FINANCE, BIODIVERSITY AND MANAGED ECOSYSTEMS: WHERE'S THE DATA?

FINAL REPORT

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1 Management Summary

Introduction

1.1 The Natural Environment Research Council (NERC) asked Z/Yen Group Limited (Z/Yen) to investigate the environmental data and modelling requirements of the financial services sector regarding biodiversity and managed ecosystems. This paper presents recommendations on how NERC might invest in future research and, more specifically, the development of metrics to meet the information needs of the financial services sectors with respect to biodiversity and ecosystem services (BES).

1.2 NERC's research centres, such as the Centre for Ecology and Hydrology (CEH), host large depositories of biological data which can be of relevance to financial services and corporate organisations. In addition, NERC funds a number of research programmes, projects and collaborative initiatives aimed not only at advancing scientific knowledge but also at making research and data both relevant and accessible to public, private and not-for-profit organisations.

1.3. NERC seeks to engage its research centres, collaborative centres and the UK scientific community it funds with the financial services sector in order to maximise the use of current datasets and to anticipate future demand for further research, data and modelling tools.

1.4. This paper seeks both to alert the financial services sector to the existing research capabilities and data resources of NERC science assets, and to encourage an active exchange of information which will benefit both scientific research and financial activities.

Critical Issues

2.1 Ecosystems provide critical services to society and the economy. Their continuing loss and degradation, and the resulting economic implications, are poorly understood and not fully accounted for. This is due to a combination of scientific uncertainties associated with BES complexity, interconnectivity and variability in space and time, and a related failure to value their economic contribution.

2.2 With increasing regulatory constraints, mounting civil society pressure and growing risks of disruption to supply chains, the materiality of biodiversity loss and ecosystems degradation is becoming more obvious. BES degradation can present financially material risks and opportunities for bankers, investors, insurers and traders. This is particularly true for financial activities where exposure to companies with a high degree of impact and/or dependence on BES, such as the agribusiness industry, can affect financial returns, and in relation to the emerging development of market-based mechanisms to sustainably manage and conserve BES.

2.3 BES risks and opportunities need to be integrated into business models and strategies both to protect existing revenue streams and to ensure long-term growth. To date the integration and management of BES risks and opportunities within financial services has been limited. BES factors are primarily considered in relation to project finance. The relevance of BES is gradually being recognised in other areas of finance, particularly insurance and overall portfolio risk management, driven by regulatory developments and reputational concerns as well as operational and credit risks issues. In every case, however, challenges of measurement and valuation remain daunting.

2.3 Methodologies, metrics and standards still need to be developed to assess impact and dependence on BES, to understand how value is created or lost, to steer sustainable management and to facilitate integrated accounting of BES.

2.4 Market-based approaches to the management of BES are emerging, spurring growing interest among governments, financial institutions and corporations as an alternative approach to enabling and financing conservation. Existing markets for BES include certified agricultural products, payments for ecosystem services, mandatory and voluntary biodiversity offsets and bio-prospecting contracts. These markets, however, remain relatively small and underdeveloped.

2.5 A number of financial, regulatory and market pre-requisites still need to be addressed to provide an enabling framework for BES markets to emerge. Among the mechanisms considered, biodiversity offsets and payments for ecosystem services hold the best prospects for growth in the coming years, provided that joint scientific and financial markets collaboration and appropriate regulatory developments support their emergence.

Emerging Data Needs

3.1 The financial services sector's interest in BES data is driven by concerns over associated compliance, reputational and operational risks and how these might affect performance and value. There is also some interest in new opportunities to correlate conservation benefits with financial returns. The relevance of specific BES data will vary however between the following user groups:

- investors – who commit funds to direct or indirect investments with the expectation of financial returns – e.g. corporate investors, asset managers, lenders;
- traders – who buy, sell and make markets in securities;
- guarantors – who insure or re-insure project or corporate operations and risks.

While these user groups will all seek to assess the risk profile of their financial product or transaction, their potential data needs are likely to be product and activity specific, arising from a combination of their respective environmental due diligence, risks assessment and management procedures.

3.2 **Investors**, especially those with a long-term investment horizon (e.g. institutional investors), increasingly recognise that environmental aspects might have a material impact on risks and returns. The integration of BES-related risks into investment assessments, however, remains limited, due in part to the need for

- additional tangible evidence of the business case;
- comprehensive and standardised corporate reporting processes to allow access to comparable data on corporate performance in managing BES;
- improved methodologies to incorporate BES risk assessments into financial reporting processes.

To account for BES-related risks and opportunities, investors' data requirements are likely to be very location-, sector- and project- specific.

3.3 **Guarantors**' integration of BES aspects into insurance policies, beyond accidental pollution events due to the fault of an operator, is recent and primarily driven by regulatory development such as the implementation of the EU Environmental Liability Directive (ELD). Guarantors' data requirements involve large volumes of historical and scientific data necessary to assess the range and scale of risks involved, particularly when developing insurance products for a new asset class such as BES. Currently, BES risks in the context of the ELD are assessed as

part of the underwriting process, based on location-specific biological and geographical data available in the public domain (through Google Earth or habitat databases). Insuring BES risks also requires the ability to price these risks, highlighting the need for further work on valuation methodologies to help quantify BES risk and the guarantors' potential exposure.

3.4 **Corporations**, particularly those with a heavy stake in BES, are starting to recognise that the sustainable management of BES exposure is beneficial for long-term prosperity. Hence, integrating BES risks and opportunities into corporate planning and decision-making processes makes business sense. Industries, however, face general data and methodological challenges due to the spatial variability of BES attributes and related environmental conditions as well as to the lack of agreed sector-specific indicators and methodologies. Data requirements are likely to be both sector- and location- specific. Leading corporations engage with scientific research centres and specialist consultants to meet specific research needs and to develop tools and methods tailored to their needs.

BES Measurement: Considerations and Constraints

4.1 Global information about biodiversity, species and natural ecosystems, as well as indicators of major stresses to ecosystems, is not always readily accessible. This is partly due to the complexity of BES themselves, to their geographical and temporal variability, to the perceived intangibility of some ecosystem services and to remaining scientific uncertainties associated with changes in BES.

4.2 The central theoretical issue associated with BES 'measurability' is whether it is possible to conceive of a small number of measures, which could be used in a similar manner to CO_2 tonnes or parts-per-million (ppm) for carbon emissions comparisons. Major practical issues regarding measurement include selecting appropriate indicators to assess BES health and changes, the capacity to collect data in a systematic and regular manner, and the ability to compare data at the global level and over time. From a corporate perspective, the development of a sound ecological footprint assessment across the supply chain could prove a useful basis from which to build consistent impact and dependence assessments. Here too, location- and scale-specific environmental data would be required to enable sound cross-referencing with corporate assessments in order to identify risks and opportunities associated with the management of land and BES.

4.3 Facilitating the effective compilation, comparison and accessibility of datasets at the global level is critical to the dissemination of scientific knowledge on BES. Opportunities for collaboration with technology providers and developers such as satellite information providers offer new possibilities to improve the distribution, visualisation of, and access to, up-to-date and detailed environmental scientific research and data.

4.4 Changes in BES, as well as actors' impacts and dependences on it, need to be quantified using consistent and comparable measurement tools. Appropriate valuation methods are required to translate these measurements into financially meaningful figures which could inform both business decision-making processes and financial services' risk and valuation assessments.

Conclusions

5.1 Increasing awareness of the economic implications of BES loss and degradation, as well as of new market-based opportunities being developed to finance the sustainable management

and conservation of BES, suggest that in the coming years, more precise and demanding data requirements are likely to emerge.

5.2 Given the increasing stresses being placed on nature, we conclude that the cross-disciplinary dialogue and work to meet data requirements ought to increase. It is important that the challenge should not be laid solely at the door of the scientific community. The financial services professionals will need to work hard to define their own information and data needs, and to work jointly with the scientific community on what will remain an extremely challenging set of valuation challenges.

5.3 The core recommendation of this paper is that NERC could position itself as a key partner to assist financial services on the difficult task of better integrating BES aspects into relevant financial activities by advancing understanding of BES issues and educating the financial sector on the availability of BES datasets and research developments, especially regarding metrics for changes in BES and valuation techniques.

2 Introduction

2.1 Background

The Natural Environment Research Council (NERC) asked Z/Yen Group Limited (Z/Yen) to investigate the environmental data and modelling capability requirements of the financial services sector to support risk and opportunity assessments and inform investment decisions related to biodiversity and managed ecosystems. This report presents findings on the current and emerging biodiversity-related data needs of the financial services sector, and puts forward recommendations on how NERC's research centres[1] and its associated scientific community could support the integration of biodiversity and ecosystem services (BES) considerations into financial services decision-making by providing expertise, data, models and other analytical tools.

The NERC science community is progressing towards a better understanding of the dynamic complexity of biodiversity and how it underpins ecosystem services. These include the extent to which different ecosystems are resilient; the identification as well as the ability to predict critical thresholds beyond which the capacity of ecosystems to provide key services might be critically degraded; and the impacts such BES loss and degradation will have on society.

Some relevant BES datasets and related models already exist, some of which are outlined in Appendix 1 – NERC Research and Data on BES. While some of these may be readily adaptable to the needs of financial services, the science community has a key role to play in the development of sound metrics and methodologies to assess BES health, quantify impact and dependence, and underpin the valuation of BES assets. Progress here is a pre-requisite for the financial assessment of BES-related risks and opportunities, and depends on constructive engagement and collaborative learning between the science and financial services communities.

NERC is one of the many public institutions supporting research on the sustainable use of natural resources. By funding research, training and knowledge exchange in environmental sciences, NERC contributes to the advancement of science and a more informed understanding of the environment, including biodiversity and ecosystem services. NERC's science assets, such as the Centre for Ecology and Hydrology (CEH[2]), have been collecting data and monitoring changes in the environment across the UK for over a century. NERC is developing and optimising processes with the object of increasing transparency and access to facilitate the external use of existing datasets and models – please refer to Appendix 2 for details regarding NERC Data Policy.

NERC aims to increase opportunities for engagement with industry, civil society and policy-makers to better understand users' data and knowledge requirements**.** While some collaborative projects on the sustainability of biodiversity and ecosystems services are underway (see Appendix 1), this project represents the first step towards engaging NERC scientists directly with the financial services sector.

Biodiversity and ecosystems have generally been overlooked as an asset class or risk factor by wholesale financial markets**.** The links between environmental science and financial services are still tenuous. There has been some progress in the development of biodiversity offsets, the

[1] This research project is partly based on consultations with the Centre for Ecology and Hydrology, one of four wholly-owned research centres. However, other NERC owned or funded research centres also hold valuable data and research on biodiversity and ecosystems.
[2] http://www.ceh.ac.uk/

consideration of BES risks at project finance level in banking, and multi-stakeholder' engagement with companies which have a stake in BES.[3] As economic and demographic growth put increasing pressure on ecosystems and biodiversity, investors will need a greater quantity of sophisticated BES data and models to inform investment and risk control decisions. BES risks and opportunities will need to be accounted for through the translation of scientific measures of BES exposure into financially quantifiable values. Only when this is achieved, will it be possible to integrate BES opportunity and risk assessments into decision-making processes in an adequate manner.

2.2 Objective

This research project was commissioned to explore how NERC's BES research, datasets and modelling could be best optimised in order to provide relevant information and data, and to develop models for use by the financial services sector. This paper outlines the scope for NERC's active participation in creating an interface through which its scientific assets and capabilities might best be delivered to financial institutions. Moreover, it advances a series of preliminary recommendations to promote knowledge exchange between NERC's scientific community and the financial services sector; to aid the development of a package of scientific BES information; and to establish preliminary parameters for the exploration of metrics, models, geographies and specific aspects of data.

2.3 Approach

Z/Yen is a delivery partner of the Financial Services Knowledge Transfer Network, on behalf of NERC. NERC's expectations of the outcomes of the Finance, Biodiversity and Managed Ecosystems' initiative are:

- to improve working processes between research centres and industry;
- to impact on industry;
- to influence government policy;
- to develop more joint research publications;
- to foster industry enquiries that NERC might fulfil.

This project engaged a cross-section of the financial services industry between October and December 2010, including professionals working in conservation finance, investment management (including socially responsible investment), commercial banking, development banking, insurance and re-insurance, and financial services information providers. The project began in October 2010 with a workshop attended by eight financial services and industry professionals, and four members of the scientific research community. Issues identified at this meeting were pursued through a series of 25 interviews between October and December with financial services and industry professionals – please refer to Appendix 3 for a list of the organisations that have been consulted. An interim report was presented and discussed at a symposium hosted by the Chartered Institute for Securities and Investment in November 2010 and feedback was sought from participants.

[3] See, for example, Madsen B, Carroll N. and Moore-Brands K. (2010), PricewaterhouseCoopers LLP on behalf of BBOP and UNEP FI (2010) and UNEP FI CEO Briefing (2010) in References, p.35

3 Critical Issues

3.1 Understanding Biodiversity

Based on the Convention for Biological Diversity (1992) *biological diversity* is here understood to be "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems"[4].

Biodiversity and ecosystem services are critical for well-being. Ecosystems, defined as the "dynamic complexes of plant, animal, and micro-organism communities and the nonliving environment interacting as a functional unit" [5], provide key services to society. The Millennium Ecosystem Assessment (2005) investigated the links between ecosystems services, health and well-being, and how these are underpinned by the diversity of life on earth. The distinction between ecosystem provisioning services (e.g. food, timber), regulating services (e.g. climate, disease regulation), cultural services (e.g. recreation, education) and supporting services (e.g. soil formation, primary production, nutrient cycling), illustrates the multiple benefits that biodiversity and ecosystems, provide to society and the economy.[6]

Insights into BES are driven by historical and cultural trends, which have partly defined historic research through funding. The popular understanding of BES tends to be built around perceptions of pristine natural environments visibly damaged by economic activities, and attractive species such as birds, dolphins, or pandas, to which high cultural values have been attributed. This culturally-influenced view of BES has influenced the development of dedicated monitoring schemes resulting in extensive quantitative and qualitative data available for butterflies, birds and mammals' species.

Biodiversity loss and ecosystem services degradation is ongoing. There are multiple indications of biodiversity loss and decline for all three main components: genes, species and ecosystems. To take a few examples, crop and livestock genetic diversity continues to decline in agricultural systems; nearly a quarter of plant species are estimated to be threatened with extinction; and natural habitats such as freshwater wetland and coral reefs continue to decline in terms of both size and integrity in most parts of the world.[7]

Understanding BES components (genes, species and ecosystems) and their mutually interactive relationships is vital for a better appreciation of the implications of BES degradation on society. While information on provisioning ecosystem services (e.g. the provision of food) is available, there is little knowledge regarding supporting ecosystem services (e.g. the maintenance of species and genetic diversity), the interactions between biodiversity and ecosystems, and the trade-offs associated with their use and management.
Drivers of change and BES must be considered together, particularly in light of the considerable uncertainties surrounding ecosystems' resilience and the difficulty in predicting when tipping

[4] Convention on Biological Diversity (1992), Article 2 - Use of Terms, http://www.cbd.int/convention/articles.shtml?a=cbd-02
[5] Millennium Ecosystems Assessment (2005), *Ecosystems and Human Well-being: Biodiversity Synthesis*, World Resources Institute, Washington, DC, p. v, http://www.maweb.org/
[6] Millennium Ecosystems Assessment (2005), *Ecosystems and Human Well-being: Biodiversity Synthesis*, World Resources Institute, Washington, DC, p. vi, http://www.maweb.org/
[7] CBD Secretariat (2010) Global Biodiversity Outlook 3, Montreal, http://www.cbd.int/gbo3

points leading to irreversible harm to nature will be reached.[8] Habitat change (e.g. land use change by converting natural habitats into agricultural land), invasive alien species, overexploitation of natural resources, pollution and climate change are all widely recognised as direct drivers of biodiversity loss and ecosystems degradation. Global economic and demographic growth is accelerating the negative impact of these drivers.[9]

"Failure to account for the full economic values of ecosystems and biodiversity has been a significant factor in their continuing loss and degradation"[10]. Since Costanza and others' monetary valuation[11] of 17 ecosystems services in the biosphere amounting to an average US$ 33 trillion/year in 1987, few ecosystems are being explicitly priced and, when they are, the prices tend to reflect the *direct-use values*[12] of provisioning ecosystem services such as crops or fish which are directly consumed by people. *Non-use values*[13] - such as the cultural value associated with a species - are rarely reflected in monetary terms, while *indirect-use values*[14]of regulating services – such as the contribution of pollinating services to agricultural outputs – have only recently begun to be assigned an economic value.[15] An all-encompassing economic valuation of the benefits to society derived from BES would enable a better appreciation of the financial implications and costs of BES loss and degradation resulting from misuse and overexploitation.[16]

Market signals imperfectly account for either the economic value of services provided by biodiversity and ecosystems, and the costs of BES degradation resulting from human activities. As a result, the overexploitation of natural capital (such as forests or fisheries) becomes a logical and profitable undertaking, often due to distorted signals influenced by subsidies, taxation, pricing and state regulation, as well as to land tenure and use rights issues.[17] Trucost, for example, calculated that the global environmental costs caused by human activity amounted to an estimated US$6.6 trillion in 2008. These environmental costs, which arise from the depreciation of natural capital and the cost of maintaining ecosystems, are not borne directly by the actors who cause them, but rather are "externalised" and borne by society at large.[18]

[8] The Economics of Ecosystems and Biodiversity (TEEB) (2010), *Mainstreaming the economics of nature: synthesis of the approach, conclusions and recommendations of TEEB*, p. 7, http://teebweb.org
[9] Millenium Ecosystems Assessment (2005), *Ecosystems and Human Well-being: Biodiversity Synthesis*, World Resources Institute, Washington, DC , p. vi and 19, http://www.maweb.org/ and The Economics of Ecosystems and Biodiversity (TEEB) (2010), *Mainstreaming the Economics of Nature: a Synthesis*, p. 9, accessible at http://www.teebweb.org
[10] TEEB (2010), *Mainstreaming the Economics of Nature: a Synthesis*, p. 9, http://www.teebweb.org and CBD Secretariat (2010) *Global Biodiversity Outlook 3*, Montreal, http://www.cbd.int/gbo3
[11] Costanza R et al. (1987), *The Value of the World's Ecosystem Services and Natural Capital*, in Nature vol. 387, p. 253-260, available at http://www.ecy.wa.gov/PROGRAMS/wr/hq/pdf/naturepaper.pdf
[12] *direct-use value* refers to "the benefits derived from the services provided by an ecosystem that are used directly by an economic agent. These include consumptive use (e.g. harvesting goods) and non-consumptive use (e.g. enjoyment of scenic beauty)" in TEEB(2010), *Mainstreaming the economics of nature*, p.33, http://www.teebweb.org
[13] *non-use value* refers to "benefits which do not arise from direct or indirect use" in TEEB (2010), *Mainstreaming the economics of nature*, p. 3, http://www.teebweb.org
[14] *indirect-use value* refers to "the benefits derived from the goods and services provided by an ecosystem that are used indirectly by an economic agent. For example, the purification of drinking water filtered by soils", in TEEB (2010), *Mainstreaming the economics of nature*, p.33, http://www.teebweb.org
[15] TEEB (2010), *Mainstreaming the economics of nature* , p. 7-9, http://www.teebweb.org
[16] WBCSD (2010), *Corporate Ecosystem Valuation: Building the Business Case*, p.6, http://www.wbcsd.org
[17] TEEB (2010), *Mainstreaming the economics of nature*, p.9, http://www.teebweb.org
[18] Trucost on behalf of UN PRI Investment and UNEP FI, (2010), *Universal Ownership :Why environmental externalities matter to institutional investors*, http://www.trucost.com

The science community has a key role to play in advancing society's understanding of BES and in informing the development of valuation methods to enable a more complete integration of BES aspects into economic valuations and decision-making processes.

3.2 The Materiality of BES Risks and Opportunities to Corporations and Financial Services

With increasing regulatory constraints, mounting civil society pressure, and growing risks of disruption in supply-chains, the materiality of biodiversity loss and ecosystems degradation to the socio-economic system is becoming more obvious, as is its need to be integrated into decision-making processes. The economic relevance of BES has often been overlooked due to their perceived abundance and the intangibility of their contributions to the economy (notably regarding supporting services). Nonetheless, cases such as the BP oil spill in the Gulf of Mexico in 2010 – which caused not only environmental damage but also triggered a host of legal and compliance issues, and a sharp drop in share prices – is just the largest of an increasing number of incidents which illustrate the potential financial impact of BES degradation.[19]

BES degradation can present financially material risks and opportunities for bankers, investors, insurers and traders, particularly those exposed to industries directly impacting on BES (e.g. extractive industries), or depending on BES (e.g. agriculture, fisheries).[20] BES risks can translate into material risks to financial returns on investments; reputational risks (strongly associated with regulation); operational risks (particularly for companies with a stake in BES such as agribusinesses); and litigation risks.[21] It remains difficult, however, to assess short-term sector- and location- specific financial impacts on companies' returns, beyond those which are visibly and heavily BES-related. Profitable business opportunities exist and are being undertaken to develop, for example, investment funds supporting conservation and the sustainable use of BES. This is particularly attractive for investors with a long-term horizon, especially in the context of growing demand for increasingly scarce natural resources.[22]

The financially material impact of BES risks is primarily being assessed in relation to project finance. Over 70 financial services actors[23], including commercial and development banks, investment managers and brokers as well as institutional investors such as pension funds, have adopted the Equator Principles[24], a voluntary set of standards for determining, assessing and managing environmental and social risk in project financing, which includes voluntary requirements to comply with the IFC Performance Requirement 6 addressing Biodiversity Conservation and Sustainable Natural Resource Management.[25] BES-related issues are, however, gradually being recognised in other areas of finance, particularly insurance and overall portfolio

[19] UNEP Finance Initiative - CEO Briefing (2010), *Demystifying Materiality : Hardwiring biodiversity and ecosystem services into finance*, http://www.unepfi.org
[20] UNEP FI – CEO Briefing (2010), *Demystifying Materiality : Hardwiring biodiversity and ecosystem services into finance*, p.2, http://www.unepfi.org
[21] UNEP FI – CEO Briefing (2010), *Demystifying Materiality : Hardwiring biodiversity and ecosystem services into finance*, p.2 and 8-11, http://www.unepfi.org
[22] Nyenrode- IUCN-ECNC (2009), *Boosting Investments in Biodiversity and Ecosystem Services*, Conference paper, Amsterdam 11-12 November 2009, p.7
[23] As indicated on the Equator Principles website on 11 January 2011, http://www.equator-principles.com/
[24] http://www.equator-principles.com/
[25] IFC (2006) *Performance Standard 6: Biodiversity Conservation and Sustainable Natural Resource Management*, http://www.ifc.org

risk. This recognition has to date primarily been driven by reputational concerns, followed by regulatory, operational and credit risk issues.[26]

The 'externalisation' of costs associated with the BES impacts of corporate action can affect returns on investments in that and other companies. Environmental externalities pose financial risks to large diversified portfolios of institutional investors. The externalised environmental costs of one company can, for example, translate into increased insurance premiums, taxes, physical costs associated with damage and inflated input prices, for the company itself, industry peers and other entities present in the same large diversified portfolios, particularly those relying on nature.[27]

BES risks and opportunities need to be integrated into business models and strategies to ensure long-term growth. Companies, particularly those that rely or impact significantly on BES, need to assess this exposure, quantify and establish valuation metrics for the associated business risks, develop the relevant management processes to set targets and monitor performance, and apply the mitigation hierarchy (i.e. avoid, minimise, mitigate BES risks) where relevant.[28] The financial services industry needs to investigate BES and wider environmental risks associated with investments, as part of the environmental and social due diligence process.[29] Risks assessment procedures are in particular need of improvement, as the approach to BES to date has been neither consistent, nor systematic.[30]

Methodologies, metrics and standards still need to be developed to assess impact and dependence on BES, to understand how value is created or lost, to steer sustainable management and to facilitate integrated accounting of BES.[31] TEEB's development of a framework for economic analysis and decision-making contributes to a better understanding of the macro-economic context of BES by compiling constitutive evidence of their economic importance. The potential economic impact of BES risks at company-, sector- and country- levels, however, will need to be explored and assessed using appropriate metrics. Most initiatives here are still at the inception stage. These include developing a corporate biodiversity footprint, compiling sector- and country- specific BES risk profiles and the inclusion of BES criteria in country-based risk assessments by credit rating agencies.[32] Science has a role to play in informing the design process and in testing the validity of all such assessment and valuation methodologies. That said, appropriate regulatory schemes and incentives will be necessary to impart impetus and standardisation to the whole process.[33]

[26] See "Table 1 – exposure of BES risks for a diversified financial sector" in UNEP FI – CEO Briefing (2010), *Demystifying Materiality : Hardwiring biodiversity and ecosystem services into finance*, p.7, http://www.unepfi.org
[27] Trucost, on behalf of UN PRI and UNEP FI (2010), *Universal Ownership :Why environmental externalities matter to institutional investors*, http://www.trucost.com
[28] TEEB (2010), *TEEB for Business : Executive summary*, p.20, http://www.teebweb.org
[29] UNEP FI – CEO Briefing (2010), *Demystifying Materiality : Hardwiring biodiversity and ecosystem services into finance*, http://www.unepfi.org
[30] PricewaterhouseCoopers LLP on behalf of BBOP and UNEP Finance Initiative (2010), *Biodiversity Offsets and the Mitigation Hierarchy : A Review of Current Application in the Banking Sector*, p.5, http://bbop.forest-trends.org
[31] TEEB (2010), *Mainstreaming the economics of nature*, p.27, http://www.teebweb.org and UNEP FI – CEO Briefing, *Demystifying Materiality : Hardwiring biodiversity and ecosystem services into finance*, p.5, http://www.unepfi.org
[32] Source for the third example - UNEP FI – CEO Briefing (2010), *Demystifying Materiality : Hardwiring biodiversity and ecosystem services into finance*, p.18, http://www.unepfi.org
[33] TEEB (2010), *Mainstreaming the economics of nature*, p.25-27, http://www.teebweb.org and RSPB (2010), *Financing Nature in an Age of Austerity*, http://www.rspb.org.uk

3.3 Investing in Nature: the Emergence of Markets for BES

Markets for BES are emerging and are expected to grow, provided that appropriate public policies create the enabling framework. Existing markets for BES include certified agricultural products, payment for ecosystems services, mandatory and voluntary biodiversity offsets and bio-prospecting contracts. According to TEEB, market sizes ranged from $3.4 billion in the case of US mitigation banking to $40 billion for certified agricultural products in 2008.[34] Innovative projects are also being explored, such as the "Green Development Mechanism (GDM) Initiative" a possible financial mechanism to be developed under the Convention for Biological Diversity (CBD, 1992) to facilitate a market for biodiversity credits at the global level.[35] Through the establishment of a standard metric and an accreditation process for certifying the sustainable management of geographically-defined areas in accordance with CBD 1992, and the facilitation of a functioning market for those areas, GDM could enable the financing of GDM-certified areas by a range of private and public investors. [36]

Governments and businesses are increasingly interested in the use of market-based instruments to manage their biodiversity footprint. Biodiversity offsetting, for example, has the potential to develop into an attractive mechanism for conservation financing, thereby reducing the burden on public expenditure, while preserving nature and encouraging sustainable management of natural assets. Ultimately, as biodiversity is an attribute of land and cannot be physically dissociated from it, investments in BES assets will tend to follow property market, rather than commodity market, dynamics.

The emergence of financial markets for BES appears, however, to be tied to a number of financial, regulatory and market pre-requisites. Financial requirements include the clear delineation of BES 'credits' and 'debits', the insurability of BES 'credits', and the requirement for combined scientific, business and financial expertise. On the regulatory side, the importance of appropriate regulatory and incentives schemes is rooted in the need for regulated access to, and use of, ecosystems, the definition of clear baselines to assess the 'additionality' of BES investments; and an enabling framework including approved standards and methods to assess debits and credits. Market requirements include clearly defined asset classes; commonly accepted monitoring, verification and enforcement systems; and competitive intermediary services (e.g. brokers).[37] These pre-requisites all illustrate the complexity of measuring and valuing BES, as well as the imperative need for an appropriate regulatory framework.

3.3.1 Biodiversity Offsets

The current annual global market size for biodiversity offsets is estimated to range between US$1.8 and US$2.9 billion[38], and to result in an estimated 86,000 hectares of land per year

[34] See "Table 2: Emerging markets for biodiversity and ecosystem services" in TEEB (2010), *TEEB for Business: Executive Summary*, p. 11, http://www.teebweb.org
[35] Earthminds (2010) *The GDM 2010 Report: Towards a Market-Based Financial System to Support Biodiversity and Development*, http://www.earthmind.net
[36] Earthminds (2010), *The GDM 2010 Report: Towards a Market-Based Financial System to Support Biodiversity and Development*, p.6, http://www.earthmind.net
[37] See "Table 3: pre-requisites for developing markets for BES" in TEEB (2010), *TEEB for Business: Executive Summary*, p. 12, http://www.teebweb.org
[38] This figure considers biodiversity markets designed to reduce development impacts (i.e. compensatory mitigation) and should be considered as indicative of a minimum market size as most programmes identified are not transparent enough to estimate market size. For example, TEEB for Business estimated the 2008 market size of mandatory biodiversity offsets as being £3.4 billion. See Madsen B, Carroll N. and Moore-Brands K. (2010) *State of Biodiversity Markets Report: Offset and Compensation Programs Worldwide*, http://www.ecosystemmarketplace.com

coming under some form of conservation management or permanent legal protection. While conservation finance is better established in certain areas of the world (e.g. the USA and Australia) due to enabling regulatory frameworks, it is still at a very early stage in Africa, Asia and Europe. [39] In the UK, Environment Bank Ltd has been working to develop such a scheme and launched the Thames Headwater Conservation Credits Project in May 2010, a pilot scheme run in partnership with the Wildfowl & Wetland Trust and three wildlife trusts (Wiltshire, Gloucestershire and Berks, Bucks & Oxon).[40]

Markets for BES and the ability to trade BES-related products are constrained by the inherent complexity and uniqueness of biodiversity, and difficulties associated with the measurement and valuation of impacts on BES and BES outcomes of conservation projects. Global initiatives such as the Business and Biodiversity Offsets Programme (BBOP[41]) – a partnership between 40 leading organisations and individuals including governments, financial institutions, companies and conservation experts – are essential to demonstrate conservation outcomes in a portfolio of biodiversity offsets pilot projects; to develop, test and disseminate best practices; and to contribute to relevant policy and corporate development on offsets so that they can meet both biodiversity and business objectives.[42]

There are scientific, economic, political and ethical considerations which must be considered due to the unique nature of BES. Biodiversity is, in fact, characterised by non-interchangeability in type (e.g. species), space (unique habitats) and time (genetic bottlenecks alter population characteristics).[43] This raises critical issues as to, for example, whether BES degradation in one place can be compensated for by conservation outcomes in another place.

Sound scientific metrics and financial valuation methodologies need to underpin the delineation of BES 'credits' and 'debits'. The Business and Biodiversity Offsets Programme (BBOP) case study of the Ambatovy offsets programme[44], for example, used the 'Benchmark' and 'Habitat Hectare' methodology[45] to determine the scale of the offset needed to achieve conservation gains that would result in 'no net loss' of biodiversity. The design and implementation of the offset programme has progressed, but predicted conservation outcomes have not yet been fully calculated.[46]

The financial services sector's involvement in biodiversity offsetting is currently limited due to a number of barriers including the timing of involvement in project finance; concerns over the time and efforts involved in the development, implementation and monitoring of offset programmes; and issues concerning the credibility and value of offsets in the absence of agreed methodologies and standards.[47] While biodiversity offset projects are still in early stages, many

[39] Madsen B, Caroll N and Moore-Brands K (2010) *State of Biodiversity Markets Report: Offset and Compensation Programs Worldwide*, p. v-xii, http://www.ecosystemmarketplace.com
[40] Environment Bank Ltd (2010), *Biodiversity is the next big issue*, p. 1
[41] http://bbop.forest-trends.org/
[42] http://bbop.forest-trends.org/
[43] Walker, Susan et al. (2009) *Why bartering biodiversity fails*, in Conservation Letters (2), p. 149-157, Wiley Periodicals
[44] BBOP (2009), *BBOP Pilot Project Case Study – Ambatovy Project*, BBOP, Washington, D.C., http://bbop.forest-trends.org/
[45] More information on this methodology is available in BBOP (2009), *Biodiversity Offset Design Handbook: Appendices*. BBOP, Washington, D.C, p. 18-20, http://bbop.forest-trends.org/
[46] BBOP (2009), *BBOP Pilot Project Case Study – Ambatovy Project, http://bbop.forest-trends.org/*
[47] PwC LLP on behalf of BBOP and UNEP Finance Initiative (2010), *Biodiversity Offsets and the Mitigation Hierarchy : A Review of Current Application in the Banking Sector*, p.7, http://bbop.forest-trends.org

private sector actors, including corporations and leading investors, recognise the potential for profitable business opportunities arising from the combined prospects for strengthening corporate licenses to operate, accessing new sources of capital, managing social and environmental risks and liabilities, and offering new market opportunities. [48]

3.3.2 Other Potential Market Mechanisms

Payments for ecosystem services (PES) represent another promising economic tool to manage ecosystems sustainably and preserve biodiversity. PES schemes generally involve a voluntary transaction between a 'buyer' and a 'provider' who effectively controls or manages the provision of an ecosystem service or a land use to secure its integrity.[49] Existing PES schemes are either regulated, private (i.e. when a business negatively impacts on ecosystems' services delivery and pays other businesses for their provision) or mediated (i.e. where a public agency or NGO coordinates PES payments), and currently concentrate on carbon sequestration, watershed management and biodiversity conservation.[50] There is considerable scope for growth in PES schemes. Agricultural ecosystems, for example, are not only vital for society in terms of food and water provision, soil preservation and regeneration, nutrients recycling and genetic resources, but also represent the largest managed ecosystems in the world. Land cover change, intensive land-use and the related transformation of habitats resulting from agricultural activities are all factors contributing to agro-biodiversity loss. A PES scheme, in this context, could provide financial incentives to land users and farmers to improve agricultural practices so that key functions of agro-ecosystems and their associated biodiversity are preserved.[51] Scientific understanding of ecosystem services, and of their functioning in particular, is needed to help identify and inform the development of new PES opportunities.[52] In addition, government intervention is likely to be required to encourage private sector financing of such schemes. Many ecosystem services, such as wildlife habitat and diversity, as well as scenic landscapes, are traditionally considered as free, or public[53], goods. This often means that while users may value them, no one has an incentive to pay to maintain these services. Hence, the natural emergence of markets mechanisms to regulate their use is nearly impossible in the absence of regulation.[54]

Index-linked biodiversity bonds could represent a promising innovation in conservation finance, particularly for developing countries where unstable currencies and fluctuating economic growth exacerbate the difficulties of addressing sovereign debts through bonds issuance. Investors interested in a country meeting its BES targets could buy sovereign debt whose interest rates were lower when the government met its targets. Governments would pay a higher interest rate

[48] Nyenrode-IUCN-ECNC (2009), *Boosting Investments in Biodiversity and Ecosystem Services*, Conference paper, Amsterdam 11-12 November 2009, p.18-19

[49] Adapted from RSPB (2010), *Financing Nature in an Age of Auste*rity, p.50, http://www.rspb.org.uk and Nyenrode-IUCN-ECNC (2009), *Boosting Investments in Biodiversity and Ecosystem Services*, Conference paper, Amsterdam 11-12 November 2009, p. 8 and 26

[50] RSPB (2010), *Financing Nature in an Age of Auste*rity, p.50-51, http://www.rspb.org.uk and Nyenrode-IUCN-ECNC (2009), *Boosting Investments in Biodiversity and Ecosystem Services*, Conference paper, Amsterdam 11-12 November 2009, p.26

[51] Nyenrode-IUCN-ECNC (2009), *Boosting Investments in Biodiversity and Ecosystem Services*, Conference paper, Amsterdam 11-12 November 2009, p.26-27

[52] RSPB (2010), *Financing Nature in an Age of Auste*rity, p.56, http://www.rspb.org.uk

[53] A public good is characterised by non-rivalry (i.e. consumption of the good by one individual does not impede consumption by another individual) and non-excludability (i.e. it is virtually impossible to exclude anyone from the consumption use of the good). Many BES components have public good features e.g. climate regulation.

[54] RSPB (2010), *Financing Nature in an Age of Auste*rity, p.50-55, http://www.rspb.org.uk, and Nyenrode-IUCN-ECNC (2009), *Boosting Investments in Biodiversity and Ecosystem Services*, Conference paper, Amsterdam 11-12 November 2009, p.26-27

on their own debt if they fail to meet agreed BES targets.[55] With adequate metrics to assess country performance in preserving BES assets, the maintenance of tight control over sovereign land rights and the protection of the related natural stocks, a combination of the yield from sustainable management and the underlying value of the assets, should allow for the creation of a bond with an attractive yield and significant potential for capital growth.[56] While this is attractive in theory, comparable attempts to develop index-linked carbon bonds in the context of climate change have, however, proven difficult to implement not least because of measurement and verifiability issues. Moreover, while approved units of measurement exist for carbon emissions, standard metrics for BES still remain to be agreed upon. This suggests that BES bonds will prove an even more difficult challenge than index-linked carbon bonds.

While numerous challenges clearly remain to be addressed, innovative private sector mechanisms to finance and encourage sustainable management of BES are likely to develop further, given the imperatives of increasing natural resources scarcity, continuing BES degradation and loss and the potentially devastating consequences of such loss for society and the economy. The examples outlined above clearly illustrate the need for a better scientific understanding of BES to inform the development of such schemes together with appropriate government intervention and regulations. Markets for BES such as biodiversity offsets and PES schemes do, however, present proof that current experiments offer encouraging prospects for future growth and profitability.

[55] Based on a similar concept developed for carbon in Mainelli M and Onstwedder JP (2009) *Carbon debts: index-linked carbon bonds*, http://www.zyen.com/index.php?option=com_content&view=article&id=230
[56] Mainelli M and Onstwedder JP (2009), *Carbon debts: index-linked carbon bonds*, http://www.zyen.com/index.php?option=com_content&view=article&id=230

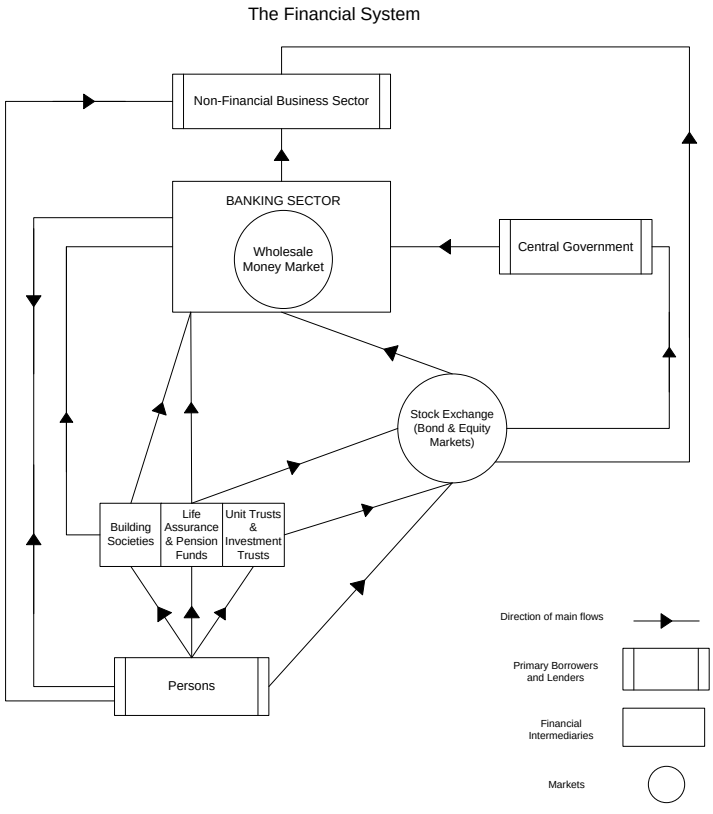
4 Emerging Data Needs of Financial Services and Related Industries

The financial services sector still has a limited understanding of BES and how changes in BES can affect its activities. The modest level of understanding of the issue is reflected in the limited integration of BES considerations into financial services activities. The knowledge gap between science and finance on BES is the product largely of the inherent complexity of BES, which does not resemble a single, tangible and delineable asset such as timber or copper.

Science has a key 'educational' role to play in raising awareness of the mutually interactive relationship across and within ecosystems, species and genes, and of the risks associated with BES degradation. Before the financial sector can actually define its precise data and modelling needs, its level of understanding of BES must first be raised through scientific outreach. Only then, will it be possible to proceed to develop consistent metrics and valuation methodologies required to inform pricing, investment and risk assessment decisions.

The relevance of specific BES data will vary for investors, traders and guarantors (see Fig. 1). Investors are defined as persons or entities committing funds to activities or products (e.g. projects, companies' shares, loans and equity portfolios) with the expectation of financial returns. These include corporate and individual investors, assets managers and, for the purpose of this report, bankers lending capital. Guarantors are defined as entities insuring or re-insuring project or companies' operations and risks. Traders are those buying, selling and making markets in securities (stocks, bonds, derivatives etc). Corporations that rely significantly on biodiversity (e.g. agribusinesses, pharmaceuticals) fall largely under the heading of investors.

Fig 1. The Financial System



Source: Adapted from *How the City of London Works*, William M. Clarke, (2008) 7th Edition

Investors, guarantors and traders share some common concerns regarding BES reputational and compliance risks, and how these might impact on performance or value. All three users' groups will seek to assess the risk profile of their financial product. Their potential data needs, however, are product and activity specific, and will arise from the combination of their respective environmental due diligence, risk assessments and management procedures. Thus, they are likely to make detailed but variable BES-related demands on scientific data providers.

Moreover, BES risks and opportunities cannot be disassociated from the geographic context in which assets are located or operating. Based on the recognition that different places and scales involve different types of habitats and biomes[57], individual data needs will incorporate distinct and very specific requirements. BES complexity together with its variability across space and time, is likely to have implications in terms of the biological data available, thus presenting challenges for the provision of detailed and comparable data matching the likely present and future requirements of the financial services sector.

The sub-sections below offer some perspective on the likely BES data needs of investors, guarantors and corporations, based on a series of 25 semi-structured interviews with professionals working in conservation finance, investment management (including socially responsible investment), commercial banking, development banking, insurance and re-insurance, as well as financial services information providers.[58]

4.1 Investors' Perspective on the Integration of BES Aspects

There is growing recognition that environmental aspects, including BES-related ones, have a material impact on investment risks and returns. Driven by increasing awareness of the positive impact of sustainable business practices on long-term profitability, the business and financial services sectors have come to recognise the importance of a sustainable environment. Initiatives such as UN Principles for Responsible Investment or UNEP Finance Initiative are illustrative of efforts to demonstrate and further explore the relationship between environmental, social and governance issues and financial performance. Many investors active in socially responsible investment (SRI), particularly pension funds and other institutional investors, take a growing interest in environmental, social and governance (ESG) aspects related to their investments, including environmental issues such as climate change, water scarcity and biodiversity.[59] Moreover, in 2010 an unprecedented number of reports have attempted to raise awareness of the business case for the sustainable management of BES aspects, and the link between BES management, risk management and financial performance.[60]

In most instances, however, the integration of BES considerations into investments assessments remains limited and as a result BES risks and opportunities fail to be accounted for and quantified appropriately. While the lack of understanding of BES offers a partial explanation, it is equally clear that the business case on the links between BES loss and degradation and

[57] Biomes are defined as "large geographic regions, characterised by life forms that develop in response to relatively uniform climatic conditions. Examples are tropical rain forest, savannah, desert, tundra." in TEEB (2010), *Mainstreaming the Economics of Nature*: *a Synthesis*, p.33, http://www.teebweb.org

[58] Given more time, it would have been useful to have even more perspectives, e.g. primary commodities traders, government debt offices.

[59] Nyenrode-IUCN-ECNC (2009), Nyenrode-IUCN-ECNC (2009), *Boosting Investments in Biodiversity and Ecosystem Services*, Conference paper, Amsterdam 11-12 November 2009, p.8

[60] Numerous reports have been released in 2010, mostly on the occasion of the 10th Conference of the Parties to the Convention on Biological Diversity held in Japan in 2010. See for example, SwissRe (2010), Ca Cheuvreux (2010), RSPB (2010), UNEP FI (2010), Trucost (2010), WBCSD (2010) in References, p.35

financial returns needs to be better understood and documented. This requires the improvement of tools and methods to account for impacts and dependence on BES in an integrated and scientific way. Finally and most importantly, BES-related data needs to be translated into financial values to facilitate the integration of BES aspects into investment risk and financial performance assessments.

Some investors do take a more integrated approach to environmental, social and governance issues (ESG), including BES aspects, as part of the due diligence applied to investments. Reasons for taking a more integrated approach include regulatory or voluntary requirements; social and responsible investment mandates as in the case of development banks and other financial services organisations that have adopted the Equator Principles for example; early mover advantages; and business strategy.

The European Bank for Reconstruction and Development (EBRD), for example, considers BES-related impacts as part of the due diligence applied to project finance through generic requirements outlined in its Performance Requirement 6 (PR6), based on the IFC Performance Standard 6[61] as well as other relevant international and national regulations. Ultimately, the responsibility to advance measures in order to ensure compliance with PR6 lies with the client applying for financing and is likely to involve the use of project- and location- specific BES data. The EBRD may, however, also engage independent biodiversity specialists to assist with due diligence assessments.[62]

Earth Capital Partners, an investment management firm specialised in sustainable development investments, may have more demanding requirements as they incorporate ESG impacts, including BES aspects, into all investment evaluation, portfolio management and reporting processes. The Earth Dividend Metric (EDM), a methodology developed in-house, is used to report the ESG impact (positive and negative) of their investments for five separate categories of ESG issues, including natural resources, ecosystem services and pollution, each category consisting of six indicators.[63] The metrics and related data needed to assess an investment performance on the 30 indicators included in the EDM are in most instances, determined by location- and project- specific aspects, sometimes based on compliance documentations (e.g. Environmental Impact Assessments) and/or on consultations with the project operator.

Both the lack of comparable data on corporate performance in managing BES, and the lack of standardised reporting processes hinder the integration of BES information into investment risk assessments and related decision-making processes. Various collaborative initiatives are seeking to fill this gap and, as a result, a number of mechanisms and tools are being, or have been, developed to help evaluate corporate performance in the context of BES impact and dependence, some of which are outlined below.[64]

In the case of biodiversity-focused tools linked to ecosystem services, Conservation International, BirdLife International and the UNEP World Conservation Monitoring Centre jointly developed the Integrated Biodiversity Assessment (IBAT). IBAT is a computer-based tool that enables companies to incorporate biodiversity into their risk analysis, decision-making

[61] IFC (2006), *Performance Standard 6: Biodiversity Conservation and Sustainable Natural Resource Management*, http://www.ifc.org
[62] EBRD (2008), *Environmental and Social Policy*, p. 44 to 4, http://www.ebrd.com
[63] Earth Capital Partners (2010), *Introduction to Earth Capital Partners*, p. 2 -3, http://www.earthcp.com
[64] Waage S, Stewart E and K Amstrong (2008), *Measuring Corporate Impact on Ecosystems: a Comprehensive Review of New Tools*, Business for Social Responsibility

and planning processes, and is designed ultimately to inform Biodiversity Action Plans (BAP) and Environmental Impact Assessments (EIA).[65] While IBAT relies on scientific knowledge and data collected on a location-specific basis, and delivers cost-effective basic BES risk screening in a timely manner, it focuses on areas of high biodiversity thereby limiting application to wider industrial operations.[66] The identification of designated protected areas and other recognised spatial zones on a global scale is, however, of significant importance and allows a first screening in the context of project and operational developments. Nevertheless, BES aspects that are not necessarily captured in protected or designated areas will not be reflected by tools such as IBAT, thereby limiting their scope for application when analysing whether or not, and how, banks assess biodiversity risks associated with investments. Relying solely on designated protected areas and the like could result in BES risks and opportunities being missed.[67]

Considering wider ecosystem services tools, the Natural Valuation Initiative (NVI) developed an Ecosystem Services Benchmark (ESB) to help investors assess how companies manage BES risks and opportunities in the food, beverage and tobacco sectors. ESB innovates in that it considers both impacts and dependence on BES at company-, industry- and cross-sector- levels, and it structures BES performance across five categories – competitive advantage, governance, policy and strategy, management and implementation and reporting; aiming to demonstrate how BES integrates into broader risk management processes. Due to the lack of agreed standards and metrics as well as the absence of regulatory requirements for companies to assess, monitor, report and disclose their BES–related performance, ESB takes management processes related to BES as a proxy for corporate performance on BES.[68] While this limits ESB's utility for real quantification, this benchmark tool does constitute a significant step forward in the development of corporate BES performance tools for use by investors.

Specialist information providers that supply ESG information to investors highlighted similar issues regarding performance assessment and corporate reporting on BES issues. If and when ESG research includes BES appraisals, information providers tend to focus on the impact dimension, rather than dependence on BES, and use largely qualitative data**.** EIRIS, for example, looks at how companies assess and manage their impact on BES based on relevant compliance statements (e.g. Environmental Impacts Assessments (EIA), Biodiversity Action Plans (BAP)), sustainability strategies, and performance reports; by engaging and liaising with companies on their ESG performance; by monitoring allegations of breaches to international and national regulations such as the Convention on Biological Diversity; and by assessing how companies manage and respond to allegations of such breaches. Respondents active in the area of ESG information and research stress the need for agreed metrics to assess both BES impact and dependence, with a sector-, location- and eventually BES subthemes- focus. They also underlined the need for agreed valuation methodologies to support performance assessment on both financial and extra-financial (i.e. ESG) areas.[69]

[65] Waage S et al. (2008), *Measuring Corporate Impact on Ecosystems: a Comprehensive Review of New Tools*, Business for Social Responsibility, p.11
[66] Waage S et al. (2008), *Measuring Corporate Impact on Ecosystems: a Comprehensive Review of New Tools*, Business for Social Responsibility, p.16
[67] PwC LLP on behalf of BBOP and UNEP Finance Initiative (2010), *Biodiversity Offsets and the Mitigation Hierarchy : A Review of Current Application in the Banking Sector*, p.6, http://bbop.forest-trends.org
[68] Grigg A et al. (2009), *The Ecosystem Services Benchmark. A guidance document,* Fauna & Flora International, UNEP FI and Fundação Getulio Vargas; and Waage S. et al. (2008), *Measuring Corporate Impact on Ecosystems: a Comprehensive Review of New Tools*, Business for Social Responsibility, p.16
[69] Nyenrode Centre for Sustainability, IUCN Netherlands, Fauna & Flora International (2010), *Identification and Development of Opportunities for Biodiversity Information Services by Sustainability Rating Agencies*, p.28-30

While there is general evidence of the relationship between BES risks and opportunities and a project/company's performance, it remains difficult to quantify how that impacts on asset values or investment returns, except in a few relatively clear-cut cases such as the impact of BP's Gulf of Mexico oil spill on its share price and dividend.[70] Working on a global scale in an attempt to demonstrate the impact of environmental damage (including BES) on financial returns, Trucost recently estimated the global costs associated with the environmental impact of the operations of the largest 3,000 companies in the world, to be in the order of US$2.15 trillion.[71] Global environmental costs were calculated using data on green-house gas emissions, water abstraction, pollution emissions (e.g. VOCs), waste and natural resources depletion (focusing on fisheries and timber). The costs of the resulting environmental damage were valued using TEEB's 'total economic value' as a framework to monetise ecosystems goods and services based on their 'in use' values and other benefits. This analysis, however, acknowledged limitations in relation to global data availability for natural resources, other than fisheries and timber, as well as for environmental impacts such as water pollution, heavy metals, land-use change and waste, particularly in non-OECD countries. Moreover, Trucost stressed the fact that its results could be significantly higher, if methodological and data obstacles could be overcome in order to account for ecosystem services' degradation (e.g. climate regulation) as the result of companies' activities.[72]

4.2 Guarantors' Perspective on BES Risks

Insurance offers a private market mechanism for sharing risks and could therefore encourage better management of operational risks of causing BES loss and degradation. While private insurance is thought to offer a cost-efficient way of recovering financial compensation for environmental damages, it has a key role to play in preventing damage occurrence and influencing responsible behaviour by engaging with stakeholders, offering premium incentives, encouraging risk monitoring and spreading risks across a larger group of actors.[73] In the context of insurance coverage for BES risks, SwissRe, for example, has been active in engaging with clients and fostering stakeholder dialogue by participating in expert hearings on the EU Environmental Liability Directive and by setting an internal framework to facilitate the identification, mitigation or elimination of potential environmental, social and ethical risks associated with business transactions.[74]

The insurance sector is, however, only starting to develop specific BES-risk assessment and insurance products. First, BES loss and degradation is complex to identify and measure. Assigning liability is difficult as many actors can contribute to the degradation of the same ecosystem or habitat. Second, guarantors need to quantify their exposure to their clients' risks in order to be able to insure them. This entails the need for a large volume of historical and scientific data to estimate the likely extent of the damage, as well as the use of sound economic

[70] Nyenrode Centre for Sustainability, IUCN Netherlands, Fauna & Flora International (2010), *Identification and Development of Opportunities for Biodiversity Information Services by Sustainability Rating Agencies*, p.9
[71] Trucost on behalf of UN PRI and UNEP FI (2010), *Universal Ownership :Why environmental externalities matter to institutional investors*, http://www.trucost.com
[72] Trucost on behalf of UN PRI and UNEP FI (2010), *Universal Ownership :Why environmental externalities matter to institutional investors*, p.4, http://www.trucost.com
[73] Pearce D (2000) *The Insurance Industry and the Convention on Biological Diversity*, prepared for the OECD Working Group of Economic Aspects of Biological Diversity, p.9
[74] Bresch D, SwissRe (2010) "Ecosystem services and natural hazards prevention" a presentation delivered at the conference *Business of Biodiversity*, held in London on 13 July 2010, slide 3 and "Case study: SwissRe's Framework to Manage Sustainability Challenges" in CRO Forum (2010), *Recommendations for Managing Environmental, Social and Ethical Challenges in Business Transactions*, p.12

valuation methods to translate damage estimates into financial terms. None of these requirements are currently being met in relation to BES. Third, the insurance industry is highly competitive and insurers tend to avoid increases in price premiums beyond what is necessary in terms of compulsory requirements, which limits de facto the proactivity of the industry in terms of the development of what would be complex products. The overall challenge of integrating BES risks into insurance coverage lies in establishing viable regulation requiring corporations to incorporate BES aspects into their business processes without oversimplifying the issue of BES loss and degradation.

The development of environmental insurance policies including coverage for damage to BES is primarily driven by regulatory developments.[75] Most environmental risks, including biodiversity loss and ecosystem services degradation, are rather long-term and systemic – i.e. BES components can rarely be dissociated from the system/ecosystem/habitat to which they pertain. Moreover, benefits derived from BES often exhibit 'public good'[76] features which have implications in terms of economic valuation and marketability. As a result, many environmental risks remain uninsurable in the absence of a playing field laid out by regulation. In the European Union, the Environmental Liability Directive (2004/35/EC[77]) establishes a liability framework for damage on environmental resources (including animals, plants, natural habitats, water resources and land) and applies for damage caused from 2007 onwards. Prior to the ELD, environmental insurance coverage in Europe was primarily inspired by US products and related mostly to pollution control. The implementation of the ELD spurred the development of environmental insurance policies covering the risks of environmental degradation associated with corporate operations beyond pollution events. One type of liability covered by the ELD is strict liability applying to dangerous or potentially dangerous occupational activities listed under Annex III of the ELD, such as agricultural or industrial activities requiring a license under the Directive, waste management activities and activities regarding genetically-modified organisms. This first group of liabilities holds that the operator may be held responsible for damage to the environment, even if it is not directly at fault. A second type of liability arises from damage or threat of damage to species and habitats stemming from an operator's fault or negligence, and applies to all occupational activities other than those listed in Annex III.[78]

Data requirements to enable sound BES risk assessments and to inform the development of new insurance products are currently not being met. Large volumes of historical and scientific data are required to understand the wide range of risks involved and allow sound risk assessments to be made, particularly when it comes to developing products for a new asset class such as BES. Currently, environmental underwriters assess BES-related risks and how clients manage them based on location-specific biological data available in the public domain, such as Google Earth and Natural England's ecological habitats database, corporate environmental impact assessments and corporate environmental strategies. In addition, risk assessments are also based on underwriters' own experience and expertise, given that most environmental underwriters/insurers have a scientific and technical background in addition to the knowledge of industry types. When insurers are unsure about certain risks they can to some extent opt out and thereby limit their

[75] UNEP Finance Initiative – Insurance Working Group (2009) *The Global State of Sustainable Insurance: understanding and integrating environmental, social and governance factors in insurance*, p.13-14, http://www.unepfi.org

[76] A public good is characterised by non-rivalry (i.e. consumption of the good by one individual does not impede consumption by another individual) and non-excludability (i.e. it is virtually impossible to exclude anyone from the consumption use of the good). Many BES components have public good features e.g. climate regulation.

[77] http://europa.eu/legislation_summaries/enterprise/interaction_with_other_policies/l28120_en.htm

[78] http://europa.eu/legislation_summaries/enterprise/interaction_with_other_policies/l28120_en.htm

exposure to clients' risks by excluding specific risks from the insurance coverage, increasing the retention, increasing the premium and/or by encouraging the client to strengthen its corporate risk management procedures.

To date, no claims have yet been made under the ELD specifically regarding damage to BES. In the event of such claims being brought forward in the future, claim investigations undertaken by a loss adjuster (i.e. independent companies with relevant technical expertise) will take into account the costs of clean up, reinstatement and the economic value of BES aspects to evaluate the scope of the damage measured against an environment's baseline condition. The insurer's liability, however, will stay within the limits of the financial coverage offered by the related policy, rather than extend to the full costs of the damage.

Guarantors could make effective use of an 'environmental snapshot' combining environmental data, including BES dimensions, and using satellite imagery and technology. Currently Google Earth maps and certain habitats' datasets are frequently used in the underwriting process because of their ease of access and use. NERC could certainly contribute to producing a more powerful tool, thereby making effective use of its existing data, as detailed below in section 5.2.

Insuring BES risks ultimately depends on the ability to both diversify risks and put a price on them. Efforts such as TEEB have contributed to building a body of evidence that demonstrates the economic implications of BES loss and degradation. The scientific community should work with financial specialists on developing valuation methodologies that could then be applied in the insurance sector when modelling the likelihood and economic consequences of an event damaging BES assets. In this respect, NERC should continue to support scientific research in the area of valuation. Some respondents have in addition suggested that producing broadly-based valuation methods with well-documented uncertainties and error ranges would be a valuable interim contribution while waiting for more comprehensive valuation assessments to emerge.

4.3 Corporate Perspective on BES Risks and Opportunities

Virtually every corporation impacts and depends on BES, though to varying degrees and in different ways. As a result, and based on the recognition that the sustainable management of BES is beneficial for long-term prosperity, there is growing recognition that BES-related risks and opportunities need to be accounted for in formal corporate planning and decision-making processes. This is particularly true for sectors relying and/or impacting heavily on nature. For the purpose of this section, respondents included sustainability managers or the like from leading corporations in the agribusiness and extractive industries.

Industries which depend or impact significantly on the environment tend to be more proactive with respect to BES risks and opportunities, driven by a combination of regulatory, reputational and sustainability concerns. In the agri-business industry, the long-term supply of raw materials is a key concern spurring the drive for more sustainable management of BES. Heineken UK is reconsidering the relevance of biological approaches (as opposed to chemical approaches) to farming practices. Investigations into a more proactive management of BES in the context of cider production, for example, are driven by the need to ensure long-term supply of apples, while contributing positively to the enhancement of biodiversity in orchard fields. Lafarge, a mining company producing building materials, has been progressively formalising the integration of BES issues into decision-making and operational processes. Operating in an area that is extensively regulated, especially in the UK, Lafarge takes a life-cycle approach to quarrying activities and the associated management of BES from the pre-planning permission application

stage until the aftercare stage. Ecological restoration activities, in particular, are perceived as necessary to ensure a long-term license to operate, as restoration is the legacy on which the company will be judged, and given that the exploitation of mining sites can span over 20 years.

Industries face several general data and methodological challenges when assessing BES. In the agri-business sector, commonly agreed indicators need to be defined to enable systematic and consistent assessments of sustainability and of BES health in particular. At present, the selection of indicators is inconsistent across crop types, farm systems, companies and regions. While this is partly explained by the inherent complexity of biological systems and the localised environmental conditions associated with these, detailed technical work is desirable to develop methodologies that allow conversion of results across crops and locations, thus enabling comparison of different agro-ecosystems. As for the extractive industry, efforts at the standardisation of BES assessments have contributed to the effective and consistent management of BES issues. In the UK, for example, the development of guidelines to assist in the calculation of associated ecological impacts by the Institute for Ecology and Environmental Management (IIEM[79]) has helped inform the technical work of specialist consultants assisting mining operatives with the management of operational risks including BES. The industry, however, also faces data and methodological challenges, as agreed indicators and methodologies need to be improved in order to compare habitats pre- and post- extractive operations and to demonstrate in an accurate and consistent manner the 'no net loss' or 'positive gain' in terms of biodiversity.

Corporate reporting on the sustainable management of BES aspects can also prove to be challenging, particularly with regard to the choice of appropriate indicators, demonstrating performance, and allowing comparison across countries. As part of its sustainability reports, Lafarge reports on land use indicators – such as the area of land currently being quarried, stripped or restored in a particular year-, as well as biodiversity indicators, derived from the Biodiversity Management System developed by Lafarge and validated by WWF International, which give an indication of sites where biodiversity is important either as an obligation or as an opportunity and should, hence, be considered in the rehabilitation plans. Lafarge is keen, however, to consider new indicators that could not only measure processes but also outcomes in terms of BES. In the UK, one such option could be to assess the hectarage of broad habitat created through restoration activities and determine the resulting contribution to national Conservation Plans.

Leading corporations engage with specialist consultancies and the scientific community, as relevant, to advance thinking on the sustainable management of land and associated natural assets, and to develop assessment tools and methods relevant to their specific industry context and needs. Corporations often commission scientific research to identify BES-related risks, such as pests and diseases, and opportunities, such as pollination and predatory insects, in the case of Heineken UK, and the associated consequences on supply chains. Lafarge, for example, worked jointly with a specialist consultancy to develop an index derived from the rarity of species in an attempt to demonstrate the value of sustainable BES management and to show 'no net loss' or 'positive gain' in terms of biodiversity at its quarrying sites. While procedural challenges remain, particularly regarding habitat comparison and changes in species, this latter example illustrates the positive trend of corporations working with specialists in order to develop tailored tools and methodologies to suit their specific needs.

[79] http://www.ieem.net/

There is scope for further collaboration between the scientific community and industries' representatives. Science is particularly needed to advance the understanding of natural processes and advise on how to adapt production processes accordingly. In addition, science should underpin the development of corporate risk assessment tools and methods used by corporations to manage BES issues in their respective operational context.

5 BES Measurement: Considerations and Constraints

Global information about the distribution of biodiversity, the condition of species and natural ecosystems and the major stresses to ecosystems is not always readily accessible.[80] Indeed, BES data is often inconsistent across both indicators and regions. This is partly explained by the inherent complexity of BES; the geographical and temporal variability of biodiversity and ecosystem features; the intangibility of some ecosystem services such as climate regulation; and associated uncertainties such as the inability to predict and prevent tipping points in ecosystems. Moreover, BES-related data is often collected through field studies, usually resulting in a localised focus with outcomes and results that are not always comparable.[81]

In the context of financial services risk assessments and decision-making processes, changes in BES, and actors' impact and dependence on it, need to be quantified using consistent and comparable measurement tools. Scientific assessments of risks and opportunities need to be translated into financially-relevant numbers using appropriate valuation methodologies. With this in mind, this section offers some reflections on the 'measurability' of BES and puts them in perspective with existing initiatives and potential opportunities for NERC.

5.1 The Selection of BES Indicators

The main issues regarding measurement include the selection of appropriate indicators to assess BES health and change, the capacity to collect data in a systematic and regular manner and the comparability of data at a global level and over time[82]. "Biodiversity indicators use quantitative data to measure aspects of biodiversity, ecosystem condition, services, and drivers of change, to help understand how biodiversity is changing over time and space, why is it changing, and what the consequences of the changes are for ecosystems, their services, and human well-being"[83]. Commonly-used proxy indicators of biodiversity and ecosystems health include species counts (e.g. butterflies, bird species), endangered species, species richness (i.e. the number of species present in a defined area) and species diversity indices (e.g. the Shannon Index), genetic diversity, functional diversity and land fertility[84]. While numerous indicators exist and are used to identify areas of high biodiversity value and conservation importance at various scales, they do not easily capture an ecosystem's functionality (e.g. for regulating or provisioning services).[85] Moreover, the breadth and quality of data is not necessarily comparable across countries and regions, or indeed across species. Among the potential measures of risks to biodiversity, land cover offers a useful indicator of the size and trends of pressures on BES, available at global scales. Time series required to construct the necessary metrics are, however, incomplete.[86]

[80] Environmental Performance Index (EPI, 2010), background information on biodiversity and habitat, accessible at http://epi.yale.edu/Metrics/BiodiversityAndHabitat
[81] EPI (2010), background information on biodiversity and habitat, accessible at http://epi.yale.edu/Metrics/BiodiversityAndHabitat
[82] UNEP WCMC, GRI and CREM B.V. (2010) *Incorporating Ecosystem Services into Corporate Performance*, Draft report, p.9
[83] Definition of "Biodiversity indicators", available at http://www.unep-wcmc.org/eap/bio-indicator.aspx
[84] Reyers B et al. (2010),)"Chapter 3: Measuring biophysical quantities and the use of indicators" in TEEB (2010) *The Ecological and Economic Foundations*, p. 3-15, http://www.teebweb.org
[85] Reyers B et al. (2010)"Chapter 3: Measuring biophysical quantities and the use of indicators" in TEEB (2010) *The Ecological and Economic Foundations*, p. 11-15, http://www.teebweb.org and UNEP-WCMC (2009) "Background paper for ecosystem service indicators workshop participants", in the context of the *Expert Workshop on Ecosystem Service Indicators* held in Cambridge (UK) on 22 and 23 September 2009.
[86] Reyers B et al. (2010),)"Chapter 3: Measuring biophysical quantities and the use of indicators" in TEEB (2010) *The Ecological and Economic Foundations*, p. 11-15, http://www.teebweb.org

A central theoretical question relating to the 'measurability' of BES lies in the extent to which it is possible to agree on few units of measure, in the same fashion as CO_2 equivalent (CO_2e tonnes and parts-per-million have been established as units of measurement for emissions in the context of climate change impact assessments. Most substances[87] that are regulated under international treaties, such as the Kyoto Protocol and the Montreal Protocol, for their negative contribution to climate change can, indeed, be expressed in terms of amounts of 'CO_2 equivalent' (CO_2e), using sound scientific methodologies. This, together with standards and regulatory developments, has helped facilitate the emergence of carbon dioxide as the 'currency' for climate change related measurements and trading in emissions' permits. Measurement is central to assessing changes in the state of BES, but also to developing market-based instruments for nature conservation, including biodiversity offsets. Species richness, species uniqueness, intra-specific genetic diversity, habitat hectares, habitat cover, protected areas' coverage and ecosystem services are potential candidates to assess BES health and changes. As a result, defining the 'currency' for BES assessments and transactions is extremely difficult, both because of the inherent complexity, spatial and temporal variability and connectivity of BES, but also because BES assessments cannot be dissociated from land and depend on the specific context/scale as well as the availability, reliability and comparability of data.[88]

The challenge, hence, lies in the definition of a set of indicators that appropriately reflects changes associated with BES, based on an accepted method, which "captures the often non-linear and multi-scale relationships between ecosystems and the benefits that they provide, and can be converted into economic terms"[89]. Ecological footprint assessments such as the method developed by the Global Footprint Network are useful to assess human demand on global ecosystems and include indicators on various components such as crop and grazing land, fishing grounds, forest land, built-up land and carbon footprint. In order to depict a comprehensive and accurate picture of pressures on ecosystem services, existing methods need to include additional indicators regarding natural resources (e.g. water use and availability) and biodiversity (e.g. in terms of species).[90]

From a corporate perspective, developing a sound framework for ecological footprint assessment at the company level could prove a useful base from which to build consistent BES impact and dependence assessments which would enable comparisons across industries and regions. Organisations such as UNEP WCMC, the Global Reporting Initiative (GRI) and WBCSD are looking at how corporate reporting could account for BES-related pressures, impacts, dependences and responses to inform such ecological footprint assessments. Current constraints relate to the complexity and interconnectivity inherent in BES; the difficulty of delineating the physical boundaries of companies' operations; and the challenge of distinguishing between impacts from different actors, as well as between different types of impacts and dependences (e.g. direct, indirect, secondary and cumulative).[91] Given the complexity of developing a sound and comprehensive ecological footprint methodology, some respondents suggested the use of

[87] For example: carbon dioxide(CO2), methane (CH4), nitrous oxide(N2O), PFCs, HFCs, SF6, CFCs, HCFCs.
[88] Bishop J, IUCN, "Biodiversity and compensation: legal and economic issues", a presentation delivers at the conference *Journee Biodiversite & Entreprises* on 18 November 2008
[89] Reyers B et al. (2010),)"Chapter 3: Measuring biophysical quantities and the use of indicators" in TEEB (2010) *The Ecological and Economic Foundations*, p. 3, http://www.teebweb.org
[90] Bank Sarasin (2010), *The World in a Dilemma between Prosperity and Resource Protection*, p. 7-8, http://www.london-accord.co.uk
[91] UNEP WCMC, GRI and CREM B.V. (2010), *Incorporating Ecosystem Services into Corporate Performance*, Draft report

leading indicators such as carbon, water and waste as benchmarks based on the ready availability of consistent and comparable data.[92]

Cross-referencing corporate ecological assessment of BES impact and dependence with location- or scale- specific environmental data further enables the identification of risks and opportunities associated with the management of land and BES. In this context, tools such as CBD country profiles[93] (i.e. compiling biodiversity information in line with the Convention on Biological Diversity) or the Integrated Biodiversity Assessment Tool[94] (IBAT – a GIS spatial tool that allows companies to identify protected areas and key biodiversity-rich areas) facilitate access to detailed information on BES trends in specific parts of the world.

NERC and its research community have a key role to play in guiding and informing the selection of appropriate BES indicators against which governments and companies could assess changes associated with BES, as well as in the development of appropriate standards and protocols for reporting processes and data collection. In addition, by supporting and engaging in collaborative efforts to select indicators and develop methods to inform corporate BES impact and dependence assessment, NERC could gain better insights into users' needs and knowledge constraints.

5.2 Format of, and Access to, BES Data

Facilitating the effective compilation and access to comparable datasets at the global level is critical to the global dissemination of scientific knowledge. Several pan-national initiatives are working towards compiling and improving access to data, often including a range of detailed maps and graphs at various scales (e.g. global, regional, national and local). These include the UNEP World Conservation Monitoring Centre[95] – which compiles BES-related datasets from all over the world and offers access to interactive maps; the Environmental Performance Index 2010 (EPI[96]) – which ranks 163 countries on 25 performance indicators tracked across ten policy categories covering both environmental public health and ecosystem vitality and offers maps and related graphs to allow comparisons across countries and against other dimensions such as GDP; and the World Resource Institute's Ecosystem Services Indicators Database (ESID[97]), a collaborative[98] online database aiming to improve the availability of ecosystem service metrics and indicators for use in policy dialogues and decisions, in ecosystem assessments, and in natural resource management decisions.

Opportunities for collaboration with technology providers and developers offer new measurement, visualisation and distribution options. Technologies such as Light Detection and Ranging (LIDAR[99]) open the way to the use of remote sensing devices which could have revolutionary applications in BES assessments. Moreover, collaborations with satellite and internet technology providers such as Google and the European Space Agency could further improve the distribution, visualisation of, and access to up-to-date and detailed environmental scientific research and data.

[92] CA Cheuvreux (2010) "Analysing Corporate Biodiversity Performance", a presentation delivered at the WWF conference *Biodiversité, le capital pour l'entreprise* on 16 September 2010
[93] http://www.cbd.int/countries/
[94] http://proteus.unep-wcmc.org/ibat.aspx
[95] http://www.unep-wcmc.org/
[96] http://epi.yale.edu/
[97] http://www.esindicators.org/
[98] For example, UNEP-WCMC is a significant contributor of indicators.
[99] LIDAR is an optical remote sensing technology that measures properties of scattered light to find range and/or other information of a distant target, http://en.wikipedia.org/wiki/LIDAR

NERC's participation in such global initiatives with scientific networks and technology providers would raise its profile and help maximise the exploitation of its data and expertise, while sharing the costs associated with technology development and database maintenance. NERC is already working towards increased transparency on, and access to, its data resources at the UK level. Contributing to international initiatives compiling scientific information on BES could increase the relevance and reach of NERC data worldwide. Moreover, it could favour the development of an integrated 'environmental snapshot' featuring a range of BES indicators, which in turn could be of tremendous benefit to all concerned sectors of society, including corporate and financial services' professionals.

5.3 The Economic Valuation of BES Changes

Appropriate valuation methodologies are essential to translate measures of changes in BES into financially-meaningful numbers that can be integrated into financial assessments and decision-making processes. The economic valuation of BES would enable for accounting impact, dependence and changes associated with BES, which is a pre-requisite for a better integration of BES-related risks and opportunities into financial services' risk assessment and decision-making processes.

Numerous valuation methodologies (including market-based, stated preferences and revealed preferences) exist and can provide some help in estimating the consequences of changes resulting from the management of land and BES. All, however, have advantages and disadvantages.[100] TEEB, in its review of the main methods, highlighted several issues. First, valuation results depend on variable social, cultural and economic contexts. Second, major uncertainties exist (e.g. stemming from gaps in knowledge about ecosystem dynamics,) and as a result significant valuation difficulties arise (e.g. in situation of radical uncertainty or ignorance about ecosystems' tipping points). Finally, the limitations of monetary valuation are especially relevant as ecosystems approach critical thresholds and ecosystem change becomes irreversible or reversible only at prohibitive cost.[101]

The economic valuation of BES impacts, dependences and changes is needed to inform business decision-making processes as well as financial services' risk assessments, lending and investment decisions. Concepts such as corporate ecosystem valuation (CEV) ,– i.e. "the use of ecosystem valuation by business where both ecosystem degradation and the benefits provided by ecosystem services are explicitly accounted for with the intention of informing and improving corporate decision-making"[102]-, are gaining ground, driven by a combination of regulatory, reputational and other risk management related pressures.

NERC could lead scientific work on valuation in the UK and promote the involvement of its research community in international scientific networks with similar objectives. Further interactions between NERC and the financial services sector, could lead to NERC-funded scientists advising on the selection of BES indicators and to the development of tailored valuation methods for a better integration of BES aspects into financial and corporate processes.

[100] TEEB (2010), *Mainstreaming the Economics of Nature* : a Synthesis, p.1, http://www.teebweb.org
[101] Unai P et al, (2010)"Chapter 5: The Economics of Valuing Ecosystem Services and Biodiversity" in TEEB (2010) *The Ecological and Economic Foundations*, p. 4. http://www.teebweb.org
[102] WBCSD (2010), *Corporate Ecosystem Valuation: Building the Business Case*, p.5, http://www.wbcsd.org

6 Conclusions

Scientific research to explore uncertainties associated with the complexity of, and changes in, BES is an ongoing process. There is, however, a wide gap between the scientific and financial communities in terms of the understanding of BES and their critical role in supporting our socio-economic system. While corporations with high BES exposure are progressively integrating BES into decision-making and management processes, the understanding of how changes in BES can translate into business and financial risks is still limited in the financial services sector.

Changing the situation will require a combination of adequate regulatory frameworks enabling markets for BES to emerge and increased compliance standards for managing and accounting for BES risks. There is also an urgent need for the development of BES metrics that can be translated into financial values. This will require an enhanced and effective exchange of knowledge between the financial services sector and the science community, together with a shared understanding of the as yet ill-defined information requirements of the former.

6.1 Concluding Thoughts

1. While ecosystems provide multiple and critical benefits to society and the economy, their economic relevance has often been overlooked due to their perceived abundance and the intangibility of their contributions to the economy. Hence, biodiversity loss and ecosystems' degradation is continuing and the failure to account for the full economic value of BES has certainly contributed to this trend.

2. The management of BES is no longer solely the responsibility of governments and other public and not-for-profit agents. To ensure sustainable long-term economic growth, the risks and opportunities associated with the use and management of nature have to be delineated and integrated into corporate decision-making processes, business models and strategies.

3. The degradation of BES can present financially material risks and opportunities for the financial services sector. This is particularly true for activities where exposure to companies with a high degree of impact and/or dependence can impact on financial returns; and equally in the context of emerging market-based opportunities for investment in the sustainable management of nature. The understanding and implications of these issues needs to be further advanced in the financial services sector.

4. Appropriate methodologies, metrics and standards need to be developed to ensure an integrated system of accounting for environmental impacts and dependences, including those associated with BES. Such products are vital to understanding the relationship between nature and value, and informing associated risk assessments and investment decisions. Such metrics will require sustained scientific-financial collaboration.

5. The financial services sector would benefit from the availability of an 'environmental snapshot' compiling relevant environmental data including key BES indicators at the global level, and using satellite imagery and technology combined with a user-friendly IT interface. Given the costs and efforts involved, such an undertaking will require collaboration between scientists, technology developers and end users, including a cross-range of financial services professionals.

6.2 Recommendations

1. NERC has a key role to play in advancing the general understanding of BES and associated risks and opportunities in the financial services sector. This can be achieved by facilitating dialogue between scientists and financial services as well as corporate professionals and by encouraging its research community to translate complex scientific information into more accessible forms. NERC's ongoing Knowledge Exchange activities and programmes should allow the identification of further opportunities for collaboration to maximise the utility and relevance of NERC-funded research, data and information across potential users.

2. Given the enormous difficulties associated with developing a single unit of measurement for BES, NERC could play a particularly valuable role by facilitating work to produce a 'benchmark index', composed of selected indicators where the availability of data is relatively high, the relationship to overall BES health is relatively high and clear-cut, and the potential for standardising measurement is such as to allow rapid progress.

3. NERC should continue to participate in the development of corporate risk assessments of BES impact and dependence, including standards and processes. Ongoing engagement with both leading corporations that are tackling BES dimensions in their own sectors, and financial services ESG specialist information providers will pave the way for a wider understanding of the requirements underlying the need for quantitative BES impact and dependence assessments' methodologies.

4. NERC should continue to encourage the participation of its research community in collaborative scientific initiatives at the national, regional and global levels. Similarly to TEEB efforts in raising the profile of nature valuation and BES loss and degradation at the international level, NERC should continue to invest in developing an economic assessment approach to nature and in compiling evidence of the economic implications of BES loss and degradation.

5. NERC should continue to improve access to existing research, data and models by enhancing the visibility and accessibility of its scientific assets through web portals and other digital library facilities.

6. NERC should explore opportunities for partnerships with existing global data centres, and satellite and internet technology providers to facilitate global compilation of data and encourage new visualisation and mapping options, thereby maximising the utility of its data while sharing the costs associated with technology development and database maintenance.

6.3 Suggested Next Steps

1. One way for NERC and its Research Centres to move forward at this stage might be engaging with financial services and corporate organisations in order to become a key provider of scientific advice on the understanding, assessment and integration of BES-data into risk assessment and decision-making models.

2. Continuing loss and degradation of BES, its significance to our socio-economic system and the emergence of BES as an asset class suggest that NERC could prioritise research on key themes including:

- research and data provision on specific ecosystems e.g. water, forestry, soil;
- the development of a BES benchmark to inform assessments of BES health;

- valuation methods to enable the economic accounting of impact and dependence on BES.

3. NERC could champion the development of a comprehensive 'Environmental Data Snapshot', compiling data on nature including specific ecosystems (water, forestry) as well as biodiversity underpinning these and trends of changes in nature. This could be achieved by joining efforts with other scientific networks and seeking commercial partners to collaborate through funding.

4. As financial and corporate industries' awareness of environmental issues increases and translates into better delineated data requirements, NERC should capitalise on its ability to supply relevant data and expertise to work in collaboration with mainstream financial services information providers and rating industries.

Appendix 1 – NERC Research and Data on BES

Biodiversity is one of the seven priority science themes that NERC tackles by funding and managing research, training and knowledge exchange in the environmental sciences. NERC supports scientific research, development and archiving of datasets and models, as well as joint programmes with industry, policy-makers and society. This occurs via its four fully owned research centres, which include the Centre for Ecology and Hydrology (CEH), collaborative centres and through grants supporting scientific research in Higher Education Institutes (HEIs) and Independent Research Organisations (IROs) across the UK.

NERC invests in key research programmes to advance scientific knowledge on biodiversity. The Biodiversity and Ecosystem Services Sustainability initiative (BESS[103]) is an example of one such large-scale, integrated research programme, which aims to improve the understanding of the role of biodiversity on ecosystem functioning and service provision at a landscape-scale. The objectives of BESS include understanding the functional role of biodiversity in UK ecosystems across a range of ecosystems goods and services, environmental gradients and scales typical of real landscapes; identifying critical levels of biodiversity required to deliver a range of ecosystem services that meet societal needs, and the land and resource use associated with these biodiversity levels; and developing impact assessment tools to explore the implications of land and resource use change on biodiversity and a range of ecosystem services.

NERC also funds the Valuation Network[104], a network which intends to promote and develop research capacity in the valuation of biodiversity, natural resources and ecosystem services by facilitating and fostering an integrated interdisciplinary community.

NERC is involved in key national and international collaborative initiatives related to biodiversity and the management of ecosystems. NERC supports the UK National Ecosystem Assessment[105], the first analysis of the UK's natural environment in terms of the benefits it provides to society and to continued economic prosperity. In addition to NERC-funded scientists, this project also involves many governments, NGOs and private sector institutions. Another example is Diversitas bioSUSTAINABILITY, a European research project that aims to establish international networks of ecological, economic, political and social scientists working on biodiversity, in order to inform the formulation of effective policies to halt and reverse biodiversity loss. Moreover, some NERC-funded scientists have been or are involved in collaborative initiatives at the international level such as for the Millennium Ecosystem Assessment in 2005[106] and the upcoming IPCC fifth assessment report[107].

NERC Research Centres and funded scientific community initiate and participate in collaborative projects with industries, policy-makers, NGOs and communities. The "Finance, Biodiversity and Managed Ecosystems" research project is an example of industry engagement, which aims to understand the financial services sector's data and modelling capability requirements relating to investment decision-making and risk assessment processes. NERC research centres and scientists are also working with industries that have a significant stake in

[103] http://www.nerc.ac.uk/research/programmes/bess/
[104] http://www.nerc.ac.uk/research/programmes/valuation/background.asp
[105] http://uknea.unep-wcmc.org/
[106] for example James Chilton, Principal Hydrogeologist at the British Geological Survey as referenced at http://www.maweb.org/en/Authors.ByCountry.aspx
[107] http://www.ipcc.ch/meetings/session32/inf07_p32_ipcc_ar5_authors_review_editors.pdf

biodiversity and ecosystems. For example, the BUZZ project[108] compared new and existing agri-environmental scheme options for biodiversity enhancement on arable land between 2002 and 2004, and involved CEH, the Wildlife Farming Company and major companies such as Syngenta and Unilever.

CEH and other NERC research centres hold a wealth of environmental information gathered over decades of environmental monitoring and research. This information covers a wide range of unique national, and often global long-term datasets. For example, the Countryside Survey[109] has been collecting data on stock and change in habitat across Great Britain since 1978. The Countryside survey also collects data on species plot, soil plot, linear habitat, and freshwater habitat and produces supporting satellite map tools. Another example is the Biological Records Centre[110] which collates records of species location, habitat, etc, and has created a unique collection of spatially and temporally referenced data reaching back to 1964. CEH is also the repository of the most comprehensive datasets for species such as birds and butterflies in the UK.

NERC is committed to making data and expertise on biodiversity and the management of ecosystems accessible, either through public data gateways and/or by licensing data and models to organisations in the public and private sector – see Appendix 2 for additional details about NERC's Data policy. The CEH information gateway[111] is one portal that enables access to data resources held by the Environmental Information Data Centre, the NERC data centre for terrestrial and freshwater science and other data providers in the UK and beyond. CEH and the Biological Records Centre also participate to the National Biodiversity Network (NBN) Gateway[112], a collaborative project which acts as a 'data warehouse' for biodiversity information, which can be quickly and easily accessed to understand the distribution of particular species in the UK. Biodiversity information is gathered from government and country agencies, environmental agencies, local records centres, voluntary groups and increasingly corporations involved in the management of land and natural assets. NERC also funds data portals hosted by Higher Education Institutions, such as UKPopNet[113], the UK Population Biology Network hosted and managed by the Environment Department at the University of York. UKPopNet pays particular attention to the impacts of biodiversity change on the sustainability of ecosystems, landscapes and livelihoods, as well as to how these effects can be mitigated, by funding and/or participating in a series of inter-institutional projects and studentships.

[108] http://nora.nerc.ac.uk/1446/
[109] http://www.countrysidesurvey.org.uk/
[110] The Biological Record Centres is is the national focus in the UK for terrestrial and freshwater species recording (other than birds) and is one of the data centres within CEH.http://www.brc.ac.uk
[111] https://gateway.ceh.ac.uk/
[112] http://www.nbn.org.uk/Home.aspx
[113] http://www.ukpopnet.org/

Appendix 2 – NERC Data Policy[114]

NERC Data Policy Statement

NERC has a policy on data in order to:

a. Ensure the continuing availability of environmental data of long-term value for research, teaching, and for wider exploitation for the public good, by individuals, government, business and other organisations.
b. Support the integrity, transparency and openness of the research it supports.
c. Help in the formal publication of data sets, as well as enabling the tracking of their usage to be tracked through citation and data licences.
d. Meet relevant legislation and government guidance on the management and distribution of environmental information.

NERC defines **environmental data** as individual items or records (both digital and analogue) usually obtained by measurement, observation or modelling of the natural world and the impact of humans upon it. This includes data generated through complex systems, such as information retrieval algorithms, data assimilation techniques and the application of models.

This policy covers environmental data acquired, assembled or created through research, survey and monitoring activities that are either fully or partially funded by NERC. It also applies to environmental data managed by NERC where NERC was not the original funder. This policy does not cover NERC's information products i.e. created by adding a level of intellectual input that refines or adds value to data through interpretation and/or combination with other data. Model codes are not covered by this policy.

NERC Data Policy as of January 2011

Key principles

The environmental data produced by the activities funded by NERC are considered a public good and they will be made openly available for others to use.
NERC is committed to supporting long-term environmental data management to enable continuing access to these data.
NERC will supply the environmental data it holds for free, apart from a few special cases as detailed in the policy.
NERC requires that all environmental data of long-term value generated through NERC-funded activities must be submitted to NERC for long-term management and dissemination.

Access to data

It is NERC's policy that:

1. All the environmental data held by the NERC Environmental Data Centres will normally be made openly available to any person or any organisation who requests them.
2. The only restrictions on access which NERC will apply are those supported by the exceptions on disclosure in the Environmental Information Regulations (2004). If it is proposed to restrict access to any data, NERC will explain why.
3. To protect the research process NERC will allow those who undertake NERC-funded work a period to work exclusively on, and publish the results of, the data they have collected. This period will normally be a maximum of two years from the end of data collection.
4. All data held by the NERC Environmental Data Centres will be supplied for free except for large or complex requests where NERC may charge the cost of supply, or where

[114] This section is based on NERC Data Policy 2011, as outlined on NERC website - http://www.nerc.ac.uk/research/sites/data/policy2011.asp

third-party licence conditions either prevent such free supply, or requiring NERC to make specific charges.

5. All environmental data made available by the NERC Environmental Data Centres will be accompanied by a data licence. Data originally provided to NERC by a third-party may have their own access and licence conditions which restrict how or when NERC can make data available to others, in which case related data licence conditions will reflect these.
6. All those who use data provided by NERC are required to acknowledge the source of the data.

This appendix only reflects selected parts of NERC data policy. For more information on NERC Data Policy: http://www.nerc.ac.uk/research/sites/data/policy2011.asp

For a list of NERC Research centres and facilities, including Data Centres: http://www.nerc.ac.uk/research/sites/

Appendix 3 – List of Organisations Consulted

AXA Investment Management
British Standards Institution
CABI
CA Cheuvreux
Centre for Ecology and Hydrology
Chubb Environmental Solutions
Deutsche Bank Research
Earth Capital Partners
Earthmind
EIRIS
EKO Asset Management Partners
EnviroMarkets
European Bank for Reconstruction and Development
ForestRe
Forum for the Future
Global Balance
Global Gardens
Lafarge
Liberty International Underwriters
London School of Business and Finance
Heineken UK
Mercer
Mission Markets
Nyenrode Business Universiteit – Centre for Sustainability
PricewaterhouseCoopers LLP
Rabobank International
Royal Bank of Scotland
SwissRe
The Environment Bank Ltd
Trucost
UNEP World Conservation Monitoring Centre
Unilever
University of Reading
UN Principles for Responsible Investment
Willis

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