CEH SCIENCE AREAS

- Biosphere-Atmosphere Interactions
- Ecological Processes & Resilience
- Environmental Informatics
- Monitoring & Observation Systems
- Natural Capital
- Natural Hazards
- Pollution & Environmental Risk
- Sustainable Land Management
- Water Resources

SCIENCE AREA SUMMARY

SOIL

Soils are critical for life. Sound scientific knowledge of soil functioning is essential to assure UK and global security for food, fuel and water.

Context

Soils provide nutrients and water to grow our food, moderate floods and droughts, help regulate our climate, and support a large and diverse biological community. These and other societal benefits depend crucially on soil quantity and condition, both of which are currently at risk from threats such as over-exploitation, contamination and climate change. Understanding and managing the diverse, and sometimes conflicting, services provided by soils demands an integrated, multidisciplinary approach.

Our Research

The multidisciplinary research at the Centre for Ecology & Hydrology (CEH) makes us ideally placed to develop new understanding of soil function and the relative importance of soil biota, physical and chemical properties and their emergent properties across scales. We will apply this knowledge for improved sustainable management of soil and the ecosystem services soils provide. CEH provides a foundation on which UK soil science can come together and interact with international partners to deliver this ambition.

From croplands to deserts, from grasslands to rainforests, and from tundra to tropics, CEH, in collaboration with its partners, will provide:

- development of fundamental new understanding of soil development, structure and condition in the short and long term and how this constrains soil functionality.
- identification of thresholds, resilience and emergent properties of key soil functions across spatial and temporal scales.
- quantification of interactions between major macronutrients (C, N and P) in soils and resulting impacts on soil functions and ecosystem services at landscape scales.
- experimental and modelling approaches to quantify potential impacts of climate change and land management on carbon storage, GHG fluxes and structural integrity in soils.
- production of risk maps including sensitivity and vulnerability analysis for past and emerging threats including contamination, salinization, drought, disturbance and new land management practices.
- development of soil models to improve predictions of change in biodiversity and ecosystem functions, and to contribute to soils representation in current land-atmosphere and ecosystem service models.
- development of new tools to enable the valuation of soil services, underpinning their role in future development of sustainable and adaptive land management practices.
- delivery of novel and integrated soil observing systems, including real-time sensing, new apps and portals, and statistical and modelling approaches for integrating existing data.

Centre for Ecology & Hydrology
NATURAL ENVIRONMENT RESEARCH COUNCIL

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Science Excellence to Impact

1970s

1972: Wallingford Neutron Probe for soil moisture measurement.

1978: First Countryside Survey of GB topsoils including soil pH and organic matter.

1980s

1980s: Soil and mycorrhiza research supporting international development across Africa and Asia.

1985: Network of experimental catchments and landscape observatories established in the uplands.

1990s

1990s: UK and EU Networks of N deposition and climate change experiments established.

1995: Soil acidity critical loads methodology developed.

1996: Soil carbon reporting methodology for inclusion in the Land Use, Land Use Change & Forestry Greenhouse Gas inventory for the UK.

2007: Third Countryside Survey of GB topsoils including stock and change of physical, chemical and biological functioning, UK maps of soil mesofauna and bacterial diversity.

2008: Bio-energy and land use change experimental network for UK.

2008: UK soils heavy metals critical loads maps and ecotoxicology work for soil biota.

2000s

2010s

2011/12: **NERC Soil Portal** and ***my*Soil** app launch with BGS.

2012: Soil moisture monitoring network for UK through the COSMOS network.

2010s: Refocus of catchment and landscape observatories for soil sustainability and ecosystem services.

Photos: L to R: 1 Shutterstock; 2 H Lowther, CEH; 3 Shutterstock; 4 CEH; 5. Dr Helen Ward. CEH.

Future Research Objectives

To understand soil dynamics and soil functional processes.

By 2019, we will have:

- *exploited molecular technologies for assessing soil biodiversity and assessed their role in delivering key soil functions from UK to global scales.*
- *increased our understanding of the links between biological and physical structure of upland soils and their implications for water and carbon services.*
- *better quantified the underlying controls of soil functionality in coastal saltmarsh and sand dune systems.*
- *developed new conceptual models for the interactions among soil macronutrient cycles and their implications for soil development and function.*

To identify threats to soils for increased soil security.

By 2019, we will have:

- *improved the representation of soils in moderating greenhouse gas emissions within the Land Use, Land Use Change and Forestry Greenhouse Gas Inventory.*
- *explored metagenetics and molecular approaches for estimating soil biodiversity and evaluated their role in protecting soil from abrupt change.*
- *quantified the impacts of land use change to energy crops on soil C stocks and GHG gas emissions for the UK.*
- *improved understanding of the role of soil biological and chemical processes in influencing and mitigating the potential impact of pathogens and emerging chemical risks.*
- *improved quantification of soil vulnerability.*

To develop methods and platforms for observing soil change.

By 2019, we will have:

- *developed with our partners a new UK Soils Observatory and enhanced mySoil app to include all major soil data and information providers in the UK.*
- *initiated with our partners novel integrated soil data and map products to support a range of community modelling activities and web tools to enable self reporting of soil status for farmers and other land managers.*
- *implemented web-interfaces with partners to deliver real-time soil sensor data.*
- *developed more intelligent and efficient methods for quantifying soil quantity, condition and function.*

To provide ecosystem services tools for sustainable soils.

By 2019, we will have:

- *improved methods of evaluating soil natural capital.*
- *enhanced the ecosystem services model LUCI to better represent soil functions affecting food, fuel and water security and their trade-offs and test from catchment to national scales.*
- *developed new soil biogeochemical and water routing modules for the Joint UK Land Environment Simulator (**JULES**) models to support ecosystem science at the catchment scale.*
- *improved global predictions of climate change and land management impacts on soil natural capital.*



Photos: L to R: CEH; CEH; H Lowther, CEH

Partnerships

We are committed to delivery of fundamental research, reliable soils data, models and applications for use in scientific, management and policy activities. We are working to build a more cohesive and collaborative UK and international soil community to support these activities and enhance our impact partnerships with Defra, public agencies, devolved administrations, agricultural and water industries.

New methods of soil monitoring and portals and apps for data and products are developed with the British Geological Survey, the James Hutton Institute, Cranfield University, the Met Office and The European Commission's Joint Research Centre.

A wide range of climate change research and greenhouse gas reporting is delivered by collaborative working with the Forestry Commission, ADAS, Edinburgh University, international partners and UK HEIs (Higher Educational Institutions).

Sustainable agriculture and biodiversity research build on strong links with European partners, Rothamsted Research, Scottish Rural College and various HEIs.

Pollution research is underpinned by collaboration with UK HEIs, James Hutton Institute and international partners.

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