NATURAL CAPITAL COMMITTEE

Advice to Government on Research Priorities

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1. Introduction

Natural capital refers to those elements of the natural environment which yield services to people by underpinning the provision of clean air, clean water, food, recreation and a plethora of high value and often essential goods and services. As such natural capital sustains economic activity and wellbeing. However, the UK's natural capital is in long-term decline[1] and the Government has set out an objective "*to be the first generation to leave the natural environment in a better state than it inherited*"[2].

In addressing this objective the Natural Capital Committee's (NCC) was set up to advise on various aspects of the sustainable use and restoration of natural capital. The NCCs terms of reference[3] require it to provide advice to Government on research priorities so that future policy development can be improved. The Committee provided its initial advice in March 2014 following consultation with the UK Research Councils. This paper provides updated advice to Government and incorporates responses from further consultation with the Research Councils, other research funders and academia. As part of this consultation the NCC collated information regarding recent and ongoing research investments in this area, details of which are provided in the Annex to this paper.

We welcome the Government's recent announcement that it will incorporate NCC advice on improving decision making procedures within a revision of the H.M. Treasury Green Book. It is vital that initiatives such as those concerning the valuation of the services provided by the natural environment are mainstreamed within conventional decision making to ensure that the Government's objective of reversing long term losses in natural capital is attained.

2. Overview of major research themes

The NCC addresses arguably the most important economic challenge facing the UK; to ensure that economic development delivers sustainable growth in wellbeing into the future.

[1] NCC (2013)
[2] H.M. Government (2011)
[3] See www.naturalcapitalcommittee.org for detail.

This note sets out advice to Government on what the future research priorities for sustainable and efficient use of natural capital should be. On the basis of the Committee's work and consultations, we highlight two priority themes:

Theme 1: Sustaining natural capital.

The objective here is to assess the sustainability of natural capital in a manner which complements existing measures, most notably national income assessments such as Gross Domestic Product (GDP). GDP is a useful and internationally recognised measure of the financial performance of a country. However, it assesses income and does not consider the asset base from which that income is derived, the assumption being that increases in income will add to capital. This may well be the case for those forms of manufactured capital for which the full costs of use are reflected in market prices as these should deter excessive over-use. However, the services derived from natural capital are generally not fully accounted for, and they often lack market prices. They are therefore prone to over-exploitation or degradation such that capital can be eroded, and this is unlikely to be picked up in measures such as GDP. As part of this theme we need to develop metrics for natural capital accounting that reflect the status of natural assets and can be used to record degradation or unsustainable use, taking account of any ecological thresholds[4]. This in turn raises challenges regarding the monitoring of change. It may also be advantageous to link measures of natural capital to work undertaken elsewhere, for example the UN SEEA[5] approach to ecosystem accounts, the World Bank measures of Comprehensive Wealth[6], the efforts to prepare a more Inclusive Wealth measure by inclusion of other assets such as human capital[7] and the ONS UK Environmental Accounts and work on measures of wellbeing[8].

Theme 2: Decision making for sustainability.

While accounting approaches can, over time, reveal changes in the value of natural capital stocks, they cannot determine the best response to such trends. For this we need project appraisal techniques which can discriminate between the wider costs and benefits (including those associated with the natural environment) of alternative investment options. Although economic cost-benefit analysis (CBA) explicitly recognises the need to assess the value of environmental (typically non-market) goods, in practice appraisals are frequently incomplete. Common problems here include deficiencies in the natural science basis of assessments and an absence of robust, appropriate economic

[4] There may be a complex relationship between the size of a stock of natural capital and the services (and related values) it provides. For example, as long as the number of fish that are caught each season still leaves a sufficient population (the stock) to replenish itself then the fishery is sustainable. However, if overfishing reduces the population below the threshold level needed for restocking, then the entire fishery can collapse.

[5] United Nations Statistical Division (2013). SEEA Experimental Ecosystem Accounting, http://unstats.un.org/unsd/envaccounting/eea_white_cover.pdf

[6] http://data.worldbank.org/data-catalog/wealth-of-nations

[7] Arrow et al., 2012 and IHDP 2012 http://www.ihdp.unu.edu/article/iwr

[8] See http://www.ons.gov.uk/ons/guide-method/user-guidance/well-being/about-the-programme/index.html. This work acknowledges a role for the natural environment (e.g. through access to greenspace) in contributing to wellbeing. This role and the connections to wider measures of natural capital require further exploration.

values for the (often unintended) environmental and wider wellbeing impacts of a decision. Regarding the former issue there is a need to integrate natural science models into economic analyses to examine the variety of effects arising from decisions regarding natural capital and how these impact upon capital stocks and the services they provide. The information provided by such analyses needs to be the basis for developing economic values for ecosystem services. While methods exist for deriving such economic values (e.g. see the land use case study in NCC 2014 *State of Natural Capital Report*, chapter 4[9]) they have not been consistently and thoroughly applied to provide values in forms which decision makers can readily use. Such provision is complicated by the need to ensure that values reflect the realities of the natural environment, incorporating the variety of effects which arise when natural capital is used and how these vary across locations and over time. The valuation challenge is similarly complex. Research is needed to capture the variation in non-market values across locations and address the diversity of socio-cultural factors which determine the wellbeing which people obtain from the environment[10]. A significant and highly interdisciplinary research challenge therefore exists to provide decision makers with the tools they require to bring scientifically sound, environmental values into economic decision making. There is also a need to incorporate the impact of those decisions upon natural capital stocks. This is of particular concern when the cumulative impact of multiple decisions is considered.

3. Detailed research needs

For presentational purposes, each of the major research themes has been broken down further into two sub-themes as follows:

Theme 1: Sustaining natural capital	**Topic 1**: Defining and measuring natural capital.
	Topic 2: Understanding the impact of changes in natural capital upon the financial economy, jobs and growth.
Theme 2: Decision making for sustainability	**Topic 3**: Linking natural science, economics and other disciplines to yield robust values for the services provided by natural capital.
	Topic 4: Bringing the value of natural capital and the services it provides into decision making.

[9] See NCC (2014) State of Natural Capital Report: Restoring our Natural Assets. www.naturalcapitalcommittee.org

[10] These challenges are discussed subsequently and include reflecting the realities of the natural environment, capturing the relationship between the environment, people and their socio/cultural relations, incorporating the substitutability (or lack thereof) of natural assets, etc

Each of these are described in more detail below.

Topic 1: Defining and measuring natural capital

Natural capital incorporates both biotic and abiotic components, assets that are replaceable as well as those that are not, and assets that are spatially specific (both because of their physical location and the interaction of that location with human populations), together with those that are present globally. In order to measure natural capital in a meaningful way, we need to establish how we categorise its various component assets and what unit(s) of measurement we use so as to ensure comparability between them. The NCC has made some preliminary recommendations in order to undertake a first assessment[11], but there are substantial gaps in knowledge relating to classification, baselines, thresholds and time limits for measuring different categories of asset and how attributes such as asset replaceability, reversibility, predictability and uncertainty should be reflected in the metrics. Also, the measurement of natural capital needs to focus not only on absolute (total) amounts but on rates of change, spatial distribution, functions, cultural factors, and potential threshold effects and (ir)reversibility relationships.

Key questions

- What are the relevant components and processes in natural capital that we need to understand and measure?
- How should we define and classify natural capital for accounting purposes?
- How should we physically measure natural capital? What are the best metrics/proxies? How do these relate to economic wellbeing values?
- What is the role and potential of new technologies and advances in earth observation for improving the assessment of natural capital?
- How do natural capital metrics map onto existing monitoring schemes, are there any gaps and how should these most effectively be addressed?
- How do we derive information on thresholds and limits and incorporate this into measurement? How should we incorporate attributes such as the ability of some natural capital to renew itself and hence the degree to which degradation can be reversed?
- How should non-renewable natural capital be measured, managed and proceeds reinvested in the face of potential changes in known stocks or changes in extraction technologies?
- How do we incorporate uncertainty in our measurements and assessments?
- Should we incorporate substitute assets (including non-natural capital) into our

[11] See NCC (2014) Towards a framework for defining and measuring natural capital, NCC working paper, Number 1. www.naturalcapitalcommittee.org

analysis and if so, how?

- How should we identify the most vulnerable natural capital stocks?

Topic 2: Understanding the impact of changes in natural capital upon the economy, jobs and growth

The impact of changes in natural capital upon conventional measures of UK economic performance remains an open empirical question. While there are concerns that policies to improve the natural environment may impact negatively upon measures such as national income, growth and jobs, there is also evidence that longer term effects might be significantly positive, while the eventual costs of natural capital degradation may be very substantial[12]. There is empirical and theoretical work to be done in order to resolve the most relevant questions for policy-making.

Note that this topic explicitly focusses upon conventional financial measures of jobs, growth and economic activity. It therefore excludes non-market economic and socio-cultural measures of wellbeing. These are addressed in Topic 3.

Key questions

- How do changes in our natural capital affect measures such as national income, growth and jobs both directly and indirectly?
- What sort of frameworks do we need to examine, measure and model these links effectively?
- How do these changes vary across the short- and long-term?

Topic 3: Linking natural science, economics and other disciplines to yield robust values for the services provided by natural capital.

Given that economic appraisals have such an important role in decision making processes, a key requirement is to ensure the development and application of methods for the robust economic valuation of the services and wellbeing provided by natural capital.

[12] NCC (2015) Protecting and Improving Natural Capital for Prosperity and Wellbeing, Third state of Natural Capital Report.

This is a major concern as the limited analyses available[13] suggest that there are very substantial gains in value for money to society from ensuring that natural capital values are incorporated in decision making.

Although there have been many valuation studies undertaken over the last thirty years, very few adequately:

a. Yield economically valid estimates of value;

b. Reflect the natural science dynamics and interactions of natural assets and services;

c. Deal with the interactions between natural capital, human and other forms of capital;

d. Adequately estimate the changes in the goods and services that are being valued and the change in behaviour that might be result;

e. Account for the physical location and temporal dynamics of natural capital stocks and the services they provide;

f. Account for physical location and temporal dynamics in relation to beneficiaries and the resultant impacts on values;

g. Adequately include health and socio-cultural factors and validly translate these into economic wellbeing or other measures compatible with wider decision making; and

h. Take account of the stock characteristics of natural assets and whether they are being used sustainably, are resilient to external shocks and the extent to which degradation is reversible.

To improve future policy development, research is needed to generate better quality valuation estimates of changes in natural assets along the lines outlined above. This is essential to underpin better decision making and to deliver improvements in the value for money realised by both private and public sector investments.

Key questions

- How do we assess the economic wellbeing value of the services provided by natural capital in a manner which is robust and sensitive to the spatial and temporal variation in both services and beneficiaries?
- As part of this how do we value the non-market, health, non-use, socio-cultural and wider benefits of natural capital and the services it provides using economic and other decision compatible measures of wellbeing?
- How should we incorporate the complexity of social and cultural factors underpinning preferences within values?

[13] NCC (2015), op cit.

- What methods exist, or can be developed, for rapid, cost effective collection of data for economic and other forms of valuation?
- How can new technologies (including satellites and other remote sensing, drones, automated data recorders, etc.) and the increasing availability of massive and real time earth observation and data be employed to increase the availability and quality of values for changes in the natural environment?
- How can data resources by made readily available for researchers, decision makers, the private sector and the public?
- How should we incorporate natural capital sustainability within economic valuations, accounts and decision making?
- How should values incorporate natural capital characteristics such as non-linear thresholds?
- Where robust economic values are not available, what role might standards based (opportunity cost) measures, restoration cost accounting or other approaches play in decision making?

Topic 4: Bringing the value of natural capital and the services it provides into decision making

Allied to the goal of robust valuation (Topic 3) is the need to incorporate those values into decision making processes and practices, so that the value of changes in natural assets are fully included in the decisions we make.

Key questions

- How do we apply these various economic and other appraisal methods to assessment of the natural capital implications of existing and future public policies and private initiatives?
- How can we better enable the use of economic and other values of natural capital and the services it provides by policy makers?
- How can better decision making tools be developed to address these multiple challenges?
- How can these tools be designed to ensure their use by non-specialists or those with minimal training (including the public)?
- How can these tools be designed to support decision making at multiple scales ranging from the local to national level?
- How can we improve the evaluation of policy and decisions regarding natural

capital?

- How can such enhanced evaluations be used to feed back into better decisions?

It is vital that decision makers have access to guidelines and exemplars that clearly define how to assess the costs and benefits of investment options and that these costs and benefits should include impacts on natural capital sustainability. The H.M. Treasury (2003) Green Book[14] appraisal guidelines provide an internationally acclaimed basis for cost-benefit analysis. These provide a superb starting point for the incorporation of natural capital within conventional decision making. Such incorporation needs to integrate both the relevant natural science and economic wellbeing information and to formulate a decision level sustainability test; requirements which constitute a significant challenge to integrate the natural sciences, economics, social science and cultural research.

As part of its 2015 "State of Natural Capital" report, the Committee worked with other academics and Government officials from Treasury and Defra to produce recommendations for refreshing Government cost-benefit analysis guidelines to take better account of natural capital issues.

Research is also needed to support better evaluation of past decisions, their implementation and effectiveness. This will facilitate a move from focusing upon actions to addressing outcomes, and providing usable learnings from past policy developments.

Opportunities for learning from previous decisions are poorly exploited. Evaluations have typically been seen as an ex-post activity, with little formal connection on to future decision making. There is a research priority therefore to develop means to generate a virtuous cycle between decisions, their evaluation and future decisions. Research into the balance of benefits and costs arising from alternative policies holds the potential to deliver substantial impact.

4. Application priorities for new research

Certain aspects of natural capital require new methods that are flexible enough to be applied to the plethora of real world decision making circumstances. An initial list of topics where there are current gaps in relevant natural science, economic valuation and socio-cultural research are outlined below. These have been identified through a mixture of NCC expertise and evidence from the available literature. Noting current initiatives in some areas, a future research programme focused on these topics should not only provide a useful test bed for practical application, but should also be of substantial policy relevance.

Natural capital areas with some recent investment include:

- Energy and greenhouse gasses;

[14] https://www.gov.uk/government/publications/the-green-book-appraisal-and-evaluation-in-central-governent

- Health and the environment;
- Role and value of biodiversity; and
- Atmosphere as a natural capital asset.

Natural capital areas needing more attention include:

- Managing land for multiple objectives;
- Natural capital in urban environments;
- Natural capital in coastal and marine environments; and
- International flows of natural capital and it's services.

5. Capacity building

There is a clear need for investment in the next generation of natural capital researchers. A major problem is a lack of explicit training in the highly interdisciplinary skills required for such work. This means that the present cohort of researchers are almost all drawn from disciplinary backgrounds, generally with little formal training in other disciplines. While there are advantages in possessing in-depth knowledge, the lack of an interdisciplinary focus is a clear challenge which needs to be met.

Training programmes at undergraduate, post-graduate and PhD level are urgently required to explicitly address this issue. In addition to this there is a need to facilitate the bringing together of inter/multi-disciplinary teams, enabling them to build understanding, testing potential to integrate approaches as well as training in inter-disciplinary project management. Such initiatives should embrace both the research communities and the public and private sectors. As a part of this the UK should invest in the development of one or more Centres of Excellence in Interdisciplinary Natural Capital Research. This is important in terms of addressing the challenges set out above and developing capacity. However, such an initiative would also consolidate the UK's global leadership in this field and generate direct financial gains for the country as a training hub for the international community.

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Annex: Current research initiatives relevant to Natural Capital

The Natural Capital Committee asked the Research Councils and other bodies to provide information on funding activities which they felt supported research in the natural capital area. The tables below catalogues responses to this initiative regarding ongoing and recent research funding. Where there are joint programmes, these have been assigned to only one Research Council. Government and other bodies also fund a range of research related to natural capital but this is not captured.

Natural Environment Research Council (NERC)

The following are the key NERC funded programmes that are directly relevant to understanding Natural Capital. However, the vision of NERC is "*To place environmental science at the heart of responsible management of our planet*", with goals to: understand and predict how our planet works; and manage our environment responsibly as we pursue new ways of living, doing business, escaping poverty and growing economies; much of the research and innovation supported by NERC can be considered to support or underpin the NCC's two priority themes. The Biodiversity & Ecosystem Service Sustainability (BESS) programme (with BBSRC) and the Valuing Nature Programme (with BBSRC, ESRC and AHRC) and the previous Valuing Nature Network (VNN) have all made useful contributions here. However, the focus of these programmes has been restricted by available resources which do not reflect the major economic wellbeing values associated with changes in natural capital and have not delivered the tools required for improving decision making in this area.

Name of initiative	Purpose / objectives	Start date	End date	Funding amount
Valuing Nature Programme (BBSRC, ESRC, AHRC)	Two important research challenges that have emerged from VNN's work are: 1.the relationships between ecosystem stocks and services, the identification of so-called 'tipping points' and the links with valuation and natural capital accounting; and 2.the relationships between ecosystems and human health	FY 14/15	FY 19/20	Approx £7m (at 80% FEC)

Highlight Topic: Integrated dynamics of natural capital systems: bringing the natural environment into economic decision making.	The aim of this research is to develop an integrated model that dynamically couples the multiple components that constitute a natural capital system to the similarly multiple external stressors (or external forcings), and marries processes that operate in the natural environment to economic analyses. Such a model could enable policy and decision makers to quantitatively evaluate the response of that system to actual or hypothetical changes in the external stressors.	FY 15/16	FY 20/21	£3m (at 80% FEC)
Valuing Natural Capital in Low Carbon Energy Pathways	This programme seeks to understand the implications for natural capital and the provision of ecosystem services of a range of future energy scenarios, including scenarios that are compatible with the UK's energy policy goals of maintaining energy security, keeping energy affordable and cutting greenhouse gas (GHG) emissions by 80% by 2050.	FY 14/15	FY 22/23	£1.9m (at 80% FEC)
Biodiversity & Ecosystem Service Sustainability (BESS) (with BBSRC)	Improving understanding of the role of biodiversity on ecosystem functioning and service provision at a landscape-scale. Biodiversity & Ecosystem Service Sustainability (BESS) is a six year (2011-2017) research programme, which aims to contribute to our understanding of the functional role of biodiversity in key ecosystem processes. Biodiversity underpins ecosystem goods and services through the functional role it plays within ecosystems. There is increasing concern that the ongoing loss of biodiversity may compromise the provision of ecosystem goods and services in the near future. The BESS programme will undertake research and activities in an integrated way and take a holistic approach to exploring the functional role of biodiversity in UK ecosystems across a range of environmental gradients and scales.	2011	2017	£13m (at 80% FEC)

Ecosystem Services for Poverty Alleviation (ESPA) (DFID and ESRC)	ESPA aims to deliver high quality and cutting-edge research that will deliver improved understanding of how ecosystems function, the services they provide, the full value of these services, and their potential role in achieving sustainable poverty reduction. ESPA research will provide the evidence and tools to enable decision makers and end users to manage ecosystems sustainably and in a way that contributes to poverty reduction.	2010	2019	£40.5m (at 80% FEC)
Human-modified Tropical Forests	This research programme will integrate experimental and observational data with models to understand the role of biodiversity in major forest biogeochemical cycles, explore the spatial correlations between ecosystem function in terms of biogeochemical cycles and the distribution of species that are of conservation concern, and develop new technological capabilities for sustainable long-term observations of biogeochemical cycling in forests.	2012	2017	£8m (at 80% FEC)
Antimicrobial Resistance in the Real World	The AMR Cross-Council Initiative is led by the Medical Research Council (MRC) and will be delivered via a thematic approach with research to be commissioned under four themes: •Theme 1: Understanding resistant bacteria. •Theme 2: Accelerating therapeutic and diagnostics development. •Theme 3: Understanding the real world interactions. •Theme 4: Behaviour within and beyond the health care setting. Theme 3 of the AMR initiative has been split into three components: indoor environments, outdoor environments and the host microbiome. NERC are leading on a call on the outdoor environment, titled AMR in the Environment.	TBC	TBC	>£3.5m NERC £4m AHRC
Changing Water Cycle	The Changing Water Cycle programme will develop an integrated, quantitative understanding of the changes taking place in the global water cycle, involving all components of the earth system, improving predictions for the next few decades of regional precipitation, evapotranspiration, soil moisture, hydrological storage and fluxes.	2009	2015	£10.1m

Environmental Exposure & Health Initiative (EEHI)	The Environmental Exposure & Health Initiative will provide important new knowledge on the interconnections and pathways between environmental pollutants and interacting stressors, exposure routes and health effects in humans, including variations in susceptibility and the definition of health risks. This integrated understanding is vital for the development of evidence-based policies and practices that will reduce the adverse health effects of contaminated water, land, food or air. This is a joint initiative between the Natural Environment Research Council (NERC), Medical Research Council (MRC), Department of Health (DH), Economic & Social Research Council (ESRC), and Department for Environment, Food & Rural Affairs. The initiative was launched under the umbrella of the Living With Environmental Change (LWEC) partnership and was designed to contribute to the partnership's strategic objective on protecting human, plant and animal health from diseases, pests and environmental hazards	2009	2015	£7m
Environmental Microbiology & Human Health	The vision of this programme is to provide the scientific evidence to support fast and efficient identification of pathogenic/allergenic microorganisms and biological material in environmental media which can be used in appropriate tools and models for the protection of public health. The programme will cover process and modelling studies in freshwater and coastal waters and for bioaerosols, and develop advanced techniques to improve the speed, accuracy and reproducibility of molecular methods and address the problem of counting non-viable organisms through culture methods, as appropriate.	2015	2019	This £5·15m programme is co-funded by the Defence Science & Technology Laboratory (Dstl) and Food Standards Agency (FSA).

Environmental & Social Ecology of Human Infectious Diseases (ESEI)	The Environmental & Social Ecology of Human Infectious Diseases programme will enable society to respond proactively to the threat from novel pathogens and emerging infections by generating knowledge on the ways in which the natural and social environments affect the emergence and spread of infectious disease. The programme recognises that important new insights into the drivers and control of infectious diseases in human populations can only be achieved by taking a holistic systems approach. This a joint initiative between NERC, MRC, ESRC and BBSRC and has been designed to contribute to the NERC Environment, Pollution & Human Health theme and the Living With Environmental Change (LWEC) strategic objective on protecting human, plant and animal health from diseases, pests and environmental hazards.	2009	2017	Approximately £10m total, £4m from NERC.
Future Climate for Africa (FCFA)	Future Climate for Africa (FCFA), is a new five-year international research programme jointly funded by the UK's Department for International Development (DFID) and the Natural Environment Research Council (NERC). The Programme will support research to better understand climate variability and change across sub-Saharan Africa. Its focus will be on advancing scientific knowledge, understanding and prediction of African climate variability and change on 5 to 40 year timescales, together with support for better integration of science into longer-term decision making, leading to improved climate risk management and the protection of lives and livelihoods. FCFA projects will be delivered through collaborative partnerships of the world's best researchers. The programme's success will be measured by the way that its research generates new knowledge which can be used to benefit the poor in a sustainable manner.	2014	2019	£20m, 5 year research programme, joint NERC/ DFID.
Flooding from Intense Rainfall	To reduce the risks of damage and loss of life caused by surface water and flash floods through improved identification, characterisation and prediction of interacting meteorological, hydrological and hydro-morphological processes that contribute to flooding associated with high-intensity rainfall events.	2012	2017	£5.2m.

Land Based Renewables	By 2020, the proposed EU requirement is that the UK meets 15% of its final energy demand from renewable sources, which equates to around 40% for electricity. There is an urgent research need to understand the environmental implications of this requirement. This programme seeks to develop an integrated, quantitative understanding of the consequences of using land for renewable energy production on the resilience of terrestrial and freshwater ecosystems.	2009	2014	£2.4m which includes a £350k investment from Shell UK
Macronutrient Cycles	The overall goal of the Macronutrient Cycles programme is to quantify the scales (magnitude and spatial/temporal variation) of N and P fluxes and nature of transformations through the catchment under a changing climate and perturbed C cycle.	2011	2015	£9.5m
Marine Ecosystems	The goal of this programme is to address key knowledge gaps in marine ecosystems research by combining existing long-term data with new field-based and experimental observations. This, along with recent theoretical advances from marine and terrestrial ecology, will facilitate the development of more realistic marine ecosystem models, which in turn will help explore the impact of environmental change on marine ecosystems, including testing potential management solutions.	2013	2018	£6m
Mathematics & Informatics for Environmental Omic Data Synthesis (Omics)	The programme aims to develop the fundamental knowledge needed to integrate large volumes of genomic, transcriptomic, proteomic and metabolomic data into wider environmental analyses to address new research questions. Another major aim of the programme is to promote the development of omic informatics as a professional niche within environmental research.	2012	2019	£4m
Probability, Uncertainty & Risk in the Environment (PURE)	The aim of the PURE programme is to improve the assessment and quantification of uncertainty and risk in natural hazards by developing new methods and demonstrating their applicability to enhance the uptake of natural hazards science.	2012	2016	£6.8m

Radioactivity & the Environment (RATE)	There are many important reasons to expand UK research on radioactivity in the environment. In response to tough targets for reduction of greenhouse gas emissions, it is possible that a new generation of nuclear power plants may be commissioned in the UK and elsewhere. The UK faces serious legacy issues associated with radioactive waste and contaminated sites; and there has been a recent change in paradigm for environmental protection from radiation. To address this, NERC is commissioning a £5m, five-year capacity-building research programme - Radioactivity & the Environment - with projects planned to run between 2013-14 and 2017-18. It will form part of the NERC contribution to the wider RCUK Energy Programme	2013	2018	£5m
Resource Recovery From Waste: Challenges for the health of the environment	This £7.2m, five-year programme aims to deliver the science needed to accomplish a paradigm shift in the recovery of resources from waste. This will be driven environmental benefits (integrated across air, soil and water resources, and biodiversity), and societal ones (including improved human health, informed decision-making, new business models, commercial and broader export potential), rather than by economics alone. The programme will also forge new thinking that goes beyond carbon to understand waste as a resource from the perspective of ecological rather than carbon outcomes.	2012	2018	£7.2m
Soil Security	The overarching aim of the Soil Security programme is to deliver improved forecasts of the response of the soils system to changes in climate, vegetation or management at scales of analysis which match the scale of decision making. This will be achieved by addressing the following goals to gain an integrated and predictive understanding of (i) the ability of soils to perform multiple functions in different contexts and at different scales, and (ii) their ability to resist, recover and adapt to perturbations, such as those caused by land use change and extreme climatic events.	2013	2018	£8m funded by NERC, BBSRC, Defra and Scottish Government.
Sustainable Aquaculture	In the UK, the EU's biggest producer of finfish, the value of aquaculture is greater than £580m per year and rising - of the same order as the value of wild capture fisheries at £770m per year. This paradigm shift in resource use requires underpinning by fundamental environmental and bioscience research to understand and manage the interactions between the	2014	2017	£6m funded by BBSRC, NERC, Cefas, AFBI and Marine Scotland. The Food Standards Agency (FSA) and FSA in

	ecosystem and the industry. This is required to protect natural capital and human health, to better understand the resilience of aquatic ecosystems to pressures from aquaculture, and to ensure that production can be increased sustainably to meet the growing need for highly nutritious protein and lipid, while also addressing societal environmental concerns.			Scotland have also indicated that they will consider co-funding contributions on a case-by-case basis.
UK Droughts & Water Scarcity	The UK Droughts & Water Scarcity research programme is a five-year interdisciplinary, £12m+ NERC programme in collaboration with ESRC, EPSRC, BBSRC and AHRC. It will support improved decision-making in relation to droughts and water scarcity by providing research that identifies, predicts and responds to the interrelationships between their multiple drivers and impacts.	2013	2018	Up to £12m. NERC is investing £6.5m. Additional funds in the region of £5.5m are being sought from the other research councils in the partnership.
Understanding & Sustaining Brazilian Biome Resources	The Understanding & Sustaining Brazilian Biome Resources programme seeks to improve our understanding of the role of biodiversity in the functioning of ecosystems; the drivers and impacts of change; and options for management and restoration, within Brazilian biomes. It is jointly funded by NERC and the São Paulo Research Foundation (FAPESP). The UK supports the programme through the Newton Fund, which forms part of the UK government's Official Development Assistance (ODA) commitment.	2015	2019	NERC will provide up to £2m (80 per cent FEC) to eligible UK-based researchers and FAPESP will provide up to R$8m (approximately £2m) to eligible São Paulo State-based researchers.
Unlocking the Potential for Groundwater for the Poor (UPGro)	Unlocking the Potential of Groundwater for the Poor (UPGro), is a new seven-year international research programme which is jointly funded by UK's Department for International Development (DFID), Natural Environment Research Council (NERC) and in principle the Economic and Social Research Council (ESRC). It focuses on improving the evidence base around groundwater availability and management in Sub-Saharan Africa (SSA) to enable developing countries and partners in SSA to use groundwater in a sustainable way in order to benefit the poor. UPGro projects will be interdisciplinary, linking the social and natural sciences to address this challenge. They will be delivered through collaborative partnerships of the world's best researchers. The programme's success will be measured by the way that its research generates new knowledge which can be used to benefit the poor in a sustainable manner.	2012	2019	£12m over 7 years.

Using Critical Zone Science to Understand Sustaining the Ecosystem Service of Soil & Water (CZO)	This is a joint programme between NERC and the National Natural Science Foundation of China (NSFC) to understand and seek ways to address the challenges faced for the delivery of China's ecosystems services in association with their agricultural production and urbanisation. Resilience of these services will be key to the health and well-being of China's on-going land and water use transitions, and can best be understood by looking at these services in the context of the critical zone and the interdisciplinary science required to address it. This programme is supported by the UK through the Newton Fund which forms part of the UK governments Official Development Assistance (ODA).	2015	2018	NERC have a budget of £3m to fund eligible UK-based researchers and NSFC have a budget of 60m RMB to fund eligible Chinese-based researchers.
Atmospheric Pollution & Human Health in a Developing Megacity	This programme will have two streams of activity looking at urban air pollution and its impact on health in a Chinese megacity, and urban air pollution and its impact on health in an Indian megacity.	2014	2020	£5·5m is available for research in China, with £3m from the Newton Fund (£2m for NERC and £1m for MRC). £5·5m is available for research in India, with £3m from the Newton Fund (NERC only).
Drivers of Variability in Atmospheric Circulation	Improved prediction of the European climate is critical for the UK. The impacts of unusual weather episodes such as the 2003 heat wave, 2010 cold winter and 2012 wet summer were felt across society and the economy. Recent developments in observation, modelling and data reanalyses provide an exceptional scientific opportunity to increase understanding of the causes and predictability of these unusual seasons. This £2.5m programme will establish the underlying processes and mechanisms that underpin regional climate variability, assess the representation of those processes in climate models, and develop improvements to the models and hence regional climate predictions from months to years ahead.	2014	2018	£2.5m from NERC.

Food Security and Land Use Change Programme.	Joint call between the Belmont Forum and the Agriculture, Food Security & Climate Change Joint Programming Initiative (FACCE-JPI). UK partners are NERC, BBSRC and ESRC. To increase scientific understanding of the dynamic multiple scale interactions between food security and land use in the context of global change, and the consequences of these interactions for climate, ecosystems and social systems, including their economic and cultural dimensions. The call emphasises three fundamental topics: • Land use change impacts on food systems. • Food systems dynamics as driver of land use changes. • Feedback loop interactions between land use change and food security dynamics.	2014	2019	€10·5m

Biotechnology & Biological Sciences Research Council (BBSRC)

Name of initiative	Purpose/objectives	Start date	End date	Funding amount
Insect Pollinators Initiative (IPI) (also DEFRA, NERC, Scottish Government and Wellcome Trust)	To promote innovative research aimed at understanding and mitigating the biological and environmental factors that adversely affect insect pollinators. To provide an evidence base to inform the conservation of wild insect pollinators and to improve the husbandry of managed species, in order to avoid the potentially catastrophic loss of the ecosystem services they provide. To provide a basis for reducing current declines and sustaining healthy and diverse populations of pollinating insects for the future.	2010/11	2015/16	£10m
Tree Health and Plant Biosecurity Initiative (THAPBI) (also DEFRA, ESRC, Forestry Commission, NERC and Scottish Government)	To support the health and resilience of UK trees and woodlands, and of their associated biodiversity and ecosystems services. To generate natural and social scientific knowledge to inform the development of innovative ways of addressing current and emerging threats to trees and woodland ecosystems from pathogens and pests. To support the future health and resilience of trees, woodlands and their associated ecosystems. To facilitate collaboration between specialists in tree or forest research, and leading-edge scientists from the wider natural, biological, social, economic or other relevant research communities. To encourage and make best use of interdisciplinary and systems approaches, and improve the impact and integration of social research and economics in this area.	2014/15	2018/19	£9m
Soil and Rhizosphere Interactions for Sustainable Agri-ecosystems	To improve understanding of agricultural soil and rhizosphere interactions to underpin the development of sustainable agricultural ecosystems ('agri-ecosystems').	2014/15	2019/20	£5m

(SARISA) (also NERC)	To encourage proposals that link the development of specific agricultural innovations with agri-ecosystems approaches to analyse the potential benefits. To encourage proposals that draw on the combined expertise of bioscientists and environmental scientists, and those that link scales of research (laboratory/field/landscape).			
Resilience of the UK Food System in a Global Context (also ESRC, NERC, DEFRA, Food Standards Agency, Scottish Government)	To integrate biological, environmental and social sciences to support interdisciplinary projects addressing one or more of the following themes (these are all interlinked and proposals that address aspects of more than one theme are strongly encouraged): **1. Optimising the productivity, resilience and sustainability of agricultural systems and landscapes** At the core of this theme is understanding the relationship and trade-offs between resilience, sustainability to deliver production systems balancing the provision of food with other ecosystem services. This will help address the challenge of feeding a growing population sustainably; ensuring improved environmental, social and economic outcomes. **2. Optimising resilience of food supply chains both locally and globally** This theme is focused on understanding the economic, environmental, biological and social factors affecting the food supply chain, and the interplay between these, to increase resilience of the food system at a local-to-global level. **3. Influencing food choice for health, sustainability and resilience at the individual and household level** Central to this theme is understanding the drivers behind food choices and how these impact on the wider food system and production, in order to identify interventions that result in in provision of nutritious and sustainable food in more resilient and equitable ways.	2016/17	2021/22	£14m

Sustainable Intensification Network (with NERC)	BBSRC is planning to launch a call for a Sustainable Intensification (SI) Network on 1 October 2015 (details will be available on www.bbsrc.ac.uk). The network is intended to address relevant recommendations of the BBSRC SI Working Group (Smith, P., Bateman, I.J., Benton, T., Fitzpatrick, J., Garnett, T., Lawrence, D., Memmott, J., Mulvany, P., Norman, K. and Scollan, N. (2014) *Report of the BBSRC Working Group on Sustainable Intensification of Agriculture*, BBSRC, Swindon, available at: http://www.bbsrc.ac.uk/news/policy/2014/140930-n-comments-food-security-report.aspx). The purpose of the network is to build an interdisciplinary UK research community with the skills, expertise and capabilities to address the challenge of sustainable intensification, and to facilitate the development of high-impact interdisciplinary research in this area.	2015/16	TBA	TBA

Economic & Social Research Council (ESRC)

Name of initiative	Purpose / objectives	Start date	End date	Funding amount
Nexus Programme - Nexus Network: http://www.thenexusnetwork.org/	ESRC are supporting a series of research investments that seek to address challenges that cut across the Energy- Environment-Food Security Nexus. The challenges recognise the connectedness and global nature of the issues around e.g. equitable access to resources; understanding and encouraging sustainable behaviours; cost-benefit analysis of climate change mitigation and adaptation interventions; economic threats and opportunities of the sustainability agenda; security of and competition for resources, and understanding trade-offs; green growth and innovation; financing the green economy; new technologies and public acceptance; and how to promote effective interdisciplinary working to address these complex and connected issues. The Nexus Network will coordinate activities to improve understanding and generate new thinking in this area.	June 2014	July 2017	£1m
Nexus programme - Centre for Evaluating Complexity: http://www.esrc.ac.uk/funding-and-guidance/funding-opportunities/33584/centre-for-evaluating-complexity-across-the-energy-environment-food-nexus.aspx	To address the challenges associated with evaluating complexity, ESRC, NERC, Defra, DECC, EA and the FSA are developing a new research centre. The overarching aim of the Centre is to pioneer, test and promote innovative and inclusive methods to analyse evaluations across the energy-environment-food nexus where complexity presents an integral challenge to policy interventions.	2016	2019	£3.6m

Nexus Programme - Centre for Understanding Sustainable Prosperity: awarded to Tim Jackson, Surrey. Due to commence Jan 2016	The ESRC has recently commissioned a Centre dedicated to understanding and identifying the challenges and opportunities related to the issue of Sustainable Prosperity. • To explore the economic, environmental, social and governance dimensions of sustainable Prosperity & develop clear, pragmatic steps for enterprise, government and civil society to take, in pursuit of it. • To test the Sustainable Prosperity vision within the context of advanced Western economies and explore its macroeconomic implications. • To create a vibrant and topical research programme on the multi-faceted relationship between Sustainability and Prosperity.	Jan 2016	Dec 2019	£5m
Droughts and water security: http://www.nerc.ac.uk/research/funded/programmes/droughts/	The UK Droughts & Water Scarcity research programme is a five-year interdisciplinary, £12m+ NERC programme in collaboration with ESRC, EPSRC, BBSRC and AHRC. It will support improved decision-making in relation to droughts and water scarcity by providing research that identifies, predicts and responds to the interrelationships between their multiple drivers and impacts	2013	2018	£12m
Valuing natural capital in low carbon energy pathways: http://www.nerc.ac.uk/research/funded/programmes/valuingnaturalcapital/	Natural capital includes the elements of nature that produce value to people, directly and indirectly, including living aspects of nature as well as non-living, such as minerals and resources. The pursuit of the low carbon agenda holds unusually profound implications for the provision of these ecosystem services going far beyond the protection of the climate. So far, the scientific community and the policy world have given little attention to the low carbon/natural capital nexus. Unless evidence regarding this nexus is generated, unnecessary degradations in wider ecosystem service provision may result and opportunities to exploit synergies may be missed.	2014	2019	£1.9m
What Works Wellbeing: http://www.esrc.ac.uk/funding-and-guidance/funding-opportunities/32283/what-works-wellbeing-call-for-	The ESRC is collaborating with a range of public sector organisations to develop a proposal for a What Works Centre for Wellbeing (WWCW), commencing early 2015. Its purpose is to understand what government, communities business and individuals can do to improve wellbeing. It will collate, synthesise and translate useful, relevant evidence and make it accessible to decision makers.	June 2015	May 2018	£3.9m (£0.5m from AHRC)

proposals.aspx				
ESRC Euro China Call 2013 UK - SINCERE project: http://www.esrc.ac.uk/news-and-events/announcements/32474/europe-china-researchers-funded-for-collaborative-research-on-the-green-economy-and-understanding-population-change.aspx	The aim of this project is to provide the first systematic comparative analysis of green economy-focused eco-city projects in China and Europe. This will inform the identification of opportunities and pathways for shaping national and collaborative international urban and economic policy responses, engaging the state, the business sector and communities in delivering 'smart eco-city' projects that can promote the growth of the green economy.	2015	2018	£400k
Life study: http://www.esrc.ac.uk/news-and-events/features-casestudies/features/33914/Launch_of_Life_Study.aspx	The study, which is funded by the ESRC and the Medical Research Council, was officially launched on 23 February at the House of Lords. It will track the growth, development, health and wellbeing of over 80,000 UK babies and their parents as they grow up, in order to identify which factors in early lives are important for health and wellbeing in adulthood. The Life Study will create the largest UK collection of information to support research and policies aimed at children and young people.	2015	2017	£14m
UK energy programme (Research council) - End Use Energy Demand: http://www.eued.ac.uk/whatiseued	End Use Energy Demand (EUED) research is concerned with reducing the amount of energy required to maintain economic activity and to achieve sustainable lifestyles. EUED can be sub divided in several ways, for example by: Sector: Industry, Buildings, Transport Services: Passenger and Freight transport, Structural Materials, Sustenance, Hygiene, Thermal Comfort, Communication, Lighting End Uses: Food, Entertainment, Health, Education, Heating, Refrigeration, Travel	2013	2018	£43m

UKERC Resources and Vectors – EPSRC-led (+ESRC) http://www.ukerc.ac.uk/programmes/resources-and-vectors.html	This theme will explore the current and future roles of different resources and energy vectors in the UK energy system. Its scope includes renewable and non-renewable resources: fossil fuels, critical materials and renewable resources such as bio-energy. It also includes current energy vectors (i.e. electricity, heat and liquid fuels) and how these might change in future (e.g. to include hydrogen).	2014	2019	
CCCEP **Centre for Climate Change Economics and Policy (CCCEP)**	The ESRC Centre for Climate Change Economics and Policy (CCCEP) brings together some of the world's leading researchers on climate change economics and policy, from many different disciplines.	2008	2018	£9m

Arts & Humanities Research Council (AHRC)

Name of initiative	Purpose / objectives	Start date	End date	Funding amount
RCUK Urban Living theme plus European JPI Urban Europe (In discussion)	http://www.rcuk.ac.uk/research/xrcprogrammes/innovate-uk-urban-living-partnership/	tbc	tbc	
AHRC Cultural Value project	The Cultural Value Project seeks to establish a framework that will advance the way in which we talk about the value of cultural engagement and the methods by which we evaluate that value. The first part of the framework will be an examination of the cultural experience itself and its impact on individuals and its benefit to society. The CVP funded a number of separate projects and other activities around cultural value. http://www.ahrc.ac.uk/Funded-Research/Funded-themes-and-programmes/Cultural-Value-Project/Pages/default.aspx (webpage has links to the projects). Relevant awards include: -Grant Holder: Dr Alis Elena Oancea Project Title: Developing Innovative Methods for Configurative Capture of the Cultural Value of Arts and Humanities Research (AH/L005131/1) -Grant Holder: Professor Sian Jones Project Title: Valuing the Historic Environment: a critical review of existing approaches to social value (AH/L005654/1) Workshop - http://www.ahrc.ac.uk/Funded-Research/Funded-themes-and-programmes/Cultural-Value-Project/Pages/Workshop-taking-on-the-challenge.aspx	End 2012	End 2014	£2m
Connected Communities	AHRC-led programme. Various projects but there are two relevant themes: Communities, Culture, Environments and Sustainability (http://www.ahrc.ac.uk/Funding-Opportunities/Research-funding/Connected-Communities/Events/Documents/CC11-List-of-awards-for-web.pdf) and Communities, Culture, Health and Wellbeing (http://www.ahrc.ac.uk/Funding-Opportunities/Research-funding/Connected-Communities/Documents/CC13-Awards-for-Web.pdf)	2008	ongoing	£5m
Care for the Future	AHRC theme – various awards made under the Environmental Change and Sustainability area (http://www.ahrc.ac.uk/Funding-Opportunities/Research-funding/Themes/Care-for-the-Future/Documents/AHRC_Successful_Highlight_Awards.pdf)	2010	ongoing	

A Healthier Scotland	AHRC collaboration with the Scottish Funding Council on a Knowledge Exchange Programme – a Healthier Scotland (http://www.ahrc.ac.uk/Funding-Opportunities/Documents/AHRCSFCKEhealthyscotlandprojects.pdf)	2010	2012	AHRC contribution £0.25m
UK NEA Follow on, Cultural Ecosystem Services	Further exploration of cultural ecosystem services and how cultural, shared and plural values for ecosystem services can be better understood and operationalised into a range of decision making contexts alongside economic analyses. -Work Package Report 5: Arts & Humanities Annex 1 – Arts & Humanities Perspectives on Cultural Ecosystem Services -Work Package Report 5: Arts & Humanities Annex 2 – Additional Cultural Values work -Work Package Report 5: Arts & Humanities Annex 3 – Cultural Ecosystem Services: A Keywords Manual	Early 2012	Mid 2014	~£230k from AHRC
Examples of responsive mode and other strategic initiative grants	Natural Environments and Cultural Services – Simon James, Durham (AH/L004321/1) Cultural Planning for Sustainable Communities, Graeme Evans, Middlesex (AH/K00414X/1) Understanding Everyday Participation - Articulating Cultural Values, Andrew Miles, Manchester (AH/J005401/1) The Value of the Humanities, Helen Small, Oxford (AH/J003220/1) Museums on Prescription: Exploring the role and value of cultural heritage in social prescribing, Helen Chatterjee, UCL (AH/L012987/1)	2014 2013 2012 2012 2014	2014 2013 2017 2012 2017	~£50k (Fellowship) ~£50k (Follow On) ~£1.2m (Connected Communities) ~£80k (Fellowship) ~£440k (Grant)
Studentships	For examples, '*Evaluating the Outcomes of Cultural Services: a Mixed Methods Investigation*', Briony Birdi, Sheffield.	2012	2015	~£54k