Tom Oliver

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@Dr_Dolittle_81

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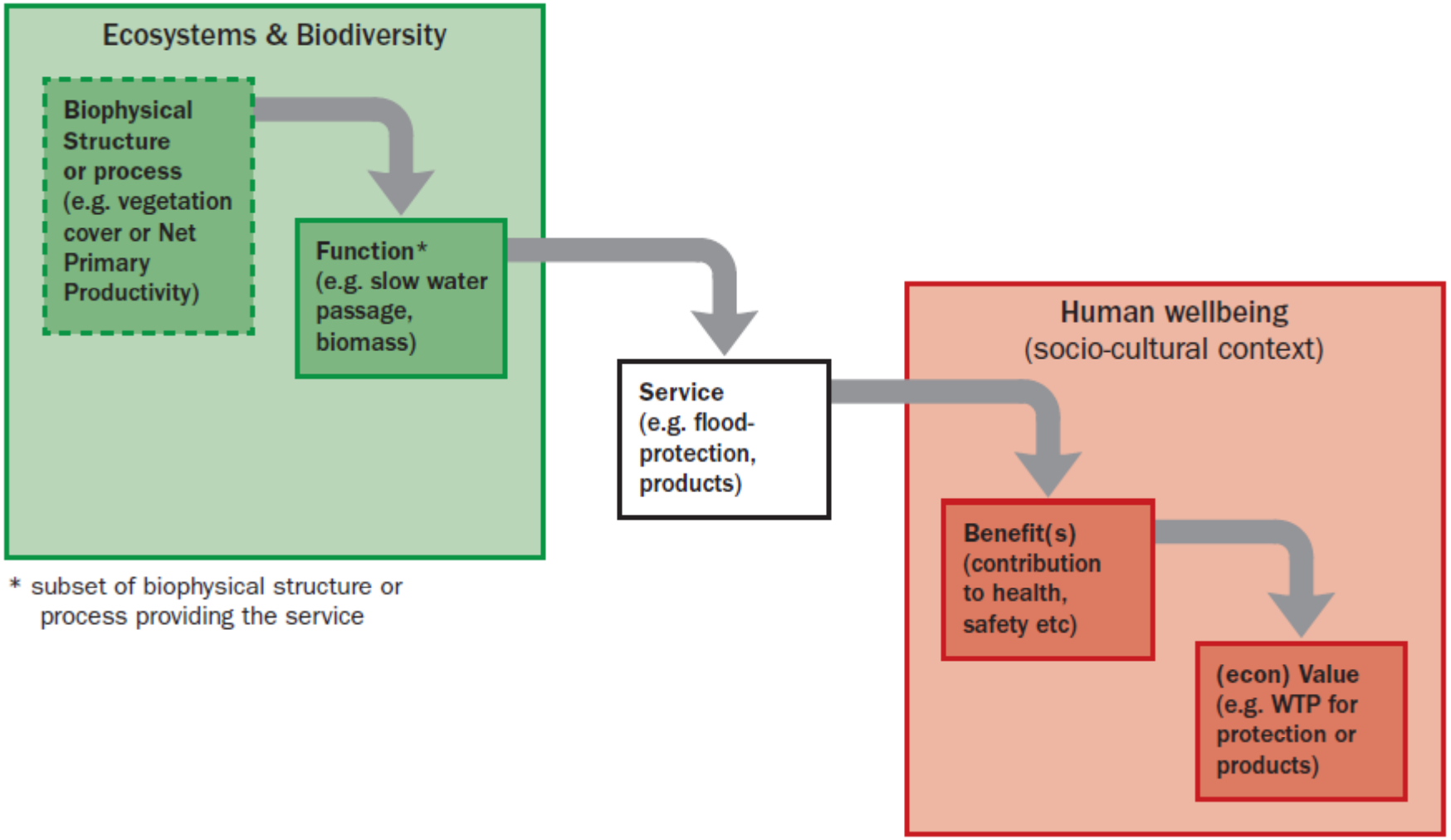
Quantifying ecosystem services

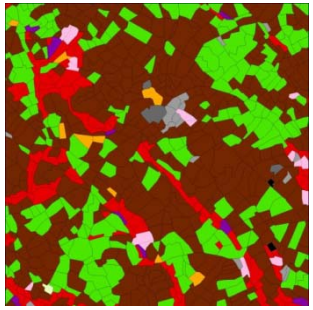


The need for models

Increasing Uncertainty

Measured Proxy 3

Habitat extent for pollinators



Measured Proxy 2

Numbers of pollinating insects at monitoring stations

Measured Proxy 1

Yield increases on sentinel plants

Ecosystem service

e.g. Crop pollination

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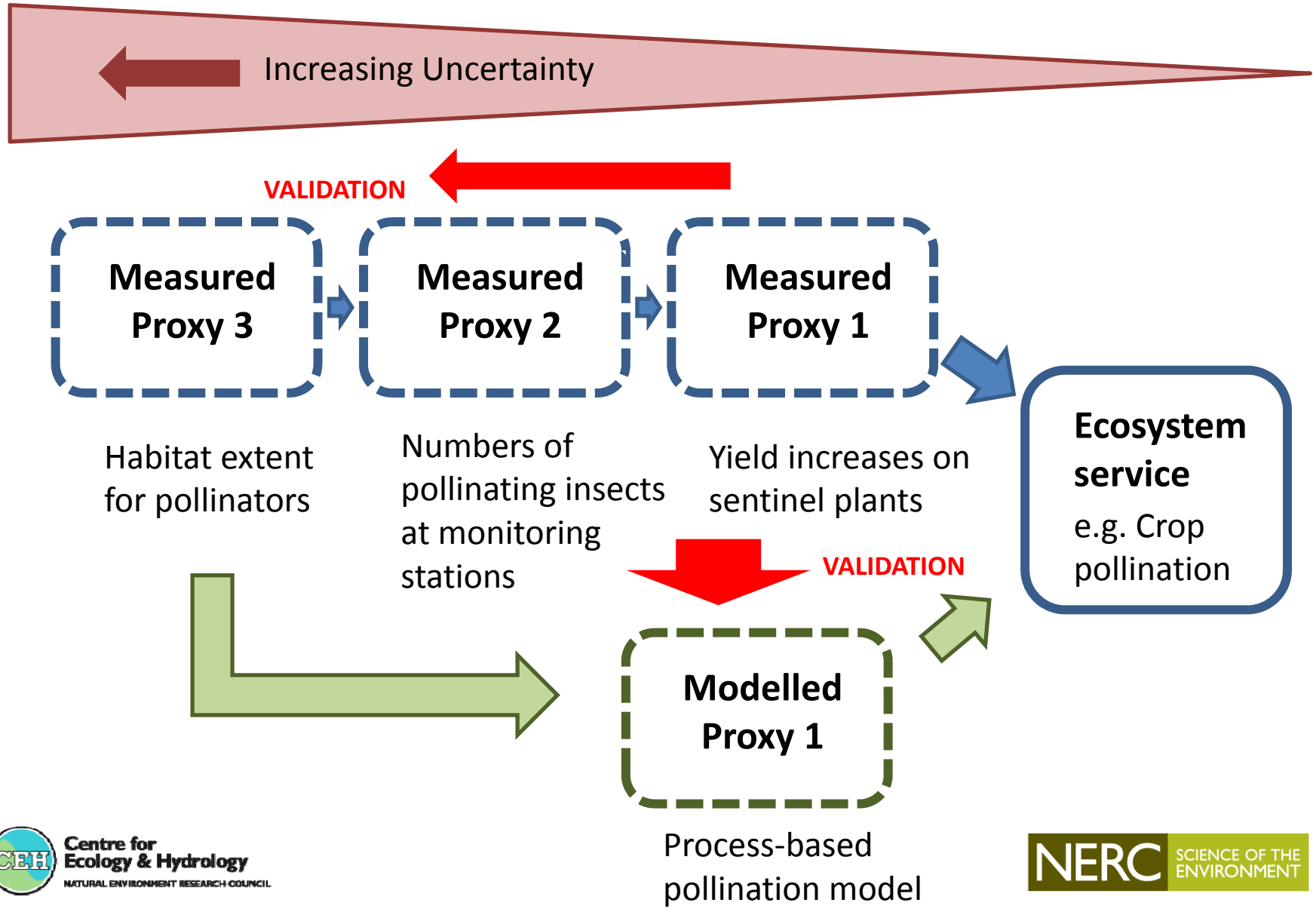
The need for models



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Types of ecosystem service model

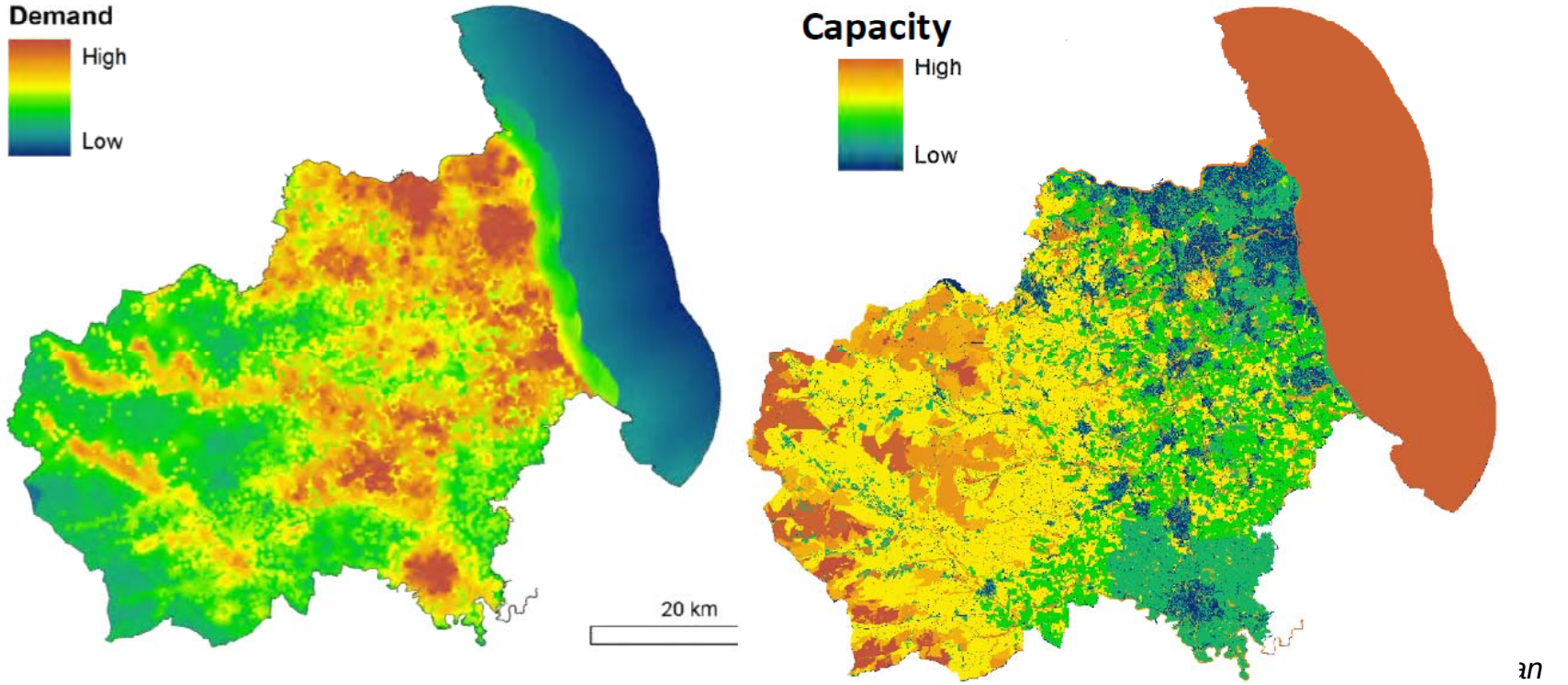
Model type	Examples	Best suited for....
Benefits transfer	*EcoServ* *Co$ting Nature*	Carbon Timber
Statistical correlative	*EcoMaps*	.....
Process-based	*InVEST* *ARIES* *LUCI* *Specialist models (e.g. Grid-to-grid)*	Pollination Water quality Recreation

Benefits transfer

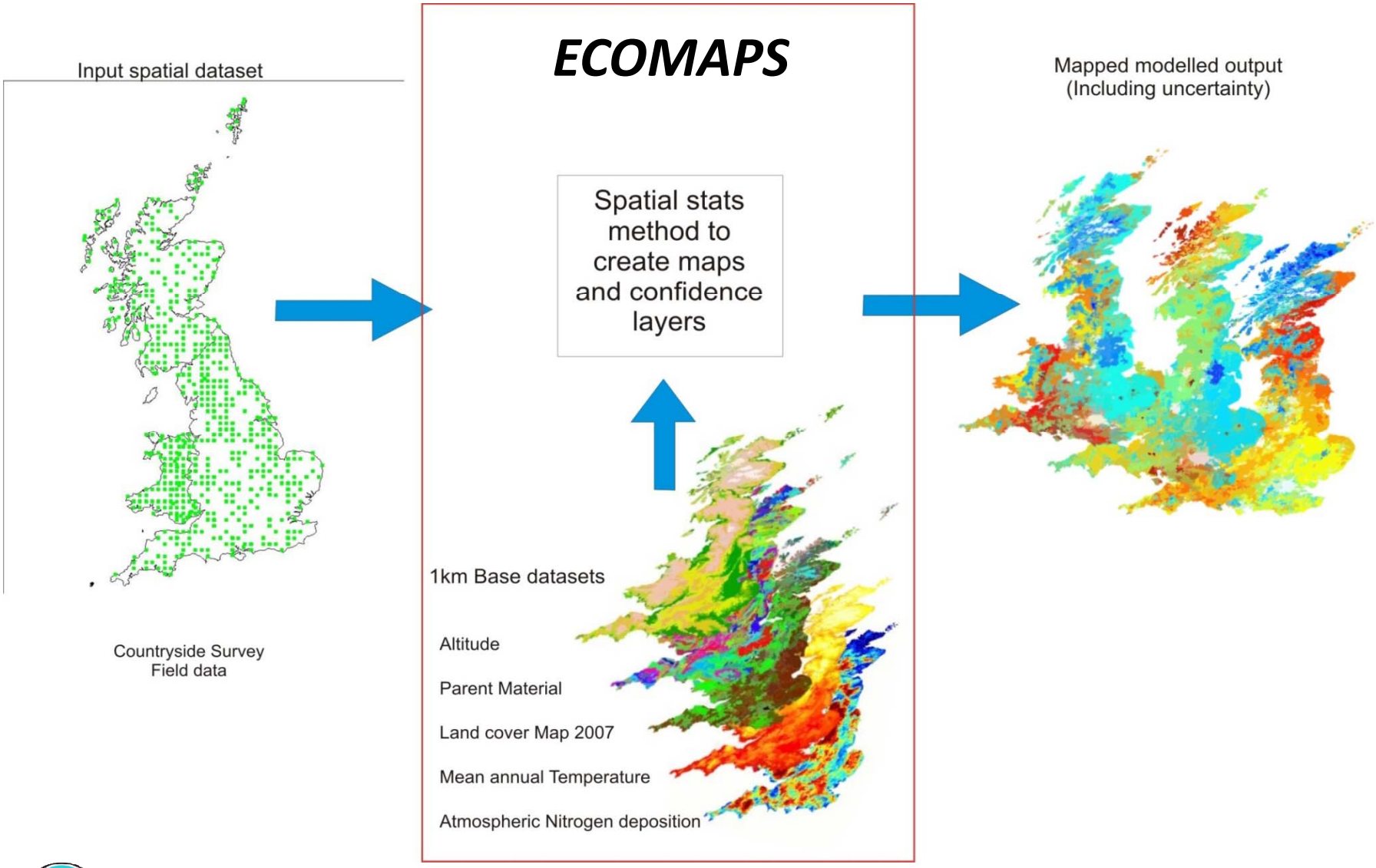
EcoServ-GIS

THE wildlife TRUSTS DURHAM

Accessible nature experience



Statistical correlative models



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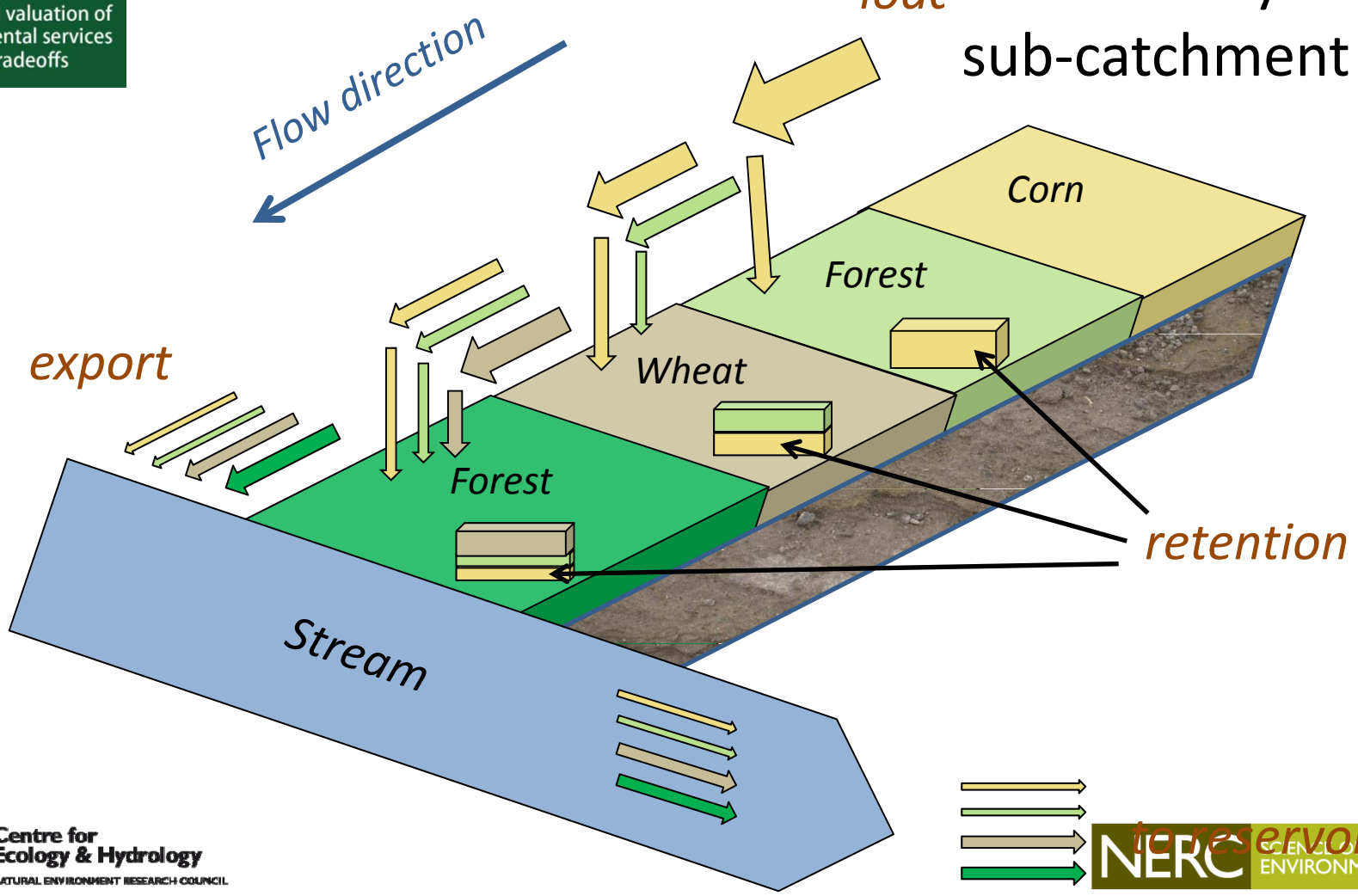
Process based models

InVEST
integrated valuation of environmental services and tradeoffs

Nutrient retention by sub-catchment



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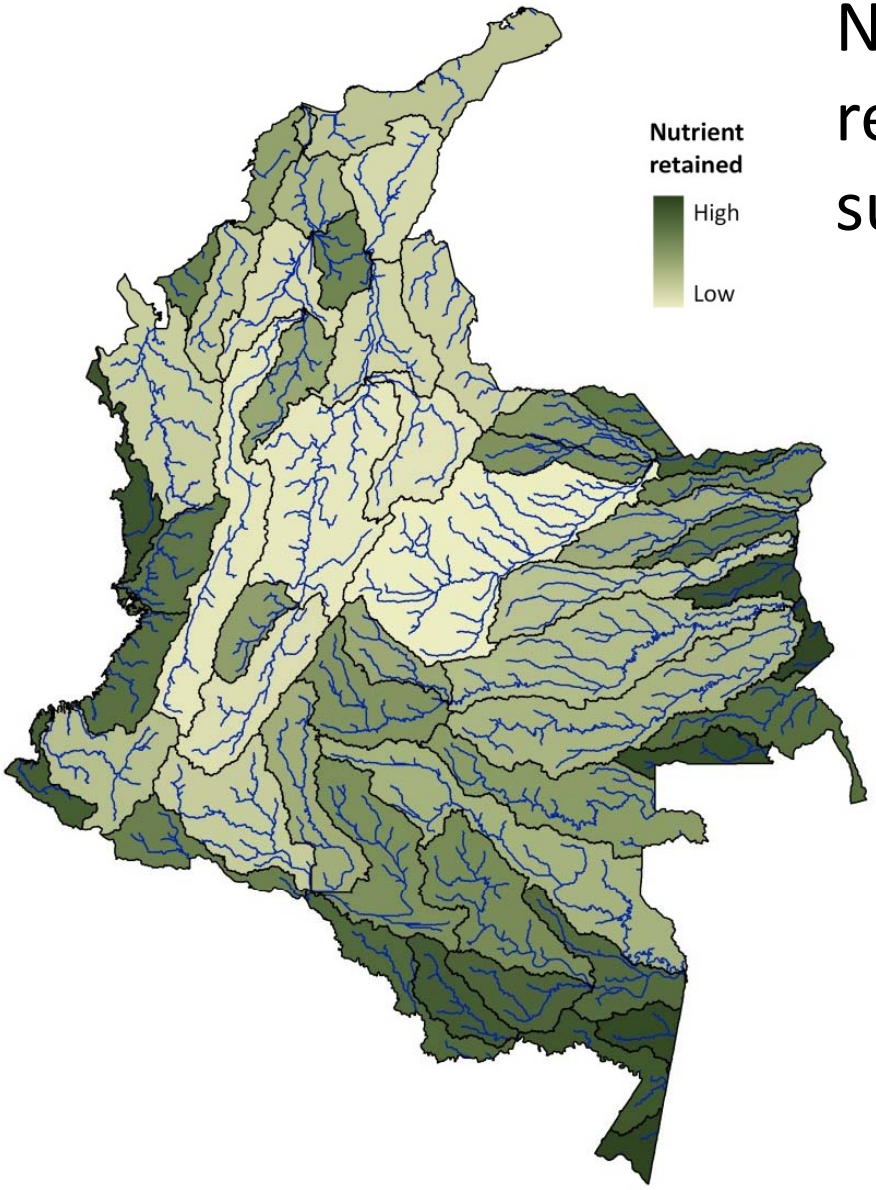

Nutrient retention by sub-catchment

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to reservoir

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Ecosystem service mapping initiatives

Choosing the best model.....

Not necessarily those that produce the prettiest outputs!

AREA 4: Functional Performance Summary by Function for Site

MANAGEMENT ACTIVITY: No management activities proposed at this time.

ACRES: 37.2

For more detail, please see next page.

INDIVIDUAL FUNCTION PERFORMANCE SUMMARY

		FUNCTIONAL ACRES BASELINE	% FUNCTIONAL PERFORMANCE BASELINE
	Abiotic Functions Score (area weighted average)	**15.7**	**42%**
ABIOTIC FUNCTIONS	Atmospheric cleansing	11.8	32%
	Carbon cycle support	18.4	49%
	Carbon sequestration	27.1	73%
	Carbon respiration	14.2	38%
	Organic matter export	12.9	35%
	Organic matter production	19.4	52%
	Erosion control	17.1	46%
	Soil retention	16.2	44%
	Sediment transport	9.5	26%
	Soil / substrate stability	26.1	70%
	Evaporation	15.1	41%
	Transpiration	10.5	28%
	Filtration	11.6	31%
	Groundwater recharge	5.4	15%
	Habitat formation	22.7	61%
	Channel diversity	0.8	2%
	Landscape connectivity	24.2	65%
	Natural flood regime	7.1	19%
	Streambed stability	1.0	3%
	Variable velocity	1.0	3%
	Infiltration	9.0	24%
	Interception	23.2	62%
	Nitrogen removal	16.1	43%
	Phosphorus retention	7.6	21%
	Pollinator support	22.0	59%
	Soil quality	20.8	56%
	Spatial separation	3.7	10%
	Subsurface flow	19.9	54%
	Temperature regulation	8.5	23%

		FUNCTIONAL ACRES BASELINE	% FUNCTIONAL PERFORMANCE BASELINE
	Biotic Functions Score (area weighted average)	**17.1**	**46%**
BIOTIC FUNCTIONS	Amphibian / turtle support	22.3	60%
	Bat support	16.5	44%
	Insect / invertebrate support	17.0	46%
	Large mammal support	14.2	38%
	Raptor support	17.7	48%
	Reptile support	19.8	53%
	Resident fish support	6.4	17%
	Small mammal support	12.0	32%
	Songbird support	20.2	54%
	Vegetation support	17.8	48%
	Natural plant succession	34.4	93%
	Plant growth	12.6	34%
	Plant reproduction	17.1	46%
	Dispersal	12.1	33%

EcoMetrix

OVERALL FUNCTIONAL PERFORMANCE SUMMARY

Average of Abiotic and Biotic Scores

FUNCTIONAL ACRES BASELINE	% FUNCTIONAL PERFORMANCE BASELINE
16.4	**44%**

Choosing the best model.....

Transparency is needed to allow rigorous **assessmen**t...

and **evidence-based decision** making that is **economically defensible**

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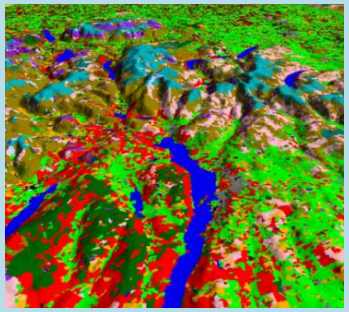
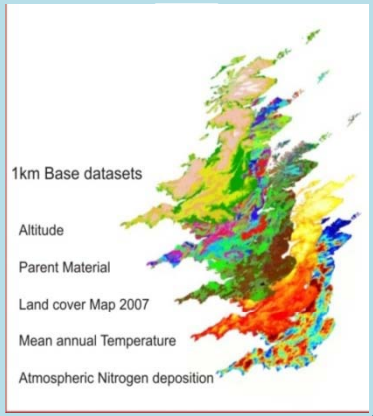
Integrated Ecosystem Service Modelling

DATA

Integrated environmental datasets





MODELS

Expertise in ecosystem service models

ARIES

ARtificial Intelligence for Ecosystem Services

LUCI

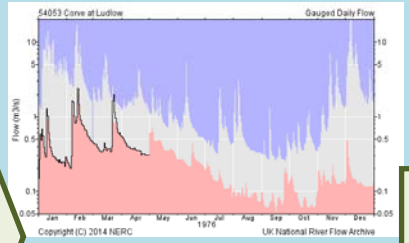
LAND UTILISATION & CAPABILITY INDICATOR

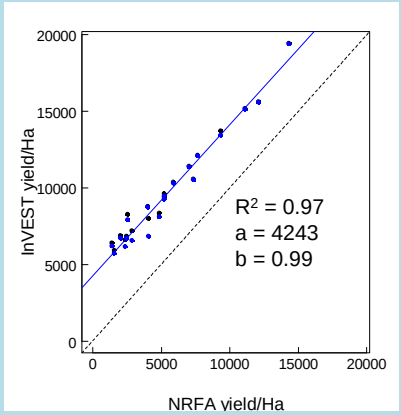
InVEST

integrated valuation of environmental services and tradeoffs

VALIDATION

Empirical data for essential model testing

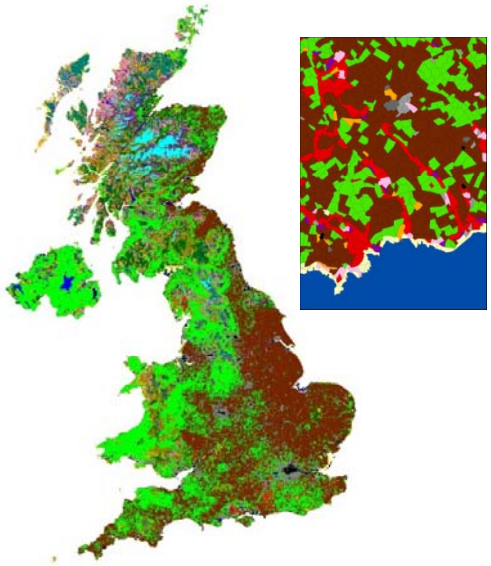




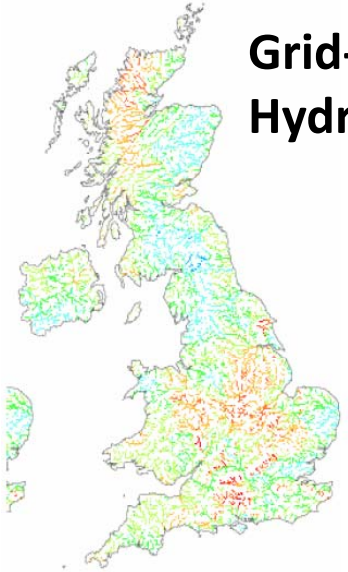
APPLICATION

Evidence-based advice on land use impacts

DATA



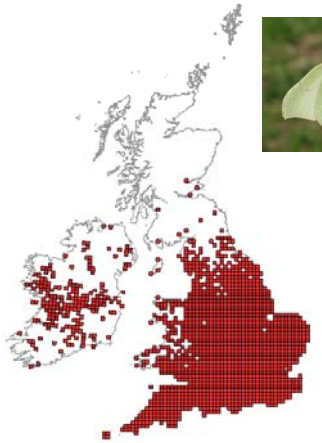
Land Cover Map 2007



Grid-to-Grid Hydrology

National River Flow Archive

Countryside Survey



Biological Records Centre

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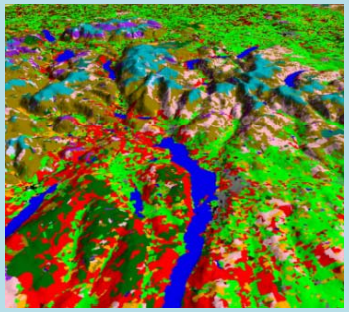
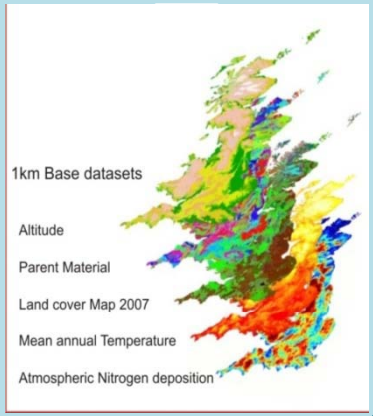
Integrated Ecosystem Service Modelling

DATA

Integrated environmental datasets





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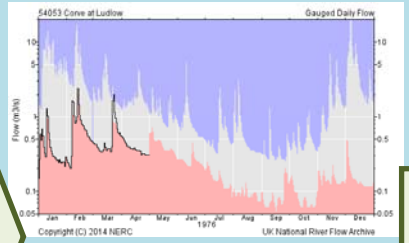
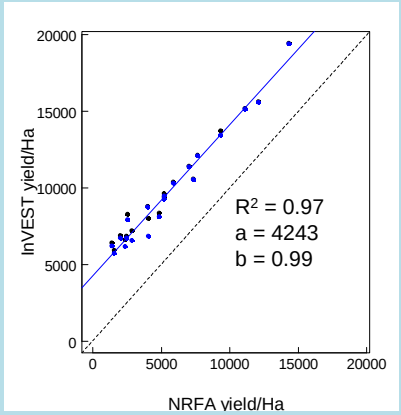




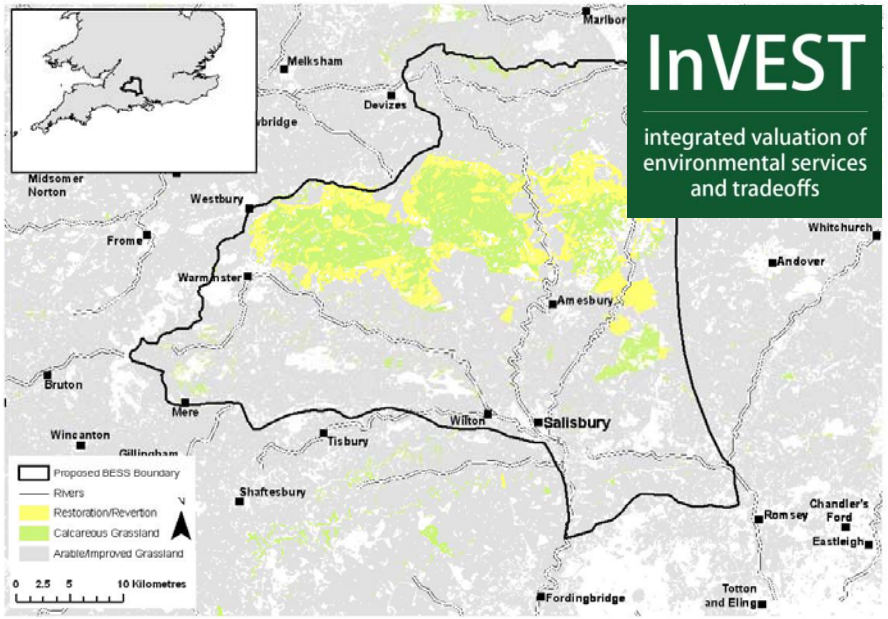
APPLICATION

Evidence-based advice on land use impacts

MODELS

Wessex-BESS http://www.brc.ac.uk/wessexbess

Providing evidence for the importance of **biodiversity** for **stocks, flows and resilience of ecosystem services** of pollination, pest control, water quality, GHG fluxes and cultural services



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

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bess biodiversity & ecosystem service sustainability

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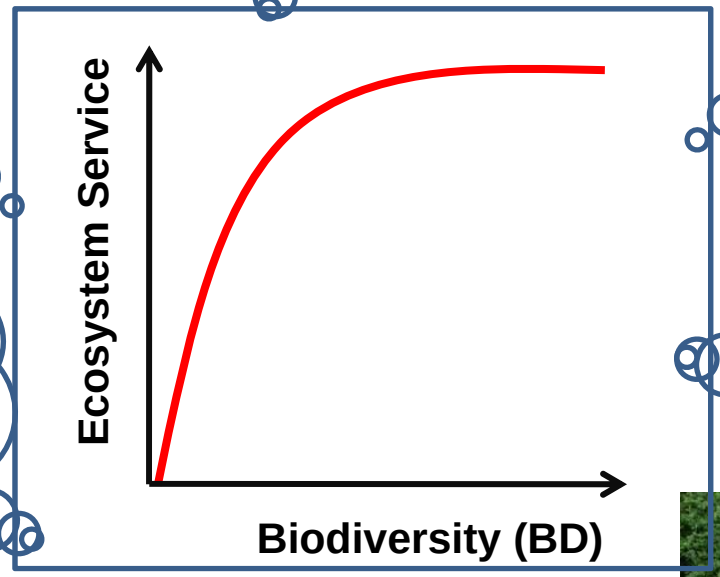
Extending models

Does BD affect ES directly – or linked responses to env change?

What are the processes behind BD-ES relationships?

At what scales should we study BD-ES relationships?



What is the role of BD in the resilience of ES delivery?

How do BD-ES relationships change across landscapes?

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MANCHESTER 1824
The University of Manchester

Queen Mary University of London

RSPB

Cranfield UNIVERSITY

UNIVERSITY OF EXETER

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Integrated Ecosystem Service Modelling

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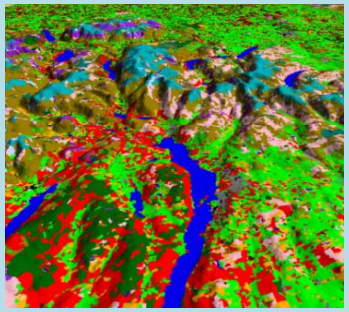

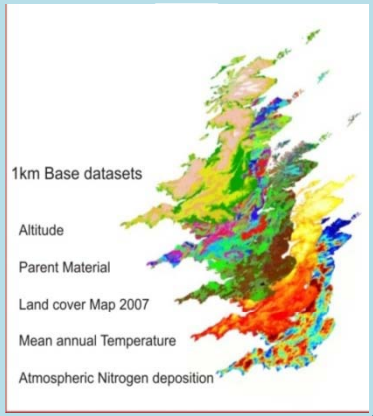

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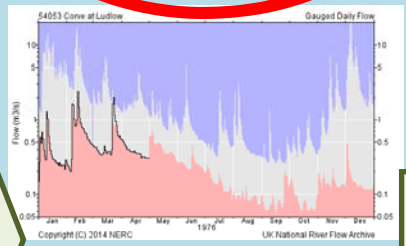
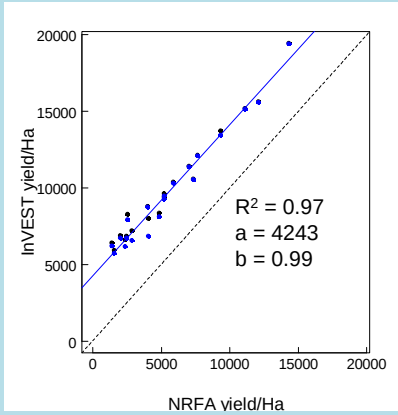




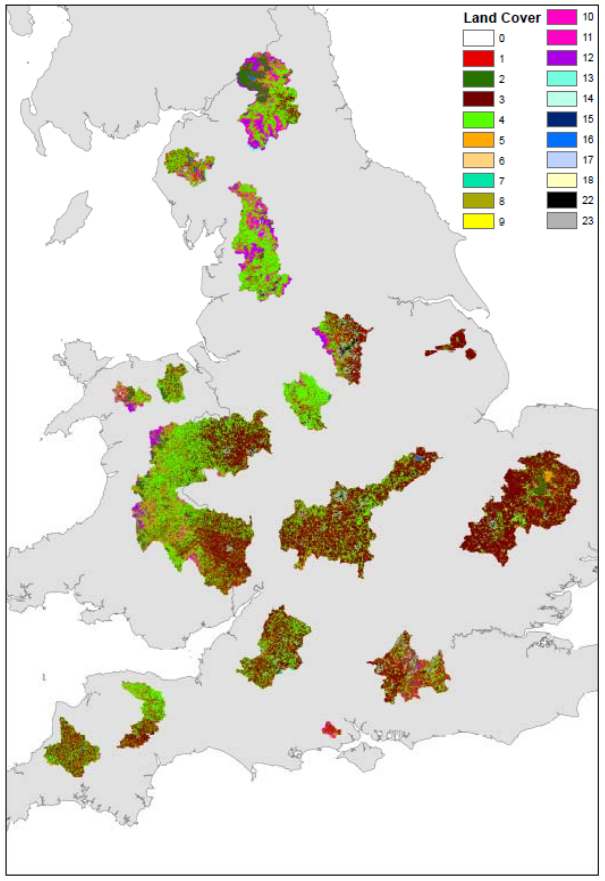
APPLICATION

Evidence-based advice on land use impacts

VALIDATION

Example 1- InVEST water yield model

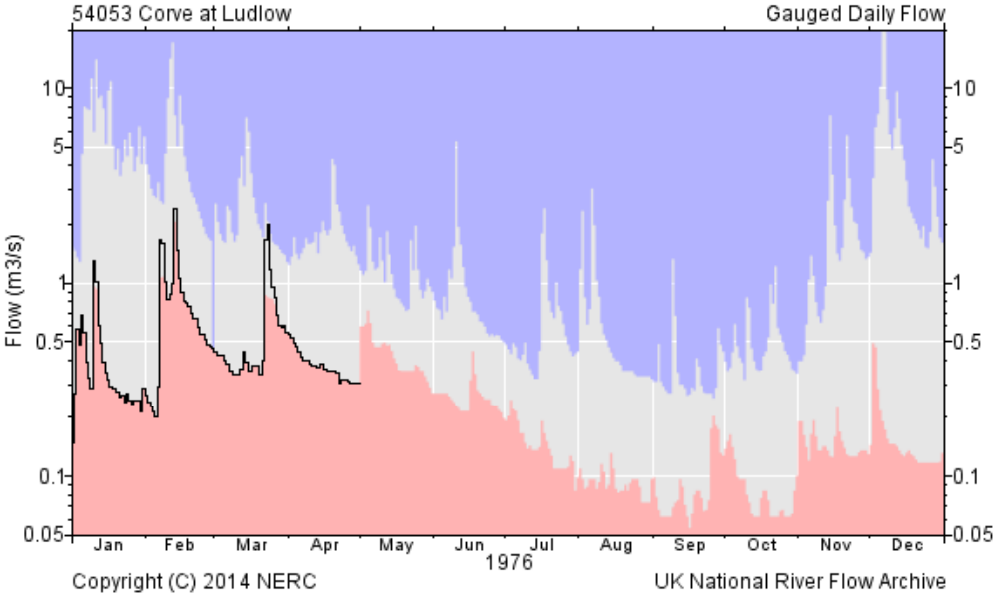
Model fitted for 20 test catchments that vary in land cover, geology and population size



VALIDATION

Validated against monitored river flow from the National River Flow Archive (NRFA)

Using mean flow for same 10 years as model inputs



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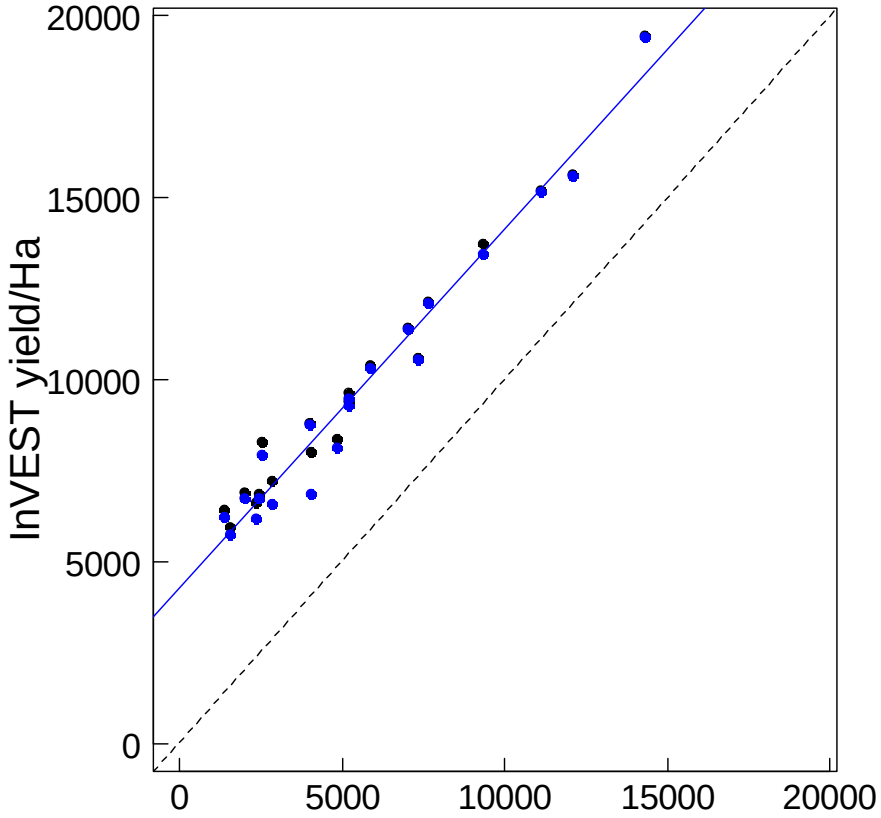
VALIDATION

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



$R^2 = 0.97$

a = 4243

b = 0.99

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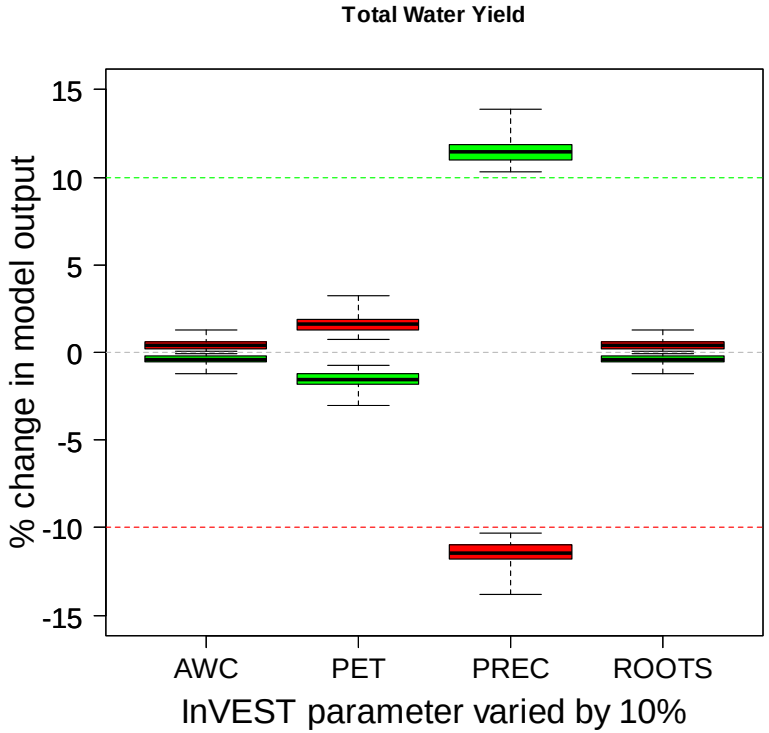
Credit: Redhead et al.

VALIDATION

Sensitivity analysis:

- Models run with varying parameters +/- 10%
- Model most sensitive to precipitation and potential evapotranspiration



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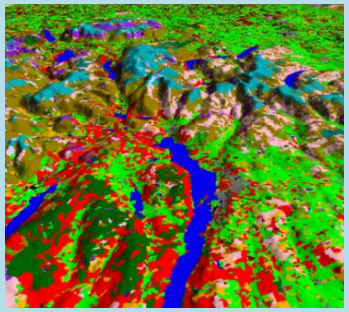

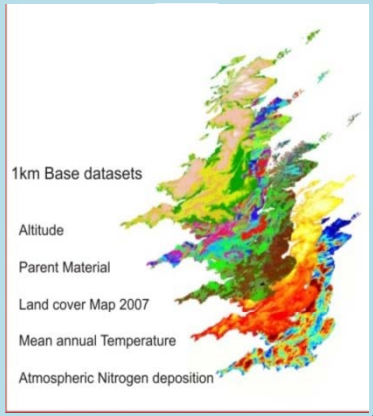

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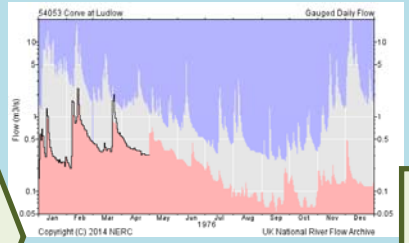

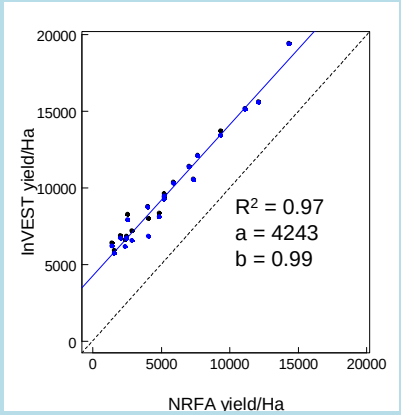

APPLICATION

Evidence-based advice on land use impacts

Conclusions

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1. More ***validation*** of ecosystem service models is needed
2. And rigorous ***comparison of models*** to pick most appropriate for given region/ spatial scale
3. Mapping supply of ecosystem services is only one side of the coin- ***demand management*** is critical

Acknowledgements

NERC, CEH colleagues (esp. John Redhead, James Bullock)

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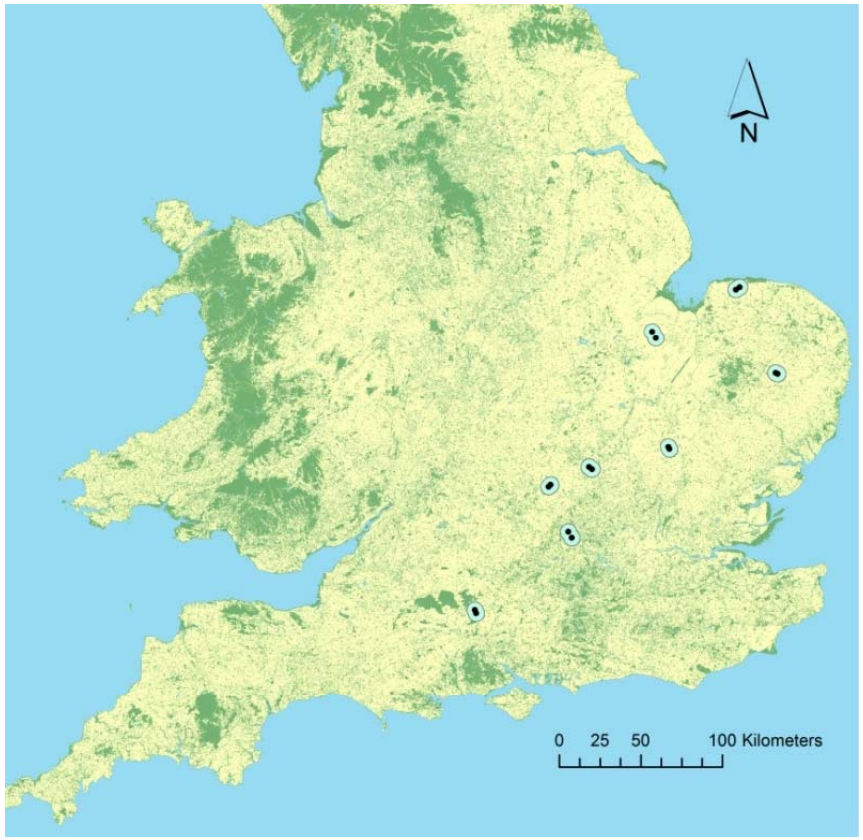
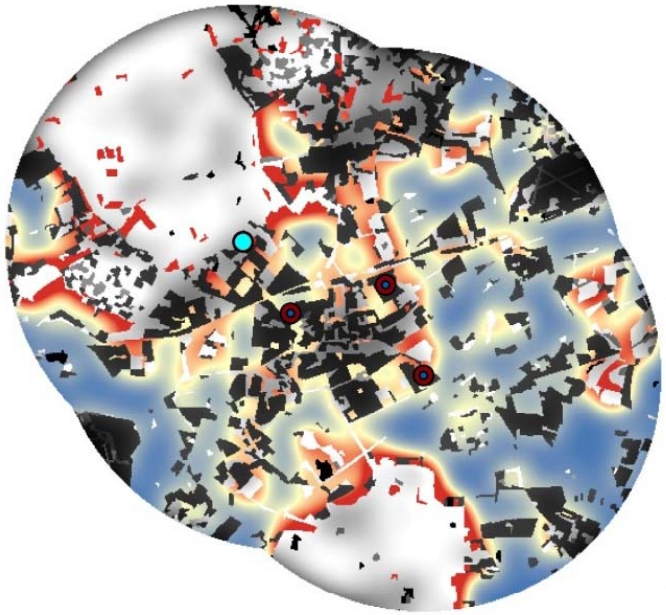
VALIDATION

Example 2- InVEST crop pollination model

2000 transects (over 4 years) across 32 1km^2 cells in eight English regions