# Contents

NERC investment creates jobs and growth across the UK  
Introduction – Environmental science and innovation for a changing world  
Ozone hole – NERC science protects lives and the environment  
Air pollution – NERC research improves air quality  
Energy and resources – NERC enables growth through efficient regulation  
Environmental hazards – NERC science saves lives and money  
Climate change – NERC research helps us manage the effects  
Water – NERC science for clean, secure water and healthy industry  
Skills – NERC delivers top talent and skills for UK economic growth  
Evaluating our performance  
NERC input and output metrics  
Notes and references
NERC investment creates jobs and growth across the UK

The Natural Environment Research Council's investment in environmental science and innovation:
- creates jobs, drives economic growth, increases productivity and reduces costs across the whole economy
- benefits industry, government and charity

70% of NERC funding lands outside London and South East, creating jobs and economic growth across the UK.

Sectors:
- Environment
- Natural resources
- Water
- Energy
- Agri-food
- Construction /infrastructure
- Healthcare
- Aerospace, defence & marine
- Transport

NERC science:
- has global reach and impact
- provides international leadership, influence and market opportunities for the UK

Relative size of circles shows extent of impact in different areas based on a sample of REF 2014 and NERC Impact Awards 2015 case studies.
Introduction

Environmental science and innovation for a changing world

NERC’s strategy, The business of the environment, explains why the environment is everyone’s business. We depend on the environment for shelter, heat, light, food and water – all provided by globally interconnected trade, transport and communications. The world’s population is growing by around one billion every 12 years. Now more than half of us live in cities and more than half the countryside is used for agriculture. People are the dominant source of change in the UK and across the planet. We aspire to escape poverty and improve our living standards. Achieving this while living within the Earth’s limits is the great challenge of the 21st century.

NERC funds the science that is vital for meeting this challenge. We work in partnership with business, government and civil society. Each year we invest £330m in cutting-edge research, training and innovation in UK universities and research centres. We invest in discovery science to understand how the Earth works: past, present and future. We invest in strategic research so that society can benefit from natural resources, build resilience to environmental hazards and manage environmental change. And we invest in translation activities that help business, government and society use our science knowledge. Together we deliver new ways of living, doing business, escaping poverty and growing economies.

This year’s Impact Report draws on a wealth of new evidence to show how NERC investment drives UK prosperity and wellbeing. Sustained NERC investment and partnership generates large, long-term economic and social benefits.

NERC environmental science is highly interdisciplinary, collaborative and leveraged

Our quest to understand and predict the physical, chemical, biological and human processes on which our planet and life itself depends – and then to manage our environment responsibly as we pursue new ways of living, doing business and growing economies – demands collaboration involving many fields of research and partners.

Recent studies show that NERC environmental science is highly interdisciplinary and collaborative, attracting significant co-investment (leverage):

- 92% of UK environmental and Earth science publications are interdisciplinary (as measured by citation distance) and high quality (as measured by field-weighted citation impact).
- Environmental and climate science impacts were found in all but one of 36 disciplines (units of assessment) in the REF2014 evaluation of quality and impact of university research.
- 89% of NERC impacts were co-funded with industry (21%), government (60%), charity (15%) or international partners (29%).
- NERC leverages at least £117m pa in public and private sector investment. For UK science as a whole, every £1 of public investment in research leverages an additional £1.36 in private funding.
Ozone hole
NERC research protects lives and the economy

NERC scientists were the first to discover damage to the ozone layer high in the Earth’s atmosphere. NERC research was crucial to the ratification of the 1987 Montreal Protocol curbing the use of man-made ozone-depleting chemicals, now widely recognised as among the most successful international environmental agreements of all time.

In 1985, scientists from NERC’s British Antarctic Survey (BAS) discovered a marked thinning of the ozone layer in the upper atmosphere, which protects the planet from harmful ultraviolet (UV) rays. This discovery depended on collection and analysis of over 30 years of Antarctic atmospheric data measurements, and prompted the publication of a seminal 1985 Nature paper.9

NERC research supported the case for the Montreal Protocol in 1987, an international treaty designed to protect the ozone layer by banning the global production of ozone-depleting substances.10

Without NERC science, it would have taken an estimated five to ten years longer to discover the ozone hole11, delaying the Montreal Protocol and increasing the negative effects of UV damage.

Impact
NERC investment in ozone research has generated enormous environmental, societal and economic benefits. Without Montreal, the UN Environment Programme has estimated that the number of global skin cancer cases would have been 14% higher by 2030. NERC science continues to protect the ozone layer by identifying new ozone-depleting substances and monitoring banned substances in the atmosphere. If current rates of recovery persist, the ozone layer will be fully restored by around 2075.

A NERC-commissioned analysis by Deloitte estimated that, by reaching international agreement 5-10 years earlier13, NERC research:

- Saved the UK £1.3bn annually – £6.1bn-£11.2bn in total:
  - Saved almost 300 lives per year from skin cancer in the UK alone, reducing annual healthcare costs by up to £560m – £2.6bn-£4.8bn in total
  - Protected farmers’ livelihoods by reducing UV damage to crops, averting annual losses worth up to £740m – £3.4bn-£6.4bn in total.
- Reduced UV damage to buildings constructed with polymer-based materials14, reducing repair costs expenditure and prolonging buildings’ lives.
- Strengthened UK leadership, increasing soft power and influence over international agreements such as the Antarctic Treaty.

Investment
Through BAS, NERC invested £14.1m in ozone monitoring since 1957. Between 2004 and 2010, NERC made grants worth an average of £1.5m annually to ozone-related research15.
Air pollution

NERC research improves air quality

Air pollution is a serious problem for the UK. It causes an average of 29,000 premature deaths per year, reduces agricultural yields and damages buildings, woodlands and other ecosystems. Since 1990, NERC research has influenced policies which have reduced major air pollutants in the UK, generating total benefits worth at least £31bn and perhaps as much as £82bn.

NERC research fed into the first international treaty on acid rain, the 1979 Convention on Long-range Transboundary Air Pollution (CLRTAP), which obliges countries to cut emissions of sulphur oxides, nitrogen oxides, volatile organic compounds, ammonia, heavy metals and persistent organic pollutants. From 1983 NERC scientists pioneered the first truly international project on acid rain, leading the UK to begin a £6bn programme to cut air pollution.

**Investment**

NERC invests around £3m a year in air-pollution research. This directly supports international agreements, strengthening the UK’s negotiating position.

**Impact**

A NERC-commissioned analysis by Deloitte suggests that NERC science:

- Influenced pollution-reduction policies that created £31bn-£82bn of UK economic benefits since 1990 – equivalent to at least £1.2bn a year.
- Provided the evidence behind a 10-year programme to reduce sulphur dioxide and nitrogen oxides, starting in 1990 and worth £6bn (€1.5bn in 2015 prices). This led to a fall in these pollutants worth an estimated £17bn-£40bn – a net benefit of £6bn-£29bn.

The Air Pollution Information System (APIS) lets local government assess environmental impacts of proposed developments. This helps avoid over-cautious regulation while protecting the environment. APIS was used to ensure the £25m London Ashford Airport expansion could go ahead without damaging the Dungeness Special Area of Conservation.

The Clean Air for London (CleanLo) project helps reduce human exposure to particulate matter (PM) pollution. CleanLo data was incorporated into the London Air Quality Network website, which offers a mobile app used by over 20,000 Londoners to view daily air-quality reports and avoid high-pollution areas. Defra estimates PM pollution costs the UK £20bn pa in health damage.

NERC investment helps individuals manage their exposure to air pollution. It supports the National Pollen and Aerobiology Research Unit’s daily pollen forecasts. These are used by the Met Office, GlaxoSmithKline and media such as the Daily Telegraph. They help sufferers manage their symptoms and avoid absences from work. Hay fever is currently estimated to cause 4m sick days per year, incurring annual productivity losses and health damage worth £970m.

UK air pollutant emissions 1980-2013

![UK Air Pollutant Emissions 1980-2013](image-url)
Energy and resources
NERC enables growth through efficient regulation

Energy generation and resource extraction make an important contribution to the UK, adding almost £35bn of gross value to its economy in 2013.24 NERC research has been prominent in supporting the development of energy industries; it stimulates private investment, develops new technology and increases competition by lowering barriers to entry, making it cheaper for firms to explore possible activities in a particular area without having to invest in drilling expensive test wells. It also enables more efficient regulation for safe, secure, cheaper and more sustainable resource use.

Impact
A NERC-commissioned analysis by Deloitte27 shows that NERC investment has produced huge benefits:

CARBON CAPTURE AND STORAGE
Enabling new industries – By monitoring the Sleipner carbon storage site in the North Sea, NERC’s British Geological Survey (BGS) was the first organisation to identify CCS as a viable option to reduce greenhouse gas emissions, giving the UK competitive advantage and the opportunity to meet emissions targets at lower cost.

Increasing investment – NERC research has identified that a cumulative carbon emissions target, rather than annual targets, is a better way to limit climate change. Shell has identified this as central to its decision to invest $1.35bn in a Canadian CCS facility.

Investment
NERC invests £6.6m a year in research relevant across various energy sectors25:

- **Shale gas**
  - £800k
  - Supports safe development, enabling efficient regulation

- **Carbon capture and storage**
  - £1.9m
  - Critical to development of CCS, estimated to cut cost of meeting 2050 climate target by £30-£40bn26

- **Oil and gas**
  - £1.6m
  - Has led to new technologies adopted by industry
WIND ENERGY

Enabling new industries – Igigawatt of wind energy capacity in Eskdalemuir, Scotland will go ahead after NERC science showed it posed no threat to human health or to a nearby MOD installation. This will create gross value added for the UK economy estimated at £1.2bn over 25 years in present value terms, or an annual average of £50m.

More efficient regulation – Scientists at NERC’s National Oceanography Centre (NOC) showed offshore windfarms do not contribute to coastal erosion, saving the industry £3.6m in monitoring costs.

NUCLEAR ENERGY

Enabling new industries – BGS is working to develop the UK’s geological disposal industry. It generates commercial income of around £1m pa for international advice on the diffusion of radioactive gases through rocks.

More efficient regulation – Research into the effects of radioactivity on wildlife at NERC’s Centre for Ecology & Hydrology (CEH) has saved the public sector £655k pa through revisions of the UK Post-Chernobyl Monitoring Programme and ceasing annual payments to farmers.

OIL AND GAS

Enabling safe development of energy sources – BGS’s assessments of the Bowland Basin in northwest England have identified potential shale gas resources of 23.3-64.6 trillion cubic metres. BGS monitoring of groundwater contamination and micro-seismic earth movements informs regulators and industry to ensure safe development of shale gas extraction.

Saving industry costs – The NERC-funded National Geological Repository (NGR) makes more than 23,000 rock cores from around the UK available for inspection, letting energy firms avoid unnecessary drilling costs of around £12m per well and enabling around £390m of economic growth each year.

New technology for industry – BGS was central in developing new geomagnetic methods for surveying well boreholes. These means smaller reserves can be targeted and more oil and gas extracted. This has generated cost savings of up to £330k per day for deep-water drilling.

Nuclear

£1.7m

Improves understanding of environmental effects of nuclear waste disposal, benefiting public health

Wind

£600k

Facilitates new projects and speeds up planning
Environmental hazards

NERC science saves lives and money

Environmental hazards such as extreme temperatures, floods and volcanic eruptions can threaten human life, infrastructure and wildlife. These events are unavoidable, but better scientific understanding can help minimise their harmful effects. NERC scientists provide information that lets government and business manage these risks more effectively. This has improved health outcomes and increased private-sector activity while reducing costs for the UK government, companies and individuals.

**Investment**
Over the last five years NERC investment in research on environmental hazards has averaged £12.8m per year.

**Impact**
A NERC-commissioned analysis by Deloitte shows that NERC investment has produced enormous benefits. NERC research:

**SEASONAL WEATHER EXTREMES**
NERC research improves forecasts, minimising deaths, economic disruption and public spending. NERC scientists developed high-speed wind forecasts that are more accurate and can predict further into the future. The Met Office included these warnings in the National Severe Weather Warning Service from 2011. It estimates these warnings save 23 lives a year, valued at £41m; reduce construction industry costs (£43m); provide efficiency savings to the emergency services (£51m); improve aircraft routing (£120m); reduce in-flight delays (£5m); and save 352,000 tonnes of CO2 by cutting fuel use.

**FLOODING**
NERC research enables earlier flood warnings and improves prediction, protecting lives and reducing flood damage by up to 10%, saving £76m+ pa. Early flood warnings increased from two to five days in advance due to a new model developed by NERC's Centre for Ecology & Hydrology (CEH) in combination with high-resolution weather forecasts. The Met Office estimates that such warnings can avoid 6-10% of flood damage. Based on Environment Agency flood damage estimates, this could cut annual costs by £76m-£127m.

**VOLCANIC ERUPTIONS**
NERC science helped minimise disruption of aviation by volcanic ash during the 2010/11 Icelandic eruptions, saving airlines up to £290m a day and reducing passenger delays.
NERC research was essential in the flexible staged lifting of the flight ban after the 2010 Eyjafjallajökull eruption, avoiding unnecessary disruption that was costing the global airline industry up to £300m a day in lost revenues. Improved risk assessment practices cut the number of flight cancellations after the 2011 Grímsvötn eruption by 98% - 900 disrupted flights around Grímsvötn versus 42,600 around Eyjafjallajökull. This saved the global airline industry up to £290m a day.

**NATURAL RESOURCES**
NERC scientists help understand risks to animal populations and protect sensitive environments without inhibiting economic activity. Modelling cod populations in the North Sea showed that the ‘closed area’ policy the EU implemented in 2001 to slow their decline was ineffective. This led to a new recovery plan, which generated increased fishing quotas worth £8.6m pa to the UK.
Climate change
NERC research helps us manage the effects

The global climate is changing far more quickly than at any other time in recent history, and is already causing serious problems for the UK. The Stern Review estimates that without action, the overall costs and risks of climate change will be equivalent to losing at least 5% of global GDP each year, now and forever. If a wider range of risks and impacts is taken into account, the estimates of damage could rise to 20% of GDP or more. Mark Carney, Governor of the Bank of England has warned that climate change poses a huge risk to global economic stability.

Supporting world-leading research that helps society respond to environmental change is central to NERC’s strategic vision of putting environmental science at the heart of responsible management of the planet.

**Investment**
NERC invests £58m a year in world-leading weather and climate research. 50 years of sustained funding has given us a wealth of scientific data and expertise on atmosphere and climate, and on the impacts that climate change will have, for example through changes in river flows and rainfall levels. See the box to the right for examples of current NERC investments in cutting-edge climate science.

**Business-led innovation to reduce risk to UK infrastructure**
Infrastructure is the backbone of the UK economy yet is vulnerable to the effects of climate change including more extreme weather events. NERC’s Environmental Risks to Infrastructure Innovation Programme (ERIIP) works with infrastructure owners and operators, environmental consultancies, regulators and policymakers to provide the knowledge they need to manage these risks. Current members include National Grid, EDF Energy, HS2, Temple Group, Transport Scotland, Atkins, Arup, HR Wallingford and the Environment Agency.

NERC is investing £5m over five years to ensure the latest research is translated into innovative solutions and tools to address the challenges facing UK infrastructure.

**Long-term monitoring of ocean circulation**
Sustained NERC investment of £44m since 2001, in partnership with the US National Science Federation and National Oceanic and Atmospheric Administration, is revolutionising understanding of the Atlantic Meridional Overturning Circulation (AMOC), a critical part of the global climate system with a substantial impact on UK climate. Building on the work of two previous programmes, NERC’s £8.4m RAPID-AMOC (2014-18) will extend the time-series to 16 years, providing critical information to enable accurate climate predictions over years and decades.

**Investing in the future of climate science**
Through the Joint Weather and Climate Research programme (JWCRP), NERC research centres work with the Met Office to deliver the next-generation UK Earth System Model (UKESM), based on cutting-edge environmental monitoring, research and development.

Alongside the Met Office and STFC, NERC’s National Centre for Atmospheric Science (NCAS) operates the British Atmospheric Data Centre (BADC) that provides access to atmospheric research and observation data. It also provides computational capacity (JASMIN) and services to support modelling of the Earth system and climate.
Impact
NERC science improves our understanding of the effects of climate change, makes long-term projections more accurate and enables more effective action to mitigate (limit or prevent climate change) and adapt (find ways to live with climate change). The case studies on pages 11-15 show how industry, government and wider society benefit from NERC research on climate change.

NERC climate science and expertise:
- Underpins the UK Climate Change Risk Assessment and informs the UK’s position at international climate negotiations, enabling evidence-based decision-making and strengthening UK leadership. NERC expertise has played a central part in all the published assessment reports of the United Nations Intergovernmental Panel on Climate Change – the cornerstones of international climate agreements.
- Allows public authorities to plan responses to climate change, enabling better use of resources and effective adaptation and mitigation while preventing unnecessary investment. For example, improved projections of sea-level rise and climate fed into the Thames Estuary 2100 Plan, showing the existing Thames Barrier can continue to protect London until 2070. This meant billions of pounds of premature investment was avoided.

“The challenges currently posed by climate change pale in significance compared with what might come. The far-sighted amongst you are anticipating broader global impacts on property, migration and political stability, as well as food and water security.”

Mark Carney, Bank of England governor, September 2015

Insulation
Saves business and consumer costs through better modelling of catastrophe risk.

Local and national government
Enables better planning, more efficient regulation and smarter infrastructure investment. Informs UK position at international climate negotiations.

Agri-food
Reduces greenhouse gas emissions from food supply chains, improving food security.

Environmental consultancy
Enables rapid growth of new generation of consultancies. Informs policy and builds resilience.

Oil and gas
NERC geological science is paving the way for storing our carbon emissions in empty oil and gas reservoirs.

Retail
Reduces carbon emissions and demonstrates corporate social responsibility.

Water
Understanding future risks for robust investment planning. Reduces infrastructure costs.

NERC science helps government and business predict and manage the effects of climate change.
Better catastrophe risk models reduce insurers’ costs

The UK is an international centre for the insurance and reinsurance industries, which are worth an estimated £29 billion a year to the UK economy.46 NERC science is crucial for maintaining this competitive position, helping insurers understand the implications of climate change in order to price risk accurately.

Storms cause more than half the risk to the sector, costing $18.4bn in global insured losses in 2014.47 The industry’s traditional methods for modelling catastrophe risk deal poorly with a changing climate and the increase in extreme weather it will drive.

An independent NERC-commissioned report conservatively valued the impact of NERC data and expertise in reducing insured losses from storm damage to be worth between £62m and £130m annually to the UK insurance industry.48

New high-resolution global climate models, developed by the NERC Centre for Atmospheric Science (NCAS) with the Met Office, enabled more accurate simulation of tropical cyclones. Global insurance broker Willis Re drew on these developments to develop its Tropical Cyclone Laboratory (TC Lab), a decision-making tool improving brokers’ understanding of weather and climate risk.

Hélène Galy, Head of Proprietary Modelling at Willis Global Analytics said NCAS support had been invaluable: “You and your team have given Willis access to data and expertise that is helping us transform our offering in terms of tropical cyclone modelling.”

NERC scientists at the University of Reading created unique software to automatically identify storms, track their movement and development and record their characteristics. This tool, known as TRACK, has been widely used by insurers and reinsurers. Risk Management Solutions, a major international catastrophe modelling company, incorporated TRACK into its proprietary storm-risk assessment models, which are widely used by insurers and reinsurers in the UK and worldwide. The scientists behind TRACK are now working with global insurer Hiscox to improve understanding of its exposure to Atlantic hurricanes.

NERC impacts

- Better models enable more accurate pricing of catastrophe risk
- UK insurance industry benefits £62m-£130m pa
NERC’s world-leading climate science provides crucial evidence to the UK government to inform national and international climate policy.

The UK’s negotiating position at UN climate talks in Copenhagen 2009 and Paris 2015 was informed by programmes such as AVOID – avoiding dangerous climate change – commissioned by DECC and Defra.

NERC scientists working with the Met Office developed models to evaluate the relationship between emissions and temperature changes, and the global impacts of climate change. Their work showed the likelihood of achieving climate targets with different emissions pathways, and the benefits in avoiding negative effects such as reduced water availability, more river flooding, lower crop production and higher energy requirements for heating and cooling. They demonstrated that cutting emissions will give more time to create buildings, transport systems and agricultural practices that are more resilient to climate change.

The Climate Change Act 2008 requires a UK-wide climate change risk assessment (CCRA) and a national adaptation programme (NAP) that sets out policies in response to the risks identified. This statutory obligation relies on UK climate projections (UKCP), the Met Office climate analysis tool for the UK over the 21st century, funded by Defra, which in turn relies on NERC climate modelling expertise.

UKCP09 was published in 2009 to show a range of possible changes in UK climate and to analyse the uncertainty of these projections. It concludes that the net economic costs of climate change to the UK are likely to be of the order of tens of billions of pounds a year by mid-century.

Based on UKCP09, the government’s response took the highest order risks and worked in partnership with numerous businesses, local government and other organisations to develop objectives, policies and proposals to address them. For example the Met Office worked with local authorities, the Environment Agency and Severn Trent Water to plan climate-resilient watercourses in Birmingham and with the construction industry to future-proof building design decisions.

NERC Impacts
- NERC science informs UK policy for international climate negotiations
- Underpins UK legal obligations for climate change risk assessment and national adaptation programme
- Helps the private and public sectors plan climate-resilient infrastructure

This research helps us quantify the benefits of limiting temperature rise to 2°C and underlines why it’s vital we stick with the UN climate change negotiations and secure a global legally binding deal by 2015.

Ed Davey, then Secretary of State for Energy and Climate Change, 2013.

The Climate Change Act 2008 requires a UK-wide climate change risk assessment (CCRA) and a national adaptation programme (NAP) that sets out policies in response to the risks identified. This statutory obligation relies on UK climate projections (UKCP), the Met Office climate analysis tool for the UK over the 21st century, funded by Defra, which in turn relies on NERC climate modelling expertise.
Making agriculture climate-friendly

By 2050 we will need to feed an estimated 9-10 billion people while also reducing the environmental impact of agriculture, which accounts for an estimated quarter of global carbon dioxide emissions. Excellent environmental science reduces the climate impact of the agriculture industry.

NERC researchers developed the Cool Farm Tool (CFT) software that is now used by major international companies across the agri-food sector to reduce greenhouse-gas (GHG) emissions from their supply chains.

The CFT is designed to let farmers of all sizes and types easily analyse their land and agricultural methods, calculating their GHG emissions and understanding the options available to reduce them. It gives the companies they supply a way to engage constructively with them to lower environmental impact.

In 2009 Unilever approached the scientists, acting on behalf of several global agri-food companies, looking for a practical software tool that could be used in food supply chains around the world to make major GHG emissions cuts.

The CFT has now been used in 16 farming systems in 18 countries, sponsored by 18 companies and NGOs including Unilever, PepsiCo, Tesco, Heinz, Marks & Spencer, Heineken, Sysco and Costco. They are promoting the tool to their suppliers, working with farmers to understand the main sources of GHGs within the supply chain and how these can be managed most effectively. Often reducing emissions will have other benefits for growers – for instance, reducing energy inputs will cut costs as well as climate impact.

This engagement with growers is enabling the companies involved to make significant progress on environmental targets. For example, PepsiCo has used the CFT to engage with the farmers who grow potatoes for its Walkers Crisps brand, in pursuit of its goal of cutting GHG emissions by 50% over five years. A representative said the tool “enabled us to set our ‘50 in 5’ GHG emission reduction target from agriculture and measure progress against it. I’m pleased to say we’re on target.”

NERC impacts
- Cool Farm Tool backed by many of the world’s largest agri-food companies
- Allows companies to work with farmers to reduce climate impact of food supply chains
- Used in 16 farming systems in 18 countries
Better carbon accounting drives transparent corporate environmental performance

To systematically improve industry’s performance in reducing GHG emissions requires a consistent set of benchmarks against which to measure progress. Until recently companies faced a confusing diversity of standards, making it difficult to compare carbon-related information from different sources.

NERC researchers changed this, working alongside ESRC, the UK Energy Research Centre, policymakers, index providers, investors and companies including Scottish Power.

Their research led to the publication of one of the first definitions of carbon accounting and how it should be done. It drove the development of new methods for objective, consistent benchmarking of corporate carbon performance, and encouraged their use by demonstrating that indices of sustainable performance are a powerful way to drive improvements in corporate carbon management.

One key impact is a carbon benchmark for supermarkets and mobile telecommunications operators. Major companies in these sectors invested more than £500k in further development and application of the research. In 2009 this led to the creation of ENDS Carbon, a spinout from the University of Edinburgh backed by £300k of investment from Haymarket PLC. To date the company has benchmarked over 1,000 companies for clients including FTSE Group, the international index provider.

The Carbon Disclosure Project, the world’s leading initiative encouraging voluntary corporate disclosure of carbon emissions, launched its Carbon Action initiative based partly on the NERC benchmarking research. This has recruited more than 90 global institutional investors managing $7tr of assets, and last year engaged with 50 large multinationals to reduce carbon emissions.

NERC impacts

- New carbon benchmarks enable transparent measurement of corporate environmental performance
- Carbon benchmarks for supermarket and mobile telecoms sectors; attracted £500k of private-sector investment and created a new spin-out company
- Used by Carbon Disclosure Project, involving more than 90 global investors managing $7tr of assets
Local authorities have an important role in preparing the UK for the effects of climate change, and NERC research is crucial in enabling them to do this.

The urban heat island effect (UHI) is one of the key ways in which human activities modify the local climate. Understanding how it will interact with global climate change, and how this will affect local populations, is essential to predicting and managing the risks facing UK cities.

NERC funding supported the BUCCANEER project, a partnership between scientists at the University of Birmingham and Birmingham City Council. They developed a reliable UHI prediction tool that lets users map vulnerability to climate change at the level of individual neighbourhoods. This informed Birmingham’s Green Commission and new development guidance. Developers must now consider the heat impacts of all new building, and are pointed to BUCCANEER as the tool with which to do this. Public health analysts and managers are using the same tool to assess the risks for people who are vulnerable to extreme temperature due to age or ill health.

The NERC-funded HiTemp project led to the Birmingham Urban Climate Laboratory (BUCL), which is transforming the city into a unique, world-class climate facility with more than 250 wirelessly-networked temperature sensors and 30 weather stations. The results are now being used to evaluate the effects of current and future climate on the city’s people and infrastructure. For example, Amey plc, which holds a 25-year contract to manage the city’s infrastructure, is incorporating BUCL data in a project to forecast winter maintenance requirements, with funding from Innovate UK.

NERC impacts

- Protecting the people and infrastructure of Birmingham from urban heat
- NERC tools and data used by developers, health planners and infrastructure managers
Water

NERC science for clean, secure water and healthy industry

The water industry turned over £10.6bn in 2012, and added £8.4bn of value to the UK economy. NERC science helps ensure a continuous supply of clean, safe water for the public. It helps regulators decide how much water companies can take from rivers, lakes and aquifers, whilst safeguarding water quality and future supplies. And it helps the water industry manage pollution to reduce treatment costs.

Investing in the future of water science
NERC invests in the skilled people, equipment, scientific infrastructure and long-term monitoring that keeps the UK at the forefront of water research worldwide. Current programmes include:

- **UK Droughts and Water Scarcity (£6.5m from NERC, plus contributions from other funders)** – research to support better decision-making around water resources in a changing environment and the creation of new and better solutions to droughts.

- **Changing Water Cycle (£10.1m)** – understanding shifts in the hydrological cycle due to climate and land-use change, and the wider effects these will have.

- **Sustaining Water Resources for Food, Energy & Ecosystem Services in India (£3m)** – a collaboration with India’s Earth System Science Organisation and Ministry of Earth Sciences that will help India manage the effects of environmental and hydrological change.

- **Unlocking the Potential of Groundwater for the Poor (UPGro) (£2m)** – science to ensure that sub-Saharan Africa’s precious groundwater resources are exploited sustainably for a secure supply of safe water.

Innovation in action – the UK Water Partnership

The UK Water Partnership, launched in February 2015, brings together researchers, water users, water companies and their supply chains. It aims to tap into the $500bn global water market and ensure that research and innovation fits more closely with industry needs and is translated and commercialised. It focuses on themes such as water and cities; flooding and drought; and farming and water: Partners include Severn Trent, Arup, British Water, Defra, Innovate UK, the Met Office, Pinsent Masons, the Society of British Water & Wastewater Industries, UK Trade & Industry and WRc. NERC leads the partnership’s research and innovation group.

Peter Drake, CEO of the Water Industry Forum said: “Over recent years the different parts of the UK water sector have tended to operate in isolation, with the biggest gap being around the take up of academic research by the water industry. That’s why I applaud the work that NERC has put into initiatives like the UK Water Partnership. NERC is helping to break down barriers, and this ultimately has to benefit UK plc.”
Impact
Benefits of NERC water science:

**Government**
Efficient, evidence-based regulation

**Water industry**
Reduced treatment costs and smarter, less burdensome regulation

**Public**
Cheaper, cleaner, plentiful water

All UK residents benefit from NERC investment in water science through cheaper, cleaner and more plentiful drinking water. They also enjoy a better environment and cleaner rivers and lakes, contributing to growth in tourism and aquatic leisure.

NERC science forms the basis for regulating how much water companies are allowed to take from watercourses and groundwater. It enables smart, efficient regulation – to ensure water abstraction is sustainable without unnecessary costs and restrictions for the industry. Science provides the basic definitions for smarter regulations, as well as the tools to implement it, and increases the UK’s influence in international negotiations on regulations.

High-quality environmental science helps water companies to manage their land in a way that minimises the costs of water treatment. It also allows them to cost-effectively manage the challenges posed by novel pollutants such as pharmaceuticals and nanoparticles.

NERC science also benefits other sectors, such as pharmaceuticals and nanotechnology, by enabling them to measure and therefore manage the environmental issues their activities cause. Availability of tests for environmental side-effects was crucial for allowing nanotechnologies access to the market; without these tests, the productivity gains these technologies offer would not be achievable.
Discoloured drinking water due to dissolved organic material is a major problem for water companies. Consumers dislike drinking and bathing in coloured water, and in some cases organic material can cause microbes to breed in water after treatment or react with disinfectants to form potentially harmful compounds. Climate change is expected to exacerbate these problems.

Peter Perry, operations director at Dŵr Cymru Welsh Water, described removal of dissolved organic material as "the major treatment cost involved in producing potable water across the industry".53

Cheaper water treatment through better land management
Yorkshire Water avoided the need for tens of millions of pounds of capital investment in water treatment facilities by using better land management to minimise discoloration of drinking water supplied to its customers. The restoration of peatland that made this possible was guided by NERC science.54 Other companies including South West Water and Dwr Cymru Welsh Water have achieved similar benefits from reducing pollution at source. NERC science also helped companies to map the areas within their catchments that were causing the problem, excluding these from their supply.

Peter Perry at Dŵr Cymru Welsh Water said that NERC research has been invaluable in helping the company understand the risks it faces: "The findings are continuously helping to improve our knowledge and understanding of the complex interactions within our drinking water catchments, and provide a valuable insight into how they affect our ability to produce drinking water." 55

Innovative monitoring technology
NERC science has improved water companies’ ability to monitor levels of organic material and other pollutants after treatment has taken place, allowing them to quickly and cost-effectively detect and respond to water-quality problems.

Salamander Ltd, a company created by NERC researchers and spun out of the University of Manchester, has pioneered a range of innovative devices that allow the industry to measure water quality in real time within water pipes – the first time this has been possible.

NERC’s £600k investment in the science behind Salamander’s technology enabled the Cheshire-based company’s success, generating significant economic growth and new employment both in the region and beyond. Salamander licensed its monitoring technology to firms including Siemens, Evoqua Water Technology and Ion Science; royalties were equivalent to £7m in sales in the five years since 2008.

Salamander’s HydraClam and Chloroclam instruments are now used across the industry to monitor turbidity (cloudiness) and chlorine levels in drinking water. For example, Severn Trent Water makes extensive use of HydraClam to avoid expensive disruptions to customers’ water supply, increasing operational efficiency.
NERC science enables smarter regulation, saving the UK billions of pounds

The water industry is heavily regulated. NERC research provides the evidence underpinning smarter regulation – that is, regulation that effectively protects the public and the wider environment while imposing as little burden as possible on the water industry.

**Scientific definition avoids major costs to UK**

Effective regulation depends on accurate and workable definitions of what is to be regulated. NERC science provides the evidence that underlies these definitions, forming the bedrock for smarter UK environmental regulation and also helping influence EU regulations. For example, NERC research at Edinburgh Napier University allowed the UK to provide a definition of ‘undesirable disturbance’, a term which had previously been only vaguely specified in the EU Urban Waste Water Treatment Directive (UWWTD).

Creating a clear scientific definition for this concept enabled the UK to mount a successful defence against charges of having infringed its obligations under the UWWTD at the European Court of Justice in 2009. This saved UK taxpayers some £6bn in compliance costs, according to Environment Agency estimates.56

**Natural remediation averts unnecessary clean-up expenses**

Research funded by NERC in collaboration with BBSRC and EPSRC saved chemical companies and local authorities at least £100m between 2008 and 2013 on the cost of cleaning up pollution that posed a potential threat to groundwater.

It did this by demonstrating that expensive remediation efforts were unnecessary because natural processes would quickly reduce the risk to groundwater to acceptable levels. Understanding the capabilities and limits of these processes means companies and regulators can rely on ‘natural remediation’ to deal with some kinds of pollution.

The NERC research led to Environment Agency approval for natural remediation in appropriate circumstances. The approach has now been adopted across Europe, and is estimated to save hundreds of millions of pounds Europe-wide.57

**Sustainable water abstraction**

Water companies and other users, such as farmers and industrial operators, take water directly from rivers, lakes and groundwater – a process known as ‘abstraction’. Because water is a shared resource, there is an economic need to regulate its allocation and set limits to how much water each organisation can extract. This means its economic and social value can be maximised while making sure the resource continues to be available in the future.

NERC science lets regulators set sustainable abstraction limits from rivers, even where direct measurements of flow rates and other variables are not available, saving the cost of acquiring these data. Sustainable abstraction from rivers and lakes ensures the valuable services they provide, and the biodiversity they support, are protected over the long term. In one case, NERC science enabled regulators to allow increased abstraction from groundwater in London, adding £27m–40m to turnover for water companies over three years.

**NERC impacts**

- Saved the UK billions of pounds in reduced cost of compliance with EU directives
- Avoided the need for unnecessary work to clean up pollution, saving UK companies £100m+
- Shaped regulation across Europe
Skills

NERC delivers top talent and skills for UK economic growth

**Advanced skills are vital for the UK economy**

A fifth of UK workers – 5.8 million people – are employed in science-based jobs, and this number grew 9% between 2010 and 2013. The 2015 CBI Education and Skills Survey showed that more than half of businesses are either facing a shortfall in experienced STEM-skilled staff or expect to face one in the next few years. 54% of respondents highlighted the need to make STEM qualifications more relevant to business, so that STEM graduates are more readily employable.

Two recent studies of innovative firms and a study of PhD graduate careers after 7-9 years found that public investment in research and training provides multiple benefits. It is good for doctoral graduates, who are highly employed and increasingly mobile, and it is good for innovation, increasing demand as well as supply.

- More than half the surveyed doctoral graduates were working outside academia, most of them directly involved in innovation.
- Doctoral graduates are vital to business success. Three quarters of employers said that the loss of their doctoral graduates would have a business-critical or significant impact on operations, and a fifth said their business could not function without them.

- Postgraduates who work outside academia: enhance industry’s capacity to absorb knowledge; stimulate demand for innovation; are more likely to initiate innovation within their companies; reduce the costs of innovation and increase its economic benefits.
- Postgraduates who remain in higher education contribute to the supply of new knowledge, technology and training that businesses need in order to innovate.

“Growth and jobs in the future will depend on the UK having a workforce that can exploit new technologies and discoveries. The growing skills vacuum is threatening the recovery, as demand from firms is outstripping supply.”

Katja Hall, Chief Policy Director, Confederation of British Industry
NERC Investment

Because high-level skills in environmental science are so crucial to the UK economy, NERC has reformed its delivery of postgraduate training. We aim to grow our investment by 20% between 2014 and 2017.

At least 1,000 PhD students a year benefit from NERC doctoral training. There are nearly 350 non-academic partners currently engaged with HEIs delivering NERC-supported postgraduate training. Of these partners, around 60% are from the private sector; 25% the third sector; and 15% government or public agencies.

NERC Doctoral Training Partnerships (DTPs) support university consortia to partner with employers to deliver excellent and broad training environments.

NERC Centres for Doctoral Training (CDTs) train students in specific skills that NERC and our partners in business and government identify as national priorities. NERC is growing a balanced portfolio of CDTs that support government’s industrial growth strategies and emerging new technologies. In 2015 two CDTs welcomed their first students: Soil Science (with BBSRC); and Risk Mitigation Using Big data (with ESRC), and we announced a new CDT in the use of smart and autonomous observation for the environmental sciences, to launch in 2016.

This year, all active doctoral training programmes (15 DTPs and the Oil & Gas CDT) were awarded an additional £1.8m to support innovation training and engagement with users in business and government.
**Sarah Watson – securing a safe and viable nuclear future**

Sarah Watson’s geophysics PhD involved mathematical modelling, geology, physics and chemistry. This unusual mix of skills allowed her to pursue a career in nuclear safety, with the UK Atomic Energy Authority (subsequently AEA Technology) and as an independent consultant. She now works at Quintessa, a specialised consultancy that leads safety assessments for nuclear waste-disposal facilities.

Her work is essential to securing a safe and economically viable future for the UK’s nuclear power industry, which is expected to play a key role in providing the nation with low-carbon energy.

Sarah leads Quintessa’s support for the UK deep disposal programme, finding safe ways to dispose of thousands of tonnes of long-lived radioactive waste that is currently stored above ground, and to decommission and clean up sites such as Dounreay and Sellafield. She also advises several other European governments.

The skills gained from her PhD are invaluable, allowing her to act as an interface between experts from diverse fields and present information coherently to different audiences.

---

**Mike Dearnaley – consulting for growth and responsible resource use**

Mike Dearnaley’s NERC-funded PhD in oceanography ultimately led him to become chief technical director at HR Wallingford, advising on crucial national projects.

For his thesis, Mike developed a simplified mathematical model of how water moves between the Pacific and Indian oceans. This gave him skills in applied physics, independent thinking and scientific problem solving that he uses every day to provide impartial expert advice to developers, regulators and other stakeholders such as fishermen.

Originally a spin-out from NERC, HR Wallingford is an engineering and environmental hydraulics consultancy with around 300 staff and £27m annual turnover. Mike joined in 1989 after finishing his PhD; he spent several years taking responsibility for consulting on projects around coasts, estuaries, dredging and the environment, and is now responsible for the company’s research programme, and for technical and delivery excellence. He has worked on initiatives including:

- Environmental assessment of tidal power generation options for the Severn Estuary
- Evaluation of the impacts of flood defence options in the Thames Estuary over the next century
- Designing the expansion of the Felixstowe container terminal

His work contributes to UK economic growth and ensures the nation’s natural resources are used effectively and responsibly.

---

“Small companies like ours provide the core expertise in this field. There is a desperate need for numerically competent geoscientists. Pretty much every single person in our company has a PhD or MSc. What we do isn’t the sort of thing that’s taught on undergraduate courses.”

“**My NERC PhD was very good training for independent thinking and provision of consultancy advice.**”
Simon Quinn – protecting the UK’s precious groundwater

Simon Quinn uses the skills he gained from his NERC-funded PhD in hydrogeology as principal consultant hydrogeologist at AMEC Foster Wheeler, a major international consultancy.

Before starting his doctoral studies, he had already worked at Shell, the University of Adelaide and as a consultant at ENTEC in Shrewsbury. His PhD aimed to find cheaper ways to track the flow of pollution underground through chalk aquifers. It developed highly sought-after skills in fieldwork, mathematical modelling, data management and risk analysis, which he draws on every day in his consulting work. He returned as a senior consultant to ENTEC, which was then acquired by AMEC.

Groundwater is a precious and undervalued resource for the UK; for example, it provides 75% of the water used in southeast England. Simon works with government and water users, such as water companies and farmers, to support appropriate regulation and ensure this supply is used sustainably. He helps water companies plan for the future and protect groundwater from pressures such as climate change and nitrate pollution from fertilisers. He also contributed to a better groundwater modelling system for the Environment Agency and government as a whole.

“The main benefit of my NERC-funded PhD was in teaching critical evaluation, how to interpret research results, reasoning and problem solving.”

Lera Miles – securing maximum benefit from UN forest conservation

Having gained an MSc and worked in conservation, Lera Miles undertook a NERC-funded PhD on how climate change is affecting tropical forests. Her thesis was widely-cited and included in the 2007 report of the UN Intergovernmental Report on Climate Change. The PhD gave her valuable skills in geographic information systems (GIS) and climate-change science.

More generally, it also trained her to think critically and turn large volumes of complex information into clear messages that are useful to policymakers.

She now puts these skills to use leading work on the Reducing Emissions from Deforestation and Forest Degradation (REDD+) initiative at the United Nations World Conservation Monitoring Centre. REDD+ involves making payments to developing countries for leaving forests standing; it aims to provide financial incentives to conserve and enhance the stocks of carbon that these forests contain. Benefits of REDD+ include reduced carbon emissions, protecting biodiversity, and preserving valuable natural services (such as food production and flood control) for local people.

Lera’s work helps ensure that payments are properly targeted at preserving original forest and are not diverted to less beneficial land uses such as commercial plantations grown on cleared forest. This will be essential to securing the greatest possible impact from REDD+.

“I wouldn’t be in this position without the NERC PhD. I think it gives you a certain sort of authority – it’s like a passport to credibility as a scientist.”
Evaluating our performance

The big picture

The economic and societal benefits of science investment are notoriously challenging to evaluate and quantify. It is often easier to illustrate the process of generating impact, and the kinds of impact we achieve, than to measure the impact itself. Impact evaluation methodology is a dynamic and evolving field of study and practice.

As yet, there are no robust and widely accepted metrics for impact. Recent analyses of the 7,000 impact case studies submitted for the 2014 Research Excellence Framework (REF), found that quantitative evidence supporting claims for impact was diverse and inconsistent, suggesting that the development of universal, robust impact metrics is unlikely.

There are a number of reasons why real-world impacts beyond academia are challenging to measure:

- Impacts tend to accrue from large bodies of research knowledge over long periods of time (often decades), seldom from single grants or projects.
- The economic benefits of any particular outcome can be difficult to quantify in the absence of counter-factual evidence, or if beneficiaries cannot place a value on the benefit they receive.
- Impact is a messy, non-linear process that often involves many players – funders, scientists, translators, intermediaries and users.

At a national level, BIS and others commission or conduct studies of innovation and impact performance across the whole UK research and innovation system. Individual actors, such as research councils, are not well-placed to conduct these whole-system studies, though NERC does collaborate with BIS and its partner organisations. This year, for example, NERC was involved in a stock-take of the UK impact policy landscape (with BIS, Innovate UK and HEFCE), the review of REF impact case studies discussed above, and a survey of engagement by public-funded academics with non-academic users (led by the National Centre for Universities and Business, NCUB). NERC also provides the Research Councils UK (RCUK) impact evidence champion, and works with other BIS partners to share best practice and resources in demonstrating the value of public investment in science.

Measuring NERC’s performance

Econometric studies of the UK research and innovation system highlight the important role of research councils. However it is rarely possible to isolate the performance of individual councils or to estimate their individual return on investment. BIS has established an agreed performance management framework for research councils that monitors performance against each of our Royal Charter objectives, including impact. Our impact is evaluated by analysing the recent input and output metrics that lead to larger, longer-term impact outcomes, and by analysing case studies of impact outcomes. The results are then presented in this annual Impact Report.

NERC’s goal is to provide robust evidence of the impact of our investment, which is then used by NERC, RCUK, BIS and HMT to inform spending reviews, investment decisions, policy formulation and minister’s speeches. For the reasons discussed above, it is not possible to track every previous NERC investment, or to identify every current impact that arises from past NERC investments, or to quantify the economic benefit of every case study. Hence we cannot demonstrate the total impact or return on investment of all NERC funding.

What we can do is develop a substantial portfolio of in-depth case studies – both qualitative and, where possible, quantitative. As our portfolio grows, we analyse collections of case studies to provide a richer picture of NERC’s impact in particular research topics, societal challenges or industry sectors. Our case studies provide vivid evidence of the extent and variety of NERC impacts across the whole economy. They also show the underlying pathway and causation, from NERC investment to impact, that makes correlations found by econometric analyses more compelling.

Taken together, the metrics, case studies, and econometric studies show the economic and societal benefits the UK derives from sustained, long-term public investment in science.
**Economic benefits of NERC science**

In 2015 NERC commissioned Deloitte to produce independent analyses of the economic benefits of NERC-funded research. Summaries of the findings appear earlier in this report. Some of the headline benefits to the UK (expressed as net present value), alongside considerable international policy influence, include:

- **Air pollution:** Influenced UK and EU policy to reduce serious pollutants, such as sulphur dioxide (acid rain), that created £31bn-£82bn of benefit to UK health, agriculture and the environment since 1990.

- **Ozone:** £6.1bn-£11.2bn benefit to UK health and crops, due to NERC discovery of the ozone hole leading to international agreement (the Montreal Protocol) to phase out ozone-depleting chemicals and restore the Earth’s ozone layer that protects us from harmful ultraviolet radiation.

  “For the first time ever, rich and poor nations alike set out together to save our planet from a serious danger.”
  (Margaret Thatcher; 1991)

- **Environmental risks:** Up to £127m pa benefit from protecting farmland and infrastructure through earlier warning of floods. Plus further health and cost-saving benefits from forecasting seasonal extremes, extreme weather, effects of volcanic ash on aircraft, protecting fisheries and preparing for climate change.

- **Energy:** £50m pa benefit from additional wind energy generation in Scotland. Plus further large benefits from enabling carbon capture and storage alongside safe and secure nuclear, shale gas and oil operations.

**NERC input and output metrics 2014–15: what they mean**

The table below shows five years of data, representing the last year of the previous spending review (CSR) period 2009–11 and the first four years of the current CSR period 2011–15.

When interpreting five-year data trends, readers need to be aware of discontinuities in some of the metrics (marked with an asterisk*) where changes to NERC’s performance reporting system in 2012–13 (move from NERC’s own database to the cross-council Research Outputs System) and 2013–14 (move from the Research Outputs System to the harmonised Researchfish system) mean that data may not be comparable between years. For metrics marked † the new methodology has been retrospectively applied to recalculate all years in the series, so this data is consistent and comparable. For metrics marked ‡ it has not been possible to retrospectively adjust previous data, so 2012–13 and 2013–14 data are not consistent or comparable with previous years.

The following commentary explains significant trends in the five-year data.

**Funds available**

Total funds available (item 1) are the sum of NERC’s budget (item 2) plus leverage income (item 3). NERC’s budget comprises three separate allocations: programme (from the ring-fenced science budget), capital and administration. As a result of the 2010 CSR allocation, NERC’s programme budget (the largest element) was flat 2010–15. The variation in items 1 and 2 is due to NERC’s capital budget, which fluctuates significantly between years depending on major projects (eg new research ships).

Leverage (items 3–13) represents non-BIS income flowing through NERC accounts. NERC generates very little income in its primary role as a research funder. However NERC owns research centres (institutes) which generate income through their operational activities: approximately two thirds of their external income derives from contract research, one third from the sale or licensing of information products. Since 2013 there has been a noticeable upturn in external income by centres, with private-sector income the largest single source. This results partly from NERC’s new strategic focus on engaging business more actively.

**Expenditure analysis**

Items 14–25 reflect the spending plans set out in NERC’s Delivery Plan for the CSR period 2011–15. One of NERC’s top goals was to shift resources into front-line science, hence other operating costs (items 19 and 24) have been driven down so that grants expenditure (items 17 and 22) and the number of principal investigators supported (item 26) could increase. Training expenditure (items 16, 34 and 36) has increased this year after falling for a few years, in line with the RCUK-wide decision to withdraw from funding taught masters courses and then NERC’s decision to increase doctoral training (see below).

**Knowledge generation (publication output)**

This section has seen a number of changes in the methodology with which the data are calculated. Data for 2014–15 are not yet available. The same methods have
been applied to all the data in the series, so the series are internally comparable, if not comparable to the data provided in previous reports.

Observers may be watching for a potential decrease in publication output commensurate with real-terms decline in the overall science budget under a flat-cash allocation since 2010. Despite an increase in grants reporting their outputs (item 29), publications (items 30-33) seem to have dipped for the first time in 2013/14. This could correspond to a decline in funding since 2010, as the time lag between grant award and journal publication is typically at least three years. However, it’s probably safer to wait for the 2014/15 to see whether this trend is sustained. NERC reacted to the initial pressure by deliberately growing its research grant volume over the same period (as discussed above), which might have offset the initial pressure; the two changes in reporting system (this year and last year) could also confound the data trend.

Non-refereed publications (item 31) and business co-authorship (item 33) have dropped, both in comparison to last year and if the data in this report are compared to previous reports, due mainly to a change in reporting methodology.

Human capital (postgraduate training output)
The number of PhD students supported (item 34) and PhD investment (item 36) have both increased in 2014/15, a reflection of NERC decisions discussed above. The number of PhD students trained per pound invested (item 36) has been more or less constant over the previous four years.

IP activity (knowledge exchange and innovation output)
Item 40 shows IP income to NERC from the operations of its owned research centres. Growth in IP income over the past two years reflects conscious effort by centres. By contrast, item 39 shows reported patent applications across all NERC-funded research organisations (HEIs and centres), where the fall in recent years (2014–15 data are not yet available) probably reflects HEFCE and RCUK policy to encourage research organisations to focus more on collaborating with business than direct commercialisation.

NERC recognises that its primary role as a funder is to enable business and other users to translate environmental science for innovation and economic growth. The UK gains more benefit when we allow inventors, innovators and entrepreneurs to capitalise on NERC science and IP than when NERC tries to retain and commercialise its own IP. Hence items 39 and 40 provide a very incomplete measure of the wider environmental science IP benefits realised by the UK as a whole.

BIS increasingly considers a wider basket of measures to evaluate the UK’s overall knowledge exchange and innovation performance. Such measures are diverse and may include, for example: license revenue; patent citation share; cross-sector article usage; cross-sector researcher mobility; invention disclosures; start-ups and spin-outs, and more. In this context it is clear that items 39 and 40 present a particularly narrow view. As yet it is difficult to assess NERC’s wider performance against a more diverse basket of metrics. However earlier sections of this Impact Report provide robust evidence of NERC’s performance in training PhDs who drive innovation in industry and in creating innovation and growth across the economy.

Human capital (destination of PhD leavers)
Item 41 shows that more PhD graduates are finding employment in universities, while there has been a slight increase in the percentage of PhDs going into the private sector (item 44). The most significant change, however, has been the reduction in the percentages of ‘Other’ (item 45) and ‘Unknown’ (item 46). Because these are residual categories, however, it is difficult to comment on these changes.

Public policy influence
Data for 2013–14 and 2014–15 are not available, and the 2012–13 data should be treated with caution due to a previous change of reporting system. However earlier sections of this report highlight the considerable impact of NERC science on UK and international policy and regulation.
### Input and output metrics

<table>
<thead>
<tr>
<th>Item</th>
<th>Metrics</th>
<th>Units</th>
<th>2010/11</th>
<th>2011/12</th>
<th>2012/13</th>
<th>2013/14</th>
<th>2014/15</th>
</tr>
</thead>
<tbody>
<tr>
<td>INPUTS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Total funds available</td>
<td>£mil</td>
<td>510.0</td>
<td>468.0</td>
<td>442.0</td>
<td>470.8</td>
<td>455.2</td>
</tr>
<tr>
<td>2</td>
<td>Budget allocation</td>
<td>£mil</td>
<td>447.1</td>
<td>411.9</td>
<td>382.3</td>
<td>403.8</td>
<td>386.5</td>
</tr>
<tr>
<td>3</td>
<td>Leverage</td>
<td>£mil</td>
<td>62.9</td>
<td>56.1</td>
<td>59.7</td>
<td>67.0</td>
<td>68.7</td>
</tr>
<tr>
<td>4</td>
<td>of which private</td>
<td>£mil</td>
<td>12.8</td>
<td>13.7</td>
<td>15.7</td>
<td>17.7</td>
<td>18.5</td>
</tr>
<tr>
<td>5</td>
<td>of which from other Research Councils</td>
<td>£mil</td>
<td>8</td>
<td>5.6</td>
<td>7.4</td>
<td>8.6</td>
<td>6.8</td>
</tr>
<tr>
<td>6</td>
<td>of which from other sources: Govt departments</td>
<td>£mil</td>
<td>13.6</td>
<td>12.8</td>
<td>13.8</td>
<td>13.9</td>
<td>15.3</td>
</tr>
<tr>
<td>7</td>
<td>of which from other sources: other operating income</td>
<td>£mil</td>
<td>14.2</td>
<td>11.0</td>
<td>11.5</td>
<td>12.7</td>
<td>11.0</td>
</tr>
<tr>
<td>8</td>
<td>of which from other sources: miscellaneous</td>
<td>£mil</td>
<td>14.2</td>
<td>13.0</td>
<td>11.4</td>
<td>14.0</td>
<td>17.1</td>
</tr>
<tr>
<td>9</td>
<td>of which private</td>
<td>%</td>
<td>20%</td>
<td>24%</td>
<td>26%</td>
<td>26%</td>
<td>27%</td>
</tr>
<tr>
<td>10</td>
<td>of which from other Research Councils</td>
<td>%</td>
<td>13%</td>
<td>10%</td>
<td>12%</td>
<td>13%</td>
<td>10%</td>
</tr>
<tr>
<td>11</td>
<td>of which from other sources: Govt departments</td>
<td>%</td>
<td>22%</td>
<td>23%</td>
<td>23%</td>
<td>21%</td>
<td>22%</td>
</tr>
<tr>
<td>12</td>
<td>of which from other sources: other operating income</td>
<td>%</td>
<td>23%</td>
<td>20%</td>
<td>19%</td>
<td>19%</td>
<td>16%</td>
</tr>
<tr>
<td>13</td>
<td>of which from other sources: miscellaneous</td>
<td>%</td>
<td>23%</td>
<td>23%</td>
<td>19%</td>
<td>21%</td>
<td>25%</td>
</tr>
</tbody>
</table>

### Analysis of expenditure

<table>
<thead>
<tr>
<th>Item</th>
<th>Metrics</th>
<th>Units</th>
<th>2010/11</th>
<th>2011/12</th>
<th>2012/13</th>
<th>2013/14</th>
<th>2014/15</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>research grants</td>
<td>£mil</td>
<td>97.1</td>
<td>104.5</td>
<td>107.7</td>
<td>120.1</td>
<td>119.5</td>
</tr>
<tr>
<td>15</td>
<td>research contracts</td>
<td>£mil</td>
<td>34</td>
<td>41.7</td>
<td>41.8</td>
<td>61.3</td>
<td>45.3</td>
</tr>
<tr>
<td>16</td>
<td>training</td>
<td>£mil</td>
<td>27.3</td>
<td>23.6</td>
<td>21.1</td>
<td>20.7</td>
<td>24.1</td>
</tr>
<tr>
<td>17</td>
<td>Total grants and training</td>
<td>£mil</td>
<td>158.4</td>
<td>169.8</td>
<td>170.7</td>
<td>202.1</td>
<td>188.9</td>
</tr>
<tr>
<td>18</td>
<td>Staff costs</td>
<td>£mil</td>
<td>114.1</td>
<td>109.4</td>
<td>105.8</td>
<td>105.7</td>
<td>108.0</td>
</tr>
<tr>
<td>19</td>
<td>Other operating costs</td>
<td>£mil</td>
<td>112.3</td>
<td>99.2</td>
<td>92.8</td>
<td>98.3</td>
<td>98.0</td>
</tr>
<tr>
<td>20</td>
<td>Other</td>
<td>£mil</td>
<td>26.7</td>
<td>35.7</td>
<td>44.6</td>
<td>33.2</td>
<td>38.4</td>
</tr>
<tr>
<td>21</td>
<td>Total expenditure</td>
<td>£mil</td>
<td>411.5</td>
<td>414.1</td>
<td>413.9</td>
<td>439.3</td>
<td>433.2</td>
</tr>
<tr>
<td>22</td>
<td>of which Grants and Training</td>
<td>£mil</td>
<td>38%</td>
<td>41%</td>
<td>41%</td>
<td>46%</td>
<td>44%</td>
</tr>
<tr>
<td>23</td>
<td>of which Staff Costs</td>
<td>£mil</td>
<td>28%</td>
<td>26%</td>
<td>26%</td>
<td>24%</td>
<td>25%</td>
</tr>
<tr>
<td>24</td>
<td>of which other operating costs</td>
<td>£mil</td>
<td>27%</td>
<td>24%</td>
<td>22%</td>
<td>22%</td>
<td>23%</td>
</tr>
<tr>
<td>25</td>
<td>of which other</td>
<td>£mil</td>
<td>6%</td>
<td>9%</td>
<td>11%</td>
<td>8%</td>
<td>9%</td>
</tr>
</tbody>
</table>

### Human capital

<table>
<thead>
<tr>
<th>Item</th>
<th>Metrics</th>
<th>#</th>
<th>2010/11</th>
<th>2011/12</th>
<th>2012/13</th>
<th>2013/14</th>
<th>2014/15</th>
</tr>
</thead>
<tbody>
<tr>
<td>26</td>
<td>Principal investigators *†</td>
<td>#</td>
<td>1144</td>
<td>1220</td>
<td>1271</td>
<td>1300</td>
<td>~</td>
</tr>
<tr>
<td>27</td>
<td>Research leaders in sponsored institutes *‡</td>
<td>#</td>
<td>95</td>
<td>96</td>
<td>107</td>
<td>94</td>
<td>~</td>
</tr>
<tr>
<td>28</td>
<td>Research Fellows *‡</td>
<td>#</td>
<td>88</td>
<td>98</td>
<td>96</td>
<td>87</td>
<td>86</td>
</tr>
</tbody>
</table>
## Input and output metrics

<table>
<thead>
<tr>
<th>Item</th>
<th>Metrics</th>
<th>Units</th>
<th>2010/11</th>
<th>2011/12</th>
<th>2012/13</th>
<th>2013/14</th>
<th>2014/15</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>OUTPUTS</strong></td>
<td>Knowledge generation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>Number of grants reporting their outputs *† #</td>
<td>1866</td>
<td>1893</td>
<td>1983</td>
<td>2009</td>
<td>~</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>Refereed publications * † #</td>
<td>4415</td>
<td>4431</td>
<td>4561</td>
<td>4237</td>
<td>~</td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>Non-refereed publications * † #</td>
<td>605</td>
<td>539</td>
<td>753</td>
<td>482</td>
<td>~</td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>Co-authorship of refereed publications - International * † #</td>
<td>2606</td>
<td>2712</td>
<td>2970</td>
<td>2726</td>
<td>~</td>
<td></td>
</tr>
<tr>
<td>33</td>
<td>Co-authorship of refereed publications - Business * † #</td>
<td>54</td>
<td>74</td>
<td>63</td>
<td>53</td>
<td>~</td>
<td></td>
</tr>
<tr>
<td><strong>Human capital</strong></td>
<td>Number of PhD Students Supported (starting in year) #</td>
<td>363</td>
<td>361</td>
<td>363</td>
<td>340</td>
<td>379</td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>Finishing rates (in 5 years) †</td>
<td>% 91</td>
<td>95</td>
<td>96</td>
<td>91</td>
<td>~</td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>Student funding/training schemes £mil</td>
<td>27.3</td>
<td>23.6</td>
<td>20.3</td>
<td>19.46</td>
<td>23.8</td>
<td></td>
</tr>
<tr>
<td>37</td>
<td>of which PhD £mil</td>
<td>24.4</td>
<td>22.2</td>
<td>20.3</td>
<td>19.46</td>
<td>23.8</td>
<td></td>
</tr>
<tr>
<td>38</td>
<td>of which Masters £mil</td>
<td>2.9</td>
<td>1.4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td><strong>IP activity</strong></td>
<td>Patents applications *‡</td>
<td># 7</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>~</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>Income from IP activity £mil</td>
<td>2.8</td>
<td>2.4</td>
<td>2.6</td>
<td>2.9</td>
<td>3.2</td>
<td></td>
</tr>
<tr>
<td><strong>OUTCOMES</strong></td>
<td>Human capital: destinations of leavers (PhDs) ‡</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>41</td>
<td>of which university %</td>
<td>49%</td>
<td>48%</td>
<td>46%</td>
<td>52%</td>
<td>~</td>
<td></td>
</tr>
<tr>
<td>42</td>
<td>of which Wider Public Sector %</td>
<td>4%</td>
<td>5%</td>
<td>5%</td>
<td>4%</td>
<td>~</td>
<td></td>
</tr>
<tr>
<td>43</td>
<td>of which Third Sector %</td>
<td>4%</td>
<td>2%</td>
<td>2%</td>
<td>4%</td>
<td>~</td>
<td></td>
</tr>
<tr>
<td>44</td>
<td>of which Private Sector %</td>
<td>17%</td>
<td>25%</td>
<td>22%</td>
<td>26%</td>
<td>~</td>
<td></td>
</tr>
<tr>
<td>45</td>
<td>of which Others %</td>
<td>17%</td>
<td>13%</td>
<td>8%</td>
<td>3%</td>
<td>~</td>
<td></td>
</tr>
<tr>
<td>46</td>
<td>of which unknown %</td>
<td>2%</td>
<td>3%</td>
<td>10%</td>
<td>5%</td>
<td>~</td>
<td></td>
</tr>
<tr>
<td>47</td>
<td>of which unemployed %</td>
<td>6%</td>
<td>6%</td>
<td>7%</td>
<td>7%</td>
<td>~</td>
<td></td>
</tr>
<tr>
<td><strong>Public policy</strong></td>
<td>Instances of influence *‡</td>
<td># 706</td>
<td>961</td>
<td>324</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
</tr>
</tbody>
</table>

* denotes a change in how a metric is reported.
† denotes that the new methodology has been applied retrospectively, so all data is consistent and comparable.
‡ denotes that data for previous years cannot be recalculated under new methodology, so 2012-13 and 2013-14 data (shaded) are not consistent or comparable with previous years.
~ denotes that data for 2014/15 is not yet available and will therefore be included in next year’s Impact Report.
Notes and references


2. Size of circles in these infographics reflects the proportion of 317 NERC impact case studies (a sample of case studies submitted to REF 2014 and NERC Impact Awards 2015) that created benefits in an identified sector, industry or geographic area.


6. NERC internal review of more than 300 impact case studies submitted to REF2014 and NERC Impact Awards competition. Note that some impacts were co-funded by more than one kind of partner; hence the four categories sum to more than 100%.

7. This figure represents an estimate of both leveraged funding coming to and managed by NERC as well as that which partner organisations contribute to NERC research programmes and operations but is administered by a partner. The only leverage or co-funding that shows as input (as per item 3 on p.27) is that which flows through NERC’s accounts because we have agreed to lead and administer joint funding on behalf of others.


Notes and references

20 £6bn refers to the expected cost of the programme over its 10 years span, as estimated at the time of its launch (1990). See full report with methodology for further details: www.nerc.ac.uk/about/perform/evaluation/evaluationreports/deloitte-report/. [Accessed December 2015].

21 DEFRA. (2010) Valuing the overall impacts of health pollution. Note that Defra’s measurement of air pollution considers PM2.5 particles only.


25 NERC. (2015) Grant spending based on search terms related to each sector (4 year average to 2014/15). Note all further references to NERC funding derive from similar estimates.


29 NERC. (2013) NOC show wind farms’ impacts on coastal erosion is not a concern. Unpublished report available on request.


45 British Antarctic Survey, Centre for Ecology & Hydrology, National Centre for Atmospheric Science, National Oceanography Centre.
65 To be published Spring 2016.
Before 2012 NERC used its own research outputs database (ROD) to collect performance information. In 2012 NERC adopted a different research outputs system (ROS) with several other research councils. In 2014 all seven research councils moved to a harmonised system, Researchfish, which is shared with other funders. During this transition year, the collection of some output metrics for 2013–14 is six months later than previous years.

The metric for Referred publications (metric 30) has been recalculated this year, with a coherent methodology. Publications from NERC affiliated authors are identified through the Thompson-Reuters Web of Science and are added to the figures obtained from the joint RCUK Research Output Collections process (Researchfish), after checking there are no duplicates.

Entries under ‘Conference proceedings’ in Researchfish (the reporting system introduced in 2012/13) are now discouraged, as proceeding abstracts are often precursors to peer review publications. This has significantly reduced the count of nonrefereed publications, as ‘Conference proceedings’ used to make up a significant share of the metric. Researchfish includes a broader classification of outputs, so datasets which may previously have been reported under ‘Maps’ are now entered under their own categories. Co-authorship of refereed publications with business has also decreased significantly as a consequence of changes in methodology. Use of Web of Science data allows us to distinguish commercial organisations more accurately from those in other sectors (third sector, medical foundations, hospitals, etc).

Finishing rate (in 5 years): The percentage of students who completed their PhD within the time stated in their initial application and, in all cases, within 5 years.

Patent applications: Prior to the introduction of the Researchfish system in 2013/14 the metric was ‘Patents Filed’. As Researchfish data is openly published, only protected IP (Patents Granted) data is encouraged. Therefore, the metric is now limited to granted patents.

Human capital: destinations of leavers (PhDs): Destinations of PhD leavers data (items 41–47) refers to those who graduated during the years in the column headings, and relates to activity 6 months later.

Instances of influence: Based on the definition on p.9 of the common question set:

http://www.rcuk.ac.uk/RCUK-prod/assets/documents/documents/ResearchOutcomesCommonQuestionSet.pdf [Accessed December 2015]. Only certain categories are relevant to NERC. It should also be noticed that because Researchfish asks this question at a grant-level, it is unlikely that all the activities undertaken by a NERC PI will be captured.