Quantifying the ecosystem services that underpin health and wellbeing

Research summary from the NERC-BESS programme

Public Health and land Cover in the UK workshop

21st March 2016

Tom Oliver

University of Reading

@Dr_Dolittle_81

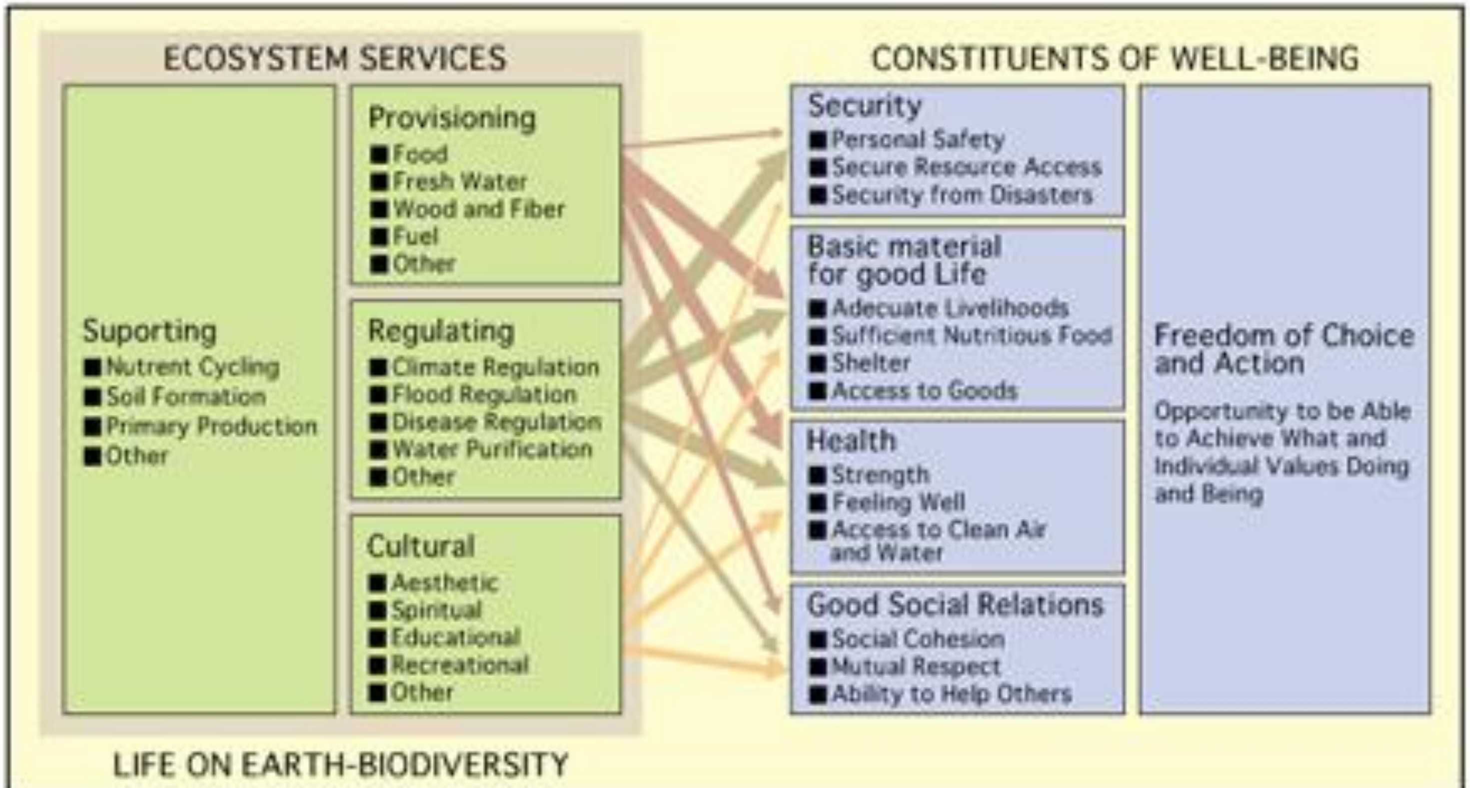
t.oliver@reading.ac.uk

BESS- Biodiversity and ecosystem services

Search for 'BESS NERC'

'Wessex BESS'

Ecosystem services and Health



'Planetary Health'

University of Reading

The Lancet Commissions

The Rockefeller Foundation
THE LANCET

The Rockefeller Foundation–*Lancet* Commission on planetary health

Safeguarding human health in the Anthropocene epoch: report of The Rockefeller Foundation–*Lancet* Commission on planetary health

Sarah Whitmee, Andy Haines, Chris Beyrer, Frederick Boltz, Anthony G Capon, Braulio Ferreira de Souza Dias, Alex Ezeh, Howard Frumkin, Peng Gong, Peter Head, Richard Horton, Georgina M Mace, Robert Marten, Samuel S Myers, Sania Nishtar, Steven A Osofsky, Subhrendu K Pattanayak, Montira J Pongsiri, Cristina Romanelli, Agnes Soucat, Jeanette Vega, Derek Yach

‘Planetary Health’

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Key messages

1 The concept of planetary health is based on the understanding that human health and human civilisation depend on flourishing natural systems and the wise stewardship of those natural systems. However, natural systems are being degraded to an extent unprecedented in human history.

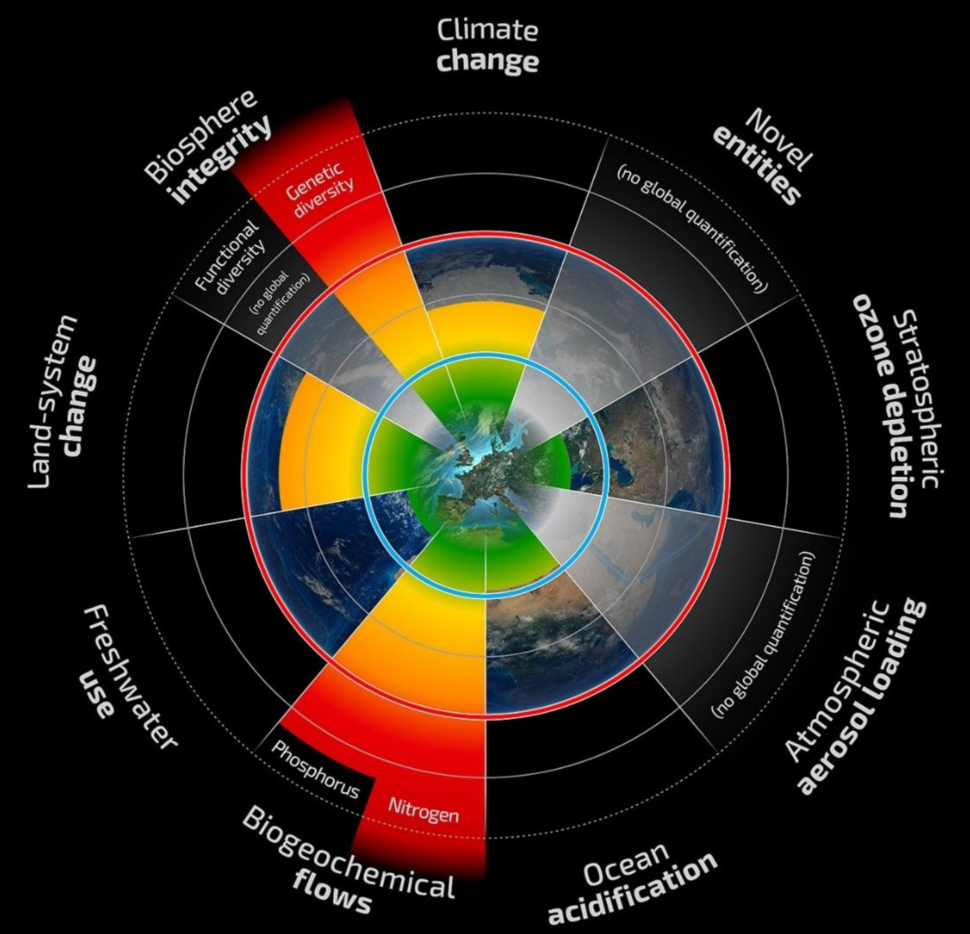
2 Environmental threats to human health and human civilisation will be characterised by surprise and uncertainty. Our societies face clear and potent dangers that require urgent and transformative actions to protect present and future generations.

3 The present systems of governance and organisation of human knowledge are inadequate to address the threats to planetary health. We call for improved governance to aid the integration of social, economic, and environmental policies and for the creation, synthesis, and application of interdisciplinary knowledge to strengthen planetary health.

4 Solutions lie within reach and should be based on the redefinition of prosperity to focus on the enhancement of quality of life and delivery of improved health for all, together with respect for the integrity of natural systems. This endeavour will necessitate that societies address the drivers of environmental change by promoting sustainable and equitable patterns of consumption, reducing population growth, and harnessing the power of technology for change.

Planetary Boundaries

A safe operating space for humanity



- **Beyond zone of uncertainty** (high risk)
- **In zone of uncertainty** (increasing risk)
- **Below boundary** (safe)
- **Boundary not yet quantified**

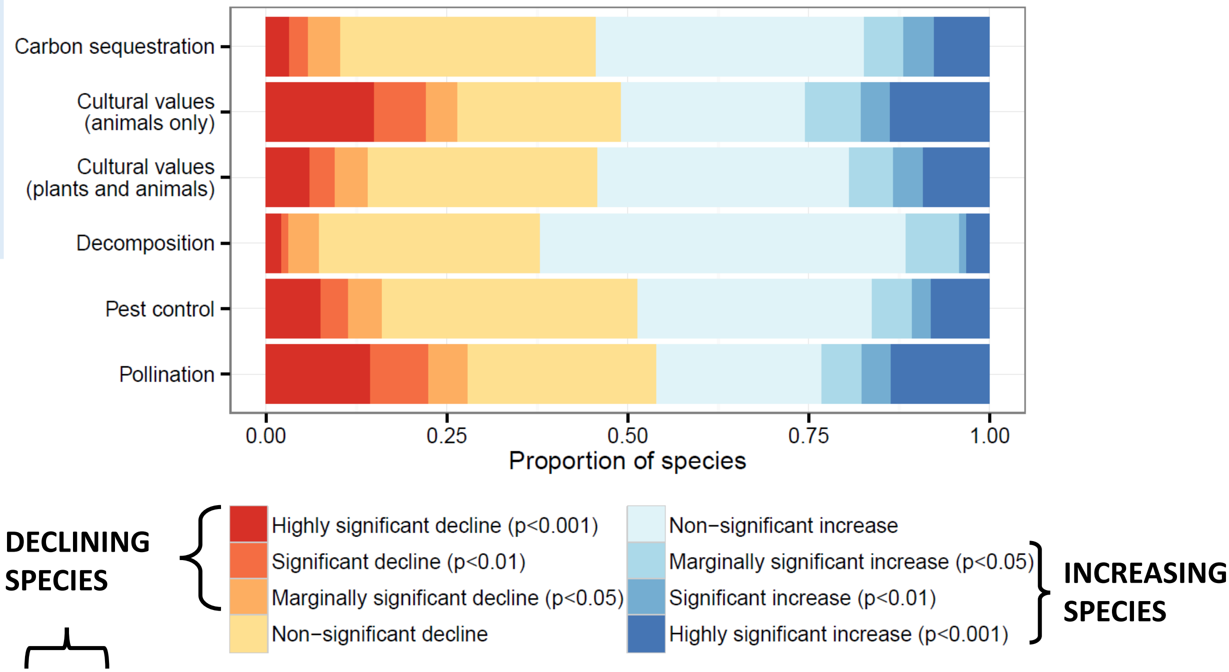
Rockstrom et al. 2006 Nature
Steffen et al. 2015 Science

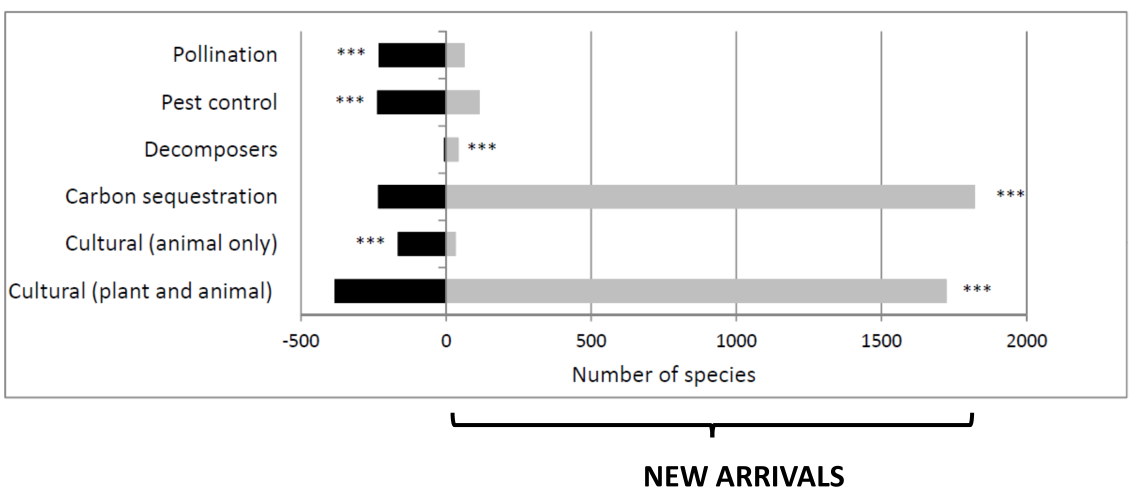
Trends in UK Biodiversity

Analysis of species trends in Great Britain from 1970-2009

4400 species across 22 taxonomic groups

- Ants
- Bees
- Birds
- Butterflies
- Carabid beetles
- Centipedes
- Cerambycid beetles
- Craneflies
- Dragonflies and damselflies
- Crickets and earwigs
- Harvestmen
- Hoverflies
- Isopods
- Ladybird beetles
- Mammals
- Millipedes
- Mosses and liverworts
- Moths
- Soldier beetles
- Spiders
- Vascular plants
- Wasps

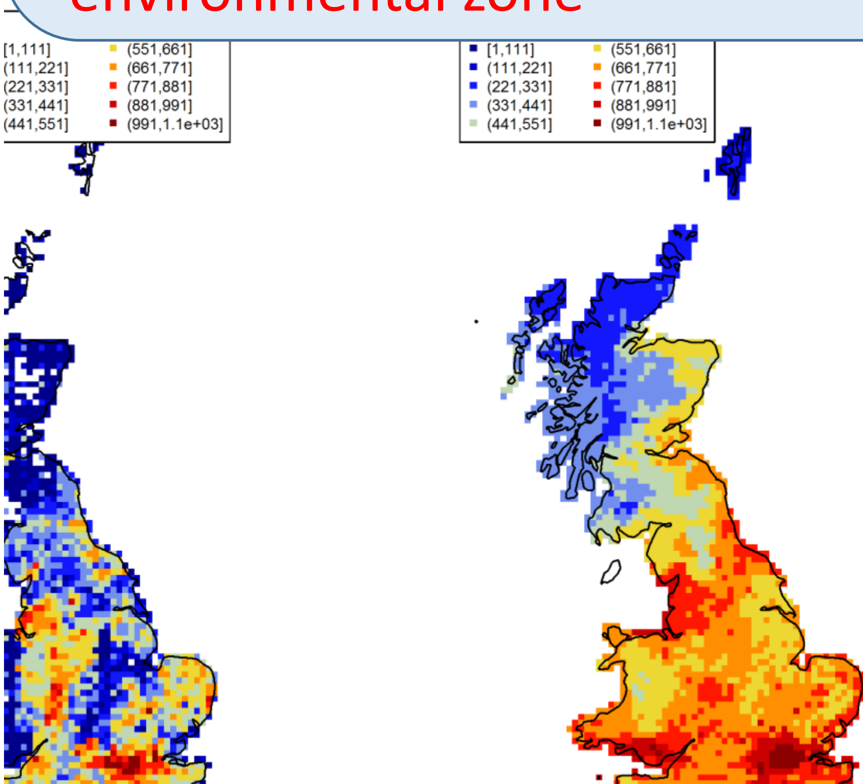




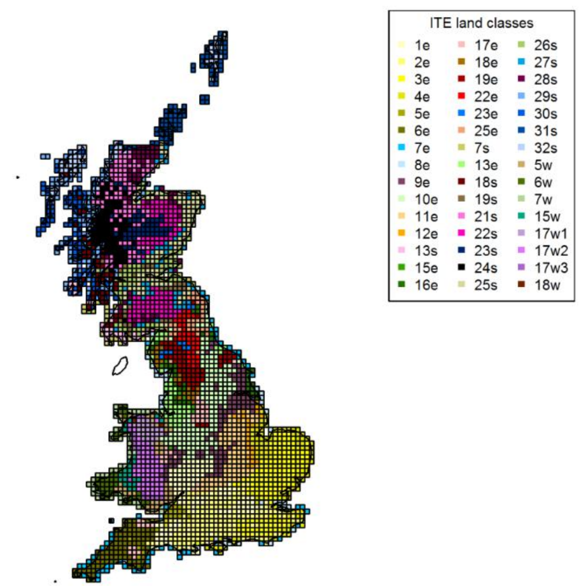
Oliver et al. 2016 *Nature Communications*

Biodiversity mapping

- Species richness assessed accounting for recorder effort using FRESCALO (Hill 2012)
- Across 12 taxonomic groups from 1970-1990 and 2000-2013
- Species richness scores are then standardised within each environmental zone

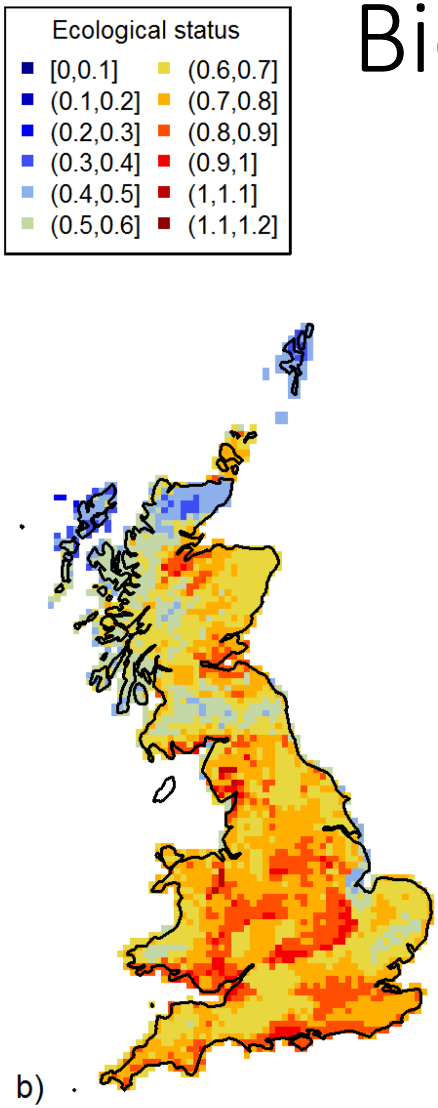


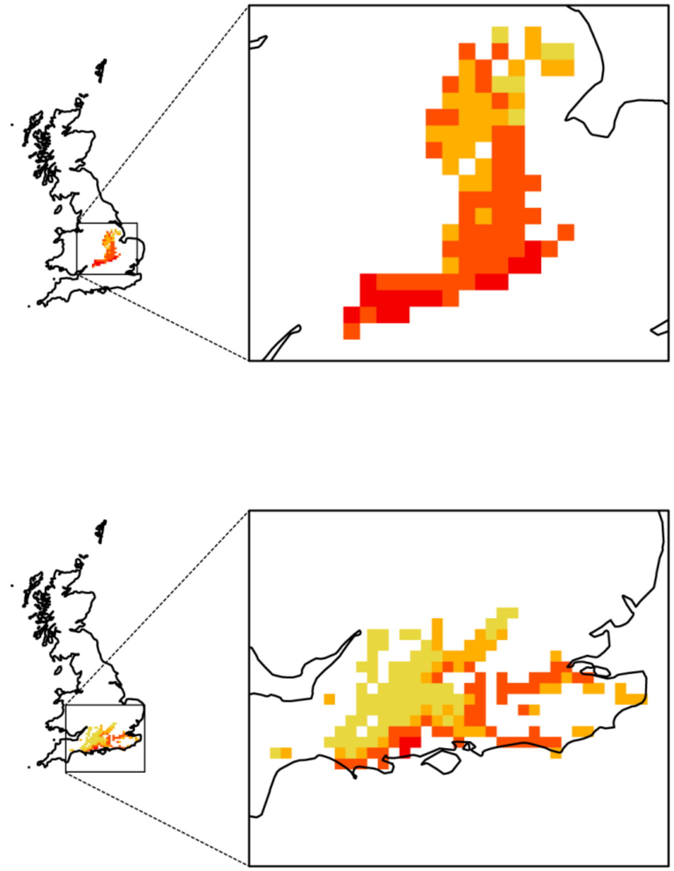
Plant species richness a) uncorrected and b) FRESCALO- corrected



UK Environmental zones based on abiotic conditions (Bunce *et al.* 2007)

Biodiversity mapping





Aggregate ecological status (species richness expressed relative to maximum for each environmental zone) across 12 taxonomic groups from 2000-2013

Dyer et al. in revision

Trends in Ecology & Evolution

Review

Biodiversity and Resilience of Ecosystem Functions

Tom H. Oliver,[1,2,*] Matthew S. Heard,[2] Nick J.B. Isaac,[2] David B. Roy,[2] Deborah Procter,[3] Felix Eigenbrod,[4] Rob Freckleton,[5] Andy Hector,[6] C. David L. Orme,[7] Owen L. Petchey,[8] Vânia Proença,[9] David Raffaelli,[10] K. Blake Suttle,[11] Georgina M. Mace,[12] Berta Martín-López,[13,14] Ben A. Woodcock,[2] and James M. Bullock[2]

Letter

A Synthesis is Emerging between Biodiversity–Ecosystem Function and Ecological Resilience Research: Reply to Mori

Tom H. Oliver,[1,2,*] Matthew S. Heard,[2] Nick J.B. Isaac,[2] David B. Roy,[2] Deborah Procter,[3] Felix Eigenbrod,[4] Rob Freckleton,[5] Andy Hector,[6] C. David L. Orme,[7] Owen L. Petchey,[8] Vânia Proença,[9] David Raffaelli,[10] K. Blake Suttle,[11]

Spatial ecosystem service modelling

Considerations in picking an *ecosystem service modelling framework:*

- Number of services modelled
- Collaboration with NGO community
- Academic rather than corporate
- Open source software
- Robust process-based modelling

Model type	Examples	Best suited for....
Benefits transfer	*EcoServ* *Co$ting Nature*	Carbon Timber
Statistical correlative	*EcoMaps*	......
Process-based	*InVEST* *ARIES* *LUCI* *Specialist models (e.g. Grid-to-grid)*	Pollination Water quality Recreation

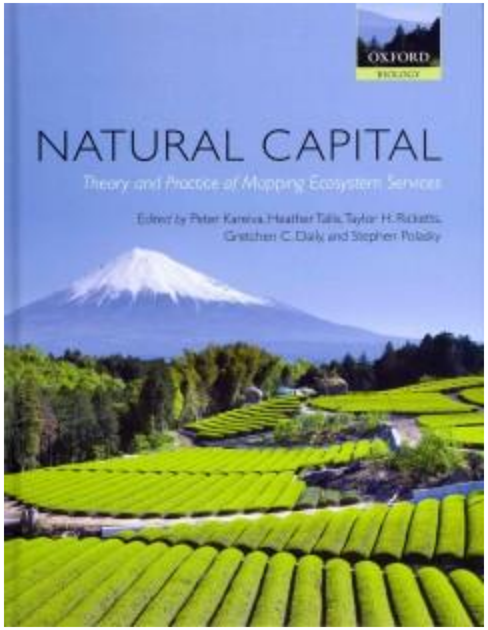
Spatial ecosystem service modelling

InVEST
integrated valuation of environmental services and tradeoffs

Developed by Natural Capital Project, Stanford University, http://www.naturalcapitalproject.org/InVEST.html

-A GIS framework (now running standalone based on Python scripts) which allows integrated modelling of ecosystem services

-Tier 1, 2 & 3 models with increasing complexity and data demands

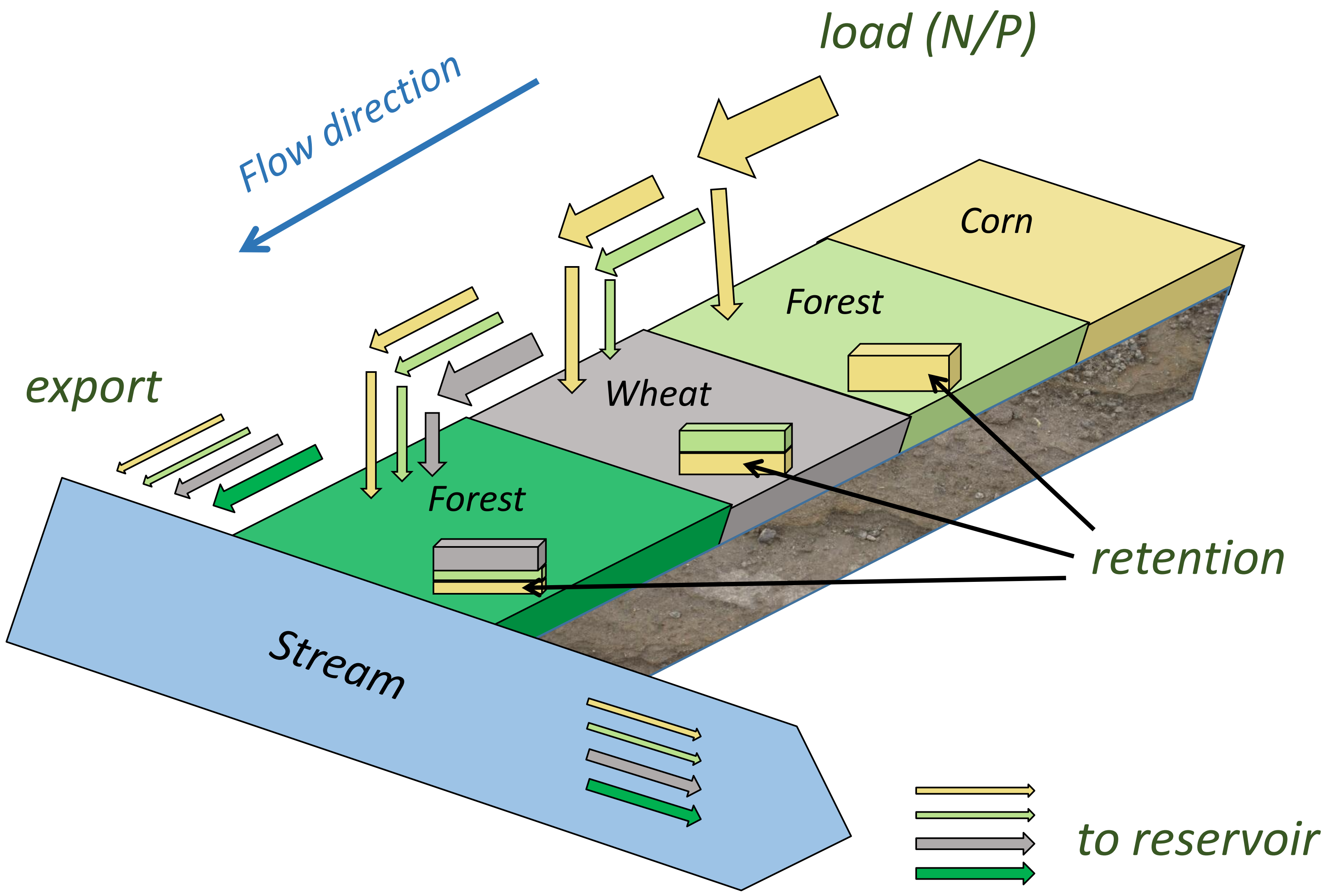


InVEST

integrated valuation of environmental services and tradeoffs

Training Course, CEH Wallingford, 14th-18th Oct 2013

Hydraulic Connectivity



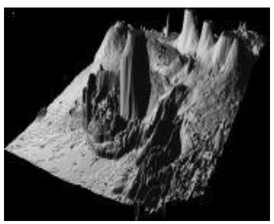
Model Inputs

Climate

Precipitation, Potential evapotranspiration, Zhang

Soils

Soil depth,
Available water content



Topography

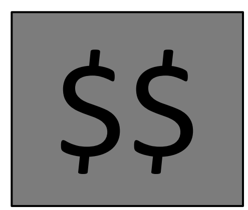
Digital elevation model

Watersheds

Catchments flowing into points of interest

Land use/Land cover

Export coefficients, retention capacity, root depth, etk



Economic

Critical loading, treatment cost, time, discount rate

Model Outputs

Nutrient Exported

Kg/year

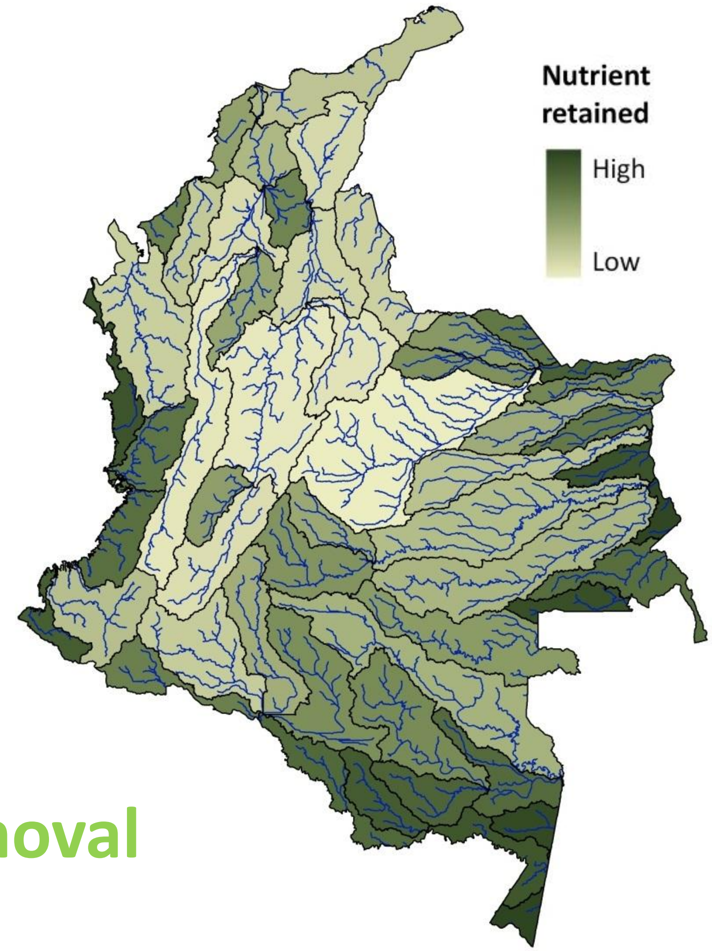
Nutrient Retained

Kg/year

Used in valuation

Value of Nutrient Removal for Water Quality

Currency over time period



Water yield - Test Catchments

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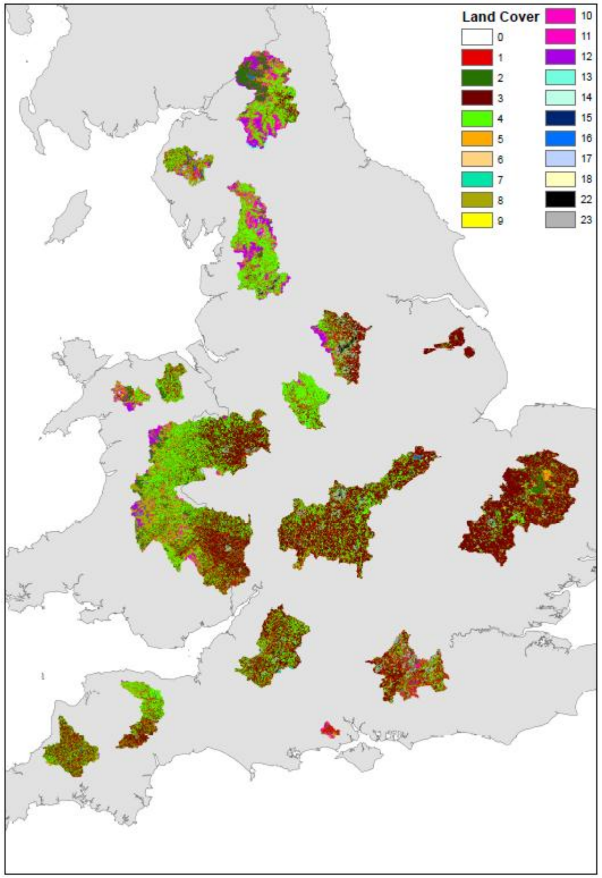
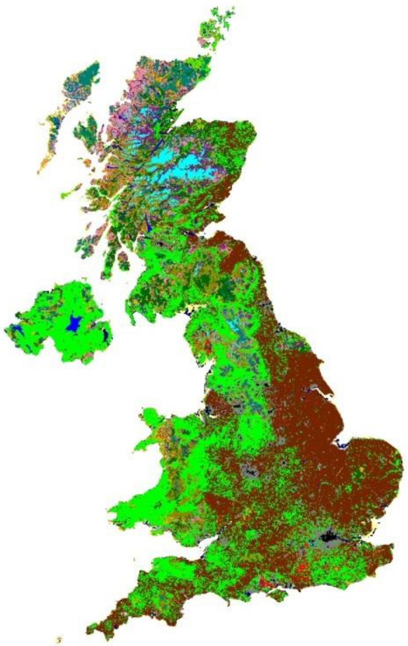
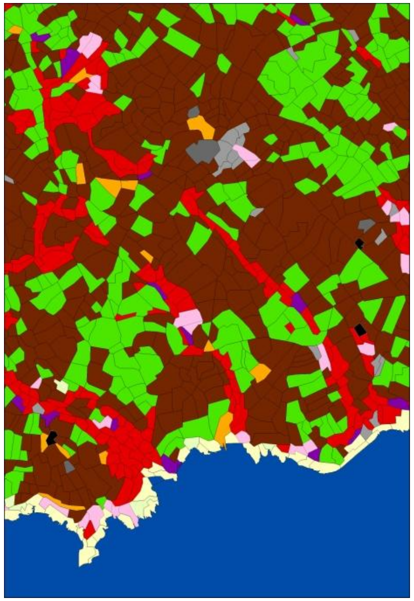
- 20 test catchments with varied landcover, geology and population size



Model Inputs – Land cover

- CEH Land Cover Map 2007

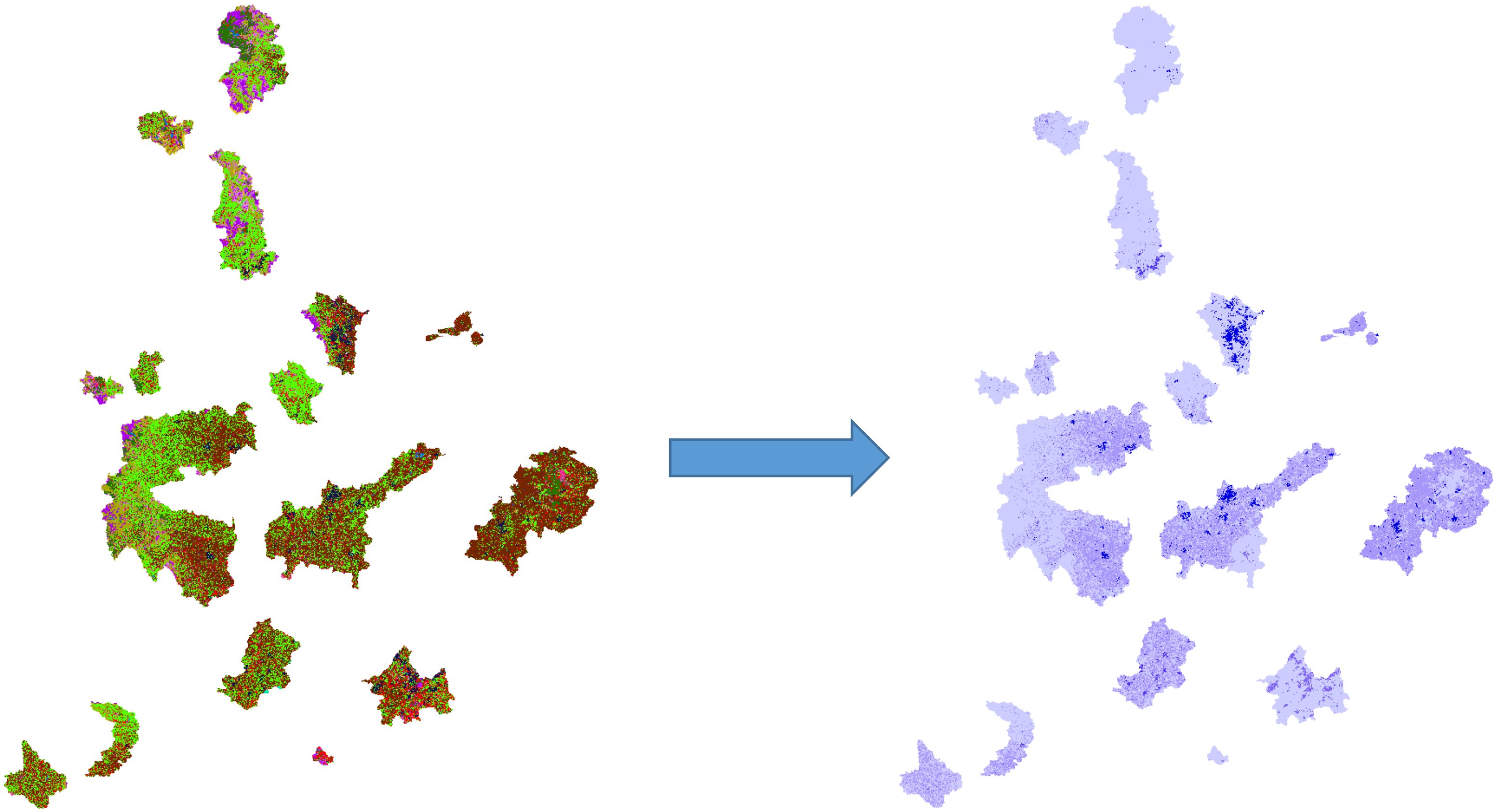




- Literature search to obtain evapotranspiration coefficients for LCM2007 classes

Model Inputs - Abstraction

- Used published regional abstraction statistics to calculate a value per hectare of land use

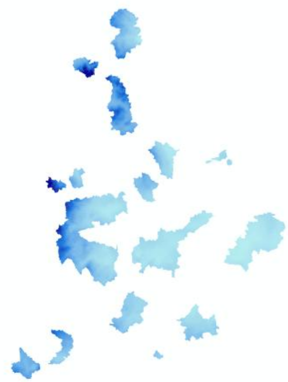


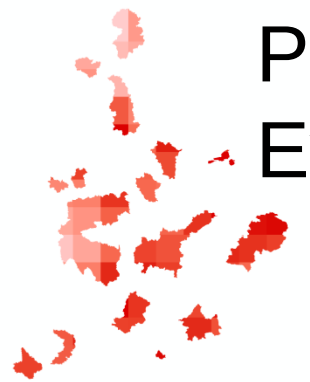
Model Inputs – hydrology/soils

University of Reading

- Hydrological/Meteorological parameters from CEH models

Precipitation

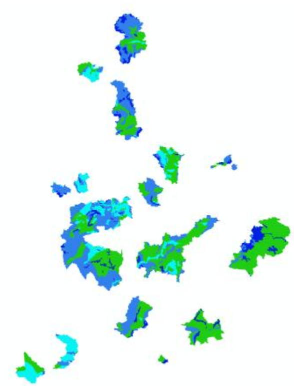




Potential Evapotranspiration

- Soil characteristics from European Soils Database

Root Depth



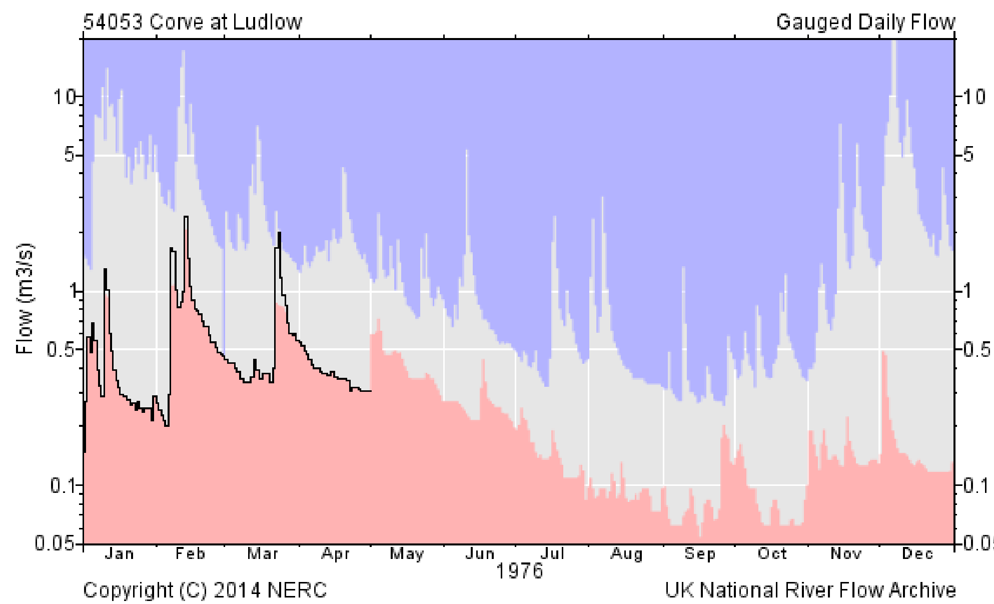
Plant Available Water Contetnt

Validation data

University of Reading

- Compared modelled water yield to monitored river flow from the National River Flow Archive

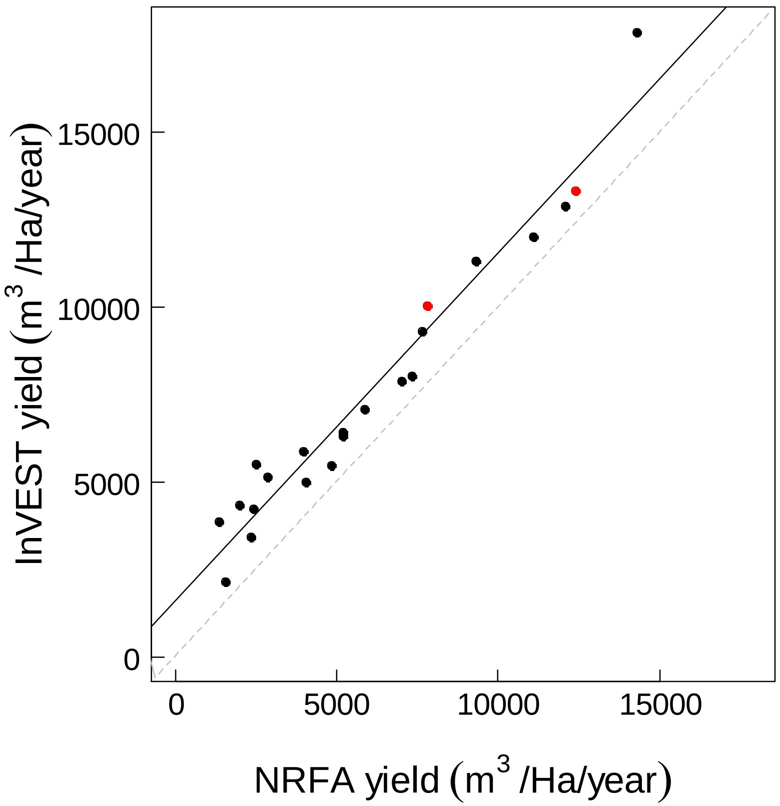
- Used mean flow for same 10 years as model inputs (2000-2010)



Water Yield– Validation results

InVEST overestimates water yield per hectare, but by a consistent amount....

R^2 = 0.95, a = 1470, b = 1.01

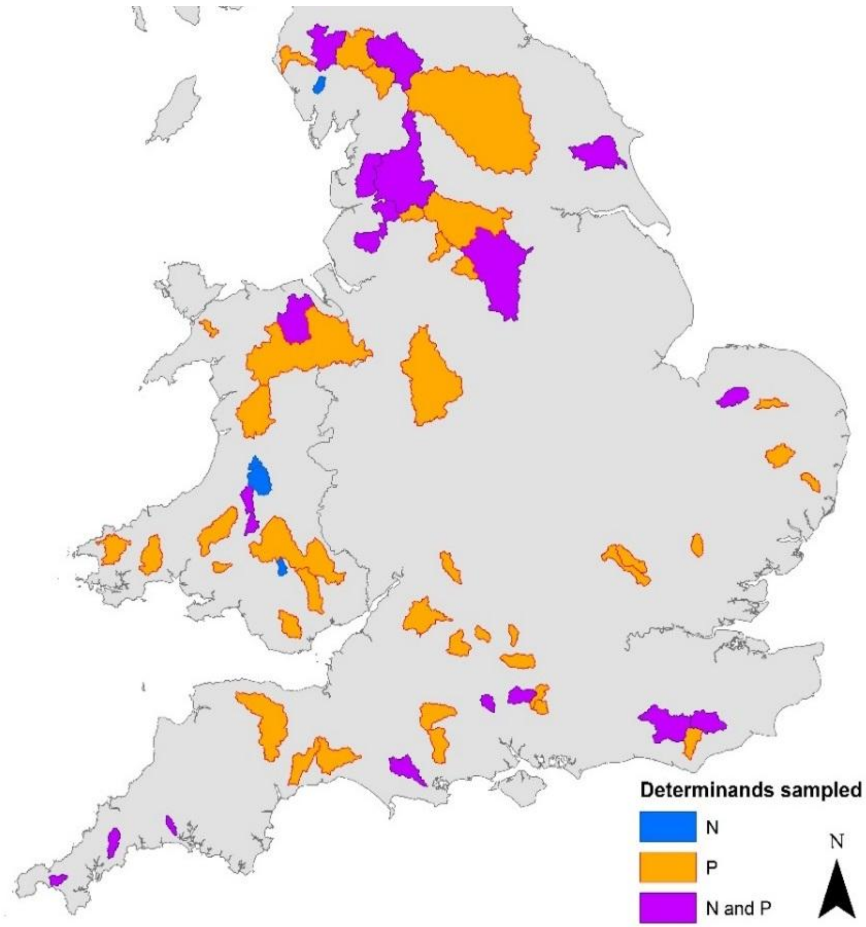


NB. Scottish catchments in **red**

Redhead et al. in prep

Water Quality - Test Catchments

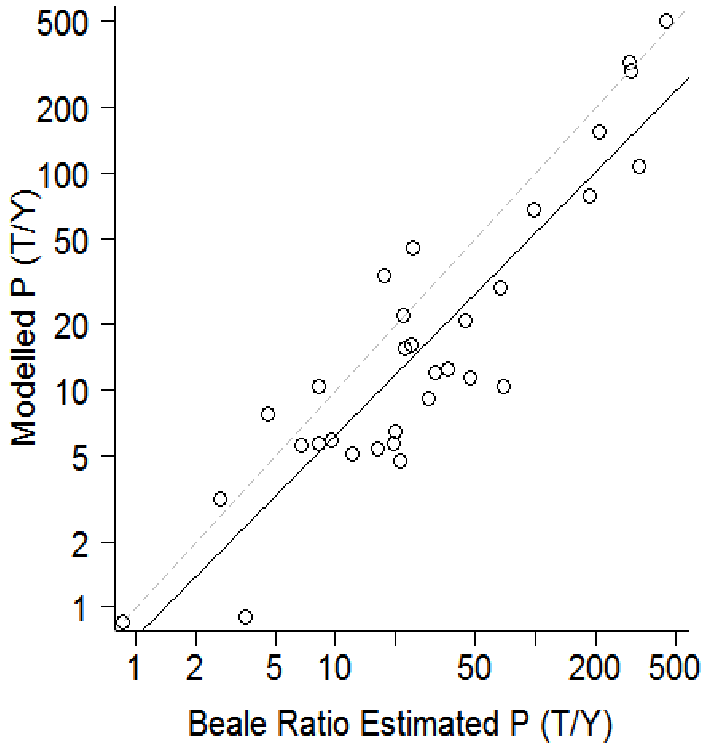
Catchments determined by presence of validation data (co-located measurements of N/P and water flow)



Model Inputs

- As for water yield, plus N/P load and retention coefficients for each land cover class obtained by literature searches
- Adjusted by estimated point source load

Water Quality– Validation results

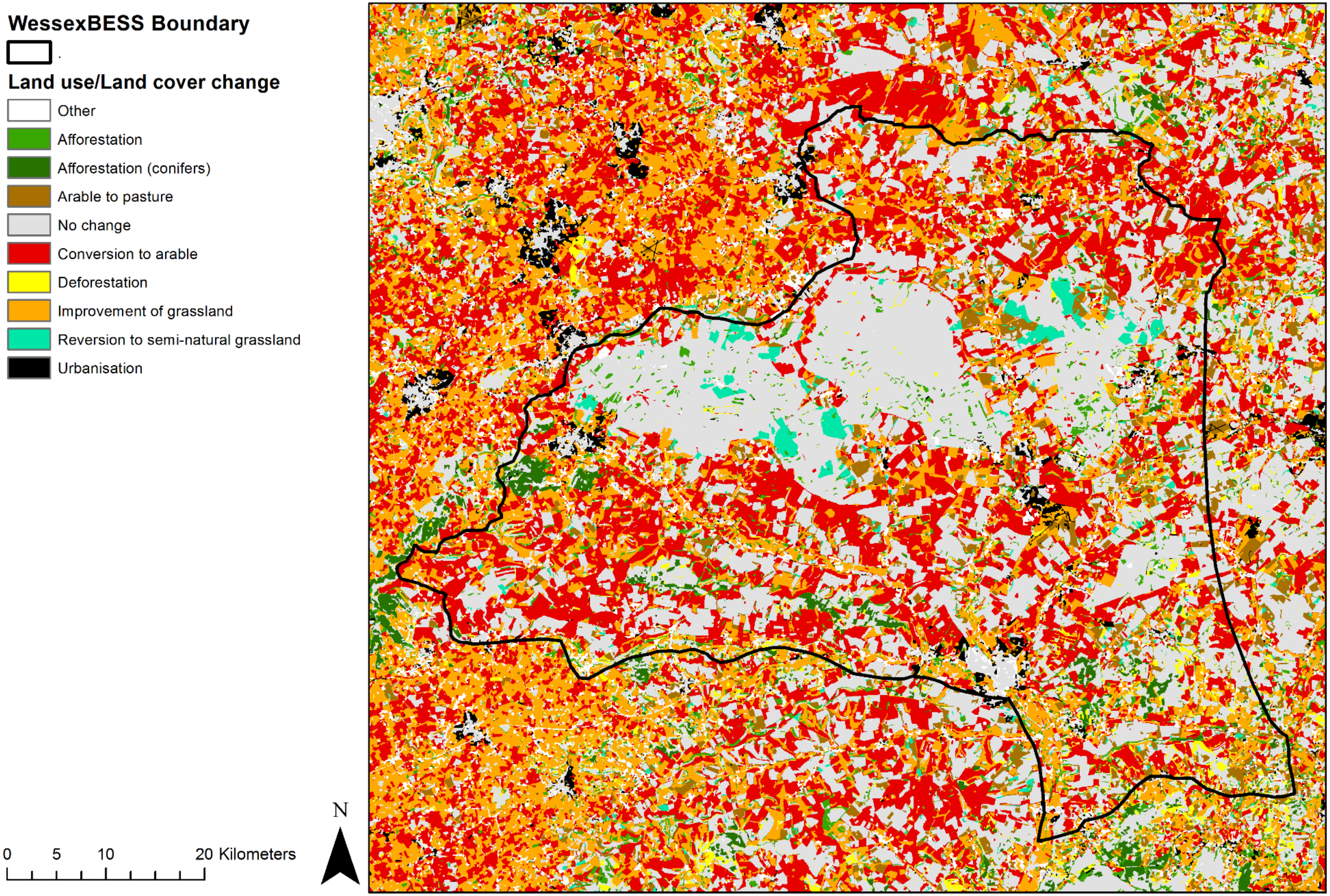


- Good fit to validation data once adjusted by point sources ($R^2 > 0.66$)
- Performs better than point sources alone or crude estimation by area

Redhead et al. in prep

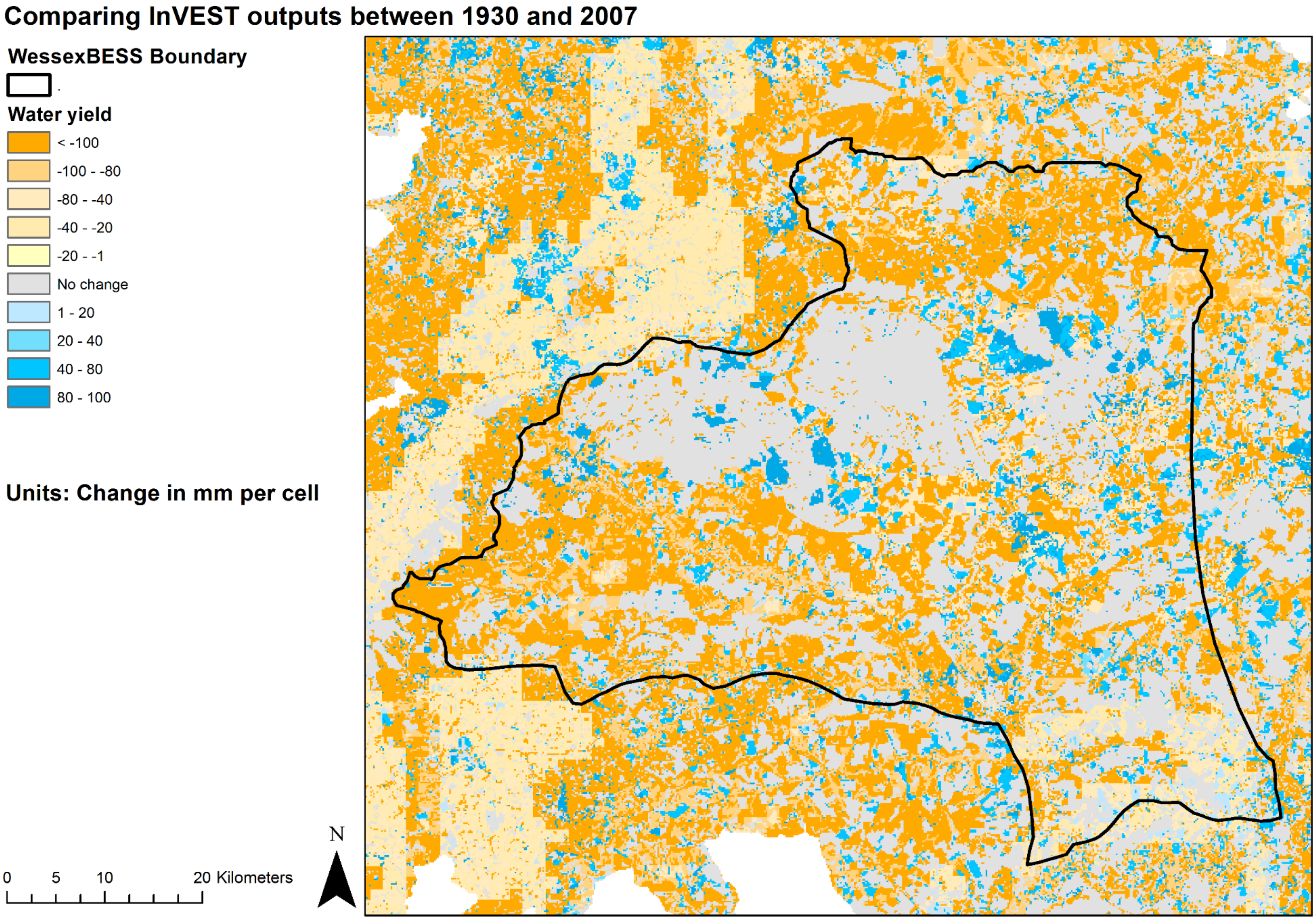
Land cover change 1930 - 2007

Comparing InVEST outputs between 1930 and 2007



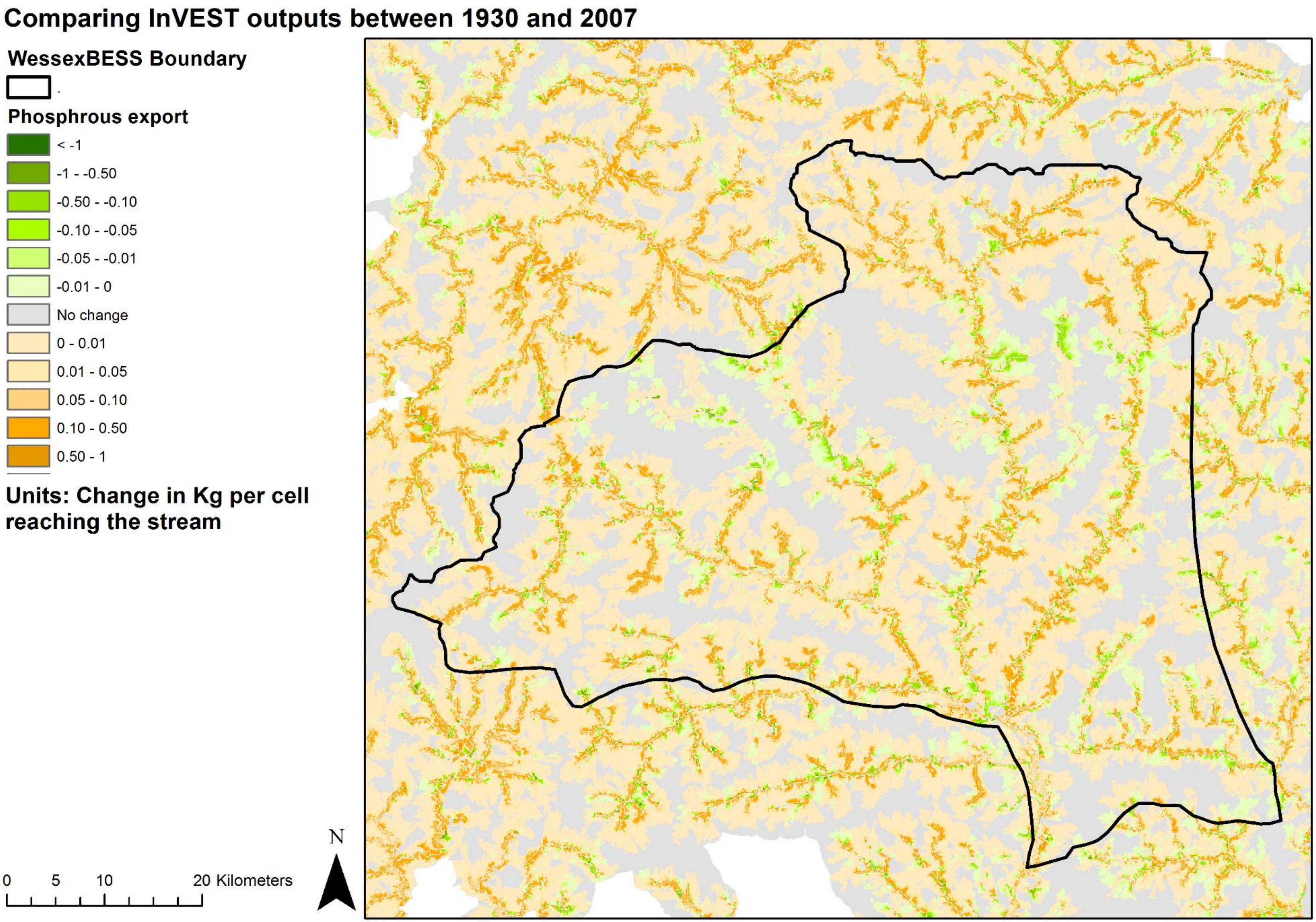
Water yield change 1930 - 2007

University of Reading

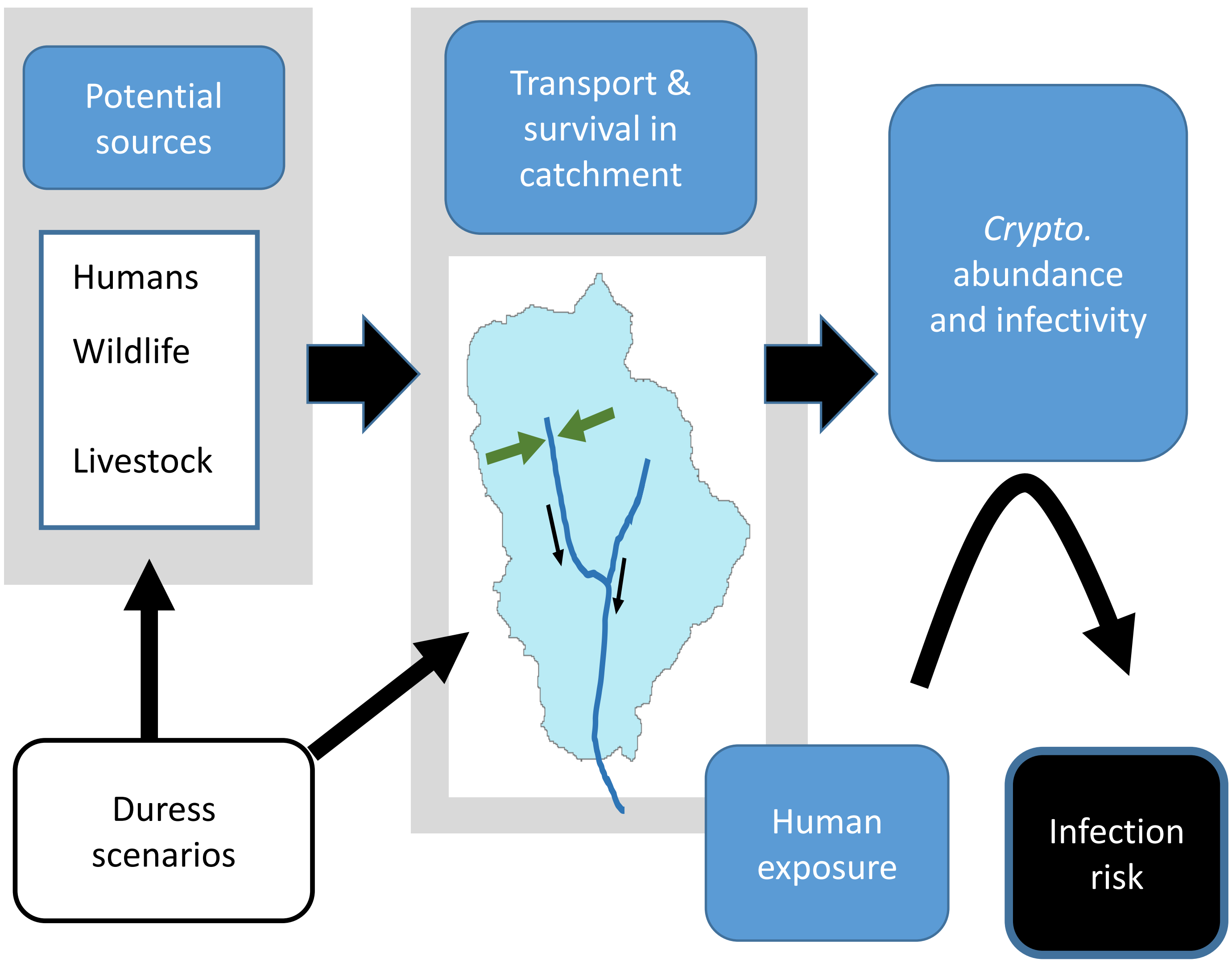


NB. “Blocky” areas due to lower resolution of PAWC and rooting depth data

Phosphorous export change 1930-2007



Spatial models of disease risk



Cryptosporidium catchment model

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Cultural ecosystem services

Wessex-BESS

Biodiversity and ecosystem services in current and future multifunctional landscapes

Home | Project team | Background | Wessex Landscape | Research Details | Project Overview | Links | Stakeholders | Opportunities | NEWS | Contact Us

Climate Regulation | Water-related Services | Crop Production | Cultural Services | Integrated ES modelling | NERC Tansley Working Group

Cultural Services

Biodiversity-supported cultural ecosystem services

This work package is led by Anil Graves at Cranfield University and explores biodiversity, cultural services, and well-being across agricultural landscapes, considering the intensive-restoring-ancient grassland gradient, species richness of key groups and charismatic species (e.g. skylarks). Particular focus will be on landscape, nature conservation, recreation, heritage and sense of place and belonging.

The work package addresses the following hypotheses:

H1. Species richness and abundance is positively associated with BSCS.
H2. Relative values for BSCS vary between residents and non residents.
H3. People place greater value on biodiversity that supports multifunctional landscapes and there is convergence of values for cultural services amongst the users and providers of BSCS.
H4. Certain species and landscape configurations correlate with increased BSCS and may be cultural service indicators.

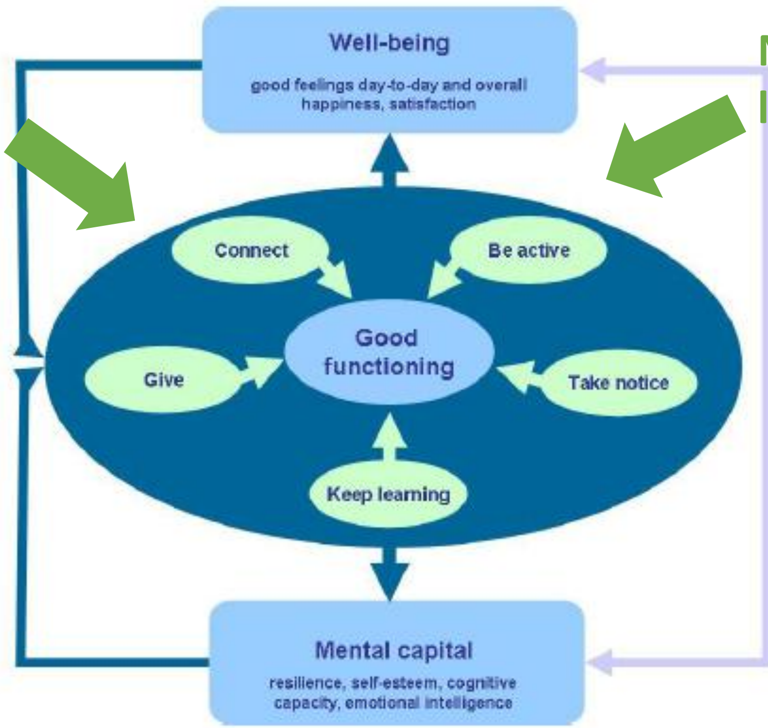
Cultural ecosystem services

University of Reading

Cultural Ecosystem Services	Description
Recreation and tourism	Presence of area for recreational activities and development and enjoyability for tourism. According to Natural England (2009) they are places where there is a lot to do; related to areas with easy access and eqquiped by rocks, pathways, roads, lakes… (1) Some of the benefits lended by these services are physical exercise, aesthetic experiences, intellectual stimulation and inspiration (2).
Aesthetic appreciation	"Appreciation of natural scenery" (3) such as the beauty of wildlife, vegetative land cover, species, urban design and structural diversity. They provide, among other needs,tranquility, creativity and freedom.
Spiritual and religious values	Presence of landscape features with stated spiritual or religious value (3). Some of the links between spiritual places and human needs stem from holistic milieus, such as Glastonbury. Human needs such as participation, identity, protection, among others, are greatly enhanced by these values (1). Further exploring about the issue are needed to understand the links between the sacred, society and nature (2).
Cultural identity	Heritage settings. Presence of landscape features providing information about the history of the place, sharing experience across generations and strengthening the relationships between actual people and their ancestral. Through the different cultures and therefore different heritage, landscapes features contribute to the human worth for "identity" and "sense of place" bestowing human needs such as protection, affection, freedom… (1)
Educational values	Landscape features providing educational interest that contribute to the expansion of knowledge. Environmental settings providing and enhancing outdoor learning and knowledge about nature, respectively (1) (3).
Inspirational services	Presence of landscape features that contribute to the development of people creativity, personal growth and self-awareness. Natural systems are the source of inspiration for a big array of artistic expressions such as books, painting, photography… Therefore inspirational services are an important hallmark of our connections to nature (4).

(1) UKNEA (2011) 'Chapter 16. Cultural Services. ', in NEA, U. UK National Ecosystem Assessment. Technical Report., Cambridge: UNEP-WCMC.
(2) PNAS (2012) 'Contributions of cultural services to the ecosystem services agenda.', Proceedings of the National Academy of Sciences, vol. 109, no. 23, June, pp. 8812-8819.
(3) de Groot, R.S., Alkemade, R., Braat, L., Hein, L. and Willemen, L. (2010) 'Challenges in integrating the concept of ecosystem services and values in landscape planning, management and decision making.', Ecological Complexity, vol. 7, October, pp. 260-272.
(4) MA (2005) 'Chapter 17. Cultural and Amenity Services. Volume 1. Current State and Trends.', in MA Ecosystems and Human Well-Being., Washington: Island Press.

Mental health



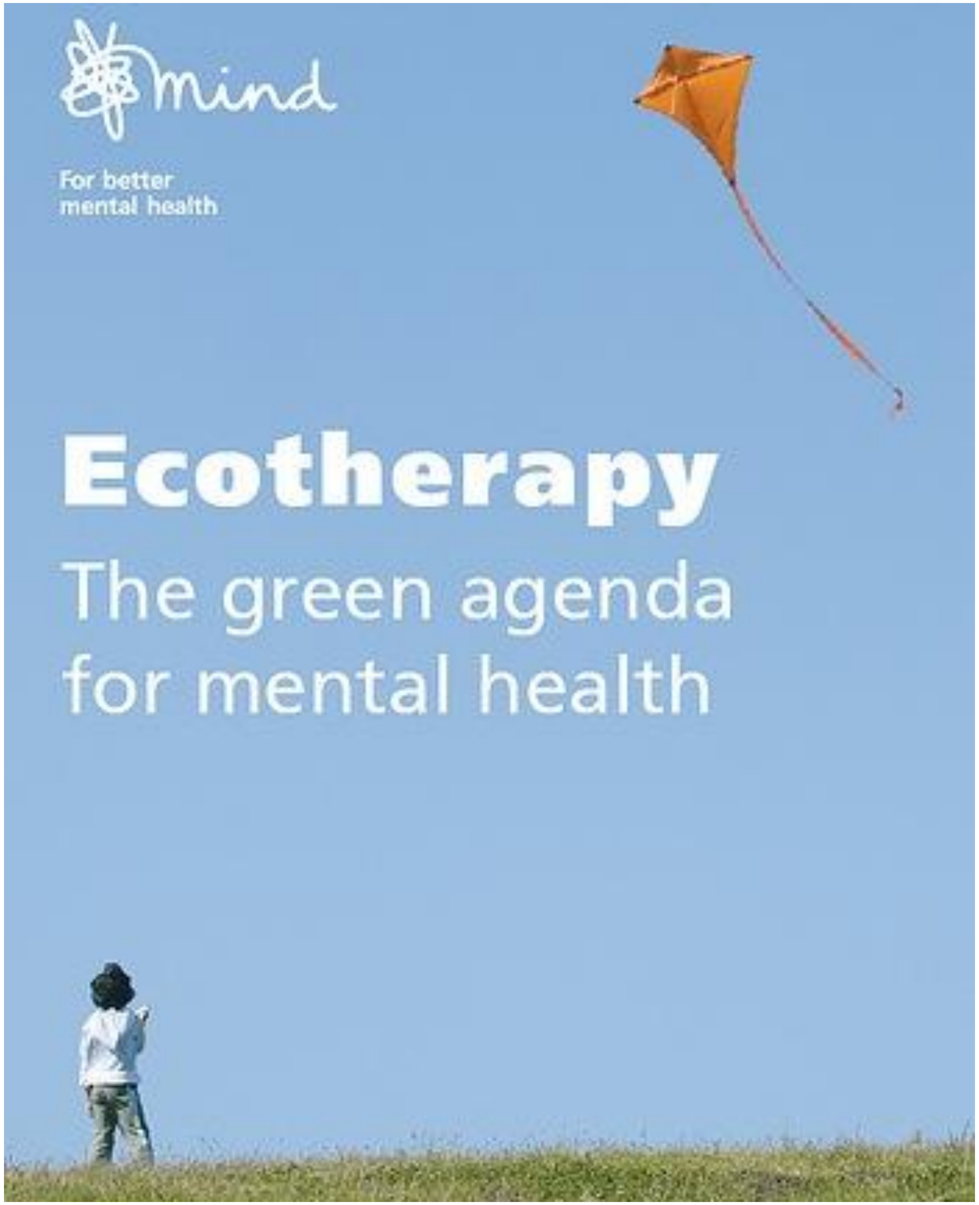
Natural Environment: land cover composition

Natural Environment: land cover composition

Natural Environment: land cover composition

Adapted from: Aked et al. *A report presented to the Foresight Project on communicating the evidence base for improving people's well-being.* Centre for well-being, **nef** (the new economics foundation)

Mental health



Lola Vázquez Peraita Msc 2014
Cranfield University
Developing cultural ecosystem services indicators for public health