APPLYING LUCI AT THE NATIONAL SCALE IN WALES (and some model inter-comparisons)

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TE WHARE WĀNANGA O TE ŪPOKO O TE IKA A MĀUI
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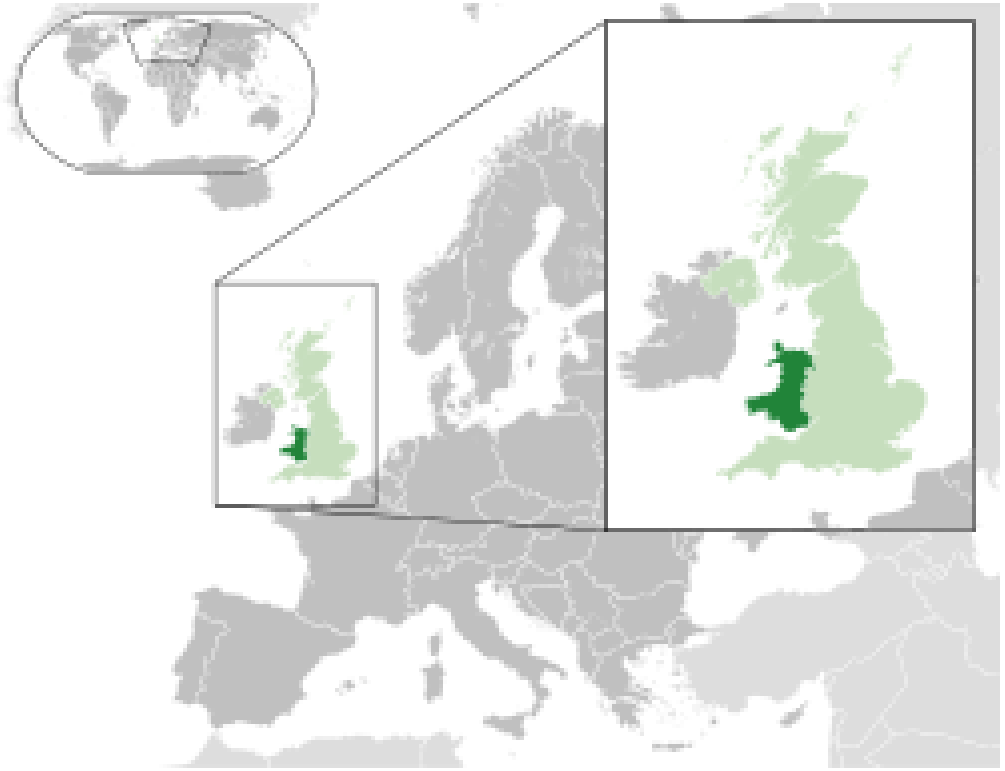
Wales



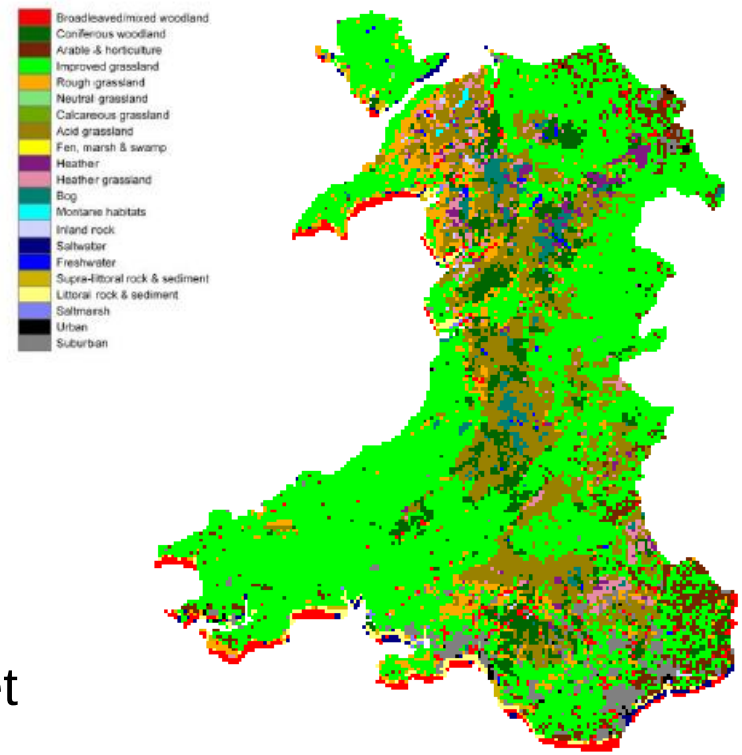
Wales – some facts

3 million people
20,000km2
1,200km coastline
One of wettest countries in Europe = grass!
95% rural land much of which is poor quality

GDP = £45blilion (of which tourism is £6B (wildlife-based £2B); agriculture £1.4B; forestry £0.5B

Devolved in 1998 from UK government

Issues:
Ongoing decline in biodiversity; failure to meet Water Framework Directive targets; GHG emissions actually increased last year; agri sector heavily dependent on subsidies; poorly performing economy/jobs



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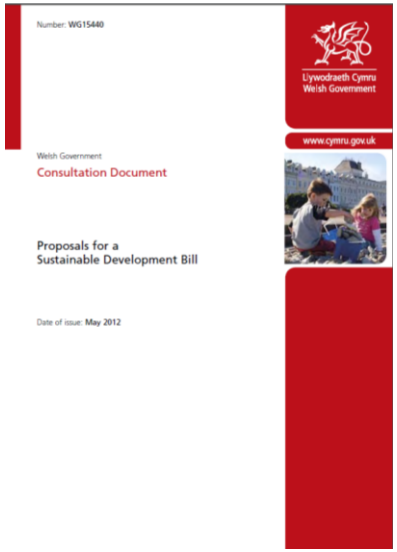
Entry point to Ministers

John Griffiths, Environment Minister, UN Climate Change Conference, DOHA 2012)

"Wales will become the first country in the world to make it legally binding for all public bodies, from health trusts to libraries and schools, to take account of the environment and social issues when they make a decision"



Wales needs the models such as LUCI to undertake the spatial planning and scenario analysis for integrated management of 95% non-urban area of the country to deliver SD. An end to silo management!

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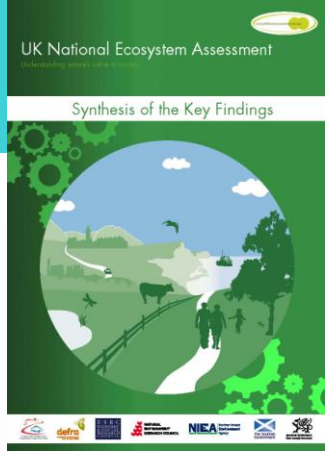
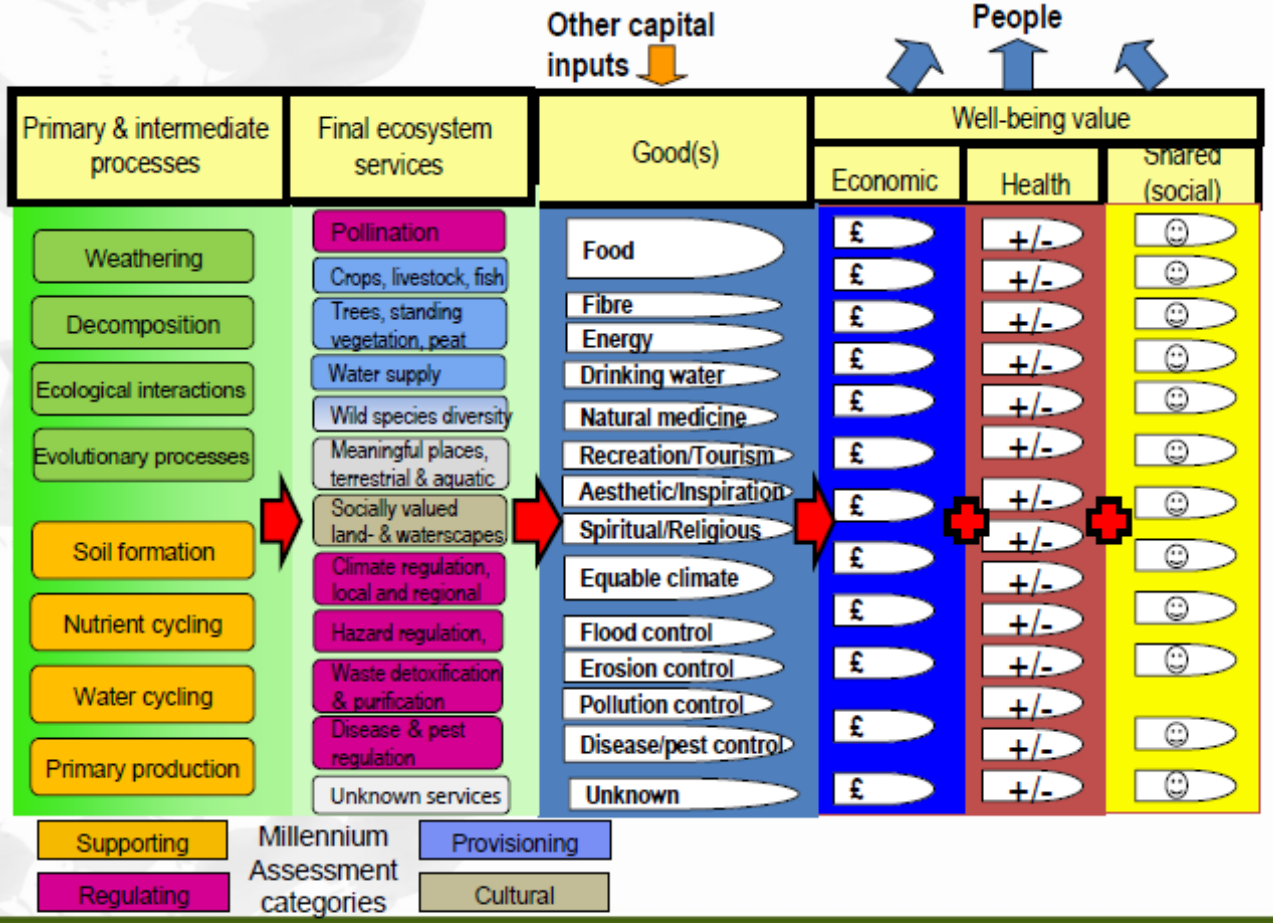
The UK National Ecosystem Assessment

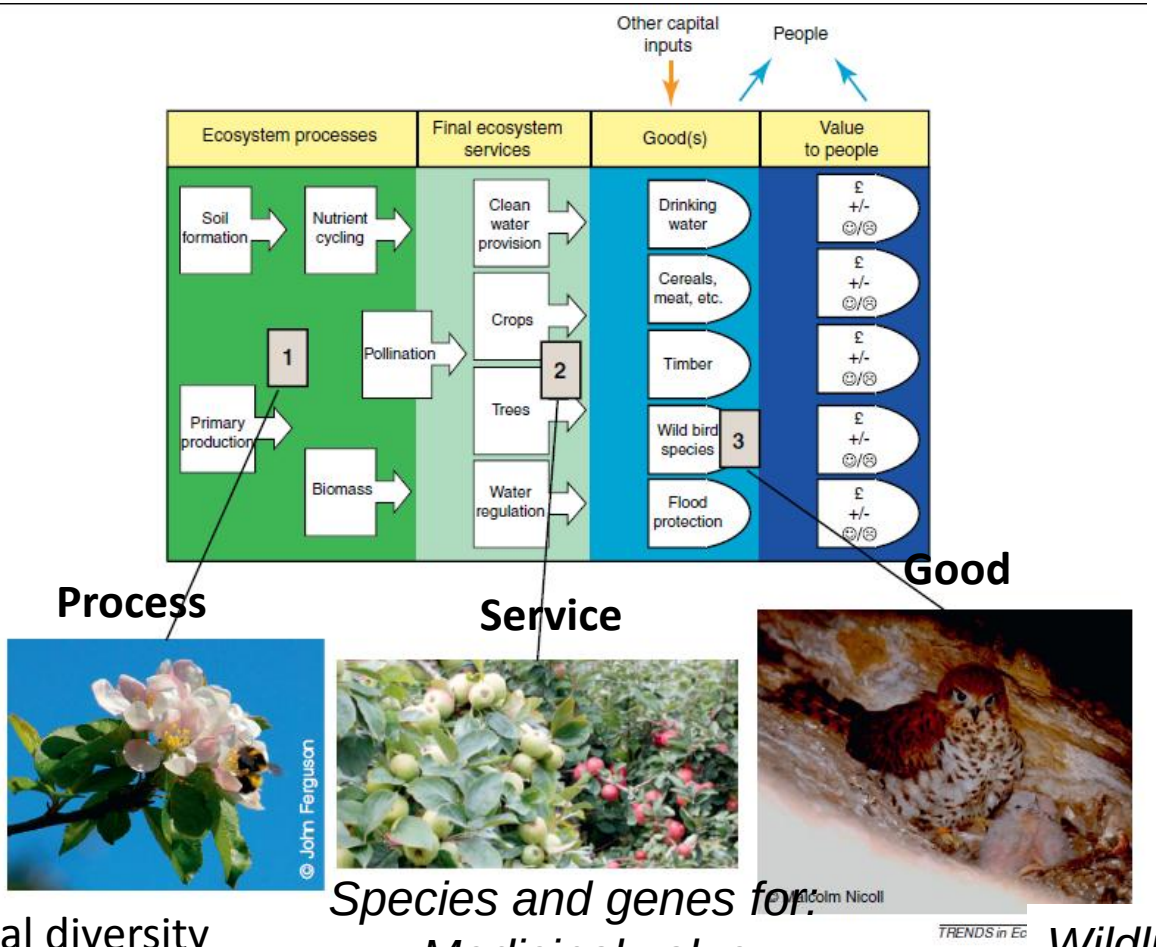


Ecosystem services – monetary and non-monetary value



Biodiversity is a regulator, a service and a good

(Mace et al. 2012; TREE 27: 19-26)



Functional diversity

Species and genes for:

- *Medicinal value*
- *Wild reservoir for farmed crop and animals*

Wildlife has value in itself:

- *cultural*
- *aesthetic*
- *spiritual*

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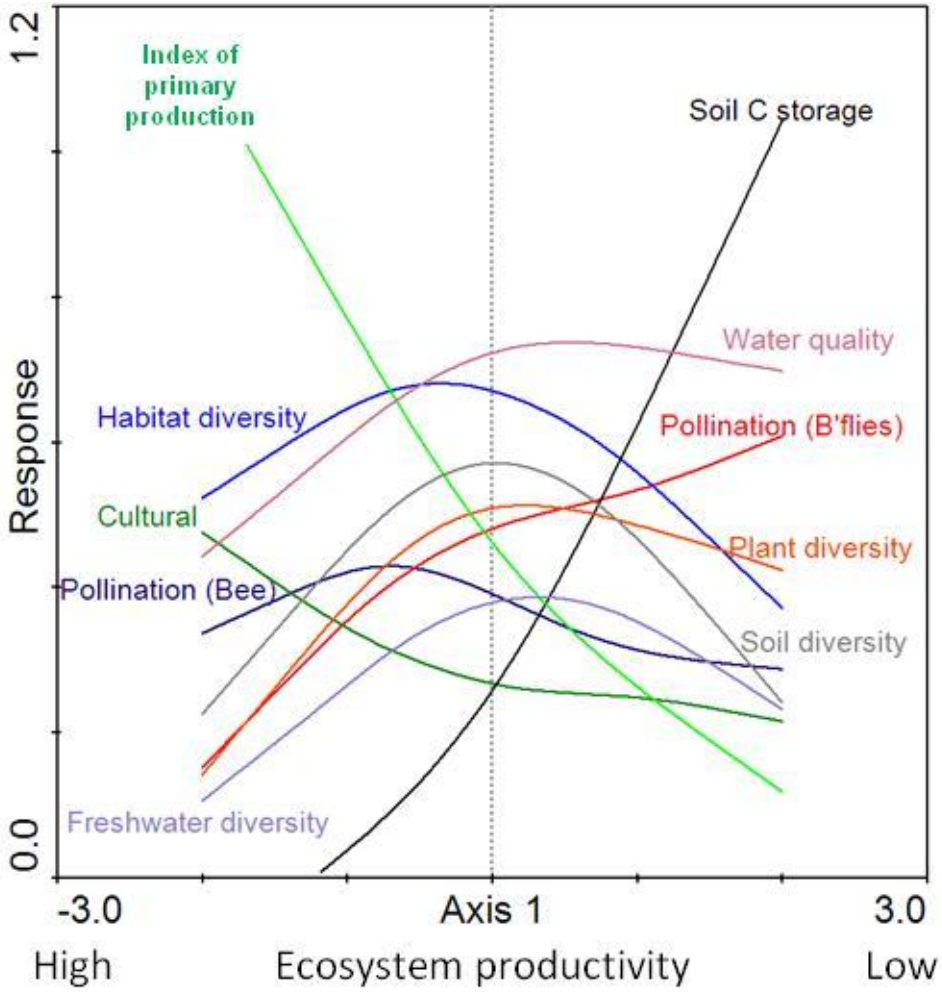
Integrated monitoring demonstrated fundamental ecological constraints on ecosystem services

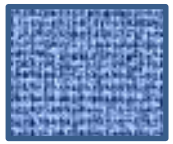


Countryside Survey Integrated Monitoring

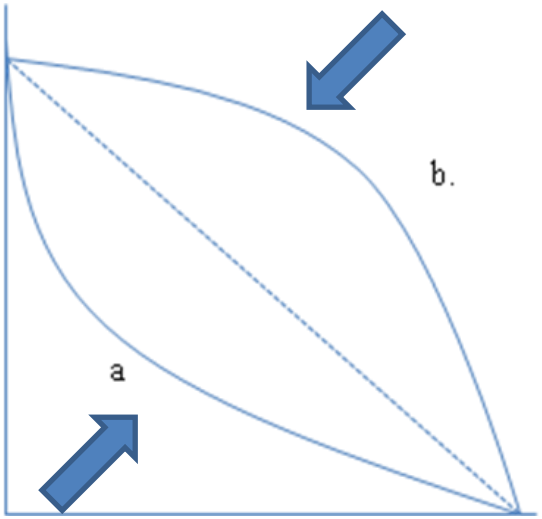
Maskell et al. (2013) Journal of Applied Ecology

Land sparing vs land sharing is a gross over-simplification as we want multiple services

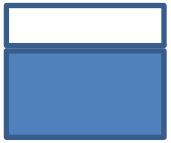
Land sharing is optimal for food and wildlife



Wildlife density

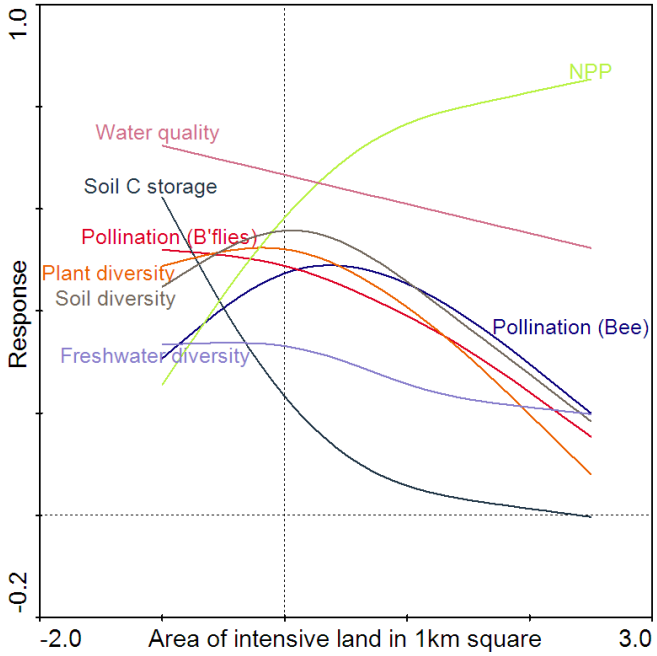


Yield



Land sparing is optimal for food and wildlife

Ecosystem service



Production / Yield

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Green et al. (2005) Science 307:550-555

In addition, Wales now has the GMEP project

Aims

- To quantify extent, condition and change of Natural Capital assets in Wales
- Attribute change and determine implications for ecosystem services
- Determine impact of land management interventions through Glastir RDP programme as it is going along!
- Scenario analysis, trade-offs and optimisation

Objective, independent, scientific approach

Land management scheme

- *A whole farm sustainable land management scheme.*
- *5 priorities:*
  - *Combating climate change (regulating)*
  - *Improving water management (regulating/provisioning)*
  - *Maintaining and enhancing biodiversity (supporting/cultural)*
  - *Landscape and historic landscape (cultural)*
  - *Increasing area and improving management of woodland (provisioning)*

GMEP = Glastir Monitoring and Evaluation Programme

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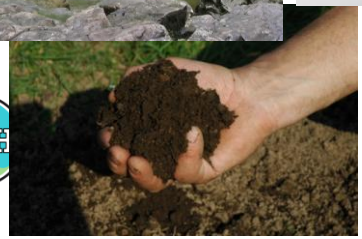
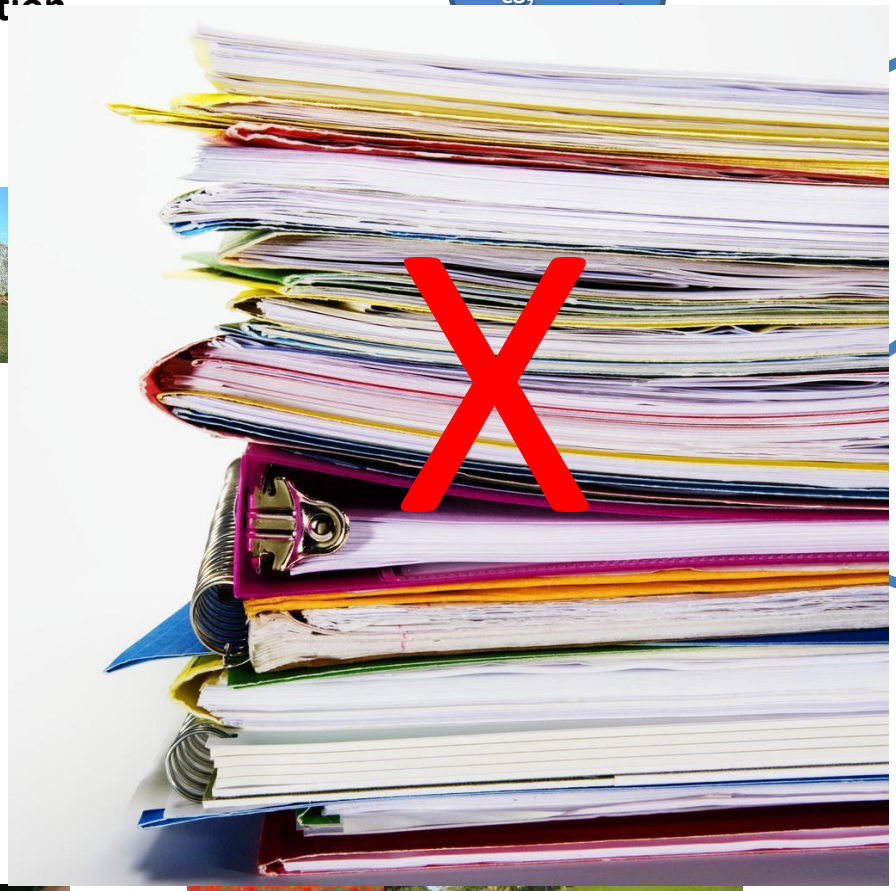
ca.£80M to Welsh farmers every year to benefit the environment and compensate for reduction in income

The question is: does it?

Landscape, historic environment, access and recreation

Soils and water flow/quality





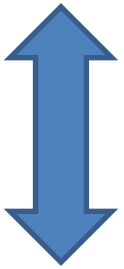
Economics

Farmer practice

Birds and pollinators

The GMEP approach

- Combined monitoring and modelling approach
- Monitoring for:
  - Evidence-base outcomes
  - Deliver reporting requirements
  - Drive models (farmer practice survey)
- Models for:
  - Early results for bidiversity, carbon and water etc!
  - Evaluate difficult to measure outcomes (GHG)
  - Upscale
  - Explore scenarios
  - Identify trade-offs
  - Models as hypotheses



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So we need models: Why LUCI?

- Biophysical process model basis
- Spatially explicit
- Can run on just 3 national datasets (but can use more if available)
- Scale (5m x 5m so can explore subfield scale and integrate to any scale)
- Modular
- Stakeholder friendly interface
- Scenarios, optimisation, trade-offs

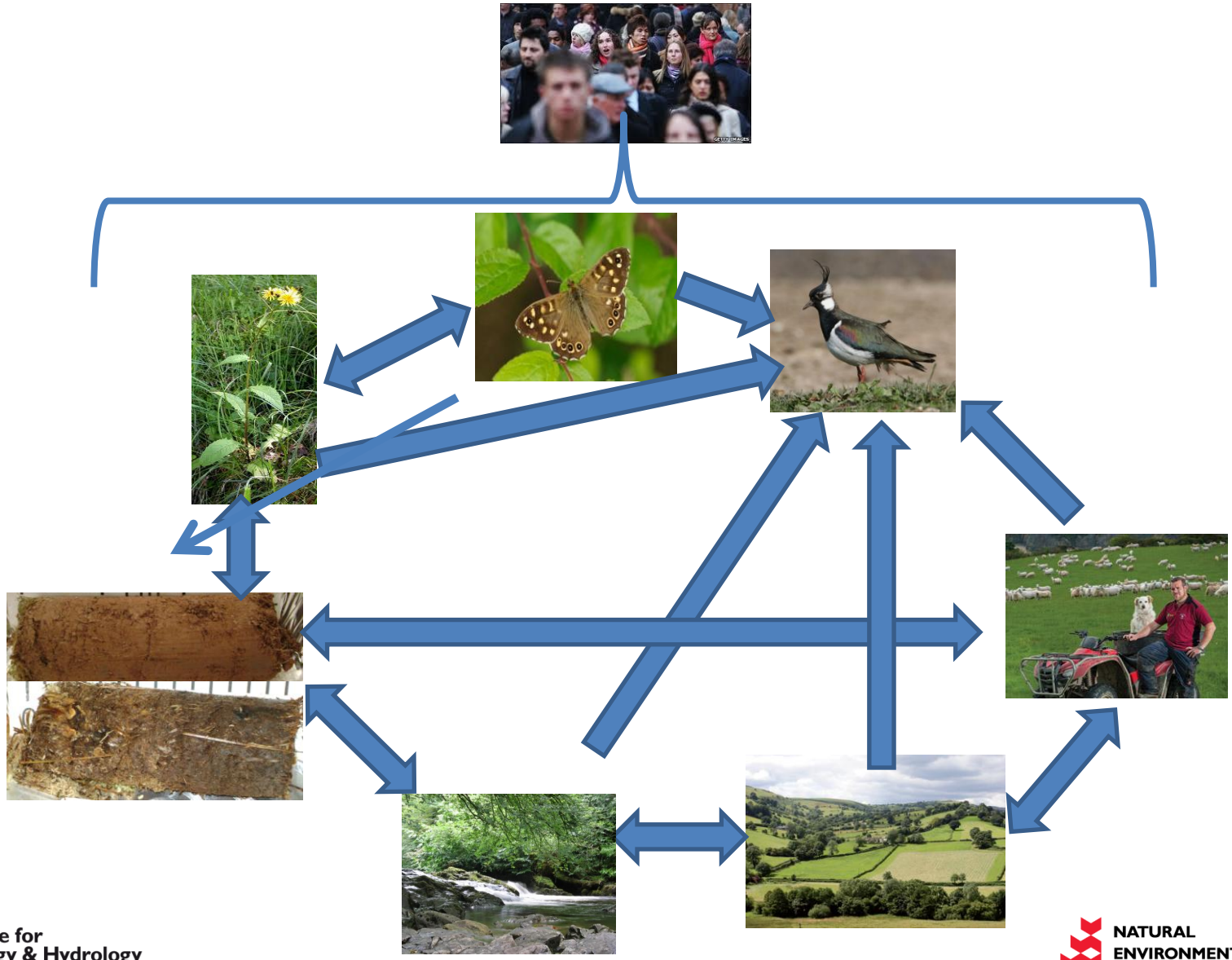
Services currently modelled by LUCI

Service	Method
Production	Based on slope, fertility, drainage, aspect
Carbon	IPCC Tier 1 – based on soil & vegetation
Flooding	Detailed topographical routing of water (5m by 5m) accounting for storage and infiltration capacity as function of soil and land use.
Erosion	Slope, curvature, contributing area, land use, soil type
Sediment delivery	Erosion combined with detailed topographical routing
Water quality	Export coefficients combined with water flow and sediment delivery models
Habitat (Approach A)	BEETLE – Forest Research's cost-distance approach to dispersal, examines connectivity of habitats
Habitat (Approach B)	Identification of priority habitat by biophysical requirements e.g. wet grassland
Tradeoffs/synergy identification	Various layering options with categorised service maps; e.g. Boolean, conservative, weighted arithmetic

GMEP uses an ensemble approach for modelling

Model name	Glastir Outcome				
	Biodiversity	Climate Change mitigation	Soil and water flow/quality	Landscape and historic features	Woodland expansion and management
ADAS GHG and diffuse pollution model		Ruminants and manures; energy; fertiliser emissions (direct and indirect)	Diffuse pollution, and sediments		
LUCI	Connectivity between semi-natural habitats only included for now	Impact of land use on biomass and soil C stocks	Runoff/flooding; sediment delivery, N and P export	Erosion damage possible	Impacts of woodland loss or expansion on C sequestration
LULUCF		Impact of land use on biomass and soil C stocks only.			Impacts of woodland loss or expansion on C sequestration
Multimove	Change in habitat suitability for > 1000 higher plants based on 6 environmental variables	Interaction between interventions and climate change on plant biodiversity	Impact of change in soil moisture resulting from interventions on plant biodiversity		Impacts of woodland management on groundflora diversity
Ecosse		Soil based GHG emissions			
LUCI	Trade-offs and spatial analysis				

GMEP uses an ecosystem approach to monitoring



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- Habitats and linear features
- Species (birds, invertebrates and plants)
- Streams and ponds (habitat, macro-invertebrates, diatoms, aquatic, plants, chemistry)
- Landscape including historic environment features, access and recreation
- Soil (physical structure, erosion, pesticides, nutrients and biodiversity)
- Diffuse Pollution and Climate Change Mitigation
- Economics for farmers & social surveys to identify wider benefits within Wales
- Integration across elements
  - Spatial context of measures
  - trade-offs and co-benefits
  - implications for Natural Capital and Ecosystem Services

So many metrics appropriate for SEEA EEA Ecosystem condition and services (LUCI outputs in red)

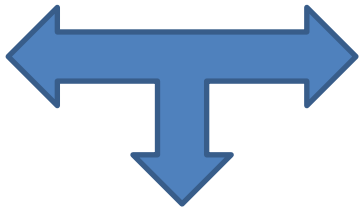
- Ecosystem condition and extent table
- Biodiversity
  – Plant, soil, bird, pollinators & aquatic; Invasives; appropriate diversity; presence of common standards species; linear features; **connectivity; habitat extent;** habitat diversity
- Soil 'quality' (physical, chemical & biology)
- **Water flow and quality**
- Primary production (specific leaf area)
- Historic features condition assessment
- etc

- Services table
- **C storage and emissions**
- **Flood regulation**
- **Water quality**
- **Production (actual and potential)**
- **Priority habitat and diversity (actual and potential)**
- **GHG emissions (just added)**
- Landscape perception / aesthetic
- Access/recreation
- Direct and indirect employment
- etc

Actual versus potential (e.g. Production)

- Potential
  - Land typology based (LUCI)
  - Climate based (JULES model)
  - Forestr models (CARBINE)

- Actual
  - Harvested timber
  - Livestock units
  - AICS data
  - Specific leaf area (proxy for primary production in semi-natural systems)

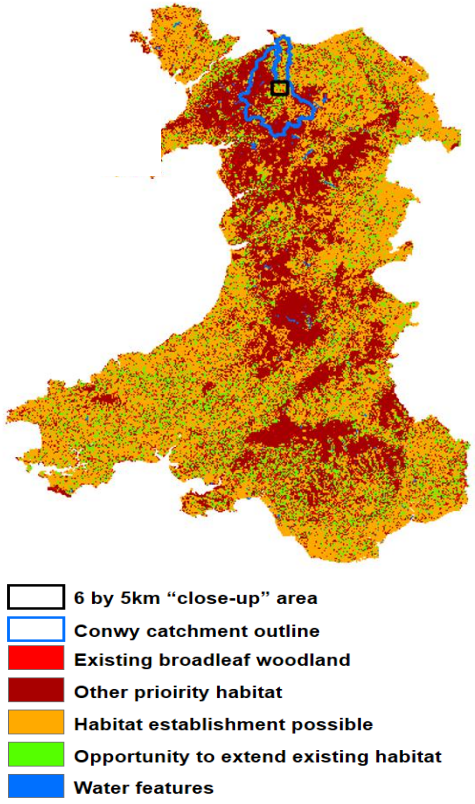


Comparison gives you:

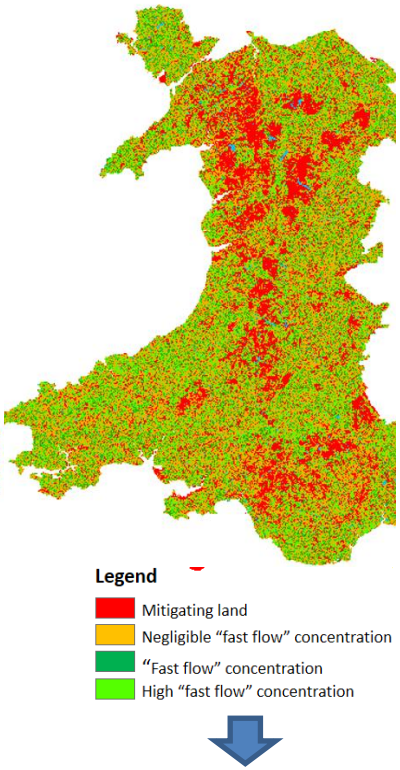
- Human modification metric
- Potential for restoration
- Areas of over or under - exploitation

National maps from LUCI showing areas of current high delivery and opportunities to enhance (driven from 3 datasets)

Habitat Priority areas

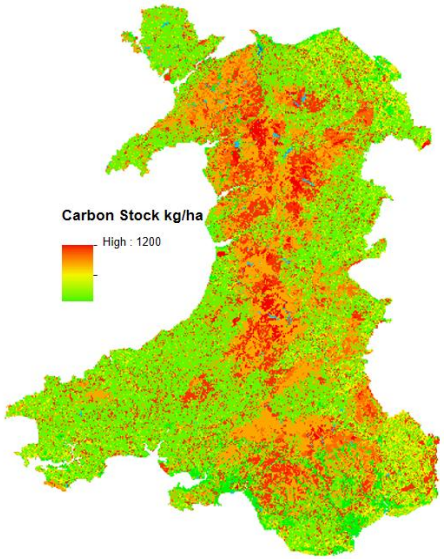


Flood generating and mitigating land

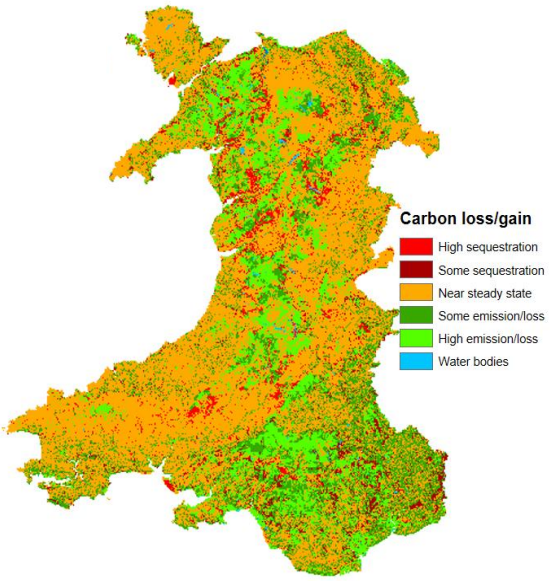


Sediment, N and P loading also available

Carbon storage



Carbon emission



N_2O and CH_4 now available (Tier 1)

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Land management interventions tested

- Retain Winter Stubbles
- Allow Woodland Edge to Develop Out into Adjoining Field
- Grazing Management of Open Country
- Grazed Permanent Pasture with No Inputs
- Create Streamside Corridor with Tree Planting
- Mechanical Bracken Control

Outcomes projected by LUCI are not large!

Management Option	Scenario	Change in stored carbon (%)	% gain in accessible area to broadleaf woodland focal species (%)	Reduction in connectivity of highly erodible land to water bodies (%)	Reduction in flood generating land (%)	Sediment reduction (%)	N reduction (%)	P reduction (%)
(Streamside Corridor	High	0.52	11.7	6.7	8.8	14.3	1.1	8.2
	Medium	0.43	9.6	5.8	7.9	11.9	0.9	6.4
	Low	0.36	5.9	4.4	6.3	8.1	0.7	3.9
Woodland Edge	High	0.41	3.7	1.5	1.7	3.5	0.9	2.3
	Medium	0.36	3.1	1.3	1.5	2.8	0.7	1.6
	Low	0.30	2.9	1.2	1.2	2.1	0.4	1.1
Open Country	High	-	-	-	-	-	1.6	2.9
	Medium	-	-	-	-	-	1.4	2.8
	Low	-	-	-	-	-	1.4	2.8
No inputs	High	-	-	-	-	-	8.2	5.6
	Medium	-	-	-	-	-	6.7	3.9
	Low	-	-	-	-	-	4.9	2.6

Uncertainty, spatial targetting and trade-offs explored

e.g. 10 fold different in the impact of tree planting if planting randomly compared to 'LUCI optimised' for benefit for water services

Scenario	% catchment with non-mitigated flood/sediment/ nutrient delivering land	Change in landcover from baseline (%)	Area of catchment benefitted by planting (%)	Ratio of area benefitted to area directly modified (-)
Baseline (LCM2007)	49.2	- (baseline)	- (baseline)	- (baseline)
Random planting	47.7	0.9	1.5	1.7
Riparian planting	33.3	0.9	15.9	17.7

Future for LUCI in Wales

- National reporting
- Identify spatial targeting of payments
- How to build in greater resilience
- Identifying alternative interventions they be paying for
- In field assessment and self-reporting by farmers using a LUCI app (linked to ‘Mysoil’ app – 12million web hits, 12000 users)
- Information for cost-benefit analysis
- National accounts!?

GMEP data also will help deliver to many other national and international requirements:

EC Rural Development Plan +

- Water Framework Directive
- Habitats and Bird Directive
- Convention on Biological Diversity
- Kyoto/UN Framework Convention on Climate Change
- etc

- Metrics (e.g. LUC) used must be consistent across these e.g. landcover change also drives LULUCF GHG reporting

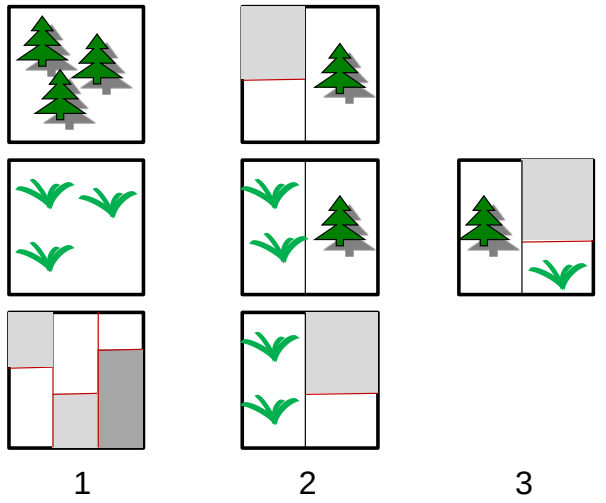
3 model comparisons in progress

Model inter-comparison 1 (River basin scale)

Models: LUCI; InVEST; ARIES

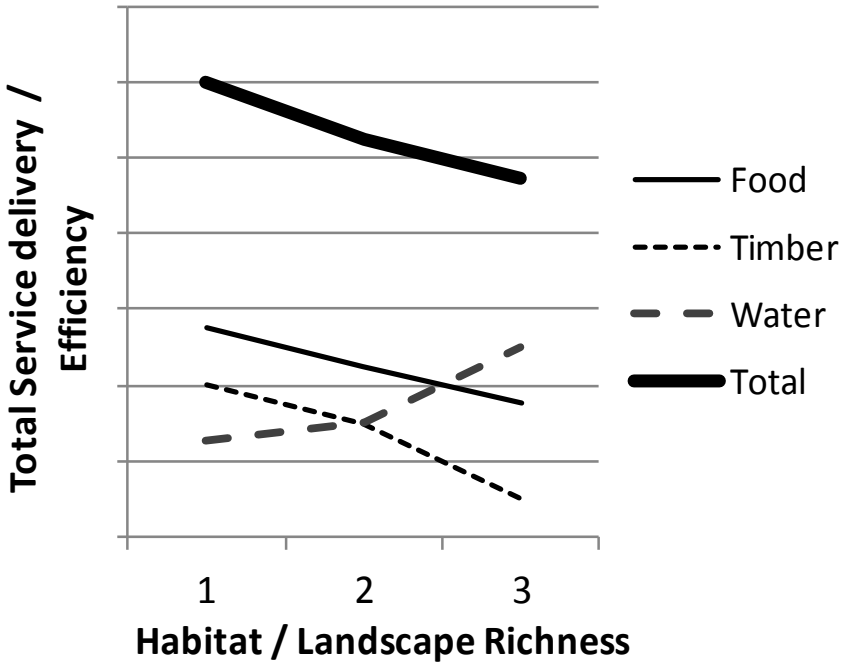
Spatial context to ecosystem service provision

The role of pattern, configuration, composition, size of landscape units for a test river basin (Conwy, North Wales)



4 services:

- Carbon sequestration
- Water supply
- Water quality regulation
- Agricultural production



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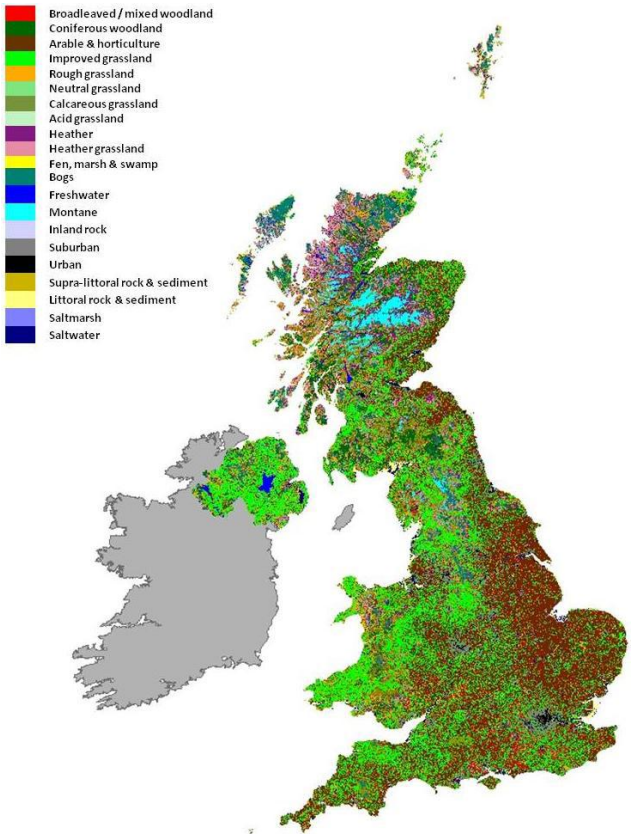
Model inter-comparison 2 (National scale)

Models: LUCI; InVEST;

InVEST application at UK scale in progress

Wales included so comparison of outputs with LUCI outputs possible



4 services:

- Carbon sequestration
- Water supply
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Model Intercomparison 3 (Multiple national scale)

Models: Co$ting Nature; InVEST; ARIES

Overarching Aim: : Which Ecosystem Service Models Best Capture the Needs of the Rural Poor in sub-Saharan Africa?"

Obj 1: To explore the appropriate level of model complexity required to map, in sufficient detail to inform policy, ES of importance to poverty alleviation in sub-Saharan Africa.

Ob. 2: To explore the potential and synergies of existing models of ES to make explicit the links between services, their benefit flows and human wellbeing changes of the poor.

Country	Biophysical data						Beneficiary data				
	p	Cro	Stor	Wat	Gra	Polli		Cro	Wat	Gra	Polli
Benin				✓					✓		
Burkina Faso			✓					✓			
Cameroon				✓					✓		
Equatorial Guinea				✓					✓		
Ethiopia	✓						✓				
Ghana			✓	✓				✓	✓		
Kenya	✓			✓	✓		✓		✓	✓	
Malawi	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
Namibia				✓					✓		
Nigeria				✓					✓		
Sierra Leone					✓					✓	
South Africa	✓	✓	✓	✓	✓	✓			✓		
Tanzania	✓	✓	✓	✓			✓	✓	✓		
Uganda				✓					✓		
Zambia	✓				✓	✓			✓		

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espa ecosystem services for poverty alleviation

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Questions?

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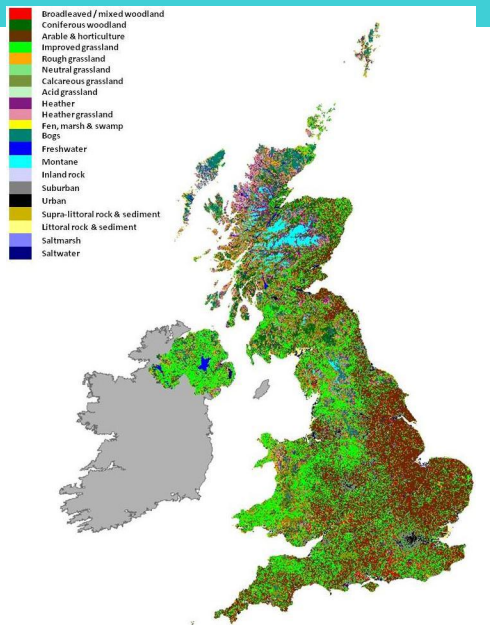
The UK is rich in data to enable integrated assessments such as that required by SEEA

- Landcover maps at 25m resolution , soils, DEM etc
- Integrated Monitoring Programmes e.g. Countryside Survey
- EU Inspire directive and UK data.gov.uk



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