

NATURAL CAPITAL COMMITTEE

Advice to Government on Research Priorities

March 2014

1. Introduction

The Natural Capital Committee's (NCC) terms of reference¹ require it to provide advice to Government on research priorities so that future policy development can be improved.

This paper makes a substantive contribution to that element of the Committee's remit by setting out the key natural capital research priorities. These have been determined in consultation with the Research Councils. The Committee and Research Councils have held three meetings since the Committee's inception in 2012 to identify research priorities as well as relevant existing research programmes.

Recognising the importance and urgency of the natural capital research agenda, the Research Councils have launched the *Valuing Nature* Programme²; a 6 year, £7 million+ initiative focusing on the following three issues.

- a. Improving understanding of the links between ecosystem stocks and tipping points, and how to value ecosystem service change as tipping points are reached and exceeded.
- b. Improving understanding of the role biodiversity and ecosystem processes play in human health and wellbeing; and
- c. Providing further support to the Valuing Nature Network.

This announcement from NERC (the Natural Environment Research Council) is welcome but significantly more investment will be needed over coming years to address some of the key research challenges and knowledge gaps as outline in this advice paper.

The paper and the accompanying annex does three key things. It provides:

- (1) An outline of the two main *themes* where further research is needed;
- (2) A detailed set of research questions for each of those themes and *sub-themes*; and
- (3) Identifies a range of priority application areas and potential case studies to further test and develop our knowledge and understanding.

¹ See www.naturalcapitalcommittee.org for detail.

² see <http://www.nerc.ac.uk/research/programmes/valuingnature/events/documents/ao-pct.pdf>

If implemented, this research programme will significantly improve the evidence necessary to inform future policy advice and development, and in turn make a real difference to how we manage our natural assets.

1. 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.

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 to date, we highlight two priority themes:

1. ***Sustaining Natural Capital:*** The objective here is to measure 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 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 often lack market prices and are therefore prone to over-exploitation such that capital can be eroded without being adequately picked up in measures such as GDP. We are interested in the development of 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 thresholds³. It may be advantageous to link measures of natural capital to work undertaken elsewhere, for example the UN SEEA⁴ approach to ecosystem accounts, the World Bank measures of Comprehensive Wealth⁵ and the efforts to prepare a more Inclusive Wealth measure by inclusion of other assets such as human capital⁶.
2. ***Decision Making for Sustainability:*** Although 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

³ While we can assume that the services provided by financial and manufactured capital are directly related to the size of those capital stocks (irrespective of the size of those stocks), this is not necessarily the case for some forms of natural capital. For example, as long as the number of fish that are caught each season still leaves a sufficient population 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.

⁴ United Nations Statistical Division (2013). SEEA Experimental Ecosystem Accounting, http://unstats.un.org/unsd/envaccounting/eea_white_cover.pdf

⁵ <http://data.worldbank.org/data-catalog/wealth-of-nations>

⁶ Arrow et al., 2012 and IHDP 2012 <http://www.ihdp.unu.edu/article/iwr>

robust, appropriate economic values for the indirect impacts of a decision. 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 4⁷) they are inconsistently applied and there is a need to generate a resources of widely available values for ecosystem services. Furthermore, there is typically no attempt to incorporate the impact of decisions upon natural capital stocks. This is of particular concern when the cumulative impact of multiple decisions is considered.

2. Detailed Research Needs

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

Theme 1: Sustaining Natural Capital

Topic 1: Defining and measuring natural capital; and

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 and economics to yield robust and case-relevant values for ecosystem services and natural capital stocks; and

Topic 4: Bringing these values and underpinning natural science into decision making.

Each of these are described in more detail below.

Topic 1: Defining and Measurement of Natural Capital

Key questions

- What are the relevant components and processes in natural capital that we need to better understand?
- 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 does this map onto existing monitoring schemes?
- How do we derive information on thresholds and limits and incorporate this into

⁷ www.naturalcapitalcommittee.org

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 analysis and if so, how?
- How should we identify the most vulnerable natural capital stocks?

The measurement of natural capital needs to focus not only on absolute (total) amounts but on rates of change and concerns regarding potential threshold effects and (ir)reversibility relationships.

Research challenges include:

- gaps in the natural science knowledge base (including arriving at a scientific consensus on the best metrics/proxies for natural capital and ecosystem services;
- pragmatically considering the data collected by current national monitoring schemes;
- criteria by which we identify the most vulnerable stocks;
- prior detection of thresholds; and
- information on depletion/restoration relationships.

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 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 assessment⁸, 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.

⁸ See NCC (2014) Towards a framework for defining and measuring natural capital, NCC working paper, Number 1. www.naturalcapitalcommittee.org

Topic 2: Understanding the Impact of Changes in Natural Capital Upon the Financial Economy, Jobs and Growth

Key questions

- How do changes in our natural capital affect measures such as national income, growth and jobs?
- 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?

The impact of changes in natural capital upon conventional measures of UK economic performance remains an open empirical question. Some argue that policies to improve the natural environment may impact negatively upon measures such as national income, growth and jobs. However, others claim that short term impacts may be minor and longer term effects might be significantly positive, while the eventual costs of natural capital degradation may be very substantial. There is empirical and theoretical work to be done in order to resolve the most relevant questions for policy-making.

Topic 3: Linking Natural Science and Economics to Yield Robust and Case-Relevant Values for Ecosystem Services and Natural Capital Stocks

Key questions

- How do we ensure that economic value estimates are underpinned by robust natural science evidence?
- How do we assess the economic value of the services provided by natural capital in a manner which is robust and sensitive to the spatial and temporal variation of those services?
- 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 restoration cost accounting or other approaches play in decision making?
- How should we incorporate the complexity of social science factors underpinning preferences within values?
- What data do we need to meaningfully incorporate non-use values in decision-making?

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 provided by and sustainability of natural capital. It is the opinion of the NCC that this is a reasonable and feasible aim but that, to date, the investment in research to support such robust valuation has been both insufficient and piecemeal.

This is a major concern as the limited analyses available (see, for example, section 4 of the Committee's State of Natural Capital report, 2014) suggest that there are major gains in value for money to society from ensuring that ecosystem service values are incorporated in decision making.

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

- a. Reflect the natural science characteristics of the ecosystem assets and services they refer to (that is, the way they behave and operate in different circumstances);
- b. Deal with the interactions between natural capital, human and other forms of capital, which are often needed in different combinations to produce the goods from which we derive value;
- c. Adequately estimate the changes in the quantities of the goods and services that are being valued and the change in behaviour that might be induced by different circumstances (i.e. attempt to take into account longer term adjustments to changes);
- d. Account for physical location in relation to beneficiaries and resultant impacts on values;
- e. Take account of the stock characteristics of natural assets and whether they are being used sustainably (which can significantly alter valuation estimates);
- f. Consider how resilient natural assets are to external shocks; or,
- g. Consider the extent to which any degradation of assets is reversible.

To improve future policy development, significantly more investment is needed in research to generate better quality valuation estimates of changes in natural assets along the lines outlined above. This is essential to underpin better decision making.

Topic 4: Bringing These Values and Underpinning Natural Science 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 – especially in, but not limited to, a public sector context.

Key questions

- How do we apply these various economic appraisal methods to assessment of the natural capital implications of existing public policies and private initiatives?
- How can we better enable the use of robust economic values by policy makers?
- How can we extend these assessments to the delivery of policy targets and aspirations such as those set out in the Natural Environment White Paper (H.M. Government, 2011) or the Making Space for Nature report (Lawton et al., 2010)?
- How can better decision making tools be developed to address these multiple challenges?

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 Book⁹ 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 information and to formulate a decision level sustainability test; requirements which constitute a significant natural and social science research challenge.

In preparation for its State of Natural Capital report 2015, the Committee, working with other academics and Government officials from Treasury and Defra, will undertake a short research project reviewing how guidelines and implementation of cost-benefit analysis might be developed to take better account of natural capital issues. This work will signal where improvements might be made in future but it is really just a start. Significantly more investment will be needed to get to the position where high quality natural capital valuation estimates routinely feature in appraisal processes across the public sector.

The NCC State of Natural Capital report 2013¹⁰ identifies a major problem for decision makers in both the public and private sector as being the lack of robust economic estimates of the value of changes in natural capital (see Topic 3 above). This severely constrains good decision making as it makes it extremely difficult to assess the inevitable trade-offs which occur when necessarily limited resources are applied to potentially different ends. High quality valuations need to address all of the issues raised above.

However, an equally important challenge is how to incorporate new, spatially and temporally robust valuation estimates into decision making processes. In the absence of investment to facilitate their ready use, many of these values will not be amenable to use by non-experts and they will tend to be generated under a necessarily complex set of parameters and

⁹ <https://www.gov.uk/government/publications/the-green-book-appraisal-and-evaluation-in-central-government>

¹⁰ www.naturalcapitalcommittee.org

incorporate a wide range of natural science and economic factors (for example, see NCC 2014 State of Natural Capital report, chapter 4).

A substantial improvement in decision making techniques delivered through the development of better tools for investment appraisal for both the public and private sector is needed. This is likely to require upfront investment in new software and models as well as the up-skilling of analysts so that they are capable of using them effectively. While this might seem like an additional cost in a time of extreme austerity and falling R&D budgets, the long-term efficiency gains are likely to deliver significant net benefits in addition to a much better allocation of resources more generally in the economy as we move from asking ‘what if’ questions in appraisals, to ‘what’s best’. Indeed, longer term, such investment in decision making techniques should reduce the cost of the appraisal process.

3. 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 both relevant science and economic valuation tools are outlined below. These have been identified through a mixture of NCC expertise and evidence from the available literature. A future research programme focused on these areas should not only provide a useful test bed for practical application, but should also be of substantial policy relevance.

- Managing land use for multiple objectives;
- Energy and greenhouse gasses;
- Health and the environment;
- Role and value of biodiversity;
- Marine environment; and
- International flows of ecosystem services.

A fuller discussion of each of these is given in the Annex.

Annex: Application Priorities for New Research in More Detail

1. Managing Land Use for Multiple Objectives: Food, Water, Climate, Energy, Recreation and Biodiversity.

There is a significant amount of evidence which documents that the current systems of land-use in England is far from optimal. This issue raises the potential for substantial net benefits to be generated by changes in the drivers of land use (policy, market forces, environmental change, social change, etc.). As such this provides an ideal test bed for developing generalizable approaches for sustainable decision making and encompasses many of the complexities of natural capital management which have to be addressed to attain sustainable economic development. Prior work (e.g. UK-NEA, 2011; Bateman et al., 2013) has shown the potential for bringing together natural science, social science and economics to evaluate the benefits and costs of alternative land use systems.

However, this approach needs substantial extension to embrace the major and inter-related consequences of land use change. In particular we need analyses which can examine the joint effects of land use change upon food production, the water environment, greenhouse gas emissions and storage, energy production and use, recreation and the multiple impacts of land use change upon the wider natural environment (e.g. impacts on habitats and wild species). To date, decision making has failed to integrate these fundamentally interlinked issues resulting in policy which has clearly failed to generate optimal outcomes for society (for example, the major negative externalities of the Common Agricultural Policy are well documented).

The research needed to address these interlinked issues must necessarily span disciplines. A firm basis of natural science is required to understand the inter-linked physical effects of land use change. Social science and in particular economic knowledge is required to understand the formation of values associated with these changes. Furthermore the analysis will need to extend beyond the land use realm in order to generate consistent, policy results. For example, analysis of the energy consequences of land use change is impossible without a clear understanding of the wider energy demand and supply issues to which it relates. Similarly the employment and growth effects of change require multi-level analysis. In effect this requires both micro and macro-economic understanding.

The benefits of such holistic analysis are considerable. It will allow an assessment of the consequences of particular interventions on the sustainability of ecosystem service delivery, including the impacts on human health and well-being. One consideration will be the relative roles of the state and the markets in ecosystem service provision, particularly in the context of CAP reform, the new National Planning Policy Framework, the use of offsets and eco-credits to deliver no net loss/net gains of natural capital, and the removal of perverse incentives and the introduction of benign incentives. This workstream will also examine the practical application of the asset check tool for assessing the state of our natural capital.

This research should embrace all land use, both rural and urban (the latter considered below). Within rural areas the remit includes agriculture, woodlands (with a particular remit to

inform the ongoing policy debate post the Independent Forestry Panel report), wetlands, moors and natural grasslands, coastal margins, etc. The objective here should be to generate a land use decision making tool which integrates natural science relationships and natural capital impacts into the analysis of the economic and social consequences of alternative decisions. The tool should facilitate integrated decision making across government departments addressing conflicting concerns regarding 'sustainable intensification', greenhouse gas commitments, rural development policy, environmental concerns, etc. It should also allow policy makers to move from the current approach of asking 'what if' questions to examining 'what's best'.

The majority of the UK population live in towns, cities and their conurbations and so urban areas are a vital element of this analysis. While these are dominated by the built environment they are highly dependent upon the natural environment both directly in terms of greenspace and greenbelt, but more fundamentally in terms of the supply of ecosystem services which make such concentrations of population viable. Services such as clean water and air quality are vital yet the role of the natural environment in supplying these goods is often ignored in planning and decision making processes. Long term planning is clearly required here. The proposed research would address this information gap by examining the symbiosis between the natural and built environment and its consequences for natural capital sustainability and planning.

Work on the topic of land use change entails the complex integration of knowledge necessary to provide a focus for the development of the advanced decision making tools called for by the NCC. We view the development of such tools as having the potential to substantially contribute to the improvement of real world decision making and the sustainability of natural capital.

2. Energy and Greenhouse Gases (GHG):

There are tremendous possibilities for synergy here with land-use issues. Work on land use needs to integrate the energy and GHG implications of change. Issues such as the natural science and cost-benefit analysis of energy crops, biochar and GHG implications of land use change all need to be integrated within the range of issues outlined in the preceding section. Similarly marine energyscapes need to be considered in a systems analysis. The intention is to ensure even-handed and dispassionate analysis of all energy options (both renewable and non-renewable) and the GHG implications of each option. This analysis must be integrated into wider decision making such that complex issues (such as land use management) are not over-simplified. A related issue concerns geoengineering, ranging from carbon capture and storage to more complex global interventions. Again analyses must be holistic and reflect the very significant uncertainties and risks raised by various options.

3. Health and the environment

Health inequalities have continued to widen in the UK, so a first step would be to deepen our understanding of the main drivers of health change. A focus on a) the most vulnerable groups in society and b) urban environments (where 85% of the population live) may provide

opportunities for greater impact. Multidisciplinary approaches should be adopted across national and local 'natural gradients', to understand how health responds to environmental factors and to new interventions (such as the creation of new 'green space'). Despite the inevitable informatics issues, this will require the integration of spatially explicit health, socio-economic and environmental data. This is a very significant challenge, but would bring direct and indirect benefits in reducing NHS bills, in the consequences of improved average health (fewer workforce sick days), and in better targeting of green space and other interventions. There are strong Medical Research Council (MRC) research themes that are relevant to this area ('Lifelong health and well-being', an MRC and Arts and Humanities Research Council (AHRC) collaboration; and 'National Prevention Research Initiative').

4. The role and value of biodiversity

NERC research programmes such as Biodiversity and Ecosystem Service Sustainability (BESS), Ecosystem Services for Poverty Alleviation (ESPA) and Valuing Nature (VN) are enhancing the empirical evidence base of the links between biodiversity and ecosystem services; in particular, more empirical studies are needed to clarify the role of biodiversity *per se* in the quality and reliability of ecosystem services.

However, there still remains a need to extend these concepts a) to define the best metrics to capture quantity and quality of underpinning biodiversity, and define the best proxies and b) to measure the contribution of biodiversity to intermediate and final services. There are particular challenges with valuing the contribution of biodiversity to cultural services; translating the intrinsic value of biodiversity into a metric that can contribute to practical decision making. Difficulties exist with current methods (stated preference), and there is an urgent need for ecologists and economists to work together to develop improved techniques and understanding.

There is also a growing recognition that our failure to meet national and international targets to halt or significantly reduce biodiversity loss by 2010, calls for a step change in nature conservation. The Lawton report, 'Making Space for Nature', recommends the establishment of a coherent and resilient Ecological Network for England. This requires action at the landscape scale, enhancing existing sites but also improving the connectivity between sites. Future research needs to:

- a. Promote science-conservation collaborations at the landscape scale which allow conservation efforts to be designed as scientific experiments, so allowing development of the empirical evidence base of 'what works';
- b. Develop valuation methodologies that explore the consequences of implementing this landscape approach. Annual costs of establishing such a network have been estimated in the report itself; methodologies to estimate the monetary benefits are less well developed;

- c. Consider alternatives to valuation if the latter are insufficiently robust for practical decision making purposes. Bateman et al. (2011) outline a variety of potential approaches which provide a useful starting point for such investigations.

5. The marine environment

The UK National Ecosystem Assessment noted that marine sub tidal biodiversity is less well characterised than terrestrial biodiversity, and consequently the links with ecosystem services are poorly quantified. Pressure from fishing has reduced fish stocks to the point where the provision of fish is now lower than at any time in the last century. A review of knowledge gaps include many of the generic issues discussed above (Beaumont et al 2007), including the relationships between biodiversity and ecosystem services, the role of biodiversity in providing resilience, detection of thresholds and developing large scale mechanisms to protect biodiversity. The development of Marine Plans and Marine Conservation Zones include specific objectives on the sustainable management of ecosystem services; this should provide the mechanism to integrate sustainable use by industry and protection of natural capital. Development of techniques for monetary and non-monetary valuation will support decision making in this area.

6. Incorporating international flows of ecosystem services into measures of natural capital.

The UK cannot provide all the ecosystem services for the health and well-being of the UK population; we depend upon overseas goods and ecosystem services (for example, for about a third of the biomass we consume). This is likely to rise as renewable energy policies are implemented, and as population increases. Consequently, the protection of natural capital overseas is important for domestic economic growth.

There is potential to moderate the UK's import demand and so reduce our impact on natural capital overseas, through increased domestic production and waste reduction. However, certainly the former may involve trade-offs with other ecosystem services, and therefore suitable decision making frameworks are required to integrate domestic and overseas considerations.

Broadening the research challenge internationally

The integrated nature of both the world's environmental and economic systems means that a coordinated international research effort is both highly recommended and arguably essential in the long term. The UK-NEA (2011) provides a useful model for individual countries to follow as an initial step towards integrated assessment and the NCC strongly encourages other countries to consider undertaking such research. Similarly international development of the metrics currently being considered by the NCC is also clearly advantageous and initiatives such as the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) may well provide global leadership in this respect.

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