NERC
SCIENCE OF THE ENVIRONMENT

NERC Impact Report

2017

NERC science delivers solutions to UK and global challenges

We work in partnership with business, government and society to deliver solutions to UK and global challenges. Together we deliver new ways of living, doing business, escaping poverty and growing the economy throughout the UK.

CLEAN GROWTH

NERC science reduces the economic and health costs of pollution and environmental degradation, delivering solutions for clean air, water and energy. UK impacts totalling £billions include:

✓ Cleaner energy thanks to increased renewable energy capacity	Page 6
✓ Cheaper, cleaner water	Page 6
✓ Cleaner business operation	Page 4 and NERC Impact Report 2015
✓ Cleaner air following prompt action against air pollution and the ozone hole	NERC Impact Report 2015

PRODUCTIVE ECONOMY

NERC science boosts economic growth by delivering more productive ways of working, smart regulation and skilled people. UK impacts totalling £billions include:

✓ Skilled people working in a wide range of sectors	Page 10 and NERC Impact Report 2016 and 2015
✓ Cheaper, safer design and construction of key infrastructure	Page 6
✓ Regeneration and business growth in UK towns	Page 4 and 5
✓ Higher yields from fishing and fish-farming	Page 8 and NERC Impact Report 2016
✓ Savings for businesses from smarter regulation of water quality	NERC Impact Report 2016
✓ Increased productivity for the oil and gas sector	NERC Impact Report 2015

RESILIENT ECONOMY

NERC science saves lives, money and lessens disruption by enabling government, business and society to better respond to natural hazards. UK savings totalling £billions include:

✓ Widespread short and long term benefits from world-leading weather and climate forecasting	Page 14
✓ Cheaper, safer, more reliable infrastructure	Page 6
✓ Greater resilience to floods for communities and businesses	Page 5, 13 and NERC Impact Report 2015
✓ Better preparedness for climate change on the ground	NERC Impact Report 2015

NERC Impact Reports 2015 and 2016 are available at www.nerc.ac.uk/about/perform/reporting/reports/

Contents

Contact: Fiona Goff, Head of Evidence
Tel: 01793 411593, fjag@nerc.ac.uk

CLEAN • PRODUCTIVE • RESILIENT

Achieving prosperity and wellbeing in harmony with the environment

This year's Impact Report draws on a wealth of evidence to show how sustained NERC investment and partnership delivers healthy environment, lives and economy.

1 NERC is the driving force of investment in environmental science

We advance the frontiers of knowledge by commissioning new research, infrastructure, innovation and training that delivers valuable scientific breakthroughs. Our science explores the physical, chemical and biological processes on which our planet, life and economy depends – from safe food and water to energy and minerals, from air quality and flooding to long-term changes in our environment and climate.

2 Understanding our changing planet is fundamental to our future wellbeing and economic prosperity

The environment we live in directly enables – and can limit – human health, productivity and economic growth. Every business and public service, every consumer benefits from natural resources (for example minerals, energy, water and food) while incurring the economic and health costs of environmental hazards, pollution and degradation.

Governments, businesses and public agencies worldwide recognise that integrated social, economic and environmental policy delivers better public health, a stronger economy (productivity, innovation, jobs) and resilience to shocks.

3 NERC science delivers solutions to UK and global challenges

We work in partnership with business, government and society to deliver solutions to UK and global challenges. Together we deliver new ways of living, doing business, escaping poverty and growing prosperity. The inside cover of this report provides an overview of how NERC delivers solutions. Later we explore in more detail impact on the infrastructure sector (page 6), the Met Office (page 10), and the impact of our support for training (page 14) and public engagement (page 18).

4 NERC science delivers prosperity and wellbeing throughout the UK

The benefits of NERC science are felt throughout the UK. NERC science has delivered real benefits to people, economies and the environment in every UK region (pages 4-5). This reflects UK-wide strengths in environmental science: we invest in excellent research and innovation throughout the UK, with over 73% of NERC funding spent outside London and South East England.

5 NERC provides UK and global leadership

Our environmental science is the best in the world and highly collaborative – harnessing the world's best scientists and knowledge to tackle complex environmental, economic and societal challenges (page 3).

NERC provides UK and global leadership

Our science is world-leading and highly collaborative – harnessing the world's best scientists and knowledge to tackle complex environmental, economic and societal challenges.

NERC invests in the best of the best:

- UK environmental science **leads the world** on field-weighted citation impact, which is a measure of research quality[1].
- UK environmental science **leads UK** disciplines on field-weighted citation impact[2].
- UK environmental scientists produce **more top-ranked publications per pound** invested than any comparable nation[3].
- NERC funds the **best of UK** environmental science[4].

NERC promotes collaboration between science disciplines, between nations and between scientists and users of science:

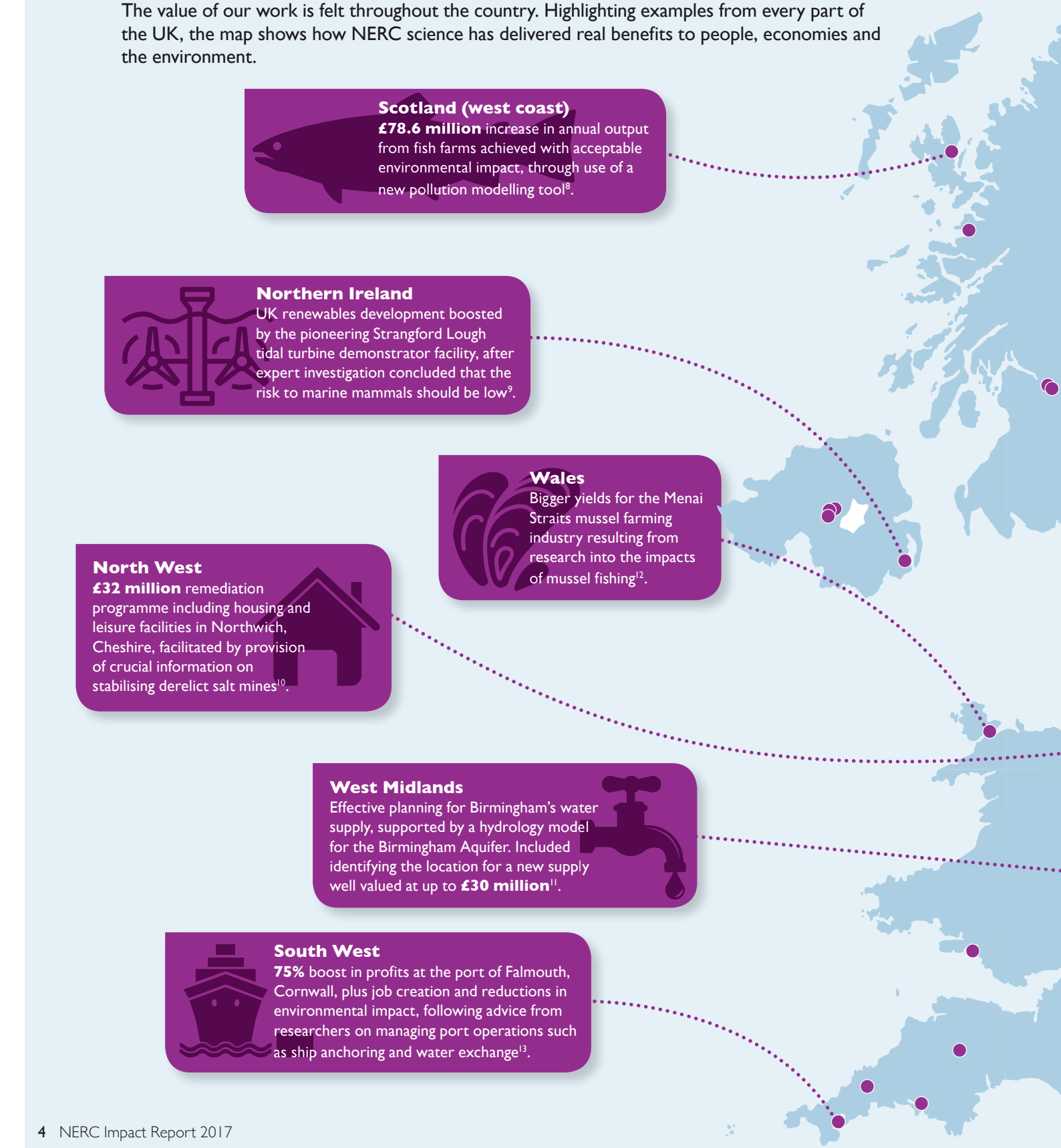
- Citation analysis found that **92%** of UK environmental and Earth science publications are **interdisciplinary**[5].
- Environmental and climate science impacts were found in **all but one of 36 disciplines** (units of assessment) in the Research Excellence Framework (REF) 2014 evaluation of quality and impact of university research[6].
- **89%** of NERC-funded impacts submitted to the REF were **co-funded** by research users (government – 60% of NERC-funded impacts, industry – 21%, charities – 15%) or by international partners – 29%[7].
- **66%** of NERC-funded publications include **international co-authors.**

CLEAN • PRODUCTIVE • RESILIENT

NERC science delivers prosperity and wellbeing throughout the UK

NERC invests in excellent research and innovation throughout the UK, with over **73%** of our funding spent outside London and South East England.

The value of our work is felt throughout the country. Highlighting examples from every part of the UK, the map shows how NERC science has delivered real benefits to people, economies and the environment.



Scotland (west coast)
£78.6 million increase in annual output from fish farms achieved with acceptable environmental impact, through use of a new pollution modelling tool[8].

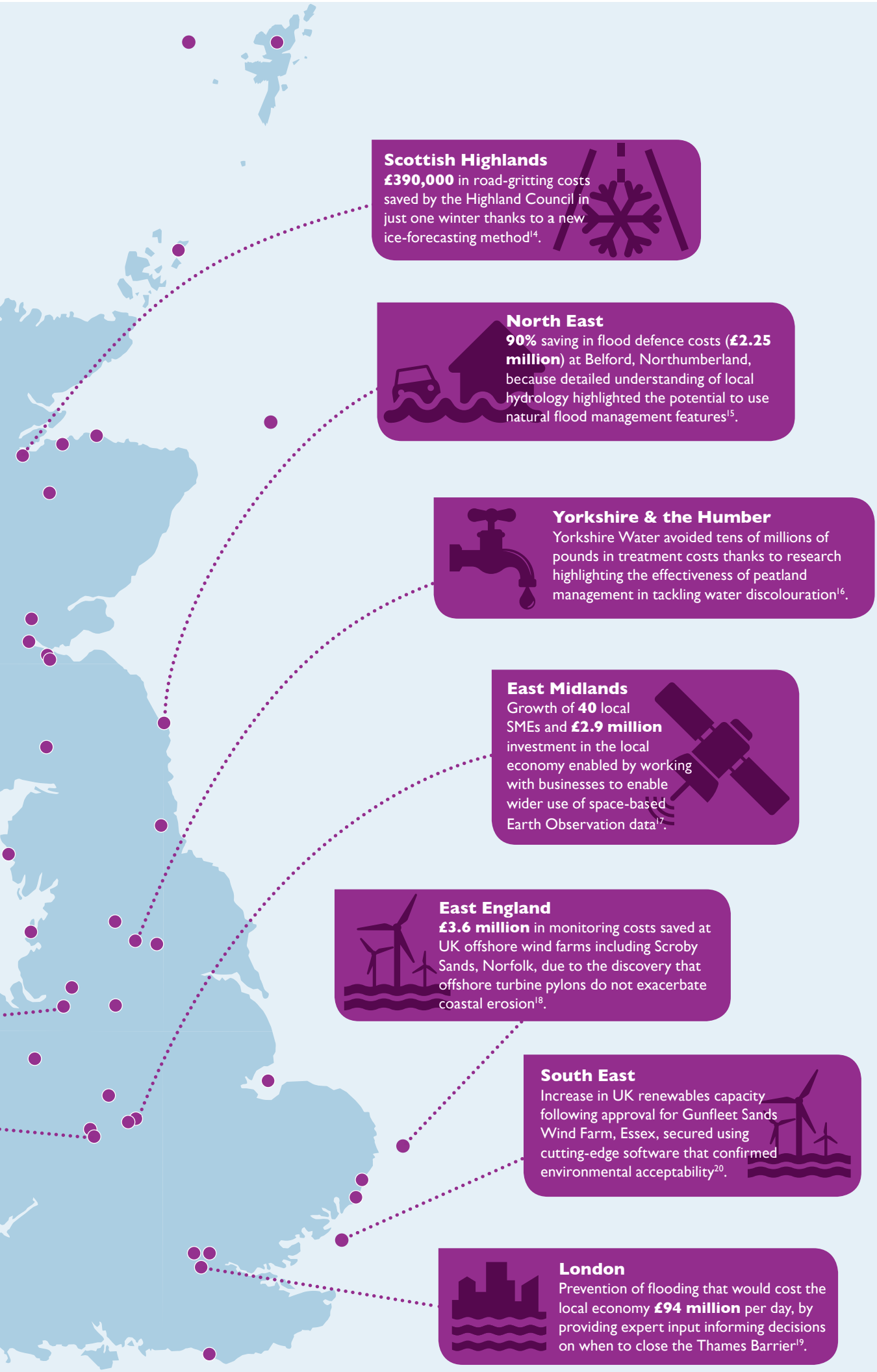
Northern Ireland
UK renewables development boosted by the pioneering Strangford Lough tidal turbine demonstrator facility, after expert investigation concluded that the risk to marine mammals should be low[9].

Wales
Bigger yields for the Menai Straits mussel farming industry resulting from research into the impacts of mussel fishing[12].

North West
£32 million remediation programme including housing and leisure facilities in Northwich, Cheshire, facilitated by provision of crucial information on stabilising derelict salt mines[10].

West Midlands
Effective planning for Birmingham's water supply, supported by a hydrology model for the Birmingham Aquifer. Included identifying the location for a new supply well valued at up to **£30 million**[11].

South West
75% boost in profits at the port of Falmouth, Cornwall, plus job creation and reductions in environmental impact, following advice from researchers on managing port operations such as ship anchoring and water exchange[13].



Scottish Highlands
£390,000 in road-gritting costs saved by the Highland Council in just one winter thanks to a new ice-forecasting method[14].

North East
90% saving in flood defence costs (**£2.25 million**) at Belford, Northumberland, because detailed understanding of local hydrology highlighted the potential to use natural flood management features[15].

Yorkshire & the Humber
Yorkshire Water avoided tens of millions of pounds in treatment costs thanks to research highlighting the effectiveness of peatland management in tackling water discolouration[16].

East Midlands
Growth of **40** local SMEs and **£2.9 million** investment in the local economy enabled by working with businesses to enable wider use of space-based Earth Observation data[17].

East England
£3.6 million in monitoring costs saved at UK offshore wind farms including Scroby Sands, Norfolk, due to the discovery that offshore turbine pylons do not exacerbate coastal erosion[18].

South East
Increase in UK renewables capacity following approval for Gunfleet Sands Wind Farm, Essex, secured using cutting-edge software that confirmed environmental acceptability[20].

London
Prevention of flooding that would cost the local economy **£94 million** per day, by providing expert input informing decisions on when to close the Thames Barrier[19].

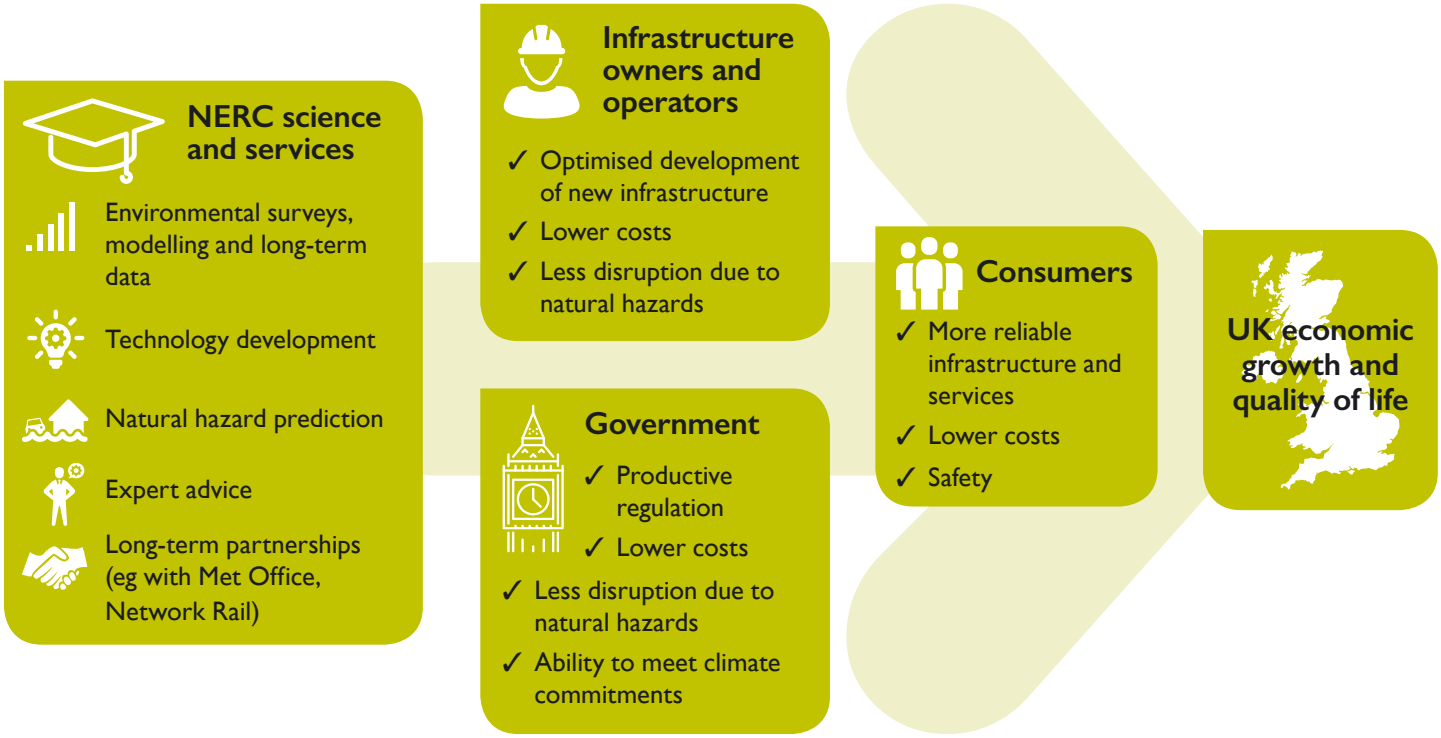
CLEAN • PRODUCTIVE • RESILIENT

Infrastructure: NERC science keeps the lights on and the UK moving

Infrastructure shapes our lives and is the foundation upon which our economy is built[21]. Providing millions of jobs and generating billions of pounds for the UK, energy, transport and other infrastructure has to meet today's needs while developing the resilience to withstand future challenges such as climate change. Central government investment in the UK's economic infrastructure is set to rise to £22 billion per year by 2020/21[22].

The natural environment presents both challenges and opportunities for UK infrastructure. NERC is working to minimise the risks and maximise the gains, from reducing damage and disruption caused by natural hazards to unlocking the full potential of clean energy sources. Our science and training delivers major benefits for business, government and consumers.

How NERC science for infrastructure boosts growth and improves quality of life.



INVESTMENT

NERC invests in research, innovation, training and specialist facilities that support UK infrastructure, for example:

- Long-term national capability funding for our research centres provides the platform for science and expertise that meets the UK's strategic needs and enables effective emergency response.

- The Environmental Risks to Infrastructure Innovation Programme (ERIIP) (2014-19) has £5 million in NERC support and involves 78 industry partners. ERIIP ensures translation of the latest research into new industry-relevant tools.

- The Probability, Uncertainty and Risk in the Environment (PURE) programme (2012-16) was supported by £6.8 million from NERC, EPSRC and the Environment Agency. PURE helped to improve assessment of uncertainty and risk from natural hazards.

- Renewable energy programmes, including Land-based Renewables (£2.1 million from NERC, plus £0.4 million from Shell) and Marine Renewable Energy (£2.4 million from NERC and Defra). These two initiatives helped to establish environmental risks and opportunities associated with new renewables technologies.

IMPACT

Cost savings, safety improvements, increased revenues and resilience: NERC solutions for UK energy, transport and other infrastructure deliver extensive benefits for owners, operators, regulators and users.

Growth of marine industries

The UK's marine industries generate nearly £3.5 billion for the economy[23]. NERC-funded, freely available high-quality maps of the UK seafloor, plus the expertise of NERC scientists, are generating big savings for government and for marine industries including oil and gas, offshore renewables, aggregates, and laying of pipelines and cables:

- **Millions in cost savings:** Since 2010, NERC's British Geological Survey (BGS) and National Oceanography Centre (NOC) have co-led high quality mapping of the UK seafloor for use by industry and government. If businesses did this themselves, it would cost £0.7 million per 1,000km^2 [24].
- **Cleaner power for two million homes:** The Forewind consortium is planning and developing the 2.4Gw Dogger Bank offshore wind farm, assisted by BGS expertise in mapping, modelling and geohazard assessment[25].

Safe, cost-effective construction

Onshore infrastructure benefits from the ready availability of detailed, reliable geological models developed and maintained by NERC-funded scientists:

- **Lower costs, improved safety:** During construction of the major Crossrail interconnection at London's Farringdon Station, BGS models helped tunnelers identify and reduce health, safety and financial risks to the project[26].
- **Supporting job creation:** NERC researchers at Durham University helped the Drigg low-level nuclear waste repository to secure approval for expanding its underground storage vaults. Their modelling of erosion risks was vital to making the safety case for a project that will create around 120 construction jobs and ensure the future of the facility until 2050[27].

Regulators have agreed that our jet engines can operate during volcanic eruptions anywhere in the world. That puts us ahead of our competitors – and places the UK in the driving seat. We couldn't have achieved this without NERC-funded data and expertise from the University of Bristol.
Rory Clarkson, Rolls-Royce plc

Data provided by the NERC British Geological Survey is used on a daily basis and offers many benefits in terms of planning, cost mitigation, safety management and resourcing.
UK Power Networks

Improved hazard protection

From volcanic ash and 'space weather' to strong winds, earthquakes and power surges, many environmental threats have potential to disrupt, damage or shut down electricity, transport and communications infrastructure. NERC science helps to limit the dangers and, as a result, reduce the costs:

- **Effective earthing:** BGS science aids cost-effective earthing of electricity substations and transformers that provides protection against power surges. Every day, BGS data on shallow ground conditions is used by 4,000 staff at UK Power Networks[30].
- **Supporting airports:** A model developed by NERC's National Centre for Atmospheric Science (NCAS) provides airports with warnings of severe winds. Now incorporated into Met Office forecasting models, it saves £1.25 million per year for the MoD in the Falklands, for instance, by minimising flight diversions[31].
- **Early warning service:** BGS and the NERC British Antarctic Survey (BAS) provide warnings enabling operators to protect infrastructure against geomagnetically induced currents triggered by space weather events. Their advice has also helped government and business to plan for such events[32].
- **Abating the ash crisis:** NERC science and expertise helped to lift the flight ban caused by the 2010/11 Icelandic volcanic eruptions – saving airlines up to £290 million per day and reducing delays without compromising safety[28]. NERC-funded input from eight universities and two of our own Centres proved pivotal to the UK's rapid response to the emergency. This included support to the Met Office Volcanic Ash Advisory Centre and NERC-funded experts who accounted for over half of the Government's Scientific Advisory Group for Emergencies (SAGE)[29].

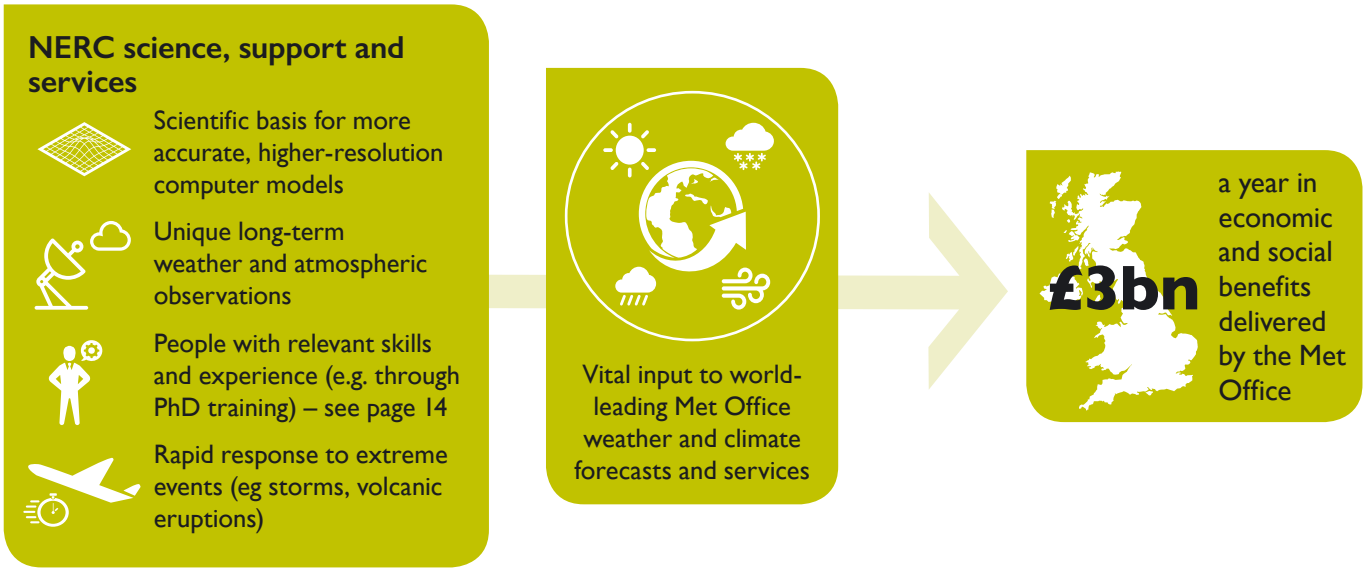
NERC inside the Met Office: NERC inside our everyday lives

A partnership delivering cutting-edge science that saves lives and money

Accurate prediction of short-term weather patterns and longer-term climate trends is crucial to the UK's prosperity and resilience. Robust and reliable forecasting is essential to the ability of government, business and the public to plan, take decisions, carry out day-to-day activities and invest in the future. It also makes it possible to minimise the disruption, distress and sheer cost caused by events such as floods, storms and severe cold weather.

As the world's number one in its field, the Met Office has a well-earned global reputation for its integrated weather and climate services, which generate benefits worth an estimated £3 billion per year to the UK[33]. NERC science is an essential component underpinning these services. Our close, proven partnership with the Met Office continues to deliver vital advances in forecasting and prediction capabilities – with benefits felt throughout society and the economy.

How NERC expertise leads to real-world benefits.



> Our research relationship with NERC is vital for the Met Office. It ensures that we can continue to produce world-leading science to support the advice and services we provide to our stakeholders and customers.
>
> ***Professor Stephen Belcher, Met Office Chief Scientist***

INVESTMENT

Over 50 years of sustained NERC funding in weather and climate science provide the foundation for our partnership with the Met Office. Examples of ongoing investment include:

- A strategic partnership between NERC and the Met Office to enable the UK to continue its leading international position in weather and climate science and forecasting. Activity within this partnership includes:
  - o The Met Office MONSooN supercomputer, in which NERC has invested over £9.5 million since 2009.
  - o The Facility for Airborne Atmospheric Measurements (FAAM), a joint capability managed by NERC comprising a large research aircraft, specialist research instruments and support services to users. We invested over £3.5 million in FAAM during 2016/17.
  - o Collaborative research projects that are pushing the frontiers of weather and climate modelling, such as the £9 million UK Earth System Modelling Project.
- CASE studentships: every year NERC funds a number of PhD students who undertake a placement at the Met Office as part of their studentship.
- Facilities providing long-term observations: in 2016/17, we invested £0.6 million in the Chilbolton Facility for Atmospheric and Radio Research and Mesosphere Stratosphere Troposphere Radar Facility. These facilities provide round-the-clock weather and atmospheric observations that improve Met Office modelling and forecasting capability.

CLEAN • PRODUCTIVE • RESILIENT

23 lives saved each year in construction sector

£120m a year saved by improved aircraft routing

IMPACT

Reduced risks, lower costs, improved productivity and profitability: by enabling the Met Office to provide a world-leading service rather than simply a standard one, NERC science plays a vital role in the delivery of an estimated £680 million of additional benefits to the UK each year (figure based on Met Office economic analysis 2015[34]).

Impact case studies developed by 21 different research organisations show how NERC science contributes to benefits that are both immediate and longer term – and serve every sector of the economy.

Improved hazard protection

NERC-funded researchers at the University of Reading worked with the Met Office to develop computer models that can identify 'sting jet' airstreams and predict severe winds several days in advance[35]. This enabled the Met Office to strengthen its severe wind warning service and deliver annual savings including:

- **23 lives:** due to work being suspended on high buildings in extreme winds.
- **350,000 tonnes of CO_2:** by reducing fuel needed for aircraft diversions.
- **£120 million:** by enabling airlines to improve aircraft routeing.
- **£5million:** from emergency services making more informed resourcing decisions[36].

NERC science also supported the Met Office in predicting strong winds and in responding to the 2010/11 volcanic eruptions in Iceland – see page 9.

up to £100m a year saved by reductions in flood damage

Better prediction of winter conditions

The NERC National Oceanography Centre (NOC) developed ground-breaking ocean models that have enabled prediction of average weather conditions up to four months in advance[37]. In addition, airborne atmospheric measurements by scientists at the University of Manchester using FAAM have improved snow and rainfall forecasting[38]. Incorporated into Met Office models, these improvements have helped the Environment Agency, the NHS, local authorities, agriculture and transport to address weather-related challenges and realise benefits including:

- **£76 million – 127 million/year** reduction in flood damage[39].
- **Reduction in the £500 million/day** cost to the economy of heavy snow[40].
- **Reduction** in cold-related deaths among vulnerable people and in unnecessary stockpiling of road salt[41].

Better informed plans and strategies

The benefits of the Met Office/NERC longer-term climate change predictions are especially evident in the fields of industry and infrastructure. They include:

- **£62 million – 130 million/year** reduction in storm-related losses incurred by the insurance industry, due to development of better global climate models by the NERC Centre for Atmospheric Science (NCAS) with the Met Office[42].
- **Billions of pounds** saved by avoiding premature investments in infrastructure costs. Scientists from the NERC British Antarctic Survey, Centre for Ecology and Hydrology and NOC, working with the Met Office, concluded that upgrading London's flood defences could safely be deferred until 2035[43].

NERC delivers top talent and skills

PhD investment keeps the UK competitive and innovative

A thriving knowledge economy depends on world-class intellectual capital. PhDs underpin the UK's ability to sustain a competitive, innovative science sector that creates growth and jobs. They generate economic benefits fundamental to the UK's success, whether working inside higher education adding to the supply of new insights, technology and knowhow, or in industry to absorb knowledge and stimulating demand for innovation.

Three-quarters of employers state that losing their doctoral graduates would mean sustaining a business-critical or significant impact, with one-fifth saying their business could not function[44].

Employment in UK science-related sectors is forecast to increase from 5.8 million in 2011 to 7.1 million by 2030[45], and employers already report challenges recruiting skilled people: 64% have difficulties attracting applicants with appropriate skills and knowledge; 39% find it hard to identify those capable of solving complex problems; 29% experience problems recruiting candidates with complex numerical and statistical skills[46].

INVESTMENT

At least 1,200 students a year benefit from NERC doctoral training:

- Doctoral Training Partnerships (DTPs) support university consortia to partner with employers and other stakeholders to deliver excellent training environments across NERC's remit[47]. An independent review this year concluded that the training being delivered through NERC's DTP model is effective, and has distinct benefits over that provided through conventional PhD support[48].

- Centres for Doctoral Training (CDTs) support the training of students in skills identified as UK priorities by NERC and by our business and government partners.[49] NERC is growing a portfolio of CDTs that support the Government's industrial growth strategies and emerging new technologies. In 2017, a new CDT in modelling and quantitative skills in ecology and evolution will welcome its first students. We have also funded a new CDT in freshwater bioscience and sustainability, which will launch in 2018.

Our training is collaborative and highly leveraged. Partners have added £25 million to our DTP investment of £60 million, and £7.3 million to our CDT investment of £6.5 million. Nearly 400 non-academic partners work with higher education institutions in delivering NERC-supported postgraduate training. Around 60% are from the private sector, 25% the third sector and 15% government or public agencies.

IMPACT

NERC analysis shows that seven years after graduation 40% of NERC PhDs are working outside academia, including 25% in the private sector. The next two pages profile six people who are using the skills developed during their PhDs to deliver benefits by working in the Met Office, and by contributing to infrastructure development.

Talent and skills:
NERC inside the Met Office

Professor Stephen Belcher
Delivering leadership in weather and climate science

Stephen was appointed Chief Scientist at the Met Office in January 2017. He leads its team of over 500 scientists who develop **weather forecasting and climate prediction capabilities crucial to the UK economy, government and society.** From critical thinking to the collation of complex data, his role harnesses an array of skills that he developed as a NERC-funded PhD student at the University of Cambridge. Focusing on how the wind generates waves, Stephen's postgraduate research provided the firm foundation enabling him to embark on an influential career in meteorology. His expertise in communicating scientific findings to non-academic, non-technical audiences – essential to his work as Chief Scientist – was also nurtured during his PhD.

Dr Lizzie Good
Providing vital evidence

Leading a team of Met Office scientists, Lizzie is using skills developed during her NERC-funded PhD at the University of Leicester to add new dimensions to the observation and assessment of land surface temperatures. Her postgraduate research focused on the use of data collected via satellite. It also equipped her with programming and software development, numeracy and team-working skills vital to the accurate analysis of large datasets. This expertise is now helping to generate new tools that support governments and businesses, such as a **ground-breaking product combining satellite data sourced through NERC's National Centre for Earth Observation (NCEO) and weather station observations to deliver daily information on land surface temperatures**[50].

Dr Adrian Hines
Maximising the practical impact of science

As Head of Applied Science at the Met Office, Adrian is responsible for translating cutting-edge science into products and services that aid day-to-day decision-making in industry and government. He joined the organisation in 1997 after completing a NERC-funded PhD at Exeter and Keele Universities on the modelling of thermohaline circulation – a process where differences in seawater density drive ocean currents. Following a range of Met Office roles in ocean modelling and forecasting, he now leads a team focused on sectors such as international development, defence and insurance/capital markets. **The team's outputs help organisations to address challenges such as food security, water scarcity, migration and health.** This work puts a premium on skills (as well as contacts) developed by Adrian during his PhD, including problem-solving, understanding scientific processes and applying scientific judgement.

Keeping the lights on and the UK moving

Professor Katherine Royse

Extending geology's benefits deep and wide

For Katherine, a NERC-funded geology PhD at Keele University was the first step on a career path focused on delivering practical value from geological data. As Director of GeoAnalytics and Modelling at the British Geological Survey (BGS), she draws on her PhD skills to lead teams exploring everything from crowd-sourcing to gaming technology. Kate's mission is to **meet the needs of infrastructure developers, householders at flood risk and many others.** Valuable outputs include 'BGS Civils' – maps of the engineering properties of the UK's geology, highlighting strength, corrosiveness and excavatability.

Professor Dickon Howell

Making a difference in the marine sector

A NERC-funded PhD provided Dickon with technical, analytical and creative skills vital to a career spanning public and private sectors and specialising in the sustainability and acceptability of offshore infrastructure. After completing his thesis at Newcastle University on environmental impacts of marine anti-fouling compounds, he joined Royal HaskoningDHV and worked on projects such as a major offshore development in Dubai. In 2009, Dickon moved to the UK Marine and Fisheries Agency as a science advisor. After its transition into the Marine Management Organisation (MMO), his positions included Head of Marine Licensing – **responsible for licensing UK offshore developments, from wind farms to sea defences** – and Chief Scientific Advisor. In 2016, Dickon set up Howell Marine Consulting, advising developers on government maritime policy and regulation, and became Visiting Professor of Practice at Newcastle University.

Dr Zoe Roberts

Harnessing science to ensure offshore safety

The viability of offshore infrastructure and operations depends crucially on both their safety and their cost-effectiveness. As Senior Metocean Analyst with Vattenfall Wind Power (UK), Zoe uses data analysis and other skills honed as a NERC-funded PhD student to **ensure the stability and durability of the company's wind power projects** across northern Europe. A key aim is to make certain that marine infrastructure is not over-engineered and therefore unnecessarily costly and time-consuming to construct. Zoe's PhD at the University of Southampton and the National Oceanography Centre, focusing on open-ocean deep convection and its implications for climate change, provided the perfect platform to foster these skills. She subsequently enjoyed spells at consultancies BMT Cordah Ltd and BMT ARGOSS Ltd before joining Vattenfall in 2012.

NERC engages the public to benefit science and society

As the UK's leading commissioner of environmental science, we understand the vital dimension that high-quality public engagement adds to our overall impact. First and foremost, such engagement enables us to meet the public's appetite for authoritative information about environmental science: 71% of people want to hear more about climate change, for instance, while researchers are the most trusted source of information on controversial environmental issues[51].

But NERC's public engagement activities do much more than empower people and enrich lives. They inspire the next generation of scientists passionate about tackling tomorrow's research challenges, finding solutions to big societal questions that are relevant to all our daily lives whether it be air quality, future energy or sustainable food production. They also create a crucial two-way connection between science and society – enabling research to respond effectively to society's needs and priorities, and to appreciate more clearly the social and ethical context within which research has to operate.

> Science is too important, valuable and fascinating to be left to professional scientists alone… For the good of society, the public and scientific progress itself, science needs a broader community.[52]
> ***Imran Khan, Head of Public Engagement, Wellcome Trust and NERC Council member***

INVESTMENT

Public engagement is a condition of every grant we award and is also undertaken by all of our research centres. In 2016, to add even more momentum to our efforts in this field, we developed a new public engagement strategy[53]. During 2016/17, we:

- Invested £0.5 million in 18 public engagement projects around the UK, focusing on challenging contemporary issues such as clean air.
- Launched a call for public engagement consortium and capacity-building projects, each of which will receive between £50,000 and £100,000 in NERC support.
- Funded a new partnership with the Association of Science and Discovery Centres (ASDC). This will use the latest research to engage over 100,000 children and adults through ten of the UK's leading science engagement organisations (including the Natural History Museum, Dynamic Earth and the Eden Project).
- Delivered our 'Into the Blue' showcase event in Liverpool and Manchester.

IMPACT

Attitudes changed, minds broadened, knowledge shared, new data generated: NERC activities deliver public engagement outcomes that benefit science and the contribution it makes to national life.

Event attracts thousands of first-time visitors

Held during October 2016 in the North West, 'Into the Blue' enabled the public, business and the media to engage with NERC research, researchers and infrastructure, including our National Oceanography Centre's research ship RRS *Discovery*:

- **62%** of the 5,000 visitors in Manchester had not previously attended any science event.
- **72%** of these visitors agreed that environmental science is important to the UK – up from 53% before their visit.
- One parent commented: "I've struggled to find things my eight-year-old daughter is really interested in, so it's been lovely to see how she's been here today. I've decided to take her to other kinds of science events to encourage her interest."

Projects produce impressive results

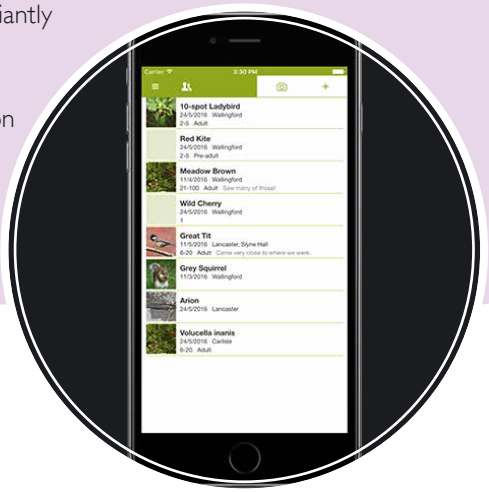
The 18 public engagement projects funded in 2017 resulted in:

- **31** school visits, eight museum/exhibition displays and seven citizen science projects, covering issues such as climate change, flooding, pollination and clean air.
- **146** researchers and 99 early-career researchers and PhD students engaged with the public.
- **24** training sessions delivered for early-career researchers to enhance the impact of their public engagement activities.
- **26** universities built partnerships with 45 external partners, including community groups, government, councils, museums, charities and non-governmental organisations.

Online tools bring science to the public

In-your-pocket online tools developed by NERC scientists are another example of the way we open up our science to wider audiences. This can be for education, recreation and professional purposes, or simply to satisfy curiosity and encourage people to 'get involved'. Many of the tools also collect valuable data for our researchers to use. Examples include:

- **Citizen science mobile apps:** NERC's Centre for Ecology and Hydrology (CEH) has developed 16 free apps that make it easy to record air pollution and sightings of wildlife, for example. Downloaded over **100,000** times, more than **25,000** people have used the apps to submit in excess of **350,000** observations of over **6,000** species. This data is supporting research and decision-making at local and national level[54].
- **OneZoom:** with more than **850,000** users in **225** countries, this easy-to-use software provides a novel way of visualising the evolutionary tree of life. Developed by Dr James Rosindell during his NERC Research Fellowship, it has won many plaudits. For instance, world-renowned scientist and author Professor Richard Dawkins has described it as a "magnificent piece of software, a brilliantly intuitive visualisation of the tree of life".
- **mySoil:** Developed by the British Geological Survey in collaboration with the CEH and other partners, this software provides farmers, land-use planners, crop advisors, students, gardeners and many others with comprehensive information about local soils in the UK and Europe. mySoil now has over **75,000** users.



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.

Analysis 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[55].

There are a number of reasons why real-world impacts of research are challenging to measure[56]:

- 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, the Department for Business, Energy and Industrial Strategy (BEIS), UK Research and Innovation and others commission and conduct studies of innovation and impact performance across the whole UK research and innovation system[57].

Evaluating research council investment

The UK's dual support system for publicly funded research provides a holistic and efficient investment appraisal and evaluation cycle compliant with HM Treasury guidance. Playing complementary roles, Research Councils focus on prospective quality assurance through rigorous peer reviewed competition for grants, while Higher Education Funding Councils focus on retrospective quality evaluation through the REF. Besides informing Funding Council allocations, REF evaluates the excellence and impact (i.e. economic and societal benefit) of university research supported by all funders, including Research Councils.

Research Councils also evaluate or audit specific investments and processes, during or after their lifetimes. We use our own performance data, commission independent studies, and rely on external evidence such as REF to evaluate NERC's performance against our mission objectives and to demonstrate long-term impact.

Measuring NERC's performance

Econometric studies of the UK research and innovation system[58] 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. BEIS has established an agreed performance management framework for Research Councils that monitors performance against each of our mission 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 the outcomes. The Research Councils and BEIS have agreed a set of common indicators that are reported in all of the Research Council Impact Reports.

NERC's goal is to provide robust evidence of the impact of our investment, which is then used by NERC, UK Research and Innovation, BEIS and HM Treasury 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. As a result, we cannot demonstrate the total impact or return on investment of all NERC funding.

What we can do, however, is develop a substantial portfolio of in-depth case studies – both qualitative and, where possible, quantitative. We analyse collections of case studies to provide a richer picture of NERC's impact relating to particular research topics, societal challenges or industry sectors. Our case studies provide vivid evidence of the extent and variety of NERC impacts throughout 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.

This year we have started using content analysis software to increase the quality and efficiency of our analysis of NERC evidence, and have started working with Research Council and Innovate UK colleagues to explore how our impact evidence could be brought together to support UKRI's strategic objectives.

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.

Input and output metrics

What they mean

Introduction

The Research Councils have agreed a set of Common Indicators on performance with the Department for Business, Energy & Industrial Strategy (BEIS). These indicators draw on information from grants databases and the researchfish® system.

researchfish® is an online system supported by researchfish ltd. It is used by Research Councils to collect information on the outputs, outcomes and impacts of Research Council-funded research. Outcomes can be entered into researchfish® at any time, but once a year there is a formal submission period when researchers are required to confirm that their outcomes information is accurate and up-to-date. The Common Question Set used by researchfish® is available at www.researchfish.com.

Notes on Common Indicators data

The outcomes data included in the Common Indicators are not static. Researchers can enter data retrospectively, which may result in changes to individual indicators in subsequent Impact Reports. NERC has used the researchfish® system for outcomes collection since 2014. As such, data for earlier years may not be complete.

A particular output (e.g. a publication or collaboration) might have arisen from more than one award. In this report, a particular output is always reported against each individual award where the unit of analysis is at the award level (e.g. the proportion of awards reporting a particular output). Duplicate outputs are removed, where possible, in analyses at the level of the type of output generated. Duplicate outputs are removed using system-generated codes to indicate when a researcher has attributed an output to more than one award. This cannot identify duplicate outputs where researchers have entered similar information independently of one another. Percentages in this report are rounded up or down to the nearest whole number and so some may appear as zero if this represents less than half of one per cent.

This section includes metric definitions and caveats, and commentary on major trends.

Total funds available

Items 1.1 and 1.2 are taken from NERC's Annual Report[59].

Budget allocation: NERC's budget allocation (item 1.1) comprises three separate allocations: programme (from the ring-fenced science budget), capital and administration. The variation in budget allocation is due to NERC's capital budget, which fluctuates significantly between years because of major projects (e.g. the new polar research vessel).

Leverage: Item 1.2 represents non-BEIS income flowing through NERC accounts. This is a combination of partner co-funding for our strategic research programmes and commercial income generated by NERC research centres (institutes), which includes both contract research and income from the sale or licensing of information products.

Additional funding leveraged by research projects: Item 1.3 reports the cash and in-kind contributions from partner organisations that were listed on the original research proposal. It does not include any further leverage funding that may have arisen during the course of the award. It does not include additional funding leveraged by NERC research centres.

Leverage (item 1.2) has continued to increase, reflecting the increasingly collaborative and multi-disciplinary nature of NERC's investments, as well as, perhaps, increased pressure on NERC and government department budgets. Additional funding leveraged by research projects (item 1.3) has been broadly stable for the last few years. The lower figure for 2016-17 reflects the fact that these data are often reported after a time lag in researchfish®.

Total expenditure

Items 2.1-2.3 are taken from NERC's Annual Report.

Research expenditure: Item 2.1 reports expenditure on research grants and research contracts. This excludes much of the research conducted at NERC Research Centres and hence is a significant underestimate of NERC's total research expenditure.

Human capital

Number of Principal Investigators (PIs): Item 3.1 reports the number of PIs supported on research grants on 1st April of each reporting year. It excludes PIs supported through intramural investments, unless they are in receipt of a research grant.

Number of Research Fellows: Item 3.2 reports the number of Research Fellows supported on 1st April of each reporting year.

Number of PIs and Co-Investigators (Co-Is) on research grants: Item 3.3 reports the number of PIs and Co-Is supported on research grants on 1st April of each reporting year. It excludes PIs and Co-Is supported through intramural investments, unless they are in receipt of a research grant. This indicator also includes the number of research organisations (including independent research organisations) where these PIs and Co-Is are located.

There were fewer PIs in 2015 and 2016 (item 3.1); this is likely to reflect NERC's move to fewer larger grants as the total number of PIs and Co-Is (item 3.3.1) has stayed broadly similar.

Postgraduate destinations: Data on the destination of leavers are drawn from the Higher Education Statistics Agency (HESA) Destination of Leavers from Higher Education (DLHE) dataset.

Collaborations, partnerships and secondments

Instances of collaborations: This indicator relates to collaborations reported within the research proposal at the point of application. It includes the proportion of awards (expressed as a percentage) reporting at least one partner organisation at the point of application.

Instances of new collaborations: This indicator relates to new collaborations as reported within researchfish®. Collaborations are only included in the indicator for the first year that they were reported, but may continue for several years after this date. Researchers may also report collaborations that were in place at the point of application.

Instances of secondments: This indicator relates to secondments as reported within researchfish®. Secondments are only included in the indicator for the first year that they were reported, but may continue for several years after this date.

All of the collaboration and secondment metrics continue to increase, reflecting the increasingly cross-organisational and interdisciplinary nature of NERC's work.

Knowledge generation

Instances of publications (item 6.1.1): A publication may have arisen from more than one award. Duplicate publication outputs are removed, where possible, using system-generated codes to indicate when an individual researcher has attributed an output to more than one award. This cannot identify duplicate outputs where different researchers have entered similar information independently of one another.

In addition to the Common Indicators discussed above, NERC has produced a count of unique publications (item 6.1.1a) and calculated the percentage of these which are internationally co-authored (item 6.1.1b) by matching rresearchfish® data with NERC-associated publications in the Thompson-Reuters Web of Science. Neither metric is part of the Common Indicators framework.

Number/proportion of awards that gave rise to at least one publication: Item 6.1.4 is reported with a 5-year time lag and is therefore only available for grants that started between 2008 and 2012.

NERC has also chosen to report its income from intellectual property (IP) activities (item 6.3a), taken from the NERC Annual Report. This appears to be a better metric than the number of instances of IP activity (item 6.3) because it directly reflects value to users. It captures the cumulative effect of IP activities, while item 6.3 only captures the most recent addition to the IP stock. Item 6.3a is not part of the Common Indicators framework, refers to financial year rather than calendar year and includes income to NERC Head Office and NERC Research Centres.

Income from IP activity (item 6.3a) has been rising over the last few years.

Instances of spin-outs/start-ups: Within researchfish®, researchers are asked to provide details of links between their research and the establishment, development or growth of new private sector organisations, including for-profit and not-for-profit organisations. Supplemental information, where available, was used to identify duplicate spin-out companies (e.g. Companies House identification numbers for UK companies).

Metrics with a 5-year lag

The remaining common metrics have a 5-year lag because of the way they are defined. Trends for these metrics are therefore only available for grants that started between 2008 and 2012, and are not comparable with the other metrics as they represent outcomes from grants awarded in the specific year, not the outcome of all grants during one year.

Further funding

Number/proportion of awards with further funding: Item 7.1.1 includes further funding to continue or develop the research, or to support the translation of outcomes into practical application.

Both the numbers and the proportions have increased, which may be a healthy indicator of the quality and relevance of NERC funding, improved reporting of this type of output, or a combination of the two.

Engagement activities

Number/proportion of awards with engagement activities (item 8.1.1): Researchers engage with a wide variety of audiences and stakeholders to communicate research outcomes, disseminate knowledge, stimulate public awareness and encourage public engagement and dialogue. The engagement activities indicator helps demonstrate the extent to which researchers are engaging with audiences outside academia.

Reported engagement activity has increased over time, which may reflect increased engagement, improved reporting of this type of output, or a combination of the two.

Influence on policy and practice

Number/proportion of awards with policy influence (item 9.1.1): Research may be used to inform policy and practice, which may subsequently lead to wider societal and economic benefit. The influence on policy and practice indicator helps demonstrate the extent to which researchers are informing decision-making within government departments and elsewhere.

This metric has also increased, which might reflect increased activity, an increase in grants funded by policy-makers, improved reporting of this type of output, or a combination of these factors.

Input and output metrics

The preceding section contains metric definitions and caveats, and commentary on major trends.

Item	Metrics	Units					
Total funds available			**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**
1.1	Budget allocation	£m	382.3	403.8	386.5	388.5	421.1
1.2	Leverage	£m	59.7	67.0	68.7	72.5	70.4
1.2.1	of which from private sector	£m	15.7	17.7	18.5	20.3	20.1
1.2.2	of which from other Research Councils	£m	7.4	8.6	6.8	5.0	8.3
1.2.3	of which from other sources	£m	36.7	40.6	43.5	47.2	42.0
1.2.1	*of which from private sector*	%	*26*	*26*	*27*	*28*	*29*
1.2.2	*of which from other Research Councils*	%	*12*	*13*	*10*	*7*	*12*
1.2.3	*of which from other sources*	%	*61*	*61*	*63*	*65*	*60*
1.3	Additional funding leveraged by research projects	£m	26.8	56.2	72.7	62.5	36.9
1.3.1	of which private	£m	1.4	2.0	17.3	1.7	10.6
1.3.2	of which public	£m	6.0	3.9	4.6	13.7	5.6
1.3.3	of which non-profit	£m	0.2	2.0	0.3	0.5	1.0
1.3.4	of which academic sector	£m	19.2	48.3	50.4	46.5	19.7
1.3.1	*of which private*	%	*5*	*4*	*24*	*3*	*29*
1.3.2	*of which public*	%	*22*	*7*	*6*	*22*	*15*
1.3.3	*of which non-profit*	%	*1*	*4*	*0*	*1*	*3*
1.3.4	*of which academic sector*	%	*72*	*86*	*69*	*74*	*53*
Total expenditure			**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**
2.0	Total expenditure	£m	413.9	439.3	433.2	428.1	452.5
2.1	of which research expenditure (research grants and research contracts)	£m	149.5	181.4	164.8	152.2	164.5
2.2	of which training expenditure	£m	21.1	20.7	24.1	22.6	26.0
2.3	of which other (including Research Centre staff costs)	£m	243.2	237.2	244.4	253.3	262.0
2.1	*of which research expenditure (research grants and research contracts)*	%	*36*	*41*	*38*	*36*	*36*
2.2	*of which training expenditure*	%	*5*	*5*	*6*	*5*	*6*
2.3	*of which other (including Research Centre staff costs)*	%	*59*	*54*	*56*	*59*	*58*
Human capital			**2012**	**2013**	**2014**	**2015**	**2016**
3.1	Principal investigators (on 1st April)	#	1182	1209	1217	1074	1055
3.2	Research Fellows (on 1st April)	#	96	87	86	84	84
3.3.1	Number of principal and co-investigators on research grants (on 1st April)	#	2080	2076	2250	2047	2158
3.3.2	*Number of research organisations, including independent research organisations (on 1st April)*	#	*105*	*96*	*121*	*119*	*146*

Input and output metrics

Item	Metrics	Units					
Human capital – postgraduates			**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**
4.1	Number of new doctoral students within that financial year	#	363	340	379	400	420
4.2	Doctoral submission rate	%	*96*	*91*	*89*	*94*	*96*
Destination of leavers			**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**
4.3.1	University	%	*45*	*42*	*47*	*43*	*41*
4.3.2	Wider public sector	%	*3*	*3*	*5*	*6*	*3*
4.3.3	Private sector	%	*35*	*29*	*25*	*30*	*27*
4.3.4	Others or unknown	%	*11*	*17*	*15*	*14*	*19*
4.3.5	Unemployed	%	*6*	*8*	*7*	*7*	*11*
Collaborations, partnerships and secondments			**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**
5.1.1	Instances of collaborations at the start of grants	#	609	655	608	770	825
5.1.1	*Percentage of grants reporting collaborations at the start of grants*	%	*26*	*29*	*32*	*31*	*39*
Collaborations, partnerships and secondments			**2012**	**2013**	**2014**	**2015**	**2016**
5.1.2	Instances of new collaborations reported in researchfish®	#	376	454	417	435	459
5.2	Instances of secondments reported in researchfish®	#	76	120	119	168	182
Knowledge generation			**2012**	**2013**	**2014**	**2015**	**2016**
6.1.1	Instances of journal articles reported in researchfish®	#	4949	5448	5010	5712	5717
6.1.1a	Number of unique journal articles (NERC only)	#	3330	3579	3304	3817	3858
6.1.1b	*Of which % international co-authored – NERC only*	%	60	64	62	63	66
6.1.2	Instances of books	#	30	48	28	30	29
6.1.3	Instances of books chapters	#	149	139	131	169	121
Knowledge generation			**2008**	**2009**	**2010**	**2011**	**2012**
6.1.4	Number of awards that gave rise to at least one publication	#	383	345	554	440	502
6.1.4	*Proportion of awards that gave rise to at least one publication*	%	*80*	*82*	*79*	*85*	*85*
Knowledge generation			**2012**	**2013**	**2014**	**2015**	**2016**
6.2.1	Instances of artistic and creative outputs	#	7	15	38	27	33
6.2.2	Instances of research databases and models reported	#	90	106	134	129	135
6.2.3	Instances of software and technical products reported	#	18	23	68	79	72
6.2.4	Instances of research tools and methods reported	#	19	20	30	39	51
6.2.5	Instances of medical products, interventions and clinical trials	#	0	0	2	0	0
6.3	Instances of IP reported	#	5	8	6	8	9
6.3a	Income from IP activity (reported by financial year – NERC only)	£m	2.6	2.9	3.2	3.2	3.9
6.4	Instances of spin-outs/start-ups	#	0	1	2	3	1

Item	Metrics	Units					
Further funding for research			**2008**	**2009**	**2010**	**2011**	**2012**
7.1.1	Number of awards with at least one instance of further funding	#	58	54	140	137	178
7.1.1	*Proportion of awards with at least one instance of further funding*	%	*12*	*13*	*20*	*26*	*30*
Engagement activities			**2008**	**2009**	**2010**	**2011**	**2012**
8.1.1	Number of awards with at least one instance of engagement	#	69	76	192	217	289
8.1.1	*Proportion of awards with at least one instance of engagement*	%	*14*	*18*	*27*	*42*	*49*
Influence on policy and practice			**2008**	**2009**	**2010**	**2011**	**2012**
9.1.1	Number of awards with at least one instance of policy influence	#	20	18	50	50	65
9.1.1	*Proportion of awards with at least one instance of policy influence*	%	*4*	*4*	*7*	*10*	*11*

Notes and references

1 ELSEVIER. (2017) International comparative performance of the UK Research Base 2016. Report prepared by Elsevier for the UK's Department for Business, Energy & Industrial Strategy (BEIS). [Online – accessed November 2017].

2 Ibid.

3 Ibid.

4 Based on NERC analysis of the field-weighted citation impact of papers submitted to REF Unit of Assessment (UoA) 7: Earth Systems and Environmental Sciences using Thomson Reuters inCites. Citation impact of NERC-funded papers: 3.22 (43% of UoA 7 papers), citation impact of non-NERC funded papers: 2.79.

5 ELSEVIER. (2015) A Review of the UK's Interdisciplinary Research using a Citation-based Approach: report to the UK HE funding bodies and MRC. [Online – accessed August 2017].

6 DIGITAL SCIENCE. (2015) The Diversity of UK Research and Knowledge: analyses from the REF impact case studies. [Online – accessed August 2017].

7 NERC internal review of more than 300 impact case studies submitted to REF2014 and the 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%.

8 A £78.6 million increase in fish farms' annual output was achieved, without harming coasts, after the Scottish Government adopted a new pollution modelling tool to help review all fish farm licence applications. The NERC-funded Scottish Association for Marine Science (SAMS) developed the tool, which models particulates produced by fish farming and indicates where their effects would be unacceptable. More information: NERC IMPACT REPORT (2014) p.7 Growing the Scottish fish-farming industry. [Online - accessed August 2017].

9 Installation of a test demonstrator of SeaGen, the world's first commercial-scale tidal stream turbine, at Strangford Lough, County Down, could not have proceeded without expert input from the NERC-funded Sea Mammal Research Unit (SMRU). Based at the University of St Andrews, SMRU helped to secure regulatory approval by identifying that the risk posed to marine mammals should be low and undertaking to conduct monitoring work following installation. More information: REF CASE STUDY. (2014) Enabling Industry compliance with offshore regulation. [Online – accessed August 2017].

10 Information on the stability and characteristics of the ground above and around derelict salt mines at Northwich, Cheshire, played a key role in English Partnership's £32 million remediation programme there. NERC-funded researchers at Keele University provided this information, which was crucial to both the design and the ongoing monitoring of the scheme. More information: REF CASE STUDY. (2014) Microseismic Monitoring for Environmental and Geotechnical Engineering Applications. [Online – accessed August 2017].

11 Further development of a customised hydrological model of Birmingham Aquifer helped to deliver improvements in the resilience, reliability, quality, cost and sustainability of local water supplies. Aiding Severn Trent Water's strategic and capital planning for the period 2009 to 2020, the NERC-funded model helped to identify, for instance, the best location for a new multi-million-pound supply well at Edgbaston – benefiting the company and its customers. More information: REF CASE STUDY. (2014) Regional Groundwater Resource Management. [Online – accessed August 2017].

12 By aiding sustainable management and the development of new planting techniques, NERC-funded research on mussel fishing enabled the Menai Strait mussel industry to boost yields and secure better markets. Allaying regulators' concerns and informing shellfish farming policy regionally, nationally and internationally, the research led directly to Marine Stewardship Council accreditation of the fishery's sustainability. This made it the world's first enhanced fishery to receive certification of this kind. More information: REF CASE STUDY. (2014) Quantification of ecosystem effects of fishing underpins the policy and practice of government, industry and retailers in relation to sustainable fisheries. [Online – accessed August 2017].

13 New management systems at the Cornish port of Falmouth helped to protect key activities there, create jobs and increase annual profits by 75%. They were developed as a result of NERC-funded research at Plymouth University which empowered the Falmouth Harbour Commissioners to ensure sustainable operations at the port, safeguarding commercial revenue streams and helping to protect its future. More information: REF CASE STUDY. (2014) Sustainable environmental management in smaller ports. [Online – accessed August 2017].

14 In a single winter the Highland Council saved £390,000 – 8% of its winter budget – by using a new ice-forecasting methodology enabling reductions in road-salt use and road-gritting fuel costs. University of Birmingham spinout company Entice developed the pioneering methodology with NERC funding. More information: REF CASE STUDY. (2014) Keeping transport systems running in winter; the contribution of Route-Based Weather Forecasting. [Online – accessed August 2017].

15 Installation of effective 'soft engineering' flood defences at the Northumberland village of Belford cost just £250,000, instead of the £2.5 million estimated for traditional 'hard engineering' defences. Locally tailored understanding of hydrological processes, funded by NERC, indicated the viability of solutions based on natural flood management features to protect residents, farms and other businesses against potentially damaging rainfall events. More information: REF CASE STUDY. (2014) Underpinning policy and practice for sustainable catchment management. [Online – accessed August 2017].

16 Thanks to NERC-funded research at the University of Leeds, Yorkshire Water was able to avoid or delay millions of pounds of expenditure on tackling water discolouration – helping to keep customers' bills as low as possible. The research showed how peatland management strategies would be highly effective in reducing discolouration, without affecting water quality or safety. REF CASE STUDY. (2014) Peatland catchment research on water colour yields economic benefits for the water industry. [Online – accessed August 2017].

17 A partnership between the University of Leicester and local businesses secured wider utilisation of space-based Earth Observation (EO) data – enabling 40 SMEs to increase their total Gross Value Added (GVA) by £950,000 within four years. Supported by NERC grants (e.g. through the National Centre for Earth Observation), the partnership achieved this via targeted interventions, development of products & services and training in the use of EO data – generating £2.9 million of investment in the East Midlands economy. More information: REF CASE STUDY. (2014) Supporting regional businesses to use satellite derived data. [Online – accessed August 2017].

18 Offshore wind farms like Scroby Sands are each saving around £100,000 because they do not now have to deploy radar to monitor their impact on coastal erosion. Coastal and wave monitoring work at NERC's National Oceanography Centre made this possible by showing that wind turbine pylons sited offshore do not exacerbate such erosion. In total, £1.6 million has been saved at 17 operational wind farms and £2 million at 20 wind farms still at the planning or consent stage. More information: NERC. (2013) NOC02 The Marine Renewable Energy Industry. [Online – accessed August 2017].

19 The Thames Barrier safeguards the lives and livelihoods of around 1.25 million Londoners, with every day of flooding prevented worth £94 million to the local economy. Monitoring and prediction of tidal and storm surges by NERC's National Oceanography Centre plays a key role in informing decisions on when to close the Barrier. More information: NERC IMPACT REPORT. (2014) p.12 People, homes and business protected from winter floods 2013–14. [Online – accessed August 2017].

20 Gunfleet Sands Wind Farm secured a licence to proceed after an environmental impact assessment found that installation would not have an unacceptable impact on the environment. PRIMER-E software, developed with NERC funding, played a key role, undertaking statistical analysis of multiple marine environmental datasets to determine the environment's sensitivity to the proposed development. More information available on request.

21 INFRASTRUCTURE AND PROJECTS AUTHORITY. (2016) National Infrastructure Delivery Plan 2016-2021. [Online – accessed August 2017].

22 HM TREASURY. (2016) Autumn statement 2016. (p.27). [Online – accessed August 2017].

23 Of gross value added. Source: UK MARINE INDUSTRIES ALLIANCE. (2011) A Strategy for Growth of the UK Marine Industries. [Online – accessed August 2017].

24 NERC. (2013) NOC08 Seafloor mapping and monitoring: Marine Protected Areas and policy advice. [Online – accessed August 2017].

25 NERC. (2013) BGS08 Seabed resources: Marine geoscience and technology. [Online – accessed August 2017].

26 NERC. (2013) BGS12 3D geological models and associated modelling technologies. [Online – accessed August 2017].

27 REF CASE STUDY. (2014) Sea-level change and coastal planning and NUCLEAR DECOMMISSIONING AUTHORITY. (2016) Planning approval secured for extra vaults at Low Level Waste Repository. [Online – accessed August 2017].

28 DELOITTE. (2015) A report on the economic and social impact of selected NERC-funded research. [Online – accessed August 2017].

29 NERC. (2013) NCAS1 Airborne and ground-based response to the atmospheric impact of volcanic eruptions and NERC. (2013) BGS04 Response to volcanic eruptions in Iceland and on Montserrat, and planning for future eruptions and REF CASE STUDY. (2014) First in situ measurements of ash spread from the 2010 Icelandic volcano eruption and REF CASE STUDY. (2014) Limiting the disruption to aviation caused by volcanic eruptions using balloon observations and model testing eruptions and REF CASE STUDY. (2014) Operational and strategic policy formation related to volcanic hazards in north-western europe. [Online – accessed August 2017].

30 NERC. (2014) Impact Award Submission. More information available on request.

31 NERC. (2013) NCAS07 A forecasting system for severe turbulence hazards at airports. [Online – accessed August 2017].

Notes and references

32 NERC. (2013) BGS02 Geomagnetic field: application in hydrocarbons production and space weather hazard. [Online – accessed August 2017].

33 LONDON ECONOMICS. (2015) Met Office – General Review Economic Analysis – Final Report. [Online – accessed August 2017].

34 Ibid. The estimated annual difference in value between a 'standard' weather and climate service and the Met Office's 'world leading' service over 2015-2025 (world leading: £29.5Bn, standard: £22.8Bn).

35 REF CASE STUDY. (2014) Storm prediction improved by sting jet discovery. [Online – accessed August 2017].

36 PA CONSULTING GROUP. (2007) Met Office - The Public Weather Service's contribution to the UK economy. [Online – accessed August 2017].

37 NERC. (2014) Impact Award Submission. More information available on request.

38 REF CASE STUDY. (2014) Improving weather and climate forecasting. [Online – accessed August 2017].

39 DELOITTE. (2015) Impacts of NERC science: Environmental hazards. [Online – accessed August 2017].

40 REF CASE STUDY. (2014) Improving weather and climate forecasting. [Online – accessed August 2017].

41 NERC. (2014) Impact Award Submission. More information available on request.

42 NERC. (2013) NCAS8 Impacts on the Insurance Industry. [Online – accessed August 2017]. and DTZ. (2010) High Resolution Climate Modelling and the Reinsurance Industry. Report prepared for NERC. Available on request.

43 REF CASE STUDY. (2014) Assessing the effect of climate change on the flood risk to London to inform flood management strategies. [Online – accessed August 2017].

44 Ibid.

45 TBR. (2011) The current and future UK science workforce: for the Science Council. [Online – accessed August 2017].

46 UK COMMISSION FOR EMPLOYMENT AND SKILLS. (2015) UKCES Employer Skills Survey 2015. [Online – accessed August 2017].

47 NERC. (2017) Doctoral Training Partnerships. [Online – accessed August 2017].

48 NERC (2017) Doctoral training partnerships mid-term evaluation 2016-17. [Online – accessed August 2017].

49 NERC. (2017) Centres for Doctoral Training. [Online – accessed July 2017].

50 EUSTACE. (2017) EUSTACE project. [Online – accessed August 2017].

51 COMRES. (2017) Research Councils UK – Public Insight Research. [Online – accessed August 2017].

52 BRITISH SCIENCE ASSOCIATION. (2017) Science: not just for scientists launched by the BSA. [Online – accessed August 2017].

53 NERC. (2017). NERC – Public Engagement. [Online – accessed August 2017].

54 e.g. by feeding into the UK State of Nature 2016 report.

55 KING'S COLLEGE LONDON AND DIGITAL SCIENCE. (2015) The nature, scale and beneficiaries of research impact. [Online – accessed August 2017].

56 WILSDON, J. et al. (2015) The Metric Tide: Report of the Independent Review of Metrics in Research Assessment and Management. [Online – accessed August 2017].

57 BIS. (2014) Insights from international benchmarking of the UK science and innovation system. [Online – accessed August 2017].

58 HASKEL, J., HUGHES, A. AND BASCAVUSOGLU-MOREAU, E. (2014) The economic significance of the UK science base: a report for the Campaign for Science and Engineering. [Online – accessed August 2017].

59. NERC. (2017) Natural Environment Research Council Annual Report and Accounts 2016-17. [Online – accessed August 2017].

Natural Environment Research Council
Polaris House
North Star Avenue
Swindon SN2 1EU
Wiltshire
Tel: 01793 411500
www.nerc.ac.uk