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Tir Cynaliadwy  
Sir William Roberts  
Centre for  
Sustainable Land Use

# CYNNAL - SUSTAIN

Sir William Roberts Centre  
for Sustainable Land Use  
Newsletter  
Spring 2022







# WELCOME

Canolfan Defnydd  
Tir Cynaliadwy  
Sir William Roberts  
Centre for  
Sustainable Land Use

From Seumas Bates, Research Officer,  
Sir William Roberts Centre

SPRING 2022  
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“Welcome to the spring 2022 edition of *Cynnal-Sustain!* The Sir William Roberts Centre continues to critically engage with themes of land use and conservation in a global context, where sustainable agriculture and forestry have never been more crucial. We hope you enjoy exploring some of the exciting work being done in these areas by scholars across our university.

The growing threat presented by disturbed and disrupted natures is a key feature of the current global context. Human interactions with hazardous and precarious landscapes are becoming increasingly common, and the impact of climate change magnifies existing threats while creating new ones. However, there has emerged a strong trend towards resilience building, as communities and individuals develop new, and innovative ways of mitigating the risks inherent to the rapidly changing Anthropocene.

I've been part of the SWRC since October 2020 working as a Research Officer with the Future Oak project in one such disturbed landscape: woodlands threatened from pests and diseases. Acute Oak Decline (AOD) is a rapid decline condition that presents a significant threat to oaks, especially across southern England, but is increasingly found further north. Private woodland owners are responsible for a very significant proportion of Britain's oaks, and thus understanding them – their perceptions and knowledge of AOD – is critical if potential interventions to halt the spread of the disease are to be successful. By conducting survey and interview research with these owners, our work within Future Oak is opening a window on to their woodland management, and with this insight we can create better policy, treatments, and theoretical models to improve management of the UK's forests.

In this issue we bring you news of research at Bangor into digital humanities, crop breeding, grazing and soil quality, climate change adaptation, and natural colonisation of woodland, along with reports on how our students are getting back in to the field after covid.”



**Seumas Bates,**  
Research Officer,  
Sir William  
Roberts Centre



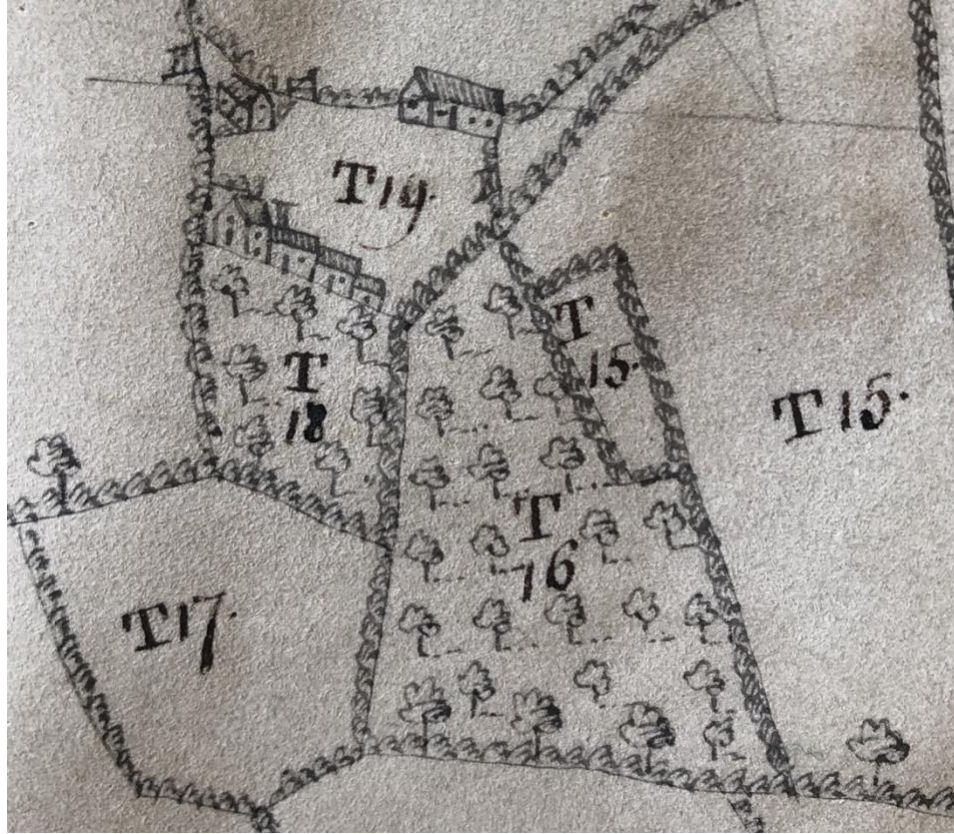


# DIGITAL HUMANITIES: 'DEEP MAPPING' WELSH LANDSCAPES

Bangor University's [Institute for the Study of Welsh Estates](#) is leading a collaborative project to 'deep map' historic estate landscapes in north east Wales. [The project](#), which is funded by the Arts and Humanities Research Council, has been established to assess continuities and changes in landownership, landscape and land use between c.1500-1920. It focuses on a case study area around Mold in Flintshire and Llanarmon-yn-Iâl in Denbighshire.

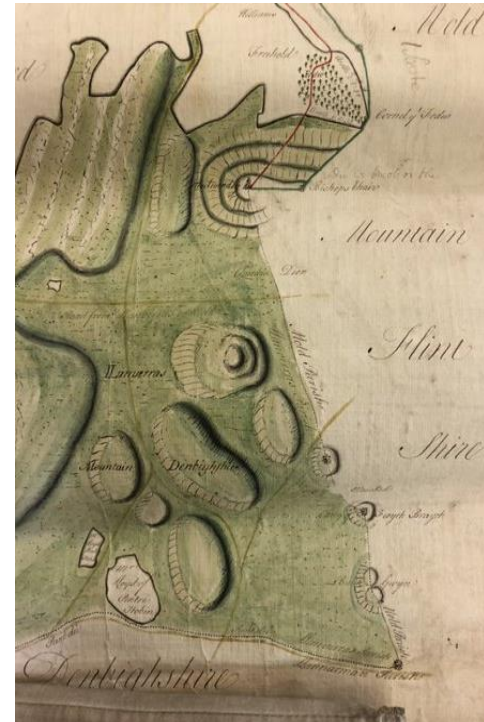
The 'deep map' is being constructed through identifying, georeferencing and layering the vast diversity of historical records connected to specific places within the project area. Historical maps (OS, tithe, enclosure, estate) have been digitised, georeferenced and polygonised to provide the critical base layers of the GIS. This builds up a 'quarry' of place-specific information (principally place names and boundaries) which allows for a host of non-cartographic records (e.g. surveys, leases, rentals, title deeds) and the information they contain to be incorporated into the system.

As was usually the case with other parts of Wales and the British Isles, before the early-twentieth century, the project area was subject to the influence of multiple landed estates and their owners. The project will help us to understand how these estates operated 'on the ground'. In particular it will help us understand how they developed (or disappeared) over time, the forms of land use they encouraged (from farming and mining to forestry and hunting), the dynamics of landowner-tenant relations, the influence they exerted on the character of 'designed' and 'vernacular' landscapes within their bounds, and the lived experience of lands over time. The end-goal is to create a publicly accessible interactive map which 1) allows users to visualise changes in landownership and landscape over time; and 2) allows users to click on an individual landscape feature within the system (e.g., field, woodland, farmhouse) to access all historical references to that feature, as built up through a chronological layering of the records relating to that place.



The project provides a methodology which could potentially expand to allow archives to facilitate map-based searching of their historical records. This would have significant benefits for multiple lines of historical enquiry. But just as importantly, an understanding of historical contexts and perspectives has an essential part to play in our collective efforts to consider future land use and management decisions, in line with environmental, sustainability and biodiversity goals.

*Dr. Shaun Evans, leader of the 'Deep mapping' project, is a Lecturer in Welsh and Early Modern History and Director of the Institute for the Study of Welsh Estates*







# HERB AND LEGUME RICH MULTISPECIES LEYS RESEARCH AT HENFAES

Soil degradation driven by agricultural intensification is a major economic and sustainability concern, estimated to cost around £0.9–1.2 billion in England and Wales annually. Loss of soil structure and soil organic matter through practices such as frequent ploughing, repeated short crop rotations with few fallow or break years, and intensive livestock grazing can threaten the crucial ecosystem services soils can provide.

This decline of soil quality, particularly in arable soils, has returned attention to the use of leys (temporary grasslands lasting 1-4 years within a rotation) to ameliorate soil degradation. In the UK, herb- and legume-rich multispecies leys are rapidly gaining in popularity, due to their promotion in agri-environment schemes and capacity to deliver significant ecosystem services. Multispecies leys, also known as herbal leys or diverse swards, often contain a mixture of deep-rooting grasses (e.g., *Dactylis glomerata*), legumes (e.g., *Medicago sativa*) and herbs (e.g., *Cichorium intybus*) which can improve the soil structure and access subsoil water and nutrients unavailable to a conventional grass or grass-clover ley. Plants selected for the multispecies ley mixture often contain high levels of plant secondary metabolites, offering a potential greenhouse gas mitigation strategy through reducing excreta nitrogen losses and improving livestock productivity.











A multidisciplinary project has been using farms across the UK to assess how these multispecies leys compare against a conventional grass-clover ley for soil quality, crop productivity, greenhouse gas emissions, and animal health. The research project funded by the Sustainable Agriculture Research and Innovation Club ([SARIC](#)) and BBSRC draws together expertise from the University of Sheffield (Prof Jonathan Leake), NIAB (Dr Lydia Smith & Dr Patrick McKenna), Bangor University (Prof Davey Jones & Ms Emily Cooledge), University of Birmingham (Prof Sami Ullah), UK-CEH (Dr Lisa Norton), Rothamsted Research (Prof Adrian Collins), and Heriot-Watt University (Dr Ian Pattison) to examine how soil quality can be restored through the [re-integration of leys and sheep into arable rotations](#). The project established split-field experimental trials in 2019, but due to travel restrictions arising from the COVID-19 pandemic, a new field site was created at Bangor University's Henfaes Research Centre for [Emily Cooledge's](#) doctoral research in summer 2020.

The new [field trial](#) at Henfaes is comprised of a 2-ha 2-year experiment, with a multispecies ley and a grass-clover ley rotationally grazed by Welsh mountain lambs each season. The aim of Emily's research is to understand how we can use multispecies leys to maximise production efficiency and reduce nutrient losses from Welsh lamb production. Having completed a year of the trial, Emily has found lambs grazing the multispecies ley had greater daily liveweight gain and improved animal health, with blood biochemistry results showing higher plasma selenium and cobalt than lambs grazing the grass-clover control. Despite finding no difference in excreta nitrous oxide (N<sub>2</sub>O) emissions in both experimental seasons, ammonia (NH<sub>3</sub>) emissions were reduced by 58% for urine collected from lambs grazing the multispecies ley compared the grass-clover control. Further research in the next few months aims to explore the driving factors behind the lower NH<sub>3</sub> emissions from urine applied to the multispecies ley.

While the main SARIC project is winding down, over the next few months an exciting new collaboration is being established between Bangor University and the University of Nottingham's [Hounsfield Facility](#). The project supports Emily's research using X-ray CT scanning to image intact soil cores and 4 mm soil aggregates to assess how ley composition affects physical soil properties, e.g., porosity, pore structure and pore distribution. The project is funded following a successful entry to the University of Nottingham's X-ray CT access competition and will be the first of its kind to use this non-invasive technology to better understand the effect of multispecies leys on soil structure. Key project updates and publications will be shared [here](#).



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# POTATO ENTERPRISE AT HENFAES

*In our autumn edition, Hollie Riddell reflected on the development of her career following work at Henfaes for her PhD at Bangor. In this issue, we highlight the work David Shaw at Henfaes focused on potato breeding. ...*

If you see an old bloke with a cloth cap wandering around Henfaes then that must be David/Dave Shaw! Retired from lecturing on genetics and plant pathology, he now runs [Sarvari Research Trust](#) and Sarpo Potatoes Ltd. Collaborating with [Katherine Steele](#), a Senior Lecturer in Sustainable Crop Production at Bangor, David breeds new potato varieties. These are resistant to late blight (remember the Irish famine) and virus diseases. These Sarpo varieties are now grown throughout UK, Europe and increasingly in West and South Africa.

To breed a new variety, you have to choose two potato varieties with useful traits and cross them. That's when you see David sitting out in the potato field on a calm, sunny day with a paintbrush, transferring pollen from the male parent to the stigma of the flower of the female parent. With luck, the flower will form a berry like a small green tomato. When ripe the berry has a hundred or so seeds. These can germinate and each seedling is a potential new variety. The challenge is to find the best seedling to save and name if it is good enough. The rest make compost or a healthy dinner. The thought that you might hit the jackpot with a blight resistant Maris Piper keeps you going.

To shorten the odds, a merry band of potato nuts (The Sarpo Breeders Club) generate their own seedlings and send them to Henfaes for assessment. Some of these are very promising. David also works with Burpee Europe, with Katherine and with research students to breed Early and Late Blight resistant varieties These are also widely grown. Ever heard of Crimson Crush?

Did you know that potato growers that don't grow Sarpos sometimes spray their fields with fungicides more than 15 times in a season? This is expensive and unsustainable. David works with the chemists in the [BioComposites Centre](#) to develop sprays to control blight and to stimulate growth based on extracts from plants, animals and seaweeds. Extracts are screened on potted plants in the greenhouse and promising ones are tested in a trial in the potato field. Fingers crossed! It all keeps you fit and young - in heart.




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## WHO PUT THAT THERE AND WHAT'S IT FOR?

The potential for natural colonisation to play a part in woodland expansion has not been explored in detail. The [Treescaples 2021 conference](#) was the perfect stage for [Theresa Bodner](#), doctoral researcher in the Sir William Roberts Centre to convene a workshop researchers and practitioners to discuss the complexity of natural colonisation, concentrating on three aspects: (1) challenges around establishment, (2) end purpose of the new woodlands, and (3) clarity in communication around natural colonisation.

Many participants discussed how natural colonisation is not a fixed state but a process, and colonising trees may be challenged at various points in time. There seemed to be consensus that if natural colonisation was brought into management approaches, or was used as a tool in an existing management plan, different sites will have different limiting factors. Active intervention to support tree establishment would have to be flexible, be it fencing, cutting bracken, changing the type of herbivores (and stock density), deer or squirrel control, or taking a hands-off approach altogether. Participants also noted that the suitability of natural colonisation depends on the end purpose of the new woodlands. Natural colonisation may take too long to turn into a woodland that provides specific benefits for us. On the other hand, some pointed out that natural colonisation may produce higher structural diversity and hybrid/transitioning habitats that offer high biodiversity value. Thought was also given to the difficulty of measuring the large-scale progress of natural colonisation to keep track of the potential new woodlands; continuous technological innovation may offer opportunities, from LiDAR to drones, high resolution satellite imagery or citizen scientists equipped with high-tech gadgets in their pockets.

Finally, various participants highlighted the differentiation between natural *regeneration* (as part of restoring established woodlands) and natural colonisation (on previously non-wooded land). This should be done both to differentiate the two different types of processes and help establish natural colonisation further as an emerging topic in the discourse around woodland expansion.





# WHAT CAN FLAGS TELL US ABOUT THE EFFECTS OF CLIMATE CHANGE?

The National Trust have recognised that climate change will likely be their biggest threat in the 21<sup>st</sup> century, but what does this mean and what can we do about it? Doctoral research by Lucia Watts, funded by KESS2, is investigating the site level impacts of climate change on National Trust sites in Wales to provide knowledge to inform the Trust's planning. One of the sites is Chirk Castle near Wrexham where high wind speeds cause closures and damage broadleaf trees in the historic parkland. These trees are important for ecology (recognised internationally as an important site for invertebrates and fungi), heritage, and recreation. The research is exploring if and when incidences of dangerous high winds may occur in the future and if any areas of the site is likely to become more exposed.

A year-long field study between November 2019 and 2020 (with the now familiar covid interruptions) investigated wind exposure across the site. Lucia installed tatter flags at 21 trees in the parkland, across five data collection periods. Tatter flags have been used extensively in the past in commercial forestry, and measure exposure through calculating weight loss for each flag. Lucia is testing the method to see if it can be used for individual parkland trees, with four flags placed at each heritage tree at two-month intervals. Despite data loss due to some very curious cattle, she has been able to estimate exposure on site currently and, using UKCP18 climate change predictions of maximum gust speeds from the Met Office, project this into the future.

Her results show that certain areas of the site are currently more exposed to high wind speeds than others, and in the future, maximum gust speeds are likely to have a large impact on site exposure. Looking forward, during future spring months, most of the site is likely to be more exposed than average to high wind gusts, potentially closing the site more often and damaging trees as they put on new spring growth. The largest impacts to trees are predicted to occur in a longer-term - between 2060 and 2080. Lucia's fieldwork shows how exposed the site currently is at different times of year, with intra-site and intra-annual variability. The results could inform management and safety checks to certain areas of the site, especially at times when exposure is likely to be greater than the average. This has been an exciting project developing new outputs using long-established methods, in an attempt to help us adapt current and future management to mitigate the impacts of climate change.







# OUT IN THE FIELD AGAIN!

Practical field-based learning has long been a critical component of education within the land-based sciences taught at Bangor. During the last couple of years, field courses have been severely constrained by the desire to keep everyone safe from covid. However, this year has thankfully seen a return to something approaching normality (albeit with continuing precautions) with a return to residential field trips.

During early March, second-year students from our environmental sciences and conservation degrees took part in residential field trips with the theme of "environmental conflicts" - of which there are many to discuss! At the beginning of the trip, students collected water samples from three rivers in Gwynedd – the Cegin, Aber and Ogwen - draining from areas of different land uses (from very rural to overwhelmingly urban). The samples were then analysed back in the lab for indicators of water quality (such as nutrient levels and bacterial counts). This generated discussions about the potential impacts of land use and management on water quality. Thereafter, environmental science students travelled towards Shropshire and Herefordshire, with stops focusing on different environmental conflicts - including flooding, the management of nature reserves for wading birds, sustainable intensification of agricultural systems, anaerobic digestion for waste management and renewable energy generation, and soil erosion from horticultural systems. It was great to return on this trip this year, giving students the opportunity to see first-hand how conflicts can or cannot be dealt with, and to meet several land management practitioners.



Around fifty postgraduate forestry students headed to southern Scotland for their field course, re-invigorating the long-held tradition of residential study tours which had been lost during the pandemic. There were many highlights of the week-long trip, including student-led debates on re-wilding, as well as visits to the Carrifran Wildwood, afforestation projects, community woodland projects, tree nurseries, small-scale private woodland estates, ancient woodlands, natural flood management projects, and a sawmill. Old friendships were rekindled and new friendships made, whilst learning a huge amount. More recently, the undergraduate foresters have been out in Wales visiting agroforestry sites in the Elwy Valley along with conservation woods in Eryri-Snowdonia and the Stump up for Trees project in the Brecon Beacons.

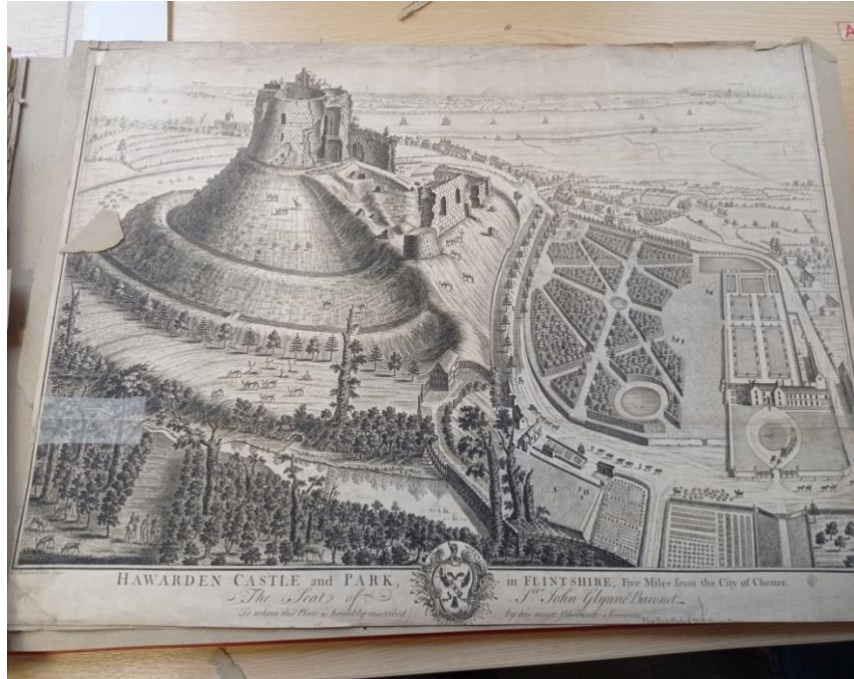
Geography and oceanography students visited the south west of England for their second-year field course, basing themselves in St Austell and Cheddar for the week. The trip covered a range of human and physical geography themes and focused on developing field and research skills. Visit locations included, the Eden Project, Charlestown, the Bissoe valley, Boscastle, Tintagel, Totnes and Cheddar Gorge.





# NEWS IN BRIEF

The Natural Environment Research Council (NERC) recently awarded Bangor University a grant to support a range of small projects across the university enabling researchers to build expertise and agility across disciplinary boundaries. A number of these related to land use and sustainability. The *Migrating knowledges: Science subjectivity and landscape* project explored the ways in which science and art present different kinds of knowledge by investigating the nature diaries of Dr Paul Whalley. The project asked what scientific and creative observations involve, where the human and subjective traces in scientific data are, and why might they be important? *History for the future: Unlocking archives to solve environmental challenges* also used historical sources such as letters, estate management records, and art – held within Bangor University's extensive archive – to explore possible new ways to address environmental challenges. Bringing together perspectives from fisheries, law, and forestry with archival research specialists the project team sought to deepen knowledge of environmental change and its driving forces. The *Farming, Fisheries and Mental Health and Wellbeing* project is an ongoing collaboration bringing together agroforestry researchers, fisheries scientists, psychologists and behavioural economists. This is exploring how the mental health experiences of farmers and fishers might impact their strategic land use and fishing decision making in response to policy change.



Archived landscape art such as this can help us understand the priorities and approaches of former land managers



A new collaboration between researchers at the Sir William Roberts Centre and the University of Limerick has begun, focusing on developing interdisciplinary sustainability assessment tools and applying these to large-scale land use issues, such as net-zero farming landscapes. This co-working has recently been cemented with the submission of an article to the *Journal of Cleaner Production* proposing a methodological framework for integrating ecosystem service impacts as indicators in life cycle assessment.

Dr Lynda Yorke is the PI of CULTIVATE, a NERC-funded research project exploring how we can grow a more inclusive teaching environment. The project is focused on the use of [digital technologies in teaching](#) to address equality, diversity and inclusion in undergraduate fieldwork across environmental sciences. In May the project team will hold a workshop to collaboratively develop the project's outputs and explore how to build new communities of practice in this arena.





# @HENFAES

Moving into spring we are right in the thick of lambing, a busy but joyful time on farm as new life enters the world. Once lambing is out of the way the Henfaes flock will be sheared and put back onto the mountain where we have grazing rights on the Aber & Llanfairfechan Common. Later in the year we will select the ewe lambs from this year's lambing to be retained as replacements for the flock.

This spring will see the retirement of **Llinos Hughes**, Senior Technician at Henfaes, who has supported countless staff and students throughout her many years' service to Bangor University. Llinos graduated from the then University College of North Wales with a BSc (Hons) in Agricultural Botany. Remaining within the University, between 1977-1979 she worked with Prof Gareth Wyn Jones in the Department Biochemistry & Soil Science. Then, following a period teaching Biology at Ysgol Tryfan in Bangor, she worked at College Farm, Aber in December 1980 as an Agronomy Technician, alongside Drs Mike Alcock and David Wright. Subsequently, there was a shift in her duties towards analytical laboratory work and working with farm animals. In 1996 Llinos moved to Henfaes and a series of research projects followed: Hemp & Flax; Menterra; Centre for Alternative Land Use; Naked Barley; Cefn Conwy; Climate Centre Wales. The roles that Llinos fulfilled continued to change over time but focused on running the commercial farm based at Henfaes, where she undertook farm secretarial duties such as business and animal movement record keeping, purchase and sales, forward budgets, completion of SPS / BPS applications and Glastir returns. Llinos also found time to Chair the Aber & Llanfairfechan Graziers Association, of which the University is a member. Her welcoming and respected presence at Henfaes will be greatly missed and we wish all the very best for her upcoming retirement.

A four-year Biotechnology and Biological Sciences Research Council (BBSRC) funded [Biochar Greenhouse Gas Demonstrator](#) has begun at Bangor University. The project is a collaboration led by the University of Nottingham aiming to address key deployment barriers to biochar for carbon sequestration. The Bangor team (Prof. Davey Jones, Prof. Dave Chadwick, Dr Rob Brown and Maria Majka) will be responsible for the deployment and monitoring of several tonnes of biochar in grassland at Henfaes, assessing its effect on plant and soil health, carbon sequestration, and ecosystem service provision. They will also compare biochar to other proposed carbon sequestration technologies (e.g., enhanced rock weathering and iron mediated soil carbon storage). Field deployment will begin in the spring with corresponding mesocosm and laboratory experiments following soon after.



© Partneriaeth Tirwedd y Carneddau

As part of a five-year scheme led by Snowdonia National Park Authority, with the support of the National Lottery Heritage Fund, a Partnership of organisations is helping people discover, record, celebrate and care for the Carneddau. We, as Bangor University, are proud to be one of the partners, and the [Carneddau Landscape Partnership](#) scheme has a conspicuous presence at Henfaes Research Centre. Most recently at Henfaes, the Partnership has:

- completed work on a growing tunnel at the new micro nursery for trees and employed the first conservation apprentice,
- built raised planting beds and planted trees in the wild,
- gathered seeds with volunteers at Abergwyngregyn to plant in the nursery,
- participated in the S4C *Heno* magazine programme to discuss COP26 and planted trees in the Carneddau with Gerallt Pennant.

This is part of a wider project to plant dispersed trees in specific areas with volunteers to improve habitat connectivity and biodiversity and record ancient trees, establish micro nurseries to plant indigenous trees, and cull invasive Rhododendron in the Carneddau. In addition, some of our students have been able to take advantage of volunteering opportunities with the Partnership and have learnt about the wider activities of the Scheme in discussions on past, present, and future land management.