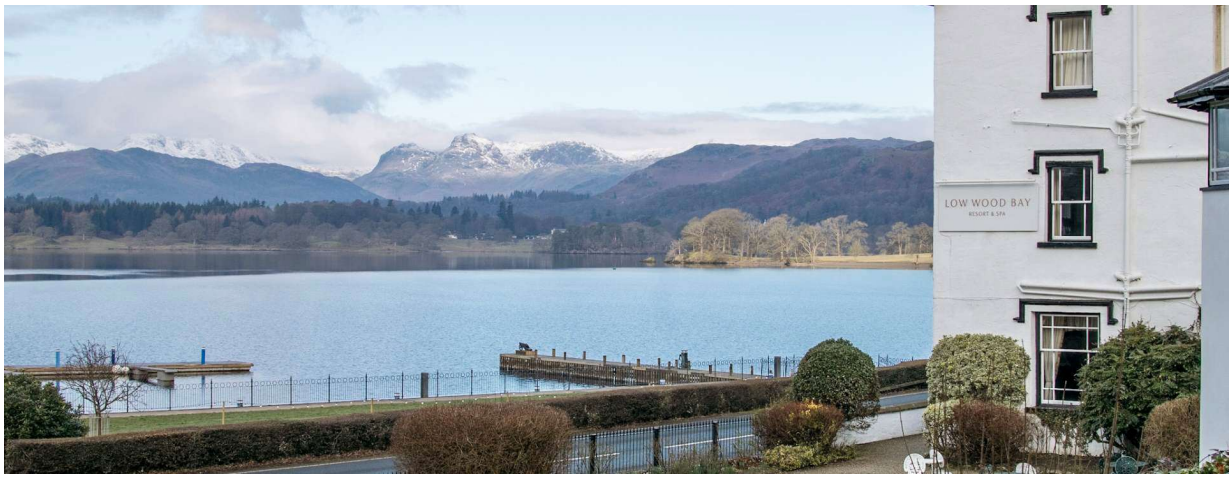
STARS
Soils Training And Research Studentships

NERC & BBSRC funded Centre for Doctoral Training

STARS Annual Meeting 2020

Life Beyond the STARS

Soil Science in Policy, Industry & The Media



20-22 January 2020

Low Wood Hotel, Windermere

#starsoil2020

Biotechnology and Biological Sciences Research Council

Natural Environment Research Council

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

The James Hutton Institute

Centre for Ecology & Hydrology
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Cranfield University

Lancaster University

Contents

Introduction by the organising committee

Welcome to the soil training and research studentships (STARS) conference '*Life Beyond the STARS: Soil Science in Policy, Industry & the Media*'. This conference takes place in a time of change: change in policy and industry as we increase our understanding of the natural world; a change in the way media is delivered to us and how science is portrayed in a digital age; and all of this change comes in a time of a dramatically shifting climate. Over the course of this event, we aim to showcase and explore the broad range and depth of research conducted within institutes across the UK, under the UK NERC and BBSRC funded STARS umbrella. But, more than this, the conference will discuss and examine the role of science beyond academia, in how it informs policy, generates strides in industry, and its portrayal and impact in media.

In what we believe is an exciting and dynamic programme, the theme of each day will be introduced by an invited keynote speaker, an expert in their field. We hope that workshops and panel discussions will springboard conversation about the role of soil science in industry, policy, and media and place into context the diverse research conveyed through oral and poster presentations throughout the event. Whilst we hope that the suite of activities over the three days will be thought-provoking and inspiring in and of themselves, there is also opportunity to 'break out' with your colleagues to develop discussions of your own, perhaps over coffee, lunch, or one of the many fantastic views situated within or around the stunning Low Wood Bay.

This year will also see the graduation of the first STARS cohort; after several years of dedicated work advancing the field of soil science in their respective disciplines, they now move forward in their lives and careers, ready to leave their mark on the world. We will congratulate and reflect upon their remarkable achievements with a celebration, including a drinks reception to set the tone of the evening, with a Ceilidh to top off the night. We would love to see as many of you involved as possible.

Finally, we hope that the STARS 2020 conference will be a place where the next generation of soil scientists can explore their ideas and work in a broader context than ever before. So, whilst presentations are grouped into practical research topics that are by no means exhaustive of soil science, we invite delegates to engage with them in the spirit of the conference key themes and ask themselves and their colleagues: Where does the novel science of the STARS consortium place itself beyond academia and within the wider world?

Conference Committee

Harry Harvey
Luke Hillary
Jess Potts
Leigh-Anne Kemp
Beckie Draper
Corina Lees

Foreword and Welcome – Life Beyond the STARS

Welcome. This promises to be a special meeting because we will have the pleasure of marking the graduation of some of our early cohort STARS students who are now starting to emerge from the work of the STARS CDT. Some are now starting to make their way out of the CDT and into the wider world, to a life beyond the STARS! In order to mark the occasion, for the annual meeting this year, the STARS students have chosen the topic *Soil Science In Policy, Industry & The Media,* attempting to give a much – needed recognition to the practical, strategic and applied aspects to their training in the fields of soil science. This also has the hope of providing the students with some ideas for future framing of their studies as they plan to launch themselves – literally - beyond STARS and into the outside world.

To deliver this vision the student team have invited an array or inspirational visitors. We have Jessica Bellarby from the Environment Agency Policy team, Vicky Robinson from the Nuffield Farming Scholarships Trust and celebrity journalist Caz Graham to provide role models and thoughts for where the discipline of soils may manifest in the twists and turns of life outside of STARS.

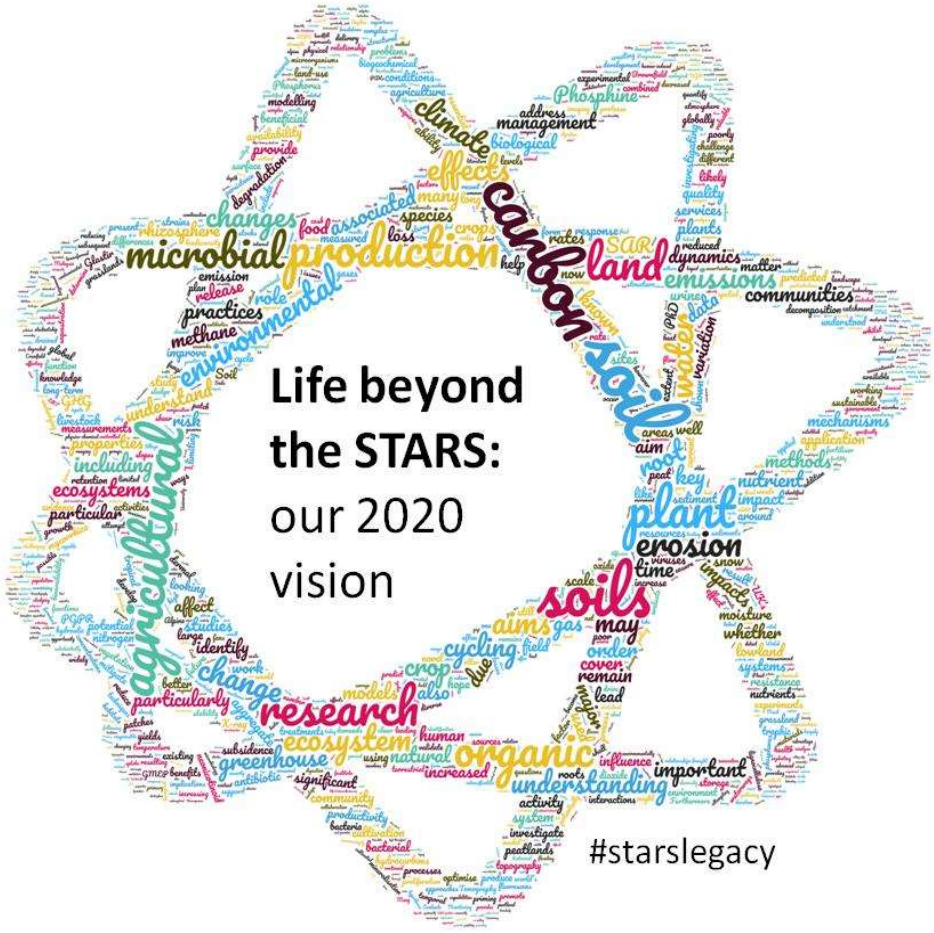
We are delighted to welcome Dan Evans launching his role as the Legacy fellow to the delivery team, who will be seeking your input. Dan is actually just in the process of completing his own soils PhD as a member of STARS and will be leading out his vision, with the students, to provide a legacy of the STARS CDT that intends to exist long after the last student has graduated. One of the exciting examples of our legacy is the recent completion of full-length professional soil documentary on soil formation, that will be premiered at our event with Film Maker Roger Appleton from Brightmoon Media. This is an aspect of the program not to be missed! And we also have (on request of the students) a fabulous 5-piece Ceilidh band which also has roots in Soils Science (I will leave you to find out the links yourself).

Thanks to the team of students who have worked with us to pull together this program, and special thanks to the CDT Administrator Olivia Lawrenson who has done such a great job in cementing together the ideas and linking with the students and staff to deliver the program.

Enjoy Life Beyond The Stars!

Prof Phil Haygarth
STARS CDT Director

A Note from the Legacy Fellow



At this year's annual conference, PhD students and their supervisors from around the country will align, once more, at the Low Wood Bay Hotel. This national constellation of soil scientists - the STARS Centre for Doctoral Training- will shine a light on some of the global existential challenges that confront society. Like last year, the programme will showcase the fascinating diversity of topics currently being examined by the STARS community, but also the areas where further research is required.

This year, I'm especially excited about the premiere of our first STARS feature length documentary film. *World Soil Orders and Their Formation in the Canary Islands* follows the third cohort across the island of Tenerife, as they discover its rich collection of soils and the processes that led to their formation.

I can recall the Tenerife trip well, and in particular, a night we spent laying flat on our backs in a lay-by, gazing up at the stars. The lichened pines and the knife-edged rock; Mount Teide's cloud-piercing finger and ever-watchful eye; the spice-like orange of the sun-scorched soil; the richly diverse island to which we had become acquainted had been vacuumed into the night. All that remained in that floating lay-by were the chirping crickets and the twinkling lanterns of the cosmos.

As I recall those galactic street lamps, I realise what we enjoyed that night was the light from stars many light years away; light that had travelled years, perhaps decades, to reach us on Earth. In fact, some of those stars may not have been 'alive' at the time their light made it down to that Tenerifian lay-by! What a journey! What a

long-lasting legacy!

Although our CDT project concludes in just over a year's time, the outputs from our consortium will, like the light from those stars, continue their journey. The work we've achieved will no doubt help sculpt the future of British soil science, influence government policy, and support the activities of industry far and wide. Our papers and presentations, our methods and data, our courses and training videos: the rich and growing STARS portfolio will be our legacy and, in my opinion, it is something we should all be proud of.

I am delighted, as your newly appointed Legacy Fellow, to officially launch the STARS Legacy Plan at this conference. There are many exciting ideas and opportunities to become part of, including the launch of our online portal, the creation of the STARS Alumni group, and the production of some inspiring films.

Of course, it isn't solely our work that will shape STARS legacy. You - our community of STARS students and supervisors - will soon undertake fresh and exciting journeys too. (Our Graduation Ceremony on Tuesday night will celebrate this). Some of you will continue in research, some will venture into policy, some through industry, and some through the media.

As you each develop your own pathways and forge new connections, share the STARS story. Spread the word. Carry the light. Be the life beyond the STARS!

I hope you enjoy an inspiring conference, and I wish you all the very best for the year ahead!

Dan Evans
STARS Legacy Fellow

Venue

The Low Wood Bay hotel is on the A591, between Windermere and Ambleside. The postal address is:

Low Wood Bay
Amleside Road
Windermere
Cumbria
LA23 1LP

Car parking is to the rear of the hotel, accessed by the new drive, 100 meters north of the hotel. There is a bus stop outside the front of the hotel. The nearest railway station is Windermere.

The venue was chosen in part due to its beautiful and inspiring location, overlooking Lake Windermere in the heart of the Lake District. In addition, it is able to accommodate the large number of participants expected and boasts spacious and comfortable conference, meeting and workshop rooms. We used the hotel last year and found that the conference went very smoothly.

As a guest at the Low Wood Bay, you will have access to the health club, which includes a 50 foot pool, squash court, gym, steam room, Jacuzzi and infrared sauna, so do not forget to pack your sports gear and walking shoes.

Please note breakfast is available between 7.00 and 10.00am. Check in is from 3pm, upon checkout, bags can be left in the hotel luggage room if desired. It will be your responsibility to settle any additional costs charged to your room during your stay.



Conference schedule

20th January	**Day 1- Policy**	**Location**		**Location**
09:00	Free time for early arrivals – student led			
10:45			Chair's briefing 10:15-10:45	Grasmere
10:30			MB Coffee	Gallery
11:00			MB meeting	Grasmere
12:15	Registration	Gallery		
12:45	LUNCH	Restaurant		
13:30	Conference welcome **Phil Haygarth**	Main room		
13:35	'Exploring resilience and your PhD - what's possible? **Will Medd**			
15:05	Conference introduction **Phil Haygarth**			
15:10	Soils and Environmental Policy – an Environment Agency Perspective **Jessica Bellarby**			
15:40	Reflections and discussion **Phil Haygarth**			
16:00	COFFEE	Gallery		
16:30	Carbon cycling in oceanic-alpine ecosystems under drought and storm events **Rosanne Broyd**	Main room		
16:45	Carbon flux partitioning from calcium carbonate rich soils using stable isotope measurements **Chris McCloskey**			
17:00	Neonicotinoids in the environment- Fate and impact **Jessica Potts**			
17:15	STARS continuing vision **Dan Evans**			
17:25	Closing remarks			
17:30	FREE TIME			
18:20	Drinks reception & film launch **Roger Appleton**	Gallery/main room		
19:30	Dinner	Restaurant		
21:00	Pub quiz **Corina Lees**	Rydal		

21st January	**Day 2- Industry**	**Location**		**Location**
09:00	Research through to Implementation **Vicky Robinson**	Main room		
10:00	Extending the Soil Lifespan: enhancing the long-term sustainability of global soil resources **Dan Evans**			
10:15	Understanding and quantifying the link between undisturbed soil pore architecture and time-lapse pre fluid flow **Mihai Cimpoiasu**			
10:30	The influence of climatic conditions and fluctuations on soil aggregate stability and microbially-mediated (de)stabilisation **Emily Dowdeswell-Downey**			
10:45	COFFEE	Gallery		
11:15	Poster flash talks	Main room		
11:45	Poster session 1 **Harry Barrat; Rose Durcan; Ben Freeman; Katy Wiltshire; John Beale; Anchen Kehler; Beckie Draper**			
12:30	LUNCH	Restaurant		
13:30	Poster session 2 **Lewis Rose; Danielle Hunt; Sam Musarika; Corina Lees; Andy Tweedie; Alex Williams**	Main room A		
14:15	Workshop "Storytelling & Soil Science" **Erinma Ochu**	Main room A	Workshop "10 tips to deliver better presentations" **Malcolm Love**	Main room B
15:15	COFFEE	Gallery		
15:45	Workshop "Generating lasting impact" **Erinma Ochu**	Main room	Workshop Yoga **Rebecca Ellis**	Grasmere
16:45	Panel discussion			
17:30	Closing remarks			
17:40	FREE TIME			
18:40	Group photograph	Stairs to Gallery		
18:45	Graduation drink reception	Gallery		
19:15	Conference dinner	Main room		
21:00	Ceilidh **Price of my pig**			

22nd January	**Day 3- Media**	**Location**		**Location**
09:00	Making the Media Dig Soil **Caz Graham**	Main room		
10:00	Selling Your Soil Story – A practical session to help present your research in a media friendly format that gets it noticed and delivers results for both you and journalists. **Caz Graham**			
10:45	COFFEE			
11:15	Life Beyond the STARS: A workshop for both students and supervisors to consider the best ways of achieving long-lasting, meaningful legacy **Dan Evans & Kerry Firth**			
12:15	Shifts in soil structure, biological, and functional diversity under long-term carbon depletion **Paul George**			
12:30	Utilising organic nitrogen: can plants produce protease enzymes from their roots? **Lucy Greenfield**			
12:45	The Impact of Soil Structure on Microbial Response to Environmental Change **Harry Harvey**			
13:00	LUNCH	Restaurant		
14:00	Application of Different Fractions of Anaerobic Digestate Significantly Influences the Carbon Cycle in Grassland Soils **Marta Cattin**	Main room		
14:15	Life, but not as we know it: exploring RNA viral diversity in soils through viromics **Luke Hillary**			
14:30	Abundance Change of Soil Alkanotrophs Around Natural-Gas Seeps **Tom Bott**			
14:45	Panel discussion			
15:30	Closing remarks and prizes			
16:00	CONFERENCE END			

Workshops

Earthwatch 1 – Storytelling & Soil Science

Exploring how and why stories matter to engage the public in soil research. Exploring the power of a carefully crafted 'soil' story.

Tuesday 14:15 Main room

Earthwatch 2 – Generating lasting impact

Identifying key stakeholders across the research cycle and exploring their motivations, values and priorities for engaging with soil science research.

Tuesday 15:45 Main room A

10 tips to deliver better presentations

Malcolm Love, the chief trainer for "Famelab" who runs master classes in public communications, will present a workshop on delivering excellent presentations in which he will address such issues as event presentation, giving media interviews, managing stage fright and presenting to camera.

Tuesday 14:15 Main room B

Yoga for stress reduction

Experienced Yoga teacher Rebecca Ellis, leads a yoga session for all abilities, with a focus on stress reduction.

Tuesday 15:45 Syndicate room

Selling Your Soil Story

Keynote speaker Caz Graham, leads a session on effective use of the Media to promote knowledge exchange and public access to science. A practical session to help present your research in a media friendly format that gets it noticed and delivers results for both you and journalists.

Wednesday 10:00 Main room

Life beyond the STARS

STARS legacy fellow Dan Evans, leads a session alongside Kerry Firth of BBSRC, exploring ways to build a strong legacy resource from the STARS CDT to continue supporting soil science research into the future. A workshop for both students and supervisors.

Dan Evans & Kerry Firth

Wednesday 11:15 Main room

Keynote Speakers

Jessica Bellarby

Jessica Bellarby has recently joined the agriculture team of the Environment Agency within the Environment & Business Directorate as an Advisor. She supports the EA Environmental Land Management workstream by providing evidence in order to influence Defra in shaping new agricultural policies. In her previous role she supported an area operations team, giving her an insight on the challenges that officers face when implementing regulation.

She has a strong research background in issues around agriculture and its environmental impact having over 10 years of experience as postdoctoral researcher at the University of Aberdeen (Environmental Modelling group) and more recently at Lancaster University under Phil Haygarth and Ben Surridge.

Vicky Robinson

Vicky Robinson is a Nuffield Scholar. She grew up on an arable farm in Oxfordshire and loved farming and also horses. Having graduated with a degree in International Agriculture and Equine Business Management she decided to focus on agriculture. Understanding the importance of conservation in farming led her to work in that area, firstly with the Environment Agency and subsequently with the Farming and Rural Conservation Agency. Following various reorganisations, she currently works for Natural England.

She spent 14 years on farms, supporting farmers with agri-environment agreements, but is currently jointly managing an EU funded pilot looking at an alternative approach to agri-environment: Payment by Results.

She is also a trustee of Wild Oxfordshire, a charity that encourages collaborative working between environmental organisations in the country.

Caz Graham

Broadcaster Caz Graham, is a member of the British Guild of Agricultural Journalists. She grew up on a mixed farm in north Cumbria.

Her first foray into agricultural journalism was reading out the fatstock prices on BBC Radio Cumbria back in the day when it was still considered public service broadcasting – and yes, that was a very long time ago.

Nowadays, Caz is a freelance journalist working primarily in radio for BBC Radio 4 often reporting for and presenting Farming Today and On Your Farm.

Still based in Cumbria, she also reports for PM and the World at One and has presented and reported for a variety of programmes for Radio 4 and the World Service over the last 18 years.

She started her career in the 1990s as a presenter on BBC local radio and in both radio and television production for BBC Scotland in Glasgow.

Caz reported extensively on the foot and mouth outbreak of 2001, presenting and producing Sony Award winning programmes.

She compiled a book, *Foot and Mouth – Heart and Soul*, which was launched by the then Director General of the BBC Greg Dyke, documenting the experiences of 50 people who'd found their lives turned upside down by the epidemic.

Caz says she is interested in pretty much anything agricultural but particularly cooperation in farming, rural communities and sustainability and upland farming. And she loves a good story to tell.

Other contributors

Will Medd

Will is going to open the conference with a wellbeing based icebreaker. Will is a coach specializing in supporting PhD students and academics.
http://www.willmedd.com/how-it-works/phd-coaching

Phil Haygarth

Director of the STARS CDT

Dan Evans

STARS CDT legacy Fellow

Roger Appleton

Film maker Roger Appleton, has produced several films with STARS, both presenting the research of individual students and capturing insight into the research process. Today Roger will introduce his latest STARS film, and provide a brief introduction to the film making process and effective ways to communicate research to a wider audience. The film, "World Soil Orders and Their Formation in the Canary Islands" was shot on location and features STARS students and staff.

Erinma Ochu

Engaging Environments is the National platform for public engagement in environmental science. It is focused on storytelling, citizen science and community organising for collective action around environmental justice concerns. The programme partners with Earth Watch, Citizens UK, Tekiu and Figshare to create lasting impact.

Dr Erinma Ochu is the storytelling lead on the programme and a Digital Society Fellow based in the school of School of Archaeology, Geography and Environmental Science at The University of Reading. Erinma has a background in neuroscience, film and urban farming. She has engaged the public in soil science in imagining the future of food.

Malcolm Love

Malcolm is a specialist in science communication and public engagement. Before joining the BBC staff in 1988 Malcolm had been a freelance journalist in Central America (Nicaragua and El Salvador). He worked for the BBC as a producer (and occasional presenter) in London, Cardiff and Bristol where he became senior producer for features and documentaries. Since going freelance in 1997 Malcolm has made many more programmes for the BBC and other outlets. This experience has enabled him to work with many well-known contributors.

As a specialist in the **public engagement of science,** Malcolm runs workshops in the UK and internationally, helping scientists and engineers to better engage with the media and the public.

Rebecca Ellis

An experienced yoga teacher, Rebecca guides complete beginners and experienced yoga practitioners alike, for an invigorating but relaxing practice.

Price of my Pig

An experienced 5 piece Ceilidh band, known for bringing a little more life and energy to a ceilidh. Interestingly the caller's grandfather, VC Farmer, was himself a soil scientist of some repute, who worked in the Macaulay Institute for many years, pioneering the use of infrared spectroscopy in mineralogy, particularly its application to clay mineralogy.

Kerry Firth

Kerry is Science Strategy Manager for Sustainable Agriculture and Food at the Biotechnology & Biological Sciences Research Council (BBSRC). Kerry has a particular interest in ensuring that projects like STARS develop strong and effective legacies to provide long lasting impact.

Oral presentations: Session 1:

Carbon cycling in oceanic-alpine ecosystems under drought and storm events

Rosanne C Broyd (Lancaster University, and The James Hutton Institute), Andrea J Britton (The James Hutton Institute), Robert T E Mills (University of York), Andy F S Taylor (The James Hutton Institute), & Nicholas J Ostle (Lancaster University)

Oceanic-alpine ecosystems in the Scottish Highlands are potentially among the most carbon rich habitats globally, with snowbeds being large stores of old soil carbon. Spring snow cover extent in the northern hemisphere has declined over recent decades and is expected to diminish by up to a further 25% by 2100. Melt water input to snowbeds may reduce and summer precipitation is also expected to decrease, with longer dry spells interspersed with heavy rain events. We examined the effects of extreme weather events on carbon cycling in two contrasting oceanic-alpine ecosystems. Here we present ecosystem respiration, net ecosystem exchange, and leachate fluxes from snowbed and alpine heath mesocosms during a drought and storm experiment and the subsequent recovery phase. We hypothesised that snowbeds would be more sensitive than alpine heath, as snowbeds currently experience more stable microclimates, but based on measurements of ecosystem respiration, snowbeds were more resistant to these events.

Key words: Snowbed, alpine heath, soil carbon, ecosystem respiration, net ecosystem exchange, dissolved organic carbon, leachate

Carbon flux partitioning from calcium carbonate rich soils using stable isotope measurements

Chris McCloskey (Cranfield University and the James Hutton Institute), Guy Kirk (Cranfield University), Wilfred Otten (Cranfield University), Eric Paterson (James Hutton Institute)

Stable isotope methods provide a reliable means to separate element fluxes from two sources, such as for carbon (C) from plant respiration and soil organic matter (SOM) mineralisation. In many soils, however, plant respiration and SOM mineralisation are not the only sources of C because dissolution of carbonate minerals provides a third, inorganic, C source. The standard two-source methodology therefore does not apply, and this limits our ability to study plant and soil C fluxes in soils containing carbonate.

We are developing a method to account for inorganic carbonate dissolution in stable isotope studies of plant and soil C fluxes. We measured CO2 fluxes and their isotope signatures in unplanted and planted soil mesocosms containing calcium carbonate under a range of temperature and moisture conditions, and used the results to develop a model of calcium carbonate dissolution and its contribution to the net C isotope signature of carbonate, SOM, and plant sources. We are testing the model through C flux monitoring of planted mesocosms to assess its suitability for generating field datasets of C fluxes from calcareous soils.

Key words: soil carbon, carbon flux partitioning, inorganic carbon, organic carbon, carbon modelling, cavity ring-down spectroscopy

Neonicotinoids in the environment- Fate and impact

Jessica Potts, David Jones, Paul Cross

Over the last half century, society's reliance on managed insect pollination of food crops has risen by over 300%, however recent findings have estimated a 76% decline in flying insect biomass over the last 27 years. Such losses are thought to be driven by several factors including parasites and diseases, agricultural intensification, climate change and possible exposure to pesticides such as neonicotinoids.
Neonicotinoids are one of the most widely used insecticides globally. Their systemic mechanisms allow for ease of application and relatively successful control of biting and sucking invertebrates. However, neonicotinoids have been strongly associated with recent declines in non-target organisms. Many neonicotinoids frequently make contact with the soil, either through application as a seed coating or soil drench, or through spray drift and drip from foliar applications. Little is known of their movement, fate and interactions in UK soils under general field management conditions.
This study aims to quantify the effects of Acetamiprid-based pesticide mixtures on below-ground soil functions, through the analysis of their chemical movement and behaviour under different organic matter levels. We also aim to assess the impact of neonicotinoids on select non-target organisms.

Key words: pesticide, neonicotinoid, invertebrate, agriculture

Oral presentations: Session 2:

Extending the Soil Lifespan: enhancing the long-term sustainability of global soil resources
Dan L. Evans, John N. Quinton, Jess A. C. Davies, Jianlin Zhao, Gerard Govers

Soil erosion is a serious threat to global sustainability, endangering global food security, driving biodiversity loss, and degrading vital ecosystem services. Media reports have repeatedly stated that there are as little as 60 years of topsoil left, but there appears to be no scientific basis for these claims. Here, we provide the first scientifically robust, globally relevant estimate of soil lifespans and the degree to which changes in land management can extend them. We amassed a global inventory of soil erosion rates consisting of 10,030 plot years of data from 255 sites under conventional and conservation management, as well as a global database of soil formation rates. Expressing soil sustainability as a lifespan, here defined as the time taken for a 30 cm topsoil to be eroded, we show that just over a quarter of conventionally managed soils exhibit lifespans of <200 years, with 16% <100 years. Conservation measures substantially extend soil lifespan estimates, with 46% of these soils exhibiting lifespans exceeding 10,000 years. Furthermore, we show that soil lifespans of <100 years are widespread globally, including in seven of the top twenty wealthiest nations. These findings highlight the pervasiveness, magnitude, and in some cases the immediacy of the threat posed by soil erosion to near-term soil sustainability. However, this work also demonstrates that we have a toolbox of conservation methods that have potential to ameliorate this issue and their implementation can help ensure that the world's soils continue to provide for us for generations to come.

Key words: Soil Erosion, Soil Formation, Soil Lifespan, Soil Conservation

Understanding and quantifying the link between undisturbed soil pore architecture and time-lapse pore fluid flow.
Cimpoiasu, M.O., Kuras, O., Pridmore, T. and Mooney, S.J.

There is a growing demand for the optimisation of agricultural practices. Understanding and quantifying the dynamic processes governing the root zone represents the first step towards this endeavour. Electrical Resistivity Tomography (ERT) and X-ray Computed Tomography (CT) are two state-of-the-art methodologies with great potential for applications in soil science. ERT allows time-lapse monitoring of solute transport in soils. X-ray CT is sensitive to bulk density changes at high resolution. Our study aims to use the specific strengths of both methods to derive a quantitative link between natural soil porosity and electrical resistivity. In a controlled lab experiment, on two undisturbed soil columns, we monitored a saline solution infiltration with ERT and segmented their corresponding air-filled pore networks from X-ray CT scans. By analysing the resulting ERT time-lapse 3D models of resistivity, we derived a direct quantitative relationship, which shows how small scale (mm) fluctuations in pore-density determine changes in the relative electrical resistivity profile, hence in the pore solution temporal and spatial distribution. This demonstrates ERT's capability to detect and monitor fluid pathways in soils and provides an empirical way to quantify in near real-time the effect the soil structure has on solute movement. In addition, we foresee the possibility of using such methodology in more complex pot-scale models of fluid dynamics, which would be used to monitor root water uptake and growth.

Key words: soil structure, pore fluid, geophysics, time-lapse resistivity, monitoring

The influence of climatic conditions and fluctuations on soil aggregate stability and microbially-mediated (de)stabilization
Emily Dowdeswell-Downey, Robert Grabowski, and Jane Rickson

Soil is a critical resource that delivers numerous ecosystem services, yet this capacity is diminished by soil erosion and further threatened by the impacts of climate change. Soil erodibility is largely overlooked when considering soils' response to climate change. Aggregate stability is widely recognised as a key indicator of soil erodibility and is influenced by multiple physical, chemical and biological mechanisms operating simultaneously. The microbial community has been reported to respond to changing climatic conditions, yet it remains unclear how microbial change influences microbial (de)stabilisation function and therefore aggregate stability. This work presents a series of experiments testing the hypothesis that climatic conditions influence the microbial community and microbial (de)stabilisation function, mediating changes in aggregate stability. Laboratory-controlled experiments using environmental chambers and rainfall simulation examined the effects of temperature and moisture content in both static and fluctuating treatments representing future climate scenarios. Static temperature and moisture content conditions significantly affected aggregate stability, however the effects varied dependent on soil texture. Increasing temperature significantly increased aggregate stability in clay loam aggregates, while moisture content significantly decreased aggregate stability in sandy loam aggregates. Multiple regression analysis showed that aggregate stability was best predicted by soil moisture content, microbial biomass carbon, gram-negative bacterial abundance and fungal abundance in the sandy loam. Temperature was the sole significant predictor in the clay loam. In conclusion, the laboratory experiments indicate that aggregate stability is significantly affected by temperature and soil moisture, as predicted with climate change, but more research is needed to understand the mechanisms in fluctuating conditions.

Key words: aggregate stability, climate change, soil erosion, microbial function

Oral presentations: Session 3:

Shifts in soil structure, biological, and functional diversity under long-term carbon depletion
Paul B.L. George, David B. Fidler, Joy Van Nostrand, Jonathan A. Atkinson, Sacha J. Mooney, Simon Creer, Robert I. Griffiths, James E. McDonald, David A. Robinson, Davey L. Jones

Soil organisms are crucial to the support and maintenance of ecosystems through the provision of ecosystem services. Nutrient cycling and decomposition are important processes by which soil organisms support aboveground plant communities. Anthropogenic disturbances can disrupt these processes. However, some organisms respond positively to disturbance and could mitigate the effects of disturbance. We assessed soil community composition and functional processes during a long-term carbon deprivation field experiment. Two sets of paired samples were deprived of carbon inputs for 10 years and 1

year, respectively. Soil DNA was extracted for metabarcoding and Geochip microarray analyses. Richness of bacteria, fungi, protists, and viruses fell under carbon depravation after 10 years, but not after 1 year. Log-fold change in gene expression of carbon cycling genes generally fell as well, though it increased for some genes involved in decomposing recalcitrant carbon. Similarly, log-fold change of several methanogenesis genes increased under carbon starvation. Several taxa were identified as indicators of both normal and deprived soils. Our results highlight the dynamic nature of soil communities. Bioindicators of carbon depravation may utilise alternative gene pathways to take advantage of opened niche space. The impact of carbon depletion requires long timescales and may be prevented with timely interventions.

Key words: Geochip; Metabarcoding; Bioindicators; Carbon cycling; Nitrogen cycling; Methanogenesis; Anaerobic respiration; Function genes

Utilising organic nitrogen: can plants produce protease enzymes from their roots?
Lucy Greenfield, Paul Hill, Eric Paterson, Liz Bagss & Davey Jones

Nitrogen (N) is an important macronutrient for plant life. Plants can uptake N in the form of ammonium, nitrate, amino acids and oligopeptides. However, plants do not have direct access to the 40% of total soil N represented by proteins. To utilise proteins they first must be broken down into oligopeptides and amino acids by protease enzymes. Therefore, the ability of plants to secrete proteases to hydrolyse proteins into small peptides and amino acids would increase the availability of N to plants. Plants utilising organic N would reduce the need to apply environmentally detrimental inorganic N fertilisers, in agricultural systems.

In a laboratory experiment, we investigated whether plant roots release protease enzymes and whether protease released from roots were up- or down-regulated by the presence of inorganic N. Seedlings (Zea mays L. and Triticum aestivum L.) were grown in sterile, hydroponic conditions in an inorganic N nutrient solution or a zero N nutrient solution. The nutrient solutions were analysed for proteolytic activity using a fluorescence aminopeptidase assay. We also measured root protease activity in situ to determine whether root proteases are surface bound. We discovered that plants roots will not release exoprotease enzymes but instead remain plasma membrane bound with higher concentrations under the zero N treatment. Consequently, proteases present on the root surface allow the plant to utilise the protein fraction of soil without losing essential nutrients into the soil matrix.

Key words: protein; organic nitrogen; amino acids; proteolytic activity; peptidase

The Impact of Soil Structure on Microbial Response to Environmental Change
Harry J. Harvey, Sacha J. Mooney, Ricky D. Wildman, Simon V. Avery

Environmental perturbation, anthropogenic or otherwise, can have a profound effect on soil microbiota and essential biogeochemical processes. The general resistance and adaptation of microorganisms to stressors has been well studied in vitro. However, the influence of key environmental variables, such as soil aggregation and pore structure, on microbial response to perturbation is very poorly understood. Using artificial structures to expose organisms to structure-specific stress, and manufacturing soil macroaggregates with known microbial composition and position, current research is focused on disentangle the key parameters of a structured soil environment which may influence microbial stress response. In particular, environmentally relevant stressors such as heavy metals, anoxia, and temperature are being

examined. Thus far, results suggest that both mean structural pore-size and microbial position within a soil macroaggregate can impact on the survival of wild yeast isolates in response to stress.

Key words: Microbiology, Structure, Fungi, Environmental Perturbation

Oral presentations: Session 4:

Application of Different Fractions of Anaerobic Digestate Significantly Influences the Carbon Cycle in Grassland Soils

Marta Cattin, Kirk T. Semple, Marc Stutter, Gaetano Romano, Alfonso Lag-Brotons, Chris Parry and Ben W.J. Surridge

Applying digestate to soil is of growing interest in agriculture. However, the impacts of digestate on soil biogeochemical cycles often remain unclear, especially after solid-liquid separation of whole digestate (WD). We used a 21 d incubation to examine the effects of WD and solid digestate (SD) on CO2-C efflux, dissolved organic carbon (DOC), microbial biomass C (Cmicro), phospholipid fatty acid (PLFA) and carbon use efficiency (CUE) within two grassland soils of contrasting nutrient status. Application rates for SD and WD were based on recommended N inputs to grassland soils for these organic materials. Compared to un-amended controls, cumulative CO2-C efflux, Cmicro and the fungal:bacterial in soils increased significantly following SD application, regardless of the soil nutrient content (+20% CO2-C, +29% Cmicro, +58% fungal:bacteria for high nutrient soil; +563% CO2-C, +36% Cmicro, +18% fungal:bacteria for low nutrient soil). In contrast, WD produced a significant effect on CO2-C efflux and fungal:bacterial only in the low nutrient soil. Our results also indicated that both digestate fractions and the initial soil nutrient status affected CUE. Applying both SD and WD to a low nutrient soil potential leads to decreases in soil C stocks, whilst the application of SD to a high nutrient soil can potentially enhance soil C stocks. Digestate application must be carefully planned, accounting for both the nature of the digestate and of the soil, in order to avoid adverse impacts on soil C stocks.

Key words: digestate, CUE, grassland fertility, bacteria respiration

Life, but not as we know it: exploring RNA viral diversity in soils through viromics

Luke S. Hillary, Evelien Adriaenssens, Davey L. Jones, James E. McDonald

Viruses play a crucial and underexplored role in soil microbial ecosystems, but soil viral ecology has focused exclusively on DNA viruses. The role of RNA viruses in soil ecosystems has therefore been largely overlooked, despite their significant impact on public health and food security. Here, we report the first ever study to apply viromics to survey soil RNA viral communities from five sites along an altitudinal primary productivity gradient in the UK. We identified 2100 viral sequences, of which over 1200 were unclassified, and newly identified viruses were placed in a global context by the phylogenetic comparison of their RNA-dependent RNA polymerase genes. Unlike DNA viral communities, the RNA viromes were heavily dominated by viruses of eukaryotes, including pathogens of plants, fungi, vertebrates and invertebrates. Sampling sites showed minimal similarity in viral community composition, suggesting that we have just scratched the surface of soil RNA viral diversity. Wider sequencing efforts and method development are required to further explore soil RNA viromes and understand their ecological function; however, this study represents an important step

towards the characterisation of soil viral communities and interactions with their microbial hosts, which will provide a more holistic view of the biology of economically and ecologically important soils.

Key words: soil biodiversity, viral ecology, RNA viruses, metagenomics

Abundance Change of Soil Alkanotrophs Around Natural-Gas Seeps
Tom Bott

The UK has a legacy of onshore oil and gas wells. Ageing extraction wells, with deteriorating cap engineering, may act as preferential pathways for gas seepage from the sub-surface. Seeps from hydrocarbon reservoirs are predominately composed of potent greenhouse gases, such as methane and carbon dioxide. Shifts in the soil microbial community are potential indicators of alkane gas fluxes from the sub-surface. Therefore, soil microbial community change could be used as a tool for monitoring ageing, legacy wells, for gas seepage. An increase in bacteria that metabolise methane (methanotrophs), or, C3-C4 alkanes (propanotrophs/butanotrophs) should be correlated with an increased flux of those gases, thereby indicating the presence of a seep. The abundance of alkanotrophs within a bacterial community can explored using qPCR assays of the key genes used in alkane metabolism. In France, there are several natural-gas analogue macro-seeps where the soil microbial community is interacting with increased alkane fluxes from a point source. Two, well characterised, sites were visited. Gas flux measurements, soil-pore gas concentrations and soil samples were collected. The soil samples underwent DNA extraction and the extracted DNA used in qPCR assays to estimate the proportion of methane monooxygenase and butane/propane oxidising genes within the total bacterial community (using 16S as a proxy). The in-field measurements of gases were contrasted with the relative abundance of methanotrophs and propanotrophs/butanotrophs.

Key words: Natural-gas, Macro-seeps, Methanotrophs, Microbial Soil Ecology

Poster presentations: Session 1:

Awaiting title
Harry Barrat

This year we discovered that Broadbalk has never had a total greenhouse gas flux calculated in-situ, let alone over various seasons throughout the year. So in 2019, we started a unique experiment that uses traditional static chambers to measure nitrous oxide, carbon dioxide and methane from the continuous wheat sections. We are interested in how 150 years of inorganic and organic fertiliser use has impacted the soils chemistry, biology and subsequent emissions. Specifically, the difference between farmyard manure (220 kg N ha) and inorganic nitrogen (N) at a relatively high rate (240 kg N ha), as well as a control which does not have any nitrogen applied, but receives potassium and phosphorous.

We plan on measuring for a whole year from when each fertiliser is applied (inorganic N April 2019-2020 and farmyard manure October 2019-2020), and we are taking soil samples to correlate emissions to soil chemistry (total oxidised nitrogen, ammonium, soluble organic carbon, total N and total C), and soil biology by freezing soil in the field for microbial analysis. Eventually we would like to calculate an annual GHG budget and compare the legacy effect of Broadbalk's continuous wheat plots of both inorganic and organic fertiliser to literature data, and a new field trial running adjacent to Broadbalk (Rothamsted's Large Scale Rotation Experiment).
Key words: GHG emissions, legacy impact, organic and inorganic fertilizer

Soil carbon dynamics of the Gran Chaco, Argentina, in the face of land use change and a changing climate
Rose Durcan

In recent years deforestation of the Gran Chaco of Argentina has increased dramatically to make way for agricultural expansion. Extensive cattle ranching in particular is widespread across the country, and in the Chaco region of the north west much of the natural vegetation has been lost to beef and crop production. The effects of forest clearance and grazing over time on soil carbon dynamics are unclear, with some evidence suggesting that soil carbon can to some extent recover under low intensity grazing practices, whilst others find that conversion to pasture followed by years of grazing consistently decreases soil carbon stocks. This study uses a chronosequence design to investigate the effects of land use change from forest to pasture over time in the dry Chaco of north western Argentina on soil carbon stocks through the measurement of biological, physical and chemical variables within the soil. Destructive soil samples were taken from forest patches and pastures of 0-5, 10-15 and >20 years since deforestation and were tested for carbon, nitrogen, phosphorus, root biomass, pH and EC and texture. Furthermore, intact cores were extracted from each site and incubated under mixed climate effects of hot and wet, hot and dry, cold and wet, cold and dry. The incubated cores were sampled for greenhouse gas emissions over a period of two weeks. The study aims to investigate how carbon stocks in the Chaco have been affected by extensive grazing, and how this may change in the face of future climate change.

Key words: Land use change, grazing, climate change, semi-arid, soil carbon, respiration, subtropical

Can a nitrification inhibitor reduce greenhouse gas emissions from agricultural peat soils?
Ben Freeman

Agricultural use of lowland peatlands is probably the largest source of land-use derived greenhouse gas (GHG) emissions per unit area in the UK. Drainage-induced, microbial decomposition drives emissions of ~39 t CO2-eq ha-1 yr-1 on arable land in the East Anglian fens. Nitrous oxide (N2O) emissions make up ~25% of this total. The fens include ~50% of England's Grade 1 agricultural land and are highly productive. Developing mitigation options is vital for balancing food production with emissions targets. The nitrification inhibitor, dicyandiamide (DCD) has been widely found to reduce soil N2O emissions on mineral soils. If DCD can reduce emissions without negatively affecting food production then it could provide a valuable management tool for agricultural peats. We report on a 16-week laboratory incubation examining whether DCD can reduce emissions from agricultural peats. We tested DCD under a range of soil moisture conditions and following amendment with lettuce residue. We measured GHG fluxes and soil concentrations of nitrate, ammonium and DCD. We hypothesise that DCD will reduce N2O emissions, including those resulting from residue incorporation. However, we expect the effectiveness of DCD to vary depending on soil moisture content. The balance between food production and GHG regulation in the fens is highly relevant to policy makers and industry alike. This research evaluates a practical option for improving the balance of ecosystem services delivered by the soils of this productive yet fragile system.

Key words: Greenhouse Gases, Nitrous Oxide, Nitrification Inhibitors, Lowland Peatlands, Sustainable Agriculture

Awaiting title
Katy Wiltshire

Accelerated soil erosion due to human activity and changes in climate results in a significant flux of soil, nutrients, and organic carbon (OC) from land to freshwater. Quantifying this OC flux in watersheds is vital for understanding driving mechanisms (natural or anthropogenic), and the assessment of impact on the exchange of CO2 with the atmosphere and the global carbon budget.
Spatially distributed modelling can identify areas at risk of soil erosion, however, areas with high soil loss rate are not necessarily regions contributing most sediment to the streams and areas contributing most sediments to streams may not contribute the most OC. There is, therefore, a need to compare soil erosion and OC stock modelling with other, independent evidence of sediment source origin.
For two UK catchments, Loch Davan, Aberdeenshire, and Carminowe Creek, Cornwall, soil and sediment samples were collected from terrestrial and aquatic sites encompassing all major land-uses. These data are used with existing land-use, soils and environmental databases to assess i) the effects of land-use and topography on the variation of soil OC stocks with depth and ii) the impact of lateral sediment connectivity and land-use on sources of particulate OC delivered to catchment streams. This study integrates identification of land-use sources of aquatic sediments through OC fingerprinting with detailed modelling/mapping of soil OC distribution, erosion and transport.
This research seeks to identify sources of aquatic sediments and OC in watersheds to help inform management decisions that mitigate the impact of climate induced sediment flows and promote water quality.

Wet and Dry References for Soil Moisture Retrieval
John Beale

Remote sensing and land surface modelling offer the potential to provide wide area estimation of soil moisture to support agriculture, hydrological modelling and weather forecasting. Their output is, typically, a relative surface soil moisture value between wet and dry conditions, exemplified by the recent release of the Copernicus Surface Soil Moisture (SSM) and Soil Water Index (SWI) products which are based on remote sensing, and the USDA root-zone soil moisture index. These products often state that they are relative to available water (AW) - the difference between the Field Capacity (FC) and Permanent Wilting Point (PWP) - and conversion to (for example) soil water deficit requires knowledge of soil properties. The penetration depth of remotely sensed data throws into question the use of FC and PWP as wet and dry references, as we show that the surface layer soil is often outside this range. This poster evaluates, as candidate references, other soil moisture parameters that may be calculated from soil hydrological properties obtainable from LANDIS. By examining the coefficient of correlation, bias and offset of SSM-derived volumetric water content with COSMOS UK measurements and WASIM simulated surface soil moisture, we demonstrate that the model fitting parameters of the Van Genuchten model, θs and θs are the most appropriate to minimise error.

Key words: Soil Moisture, Remote Sensing, Hydrology, Irrigation

The utilisation of aminomethyl phosphonic acid by soil micro-organisms as a phosphorus nutrient source
Anchen Kehler

Our global climate continues to change, and with that comes the change of our soil climate. Reports by the IPCC indicate annual increases in prolonged rainfall events within temperate climates; thus exacerbating widespread autumn/winter waterlogged conditions within in the years to come. For our soils, this means the development of anaerobic systems as wetland areas and frequent flooding become more common. Reducing systems like these are capable of facilitating conditions in which alternative oxidation states of the vital elements needed for soil health present themselves. The change of our soil climate is rarely considered when attempting to understand how phosphorus is cycled and how it might be affected in an alternative environment. Existing knowledge from the marine sector demonstrates that a low oxidation state group of compounds known as phosphonates (+3) are successfully utilised by micro-organisms instead of phosphate (+5) as their phosphorus source; thus demonstrating that the phosphorus biogeochemical cycle is much more complex than previously regarded. In the case of the soil environment, there is a large quantity of inaccessible phosphorus present that might be utilised through similar microbial mechanisms when considering a reducing system. The aim of this research is to alter the understanding of global phosphorus cycling and additionally of ecosystem phosphorus limitation. This is done by assessing the capabilities of certain biological species to process phosphorus in alternative oxidation states, highlighting the importance of reduced phosphorus compounds on the global redox cycle.

Key words: Phosphorus, Soil, Phosphonate, cycling, redox

Effects of zinc nanoparticles and AMF on wheat
Beckie Draper

My experiment is looking at differences that occur when wheat is inoculated with AMF and then grown in soils spiked with different species and concentrations of zinc nanoparticles. I am currently collecting data.

Key words: Zinc nanoparticles, AMF, wheat

Poster presentations: Session 2:

Use of radon-222 to predict the soil gas diffusion coefficient
Lewis Rose

Soils are complex systems and involve myriad cycles of chemical, biological, and physical significance. The separation of these goes some way to helping us understand the soil system. This research covers soil gas dynamics, namely the use of the inert trace gas radon-222 to drive computer models of soil gas diffusion and better predict soil gas movements. This involves non-invasive observation of diurnal and annual cycles in belowground gas concentrations and estimation of the soil gas diffusion coefficient.
Knowledge of how the soil gas diffusion coefficient varies with time enables the assessment of the extent to which physics drives soil greenhouse gas concentrations. The estimation of the biological and chemical activity levels in a soil at a given time point is then possible, and any changes in this activity can be easily observed.
Furthering our understanding of soil gas dynamics is vital for not only human health but also for informing the protection of ecosystems in a world increasingly reliant on what's under our feet.

Key words: soil gas, computer model, greenhouse gas, tracer

Exploring how nitrogen cycling from urine patches vary on different soil types between agricultural grazing systems
Danielle Hunt

Urine patches in grassland ecosystems present unique environments where extreme (N) loading occurs. This results in harmful environmental N losses into the atmosphere or leaching from soil. N losses vary due to climate conditions, soil conditions, and management practices. Much of the current literature has focused on typical lowland agricultural systems, and it is unclear how upland grazing systems differ to our current understanding. We have investigated this by using a catena sequence across upland and lowland agricultural grazing systems. By using the different soil types along the gradient, we can explore how nitrous oxide emissions vary across the sequence, and explore how other losses of N change in response to soil type between the uplands and lowlands. This has been studied by conducting a laboratory incubation and a mesocosm experiment. These experiments should help to improve our understanding of N losses and provide more realistic, regional, and accurate emission factors for upland farming systems.

Key words: Nitrous Oxide, Urine, N cycling, Greenhouse gas, Grassland, Upland, Nitrogen

Effects of crop residue on carbon dioxide, methane and nitrous oxide emissions on cultivated peat soils

Sam Musarika

Peatlands cover three percent of the global land surface. However, they store significant amounts of carbon (C), approximately 30%. Peatlands are drained to support agricultural production. It's estimated that agriculture exploits approximately 20% of peatlands worldwide. The exploited peatlands are significant emitters of carbon dioxide (CO2) and nitrous oxide (N2O). In Europe, agriculture is the second largest contributor of greenhouse gas (GHG) emissions. In addition to GHG emissions, we are fast losing productive peatlands; it's estimated by 2050, a third of productive peatlands will be lost. Loss of productive peatlands will affect productivity and food security.

To prolong use of peatlands, ploughing in of crop residue, either from the previous season or specially grown crop, is often considered a mitigation option. Nevertheless, there is concern that fresh organic matter (FOM) might accelerate decomposition of existing organic. This study assesses effects of FOM on the emissions of CO2, methane (CH4) and N2O in a cultivated peatland. A mesocosm experiment was carried out using intact cores with added FOM and manipulated water table (WT), -20 and -50 cm.

The results show there is an effect of both WT and FOM on emissions. CO2, CH4, and N2O emissions differ in the different WT treatments. The -20 cm cores produced more methane than the -50 cm. It is evident that leaving crop residue and then ploughing it in does not have the desired effect as it led to increased emissions.

Key words: Peatlands, FOM, Green House Gas, Agriculture

Grass efficacy in preventing concentrated flow erosion at an early establishment stage.

Corina Lees

Grassed waterways are often implemented to prevent the loss of fertile soil from erosion prone agricultural fields. They slow down the runoff, prevent scouring and encourage sediment deposition. The aim of this study is to assess efficacy of conventional and novel grass species to control soil erosion at an early establishment stage (6 weeks). The experimental treatments used in this study were: bare soil (B), a conventional mixture of Lolium perenne and Festuca rubra (C), Festulolium cv prior (F1), Festulolium cv prior and Festulolium bx511 (F1+F2), and all grass species combined (F1+F2+C). The grasses were grown in a sandy clay loam soil for 6 weeks in summer conditions. There was no significant difference in % germination. After 6 weeks, the treatments were subjected to concentrated flow erosion, using a hydraulic flume with increasing flow rates. The effects of roots and shoots, and of roots only on soil detachment were tested. Preliminary results show that detachment rates were reduced for all grass treatments when compared to the bare soil control across all flow rates ($p<0.05$). All C treatments yielded significantly less soil than the F1 (roots only), the F1+F2+C (root and shoots) and the F1+2 (roots only). Therefore, planting grassed waterways with the C treatment is recommended due to low soil loss. These grasses provide good soil protection in terms of reducing runoff velocities and prevention of soil detachment at an early growth stage.

Key words: Grassed Waterway, Soil Erosion, Soil Erosion Control, concentrated flow, Festulolium, Lolium perenne, Festuca rubra.

Determining change in phosphorus solubility with organic carbon type and amount: a replicated soil pot experiment

Andy Tweedie

Understanding how the solubility of phosphorus (P) in agricultural soil is affected by inputs of organic matter (OM) could inform decisions on future farming practices, to make better use of existing soil P reserves and improve the efficiency of usage of inorganic P fertiliser. Phosphorus is in its most mobile state in the soil as soluble orthophosphate ($H_2PO_4^-$ and HPO_4^{2-}). In this form it is highly available to the crop, but simultaneously it is also most at risk of loss from the agricultural system by leaching and run-off, with negative environmental impacts. Different forms of OM provide carbon (C) and nutrients to the system at different rates, depending upon how they are decomposed by the soil microbial community.

This poster will describe an experiment that is currently ongoing and testing the hypothesis that additions of organic matter will affect the solubility of P in soil. Mesocosms of 2 agricultural top soils of moderate and low P availability are amended with a commercial humic soil amendment (lignite) or a common crop residue (barley straw) at 2 levels of addition. A further level of treatment of with/without P fertiliser is included. The system is planted with *Lolium perenne* at a standard rate and run outdoors for a full growing season. Leachate from these mesocosms is collected and analysed for soluble P, nitrogen and C at approximately 6 weekly intervals.

Initial results from autumn sampling indicate an increase in P concentration in leachate over time both with and without P fertiliser treatment, increases in dissolved organic carbon relating to OM treatment and a positive effect of P fertilizer on plant growth in the low P soil. Interpretation of the final results will consider how the release of carbon (C) and nutrients from OM and their subsequent impact on the system, are controlled by microbial activity according to ecological stoichiometric theory, the resistance of the OM to microbial decomposition and the chemical nature of the soil. These results should help to inform future research into improving P utilisation in agriculture.

Key words: Soil, Phosphorus, Organic Matter, Mesocosm, Humic

Characterisation of the Microbial Community Structure and Resistome of Soil Receiving Cattle Slurry Amendment

Alex Williams

International and UK government reports have cited antibiotic use in agriculture as a significant driver of antibiotic resistance (AR) in the environment. In particular, application of animal slurry as a soil-fertiliser may contribute to the spread of AR, since it can contain un-metabolised antibiotics and antibiotic-resistant bacteria derived from livestock. However, assessing the flow of antibiotic resistance within farm environments is challenging due to their complex, multi-compartmental nature. As a result, the response of soil microbial communities and their associated resistome to repeated animal slurry exposure remains poorly understood.

Key aims of this investigation were to quantify AR within cattle slurry-amended soils and to

characterise factors which govern AR. Samples from fields at the University of Nottingham (UoN) Dairy Farm were sampled and assayed over two seasons (2017/18) using a combination of culture and molecular techniques. Specific objectives were to determine how antibiotic resistance profiles and the community structure of soil bacteria respond to successive slurry applications and to establish a baseline for unamended soils in the same geographical area. In total, 300 isolates were recovered from soils and tested for phenotypic resistance to a range antibiotics over the study period. Approximately 11% of these isolates were multi-drug resistant. Metagenomic analysis detected over 400 putative antibiotic resistance genes (ARGs), with 149 detected ARGs explaining much of the variation between slurry, slurry-amended and un-amended soils. Relatively few ARGs associated with slurry were detected in slurry-amended soil, although many were shared between the slurry-amended and un-amended soil.

Key words: Field Study; Antibiotic Resistance; Antibiotic susceptibility testing; Metagenomics; Animal husbandry waste

List of attendees

Roger	Appleton	Speaker
Harry	Barrat	STARS student
John	Beale	STARS student
Jessica	Bellarby	Speaker
Martin	Blackwell	STARS Supervisor
Tom	Bott	STARS student
Rosanne	Broyd	STARS student
Emma	Burak	Former STARS student
Laura	Cardenas	STARS Supervisor
Marta	Cattin	STARS student
Dave	Chadwick	Management Board
Mihai	Cimpoiasu	STARS student
Paul	Cross	STARS Supervisor
Emily	Dowdeswell-Downey	STARS student
Beckie	Draper	Conf Organising committee
Rose	Durcan	STARS student
Rebecca	Ellis	Workshop leader
Dan	Evans	STARS student
Kerry	Firth	BBSRC
Benjamin	Freeman	STARS student
Paul	George	STARS student
Caz	Graham	Speaker/workshop leader
Lucy	Greenfield	STARS student
Simon	Gregory	STARS Supervisor
Harry	Harvey	Conf Organising committee
Phil	Haygarth	Management Board
Luke	Hillary	Conf Organising committee
Danielle	Hunt	STARS student
Davey	Jones	Management Board
Anchen	Kehler	STARS student
Leigh-Anne	Kemp	Conf Organising committee
Guy	Kirk	Management Board
Olivia	Lawrenson	STARS administrator
Corina	Lees	Conf Organising committee
Malcolm	Love	Workshop leader
Chris	McCloskey	STARS student
James	McDonald	STARS Supervisor
Steve	McGrath	Management Board
Will	Medd	Speaker/workshop leader
Sacha	Mooney	Management Board
Samuel	Musarika	STARS student
Erinma	Ochu	Workshop leader
Nicholas	Ostle	STARS Supervisor, Other
Eric	Paterson	Management Board
Jessica	Potts	Conf Organising committee

John	Quinton	STARS supervisor
Vicky	Robinson	Speaker
Lewis	Rose	STARS student
Heather	Ruscoe	Former STARS student
Emma	Sayer	Management Board
Fiona	Seaton	STARS student
Rob	Simmons	STARS supervisor
Marc	Stutter	STARS Supervisor
Andrew	Tweedie	STARS student
Andrew	Tye	Management Board
Toby	Waine	STARS Supervisor
Helen	West	STARS Supervisor
Alex	Williams	STARS student
Katy	Wiltshire	STARS student