Institution: University of Exeter		
Unit of Assessment: UoA 16 Economics and Econometrics		
Title of case study: Shaping UK environment and agriculture policy and embedding environmental valuation within H.M. Treasury guidance.		
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:**
Ian Bateman	Professor of Environmental Economics, OBE, FBA	Sep 2015 – present
Brett Day	Professor of Environmental Economics	Sep 2015 – present
Amy Binner	Senior Lecturer	Sep 2015 – 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: 1st Sep 2015 to 31st Jul 2020		
Is this case study continued from a case study submitted in 2014? N		

1. Summary of the impact

Research by University of Exeter's Land, Environment, Economics & Policy (LEEP) Institute:

i. **Led to profound shifts in UK environmental and agricultural policy** by informing the creation of **HM Government's 25 Year Environment Plan**, subsequent **Environment Bill**, and underpinning adoption of the transformative principle of 'public money for public goods' within the 2020 **Agriculture Act.**

ii. **Enabled the design of UK agricultural policy implementation post-Brexit** by providing core evidence to restructure **GBP2.4 billion** of annual agriculture support payments, under the new Environmental Land Management Scheme (ELMS), regarded as "*the biggest change in agricultural policy in half a century*" **[5.4]**.

iii. **Embedded environmental value requirements into H.M. Treasury public spending guidelines, '**the Green Book', through new sections written in the 2018 revision. All government spending now has to conform to these guidelines, affecting **GPB127 billion** of public sector investments (to Dec 2020), since the 2018 Green Book revision was published **[5.7]**.

2. Underpinning research

The LEEP Institute is a global leader in environmental economic research. A key concern of this discipline is the methodological development and application of techniques to reveal the role of natural resources as valuable capital stocks, from which an array of services flow into the economy delivering benefits to society. For example, in the context of land use, natural resources underpin the production of a range of marketed goods, such as food and timber, but also deliver a vast and valuable array of non-market 'public goods', including water quality, flood mitigation, biodiversity, greenspace to engage with nature, clean air and of course contributions towards addressing climate change. As these 'public goods' are not provided through markets, their value to society can be overlooked in private decision-making such that their sustainable provision is dependent upon government policy.

LEEP has a considerable track record of methodological contributions to the development of novel techniques for assessing the economic value of non-market public goods, particularly those associated with land use change (for example Day, Bateman, Binner and Fezzi **[3.1]**). Extending these contributions through pioneering interdisciplinary research combining integrated environment-economy modelling and mechanism design, the LEEP Institute has addressed an array of critical policy questions, many of which relate to land use: what principles should govern

land use policies? Where should land use changes be targeted? How should interventions be designed to deliver those desired land use changes?

Within the context of post-Brexit agricultural subsidies, Bateman and Balmford **[3.2]** provide an influential exposition of the transformative principle of 'public money for public goods' within UK land use policy to bring about long-term environmental improvements and greater value-for-money for the public. It recommends adoption of this principle through the allocation of payments to farmers via a range of mechanisms, such as systems of competitive bidding, to incentivise the efficient production of public goods. Bateman and Balmford **[3.2]** also proposed a tapered reduction in those conventional per hectare subsidies which are not linked to public goods.

Building on LEEP's track record of environmental-economic research, the complexity of designing new policies impacting on land use was explored through Day and team's development of the ground-breaking **Natural Environment Valuation (NEV) model** (2017-2020) with an award of **GBP685,000** from the UK government's Department of Food, Environment and Rural Affairs (Defra). The NEV model is a uniquely-comprehensive, integrated environment-economy modelling suite, working at a fine spatial resolution across the UK **[3.3]**. It couples representations of agricultural and forestry systems with natural system models to evaluate service flows emanating from (amongst others) food production, flood mitigation, carbon sequestration, water quality, biodiversity and outdoor recreation opportunities.

Recognising that land use decisions in the UK are made by a myriad of private landowners, policy design must be cognisant of the manner in which different policy measures reshape those actors' incentives. Addressing that issue, Day and team used NEV to explore the use of mathematical programming techniques to identify optimal pricing strategies for policies offering incentive payments to land owners to effect land use change **[3.3]**.

Bateman, Binner, Day and Fezzi provide an example of the NEV model exploring the trade-offs between food production, water quality and other ecosystem services under predicted climate change scenarios **[3.4]**. This theme is further developed in **[3.5]** which explores the complex interconnection of climate and agricultural systems revealing the dramatic consequences for food production associated with non-linear climate 'tipping points'.

Day and team augmented the NEV model with an agent-based simulator of landowner bidding strategies in reverse auctions for land use change contracts **[3.6]**. With those extensions, NEV became uniquely capable of providing evidence to government to support the design of post-Brexit agri-environment policy; which LEEP was tasked to do by Defra in late 2018.

3. References to the research

[3.1] **Day, B.H., Bateman, I.J., Binner, A.R.,** Ferrini, S., **and Fezzi, C.** (2019) Structurally-consistent estimation of use and non-values for landscape-wide environmental change. *Journal of Environmental Economics and Management*, 98: 102256 https://doi.org/10.1016/j.jeem.2019.102256

[3.2] **Bateman, I.J.** and Balmford, B. (2018) Public funding for public goods: A post-Brexit perspective on principles for agricultural policy, *Land Use Policy*, 79: 293-300, https://doi.org/10.1016/j.landusepol.2018.08.022

[3.3] **Day, B., Owen, N.**, **Binner, A., Bateman, I**., Cho, F., De-Gol, A., Ferguson-Gow, H., Ferrini, S., **Fezzi, C.**, Harwood, A., **Lee, C.**, Luizzio, L., **Mancini, M.**, Pearson, R., (2020) The NEV Modelling Suite: A Summary Technical Report. Prepared for Defra. PDF available on request - CONFIDENTIAL.

[3.4] **Bateman, I.J.**, Agarwala, M., **Binner, A.**, Coombes, E., **Day, B.,** 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] Ritchie, P.D., **Smith, G.**, Davis, K.J., **Fezzi, C.**, Halleck-Vega, S., Harper, A., Boulton, C.A., **Binner, A.R.**, **Day, B.H.,** Gallego-Sala, A., Mecking, J.V., Sitch, S., Lenton, T.M.

and **Bateman, I.J.** (2020) Shifts in national land use and food production in Great Britain after a climate tipping point, *Nature Food*, 1:76–83, https://doi.org/10.1038/s43016-019-0011-3

[3.6] **Day, B., Lee, C., Binner, A.,** Cho, F., **Mancini, M., Owen, N.**, and **Smith, G.,** (2020). The Natural Environmental Valuation (NEV) modelling suite Auction Simulator: Technical Report. Report to Defra. PDF available on request - CONFIDENTIAL.

4. Details of the impact

Led to profound shifts in UK environmental and agricultural policy

From 2015 to 2020, LEEP research directly shaped the transformation of the UK Government's approach to environmental and agricultural policy. Through influencing policy principles, developing the content of core policy materials and delivering policy-critical evidence, LEEP has helped guide a profound shift in the policy landscape towards reversing environmental decline, tackling climate change and bringing enduring benefits to society.

Through his eminent position on the Government's independent Natural Capital Committee (NCC), reporting to H.M. Treasury and advising Defra, Bateman advised government (2015-2020; **[5.1]**) on the valuation and efficient allocation of environmental resources **[3.1, 3.2, 3.4]**. This advice was delivered through more than twenty official papers to government and Ministers, a series of personal ministerial briefings with the Secretary of State for the Environment and through reports to the Chancellor of the Exchequer.

Through these routes, LEEP research findings and advice were directly incorporated into the seminal **25 Year Environment Plan (25YEP; [5.2])**, initially proposed by Bateman and NCC colleagues in 2016. Widely regarded as pioneering, the **25YEP** laid out a long-term plan for improving the environment based on natural capital principles and, as such, became "*the cornerstone of environmental improvement*" **[5.1]**.

In writing to thank Bateman for his "*ground-breaking*" **[5.1]** work with other NCC members proposing the 25YEP, the Head of the Defra NCC Secretariat, stated:

> *"Professor Bateman led the work on land use and agriculture in the initial (25YEP) proposal.* (His) *advice was therefore pivotal in both proposing and shaping the 25 YEP".* **[5.1]**

In 2017, the Secretary of State for the Environment accepted the 25YEP proposal and formally requested advice from the NCC on how to "*enshrine the 25YEP in legislation and ensure it is implemented effectively*" **[5.1]**. Bateman was subsequently lead author of the NCC's influential response, **[5.1]**, the 2017 report 'Advice to Government on the 25YEP' **[5.3]**. Of the 14 policy recommendations set out in this report **[5.3, p.6-7]**, 11 were subsequently adopted by government into the new **Environment Bill [5.1; 5.3]**. This included advice on the requirement for statutory targets for environmental improvement and creation of the Office for Environmental Protection designed to uphold environmental legislation **[5.1]**, as confirmed in the UK government Spending Review 2020.

Guiding "*the biggest change in agricultural policy in half a century*" **[5.4]**, LEEP research and advice additionally laid out the case for replacement of the inefficient allocation of farm support payments under the EU's Common Agricultural Policy (CAP), with a new system based on the principle of 'public money for public goods'. This system was formally adopted into the **new Agriculture Act 2020** and LEEP's impact acknowledged **[5.1]**:

> "*Professor Bateman's advice … directly influenced Defra's post-Brexit agricultural policy. Specifically … research findings as set out in Bateman & Balmford (2018)* **[3.2]***, resulted in the adoption of the concept 'public money for public goods' as the central and transformative principle of the new Agriculture Bill*". **[5.1]**

Enabled the design of UK agricultural policy implementation post-Brexit

[text removed for publication]

Embedded environmental value requirements into H.M. Treasury public spending guidelines

The 2018 revision of the H.M. Treasury 'Central Government Guidance on Appraisal and Evaluation', better known as the **'Green Book'** – the official guidelines used by *all* government departments and agencies to prepare government spending business cases – provides further evidence of the recent paradigm shift in government decision-making around environmental policy and valuation **[5.7]**.

Bateman, in his pivotal role on the NCC, co-authored ground-breaking sections of the revised 2018 **Green Book** guidance **[5.7; 5.8, 3.4]**, namely Chapter 6 "Valuation of Costs and Benefits" and Appendix A2: "Non-market Valuation and Unmonetisable Values". Based on LEEP research and advice, this revision - the first in 15 years **[5.8]** - updated guidance on appraising environmental values in response to the UK's adoption of the 25YEP and introduced the notion of ensuring that natural capital stocks did not fall below crucial tipping points **[3.5]**. These changes elevated the value of ecosystem services to a position of parity with the financial costs and benefits routinely evaluated in project and policy appraisal. Application of Green Book guidance will deliver enduring benefits to society, through the sustainable provision of critical environmental services, such as clean air and water, the fertility of soils, mitigation of floods, climate stability, and the space to connect with nature.

Bateman was subsequently asked by H.M. Treasury **[5.7]** to deliver a unique cross-government event to present methods for applying the new **Green Book** guidance on environmental values. This event (April 2019) was attended by economists from no less than 12 of the 24 ministerial government departments, and 7 further government agencies and public bodies **[5.7]**.

In thanking Bateman for his contributions to the 2018 revised **Green Book**, Head of the Economics Branch, HM Treasury and Editor of the **Green Book**) wrote:

> "*My colleagues and I are very grateful for your invaluable advice and input ...[to] the new Green Book*. … *The resulting guidance is likely to be both enduring and provide a lasting legacy. Your contribution will therefore have a considerable and lasting impact upon the public policy and spending appraisal for many years to come*." **[5.7]**

Since publication in March 2018, the revised **Green Book** has been actively used to appraise Government projects and policies. In 2019, a NCC-commissioned review of the official appraisals of over 200 government spending decisions with significant natural capital effects confirmed that the new **Green Book** guidance had been applied, and so shaped government spending decisions worth many billions of pounds **[5.9]**. An example is provided by the Defra 'Biodiversity net gain and local nature recovery strategies' programme **[5.10]** which aims to deliver benefits to the environment and society through habitat creation and avoided habitat loss. Approved by the Regulatory Policy Committee's Impact Assessment in 2019, it conforms to the guidance in sections of the new **Green Book** guidelines, that were co-authored and based on LEEP research, and delivers a net present value of approximately **GBP 8.2 billion [5.10]**. All government spending now has to conform to these guidelines, affecting **GPB127 billion** of public sector investments (to Dec 2020), since the 2018 Green Book revision was published **[5.7]**.

5. Sources to corroborate the impact

[5.1] Letter from Head of NCC Secretariat, Defra, 25th March 2020.

[5.2] H.M. Government (2018) A Green Future: Our 25 Year Plan to Improve the Environment, https://www.gov.uk/government/publications/25-year-environment-plan LEEP research cited (p.77;134); Bateman/NCC advice (p.16; 24-30; 135; 141)

[5.3] Natural Capital Committee (2017). Advice to Government on the 25 Year Environment Plan. Sep 2017. https://www.gov.uk/government/publications/natural-capital-committee-advice-on-governments-25-year-environment-plan

[5.4] Defra (2020) The Path to Sustainable Farming: An Agricultural Transition Plan 2021 to 2024. Nov 2020. https://www.gov.uk/government/publications/agricultural-transition-plan-2021-to-2024

[5.5] [text removed for publication]

[5.6] **(a)** Letter from Deputy Director of the Environment Analysis Unit, Defra and Economic Advisor, Defra, 1st Dec 2016; [text removed for publication].

[5.7] Letter from Head of the Economics Branch, H.M. Treasury, April 2019

[5.8] H.M. Treasury (2018) The Green Book: Central Government Guidance on Appraisal and Evaluation, H.M. Treasury, London. Sections authored: p.47, 63-64, 67, 115, 118-119.

[5.9] NCC (Mar 2020) The Green Book guidance: embedding natural capital into public policy appraisal, Natural Capital Committee.

[5.10] Regulatory Policy Committee (2019) Biodiversity net gain and local nature recovery strategies, Impact Assessment. RPC-4277(1)-DEFRA-EA, Department for Business, Energy and Industrial Strategy (BEIS).