Living With Environmental Change
LWEC

UK National Ecosystem Assessment

Ecosystem Services:

Emerging Science and the UK National Ecosystem Assessment

Ian Bateman, Head of NEA Economics Team

Presented at the First Annual Science Conference of CAMERAS
(Coordinated Agenda for Marine, Environment and Rural Affairs Science)

3rd March 2010

Discovery Point, Discovery Quay, Dundee

Understanding nature's value to society

NATURAL ENVIRONMENT RESEARCH COUNCIL

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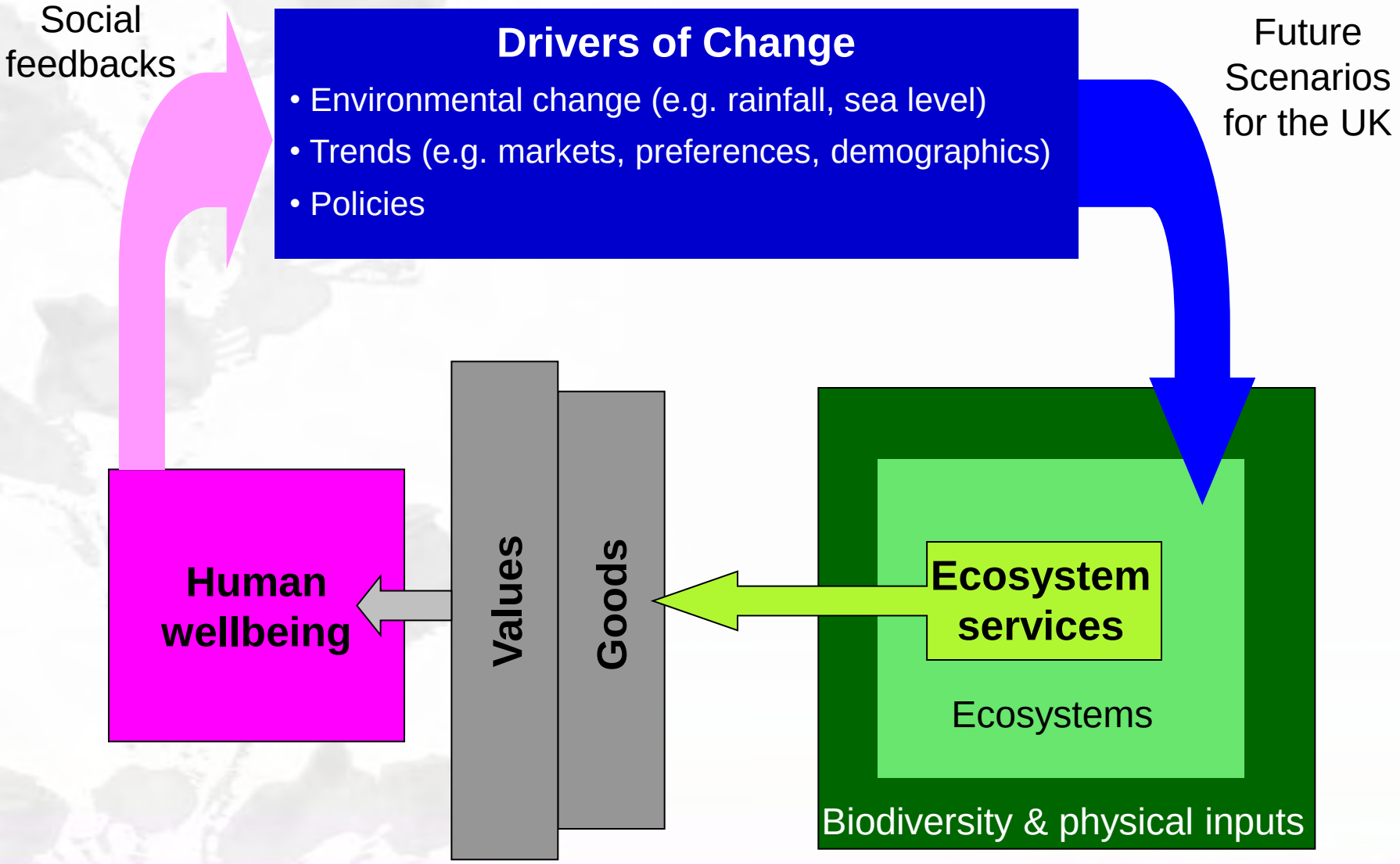
The Scottish Government

Llywodraeth Cynulliad Cymru
Welsh Assembly Government

Cyngor Cefn Gwlad Cymru
Countryside Council for Wales

NIEA Northern Ireland Environment Agency

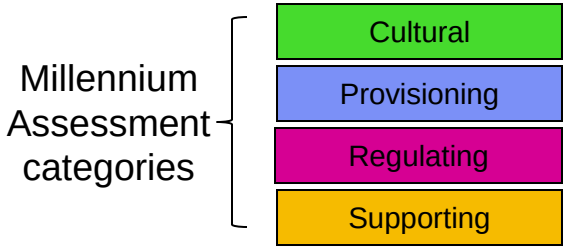
NEA: Overall Conceptual Framework



Drivers of change (Scenario generators)

Environmental change
Climate change (e.g. temperature, precipitation, atmospheric CO_2)
Air pollution (e.g. acid deposition, tropospheric ozone)
Sea level (e.g. flood risk)
Trends
Market forces (e.g. fuel price change, food supply)
Economic growth (e.g. demand for resources)
Social forces (e.g. Change in population, demographic s, ethnicity, etc.)
Technological change and input change (e.g. new crops, fertiliser usage)
Species introduction & removal
Policies
Subsidy and taxation levels (e.g. CAP reform)
Legislation (both environmental and related) (e.g. WFD)

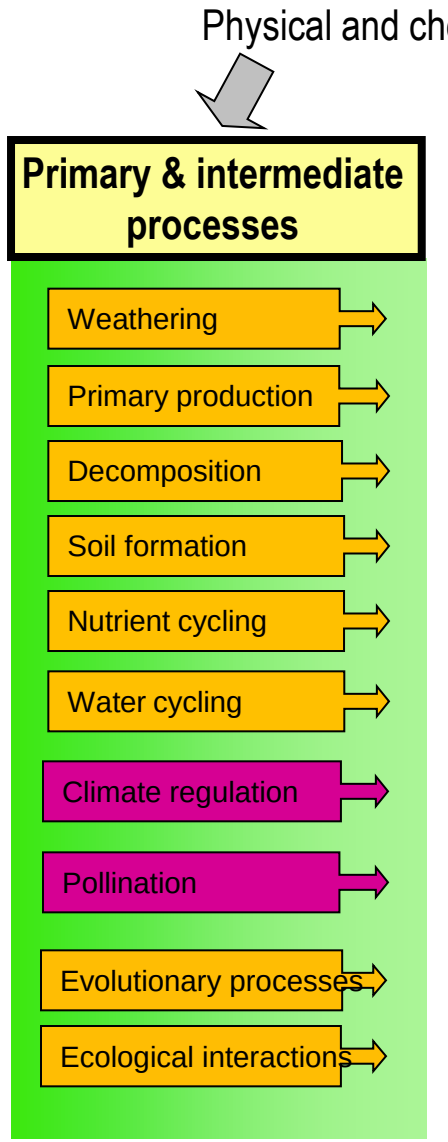
From ecosystem services to their value (avoiding double counting)



From ecosystem services to their value (avoiding double counting)

Millennium Assessment categories

- Cultural
- Provisioning
- Regulating
- Supporting



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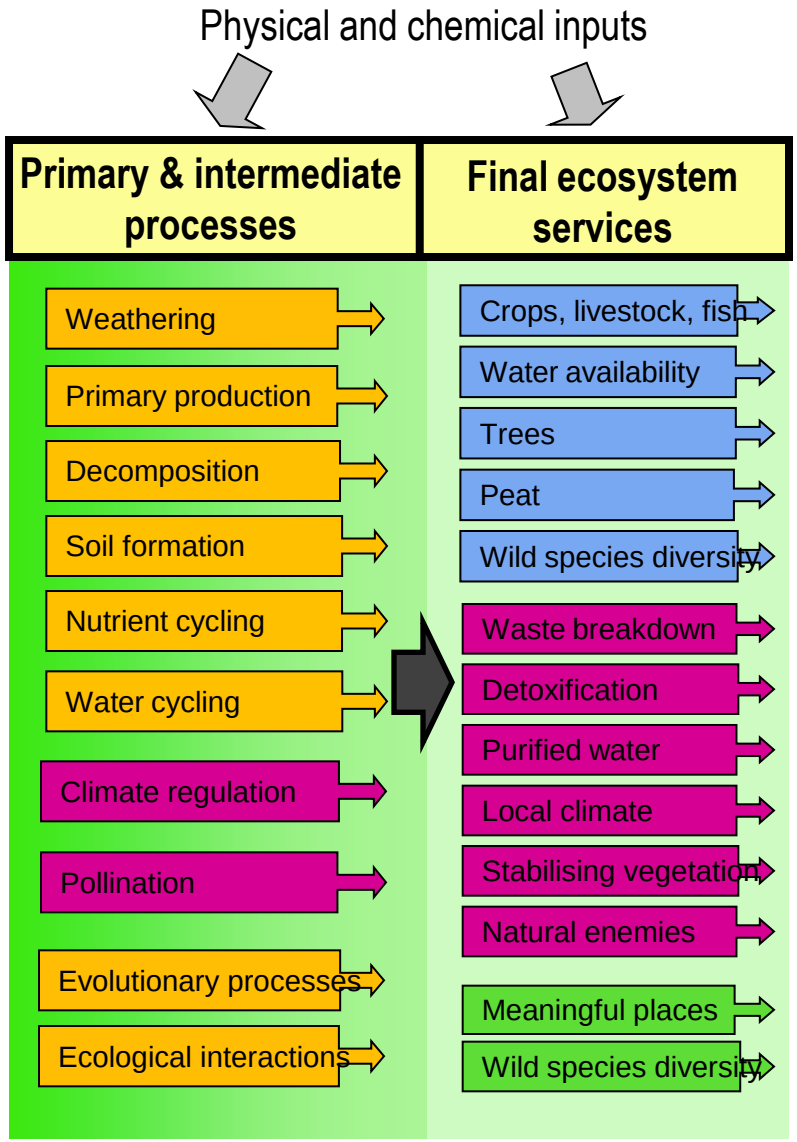

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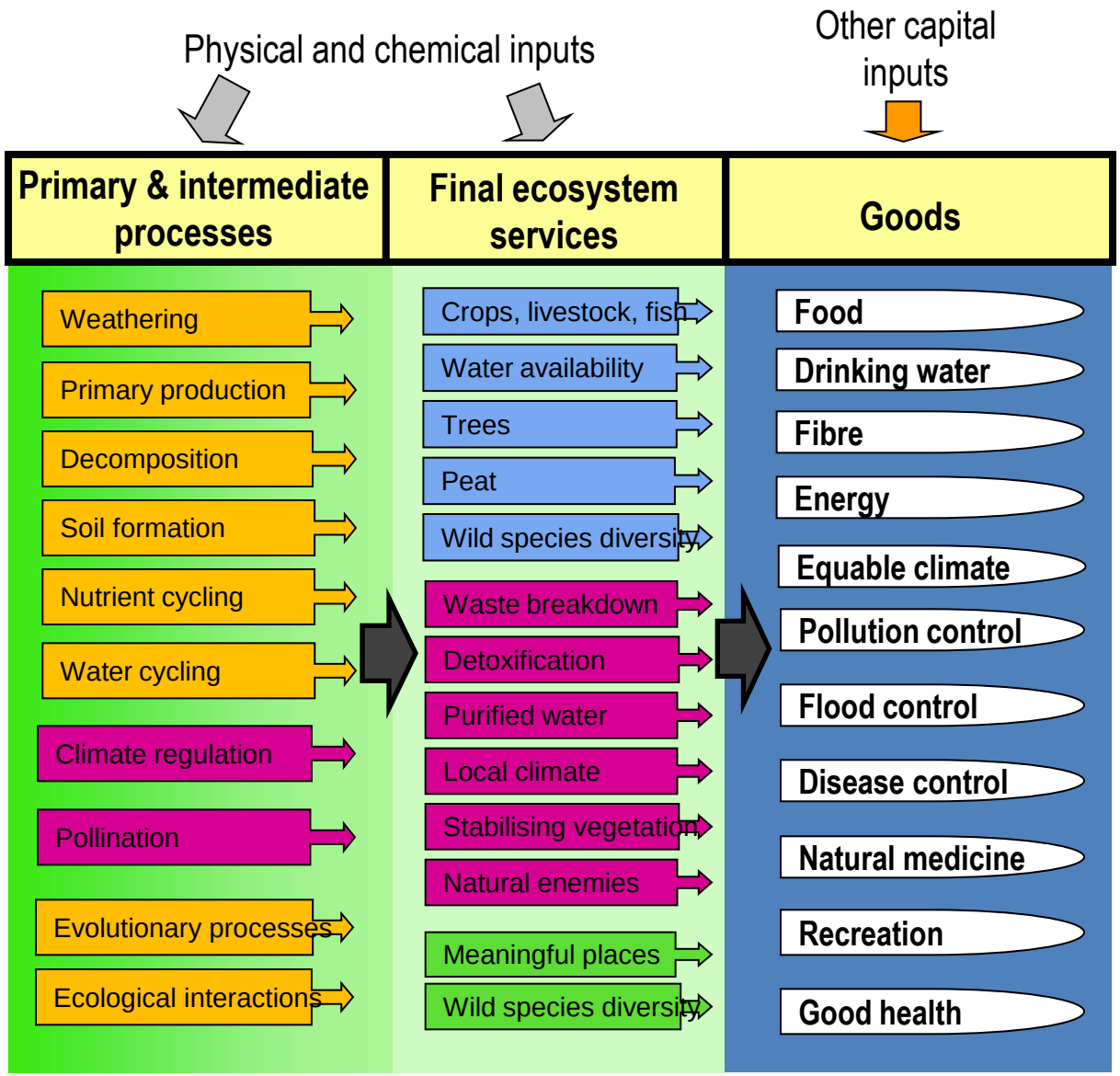

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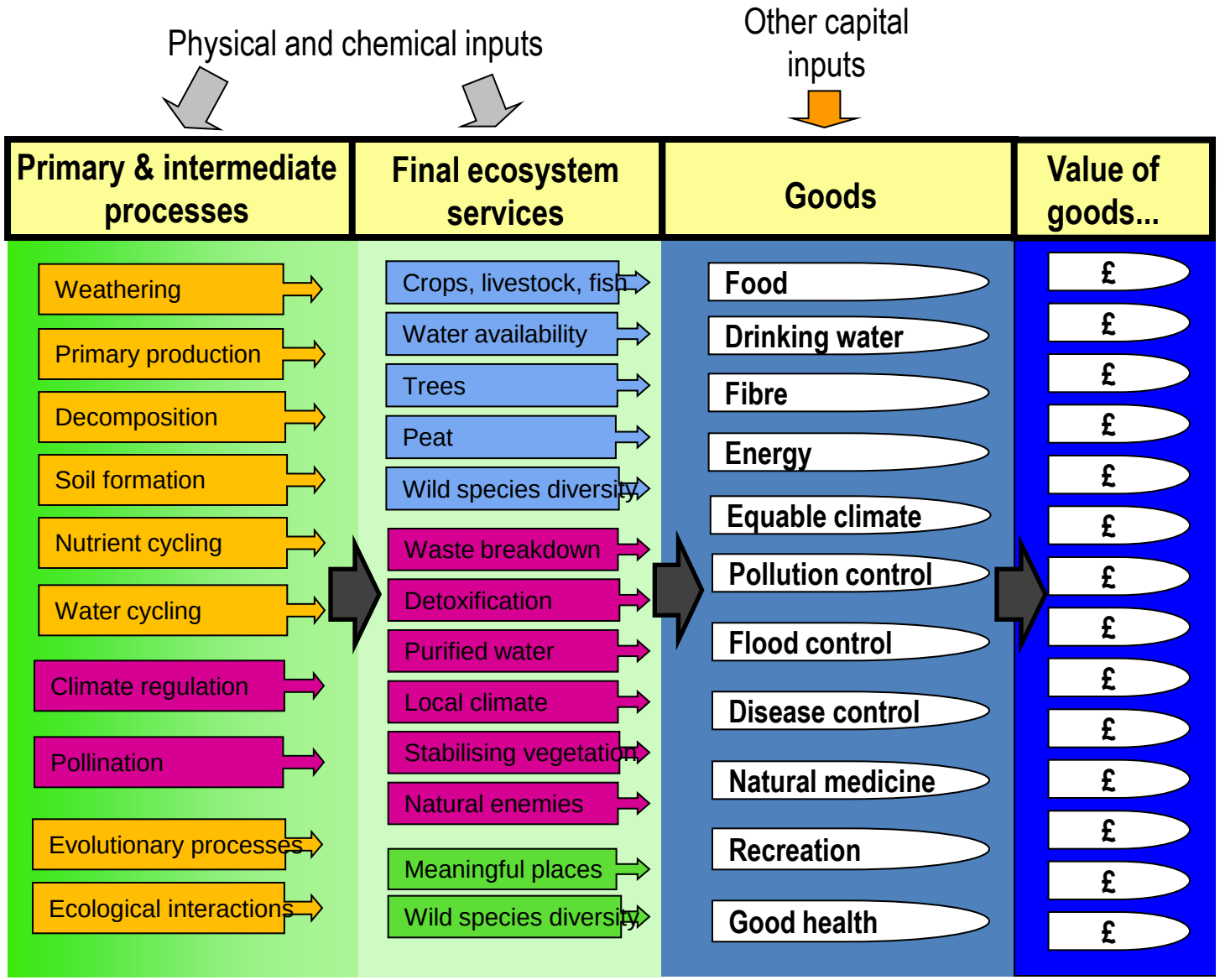

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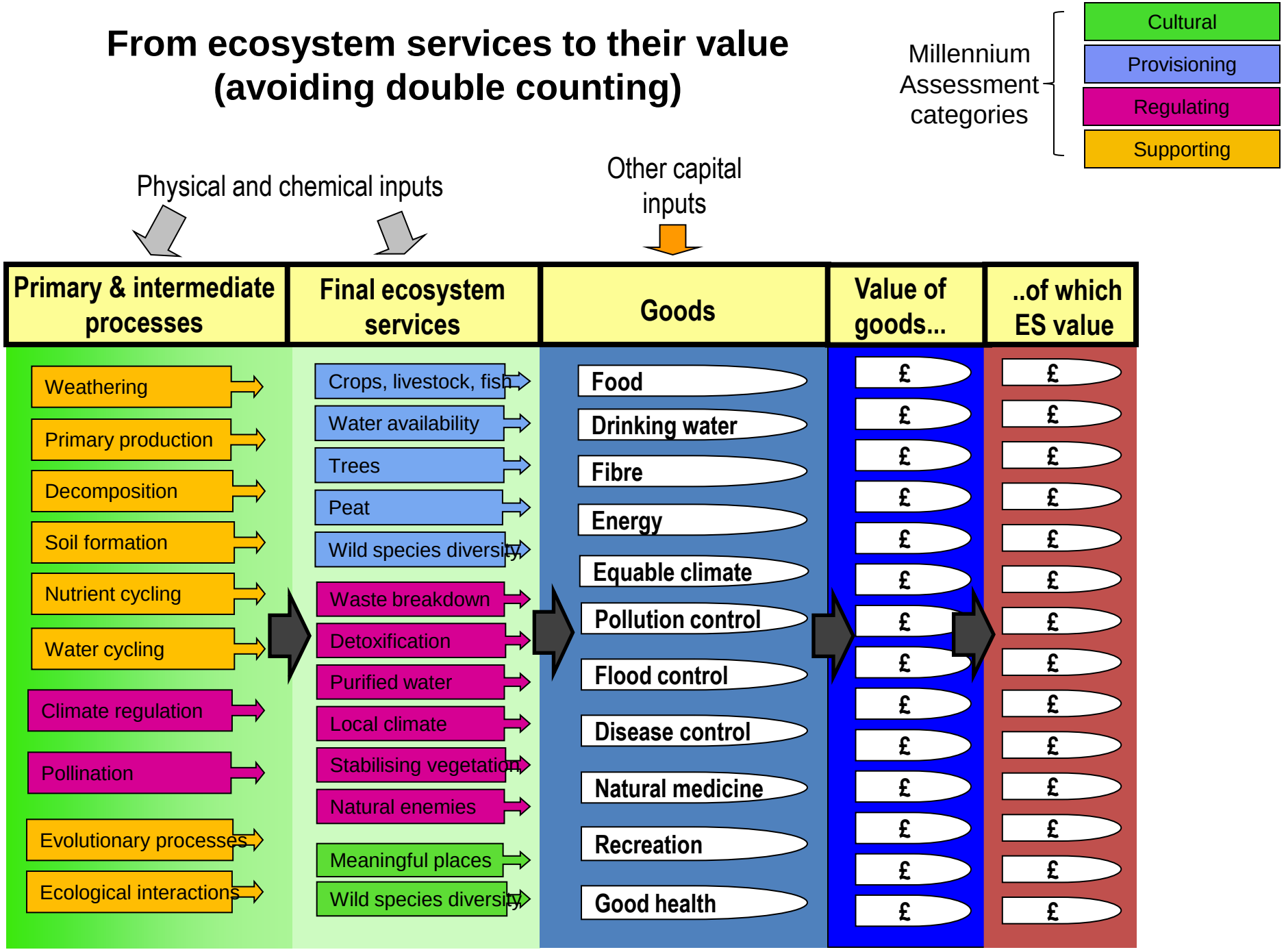

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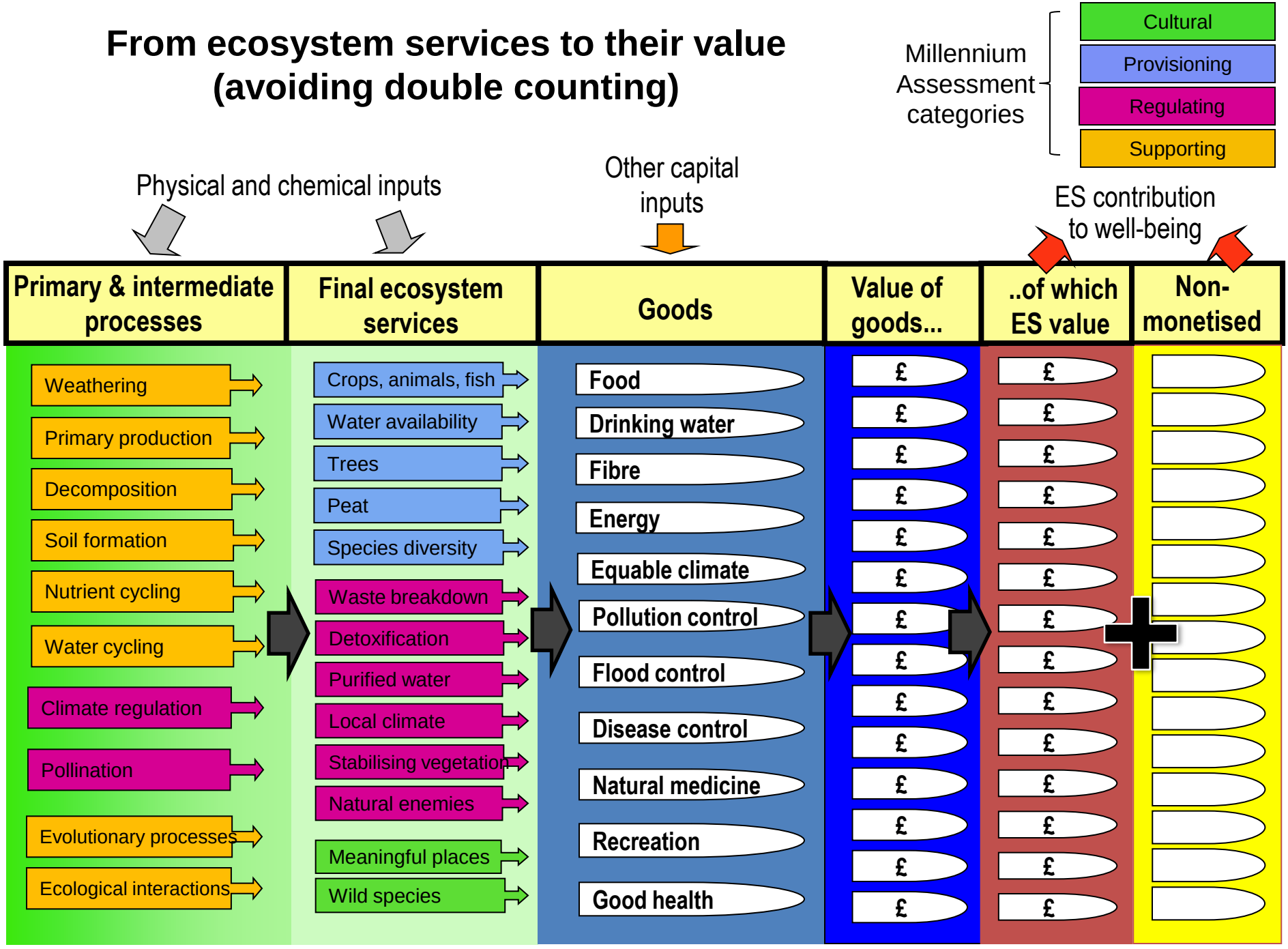
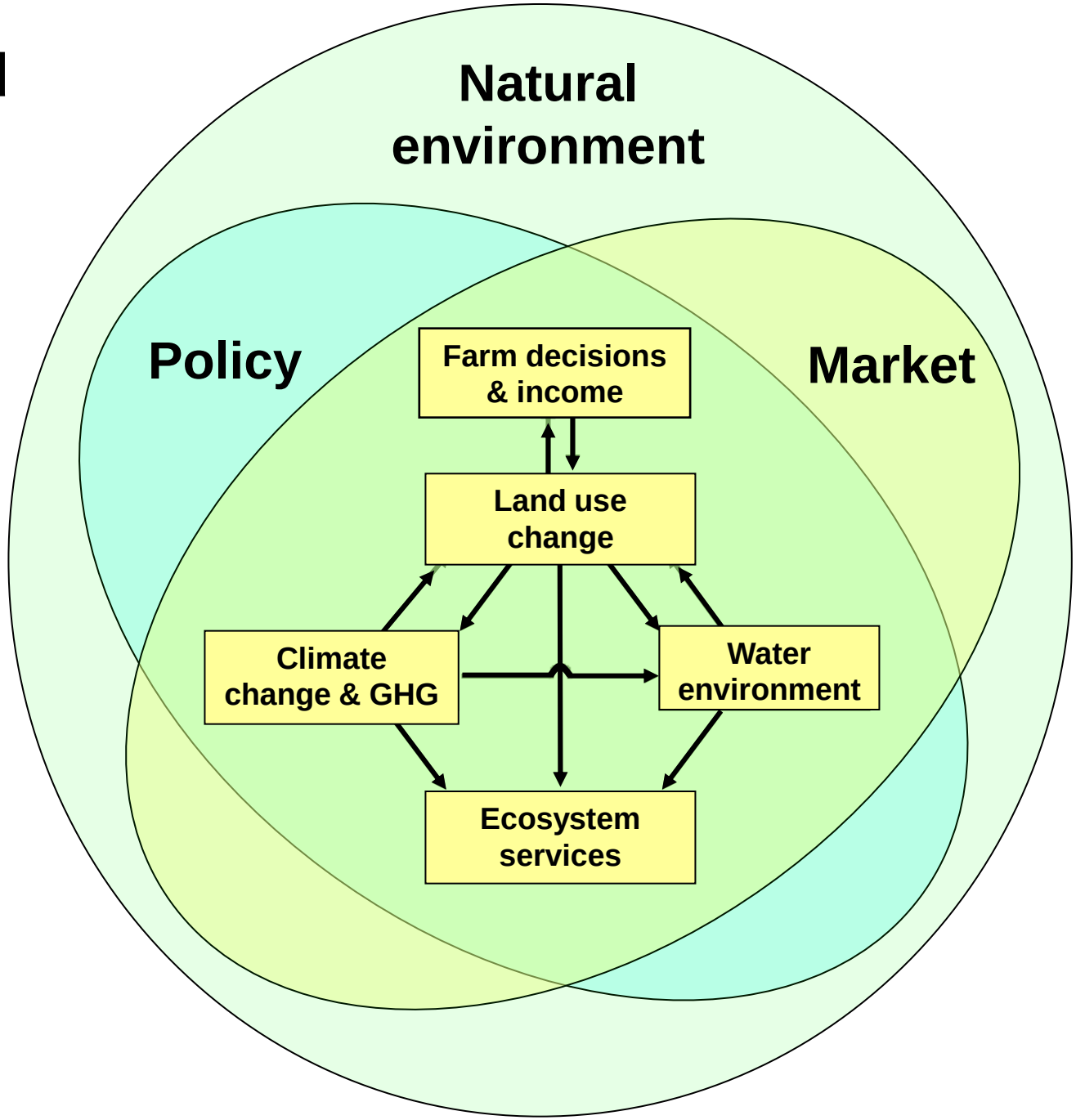


Integrated modelling



The main drivers of land use change

Set aside rate	Output prices	Soils
NVZ, ESA, Parks, etc.	Input costs	Temperature
Milk quota	Technology	Rainfall

Data

We assemble Agricultural Census data for **every 2km grid square, for all of England and Wales from 1969 to 2004** and combine this with over **50,000 farm years** of data from the **Farm Business Survey**. This gives:

- Agricultural **land use** hectares (wheat, barley, grass, etc.);
- **Livestock** numbers (dairy, beef, sheep, etc)
- **Time trends** (response times, new crops, etc.)

We then add

- **Environmental and climatic variables** (rainfall, temperature, machinery working days, field capacity, etc.);
- **Policy** determinants (NVZ, NSA, ESA, Parks, etc.)
- **Input** and **output prices** for the period

Analysis

We specify a quadratic profit function normalised to account for fuel price fluctuations and estimated using a panel tobit analysis solving equations for each land use activity as a joint system

$$\bar{\pi} = \alpha_0 + \sum_{i=1}^{m+n-1} \alpha_i r_i + \frac{1}{2}\sum_{i=1}^{m+n-1}\sum_{j=1}^{m+n-1} \alpha_{ij} r_i r_j + \sum_{i=1}^{h} \beta_i l_i + \frac{1}{2}\sum_{i=1}^{h}\sum_{j=1}^{h} \beta_{ij} l_i l_j + \sum_{i=1}^{k} \gamma_i z_i +$$

$$+ \frac{1}{2}\sum_{i=1}^{k}\sum_{j=1}^{k} \gamma_{ij} z_i z_j + \frac{1}{2}\sum_{i=1}^{m+n-1}\sum_{j=1}^{h} \delta_{ij} r_i l_j + \frac{1}{2}\sum_{i=1}^{m+n-1}\sum_{j=1}^{k} \phi_{ij} r_i z_j + \frac{1}{2}\sum_{i=1}^{h}\sum_{j=1}^{k} \varphi_{ij} l_i z_j$$

Does it work?

The corresponding land use equations:

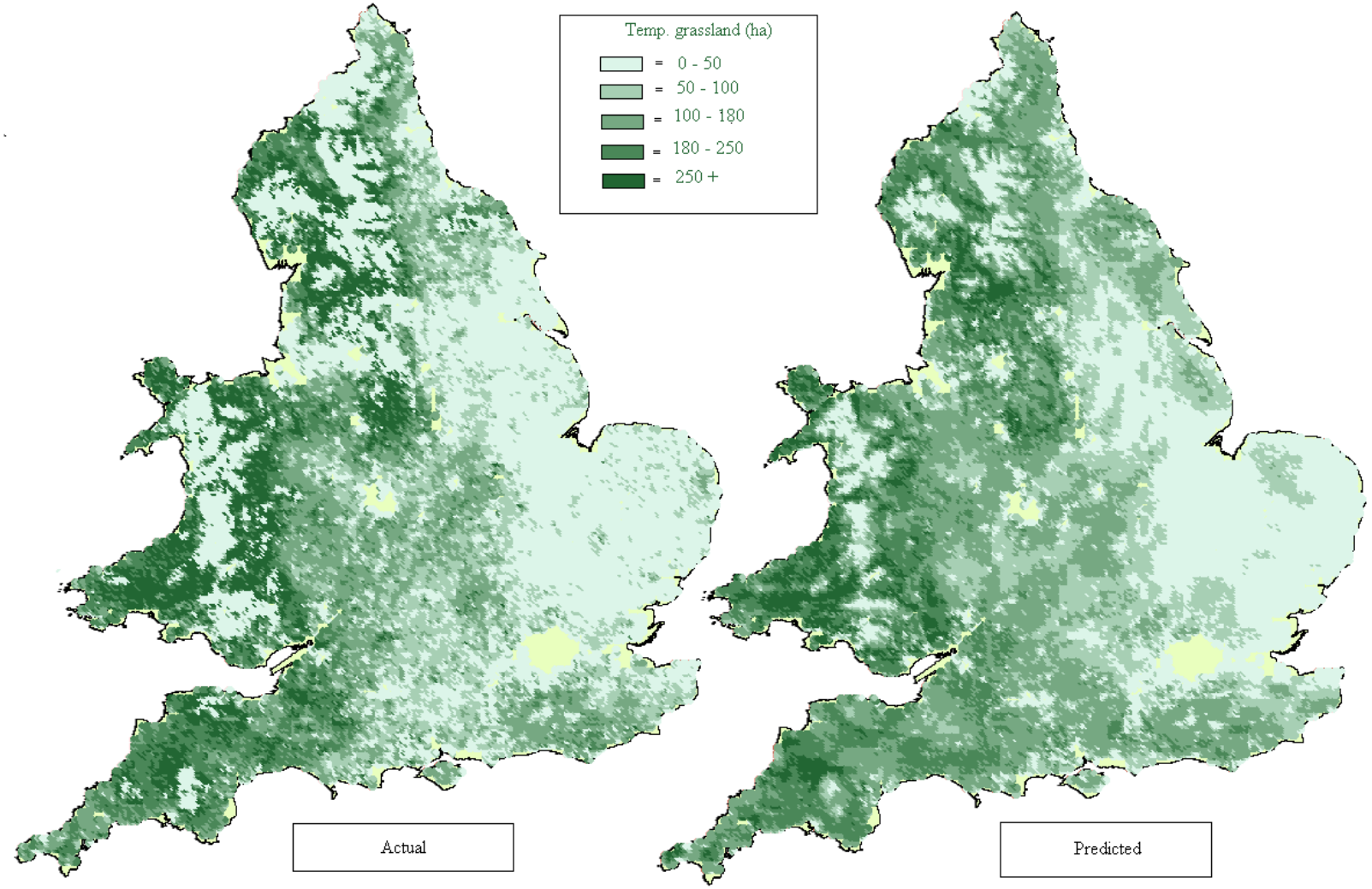
$$l_j = \theta_j + \sum_{i=1}^{m+n-1} \theta_{ji} r_i + \sum_{i=1}^{k} \vartheta_{ji} z_i + \vartheta_j L$$

and livestock intensity equations:

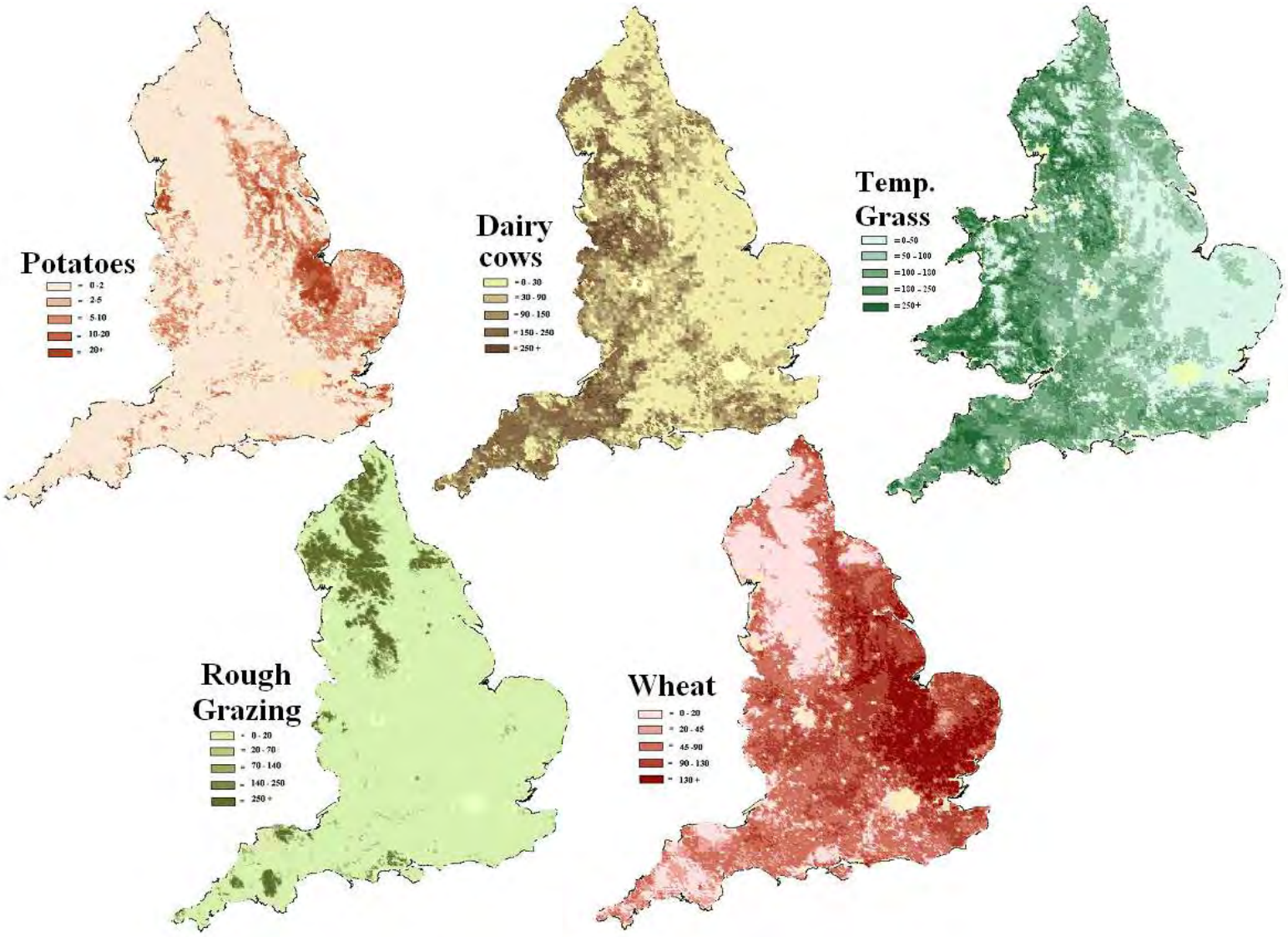
$$y_i = \alpha_i + \sum_{j=1}^{m+n-1} \alpha_{ij} r_j + \sum_{j=1}^{h} \delta_{ij} l_j + \sum_{j=1}^{k} \phi_{ij} z_j$$

Actual versus predicted test

Example: predicting the amount of temporary grassland

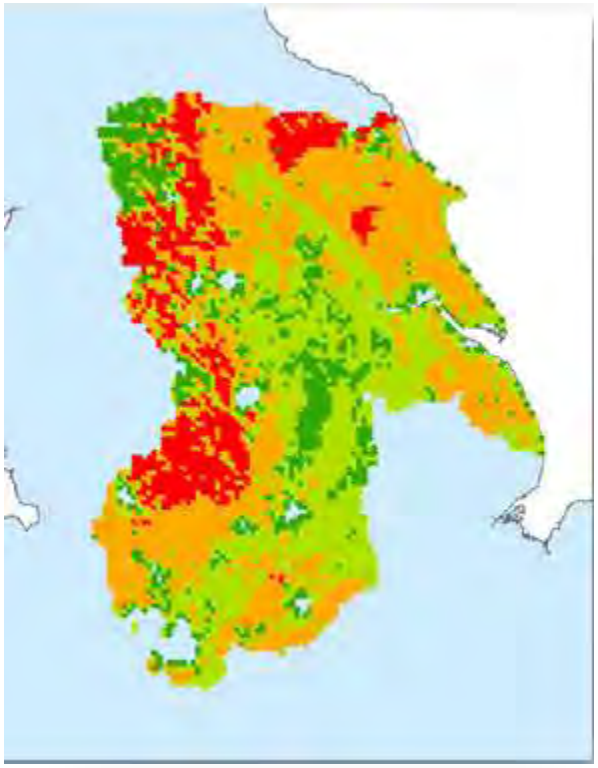


Predicting other land uses



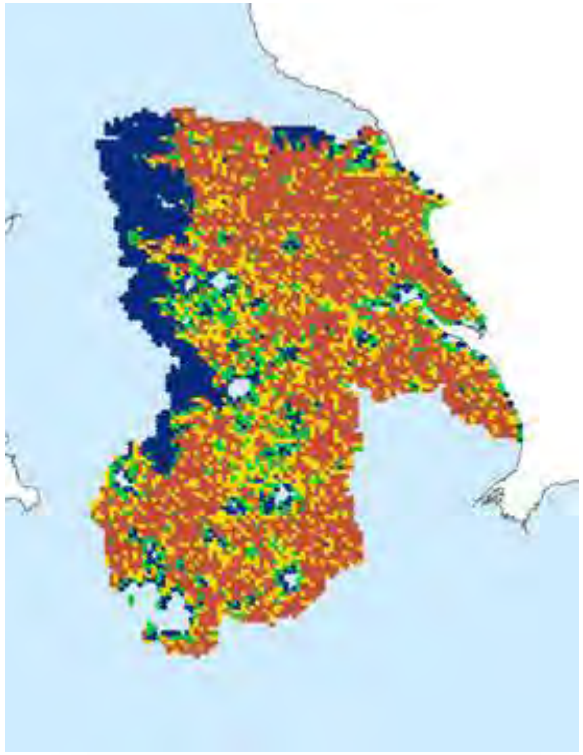
Predicting farm response to changes

e.g. Market liberalization:
impact on beef cattle numbers



= none < 35
= small 35 - 65
= moderate 65 - 95
= significant 95 +

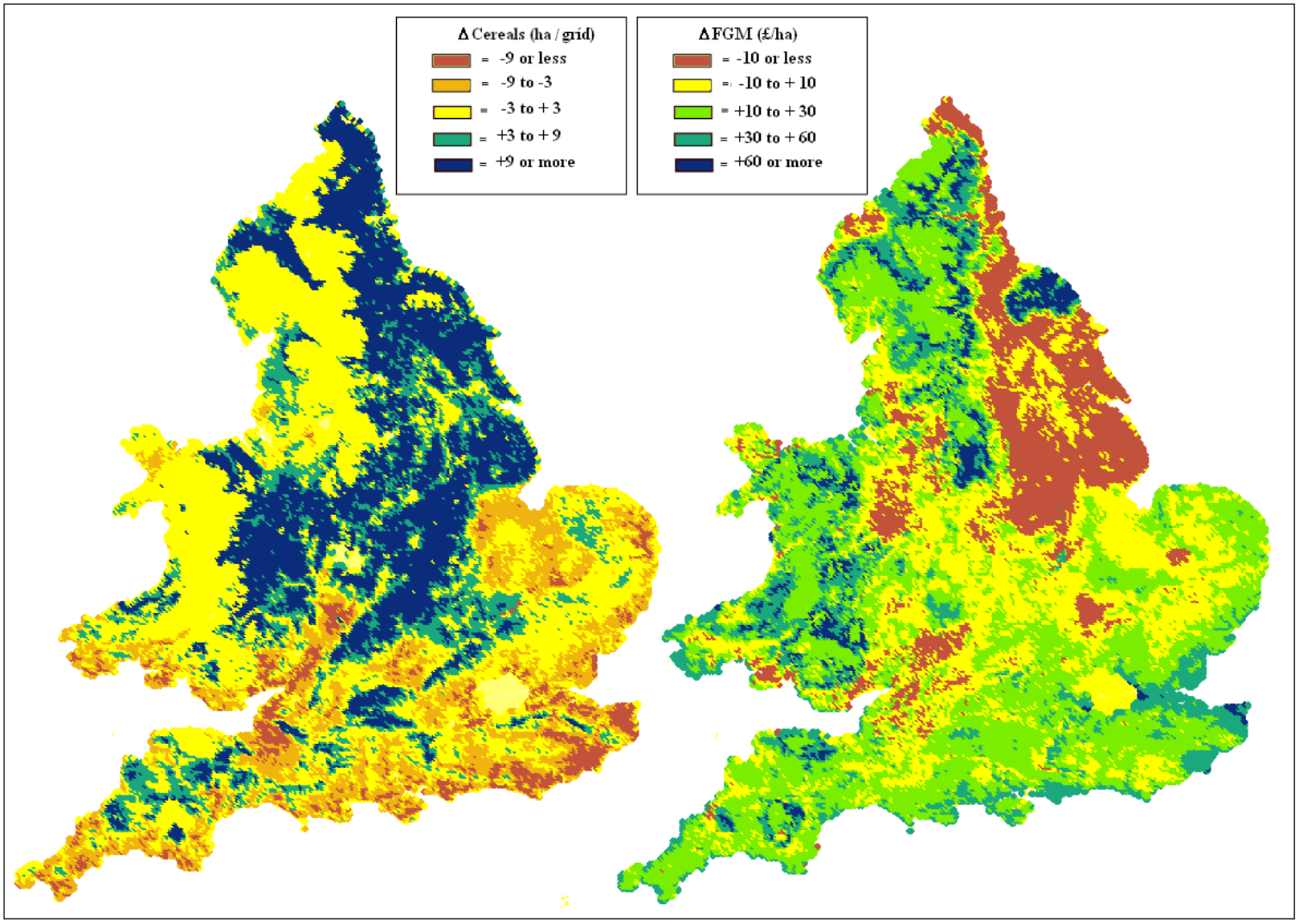
e.g. Climate change:
impact on cereal acreage



= none < 4ha
= small 4ha - 10 ha
= moderate 10ha - 15ha
= significant 15ha +

Full country analysis: e.g. Climate change simulation

Simple test: 1^0C increase (currently analysing UKCP09)

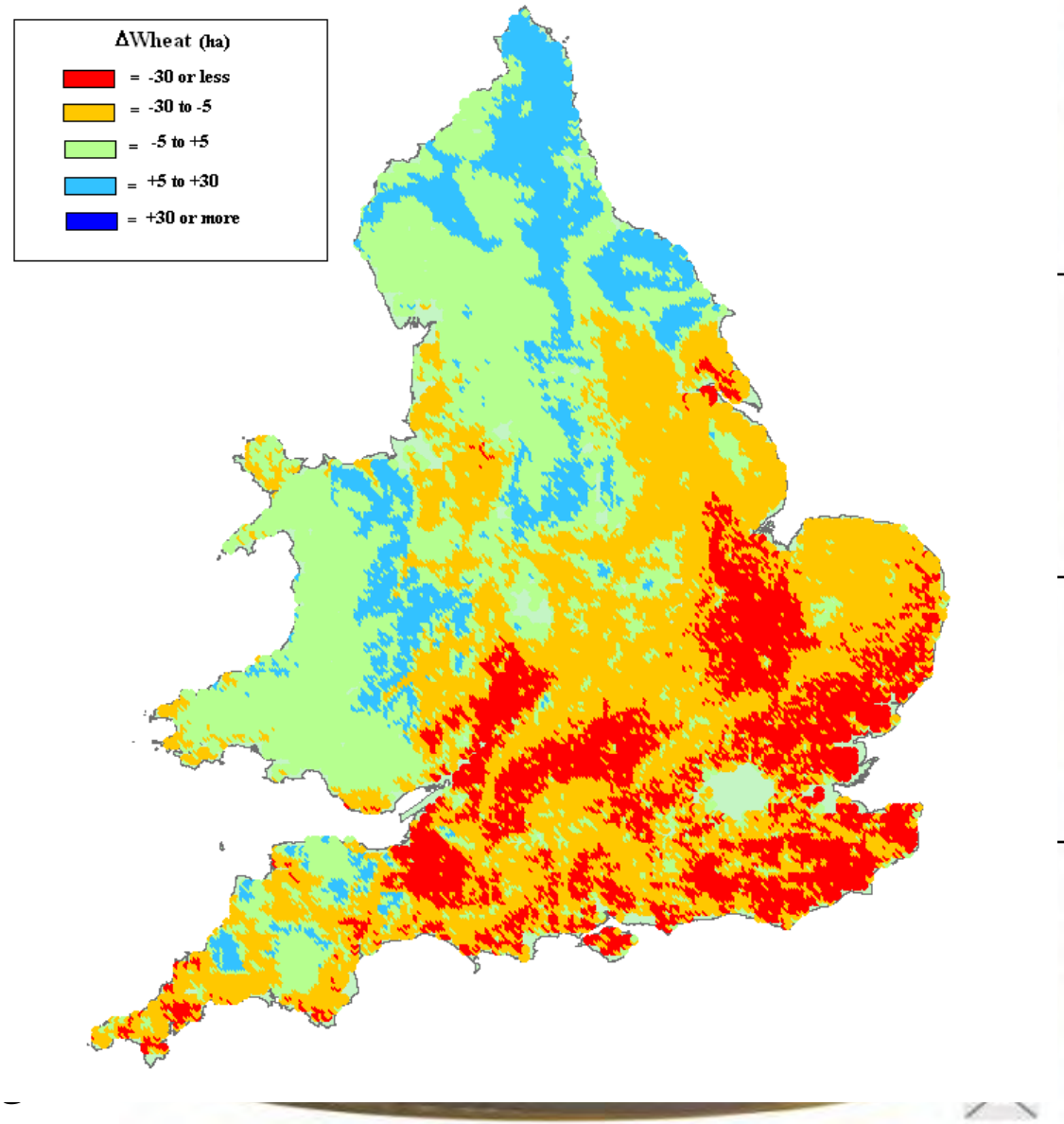


Land use change & water quality

Modelling land use change as a result of:

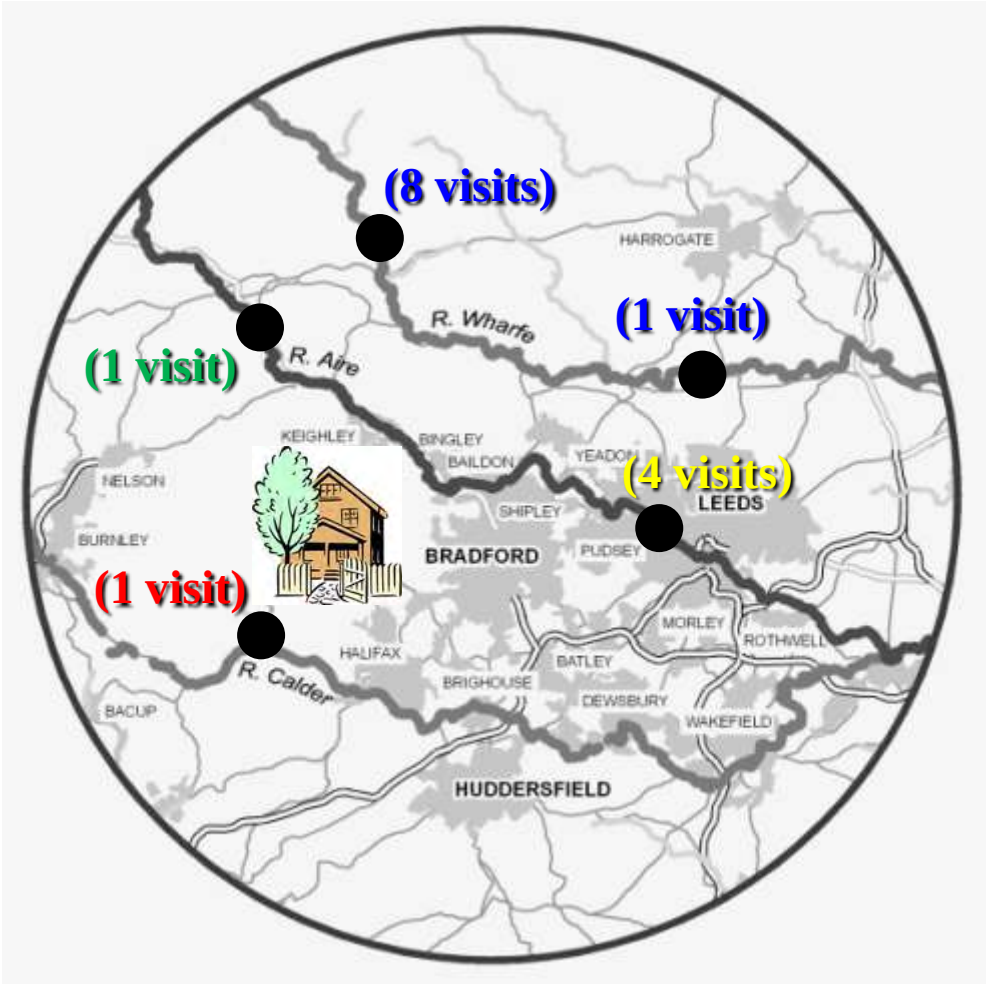
- climate change;
- new policy;
- world market shifts;
- etc.

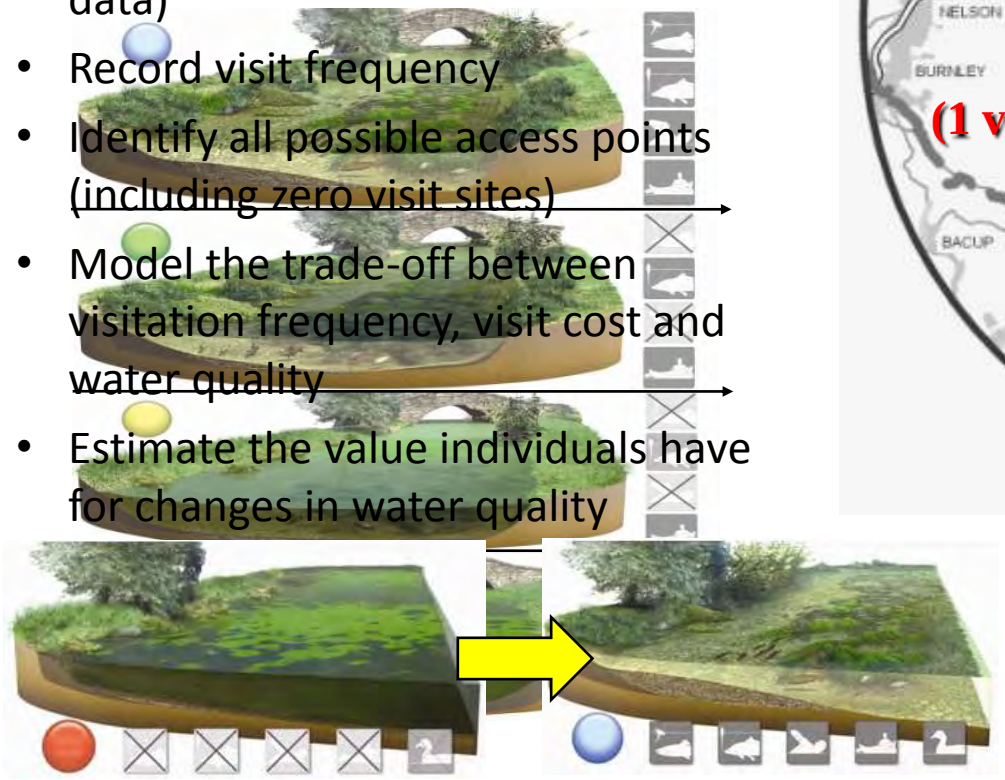
Integrated modelling:
Modelling the impacts of land use change on river water quality and ecosystems services
Linking land use with diffuse water pollution
Also estimating resultant farm incomes - and how water policy forces land use to change



Valuing water quality improvements

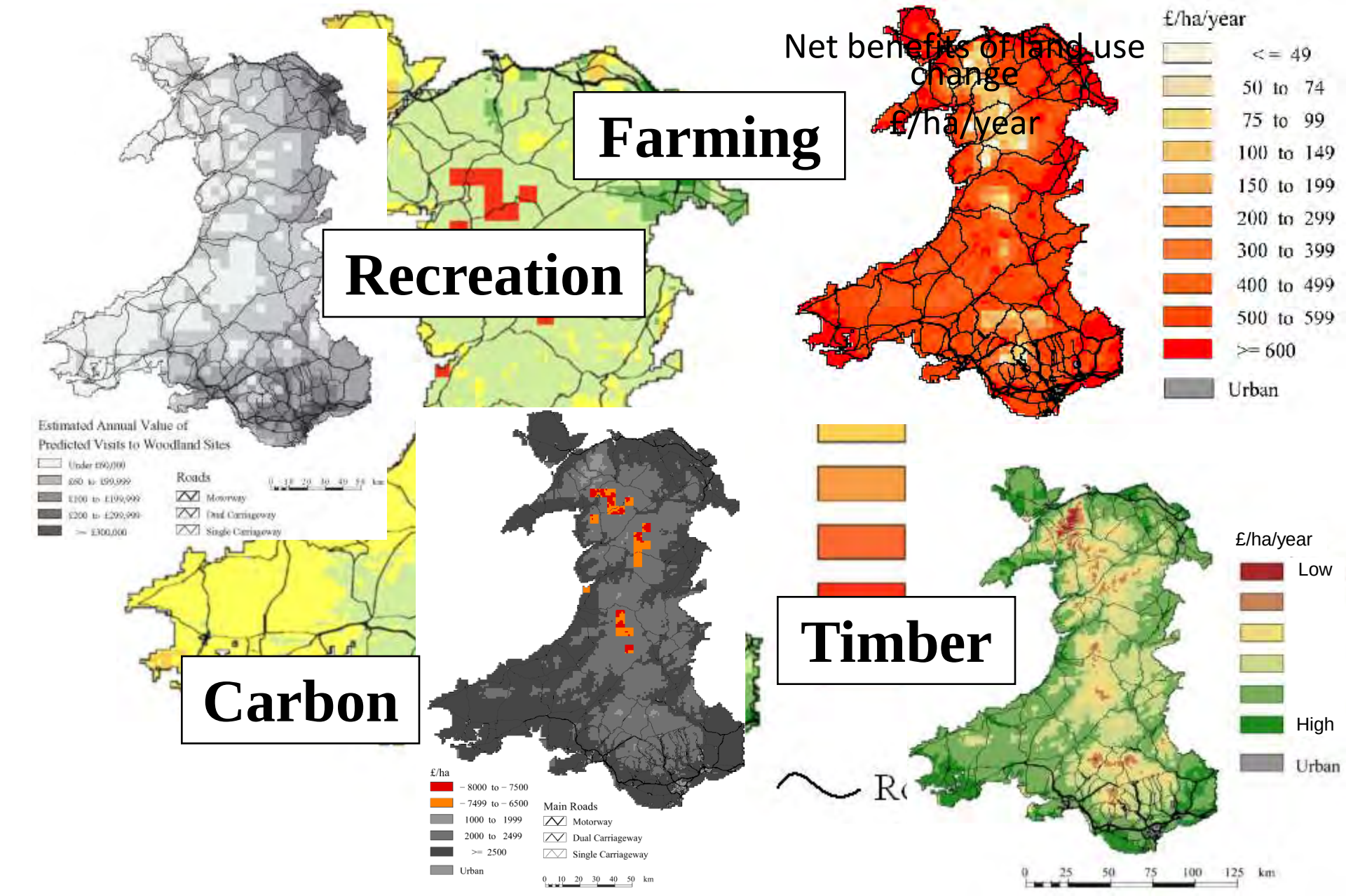
- Survey of a diverse sample of over 2,000 households across a wide area with variable water quality (enhances transferability)
- For each respondent: Home located
- Locate visited sites
- Characterise water quality (e.g. EA data)
- Record visit frequency
- Identify all possible access points (including zero visit sites)
- Model the trade-off between visitation frequency, visit cost and water quality
- Estimate the value individuals have for changes in water quality





Moving from poor to good quality water increases the value of a river visit by about **£14** per party

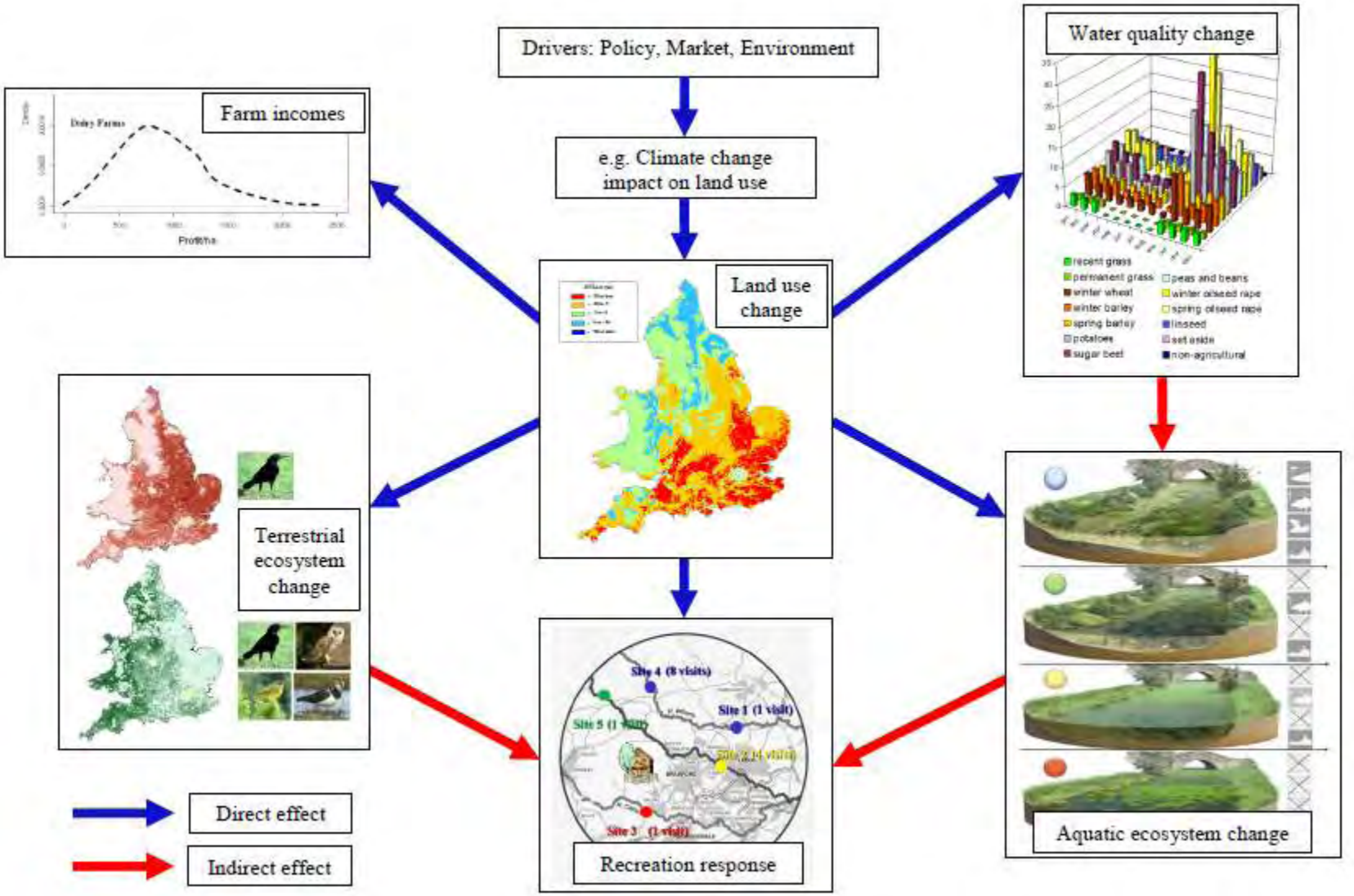
Decision making for competing land uses



Ongoing work:
Biodiversity impacts of land use change

- With BTO and others
- Link data on wildlife to data on land use
- Models predict ecosystem service response to policy, market and climate change pressures
- Allows targeting of policies

Summary: Integrated modelling of policy, market or environmental change



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