and analytical time, the data enables the farm to reduce land management costs, reduce nutrient runoff or leaching, improving input-use efficiency, and strengthening long-term soil health. The integration of isotopic data and nutrient landscapes supports the identification of carbon/nitrogen pathways and nutrient-use efficiency, providing a much-needed baseline for assessing future regenerative soil management practices.

Funded by: Lynster Farmers Group

Keywords: Soil nutrient mapping, Isotopic analysis, Precision agriculture, Nutrient-use efficiency, Regenerative.

Soils For Water:

Oral Abstracts

Predicting Soil Erosion through Plant–Soil Interactions in Wheat under Different Agronomic and Water Regimes.

By **Sophia Bahddou**[1], Wilfred Otten[3,5], R. Jane Rickson[3,5], Richard Whalley[2,5], Kamrun Suravi[2], Ho-Chul Shin[2], Mohamed El Gharous[1], Adnane Beniaich1, W. Hannah V. Cooper[3,4,5]

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Soil erosion poses a significant threat to agricultural productivity, environmental sustainability, and food security. Accurately assessing the factors influencing erosion processes is crucial for developing effective soil conservation strategies and ensuring the long-term viability of agricultural systems. This research aims to study the effect of different wheat lines subjected to different sowing densities and water regimes on soil physical properties and plant traits. The subsequent effect on runoff and soil loss was predicted using the modified Morgan-Morgan Finney (mMMF) model. The outcome of this study shows that the dwarf wheat line exhibited better drought tolerance, maintaining plant height under water stress, and demonstrated higher root density, particularly at higher sowing densities and under dry conditions. It exhibited superior erosion control capabilities (reduced soil loss by 25%) compared to the wild-type wheat line, particularly at later growth stages, due to its higher canopy cover and ground cover providing better soil protection. Higher sowing densities reduced soil loss by 31%, compared to lower sowing densities, through increased root length density, canopy cover, and ground cover, and improved soil

physical properties. Drought stress significantly impaired plant growth, reducing canopy cover, tillering, plant height, aboveground biomass, and root length density, which led to increased predicted erosion risks. In contrast, well-watered conditions promoted plant growth and soil protection, resulting in a 23% reduction in soil loss compared to drought conditions. The presence of plants significantly reduced runoff and soil loss by 38% and 41%, respectively, compared to bare soil, underscoring their importance in erosion control. These findings emphasize the need for integrated management approaches that consider plant genetics, sowing practices, and environmental factors for sustainable soil conservation and erosion control.

Funded by: OCP Group

Keywords: Drought, mMMF model, Runoff, Shoots, Soil loss, Roots, Soil properties.

Signatures of soil structural degradation: exploring stable water isotopes in soil pores.

By **Jessica Brook**[1], Josie Geris[2], Paul Gaffney[3], Peter Gilbert[4], Paul Hallett[1]

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3. Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, Beijing, China

4. RSPB, Scotland

Limited data exists from broad-scale surveys that assess the threat of soil structural degradation using multiple metrics, especially across multiple time-points. This was addressed by combining visual, physical and isotopic data to identify signatures of structural degradation on nine agricultural fields across three river catchments in Scotland, with sampling undertaken in September 2024, and repeated in February 2025. In each of the nine fields, three replicate samples were collected from each of: field margins, in-field locations, and areas with visible degradation to the soil surface. Intact soil cores were collected at depths of 2-7cm and 30-35cm, as well as disturbed bulk soil samples. The qualitative Visual Evaluation of Soil Structure (VESS) was combined with quantitative measurements of penetration resistance, dry bulk density, water retention characteristics and saturated hydraulic conductivity. These conventional soil physical tests were supplemented by the novel results of a rapid compaction assay and the new trial of using stable water isotopes to analyse signatures of soil pore water.

For the September sampling, topsoil bulk density of in-field soils were 26.7% denser than field margins, and only 2.2% less dense than the visibly degraded locations. The February sampling showed similar results, with in-field samples 16.42% denser than the field margins, and only 0.84% less dense than visibly degraded locations. These results were also reflected in saturated hydraulic conductivity. A substantial seasonal reduction in soil structural health was found across all field locations, with bulk density for in-field and visibly degraded locations increasing by 35.7% and 37.9% respectively between September and February. Preliminary δ2H and δ18O

data revealed a negative correlation with increasing bulk density, which may reflect different soil water storage and flow in compacted soils, and suggesting a potential alignment between stable isotope signatures and soil physical properties that could provide an indicator of soil compaction.

Funded by: SUPER DTP and The William J McLean Agricultural Scholarship Award

Keywords: soil health, structural degradation, catchment management, stable water isotopes.

Resilient soils for a sustainable future in Scotland - using soil data to inform improved recovery of waste material on land.

By **Alan Cundill**, David Shannon

Scottish Environment Protection Agency

From November 2025, all waste recovery on land in Scotland will be regulated under the Environmental Authorisations (Scotland) Regulations (EASR), which introduce a consistent regulatory framework for waste spreading activities. Under EASR, recovery of waste on land must be carried out for the purpose of soil improvement, and the regulations use a mixture of general binding rules, notifications and permits to control waste spreading to land, updating compliance requirements for waste spreading activities to ensure that this requirement is met.

The Scottish Environment Protection Agency (SEPA) has regulated waste recovery on land in Scotland since 1996. Research and development, together with SEPA audits of operator data and sampling activities, have helped to inform how regulation of waste recovery on land will be taken forward under EASR. For example, data audited by SEPA showed that in some instances, crop phosphorus requirements were not being fully accounted for when spreading waste materials, leading to risks of excess phosphorus addition and accumulation in soil. Meanwhile, field audits suggested that some data returned by operators may be less accurate than desirable.

This led, respectively, to SEPA using the EASR regime to introduce requirements to reduce phosphorus addition rates from waste spreading where soil extractable phosphorus levels are already above optimum and requirements for key analytical tests to be accredited. Compliance with EASR will help to ensure that future waste recovery on land in Scotland is sustainable and delivers resilient soils.

SEPA will continue to use a combination of research and development, both in-house and external, and audit outcomes to improve regulation of waste recovery on land for soil improvement into the future. An important active area of research covers contaminants of emerging concern, such as microplastics, in waste materials and the impact of these on soils.

Keywords: Waste recovery on land, SEPA, EASR, soil improvement.

Genotypic variation in wheat root architecture, soil pore structure and hydraulic properties.

By **Bartolo Giuseppe Dimattia**[1], Maria Hernandez-Soriano[2], Silvio Salvi[1], Marco Bittelli[1]

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Plant roots play a crucial role in maintaining soil health by influencing physical structure and hydraulic properties. This study investigates relationships between root morphology of wheat genotypes and their impacts on soil structure and hydraulic characteristics. Using shovelomics, we characterized root systems of wheat cultivars (Paragon, Bologna) and landraces (Senatore-Cappelli, Watkins238) selected for contrasting root morphologies. X-ray computed tomography (CT) was applied to examine soil pore networks at cylinder and aggregate scales, while soil hydraulic properties were measured using Wind evaporation and dew point techniques.

Results demonstrated significant genotype-driven differences in soil morphology and hydraulic functions. Structural analyses (Minkowski functionals, percolation theory) showed significant variability in bioporosity and pore connectivity among genotypes compared to bare soil. Senatore-Cappelli exhibited notably larger biopores (>1 mm diameter). Hydraulic characterization using a van Genuchten bimodal model revealed statistically significant differences in soil water retention curves and hydraulic conductivity among genotypes. Root traits, including total root length, branching frequency, lateral root length, and root diameter, significantly correlated with soil pore size distribution and hydraulic parameters.

This analysis underscores the importance of root architecture in modulating soil structure and water dynamics, highlighting the potential of specific wheat genotypes to affect soil health, water retention, and agricultural sustainability.

Funded by: EJP Soil, MASAF

Keywords: agricultural sustainability, water retention, soil health, water dynamics, Root traits

Soils For Water:

Poster Abstracts

Bare Soil Erosion Dashboard

By **James Cooke**[1], Stephanie Ties[2], Jamie Williams[2], Arwel Williams[1]

1. Welsh Government

2. Environment Systems

The interactive bare soil erosion dashboard identifies areas of bare soil, within field parcels, and categorises the risk to water associated with those areas. It has been created to test the potential of an all-Wales system to identify the risk that bare soil may present within river catchments across Wales and assess how it may be used to identify, quantify and manage that risk. The dashboard reports at national, main and sub-catchment scales.

The dashboard delivers a near-real time bare soil erosion-risk map for the whole of Wales. Each field parcel has been assessed with regards to topography (slope and flow pathway), soil texture and vegetation. Satellite imagery from the Sentinel-2 optical satellites are used to identify areas of bare soil and reassess the risk these pose to a catchment on a rolling monthly basis. Risk is only displayed for fields that contain more than 1 hectare of bare soil across 5 categories - low; low / medium; medium; medium / high; high.

The trial will operate from July 2025 to July 2026 and initial data covers the beginning of the harvest and cultivation season. Over 4 months, the area of bare soil at risk to water (for all 5 risk categories) has risen from 9,500ha to 30,000ha; >80% of which is within the medium. medium / high, and high risk categories.

The poster will likely contain a visual overview of the dashboard; summary of method & purpose of the trial; potential uses; data from May to November 2025; comparison example field view against dashboard view; limitations.

Funded by: Welsh Government

Keywords: erosion, soil, satellite, sentinel, water, risk, dashboard, runoff, catchment.

Link to Poster

Combined effects of maize genotypes and nitrogen fertilizer regime regulates the rate of change of mineral N and soil microbial functional diversity.

By **Christopher Feeney**, Katrina Sharps, Tarun Bisht, Amy Thomas, David Robinson, Bryan Spears, Linda May

UK Centre for Ecology & Hydrology

Africa is estimated to have the highest average soil loss rates by water of any continent (3.88 t/ha/yr). Additionally, African croplands exhibit the severest soil phosphorus deficits on average worldwide (-9.6 kg/ha/yr), fuelling migration and cropland expansion in more fertile lands. The Lake Victoria Basin (LVB) has seen its population rise to ~40 million people in recent years, with 85 % of people working in agriculture. Supporting this population long-term requires healthier balances in cropland nutrient levels, both through changes in fertiliser use and mitigating soil erosion. Here, we present results detailing soil phosphorus balances on croplands across the LVB for 5 years: 2000, 2005, 2010, 2015 and 2022. Soil erosion rates and nutrient dynamics were simulated for each year using the InVEST platform of spatial models, and combined with digital soil maps and plant nutrient uptake estimates to determine cropland nutrient balances. The median LVB cropland soils show healthier phosphorus balances than the African average, increasing by over 400 % from a deficit (-0.14 kg/ha/yr) to a surplus (0.51 kg/ha/yr) between 2000 and 2022. Additionally, there is a co-occurring accelerated soil erosion rate trend (from 7.9 to 8.4 t/ha/yr) over this same period, implying that improving nutrient balances result from increasing inputs from fertilisers. We identified a sharp increase in phosphorus exports into rivers draining the LVB from 7.7 Kt/yr (+6.7 / -4.9 Kt/yr) in 2000 to 10.9 Kt/yr (+7.1 / -5.4 Kt/yr) in 2022. We speculate that high rates of nutrient loads to land in the north-east and severe erosion rates of nutrient-rich soil stocks in the west are the dominant drivers of spatial differences across the LVB. We believe these results will provide an important evidence base for the Soil Initiative for Africa and we have incorporated them into a web portal to facilitate data access for decision making.

Funded by: UK Research and Innovation Natural Environment Research Council as part of the NC-International programme [NE/X006247/1] delivering National Capability

Keywords: Soil erosion; Nutrient balances; Croplands; InVEST; Food security; Water quality.

Link to Poster

Copper and zinc from slurry applications shape grassland microbial community structure.

By **Coalain McCreanor**[1,2], Paul Williams[1], Selvakumar Dhandapani[2], Andrew Meharg[1], Caroline Meharg[1], Manus Carey[1], Wanqi Jia[1], Jonathan Holland[2], Jonathan McComb[1]

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Soil microbes are crucial in maintaining soil health and enhancing agronomic productivity. This study investigates long-term cow and pig slurry applications on soil microbial community structures, soil chemistry, and herbage yield in a ~50-year Long-Term Slurry (LTS) experiment on a permanent grassland located in County Down, Northern Ireland. Illumina and PacBio rRNA sequencing (analysing 16S and ITS genera) were used to investigate soil samples from the experiment's treatments to depths of 15cm. Slurry type and application rate were found to alter the relative soil microbial community. In comparison to the non-amended control treatment and inorganic fertiliser treatment, higher slurry rates had the greatest log2 fold change of relative microbial abundance, alongside increasing soil pH and total carbon. Soil pH, copper and zinc concentrations were found to be significant key drivers of soil microbial community shifts (permutation test, $P<0.001$). More specifically, copper primarily influenced 16S and zinc was the greatest influence on ITS genera. CAP analysis revealed that relative abundance changes of 16S genera diverged depending on slurry type and rate, with ITS genera only distinguished by rates of slurry.

Funded by: Department of Agriculture, Environment and Rural Affairs

Keywords: Nutrient treatments, Slurry, Carbon, Copper, Zinc, Soil microbes, Grasslands.

Link to Poster

Effects of bio-fertilisers on advancing sustainable soil nutrient management and crop production

By **Md. Raju Ahmad1,** Paul N. Williams1, Jason Chin1, Thomas Hastings2, Mahmud Hossain Sumon3, SM Ashekuzzaman4

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Bangladesh is an agro-based country that produces substantial amounts of organic waste from agriculture, livestock, and households, creating opportunities for waste-derived bio-fertilisers. Two potential sectors, commercial composting (CC) and anaerobic digestion (AD), where CC involves the sale and marketing of compost, while AD is operated to produce bioenergy and digestate as by-products. Compost samples were collected from market-available government-authorised CC (ACC, n = 29) and government-unauthorised CC (UACC, n = 16) during 2022–2023. This study assesses the physicochemical properties and contamination of CC. It also evaluates the impacts of compost/digestate combined with the chemical fertiliser triple superphosphate (TSP) on crop production and nutrient dynamics. Compost quality varied significantly with feedstock composition and compost processing. Nutrient-rich poultry manure composts (N, P, K, and S) exhibit a higher electrical conductivity due to rapid mineralisation. Poultry and cattle manure, or a mix of these two with agricultural and household waste, showed higher chemical variability because the feedstock was not properly sorted/mixed or processed. The UACC showed inadequate aeration and more variable levels of Cd, Cr, Co, and Pb, indicating increased risks of soil contamination, plant accumulation, and diminished crop productivity. Field trials on Potatoes, T. Aman rice (wet season), and Boro rice (dry season) indicated that composts/digestates, either alone or combined with TSP, enhanced or were similar to crop yields and P use efficiency compared with TSP alone. P, Mg, Mn, and Zn uptakes were higher in tubers and grains, indicating their availability in the soil. Reduced Cd accumulation in rice grains suggests that lower soil Cd availability is due to fixation in the organic fraction. Therefore, bio-fertilisers enhance soil fertility and crop productivity and reduce reliance on imported mineral fertilisers, such as TSP. Long-term cultivation practices with bio-fertilisers can also improve carbon sequestration by increasing soil organic matter accumulation.

Keywords: Anaerobic digestion (AD), commercial composting (CC), bio-fertiliser, compost, digestate, nutrients & contaminants and sustainable farming

Sediment Signals: What Rating Curves Reveal About Land Resilience?

By **Hari Ram Upadhayay**[1], Kezhen Wang[2], Adrian L. Collins[1]

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Agricultural soils are suffering from intensive management and environmental pressures threating both production and regulating functions. Robust land in terms of sediment loss regulation is vital for reducing sediment pressures on aquatic environments. However, explicit evaluations of the robustness of agricultural land for sediment loss regulation are scant, limiting the broader understanding of soil resistance against erosion in the context of changing rainfall patterns. This study therefore investigated changes in soil drainage season turbidity (Tn) and flow (Q) relationships through time using dynamic linear models which provide insights into the overall degree of Tn-Q dynamicity. Dynamicity values (δ) remained highly variable and inconsistent through time, signifying this parameter is not sufficiently sensitive to detect changes in Tn-Q over soil drainage seasons at the field scale. However, the dynamics of the intercept and slope coefficients in the linear models confirmed that tilled soil had significantly lower resistance against erosion and saturation-excess runoff further reduced sediment loss regulation compared to its neighbouring grassland. Moreover, soil moisture analysis revealed soil saturation increased sediment availability and loss from arable land. This study is the first to directly assess the robustness of agricultural land for sediment loss regulation using dynamic linear models at field scale. Our work reveals the decreased robustness of sediment loss regulation associated with grassland conversion to arable agriculture.

Funded by: UK Research and Innovation-Biotechnology and Biological Sciences Research Council

Keywords: agroecosystem robustness; erosion; arable, grassland, dynamic linear models.

Evaluating the phosphorus release efficiency of duo-biochar to spring wheat.

By **Christina Van Midden**[1], Suzanne Higgins[1], Deb Jaise[2], Rajan Ghimere[3], Nitesh Kasera[4], Sushil Adhikari[4], David O'Connell[5], Sofia Vitsa[5]

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High legacy soil phosphorus inputs from slurry and organic manures are an issue in intensively managed agricultural areas within Northern Ireland, Ireland and North America, reducing water quality. Since much of this phosphorus is in a form that is not available to plants, fertilisers are used to meet plant requirements, but rapid fixation to soil constituents results in 70-90% of applied phosphorus becoming plant unavailable. Therefore, solutions are required to both retain excess phosphorus in the soils, thereby protecting freshwater and coastal habitats, and act as a slow-release fertiliser to provide plants with sufficient phosphorus during growth. Biochar, a carbonaceous material produced from the thermochemical conversion of biomass, is capable of absorbing phosphorus, and its capacity to do so can be increased by modification with metals, such as iron. This experiment aimed to test the effects of Fe-doped biochar versus unmodified biochar on crop production and water quality, whilst also using stable isotope-P labelling to quantify the phosphorus release from biochar into the plant.

Fe-modified and pristine biochar were loaded with isotope labelled P and applied in a pot scale experiment at a rate equivalent to 10 t ha-1 and compared to a biochar-free control. At 40-, 80- and 120- days following sowing, pots were leached with deionised water and the leachate measured for total and soluble reactive phosphorus. Following leaching, crop and soil samples were taken and biochar separated from the soil, to measure the total and bioavailable phosphorus in each fraction. Analysis of stable isotope on these samples was also measured to quantify

the amount of P released by the biochar and determine the proportions that are lost to leaching, soil fixation or taken up by the crop.

Data collection is currently underway therefore no results available to provide a discussion.

Funded by: Department of Agriculture, Environment and Rural Affairs (DAERA – NI), the Department of Agriculture, Food and the Marine (DAFM – ROI) and the National Institute of Food and Agriculture (NIFA – USA).

Keywords: Biochar, Leaching, Stable isotope-P, Soil available P, Soil amendment.

The development of mycoremediation filter systems to improve water quality.

By **Hannah Walling**[1,3,4], Lipe Renato Dantas Mendes[2,3], Phillip Schuler[3], Lucy Crockford[1], Marc Stutter[2,4], Mark Wilkinson[2], Paul Quinn[2,5], Stephanie Terreni-Brown[3]

1. Harper Adams University

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3. Rhizocore Technologies

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5. Newcastle University

Diffuse pollution from agricultural systems remains a major threat to freshwater quality, with excess nutrients contributing to downstream eutrophication and ecosystem degradation. Mycoremediation - the use of fungi to remove these contaminants - has potential to contribute an innovate, low cost and sustainable solution. This project aims to develop and test a mycoremediation filter for use in agricultural field drains and ditches to remove nitrates and phosphates close to the source.

Through the collection, isolation, genetic confirmation and initial laboratory screening multiple strains of saprotrophic fungi have been identified with strong potential for removing nitrates and phosphates from water. Nitrate and phosphate removal rates was found to differ significantly based on species and seed zone of origin.

Selected strains have been incorporated into prototype filter units for deployment at multiple agricultural field sites to assess performance under field conditions. Ongoing work focuses on quantifying pollutant removal efficiency and evaluating filter longevity. The outcomes of this research hopes to inform the development of scalable, nature-based solutions for mitigating diffuse agricultural pollution and improving water quality.

Funded by: Innovate UK

Keywords: Water Quality, Mycoremediation, Agricultural Runoff, Innovative technology.

Soil Science Across Boundaries: Pecha Kucha

Exploring the Potential of Underutilised Plant Species to Improve Soil Health in Sub-Saharan Africa

By Grant Campbell, Jo Smith

University of Aberdeen

Soil degradation remains a critical barrier to the development of sustainable agriculture across Sub-Saharan Africa (SSA), with notable widespread declines in soil fertility, structure and biodiversity.

As part of the interdisciplinary CROSSROADS-SSA project, this presentation will discuss outcomes from a systematic review of underutilised plant and crop species across SSA, evaluating their potential to contribute to soil health restoration and resilience.

The review synthesises evidence from peer-reviewed literature to identify species with promising attributes such as nitrogen fixation, deep rooting systems, organic matter contribution and ability to minimise soil erosion.

The findings highlight a diverse range of species which offer multifunctional benefits for soil structure, nutrient cycling, and erosion control. Particular attention is given to species with potential for integration into agroecological and smallholder farming systems. This research contributes to a growing body of knowledge advocating for biodiversity-based solutions to soil degradation and supports the development of context-specific, sustainable land management strategies across SSA.

Through the identification and characterisation of these species, this review provides an important framework for future field experiments and participatory research aimed at evaluating their potential to improve soil health and scaling their use in climate-resilient farming systems.

Funded by: Global Centre on Biodiversity for Climate/DEFRA, CROSSROADS partners – Hawassa University, International Water Management Institute (IWMI), Central Ethiopian Agricultural Research Institute (CEARI)

Keywords: Underutilized plants, soil health, biodiversity, sustainable agriculture, phosphorous mobilizing, nitrogen fixing, carbon sequestration, food security, Sub-Saharan Africa

Reconstructing Soil Acidity Neutralization Curves Using Machine Learning and Chemical or Spectral Soil Signatures

By Ismail Kouera, Hamza Jouichat, Lotfi Khiari, Achraf El allali

University Mohammed VI Polytechnic

Soil acidity management across sub-Saharan Africa remains constrained by lime recommendation methods that are often imprecise, time-consuming, or reliant on hazardous reagents such as the SMP buffer. In this study, we evaluated the potential of machine learning (ML) models to predict soil pH change (ΔpH) in response to hydrated lime [$Ca(OH)_2$] applications, using a dataset of 500 soils collected from six countries (Ghana, Ivory Coast, Zambia, Zimbabwe, Mozambique, and Malawi). Each soil was analyzed for routine chemical properties, mid-infrared (MIR) spectral signatures, and subjected to both acid-base titration and incubation experiments to generate reference ΔpH curves. Two ML approaches were tested: a Chemical Signature Model (based on routine soil analyses) and a Spectral Signature Model (based solely on MIR spectra).

For incubation, the Chemical Signature Model achieved an R^2 of 0.91 with RMSE 0.33 pH units, while the MIR Spectral Model achieved an R^2 of 0.89 with RMSE 0.37 pH units. For titration, the Chemical Signature Model reached an R^2 of 0.93 with RMSE 0.19 pH units, and the MIR Spectral Model attained the highest performance, with an R^2 of 0.95 and RMSE 0.16 pH units. Variable importance analysis confirmed that lime dose, cation exchange capacity, texture (clay, silt, sand), and soil pH were the dominant predictors in chemical models, whereas MIR models highlighted spectral regions linked to hydroxyl, carboxylic, and organo-mineral functional groups, consistent with soil chemistry principles.

These results demonstrate that both MIR spectroscopy and routine chemical analysis can be leveraged for accurate, non-hazardous, and scalable lime requirement prediction across diverse African soils, offering a practical alternative to conventional methods.

Funded by: OCP AFRICA UM6P

Keywords: Soil acidity, Machine learning, Mid-infrared spectroscopy, Soil incubation, Acid-base titration

Archaeological Investigations – Planning for Sustainable Soil Management

By Bruce Lascelles, Daniel Evans

Arcadis

A significant number of major infrastructure projects are currently being planned for or are being constructed, many of which support energy transition. The associated planning applications require all environmental disciplines to describe the baseline and set out appropriate mitigation measures. This does at times put disciplines in conflict with each other in terms of their requirements for avoidance of, or mitigation for, identified impacts. Cultural Heritage experts will be required to produce a Project Design (formally known as a Written Scheme of Investigation/WSI) which sets out the scope and methodology for archaeological evaluation (usually including trial trenching). This work is often undertaken pre-construction and so is not covered by planning requirements such as the implementation of a detailed Soil management Plan.

Trial trenching is often required to cover 2% of the construction area; on a major scheme this can comprise many trenches and the associated compounds, access routes and stockpiles. A Project Design will usually include a requirement for topsoil and subsoil to be stockpiled separately but often does not include any further consideration of soils (such as cessation of works in wet weather or remediation of compaction).

Using experience gained through all stages of planning and construction, examples will be given of the sorts of problems that can arise where the archaeological investigation requirements (often associated with programme pressures, contractual arrangements and budgets) do not align with all the requirements of sustainable soil management. Recommendations will be set out to show how, through collaborative working and strong engagement, good practice measures can be incorporated into Project Designs without affecting the delivery of the archaeological evaluation and its importance to the impact assessment. In addition, recommendations will be made to highlight how assessments of soils can benefit from greater integration with archaeological investigations to drive more sustainable development practices.

Keywords: EIA, archaeological evaluation, trial trenching, sustainable soil management, soil handling

Identifying Arsenic Mobility Control Zones in Soils Using the Global Dataset: Machine Learning Insights from pH–OC Interactions Across Textural Classes

By Dr Jajati Mandal

University of Salford

Understanding the factors that govern arsenic mobility in soils is essential for effective risk assessment and remediation. Using a globally harmonized dataset and machine learning (ML) models, the combined influence of soil pH, organic carbon (OC), cation exchange capacity (CEC), total arsenic (TAs) and clay content on the mobile arsenic fraction (PF_1) has been modelled. The dataset comprised (n = 442), of which 80% was used as the training set (n = 353) and remaining 20% as the testing set (n = 89). Three regression models Random Forest (RF), XGBoost, and Generalized Additive Models (GAM) were trained to predict PF_1, with respect to pH, OC, CEC, total arsenic and clay content. Random Forest outperformed others in terms of model matrices. To identify mobility zones a grid of 2,100 OC–pH combinations were generated as per soil textural class, yielding 25,200 total simulation points across 12 texture classes. Mobility zones were defined as OC–pH combinations where predicted PF_1 was below 10%, if TAs remained <20 mg/kg. Kernel density estimates (median and mode) were then used to identify the most probable OC–pH combinations associated with mobility control. To further test the robustness of these optimal ranges, a bootstrap simulation with 1,000 iterations was performed. Results from the Random Forest model indicated that slightly acidic soils (pH 5.5–6.5) with low-to-moderate organic carbon (<2%) minimized arsenic mobility, particularly in clay-rich soils. In contrast, coarse-textured soils exhibited wider "mobility control zones," maintaining PF_1 below the 10% threshold, whereas fine-textured soils were more sensitive to variations in pH and OC. These findings provide a framework for targeted remediation. Beyond reducing arsenic concentrations through amendments or stabilization, management practices should also account for soil texture and chemistry, ensuring interventions are tailored to minimize the fraction of arsenic that remains mobile.

Keywords: arsenic, pH, clay, organic carbon, mobile fraction, machine learning, management

Digging soil: Collaboration potential between soil science and archaeology

By Meike van Lit

University of Glasgow

One commonly acknowledged limitation in monitoring and regulating soil health is the lack of trend data. The 2011 'State of Scotland's Soils' report emphasises that this makes it difficult to forecast the state of soils. And the 2019 'State of the environment: soil' report by the Environment Agency states that there is insufficient data on soil health. That lack of data poses a problem in combatting the twin crises of climate change and biodiversity loss, as well as the interconnected issue of soil degradation. And the suggested solution? Increased investment to facilitate regular soil monitoring which will develop trend data needed to form appropriate legislation on soil management.

This paper wonders if an additional creative solution can be found, through interdisciplinary collaboration between soil science and archaeology. Can soil samples from archaeological sites be analysed to understand the effect of different land management strategies on soil properties, and can this contribute to the creation of trend data?

This question is explored using the case study of a multi-year excavation in Glencoe, Scotland. This excavation has revealed a kailyard and extent of rig and furrow, indicating that different land management strategies were employed. Additionally, both these features have at least two distinctly separate phases of activity. Soil samples were taken from different depths within these features to measure soil properties such as cation exchange capacity, bulk density, and soil organic matter. As such, this paper will review how different land management strategies have affected soil properties, and will kickstart the discussion whether collaboration between soil scientists and archaeologists could provide fruitful in understanding soil changes under land use.

Keywords: Interdisciplinarity, Archaeology, Soil trend data, Land use, Creative solutions

Funded by: Glencoe Archaeology, Landscape and Storytelling; Society of Antiquaries of Scotland

Insights into the effects of varying biochar C:N ratios on greenhouse gas emissions and soil carbon pools across contrasting soil types

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The influence of biochar with varying C:N ratios on soil health and its variability across soil textures remains insufficiently explored. This study, therefore, aimed to clarify the underlying processes driving changes in soil organic carbon (SOC) fractions and greenhouse gas (GHG) emissions following the application of N-enriched biochar (NB) in sandy and loamy soils. The experimental setup included a control treatment (CK; no biochar) and four biochar variants: one pristine biochar (PB) and three N-enriched forms (NB1, NB2, and NB3), each applied at two rates: 20 t ha^{-1} (L1) and 40 t ha^{-1} (L2). Both the type and dosage of biochar significantly impacted methane CH_4 and CO_2 emissions. NB treatments led to a reduction in CH_4 emissions while promoting CO_2 release in both soil types. Enhancements in SOC pools were observed with NB applications, largely due to increases in mineral-associated (MOC) and particulate organic carbon (POC) in both loamy and sandy soils. Moreover, enzyme activities (specifically β-glucosidase, cellobiohydrolase, and β-xylosidase) were markedly stimulated by NB, especially at the higher application rate (L2), with more substantial effects seen in loamy soil. Structural equation modeling (SEM) confirmed that both biochar type and application rate had significant effects on CH_4 and CO_2 emissions as well as SOC dynamics. These findings offer important guidance for the strategic use of biochar to curb greenhouse gas emissions and enhance soil fertility, supporting more resilient and sustainable agricultural systems globally.

Funded by: Agricultural-Photovoltaic Complementary Project of China Datang Dali New Energy Co., Ltd. (DTDL-XNY-2023-025), Yulin Science and Technology Bureau (2023-CXY-219), and the Key R&D Program of Shaanxi Province (2022ZDLNY02-03).

Keywords: Carbon dioxide; C:N ratio; N-modified biochar; Soil organic matter; Soil enzymatic activities.

A Pan-Wales study of management intensity effects on Soil Organic Carbon

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Soil is the fundamental natural resource that underpins a whole farm system. Its significance to agricultural production, nutrient cycling and climate change adaptation should not be overlooked. Soil is a vital carbon store and therefore, protecting and maximising the carbon stock should be prioritised. Variation in soil properties, including soil carbon, is influenced by a number of factors, such as soil type, climate and the management of the land.

Building on existing research, a replicated Pan-Wales project focusing on estimating soil organic carbon levels (from the topsoil to a depth of 50cm) from varying grassland-based farming systems (n=56) was established, with a strong focus on bridging the gap between soil science in relation to carbon, and farming practices. Here, we will focus on results from two groups of Welsh farms: one group sampled in Autumn 2023 (n=17) and the other group in Spring 2024 (n=24). During the project's final phase, Project Officers are collaborating with specialist researchers to draw upon conclusions in terms of variation in soil organic carbon levels, focusing on land management and soil type as potential key drivers.

Results analysed post abstract submission will enable us to better understand the link between management intensity and soil organic matter and carbon levels. Furthermore, to explore the impact of soil type as a predictor of soil carbon. The project's findings will not only provide baseline data in relation to soil organic carbon levels for the project farms, but should also be of significance to other practitioners, researchers and the wider agricultural industry in learning more about synergies between soil and management practices.

Funded by: Welsh Government

Keywords: Soil, organic matter, carbon, agriculture, farms, management intensity, industry

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