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# **Integrated Science for Our Changing World:** **DELIVERY PLAN 2008 - 2013**

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**Centre for  
Ecology & Hydrology**

NATURAL ENVIRONMENT RESEARCH COUNCIL

**CEH Delivery Plan 2008 - 2013**

Edition 1 - December 2008

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# CEH Delivery Plan 2008 – 2013

## Our Vision

To be the world-leading centre for integrated science in terrestrial and freshwater ecosystems.

## Our Mission

The Centre for Ecology & Hydrology is the UK's Centre of Excellence for integrated research in terrestrial and freshwater ecosystems and their interaction with the atmosphere. As part of the Natural Environment Research Council (NERC), we provide National Capability based on innovative, independent and interdisciplinary science and long-term environmental monitoring, forming an integral part of NERC's vision and strategy. Working in partnership with the research community, policy-makers, industry and society, we deliver world-class solutions to the most complex environmental challenges facing humankind.

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## 1. Introduction

The primary goal of the Natural Environment Research Council's (NERC) Centre for Ecology & Hydrology (CEH) is to undertake cutting edge research to deliver world-class solutions for today's most urgent environmental problems. This goal is a key part of the challenges described in the CEH Science Strategy 2008-2013, [Integrated Science for Our Changing World](#).

This Delivery Plan sets out how CEH will address the challenges of our Strategy. The first part summarises the CEH Science Strategy, shows how we set our priorities for delivering our science and managing our organisational structures, and explains how we will monitor and evaluate our progress. The second part details how specific objectives will be delivered through CEH's Science Programmes that are based on internationally leading research necessary to provide **National Capability** to underpin the ability of the UK to undertake world-class environmental science, our expertise to deliver the NERC **Research Programmes** and the innovation essential for **Responsive Mode** research.

The Delivery Plan bridges the gap between our Science Strategy and our annual Operating Plan. As such, the Delivery Plan: (i) provides guidance to CEH's staff of the Centre's science priorities, (ii) demonstrates to stakeholders how our science remains focused on their priorities, and (iii) directly supports NERC in delivering its mission and the NERC strategy, [Next Generation Science for Planet Earth 2007-2012](#).

## 2. CEH's Science Strategy 2008–2013: *Integrated Science for Our Changing World*

*Integrated Science for Our Changing World* defines the scientific challenges that will guide our research programme in the forthcoming years. The challenges provide a logical progression: from long-term monitoring and experimentation, through to process and mechanistic research, and providing solutions.

The six overarching scientific challenges are ambitious. We will address them through interdisciplinary and collaborative projects that bring together the wider research community, policy-makers and practitioners from the outset. Only through this integration can we ensure that our research is both relevant and world-class, and that the results are transposed into real world practice and thus have a positive impact on the environment and our daily lives.

### CEH Scientific Challenges

Challenge I: *Deliver early warnings of environmental change through large-scale, long-term monitoring and experiments.*

Challenge II: *Identify processes linking physical and chemical changes in the environment with ecosystem responses.*

Challenge III: *Improve predictions of climate change models by incorporating ecological, hydrological and biogeochemical processes and their feedbacks.*

Challenge IV: *Quantify the impact of environmental change on natural resources.*

Challenge V: *Determine the risks of chronic and extreme exposure of ecosystems and humans to biological, hydrological and chemical threats.*

Challenge VI: *Identify strategies and control measures to mitigate impacts of environmental change on ecosystems, ecosystem services and human health.*



Outputs from our research inform national and international policy decisions, provide National Capability in the environmental sciences and directly support all of the NERC Science Theme Action Plans. As part of our research expertise CEH provides National Capability in the key task of collecting, managing and disseminating environmental data. Integration and interpretation of these data enable testing of assessments and predictions of environmental impacts and risks. An overarching requirement is the development and evolution of tools for measurement and modelling that continue to advance our research capability. In addition to established *in situ* methods, we will promote advances in Earth Observation (i.e. remote sensing) as a key element of our strategy. The outcomes of CEH science help the development of strategies and solutions for the management of environmental change.

CEH contributes to the UK National Capability through the continuation and management of a wide range of nationally (and often globally) unique long-term datasets: e.g. Biological Records Centre (including the National Biodiversity Network and Butterfly Monitoring Scheme) (BRC), Countryside Surveys (CS), National River Flow Archive (NRFA), Land Cover Map (including CORINE) (LCM), NERC Bioinformatics Facility (N-BIF that incorporates the NERC Environmental Bioinformatics Centre, NEBC), UK-Phenology Network, Isle of May Long-Term Monitoring Study (IMLOTS), Predatory Bird Monitoring Scheme (PBMS) and Environmental Change Network (ECN) and many CEH-controlled long-term experimental sites studying physical processes, climate change, ecosystem restoration, and the population dynamics of interacting species.

Below we provide some selected examples of new scientific activities that address the six overarching scientific challenges. These demonstrate how we bring together and integrate our scientific expertise and data to address key issues.

**Challenge I: *Deliver early warnings of environmental change through large-scale, long-term monitoring and experiments.*** CEH provides accurate information and independent advice relating to the status of the UK natural environment and the combined impact of those changes that threaten biodiversity, ecosystems, natural resources, and human well-being. One of our priorities for the next five years will be the development of the CEH Information Gateway and delivery of advances in real-time measurements and informatics. By integrating long-term, large-scale monitoring, Earth Observation products and experimental datasets, within a spatial and temporal framework, we will be better able to investigate and identify trends at relevant ecological scales necessary to model and predict the impact of climate, land use and other drivers of environmental change.

**Challenge II: *Identify processes linking physical and chemical changes in the environment with ecosystem responses.*** CEH is developing the ‘Source to Sea’ initiative that provides large-scale observatories that integrate biological, atmospheric and climate data with measures of the effect of urban and rural land use at the catchment scale. Our objective is to quantify and test the resilience of natural ecosystem processes from populations up to the landscape scale, and develop a more detailed mechanistic understanding of the associated biotic and abiotic interactions that link biodiversity with function.

**Challenge III: *Improve predictions of climate change models by incorporating ecological, hydrological and biogeochemical processes and their feedbacks.*** We are enhancing the Joint UK Land Environment Simulator (JULES), developed in partnership with the Met Office, to improve model accuracy and provide better quantification of land surface/climate feedbacks at different scales. Representation of key ecological, biogeochemical and hydrological processes, and feedbacks, will be improved at appropriate scales.

**Challenge IV: *Quantify the impact of environmental change on natural resources.*** Building on the 30 years of unique information we have collected during the UK National Countryside Surveys, monitoring and experimental datasets will be further integrated with models and experimental manipulations to provide quantitative assessments of how environmental change affects the availability and security of a range of natural resources. Our key objectives are to quantify the impacts

of policy developments (e.g. for land use and energy) on services such as freshwater resources, flood regulation, biodiversity, nutrient cycling, Carbon sequestration and soil sustainability.

**Challenge V: *Determine the risks of chronic and extreme exposure of ecosystems and humans to biological, hydrological and chemical threats.*** To improve predictive capability and better quantify hazards, we will develop next-generation integrated risk assessment methodologies to evaluate biological, hydrological and chemical threats. Specific examples include more accurate tools for forecasting river flood and drought frequencies, and temporally and spatially explicit tools that map the distribution and transport of pollutants and invasive species (including pathogens) at a range of spatial scales.

**Challenge VI: *Identify strategies and control measures to mitigate impacts of environmental change on ecosystems, ecosystem services and human health.*** Our research outputs already include advice to a wide range of customers. However, we aim to better exploit new approaches in knowledge exchange based on informed, integrated, sustainable environmental management strategies. We will provide science-based advice on the options required to establish good practice in the UK for the selection of appropriate adaptation and mitigation strategies in the face of the combined impacts of climate and other environmental changes. We will focus on a number of key habitats to test predictions of effective management and restoration. For example, in wetlands, key objectives include the identification and quantification of the critical hydrological, biogeochemical and ecological processes that provide ecosystem services.

The delivery and success of *Integrated Science for Our Changing World* also depends on a set of organisational goals concerning: People and Skills, Knowledge, Facilities and Foresight. The organisational goals go hand-in-hand with our research priorities.

### **3. Delivering our Strategy**

#### **3.1 Organisational Governance**

Corporate-level management of CEH is the responsibility of the Executive Board, supported by Finance and Personnel sub-committees. The Science Board is responsible for delivery of the integrated Science Programme. The Executive Board and Science Board collectively will lead delivery of the CEH Science Strategy, including the six overarching challenges and the organisational goals.

CEH has three interdependent Science Programmes - Biodiversity, Water and Biogeochemistry - underpinned by the Environmental Information Data Centre (EIDC). Infrastructure staff provide professional support to all the teams across the organisation. Scientific and infrastructure staff are managed through Sections. Science Programme activity is coordinated through Programme Colleges, each led by a Science Director. Science and Infrastructure Section Heads, together with the Executive Board, form the Senior Management Team, which is responsible for resource management across Science Programmes and Infrastructure, and as such addresses key corporate responsibilities across the organisation.

The Director receives advice from the CEH Advisory Committee (AC) and the CEH Programme Development Group (PDG). The AC advises the Director of CEH on future developments and the research needed to provide evidence-based Government policy. The Committee comprises senior advisors drawn from CEH's key stakeholders. The PDG comprises internationally recognised scientists who annually review the science performance within the Science Programmes against agreed objectives and deliverables, and advise on future strategy.

As a NERC Research Centre, CEH will provide details of how the organisation directly supports the NERC Theme Action Plans and National Capability in an annual Centre Activity and Resource Plan (CARP). CEH will report to NERC annually on its performance. Whilst the CARP and performance report may not be published, CEH intends to publish a review of our achievements, within the context

of our Science Strategy and the impacts of our research, at mid-term and completion of the 2008 - 2013 strategic period.

CEH provides National Capability through support of environmental surveys and monitoring, shared services and facilities, skills and expertise, research infrastructure, training and knowledge exchange and advice to a range of policy-makers and stakeholders. The National Capability Advisory Group (NCAG), a sub-group of the NERC Science & Innovation Strategy Board, will advise on NERC's long-term National Capability needs. The Director of CEH is a member of NCAG.

### **3.2 Meeting our Scientific Challenges**

Our scientific challenges will be addressed through our Science Programmes in conjunction with the EIDC. The Science Programmes and EIDC identified 10 high-level Science Topics and specific Topic Objectives (see Section 4). As members of the CEH Science Programme Colleges, Topic Leaders will support the Science Directors in planning, organising and delivering the Topic Objectives. To coordinate research projects and promote further integration within and between the Science Programmes, Objective Champions will take responsibility for overseeing and highlighting activities within each of the Objectives. Each Objective aligns to a specific Scientific Challenge, thus providing an explicit demonstration of how our Science Programmes and EIDC will together deliver our Science Strategy. In all these activities CEH works closely with NERC, the NERC Theme Leaders and a range of external partners.

CEH has a responsibility to manage and disseminate its data and information holdings for the benefit of internal and external users. This wealth of environmental information and data will be delivered through EIDC. Delivery will be enhanced by the development and application of advanced tools for integrating monitoring, informatics, computational biology, modelling, and Earth Observation. Additional National Capability includes environmental observatories and facilities for large-scale ecological monitoring and survey, and experimental manipulations. Together these experimental, information, and knowledge transfer systems enable near real-time assessments of environmental changes and their implications. Linking of biological, physical and chemical knowledge will address processes at the atmosphere-biota-soil-water interface that underpin ecosystem services.

### **3.3 Science in Partnership**

As outlined in CEH's Science Strategy, *Integrated Science for Our Changing World*, the scientific challenges represent fundamental and complex endeavours that can only be addressed through interdisciplinary and collaborative projects, bringing together the wider research community, policy-makers and practitioners from the outset. We work in partnership to achieve our goals, and collaborate widely with other NERC research and collaborative centres, universities, research institutes, government departments, industry and charities to provide world-class environmental science. We are a well-respected partner in the scientific community, and will deepen our collaborations with research institutes and higher education establishments through our engagement in collaborative research projects and cross-council funding (BBSRC, EPSRC etc.). Particular emphasis will be given to partnering with organisations that can provide the complementary expertise needed to meet our scientific challenges, especially in the fields of social and economic research. We will further develop strategic partnerships with the university sector to promote the benefits we have achieved through the Lancaster Environment Centre (with Lancaster University) and the Environment Centre Wales (with Bangor University). In collaboration with partner universities we will continue to train young graduate and post-graduate researchers.

We will further our integration with other NERC research and collaborative centres with the aim of creating added value across NERC. Integration will embrace not only research and monitoring activities, but also environmental databases and related discovery and delivery services. We will actively contribute to large-scale programmes such as *Living with Environmental Change (LWEC)*, as these will provide key support for the execution of our Delivery Plan. We fully endorse the efforts of the Environment Research Funders' Forum (ERFF) to maximise the coherence and effectiveness of the country's environmental research. In our role as one of the UK's most important custodians of environmental data and co-ordinator of major monitoring programmes, we will engage with the UK

Environmental Observation Framework (EOF) to ensure our monitoring efforts are as effective and efficient as possible.

Our scientific challenges cover the world's most pressing environmental problems. Therefore, it is of the utmost importance that we include policy-makers in our research projects from the outset, in order to ensure that our science targets the right questions and that policy can rely on the best possible scientific evidence. We will continue to develop our long-standing collaboration with the Department for Environment, Food and Rural Affairs (Defra), as well as with the recently created Department of Energy and Climate Change (DECC). Similarly, we will seek to broaden our contacts with other government departments, responding to the need to mainstream environmental policies into other sectoral policies. By default this implies also a stronger collaboration with other public regulators and agencies, such as the Environment Agency and Natural England. With locations across Great Britain, we will develop further our successful collaboration with legislative and executive bodies in Scotland and Wales, such as the Scottish Government and Scottish Environment Protection Agency (SEPA), the Welsh Assembly and the Countryside Council for Wales. We will also seek collaboration with regional and local authorities wherever case studies are needed to solve large-scale environmental problems.

As a consequence of global climate change and a globalised economy, environmental policies are increasingly made at the European and global levels. We will enhance further our support to the European Commission and strengthen our partnership with European bodies such as the European Environment Agency, Eurostat and the Joint Research Centre, e.g. by providing advice in Working Groups and Advisory Panels. Through our co-ordination role in major EU research projects (e.g. Alter-Net, WATCH, NitroEurope) we will actively foster the transfer of research results into EU policy making. Building on our well-established links with UN organisations such as the World Meteorological Organization (WMO) and the United Nations Economic Commission for Europe (UNECE), we will broaden our collaborations with global entities. This will include our contributions to global initiatives such as the Intergovernmental Panel on Climate Change (IPCC) and the upcoming Intergovernmental Panel on Biodiversity and Ecosystem Services (IPBES). In partnership with the International Long Term Ecological Research Network (ILTER) and similar initiatives in the UK and beyond, we will take a leading role in establishing international research infrastructures such as LifeWatch.

In order to maximise the quality of our products and the impact of our research, we will interlink our Science Programmes with those of our sister organisations in the Partnership for European Environmental Research (PEER). PEER is a strategic partnership of CEH and six other major European environmental research centres<sup>1</sup>, which have similar missions and size, with a combined annual budget of approximately 400 million euros and 4,800 staff. Thus, our Delivery Plan will be strategically managed to optimise the knowledge exchange and scientific interaction necessary to create the critical mass necessary for tackling specific questions related to our scientific challenges. This represents an important step towards the Joint Programming of Research in Europe, delivering not only better solutions to environmental problems, but also helping the EU to achieve its aim of becoming the most competitive knowledge-based society in the world.

Public-private partnership is of paramount importance in transferring the results of research into practice, and in accessing skills and knowledge within the private sector. We will therefore foster the engagement of industry, in particular small and medium-sized companies, as partners in our research projects and/or users of our products. We will promote the use of our data through licensing agreements and continue to engage in commercialisation activities, encouraging further spin-out companies based on our research, following the successful examples of Wallingford Hydrosolutions, Microbial Solutions and Oxford Expression Technologies.

We will engage with the public, not only fostering public dialogue and providing impartial and unbiased scientific advice, but also involving people in our research as powerfully demonstrated

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<sup>1</sup> Alterra/University of Wageningen (Netherlands), CEMAGREF (France), JRC-IES (European Commission), NERI/University of Aarhus (Denmark), SYKE (Finland), UFZ (Germany)

through the engagement of volunteers in biodiversity monitoring. Innovative communication tools will help enable a paradigm shift in which science will become more interactive and accessible to the public, involving stronger collaboration with non-governmental organisations.

#### **4. CEH Science Programmes and Environmental Information Data Centre**

Our scientific challenges will be delivered through our interdependent Biodiversity, Water and Biogeochemistry Programmes, with all data outputs integrated within the newly established Environmental Information Data Centre. The Science Programmes have been organised into defined Topics, divided into key Objectives that align to one of our six scientific challenges. This organisational structure provides a simple mechanism for integrating our interdisciplinary research expertise through cross-Programme delivery. It highlights CEH's unique National Capability for integrated science in terrestrial and freshwater ecosystems.

Each year CEH will produce an **Operating Plan** that details the specific project-based deliverables against the Objectives set within each of the 10 Science Programme Topics described below.

##### **4.1 Environmental Information Data Centre**

###### ***Delivering a UK portal into environmental information***

The Environmental Information Data Centre (EIDC) underpins all CEH scientific challenges. Its primary purpose is to provide the capability to co-ordinate our extensive information assets and thereby support integrated environmental research. To achieve this goal requires a corporate approach for the curation and integration of science information assets across all the Science Programmes to make them more readily accessible to all. This novel construct will evolve during the next five years and requires the development of new skills and expertise. The EIDC will develop informatics tools such as the Information Gateway to disseminate CEH data and contribute to NERC's data discovery services. This will meet our wider obligations including those of a NERC Designated Data Centre (DDC) and compliance with the EU INSPIRE Directive. A key deliverable will be the provision of an integrated reference service linking libraries, archives, samples and digital data as an institutional repository.

##### **4.2 Biodiversity Programme**

###### ***Defining biodiversity change and its role in ecosystem structure, function and resilience***

The Biodiversity Programme will maintain and enhance CEH's capability to monitor changes in biodiversity, to undertake survey and experimentation targeting underlying mechanisms and processes, and to develop evidence-based management and mitigation strategies. Priority areas include national surveys to quantify the trends in biodiversity, identification of the main drivers of biodiversity change and measuring and predicting the impacts on ecosystem services and human well-being so that we define the link between biodiversity and function. These will enable the development of practical and sustainable adaptation and mitigation strategies to conserve and restore biodiversity across biological and physical scales.

##### **4.3 Water Programme**

###### ***Delivering science for the sustainable management of catchments and water resources***

The Water Programme will maintain and enhance activities in observing the long-term status of water systems including the morphology, biology and chemistry of lowland and upland rivers and lakes. The data will be used for trend detection, model evaluation and model construction. Priority areas include the establishment of new experimental and field facilities such as: experimental wetland, fish mesocosms, the River Lambourn Observatory, and 'Source to Sea' monitored catchments. These will provide a focus for integrated environmental science and 'laboratories' for the determination of processes and linkages.

##### **4.4 Biogeochemistry Programme**

###### ***Assessing global biogeochemical cycles and the sources, fate and effects of pollutants***

The Biogeochemistry Programme will maintain and enhance monitoring programmes, large-scale field experiments and modelling tools to improve knowledge of biogeochemical cycles and their role in

ecosystem functions and services. Perturbation of biogeochemical cycles (e.g. as a result of land use change) will be quantified and modelled to identify the implications for natural resources such as soil and biota. Integrated risk assessment tools, strategies and control measures will be developed to help protect and enhance ecosystem function for the future. Priority areas include our Carbon Catchments, operation and development of the JULES model with linkage to Earth System Models, large-scale field experiments targeted on pollutant impacts and climate change, and participation in the International Nitrogen Initiative and other international impacts and atmospheric chemistry programmes.

*The figure below illustrates the contribution that Science Programme Topics make to each of the CEH scientific challenges.*

| CEH Programme Topics  | CEH Challenge |             |             |             |             |             |
|---|---------------|-------------|-------------|-------------|-------------|-------------|
|   | I             | II          | III         | IV          | V           | VI          |
| <b>BD-1:</b> Observations, Patterns and Predictions for Biodiversity                | Light Green   | Light Green | Light Green |             |             |             |
| <b>WA-1:</b> Variability and Change in Water Systems                                |               |             |             | Light Green |             |             |
| <b>BGC-1:</b> Monitoring and Interpretation of Biogeochemical and Climate Changes   | Light Green   |             |             | Light Green |             |             |
| <b>BD-2:</b> Ecological Processes in the Environment                                |               | Light Green |             | Light Green | Light Green |             |
| <b>WA-2:</b> Ecohydrological Processes  |               | Light Green |             |             | Light Green |             |
| <b>BGC-2:</b> Biogeochemistry and Climate System Processes                          |               | Light Green | Light Green |             | Light Green |             |
| <b>BD-3:</b> Managing Biodiversity and Ecosystem Services in a Changing Environment |               |             |             |             | Light Green | Light Green |
| <b>WA-3:</b> Science for Water Management   |               |             | Light Green | Light Green | Light Green | Light Green |
| <b>BGC-3:</b> Managing Threats to Environment and Health                            |               |             |             |             | Light Green | Light Green |
| <b>EIDC:</b> Providing Access to Co-ordinated Data Resources and Informatics Tools  | Light Green   | Light Green | Light Green | Light Green | Light Green | Light Green |

The following tables detail the Topic Objectives and their fit to the six CEH scientific challenges, provide examples of National Capability within each of the Biodiversity, Water, Biogeochemistry Programmes and EIDC Topics, and how their outputs map to the NERC Themes. In Section 5 we provide further specific examples of key areas of research and how CEH activities contribute to the delivery of NERC’s Strategic Goal.

### Environmental Information Data Centre (EIDC) Science Topics and Topic Objectives

#### EIDC-Topic 1 Providing access to coordinated data resources and informatics tools

*Giving researchers access to the co-ordinated data resources and informatics tools needed to answer complex, multidisciplinary environmental questions.*

| Topic Objectives  | National Capability activity within the Topic   |
|---|---|
| <p><b>EIDC-1.1</b> Develop a framework to ensure quality, security and reusability of CEH &amp; NERC data. (All Challenges.)</p> <p><b>EIDC-1.2</b> Describe and curate CEH information resources and integrate key data holdings. (All Challenges.)</p> <p><b>EIDC-1.3</b> Provide access to CEH’s key data and information assets, ensure CEH meets its legal obligations for data sharing (INSPIRE, EIR) and promote EIDC’s role as a NERC Designated Data Centre. (All Challenges.)</p> <p><b>EIDC-1.4</b> Advance informatics research to meet CEH data and information needs and to contribute to national and international data sharing and monitoring initiatives (SEIS, GEOSS, Kopernikus). (All Challenges.)</p> | <ul style="list-style-type: none"> <li>Ensuring large-scale and long-term datasets produced by CEH Science Topics are secure and accessible for future use, and are made interoperable to enable integrated research.</li> <li>Delivering NERC Designated Data Centre functions: hosting and providing access to NERC data assets, and providing services to the wider research community.</li> <li>Providing a portal for discovery and delivery of national asset datasets: the CEH Information Gateway.</li> </ul> |
| <p><b>NERC Science Themes</b></p> <p>Natural Hazards</p> <p>Biodiversity</p> <p>Sustainable Use of Natural Resources</p> <p>Environment, Pollution and Human Health</p> <p>Climate System</p> <p>Earth System Science</p> <p>Technologies</p>   | <p>✓</p> <p>✓</p> <p>✓</p> <p>✓</p> <p>✓</p> <p>✓</p> <p>✓</p>  |

# Biodiversity Science Topics and Topic Objectives

## BD-Topic 1 Observations, Patterns, and Predictions for Biodiversity

Deliver long-term, large-scale monitoring and experiments for the collection, provision, analysis and modelling of biodiversity data.

| Topic Objectives  |                 |                |  | National Capability activity within the Topic   |                  |                      |              |
|---|-----------------|----------------|--|---|------------------|----------------------|--------------|
| <p><b>BD-1.1</b> Develop rigorous standards for data collection, quality, management and integration with external sources to improve capability and interpret patterns of biodiversity. (Challenge I.)</p> |                 |                |  | <ul style="list-style-type: none"> <li>National data holdings and surveys on biodiversity loss and change (e.g. BRC, CS, ECN, UKBMS, UK-PN).</li> <li>Soils &amp; DNA archive (e.g. ECN &amp; CS).</li> <li>Expertise in data capture, validation, QA, coordination, management, reporting and dissemination of biodiversity data (e.g. BRC-NBN, ECN, CS, NBiF/NEBC).</li> <li>Operation of Biodiversity Observatories for large-scale, long-term experiments and monitoring (e.g. IMLOTS).</li> <li>National focal point Long Term Ecosystem Research networks (e.g. LifeWatch and ILTER).</li> <li>Evidence-based scientific advice on long-term biodiversity trends and policy (e.g. government and European agencies).</li> </ul> |                  |                      |              |
| <p><b>BD-1.2</b> Provide real-time data collection systems to record and assess changes in the abundance and distribution of biodiversity, from genes to ecosystems. (Challenge I.)</p>                     |                 |                |  |   |                  |                      |              |
| <p><b>BD-1.3</b> Undertake long-term / large-scale monitoring and experiments to detect and attribute the cause and consequences of environmental change. (Challenge II.)</p>                               |                 |                |  |   |                  |                      |              |
| <p><b>BD-1.4</b> Quantify and model interactions to determine the impacts and feedbacks between biodiversity, climate and other environmental change. (Challenge III.)</p>                                  |                 |                |  |   |                  |                      |              |
| NERC Science Themes   | Natural Hazards | Biodiversity ✓ | Sustainable Use of Natural Resources ✓ | Environment, Pollution and Human Health   | Climate System ✓ | Earth System Science | Technologies |

## BD-Topic 2 Ecological Processes in the Environment

Define the mechanisms that drive biodiversity and its response to environmental change.

| Topic Objectives   |                 |                |  | National Capability activity within the Topic  |                  |                      |                |
|--|-----------------|----------------|--|--|------------------|----------------------|----------------|
| <p><b>BD-2.1</b> Determine how interactions between above- and below-ground biodiversity structure ecosystems and their functioning. (Challenge IV.)</p>                                     |                 |                |  | <ul style="list-style-type: none"> <li>Facilities and expertise in developing environmental indicators for ecosystems, including -omics, and remote sensing (e.g. LCM).</li> <li>Controlled environment plant growth facility.</li> <li>Data portals, distribution maps and integrated risk assessments on invasive species and pathogens (e.g. ALARM, DAISIE, GISIN, NNSP).</li> <li>Expertise in biometrics and modelling of biodiversity and ecosystem functions (e.g. IBMs, population processes, community food webs, spatial dynamics; i.e. GB-MOVE, MAGIC).</li> <li>Guidance for policy and government consultations on climate change and adaptation strategies.</li> </ul> |                  |                      |                |
| <p><b>BD-2.2</b> Quantify the impact of invasive species, pathogens and vectors of disease on the population ecology of target species, including humans, and ecosystems. (Challenge V.)</p> |                 |                |  |  |                  |                      |                |
| <p><b>BD-2.3</b> Identify indicators and traits of ecosystem status, and quantitative estimates of resilience and response. (Challenge II.)</p>  |                 |                |  |  |                  |                      |                |
| <p><b>BD-2.4</b> Estimate the impacts of the main drivers and pressures on biodiversity and ecosystem function and model future change. (Challenge IV.)</p>                                  |                 |                |  |  |                  |                      |                |
| NERC Science Themes  | Natural Hazards | Biodiversity ✓ | Sustainable Use of Natural Resources ✓ | Environment, Pollution and Human Health  | Climate System ✓ | Earth System Science | Technologies ✓ |

## BD-Topic 3 Managing Biodiversity and Ecosystem Services in a Changing Environment

Develop and deliver practical and effective strategies to conserve and restore biodiversity and associated ecosystem functions and services.

| Topic Objectives   |                 |                |  | National Capability activity within the Topic   |                  |                      |              |
|--|-----------------|----------------|--|---|------------------|----------------------|--------------|
| <p><b>BD-3.1</b> Develop methods to quantify the link between biodiversity and the provision of ecosystem goods and services. (Challenge VI.)</p>  |                 |                |  | <ul style="list-style-type: none"> <li>Operational capability to co-ordinate, integrate, validate and interpret large-scale, UK-wide integrated environmental assessments and data they generate (e.g. CS, ECN, Agri Env. Assess: Moorehouse, Wytham, Hillesden, Lambourne, CEH 'Source to Sea').</li> <li>Planning and delivery of long-term monitoring, survey and restoration activities at landscape scales.</li> <li>Earth Observation and remote sensing expertise for land use, net primary productivity and data modelling (e.g. LCM).</li> <li>Independent policy advice to government and NGOs, response to UK government consultations.</li> <li>Assessment of the implementation and efficacy of national policy instruments for management of the countryside.</li> <li>Developing methods for valuing ecosystem services and biodiversity.</li> </ul> |                  |                      |              |
| <p><b>BD-3.2</b> Develop and test practical measures to ameliorate the effects of intensive land management, climate change and other anthropogenic drivers on ecosystem processes and services. (Challenge VI.)</p> |                 |                |  |   |                  |                      |              |
| <p><b>BD-3.3</b> Develop integrated environmental assessments and modelling to map and quantify the risks to ecosystem services. (Challenge V.)</p>  |                 |                |  |   |                  |                      |              |
| <p><b>BD-3.4</b> Provide science-based advice on the sustainable use and management of biodiversity and ecosystems. (Challenge VI.)</p>  |                 |                |  |   |                  |                      |              |
| NERC Science Themes  | Natural Hazards | Biodiversity ✓ | Sustainable Use of Natural Resources ✓ | Environment, Pollution and Human Health   | Climate System ✓ | Earth System Science | Technologies |

# Water Programme Science Topics and Topic Objectives

## WA-Topic 1 Variability and Change in Water Systems

Detection and attribution of system responses to environmental drivers – monitoring and modelling over the longer term and larger scales including analysis of uncertainty.

| Topic Objectives  |                   |                |  | National Capability activity within the Topic  |                  |                        |              |
|---|-------------------|----------------|--|--|------------------|------------------------|--------------|
| <b>WA-1.1</b> Continued long-term monitoring and integrated observation of freshwater systems. (Challenge I.)   |                   |                |  | <ul style="list-style-type: none"> <li>Data holdings (e.g. National Water Archive, Flood Estimation Handbook data sets, HIFLOWS UK).</li> <li>Operation of key nationally distributed long-term experimental and monitoring field sites (e.g. LOCAR, Plynlimon, Cumbrian Lakes, Loch Leven).</li> <li>Hydrological observatories from 'Source to Sea' (e.g. Tay, Ribble, Conwy, Thames).</li> <li>Freshwater Ecological databases, monitoring, data co-ordination and supply (e.g. NID, AWMN, wetlands).</li> <li>Informed expert integration, interpretation and analyses of a wide range of national data sets.</li> </ul> |                  |                        |              |
| <b>WA-1.2</b> Quantify variability, and departures from natural historical variability, in water quality, quantity and ecosystems health. (Challenge IV.) |                   |                |  |  |                  |                        |              |
| <b>WA-1.3</b> Model, attribute and predict impacts of climate and land cover change on hydrological and freshwater systems. (Challenge IV.)               |                   |                |  |  |                  |                        |              |
| <b>WA-1.4</b> Management and dissemination of freshwaters data. (EIDC and all Challenges.)  |                   |                |  |  |                  |                        |              |
| NERC Science Themes   | Natural Hazards ✓ | Biodiversity ✓ | Sustainable Use of Natural Resources ✓ | Environment, Pollution and Human Health  | Climate System ✓ | Earth System Science ✓ | Technologies |

## WA-Topic 2 Ecohydrological Processes

Identification and quantification of fluxes, pathways, sources and stores of water, chemicals, sediments and biology and their interactions using data and models at a range of scales (e.g. from laboratory to landscape).

| Topic Objectives   |                 |                |  | National Capability activity within the Topic   |                  |                      |              |
|--|-----------------|----------------|--|---|------------------|----------------------|--------------|
| <b>WA-2.1</b> Identify and quantify sources, fluxes and pathways of water, chemicals and sediments, including incorporation of short-term dynamics into long-term assessment. (Challenge V.) |                 |                |  | <ul style="list-style-type: none"> <li>Linking soil and water processes (e.g. development of tracer methodologies, source attribution of pollutants).</li> <li>Land/water field exposure facility (e.g. Lambourn).</li> <li>Controlled environment facilities (e.g. Fish mesocosms and artificial wetland).</li> <li>UK Fish Tissue Archive.</li> </ul> |                  |                      |              |
| <b>WA-2.2</b> Integrate the effect of urban and rural land use on the ecohydrological functioning of a landscape mosaic. (Challenge II.)   |                 |                |  |   |                  |                      |              |
| <b>WA-2.3</b> Assess the responses of river, lake and wetland ecosystems to ecohydrological drivers. (Challenge II.)   |                 |                |  |   |                  |                      |              |
| <b>WA-2.4</b> Quantify the importance of food web structure and trophic interactions in controlling freshwater ecosystem functions and services. (Challenge II.)                             |                 |                |  |   |                  |                      |              |
| NERC Science Themes  | Natural Hazards | Biodiversity ✓ | Sustainable Use of Natural Resources ✓ | Environment, Pollution and Human Health   | Climate System ✓ | Earth System Science | Technologies |

## WA-Topic 3 Science for Water Management

Provide better tools, models, methodologies, techniques, guidance and scenario analysis to enable improved adaptation, mitigation and restoration.

| Topic Objectives   |                   |              |  | National Capability activity within the Topic  |                  |                        |                |
|--|-------------------|--------------|--|--|------------------|------------------------|----------------|
| <b>WA-3.1</b> Develop next generation methods for river flow frequency estimation and forecasting. (Challenge V.)  |                   |              |  | <ul style="list-style-type: none"> <li>Method development (e.g. Flood Estimation Handbook, LOW-FLOWS).</li> <li>Integrated Modelling capability (e.g. flood forecasting, continuous simulation, water quality, aquifer recharge and chemical risk).</li> <li>Knowledge transfer (training for industry, provision of water industry tools in UK and internationally).</li> <li>Regional and global land surface hydrology models.</li> <li>Invertebrate taxonomy specialism to assess water quality (e.g. QA for EA/SEPA).</li> <li>Centre for Aquatic Plant Management (e.g. Guidance documents/information sheets).</li> <li>Water resources assessment (e.g. monthly hydrological summaries).</li> <li>Unique 'large-scale' method development (e.g. RIVPACS).</li> </ul> |                  |                        |                |
| <b>WA-3.2</b> Assessment of available water resources in a changing world based on long-term scenarios of climate, land use and population growth. (Challenge IV.) |                   |              |  |  |                  |                        |                |
| <b>WA-3.3</b> Better represent hydrological and biogeochemical processes in Earth System Models. (Challenge III.)  |                   |              |  |  |                  |                        |                |
| <b>WA-3.4</b> Develop novel and improved methods to enable the sustainable management of freshwaters and wetlands. (Challenge VI.)                                 |                   |              |  |  |                  |                        |                |
| NERC Science Themes  | Natural Hazards ✓ | Biodiversity | Sustainable Use of Natural Resources ✓ | Environment, Pollution and Human Health  | Climate System ✓ | Earth System Science ✓ | Technologies ✓ |

# Biogeochemistry Programme Science Topics and Topic Objectives

## BGC-Topic 1 Monitoring and Interpretation of Biogeochemical and Climate Changes

Deliver long-term, large-scale monitoring and experiments and assess implications for ecosystem function.

| Topic Objectives  |                 |              |                                      | National Capability activity within the Topic   |                |                      |              |
|---|-----------------|--------------|--------------------------------------|---|----------------|----------------------|--------------|
| <p><b>BGC-1.1</b> Monitor concentrations, fluxes, physico-chemical forms of current and emerging pollutants including greenhouse gases and pharmaceuticals. (Challenge I.)</p>  |                 |              |                                      | <ul style="list-style-type: none"> <li>• UK atmospheric chemistry networks.</li> <li>• Monitor long-term surface fluxes of energy, water, pollutants and GHG (e.g. EMEP super site).</li> <li>• Specialist chemical, radionuclide, stable isotope analytical facilities.</li> <li>• Eco-toxicological and environmental assessment methodologies.</li> <li>• Field exposure and controlled environment facilities.</li> <li>• Long-term / large-scale, environmental observatories and ecosystem monitoring research platforms and networks (e.g. Carbon Catchments, Predatory Bird Monitoring Scheme, Countryside Survey soils).</li> <li>• Monitoring and evaluation of biogeochemical fluxes and stores in energy cropping systems.</li> </ul> |                |                      |              |
| <p><b>BGC-1.2</b> Manage, assimilate and integrate datasets to promote their wider use including linkage to Earth Observation-derived information products. (Challenge I.)</p>  |                 |              |                                      |   |                |                      |              |
| <p><b>BGC-1.3</b> Quantify and attribute changes in biogeochemical cycles and identify the implications for ecosystem function by integrating monitoring data with large-scale experiments and models. (Challenge IV)</p> |                 |              |                                      |   |                |                      |              |
| <p><b>BGC-1.4</b> Develop innovative, effective methods for monitoring fluxes, exposure and effects. (Challenge I.)</p>   |                 |              |                                      |   |                |                      |              |
| NERC Science Themes   | Natural Hazards | Biodiversity | Sustainable Use of Natural Resources | Environment, Pollution and Human Health   | Climate System | Earth System Science | Technologies |

## BGC-Topic 2 Biogeochemistry and Climate System Processes

Quantify biogeochemical and climate system processes, their interaction and response to environmental change.

| Topic Objectives   |                 |              |                                      | National Capability activity within the Topic  |                |                      |              |
|--|-----------------|--------------|--------------------------------------|--|----------------|----------------------|--------------|
| <p><b>BGC-2.1</b> Quantify and model processes that control the emission, fate, bioavailability and impacts of pollutants including nanoparticles. (Challenge II.)</p>   |                 |              |                                      | <ul style="list-style-type: none"> <li>• Modelling approaches to upscale surface fluxes of GHG and pollutants and modelling long-range transport of air pollutants and their precursors (EMEP4UK, FRAME).</li> <li>• Pollutant flux, transfer and toxicity models (e.g. CHUM).</li> <li>• Contribute to global nitrogen cycle modelling (e.g. International Nitrogen Initiative, NEU).</li> <li>• Land surface modelling and Earth Observation-derived information products to link to and underpin Earth System models (e.g. Operation and development of JULES model).</li> <li>• Biogeochemical and ecosystem process understanding and modelling capability to develop integrated modelling platforms (e.g. GB-MOVE-MAGIC).</li> </ul> |                |                      |              |
| <p><b>BGC-2.2</b> Measure and model surface atmosphere exchange of energy, carbon and water and their responses to land use and climate changes. (Challenge II.)</p>   |                 |              |                                      |  |                |                      |              |
| <p><b>BGC-2.3</b> Determine land-climate feedback processes to improve climate model predictions. (Challenge III.)</p>   |                 |              |                                      |  |                |                      |              |
| <p><b>BGC-2.4</b> Develop model frameworks to predict future impact of environmental drivers and their interactions at local, regional and global scales including the quantification of uncertainty. (Challenge III.)</p> |                 |              |                                      |  |                |                      |              |
| NERC Science Themes  | Natural Hazards | Biodiversity | Sustainable Use of Natural Resources | Environment, Pollution and Human Health  | Climate System | Earth System Science | Technologies |

## BGC-Topic 3 Managing Threats to Environment and Health

Development of risk assessment and management tools for carbon, renewable energy and pollutants to protect and enhance ecosystem function.

| Topic Objectives   |                 |              |                                      | National Capability activity within the Topic   |                |                      |              |
|--|-----------------|--------------|--------------------------------------|---|----------------|----------------------|--------------|
| <p><b>BGC-3.1</b> Develop temporally and spatially explicit risk assessment tools for the environment and human health. (Challenge V.)</p>   |                 |              |                                      | <ul style="list-style-type: none"> <li>• Air pollution concentration, deposition and risk maps (e.g. UK Critical Load Modelling and Mapping Focal Centre).</li> <li>• Radionuclide transfers and mobility, counter measures and remediation (e.g. ERICA tool, counter-measure data sheets).</li> <li>• Soil quality, function and remediation.</li> <li>• Support to international and UK policy-makers and regulators on eutrophication, acidification, contamination and climate change issues (e.g. Defra, UN ICP &amp; IAEA, IPCC, EC).</li> <li>• International co-ordination (e.g. UNECE ICP, NEU).</li> <li>• Knowledge transfer to stakeholders (e.g. APIS).</li> <li>• National Greenhouse Gas Emission Inventories for Land Use and associated models (e.g. LULUCF).</li> </ul> |                |                      |              |
| <p><b>BGC-3.2</b> Provide the evidence base for setting Environment Quality Standards, environmental appraisal and remediation methods to enable the sustainable management of ecosystems. (Challenge VI.)</p> |                 |              |                                      |   |                |                      |              |
| <p><b>BGC-3.3</b> Deliver effective advice, models and applied science to provide the evidence base for policy developments. (Challenge VI.)</p>   |                 |              |                                      |   |                |                      |              |
| <p><b>BGC-3.4</b> Produce models, maps, databases and inventories to assess compliance with national and international policies, and evaluate mitigation and adaptation strategies. (Challenge VI.)</p>        |                 |              |                                      |   |                |                      |              |
| NERC Science Themes  | Natural Hazards | Biodiversity | Sustainable Use of Natural Resources | Environment, Pollution and Human Health   | Climate System | Earth System Science | Technologies |

## 5. Delivering NERC's Strategic Goal

CEH's Science Strategy contributes directly to the goals of the NERC Strategy 2007-2012, *Next Generation Science for Planet Earth*:

- “To deliver world-leading environmental research at the frontiers of knowledge:*
- *enabling society to respond urgently to global climate change and the increasing pressures on natural resources,*
  - *contributing to UK leadership in predicting the regional and local impacts of environmental change from days to decades, and*
  - *creating and supporting vibrant, integrated research and communities.”*

The CEH scientific challenges define an integrated approach to tackle fundamental environmental issues facing humankind. In so doing, they address many of the key challenges of the seven Science Themes defined in the NERC Science Strategy: Climate System, Biodiversity, Sustainable Use of Natural Resources, Natural Hazards, Environment, Pollution and Human Health, Earth System Science, and Technologies.

Our strategy will be delivered in consultation with the NERC Theme Leaders, who ensure that NERC develops an appropriate focus in each of their Science Themes. We will inform and support the evolving Theme Action Plans developed by the NERC Theme Leaders to ensure the successful delivery of NERC's Science Strategy and provision of National Capability. Similarly, we will develop our National Capability in concert with the National Capability Advisory Group (NCAG), a sub-group of the NERC Science & Innovation Strategy Board, who advise on NERC's long-term National Capability needs.

Environmental research is founded on knowledge that has been established over many years. NERC has identified the need for National Capability to enable the UK to deliver world-leading environmental science, support national strategic needs, and respond to emergencies. It includes the research and development activities that keep this capability at the cutting-edge.

CEH will also participate and contribute to an innovative partnership led by NERC, LWEC, which spans research councils, government and business. In so doing, we will engage with other scientific, societal and industrial communities including social sciences and engineering to help develop ways of mitigating and adapting to climate change.

CEH makes a direct and significant contribution to delivering the objectives of the NERC Science Strategy. A key CEH role is the provision of National Capability and innovative research in support of Research Programme objectives as set out within each of the seven NERC Science Strategy Themes and detailed in the Theme Action Plans. Below we provide some examples of how we meet these Theme objectives.

*The following descriptions should be read in conjunction with the CEH Science Programme details in Section 4 above.*

### 5.1 Climate Systems

Broad areas of National Capability provided by CEH contributing to this theme include:

- Field measurements and modelling of surface-atmosphere exchange of energy, carbon and water.
- Long-term spatial and time series measures of habitat type, species distribution, abundance and diversity, and related biological and chemical data against which models can be tested.
- Integrated framework for the long-term management of CEH's environmental data.

The analysis of data associated with large-scale monitoring and experimental activities is crucial to unravelling how the UK flora, fauna, habitats and ecosystems are changing. Coupled to these

assessments is the identification of the main drivers of change - physical and chemical (nitrogen deposition, ozone, rainfall, temperature, etc.) or biological and social (changes in farming practices, invasive species, emerging disease, habitat fragmentation, etc). Further incorporation of physical and biological data with climate-based models (e.g. JULES) will provide novel opportunities to investigate, predict and experimentally test the factors that influence pollutant transport and the factors that influence species range and boundaries under different climate scenarios.

## **5.2 Biodiversity**

Broad areas of National Capability provided by CEH contributing to this theme include:

- Interdisciplinary expertise, platforms, environmental observatories, large-scale experimental sites and long-term facilities for ecological research.
- Systems for long-term spatial and temporal monitoring, recording, measuring and valuing biodiversity (including novel biodiversity) across ecological scales.
- Integrated framework for the long-term management of CEH's environmental data.
- Time series assessment, management and supply of data on the stock and change of biodiversity.

Working in partnership, CEH will co-ordinate, enhance and extend national long-term datasets and monitoring activities by developing approaches that include novel molecular tools, remote sensing and computational methods, for evaluating, quantifying, modelling and predicting threats to above- and below-ground biodiversity. This allows assessment and prediction of the consequence of changes in biodiversity (both loss and gain) on the stability of ecosystem processes at a range of biological (community, population, species and genetic), spatial and temporal scales. Critically, CEH is able to provide a multidisciplinary approach in providing policy-makers with the evidence needed to understand and develop strategies to mitigate the impact of global environmental change and to quantify and value biodiversity and the services it provides.

## **5.3 Sustainable Use of Natural Resources**

Broad areas of National Capability provided by CEH contributing to this theme include:

- Interdisciplinary expertise from plot to catchment scale.
- UK Water Quantity and Quality Assessment.
- National monitoring (e.g. ECN, CS) and evaluation of the state, pressure and controls on sustainable use of soils.
- Assessment of the atmosphere-vegetation-soil-water-interface to support policy development for the protection of environmental services.
- Integrated framework for the long-term management of CEH's environmental data.

CEH provides unique long-term monitoring data from plot to catchment scale including outdoor laboratories for experimentation. Methods for trend detection, characterisation of fluxes of water and chemicals, water resource assessment and integrated assessment of air pollution are all developed and facilitated as part of this National Capability activity. In addition, we provide from this an integrated modelling capability in water, soil and atmospheric chemistry, and in water flows, storage and aquifer recharge. We will link *in situ* site-based research and survey with remotely sensed data to provide refined assessments and large-scale forecasting of the impacts of land use and climate change scenarios on the sustainable use of natural resources such as water and soil and the ecosystem services they deliver at a range of temporal and spatial scales. CEH has an established track record in developing large-scale manipulation and catchment-scale research to underpin this work and will further develop this in the 'Source to Sea' environmental observatories. Such studies will also include life-cycle assessments related to agricultural and land use change, e.g. the possibility of widespread growth of biomass crops. The EIDC provides the facility for integrating the wealth of data collected under this activity and makes it available to the science community.

#### **5.4 Natural Hazards**

Broad areas of National Capability provided by CEH contributing to this theme include:

- UK flood and drought risk assessment.
- Integrated framework for long-term management of CEH's environmental data.

CEH performs a unique role in the assessment of flood risk at the UK scale. We manage data, especially the National River Flow Archive and the HIFLOWS UK data, facilitate data integration and availability through the EIDC, develop methodologies, notably the Flood Estimation Handbook and LOW-FLOWS 2000, and construct predictive models at a range of spatial and temporal scales to understand the changing water cycle. We maintain key linkages with the Met Office, through the Joint Centre for Hydro-Meteorological Research, and the British Geological Survey to further develop flood forecasting methods, and contribute to training for industry and stakeholders.

#### **5.5 Environment, Pollution and Human Health**

Broad areas of National Capability provided by CEH contributing to this theme include:

- The UK national maps of concentration and deposition of atmospheric pollutants including the modelling of long-range transport of UK air pollutants at regional and national scales.
- Trends in organic, metal and radionuclides contaminants and their effects on biota and human health.
- Integrated framework for the long-term management of CEH's environmental data.
- UK portal for non-native species and arthropod vectors of disease.

Working with the wider community, CEH will develop integrated risk assessments of how multiple environmental changes affect biodiversity and ecosystem services. This will include monitoring of concentrations, fluxes, physico-chemical forms of current and emerging pollutants including radionuclides, nanoparticles and pharmaceuticals. Risk assessments for biota associated with these phenomena will be enabled through detailed epidemiological and molecular studies that build on the BRC-led development of a non-native species and arthropod vectors of disease portal for Britain. We will provide the evidence base for setting Environment Quality Standards, environmental appraisal and remediation methods to enable the sustainable management of ecosystems based on an integrated and holistic approach.

#### **5.6 Earth System Science**

Broad areas of National Capability provided by CEH contributing to this theme include:

- Measurement and modelling of energy, water fluxes and the biogeochemical cycling of carbon, nitrogen and a range of metals.
- Development and operation of JULES model and analysing Earth Observation datasets to underpin Earth System Models.
- Integrated framework for the long-term management of CEH's environmental data.

We are developing and supporting a community land surface model (JULES) to provide the land surface component into Earth System Models. This is now moving to the incorporation of new processes and the 'pull-through' into Earth System Models. Data provision at a range of scales ensure output is benchmarked is a priority together with development of algorithms and techniques to derive Earth Observation derived datasets to assist the development and testing of global and regional models (e.g. land use and cover, biomass burning, atmospheric trace gases, net primary productivity). We will continue to develop spatial modelling systems for the UK and beyond to predict and assess the impacts of environmental change. Much of our atmospheric chemistry National Capability is of relevance to this theme including our activities to resolve changes and controls on the global reactive nitrogen cycle.

#### **5.7 Technologies**

Broad areas of National Capability provided by CEH contributing to this theme include:

- Specialist chemical, radiochemical and ecotoxicology analytical facilities, techniques and exposure facilities (e.g. Life Sciences mass spectrometry facility).
- Long-term, large-scale, field experimental and monitoring research platforms and networks (e.g. Water Catchments, Carbon Catchments, LifeWatch, Hydrological observatories from ‘Source to Sea’).
- Expertise and facilities (e.g. molecular ecology, evolutionary biology and functional genomics).
- Integrated framework for the long-term management of CEH’s environmental data.

New developments in technologies and techniques are a core component of our research-led science programme. These range from development of new measurement techniques in the field for the measurement of changes in atmospheric chemistry, deployment of intelligent sensors in the field and our state-of-the-art laboratory analytical and microbiological facilities. The focus on new approaches enables our science to be future-proofed through investigation of emerging interest, novel equipment, analysis of novel compounds and at detection limits, time steps and spatial scales previously impractical. Earth Observation is a fast-moving area and CEH develops algorithms and techniques to interrogate Earth Observation datasets to assist the development and testing of models. We will also increase CEH's informatics capabilities through new techniques for data delivery, exploration and integration.

## **6. Organisational Goals**

The delivery and success of *Integrated Science for Our Changing World* depends on a set of organisational goals that maximise the impacts of our research across our six overarching scientific challenges. The organisational goals are led by infrastructure staff in concert with scientists throughout CEH.

### **6.1 People and Skills**

*Develop and implement the people-management approaches that will best support the creation and transfer of knowledge in our science. In doing so, we will be seeking to take forward the ideas within the people component of the NERC strategy recognizing the key role they play in delivering our objectives.*

#### **6.1.1 Resourcing**

To attract and retain the best staff so that we can deliver our strategy, we will select, manage and develop people in line with appropriate best practice. We will provide a stimulating, safe and healthy working environment, consistent with NERC policy and UK legislation. Our people management will be monitored and evaluated through our balanced scorecard approach, annual staff surveys and Investors in People accreditation.

#### **6.1.2 Learning and Development**

The skills and knowledge of our staff will be developed to enable knowledge creation and knowledge exchange. To maximise the potential of CEH scientists, specialists and professional support staff, we will provide proactive support for career development, investing in staff training and development and utilising the Investors in People standard as a benchmark.

#### **6.1.3 Career Development**

To maximise the potential of CEH scientists, specialists and professional support staff, we will provide proactive support for career development, again utilising the Investors in People standard as a benchmark.

#### **6.1.4 Creating Flexibility**

We aim to create a flexible culture with scientific integration, partnership, and collaboration valued both across internal teams and with our partners in the community. In support of this goal, we will facilitate staff interaction with community partners including interchange and opportunities for visiting scientists.

### **6.1.5 Investing in the future**

In partnership with UK universities, we will train and invest in the next generation of environmental scientists, in accordance with our mission, through studentships for PhD study, the new Research Associate Scheme and other appropriate initiatives.

## **6.2 Knowledge**

*Deliver relevant research that makes a measurable contribution to building a sustainable economy and improving quality of life.*

### **6.2.1 Accessing Information**

CEH's scientists need to access third-party information including data, models and materials in order to carry out world-class research and establish meaningful partnerships. These resources will be accessed in an effective and efficient manner, enabling our scientists to focus on research. In-licensed third-party data will be centrally managed and made available across CEH through improved intranet resources and the CEH Information Gateway. Closer working relationships will be established with organisations that most frequently provide data to CEH to minimise future contractual negotiations. Information will also be accessed through people exchange, facilitated by the objectives of People and Skills (Section 6.1).

### **6.2.2 Publishing, Licensing & Commercialisation**

CEH will endeavour to make all our scientific publications available through the NERC Open Research Archive, and develop a publishing strategy to increase the numbers of publications and to increase our exposure through higher impact journals. We will develop CEH's role as a respected publisher in environmental sciences and in so doing develop a series of themed, opinion-leading publications, linked to our past impacts and future goals. We are a major custodian of environmental data. Project activity, analyses and the data we generate and store are subject to CEH Quality Assurance standards; projects are regularly audited for compliance. Our data will be made more widely available and accessible, e.g. through increased functionality of our website and via CEH's Information Gateway. We will continue to protect and develop our intellectual property (IP), whether in the form of datasets, software or patents, and exploit our IP through licensing or spin-out companies in order to maximise the impact of our research and ultimately generate appropriate financial returns. Commercial partners will be sought for co-development projects to ensure such work is relevant and achieves its ultimate social and economic potential. More effective and efficient licensing processes and systems will be developed to increase accessibility to CEH's datasets and to better address the needs of our commercial partners.

### **6.2.3 Partnership**

CEH will increasingly approach partnerships in a strategic manner in order to maximise the impact of our research. Formal relationships with social and economic scientists will be established as a matter of priority, thereby seeking to achieve meaningful scientific integration. We will engage in Joint Programming where relevant, interlinking our Science Programmes with those of partner organisations. CEH will continue to remain responsive to our stakeholders' evolving requirements through engagement with NERC's Theme Leaders and the National Capability Advisory Group, and regular dialogue with non-government organisations and government departments and agencies alike. Furthermore, we will conclude a partner perception survey to highlight issues and opportunities for future development.

### **6.2.4 Science, Society and Policy**

Our Science in Society and Science into Policy activities will be reviewed and new corporate strategies established. We will train and support our scientists to establish them as thought-leaders and trusted sources to the media and policy-makers. CEH will communicate and engage with society through the media, events and established fora including science festivals and Cafés Scientifiques. Sponsorship and partnerships will be sought where such relationships will improve the understanding, application and impact of our science. In this regard activities will be co-ordinated to achieve greater effectiveness through initiatives such as the Beacons for Public Engagement and Sciencewise-ERC.

We will extend our relationships with policy-makers, provide targeted communications, participate in public consultations and promote our participation in expert groups and committees to inform legislation across the UK, Europe and beyond.

### **6.3 Facilities**

*Establish facilities and equipment that support cutting edge environmental research in an environmentally sustainable fashion.*

#### **6.3.1 New Laboratories and Plant Growth Facilities**

We are extending the recent development of laboratory facilities at Bangor, Lancaster and Edinburgh with new state-of-the-art laboratory facilities at Wallingford. The facilities are designed to current specified needs that support the delivery of world-class science and will be completed in 2010. In addition we will regularly reassess the laboratory needs to ensure that we maintain the facilities to a very high standard. New Plant Growth facilities are under construction at Wallingford using the most modern designs in 'Grow Dome' technology, replacing existing, aged glasshouse facilities, allowing more controlled environmental conditions.

#### **6.3.2 Building, Office and Storage Refurbishment**

We will continue our long-term building refurbishment programme covering all structures, plant and equipment to ensure that the working environment for all our staff is safe and fit for purpose. Appropriate space will be provided to new and transferring staff, and the programme will be scheduled to minimise the disruption across the organisation. The creation of more effective archive and storage facilities will include a centrally managed CEH Archive at Lancaster supplemented by smaller local storage facilities at Wallingford, Bangor and Edinburgh for items requiring more frequent access. These developments will enhance existing environmental management controls at all sites to contribute towards reducing CEH's environmental footprint.

#### **6.3.3 Access to External Facilities**

CEH will continue to retain access to a wide range of external facilities, either directly owned or through access agreements with landlords, in order to support a wide range of ecological and hydrological research. These sites will be regularly assessed to ensure maximum benefit is derived from their use.

#### **6.3.4 Information Technology**

Information Technology plays a vital role in both supporting and enabling CEH science as well as day-to-day operations. CEH is in the process of implementing a number of IT projects to improve and extend the existing IT infrastructure. Key projects that support the Delivery Plan include: High Performance Computing cluster for data management and modelling, advanced video-conferencing facilities (Access Grid rooms) to facilitate communication and knowledge exchange, Storage Area Networks across CEH to consolidate data onto dedicated storage equipment, and investment in appropriate new and emerging technologies.

### **6.4 Foresight**

*Secure resources, information, skills and finance, enabling CEH to address future environmental problems.*

#### **6.4.1 Sustainability**

We will ensure that CEH is financially sustainable and manages resources to support our Science Strategy by delivering a balanced budget whilst meeting the NERC guidelines for appropriate operational and financial control, and sound business management. To achieve these objectives, we will regularly review and develop greater in-depth understanding of the underlying science drivers and their impact on resource developments.

#### **6.4.2 Transition & Integration Programme**

The T&I programme will maintain its focus on the extensive programme of change across CEH and will ensure that we have in place the appropriate resources necessary to deliver our science. We will also continue to look forward to how we will use and integrate our new resources to best effect across the four retained sites in order to lead and develop new science initiatives for CEH.

#### **6.4.3 Skills**

We will use workforce planning techniques and income projections to develop appropriate workforce plans for the future. We will ensure that plans are communicated and implemented appropriately to ensure we have the people with the right skills to meet our future needs; and we will do this through recruitment management, organisational development and our careers initiative. We will participate in NERC's People & Skills network and continue to work with the research community to support studentships and research fellows in areas where expertise is needed for the future and particularly to maintain and develop National Capability.

#### **6.4.4 Quality Assurance**

CEH will continue to adopt the quality assurance principles set out in the Joint Code of Practice for Research issued by NERC, BBSRC, Defra and FSA. We will focus on ensuring quality assurance is a key part of project management by working with science leads and their teams in order to develop a best practice model as part of the CEH way of working. Specifically, the CEH Analytical Chemistry Laboratories at Lancaster are UKAS-accredited to ISO17025. All other activities prescribe to a minimum standard of good laboratory practice and adherence to the Defra Joint Code of Practice for Research.

#### **6.4.5 Horizon Scanning**

In the context of organisational goals, our horizon scanning is looking beyond the T&I programme to identify longer-term science trends both in terms of content and ways of working. The CEH Programme Development Group and Director Advisory Committee play a key role in evaluating activity and in advising CEH and its research staff on future plans and priorities. By working with key representatives across NERC and the wider science community, CEH will ensure that it manages its longer-term science plans and resources in support of sustainability and to meet critical national and international needs in economic, political and policy developments.

#### **6.4.6 Environmental Management**

We will develop an environmental policy for CEH consistent with NERC's environmental policy to lead this field in the public sector. We will ensure that we consider environmental issues in our planning and ways of working and minimise our impact where possible. We will ensure that we engage and work with staff across sites and provide a framework of information and support on environmental issues and concerns.

## Annex: Glossary

|                |  |
|----------------|--|
| <b>BBSRC</b>   | Biotechnology and Biological Science Research Council        |
| <b>BGS</b>     | British Geological Survey                                    |
| <b>BRC</b>     | Biological Records Centre                                    |
| <b>BMS</b>     | Butterfly Monitoring Scheme                                  |
| <b>CARP</b>    | Centre Activity and Resource Plan                            |
| <b>CCW</b>     | Countryside Council for Wales                                |
| <b>CEH</b>     | Centre for Ecology & Hydrology                               |
| <b>CHES</b>    | Climate, Ecological and Hydrological Research Support System |
| <b>CS</b>      | Countryside Survey   |
| <b>DECC</b>    | Department of Energy and Climate Change                      |
| <b>Defra</b>   | Department for the Environment, Food and Rural Affairs       |
| <b>EA</b>      | Environment Agency   |
| <b>EC</b>      | European Commission  |
| <b>ECN</b>     | Environmental Change Network                                 |
| <b>EIDC</b>    | Environmental Information Data Centre                        |
| <b>EOF</b>     | UK Environmental Observation Framework                       |
| <b>ERFF</b>    | Environment Research Funders' Forum                          |
| <b>FSA</b>     | Food Standards Agency  |
| <b>GISIN</b>   | Global Invasive Species Information Network                  |
| <b>JULES</b>   | Joint UK Land Environment Simulator                          |
| <b>IMLOTS</b>  | Isle of May Long Term Study                                  |
| <b>IMOGEN</b>  | Integrated Model Of Global Effects of climatic anomalies     |
| <b>LCM</b>     | Land Cover Map   |
| <b>LOCAR</b>   | Lowland Permeable Catchment Thematic Research Programme      |
| <b>LTER</b>    | Long Term Ecosystem Research                                 |
| <b>LWEC</b>    | Living with Environmental Change                             |
| <b>N-BIF</b>   | NERC- Bio-Informatics Facility                               |
| <b>NBN</b>     | National Biodiversity Network                                |
| <b>NCAG</b>    | National Capability Advisory Group                           |
| <b>NE</b>      | Natural England  |
| <b>NERC</b>    | Natural Environment Research Council                         |
| <b>NEBC</b>    | NERC Bioinformatics Centre                                   |
| <b>NNSP</b>    | Non-Native Species Portal                                    |
| <b>NRFA</b>    | National River Flow Archive                                  |
| <b>PDG</b>     | Programme Development Group                                  |
| <b>PEER</b>    | Partnership for European Environmental Research              |
| <b>RIVPACS</b> | River Invertebrate Prediction and Classification System      |
| <b>SEPA</b>    | Scottish Environment Protection Agency                       |
| <b>SNH</b>     | Scottish Natural Heritage                                    |
| <b>UK-PN</b>   | UK- Phenology Network  |
| <b>UNECE</b>   | United Nations Economic Commission for Europe                |
| <b>WMO</b>     | World Meteorological Organization                            |