

ANNUAL REVIEW 2022



UK Centre for
Ecology & Hydrology

2022

THE YEAR IN PICTURES



UK Environment Minister Rebecca Pow visited UKCEH and engaged with our researchers on subjects including sustainable land use, water quality, flood forecasting, and biodiversity targets.



Professor Alan Jenkins of UKCEH met the Hon. Francis Asenso-Boakyie MP, Ghana's Minister for Works and Housing, to discuss the creation of an early warning system for floods and water shortages, as part of the WMO's HydroSOS initiative.



Our hydrologists reported on the evolving drought situation around the UK, informing water resources planning.



Scottish Environment Minister Màiri McAllan visited our Auchencorth Moss field site and unveiled a plaque recognising the site's ICOS accreditation as a Class 1 Ecosystem Station. The site supports air quality, climate and ecosystem research.



Dr Semeena Shamsudheen, a land-atmosphere scientist at UKCEH, presented work on wildfires at a side event of COP27 in Sharm El Sheikh, Egypt.



We launched our E-Surveyor app, which uses artificial intelligence to allow farmers to identify plants and assess the quality of the habitats they manage.



Dr Doug Wilson joined UKCEH as our new Science Director from the Environment Agency, where he was Chief Scientist.



Dr David Odee, visiting scientist at UKCEH, was presented with the Marsh Award for Ecologists in Africa at the British Ecological Society annual meeting in Edinburgh.



Annette Burden, wetland scientist at UKCEH, featured in an HM Treasury and London Stock Exchange green finance film, talking about the development of a Saltmarsh Carbon Code.



Dr Claire Carvell spoke at an event to mark the conclusion of the ASSIST programme, which has provided scientific evidence to inform the transition to sustainable agriculture in the UK.



A new study led by UKCEH warned the red-billed leiothrix is emerging as a new invasive species in Britain, threatening to dominate the dawn chorus of native robins, blackbirds and warblers.



Dr Tom August and Dr Michael Pocock collaborated with artist Bryony Bengel and poet Thomas Sharp on an installation exploring what is gained and lost when an observation of wildlife becomes a digitised record.

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INTRODUCTION FROM THE EXECUTIVE DIRECTOR



PROFESSOR MARK J BAILEY

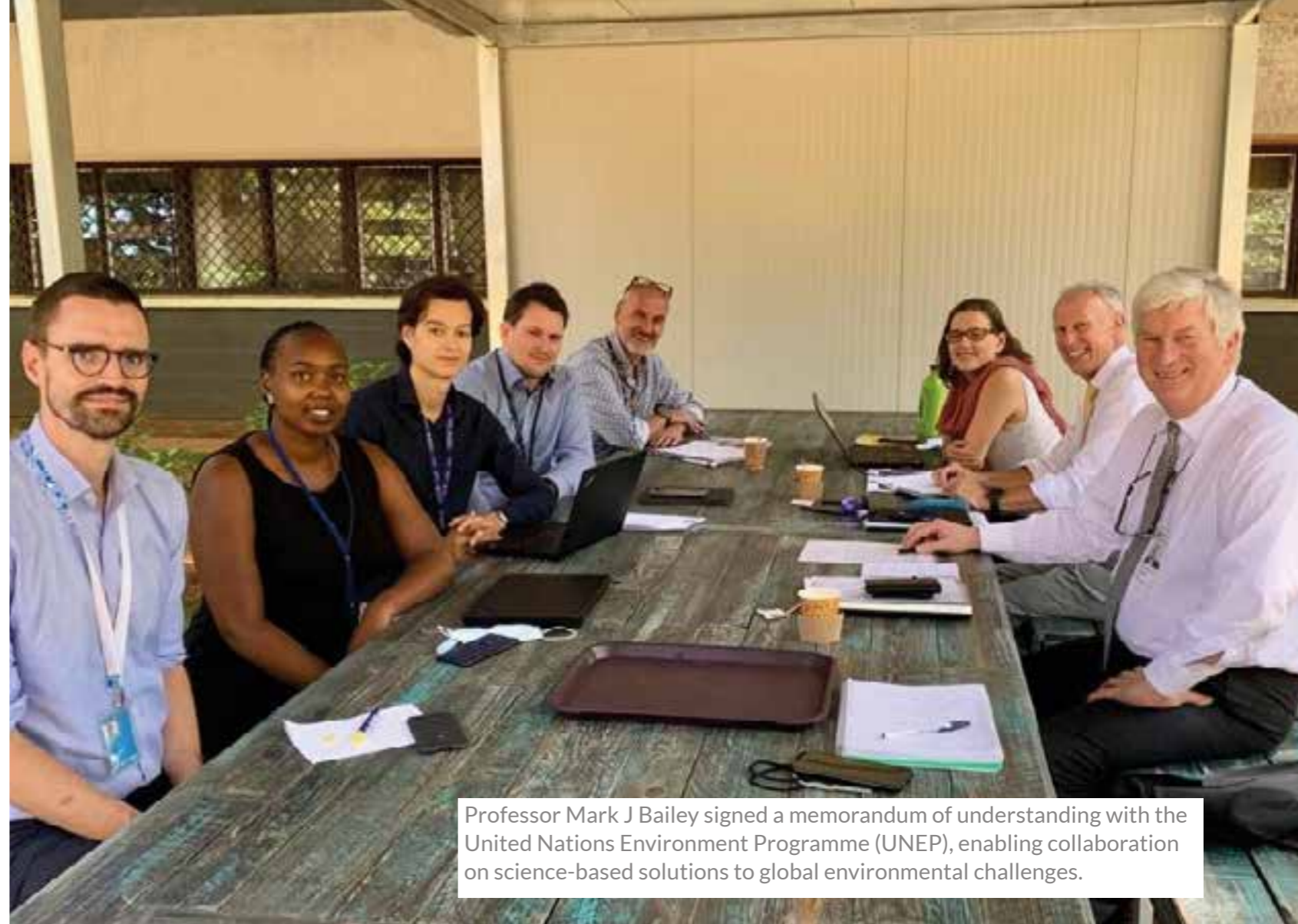
Welcome to our annual review for 2022. I am delighted to share with you a cross-section of the extraordinary work of our community over the past year, which I hope you will find as inspiring as I do.

The past year has been one of change and growth. As Covid restrictions lifted, we were delighted to welcome more of our people back to our four sites, allowing us to rebuild our community and enabling many staff to meet face-to-face for the first time.

You will read in this year's review examples of new ways in which we have collaborated to increase the reach and impact of our science – leading, for example, the development of the Saltmarsh Carbon Code, a voluntary certification standard, enabling

private investment in saltmarsh restoration, supporting the achievement of national net zero goals.

The demand for our science has continued to grow, enabling us to invest in our people and in the research infrastructures and monitoring we provide to the broader research community. With investment from the Natural Environment Research Council, we established a new centre for micro-spectroscopic analysis of environmental samples – the first of its kind in the UK.



Professor Mark J Bailey signed a memorandum of understanding with the United Nations Environment Programme (UNEP), enabling collaboration on science-based solutions to global environmental challenges.

We have continued to expand our international reach through new collaborative partnerships, supporting sustainable development around the world. We are excited to be leading a new £12.6m NERC-funded National Capability programme to support countries, organisations and companies to develop and deliver plans to reduce emissions, and to underpin high-impact investment in climate change mitigation and adaptation worldwide.

Meanwhile, in Ukraine and Russia, our scientific partnerships were disrupted by war. We have a long history of monitoring in the Chernobyl Exclusion Zone in Ukraine.

The Russian invasion has had a direct impact on our colleagues, their families and friends, and our thoughts are with everyone affected.

Sadly, this will be the last time I introduce this review, as I will be retiring in June 2023. I have been privileged to serve this organisation for the majority of my scientific career, and am proud to hand it over in such a strong position to my successor Dr Stuart Wainwright, currently Director of the Government Office for Science.

I hope you will enjoy finding out more about our work in this review, and look forward to engaging with you in 2023.



Shankari Anna Balan, Molecular
Biology Laboratories, Wallingford

WHO WE ARE

The UK Centre for Ecology & Hydrology is an independent, not-for-profit research institute, carrying out excellent environmental science with impact. We seek to understand the environment, how it sustains life, and the human impact on it – so that, together, people and nature can prosper.

We have a long history of investigating, monitoring and modelling environmental change. Our 600+ staff provide the data and insights that governments, businesses and researchers need to create a productive, resilient and healthy environment.

HOW WE WORK

Underpinning UKCEH's research and innovation are large research infrastructures and our capabilities in monitoring, measuring and observation, experimentation, data science and modelling.

Monitoring, measuring and observation

We provide flexible, long-term, large-scale monitoring and surveillance networks essential to identify and measure environmental change, and determine the factors that drive that change.

Experimental platforms and research facilities

Our experimental platforms and research facilities enable us to test the role of different drivers of environmental change and the outcomes of novel interventions to manage the environment.

Data science and modelling

We develop models to forecast and predict aspects of the environment at different spatial and temporal scales.

OUR STRATEGY

In April 2020, we published our *Strategy 2025: Research and Innovation*. The strategy sets out our role in addressing three major challenges:

- Creating and enhancing sustainable ecosystems
- Reducing and preventing pollution
- Mitigating and building resilience to climate and environmental change

Our specific contribution to these challenges focuses on ten integrated issues:



Joanna Savage, Honey Sample Archive

- Biodiversity
- Chemical risks
- Clean air
- Climate and land
- Ecosystem restoration and resilience
- Flood and drought impacts
- Net-zero greenhouse gas emissions
- Soil health
- Sustainable agriculture
- Water quality and resources



Galina Toteva, Glencorse Woodland Experiment Platform, Edinburgh

OUR NATIONAL ROLE

As a strategic delivery partner for the Natural Environment Research Council, part of UK Research and Innovation, UKCEH delivers impartial environmental science to benefit the UK research community, governments, businesses, and wider society. Our science infrastructures and national capability programmes enable researchers to observe, experiment, measure, understand and predict environmental processes, inter-connection, status and change.

OUR INTERNATIONAL ROLE

We provide research-based evidence, advice and solutions around the globe, addressing many of the world's most pressing environmental and societal challenges, including those identified by the UN Sustainable Development Goals (SDGs). We do this through international research partnerships, including our work with United Nations agencies and programmes such as the IPCC, IPBES, UNEP, UNECE, UNESCO and the WMO.

BIODIVERSITY

THE CHALLENGE

Biodiversity is under threat with species declining at the fastest rate ever recorded. The biggest threats include habitat fragmentation and loss, climate change, pollution, invasive species and pathogens.

OUR ROLE

Integrating monitoring, experimentation and modelling gives us the capacity to deliver solutions for conserving and restoring biodiversity. Our flagship Biological Records Centre brings together the scientific capabilities and data necessary to assess the status and trends of species populations.

HIGHLIGHTS

Automated monitoring of insects



Computer vision and autonomous monitoring are playing an increasingly important role in understanding species trends. As part of our work in this area,

during 2022 our scientists and technicians have been developing AMI-traps, platforms for long-term, autonomous monitoring of moths, based on a design originally published by researchers at Aarhus University.

Combining robust lighting for attracting insects with high resolution cameras and AI, the AMI-traps provide a practical and cost-effective solution for standardised monitoring. Our AMI-traps have been deployed to date in the UK, Canada, USA, Cyprus, Panama and Argentina, with plans to expand further. Insects are not harmed by the traps.

Work is underway to build in additional features to the AMI-trap design to widen the taxonomic groups it covers. Adding audible and ultrasound recording will enable us to monitor birds, bats, grasshoppers and crickets.



Professor Helen Roy and Dr Piero Genovesi, Head of Wildlife Service, ISPRA, at COP15, Montreal, Canada

Bending the curve of biodiversity loss

In a year which saw the conclusion of the UN biodiversity conference COP15 in Montreal, our scientists worked both internationally and nationally to develop strategies and targets to bend the curve of biodiversity loss.

Professor Helen Roy, who co-chairs the IPBES assessment of invasive alien species and their control, attended COP15, where she participated in an IUCN panel on biological invasions and gave a talk on the IPBES assessment.

Professor Paula Harrison took part in the IPBES Scenarios and Models Task Force, which developed the Nature Futures Framework to support the development of a diverse range of desirable future scenarios for nature and people, which was formally welcomed at the ninth IPBES plenary in 2022.

Meanwhile, Dr Nick Isaac worked closely with the UK's Department for Environment,

Food and Rural Affairs on the development of ambitious but realistic biodiversity targets to support the measurement of the UK Government's 25 Year Plan.

The plan was enacted through the landmark Environment Act 2021, which includes a commitment to halt the loss of species abundance by 2030 and mandates the creation of longer-term statutory targets for biodiversity, water, air quality and waste reduction. The details of those targets were published in December 2022.

For biodiversity, there is a target to increase species abundance by 10 per cent between 2030 and 2042, as well as targets for species extinction risk and creation of wildlife rich habitats. UKCEH was closely involved in the technical aspects of all three targets, the indicators of progress and the scenario modelling used to assess the appropriate level of ambition.

CHEMICAL RISKS

THE CHALLENGE

Chemicals are integral to human life and generate billions of pounds for national economies. However, chemical discharges can degrade the environment, having an adverse impact on ecosystems, and thereby affecting the health of humans and wildlife.

OUR ROLE

We investigate the dispersal, fate and behaviour of chemicals and polluting substances in terrestrial and freshwater environments. Priority pollutants include radionuclides, pesticides, organic pollutants, toxic metals, nutrients, and manufactured nanomaterials and plastics. We determine the effects of these pollutants across multiple scales, ranging from genes to populations.

CHEMICAL RISK HIGHLIGHTS

Monitoring in the Chernobyl Exclusion Zone

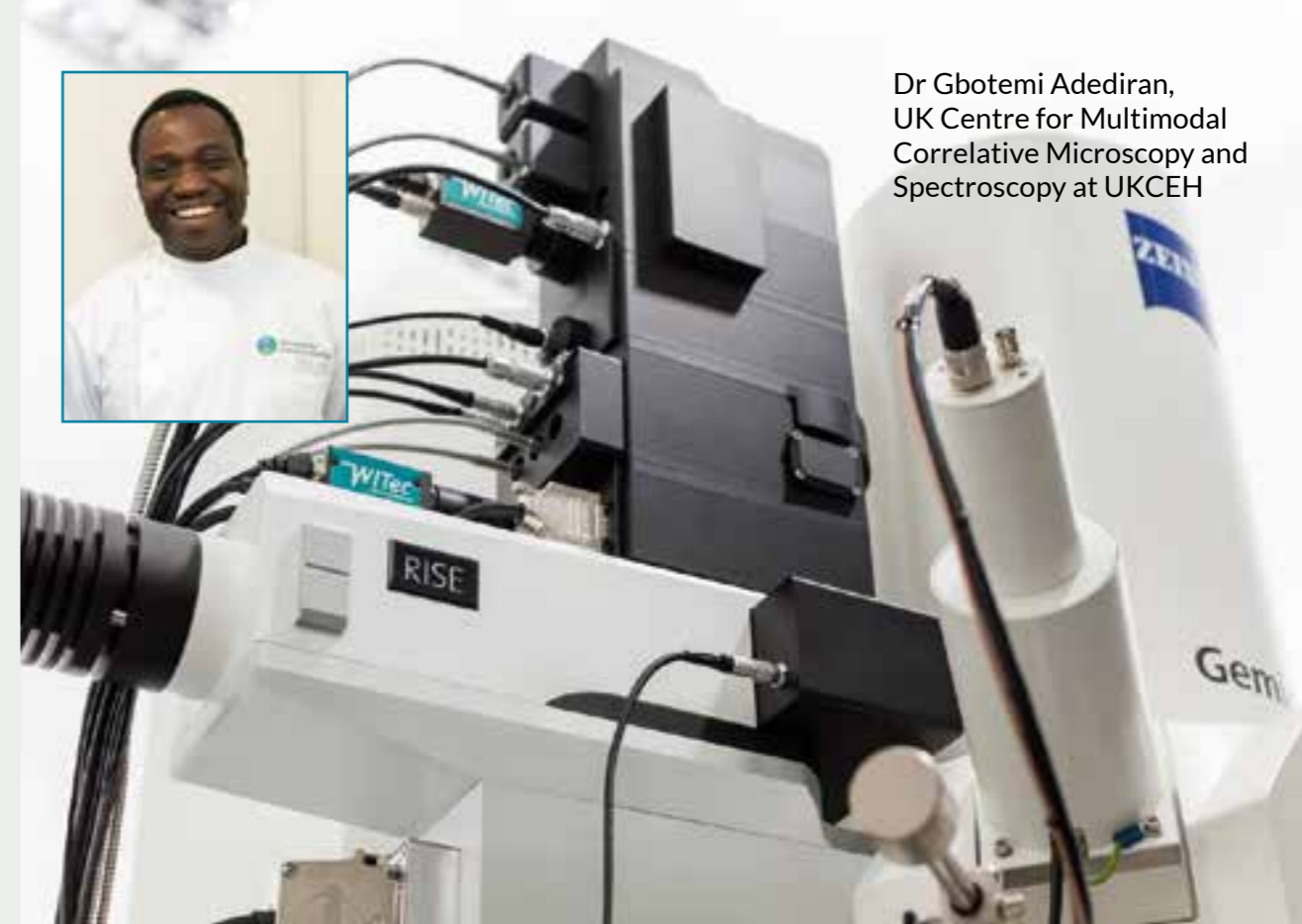


A new study led by UKCEH found that radiation levels in the Chernobyl Exclusion Zone are having no direct impact on soil biological activity three decades after the world's biggest nuclear accident. Soil organisms play an essential role supporting other wildlife, so the research provides

important evidence that the most radioactively contaminated ecosystem on Earth is in a good position to continue to recover.

UKCEH scientists also demonstrated that increases in gamma dose rates monitored in the Chernobyl Exclusion Zone during the war in Ukraine in February 2022 were not a consequence of either contaminated soil resuspension due to military vehicle movements, or a leak from the Chernobyl Nuclear Power Plant, theories which had been reported in the media.

Environmental monitoring in the Zone is now largely paused due to the war. The Russian invasion has had a direct impact on many of our research colleagues, their families and friends, and our thoughts are with everyone affected.



Dr Gbotemi Adediran,
UK Centre for Multimodal
Correlative Microscopy and
Spectroscopy at UKCEH

New facility to transform research into pollutants

In September, we secured a £750,000 investment from NERC for state-of-the-art laboratory equipment which will transform our understanding of chemical pollutants as well as natural and manmade particles, and their potential impact on the environment and human health.

With this investment, we are establishing a new research resource, the UK Centre for Multimodal Correlative Microscopy and Spectroscopy (CoreMiS), at UKCEH. The centre is the first of its kind in the country dedicated to micro-spectroscopic analysis of environmental samples. It will be available for all UK scientists to use to analyse environmental specimens such as sewage, soil and biological samples.

The suite of equipment represents a substantial step forward in capabilities for UK environmental science. It will enable scientists to see nanoparticles and nano-scale reactions in greater detail,

increasing our understanding of the impacts of pollution and climate change.

CoreMiS will deliver the world-class scientific infrastructure needed to underpin the UK's ambition for an evidence-based sustainable chemicals policy and the UK Government's ambition to develop a chemicals strategy. The centre will also support the training of students and early career researchers in cutting-edge technologies.

Dr Gbotemi Adediran, an emerging contaminant scientist at UKCEH and the principal investigator at CoreMiS, explains:

"This cutting-edge equipment will provide the UK environmental research community, for the first time, with access to a single solution dedicated to the combined analysis of environmental samples using techniques previously available only as stand-alone approaches."

www.ceh.ac.uk/coremis

CLEAN AIR

THE CHALLENGE

Air pollution is a major risk to human and environmental health. Around the globe, the adverse health effects of air pollutants are most prominent in urban areas, notably in African and Asian megacities. Air pollutants also have adverse effects on our natural environment, contributing to ecosystem damage and biodiversity loss, and impacting food security by reducing crop yields.

OUR ROLE

Through our groundbreaking flux measurement techniques and our field experimentation facilities, we generate long-term, high-frequency time series data of atmospheric composition change and identify the sources of emissions. This delivers vital data needed to inform the development and evaluation of effective clean air policies around the world.

HIGHLIGHTS

Air pollution reduces pollination by confusing butterflies and bees

A new study published in January 2022 showed that common air pollutants from both urban and rural environments significantly reduces pollination by preventing bees and butterflies from sniffing out crops and wildflowers.

Scientists from UKCEH and partner organisations investigated common ground-level air pollutants, including diesel exhaust pollutants and ozone, from both urban and rural environments. They reported that there were up to 70 per cent fewer pollinators, up to 90 per cent fewer flower visits and an overall pollination reduction of up to 31 per cent in test plants when the pollutants were present, but still at levels



Credit: Neil Mullinger, UKCEH

below current air quality standards. The theory is that the pollutants react with the scents of flowers, making them harder to find.

The study, funded by NERC, used a purpose-built fumigation facility, designed by our scientists, to regulate levels of nitrogen oxides and ozone in an open field environment.



Karen Yeung, Sarah Leeson and Dr Matthew Jones at our Auchencorth Moss Atmospheric Observatory

Reducing the impacts of air pollution on human health

UKCEH scientists have continued to improve our understanding of how exposure to air pollution affects human health, and to inform strategies and targets to reduce the risks.

Air pollution is associated with a range of diseases including childhood lung development, heart disease, stroke, cancer, asthma and increased mortality. Our scientists identified solutions to reduce health impacts from agriculture in the Chief Medical Officer for England's Annual Report on Air Pollution 2022. During the year, we also published new research, carried out with partners, showing that exposure to high levels of air pollution at critical points in life is detrimental to brain health, contributing to cognitive decline and dementia.

Our scientists have supported the development of PM_{2.5} (fine particles) targets for England, providing expert advice, evidence and modelling of future emission scenarios. New evidence published in

2022 showed that PM_{2.5} pollution can have harmful effects on people's health at lower concentrations than had been studied previously, and it is believed there is no threshold below which no harm occurs.

Our work has continued to underpin national policy elsewhere in the world, including in China, where the reduction of PM_{2.5} and reactive forms of nitrogen and sulphur is a key objective for air pollution control policies due to their major adverse effects on human health, ecosystem diversity, and climate.

We helped to assess the effectiveness of the Air Clean Plan (ACP) introduced in China, considering policy effectiveness and the co-benefits of carbon mitigation measures to environment and health. This included an estimation of the changes in PM_{2.5} concentration and premature deaths attributable to PM_{2.5} in China, at a fine resolution (1 km) from 2014–2020.

CLIMATE AND LAND

THE CHALLENGE

Changes in climate, involving interactions of physical, chemical, and biological processes of the atmosphere, ocean, and land surface, are having widespread impacts on societies and ecosystems. Understanding how the land surface interacts with the atmosphere is critical for climate change prediction, adaptation and mitigation.

OUR ROLE

Our land surface science is underpinned by detailed process understanding in hydrology, ecology, micro-meteorology, biogeochemistry, and, critically, their interactions. These processes are modelled within the Joint UK Land Environment Simulator (JULES) system, coordinated by UKCEH and the Met Office, which provides the community with a unique UK land surface model for accurate weather and climate prediction.

HIGHLIGHTS

Community and public engagement with the development of a new water cycle model

Hydro-JULES is a five-year national capability programme to develop an integrated water cycle model, which will contribute towards better early warning systems for floods and droughts and ensure reliable water supplies. In 2022, we continued to engage the hydrological community in the development of the model, as well as engaging the public with the science behind it. We delivered summer and winter schools to 50 undergraduate and postgraduate students from over 20 countries and engaged with over 6,000 school children and a further 11,000 members of the public.

Co-development of a meningitis sub-seasonal early warning system in Africa

Our scientists have supported the co-development of early warnings of meningitis outbreaks across sub-Saharan Africa. Using sub-seasonal atmospheric forecasts, weekly predictions of meningitis outbreaks are provided to the African sector of the World Health Organisation (WHO) and national health services. The system enables health organisations and medical services to be prepared and respond to outbreaks.



Scientists at the UK Centre for Ecology & Hydrology and the Met Office carried out modelling to predict future increases in wildfires.

Substantial increase in wildfires projected

A new report published by the United Nations Environment Programme (UNEP) in February predicted that even if greenhouse gases are reduced, there could be an increase of up to 50 per cent in wildfires around the world by the end of the century.

Scientists at UKCEH and the Met Office carried out modelling to predict future increases in wildfires for the report, *Spreading like Wildfire: The Rising Threat of Extraordinary Landscape Fires*. They combined the most up-to-date satellite observations of wildfires, vegetation cover and meteorological conditions with multiple climate models, enabling them to make projections for future fires with much more confidence than previously.

Although landscape fires are a natural process and, in some instances, needed for a healthy ecosystem, this report focuses on large, unusual fires referred to as wildfires, and it is the change in the pattern of these

wildfires that is causing most concern. There is projected to be a global increase of extreme fires of up to 14 per cent by 2030, 30 per cent by 2050 and 50 per cent by 2100.

The report found that some of the biggest increases will be in areas not typically used to seeing wildfires, such as the Arctic and central Europe. Areas of tropical forest in Indonesia and the southern Amazon are also likely to see increased burning if greenhouse gas emissions continue at their current rate.

UKCEH Land Surface Modeller Dr Douglas Kelley, the lead data analyst for the report, explains:

“In addition to impacts on climate, wildfires have wide-ranging impacts on people and the environment including damage to ecosystems, risk to people’s lives, health and livelihoods, and the economic costs of rebuilding.”

ECOSYSTEM RESTORATION AND RESILIENCE

THE CHALLENGE

The UN Decade of Ecosystem Restoration to 2030 recognises that ecosystem degradation undermines the well-being of 3.2 billion people. The resultant loss of species and ecosystem services across the world equates to a 10 per cent annual reduction in gross productivity.

OUR ROLE

Our multidisciplinary science enables us to develop innovative approaches to sustaining healthy ecosystems and restoring degraded ecosystems at landscape scales. We provide the evidence base to restore degraded ecosystems in such a way that they are resilient to climate change and extreme events, particularly where societal and environmental pressures are in conflict.

HIGHLIGHTS

Birmingham trees deliver nearly £4 million of health benefits

Trees are a great way to cut down noise from traffic, reducing the risk of stroke and cardiovascular ailments. Scientists from UKCEH have created a model that looks at the trees in a city and equates their noise-reducing benefits to a cash value, based on the impact on our health. In a study published in November 2022, they estimated that trees in and around Birmingham deliver nearly £4 million of health benefits to the people living there. The model can be applied to any city and enables the city to maximise the benefits of the tree planting it can afford.

Half of replanted tropical trees don't survive

On average, about half of trees planted in tropical and sub-tropical forest restoration efforts do not survive more than five years, but there is enormous variation in outcomes, new research published in November 2022 found. The study, led by UKCEH, analysed data from 176 restoration sites in tropical and sub-tropical Asia, where natural forests have suffered degradation. The research team found that, on average, 18 per cent of planted saplings died within the first year, rising to 44 per cent after five years. Further research is needed to hone the most appropriate and cost-effective methods for restoration.



Monitoring of the Cumbrian Lakes began in 1945, and has been led by UKCEH and its predecessor institutes since 1989.

Long-term monitoring reveals how climate change is affecting UK lakes

UKCEH holds more than 420 lake-years of data gathered from our monitoring sites in England and Scotland as part of the world's largest long-term lake monitoring programme.

A report published in April 2022, authored by UKCEH scientists on behalf of Scotland's Centre for Expertise for Waters (CREW), showed that climate change has already caused a rapid and extensive warming of Scotland's lochs and reservoirs, with impacts expected to intensify in future.

Between 2015 and 2019, 97 per cent of monitored Scottish lochs and reservoirs increased in temperature. While most warmed by up to 1.0°C per year over this period, 9 per cent increased by more than that – some by up to 1.3°C per year.

These changes increase the risk of harmful algal blooms developing, which could restrict

their use for recreation and water supply, and as a safe habitat for wildlife. The report made a number of recommendations to address these impacts.

Mairi McAllan, Scotland's Environment Minister, said:

“Research like this will be hugely valuable in informing the development of policy solutions and measures to mitigate and adapt to climate change, and also protect, restore and enhance these vital natural assets.”

In 2022, we also published analysis for the Windermere catchment which reveals clear evidence of the impacts of climate warming. For Windermere, Esthwaite Water, and Blelham Tarn water temperature was 0.4 – 0.8 °C warmer during the period 2017 to 2021, compared to 1981 to 2010.

FLOOD AND DROUGHT IMPACTS

THE CHALLENGE

Floods and droughts have the potential for immense destruction of homes, crops, wildlife and infrastructures. Since 2017, natural disasters and extreme weather events have been consistently identified in the World Economic Forum's top five global risks by severity.

OUR ROLE

Combining expertise in hydrometeorology with data derived from national monitoring networks, we measure and model water to accurately predict, mitigate and manage the impacts of floods and droughts. We work in partnership across the world to build local capacity in monitoring, analysis and modelling, supporting planning, response and recovery.

HIGHLIGHTS

Long-term monitoring supports planning during the 2022 drought



In 2022, the UK experienced one of the driest and warmest summers ever recorded, with impacts including widespread hosepipe bans, water pollution, crop failures and wildfires. Drawing on our long-term hydrological monitoring, UKCEH scientists reported on the evolving situation around the country, comparing it to previous droughts such as that in 1976.

We worked closely with Defra, the Environment Agency and water companies to provide information about the severity of the drought, to inform planning. We also proactively contributed to public interest stories on dry weather and drought, with over 1,700 mentions of UKCEH hydrological analysis in the UK press in August alone.



The impacts of flooding on a commune in Dakar, Senegal
©Tanya Warnaars

New portal improves forecasts of devastating storms in West Africa

In May 2022, UKCEH launched a new online portal to enable forecasters in West Africa to provide communities with earlier and more reliable storm warnings.

Storms in the Sahel region, which can reach over 100km in size, have become more extreme since the 1980s due to the changing climate, with more intense rainfall. Severe flooding during the monsoon from June to September causes human and livestock deaths, as well as causing damage to property and infrastructure.

Thanks to a recent breakthrough by UKCEH scientists, national forecasting agencies in West Africa can now make short-term forecasts, known as 'nowcasts', for six hours ahead with a higher degree of accuracy than previously. To assist forecasters, these novel nowcasting predictions and related satellite observations for West Africa have been made available via the new portal.

National forecasters can interpret the data and make localised forecasts, sending out warnings to people in areas that are expected to be hit by a storm.

Dr Steven Cole, senior hydrological modeller at UKCEH, explains:

"The portal is a great example of how new scientific understanding can be translated into useable real-time tools by working with forecasters. Importantly, this will support communities in West Africa to better manage flood risk from intense rainfall."

As part of a collaboration with ANACIM, the national meteorological service in Senegal, UKCEH has also developed short-term forecasts of potential flood impacts and risk in Dakar which are available on the portal, and intends to work with other national forecasting services to provide a similar service.

NET ZERO GREENHOUSE GAS EMISSIONS

THE CHALLENGE

Many countries, including the UK, have committed to a net zero emissions economy. To drive down greenhouse gas (GHG) emissions, we need to identify where they come from, how they can best be reduced, and ensure we fully understand the processes involved.

OUR ROLE

We undertake long-term national surveys of GHG emissions in both natural and managed environments, focusing on carbon dioxide, methane, and nitrous oxide. We make a major contribution to national and international GHG emissions inventories, providing GHG flux measurements, and improve understanding of the role that land use has on emissions.

HIGHLIGHTS



Peat camera
©Jonay Jovani, UKCEH

Using peat cameras to monitor emissions from peatlands

UKCEH have been commissioned by Natural England to establish a national network of over 50 low-cost peatland monitoring systems, which use timelapse photography to measure small movements in the peat surface and low-cost sensors to monitor environmental variables such as water table depth. These movements are linked to peatland attributes such as water table depth and carbon balance. This work will

feed into the development of the new England Peat Map, a set of accessible, online maps describing peat condition and GHG emissions, drawing on both ground-based and earth observation data. This approach will also provide a cost-effective way to monitor and verify the GHG benefits of peat restoration.

Measuring GHG emissions from lakes

As part of UKCEH's work to measure, understand and mitigate greenhouse gas emissions from UK inland waters, our scientists established the first flux towers to measure GHGs from lakes at Esthwaite and at Loch Leven. These are the first two of five highly instrumented sentinel sites we plan to establish across a range of different bodies of water, including lakes, reservoirs and ponds. Each one will be equipped with state-of-the-art GHG measurement technologies.



The restoration of the saltmarsh at Tollesbury, Essex, involving UKCEH scientists, was one of the first such projects undertaken in the UK.

Leading the development of saltmarsh and peatland carbon codes

Over the past year, UKCEH has led the development of the scientific methodology underpinning the Peatland Code, and the development of a Saltmarsh Code for the UK. These codes are voluntary certification standards, enabling peatland and saltmarsh carbon to be marketed and purchased by private investors, thus providing an income stream for restoration projects and supporting the achievement of national net zero goals.

UKCEH scientists carried out a major evidence review and developed new methods to support Version 2 of the UK Peatland Code, due to be published in 2023. The new methods use data from UKCEH's flux tower network to update estimates of greenhouse gas emissions and removals for different peatland categories. This enables project developers to estimate emissions reductions that could be achieved by raising water levels, based on data analysis published in *Nature* in 2021. They also

extend the Peatland Code to cover lowland fen peats, enabling lowland peat farmers to earn future carbon credits by raising water levels on their land, or converting to wetland farming ('paludiculture').

Annette Burden, a wetland scientist at UKCEH, who led the development of the first phase of the Saltmarsh Code during 2022, says:

"Research is underway to more fully understand carbon dynamics within UK saltmarsh habitat, including measurement of greenhouse gas emissions and water-borne carbon fluxes. These new insights will support the development of the UK Saltmarsh Code."

As part of this work, our scientists produced a new report for the UK Government in 2022, setting out what additional data and information would need to be collected to facilitate the addition of coastal wetlands to the UK greenhouse gas emissions inventory.

SOIL HEALTH

THE CHALLENGE

Healthy soils and peatlands are critical for life. They produce 95 per cent of our food and are the source of many of our antibiotics. They store more carbon than the world's forests, mitigate climate change, recycle nutrients and waste, and clean our water. Yet, they are vulnerable to pollution, unsustainable exploitation and erosion.

OUR ROLE

Our multidisciplinary, integrated soils research spans physical, biological and chemical soil processes and investigates their interaction with the biosphere. This research enables environmental risk assessment and predictions of how soils may change under future land use and climate change scenarios.

HIGHLIGHTS



Research shows that less intensively managed grasslands have higher plant diversity and better soil health

Grazed grassland makes up a large proportion of the British countryside and is vital to farming and rural communities. Now UKCEH researchers have shown for the first time that less intensively managed British grazed grasslands have on average 50 per

cent more plant species and better soil health than intensively managed grassland. The new study could help farmers increase both biodiversity and soil health.

First ever UK Soils Awareness Week

October saw the first ever UK Soils Awareness Week, designed to increase public understanding and appreciation of soils and the challenges they face. The awareness week was organised by uksoils, a not-for-profit community hub led by UKCEH and the Sustainable Soils Alliance. Activities developed and promoted during the week included a list of things people can do as part of their daily lives to protect and improve the nation's soils, a lexicon, and a soils quiz. Professor Bridget Emmett of UKCEH appeared on BBC World News to talk about the importance of soils as part of the campaign.



Michele Brentegani, Bangor Analytical Chemistry Laboratory; soil analysis

New web tool for measuring health of soils

In December 2022, UKCEH launched a new free web tool called Soil Fundamentals to help land managers monitor and improve the health of soil in common habitats in Britain.

The tool was developed using data from the UKCEH Countryside Survey, which has been exploring changes in soils and vegetation across Great Britain since 1978. It enables landowners to benchmark the health of their soil, seeing where it sits within the bigger national picture.

Unlike previous benchmarking tools for soil health, this is the first to consider the health of soils within the wider semi-natural landscape of grasslands, woodlands and wetlands, as well as agriculture, and to be built from a nationally representative sample from across Great Britain.

The new tool assesses indicators of soil organic matter, pH, bulk density and earthworm abundance. These provide

physical, chemical and biological indicators of healthy soil functioning and can be measured reliably for most environments in the UK.

Professor Bridget Emmett, Head of Soils and Land Use at UKCEH, explains:

“With these robust national benchmarks for soil health, land managers can now assess both the current state of their soil and how much improvement is possible if they adopt more sustainable management practices.”

We are now asking for feedback from the community to tell us how the tool has changed the way they manage soil and what else they would like to see included. This will help us prioritise conversion of our many other national indicators of soil health into benchmarks, such as fungi, nutrients and contaminants. New monitoring in Northern Ireland will allow us to extend the tool to cover all four nations of the UK for the future.

SUSTAINABLE AGRICULTURE

THE CHALLENGE

Population growth, changing diets and urbanisation are driving ever-increasing intensification of agriculture and land-use change. Meeting the need for increased food production and nutrition without degrading our environment is one of the greatest challenges facing society today.

OUR ROLE

Our research makes a major contribution to the development of sustainable and productive farming systems that are resilient to climate change and protect biodiversity, while promoting healthy soils, clean water, pollination and natural pest control.

HIGHLIGHTS



Supporting the transition to sustainable agriculture

ASSIST, a six-year £12 million research programme co-led by UKCEH, concluded in 2022. The programme brought together farmers and scientists to test new approaches and provide scientific evidence to inform the transition to sustainable agriculture in the UK. The multi-partner project team produced a suite of free tools to help farmers and land managers plan environmental improvements, explore future land use options, and assess the quality of wildlife habitats. We engaged with over 5,000 farmers and beekeepers over the

course of the programme and established over 50km of flower-rich field margins and in-field strips to support pollinating insects, among other achievements.

Informing the development of CAP replacement schemes in England and Wales

Over the last three years, UKCEH has coordinated over 50 experts drawn from 12 research organisations to help inform the development of Common Agricultural Policy (CAP) replacement schemes for both UK and Welsh Governments. Work for the UK Government in 2022 included a qualitative assessment of the environmental impact of over 700 management actions for over 40 ecosystem services and indicators ranging from biodiversity to air, soil and water quality, water flow, carbon sequestration and cultural services. Critically, the trade-offs and co-benefits of each action were also assessed.



Nature-friendly farming can bring wildlife back to farms without compromising food production

Agri-environment schemes can reverse declines in farmland bird and butterfly populations without damaging food production, a long-term monitoring study revealed in August 2022.

Scientists from UKCEH spent over a decade monitoring the impacts of a large-scale Defra-funded experiment at Hillesden, a 1,000-hectare commercial arable farm in Buckinghamshire. Beginning in 2005, this involved creating several wildlife habitats, including seed-bearing crops for birds, wildflowers for pollinators and tussocky grass margins to support a range of birds, insects and small mammals.

The experiment assessed the effectiveness of these agri-environmental measures in reducing biodiversity losses caused by the intensification of UK farming practices since the Second World War, including declines in species that are essential for agricultural production, such as pollinators and predators of crop pests.

Researchers found that the majority of species did better at Hillesden than on nearby farms which lacked the same mix of agri-environment habitats. There were increases of a third across populations of all bird species between 2006 and 2016, compared to an average of just under 13 per cent at other monitored sites, and 40 per cent among all butterflies 2009-2017, compared to 21 per cent elsewhere.

Marek Nowakowski, The Wildlife Farming Company, says:

“The Hillesden study shows that it is possible to balance wildlife conservation with efficient food production. I am confident other farmers could achieve similar results with the right training and advice.”

UKCEH research and monitoring over the last 30 years has contributed important evidence to underpin agri-environmental policies across the four nations of the UK.

WATER QUALITY AND RESOURCES

THE CHALLENGE

Water is a resource on which all life depends. Yet across the planet 30 per cent of people do not have access to reliable supplies of clean water. Efficient management of water is critical to addressing the competing demands of industry, agriculture and energy production, while also sustaining natural ecosystems.

OUR ROLE

Our research integrates ecology and hydrology in the evaluation of water availability and demand. We seek to understand the complex interactions that affect the availability and quality of water resources now and into the future, from local to global scales.

HIGHLIGHTS

Solutions for the global phosphorus crisis



© Glenn Rhodes, UKCEH

A major new report published in June 2022, led by UKCEH and University of Edinburgh scientists, offers solutions to the global phosphorus crisis, which threatens food and water security.

A team of 40 international experts from 17 countries, supported by the United Nations Environment Programme (UNEP),

collaborated on the *Our Phosphorus Future* report – the most comprehensive global analysis of the challenges and possible solutions to the phosphorus crisis to date. It calls on governments across the world to adopt a ‘50, 50, 50’ goal: a 50 per cent reduction in global pollution of phosphorus and a 50 per cent increase in recycling of the nutrient by the year 2050.

In December 2022, this was followed by the publication of the *UK Phosphorus Transformation Strategy*, which provides a roadmap for how the country can better manage this vital element. Drawn up by scientists from UKCEH and other institutes, the strategy’s recommendations were jointly developed with farmers, regulators, policy makers, food producers, wastewater companies and environmental managers through extensive consultation.



Heidrun Feuchtmayr,
UKCEH Aquatic Mesocosm
Facility, Lancaster

New portal supports water resources planning

A new interactive web portal launched by UKCEH in March provides an indication of hydrological conditions across the country in the coming months.

The Hydrological Outlooks Portal allows users to visualise projections for river flows from the UK Hydrological Outlook. The monthly Outlook, produced by UKCEH in collaboration with partners, supports the water and energy sectors, farmers, local authorities and others, to assess flood risk and water availability and to plan accordingly.

Users of the new portal can click on an interactive map to look at projections for a specific geographical area or river catchment of interest.

They can also customise the downloadable maps and graphs, for example, by looking at the likelihood of river flows reaching a

trigger level relevant for drought planning in a region. Projections are typically based on a comparison with what are considered ‘normal’ river flows for a location in that month historically, with categories ranging from exceptionally low to exceptionally high.

Anne Dacey, Deputy Director of Water Resources at the Environment Agency, says:

“The last few years we have seen changing weather patterns, including increasing frequency of prolonged dry weather, which may continue to become more extreme. This requires some forward planning. The UK Hydrological Outlook is an important part of the evidence we use to plan our operational incident response to prolonged dry weather risks.”

OUR PEOPLE

New science director

In 2022, we welcomed Dr Doug Wilson as our new Science Director. Doug, who was previously Chief Scientist at the Environment Agency, took up the position in April, joining the organisation's Executive Board and leading its Science Board. He succeeds Professor Alan Jenkins, who will be retiring in 2023 after 37 years working for UKCEH and its predecessor institutes.

Equity, equality, diversity and inclusion (EEDI)

In summer 2022, we launch a six-month initiative to inform future EEDI initiatives at UKCEH. As part of this, we audited and reviewed existing EEDI related policies and processes, and explored the lived experiences of our staff through focus groups, surveys and individual meetings, resulting in the creation of a comprehensive action plan to take forward into 2023.

Wellbeing

In 2022, we published our wellbeing strategy, policy and action plan, launched a wellbeing working group and improved the wellbeing resources available to our employees. We also introduced reasonable adjustment passports for staff with disabilities or other health conditions who require adjustments in the workplace.

Learning and development

During the year, our line managers completed training on topics including performance improvement, unconscious bias, mental health awareness, and anti-harassment and bullying. Our staff completed a total of over 3,500 compliance training courses, covering topics including returning to work during or after COVID-19, cyber security awareness, and EEDI.

Postgraduate and early career research

UKCEH continues to play a prominent role in training the next generation of environmental scientists. In 2022, 85 of our scientists jointly supervised 175 masters and doctoral researchers, who benefited from access to our laboratory facilities, field sites and data centres. At the end of 2022, we had 54 active research associates at UKCEH. We reviewed the support we are providing to early career researchers following the pandemic.

External training

In 2022, we trained over 400 external learners through face-to-face and online courses, on subjects ranging from using drones to map habitats to transforming environmental data in R, and from radiological environmental protection to evidence synthesis. We provided bespoke training for partners including Defra, BEIS, the Government Office for Science, The Wildlife Trusts, the Ireland Environmental Protection Agency, Lancaster University and Gloucester University.

Our scientists jointly supervised

179

postgraduate masters and doctoral researchers



Dr Mike Bowes, UKCEH GroDome facility, Wallingford



Gemma Jackson and Davide Graziano, People Team

We trained

>400

external learners through face-to-face and online training courses

We participated in

10

UKRI Doctoral Training Partnerships and

4

UKRI Centres for Doctoral Training



Fred Duarte, Atmospheric Analysis Facility: Trace Gases and Aerosols, Edinburgh

2022

THE YEAR IN NUMBERS

These numbers indicate the size, scale and excellence of the science we deliver in support of a world where people and nature prosper

1,600+
datasets (6.9 Tb) are now freely available via the Environmental Information Data Centre



2.2 million+
records were received by the Biological Records Centre, including nearly 1.5 million images



We established over **50km** of flower-rich field margins to support pollinators through the ASSIST programme



We won **218** grants and contracts worth more than **£43m**



Our researchers published over **480** peer-reviewed journal papers



We invested over **>£3.5m** in IT and science infrastructure



We used satellite data to map crops in over **1.5m** fields, supporting the reduction of water pollution from agriculture



We analysed **>450** soil samples through the UKCEH Countryside Survey



Data was downloaded from our Flood Estimation Handbook Web Service over **16,000** times by c.800 users



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The Centre owns a registered trading subsidiary, the UK Centre for Ecology & Hydrology Enterprise, a Company Limited by Shares (number 12251749), which supports our charitable purpose.

The registered office of the UK Centre for Ecology & Hydrology is at the Maclean Building, Benson Lane, Crowmarsh Gifford, Wallingford, Oxfordshire, OX10 8BB, UK.



INVESTORS IN PEOPLE
We invest in people Silver

