Institution: University of Exeter

Unit of Assessment: UoA 16 Economics and Econometrics

Title of case study: Embedding the 'Natural Capital Approach' into public and private sector decision-making and investment

Period when the underpinning research was undertaken: Sep 2015 to Dec 2020

Details of staff conducting the underpinning research from the submitting unit:

Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Brett Day	Professor of Environmental Economics	Sep 2015 – present
Ian Bateman	Professor of Environmental Economics, OBE, FBA	Sep 2015 – present
Amy Binner	Senior Lecturer	Sep 2015 – present
Luke Lindsay	Senior Lecturer	Sep 2013 – present
Carlo Fezzi	Senior Lecturer	Sep 2015 – present
Mattia Mancini	Research Fellow	Sep 2019 – present
Christopher Lee	Research Fellow	Dec 2019 – present
Greg Smith	Research Fellow	Sep 2015 – Jun 2019
Nathan Owen	Research Associate	Jun 2017 – Oct 2020

Period when the claimed impact occurred: 01/09/2015 - 31/12/2020

Is this case study continued from a case study submitted in 2014? N

1. Summary of the impact

The University of Exeter's Land, Environment, Economics & Policy (LEEP) Institute is a world-leading research centre focused on the development and implementation of the 'Natural Capital Approach' (NCA). The NCA seeks to integrate the environment into decision making through the systematic assessment of the benefits that nature provides to both society (e.g. flood mitigation, clean air and greenspace for recreation) and business (e.g. reducing costs and improving return on investment). LEEP's work has:

   i. **Accelerated the adoption and application of the NCA** in public bodies and private sector organisations through the development of government-endorsed, open-access tools for the valuation of hundreds of millions of pounds of environmental benefit flows

  ii. **Solved strategic, investment and operational challenges** through the quantification and valuation of organisations' dependencies on natural capital

 iii. **Incentivised environmental improvements through the design of innovative 'Payments for Ecosystem Services' schemes,** delivering over GBP500 million of cost savings for businesses and their customers

2. Underpinning research

The LEEP Institute is a world-leader in the development of the 'Natural Capital Approach' (NCA) **[3.1]**, a transformative framework for decision-making with regards to the natural environment. The NCA characterises the natural environment as a stock of valuable capital from which an array of services flow (e.g. clean water, carbon sequestration, recreational greenspace, etc.). These 'ecosystem services' support both economic activity and human wellbeing but, being delivered outside markets, do not command prices. As such, their value can be overlooked in public and private sector investment and decision-making. The NCA seeks to quantify and value these services and use that information to guide decisions towards the optimal and sustainable use of natural capital.

LEEP research has been influential in the widespread adoption of the NCA through a number of channels. It has: (i) provided robust evidence regarding the magnitude of natural capital values, e.g. through the development of tools such as **ORVaL [3.2]**; (ii) developed innovative mechanisms and schemes designed to address natural capital problems, bringing about natural capital change; (iii) demonstrated application of the NCA in practice to transform public and business decision-making.

LEEP research has been pivotal in developing the international understanding and application of the NCA. Bateman & Mace **[3.1]** present a framework for natural capital analysis and decision-making that links ecological and economic perspectives. The framework unites and clarifies sometimes disparate understandings of the approach that have emerged over recent years.

LEEP research has also made pioneering contributions to the development of accessible forms of natural capital valuation tools and techniques, which have enabled public and private sector practitioners to more readily adopt natural capital approaches. Day developed the world-leading Outdoor Recreation Valuation (ORVal) model. Unique in both scale and detail, ORVal estimates the daily visit choices of every adult in England and Wales to every publicly accessible greenspace site. The model delivers estimates of both the demand for access to the outdoors and the value generated by that access. ORVal was used by Day in 2020 to analyse the value of greenspace under COVID-19 pandemic lockdown **[3.2]**. An open-access, online version of **ORVal** is available at: https://www.leep.exeter.ac.uk/orval/.

Binner & Day's research **[3.3]** moved environmental valuation beyond standard, static analyses. Through the development of sophisticated dynamic-models of the integrated environment-economy system, Binner & Day were able to explore property market responses to localised reductions in air and noise pollution. They reveal how interventions designed to improve the environment for disadvantaged populations can, instead, be captured by the relatively wealthy through gentrification of such areas and associated property price increases.

Building on these complex modelling approaches, the LEEP team broke new ground through their pioneering integration of economic and natural science models in valuing environmental change in the UK. This body of research underpinned development of the Natural Environment Valuation (NEV) suite of models - a spatially-explicit, integrated modelling platform which quantifies and values the cascading effects of land use change through ecological and economic systems. NEV links drivers of change including policy, market forces and the environment to impacts on food production, carbon sequestration, water quality, flood mitigation, biodiversity and numerous other ecosystem services. For example, using NEV models, LEEP researchers revealed the costs of climate-induced land use change across a range of critical ecosystem service flows **[3.4]**.. Day and the LEEP team created an online, open-access version of the NEV model **[3.4]**, known as **NEVO** (Available at: https://www.exeter.ac.uk/leep/research/nevo/).

Many organisations and businesses are increasingly aware of the flow of value they receive from natural capital assets outside their immediate control. LEEP have also worked to design innovative 'Payments for Ecosystem Services' (PES) schemes that can incentivise the owners or managers of those assets, to maintain or enhance those value service flows. LEEP expertise in auction design and theory **[3.5]** has been central to the development of a range of auction-based PES applications. Additionally, Smith and Day's **[3.6]** research reveals the efficiency gains that can be realised through the coordination of multiple buyers in PES schemes.

3. References to the research

[3.1] **Bateman, I.J.** and Mace, G.M. (2020) The natural capital framework for sustainably efficient and equitable decision making, *Nature Sustainability* https://doi.org/10.1038/s41893-020-0552-3

[3.2] **Day, B.H**. (2020) The Value of Greenspace Under Pandemic Lockdown. *Environmental and Resource Economics*, 76: 1161-1185, https://doi.org/10.1007/s10640-020-00489-y

[3.3] **Binne**r, A.R. and **Da**y, B.H. (2018) How Property Markets Determine Welfare Outcomes: An Equilibrium Sorting Model Analysis of Local Environmental Interventions. *Environmental and Resource Economics*, 69:733–761, https://doi.org/10.1007/s10640-016-0101

[3.4] **Bateman, I.J.**, Agarwala, M., **Binner, A.**, Coombes, E., **Day, B.H.,** Ferrini, S., **Fezzi, C.**, Hutchins, M., Lovett, A.A. and Posen, P. (2016) Spatially explicit integrated modeling and economic valuation of climate change induced land use change and its indirect effects, *Journal of Environmental Management*, 181: 172-184, http://dx.doi.org/10.1016/j.jenvman.2016.06.020

[3.5] Lindsay, L. (2018). Shapley Value Based Pricing for Auctions and Exchanges. *Games and Economic Behavior*, 108, 170-181. https://doi.org/10.1016/j.geb.2017.10.020

[3.6] Smith, G.S., and **Day, B.H.**, (2018). Addressing the collective action problem in multiple-purchaser PES: An experimental investigation of negotiated payment contributions, *Ecological Economics,* 144, pp 36-58. https://doi.org/10.1016/j.ecolecon.2017.07.020

4. Details of the impact

Working with both public and private sector organisations, Day and the LEEP team applied innovative NCA methods that have: (i) accelerated the application of natural capital values into decision-making through the creation of freely-available decision-support tools (**ORVal** and **NEVO**) recommended and used by government, and directly benefiting business practices; (ii) helped to solve strategic, investment and operational challenges linked to natural capital issues; and (iii) designed and helped deliver pioneering 'Payments for Ecosystem Services' (PES) schemes, bringing about environmental change and millions of pounds of cost savings, to business and their customers. This work has been developed within the context of the UK Government's ambition to improve the environment, and recognition of the investment potential of adopting a NCA **[3.1]**, as set out by the Government's advisory Natural Capital Committee in its 2020 Progress Report on the implementation of the UK government's '25 Year Environment Plan' **[5.1a]**.

Accelerating the adoption and application of the NCA in decision-making

Day and Binner's development of two ground-breaking tools, **ORVal [3.2]** and **NEVO [**developed from **3.4]**, have benefitted business and accelerated both the adoption and application of the NCA. Both tools were powerfully endorsed by the UK Government's Department for Environment and Rural Affairs (Defra), in its highly influential 2020 guidance 'Enabling a Natural Capital Approach' **[5.1b, c]**. The uptake of both tools has had a major impact on decision-making across national and local government, businesses and the third sector, generating significant benefits for society.

Built as a front-end interface to the Outdoor Recreation Valuation (ORVal) model **[3.2]**, the **ORVal website** is a game-changing online and open-access valuation tool. The UK government's landmark 25 Year Environment Plan described **ORVal** as "*ground-breaking*" and "*world-leading*" **[5.2]**. Other examples of government endorsement include: HM Treasury 2018 Green Book **[5.2]**; Department for Communities and Local Government's 2017 Housing White Paper **[5.2]**; and Public Health England's 2020 guidance to local authority public health and planning teams **[5.3]**.

Through these endorsements and open-access, online accessibility, **ORVal** has been widely adopted in many contexts. Examples include: (i) calculating 'public realm welfare values' in a successful **GBP250 million** business case for Forward Funding made to the Housing Infrastructure Fund in 2018 for the 'Old Oak' regeneration development delivering 25,500 new homes; (ii) supporting Kent County Council's business case to fund its Rights of Way Improvement Plan (2018-2028) and as evidence in a related Public Enquiry; and (iii) preparing the first set of Natural Capital Accounts for greenspace in London's public parks in 2017; where **ORVal**-derived recreation value accounted for over **GBP17 billion,** some 19% of the total gross asset value (**GBP91 billion)**, supporting the case for continued or improved public funding of the parks **[5.3]**.

Survey evidence demonstrates that use of **ORVal** has also delivered improvements to practitioner's working practices in terms of improved quality, efficiency, flexibility and productivity and has led to better evidenced decision-making **[5.4]**. Additionally, **ORVal** has become the 'go-to' tool for a range of private sector businesses, including Mott MacDonald, AECOM, JBA Consulting and Eftec **[5.4]**. Director of environmental consultancy Eftec, said it had "*inspired*" them and was "*a game-changer*" **[5.4]**.

In writing to personally thank Prof. Day and the LEEP team for their work developing **ORVal**, Defra's Deputy Director of the Environment Analysis Unit wrote:

> "*ORVal has, without precedent…. been uniquely empowering in the way it enables non-specialists rapidly to access and to understand the substantial public value provided by accessible natural environments, and how this varies spatially.*" **[5.2]**

Funded by Defra (2016-19), LEEP also developed **NEVO**, an open-access, online version of the Natural Environment Valuation (NEV) suite of models **[3.4]**. A unique application, **NEVO** is unprecedented in bringing the power of integrated modelling to the fingertips of practitioners needing to assess a diverse range of environmental costs and benefits arising from changes in land-use in the UK.

Launched in October 2019, **NEVO** was recommended by the Committee on Climate Change **[5.3]**, an independent, statutory body advising government on building a low-carbon economy and preparing for climate change, and the National Infrastructure Commission for the natural capital analysis of the 'Rail Needs Assessment' **[5.3]**. **NEVO** is being used by the Environment Agency for a variety of different purposes, including a judicial review of Diffuse Water Pollution Plans **[5.4]**. A diverse range of local organisations, such as Shropshire Council, The Rivers Trust and a National Park, are using it to assess the effect of potential land-use change on, for example, carbon sequestration, river water quality and biodiversity **[5.4]**.

Environmental consultancies also use **NEVO** in their commercial practices as a knowledge-gathering, high-level screening and analysis tool **[5.4]**. Mott MacDonald's Environmental Scientists **[5.4]** found that **NEVO**'s accessible interface enabled them to upskill staff, routinely introduce welfare values into environmental assessments (which would previously have been impossible) and boost their commercial capability, stating that:

> "*being… an early adopter of these tools* [NEVO & ORVal] *provides a large reputational benefit… and with that a commercial advantage.*" **[5.4]**

Furthermore, Eftec consultancy reported that 33% of their annual turnover related to work on projects which incorporate values derived from **NEVO** and **ORVal [5.4]**.

Using the NCA to solve strategic, investment and operational challenges In partnership with numerous businesses, organisations and public bodies, LEEP has developed tailored evidence and advice through natural capital valuation and application of the NCA **[3.1-3.4]**.

Day and team worked with South West Water (SWW) on the natural capital evidence that underpinned their Price Review 2019 (PR19) submission to the Water Services Regulation Authority (Ofwat). SWW's 'Upstream Thinking' Environmental Programme Manager credited this work with enabling SWW to adopt a 'natural capital approach' to their investments, which helped them convey their PR19 submission more effectively to Ofwat **[5.5a]**. Furthermore, he states that the success of adopting this approach "*was reflected*" in their achieving 'Fast Track Status' (with a cost saving to SWW of **GBP 200 million**), in addition to securing funding of **GBP 15 million** for natural capital investments **[5.5a, b]**. LEEP's partnership with SWW, in collaboration with others at University of Exeter, led SWW to commit £21M co-funding in their 2020-25 business plan to establish a dedicated research centre at the University of Exeter, the Centre for Resilience in the Environment, Water and Waste (CREWW).

 [5.5a, b].

Advice and evidence provided by LEEP to consultants AECOM on the public benefits of river quality improvements, underpinned by LEEP methodological advances **[3.2; 3.3; 3.4]**, also supported Yorkshire Water's (YW) PR19 Business Case for investment in waste water treatment and 5 year Asset Management Plan. These contributions enabled YW to adopt a NCA and more effectively evaluate how the **GBP772 million** of customer money allocated by Ofwat for environmental improvements could be spent, for example, on improving sewage infrastructure or enhancing river water quality **[5.6]**.

LEEP's engagement with diverse non-academic partners has underpinned a number of other major investments. The Natural Environment Research Council funded **GBP5 million** South West Partnership for Environment and Economic Prosperity (SWEEP) programme (2017-2022), led by Bateman, with partners in the University of Plymouth and Plymouth Marine Laboratory, is delivering NCA solutions to over 200 businesses, public and third sector bodies in the South West, across a wide range of sectors. It has contributed to, or informed, 23 different private and public sector policies, strategies, business or management plans, including the Environment Agency's **GBP140 million** 'Coastal Modelling and Forecasting Strategy' and Cornwall Council's **GBP30 million** 'Forest for Cornwall'. **[5.7a]**. Likewise LEEP's new 'Dragon Capital Chair in Biodiversity

Economics' (set up in May 2020) is a **GBP1.6 million** investment by the Dragon Capital Group focused on delivering natural capital solutions to problems of global biodiversity loss **[5.7b]**.

'Payments for Ecosystem Services' schemes - incentivising environmental improvements
LEEP has also pioneered the application of 'Payments for Ecosystem Services' (PES) schemes **[3.5; 3.6]**, in both public and private sector organisations, incentivising landowners to deliver environmental services through changes in land management.

Working with Anglian Water in 2016-17, LEEP designed the first PES scheme to eliminate pollution from the pesticide Metaldehyde in the catchments of strategic water supply reservoirs. The highly innovative scheme encouraged complete within-catchment participation and was described by Anglian's Head of Environmental Quality as a *"real game-changer",* explaining that it saved Anglian Water **GBP 500 million** in avoided costs; *"a bill that customers would somehow have borne all or part of"* **[5.8]**.

From 2017 to present, LEEP has worked with EnTrade, a company implementing PES auctions for a variety of clients in the UK. Responding to various issues with EnTrade's auction implementations, LEEP proposed a first-of-its-kind, uniform-price design. This was adopted by EnTrade and implemented on behalf of Wessex Water (WW) in a scheme seeking to reduce agricultural nitrate pollution in Poole Harbour. The new design delivered a 30% fall in the price the water company had to pay to land owners for each tonne of nitrate removal activity. As reported by Entrade's Production Manager, this saving convinced WW to expand the size of the scheme doubling nitrate removals from Poole harbour and delivering a **GBP 6 million** saving to the water company and, as a consequence, the water company's customers **[5.9]**.

In 2020, the Forestry Commission (FC) launched its **GBP50 million** Woodland Carbon Guarantee (WCG) to support woodland planting over 5 years by offering guaranteed prices for carbon sequestered in growing trees through a series of auctions. LEEP worked with the FC to design an auction which encouraged competitive applications **[5.10]**. The Head of Economics at Scottish Forestry explained that it *"would have been difficult … to design the auction effectively without [LEEP] input"*, which was *"instrumental"* and allowed the FC to support woodland planting, which would not have otherwise happened, by incentivising future CO_2 removals at a carbon price of about one third of the government's estimated values required to meet climate change targets. The FC considered this *"a very successful outcome"* that had *"impressed"* H.M. Treasury **[5.10]**.

5. Sources to corroborate the impact
[5.1] **(a)** Natural Capital Committee (2020) Interim response to the 25 YEP Progress Report Defra (2020); **(b)** Enabling a Natural Capital Approach (ENCA): Guidance for policy and decision makers to help them consider the value of a natural capital approach; **(c)** Tools Summaries. https://www.gov.uk/guidance/enabling-a-natural-capital-approach-enca
[5.2] Letter, Deputy Director, Environment Analysis Unit, Department for Environment, Food and Rural Affairs, 15/04/2019.
[5.3] Publicly cited references of the ORVal and NEVO use in respect of the NCA, e.g. Natural Capital Accounting, to inform strategic decision-making, etc. Compiled Dec 2020.
[5.4] Survey of users of the online tools ORVal and NEVO, Apr 2020.
[5.5] **(a)** Interview transcript, 23/10/2019; Email correspondence 25/01/2021 UST Environmental Programme Manager, SWW - CONFIDENTIAL, available on request; **(b)** Letter, Managing Director, SWW 31/01/19.
[5.6] Letter of testimony, Associate Director of Environmental Economics, AECOM 14/01/21, referring to contribution in 2017/2018.
[5.7] (a) SWEEP Mid-Term Evaluation Report to NERC (Apr 2020); (b) Dragon Capital Group, May 2020, 'Dragon Capital supports new Chair in Biodiversity Economics at University of Exeter', https://www.dragoncapital.com/news/dragon-capital-supports-new-chair-in-biodiversity-economics-at-university-of-exeter/
[5.8] Interview transcript, Head of Environmental Quality, Anglian Water, 28/09/2020.
[5.9] Interview transcript, Production Manager EnTrade (a Wessex Water business) 17/09/2020.
[5.10] Interview transcript 17/09/20; email correspondence 27-28/01/20, Head of Economics, Scottish Forestry Commission.