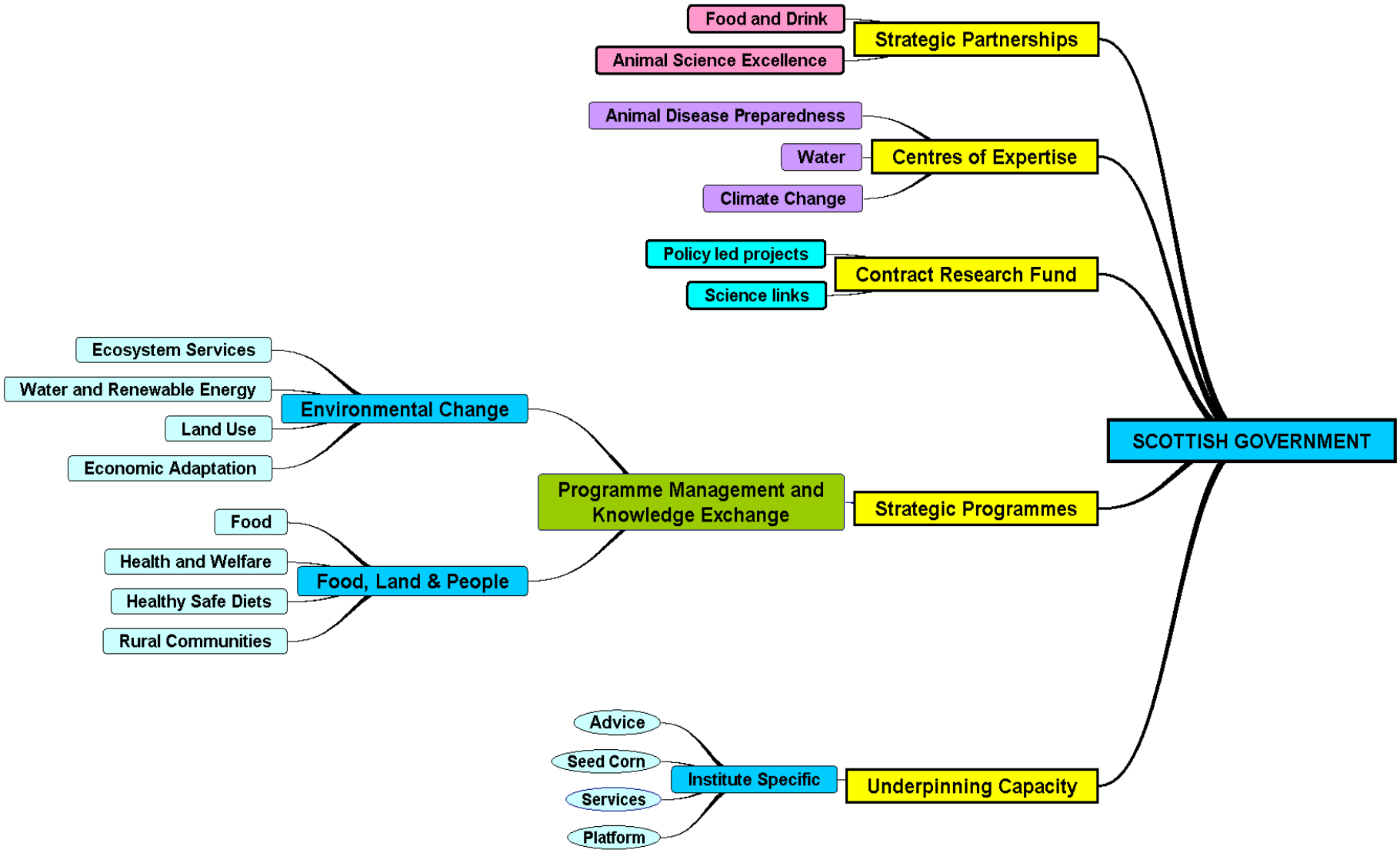
Introduction to the RESAS Programme

Phil Balls

Rural and **E**nvironment **S**cience and **A**nalytical **S**ervices

RESAS Research Portfolio

- Support for policy
- Support for innovation and the economy
- Scientific excellence
- Scientific resilience and sustainability
- Collaboration and multidisciplinary working


SCOTTISH GOVERNMENT
Strategic Partnerships
Food and Drink
Animal Science Excellence
Centres of Expertise
Animal Disease Preparedness
Water
Climate Change
Contract Research Fund
Policy led projects
Science links
Strategic Programmes
Programme Management and Knowledge Exchange
Environmental Change
Ecosystem Services
Water and Renewable Energy
Land Use
Economic Adaptation
Food, Land & People
Food
Health and Welfare
Healthy Safe Diets
Rural Communities
Underpinning Capacity
Institute Specific
Advice
Seed Corn
Services
Platform

Relevant Research

- SG Strategic Research Programmes;
- Climate Change Centre of Expertise:
- Contract Research Fund - UK Greenhouse Gas Inventory, working with the UK Government and Devolved Administrations.
- ALL DRIVEN BY HIGH LEVEL POLICY INITIATIVES AND COMMITMENTS

Challenges, Challenges …..

- Meeting international reporting requirements (United Nations Framework Convention on Climate Change);
- Tracking progress towards Scottish and UK legislative targets;
- Presenting mitigation options an individual business can apply.

‘Agriculture’ Category

Emissions primarily from:

- Use of nitrogen in agricultural soils (nitrous oxide):
- Enteric fermentation in livestock (methane):
- Agricultural manure management (methane and nitrous oxide):

‘Land Use, Land Use Change and Forestry’ (LULUCF) Category

- Unique in reporting **C sinks** as well as sources;
- Covers transitions between cropland, grassland, forest land and settlement;
- Changes in **soil carbon** the main driver;

The SG's 'Report on Policies and Proposals'

- 'Rural Land Use' = agriculture and related land use, and forestry
- 'Agriculture and Related Land Use' – brings together emissions reported under different categories in the UK GHG Inventory ('Agriculture' and 'LULUCF')

Even limited ingredients are versatile

With more ingredients the options increase!

+

=

+

Musicians, civil servants (& researchers?)

Enough to be brilliant?

“Each member of the band is a soloist in their own right. It’s only when they play together they get into trouble!”

Making Music

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Climate Change and Carbon Management

Bob Rees and Rebecca Audsley

SAC Carbon Management Centre

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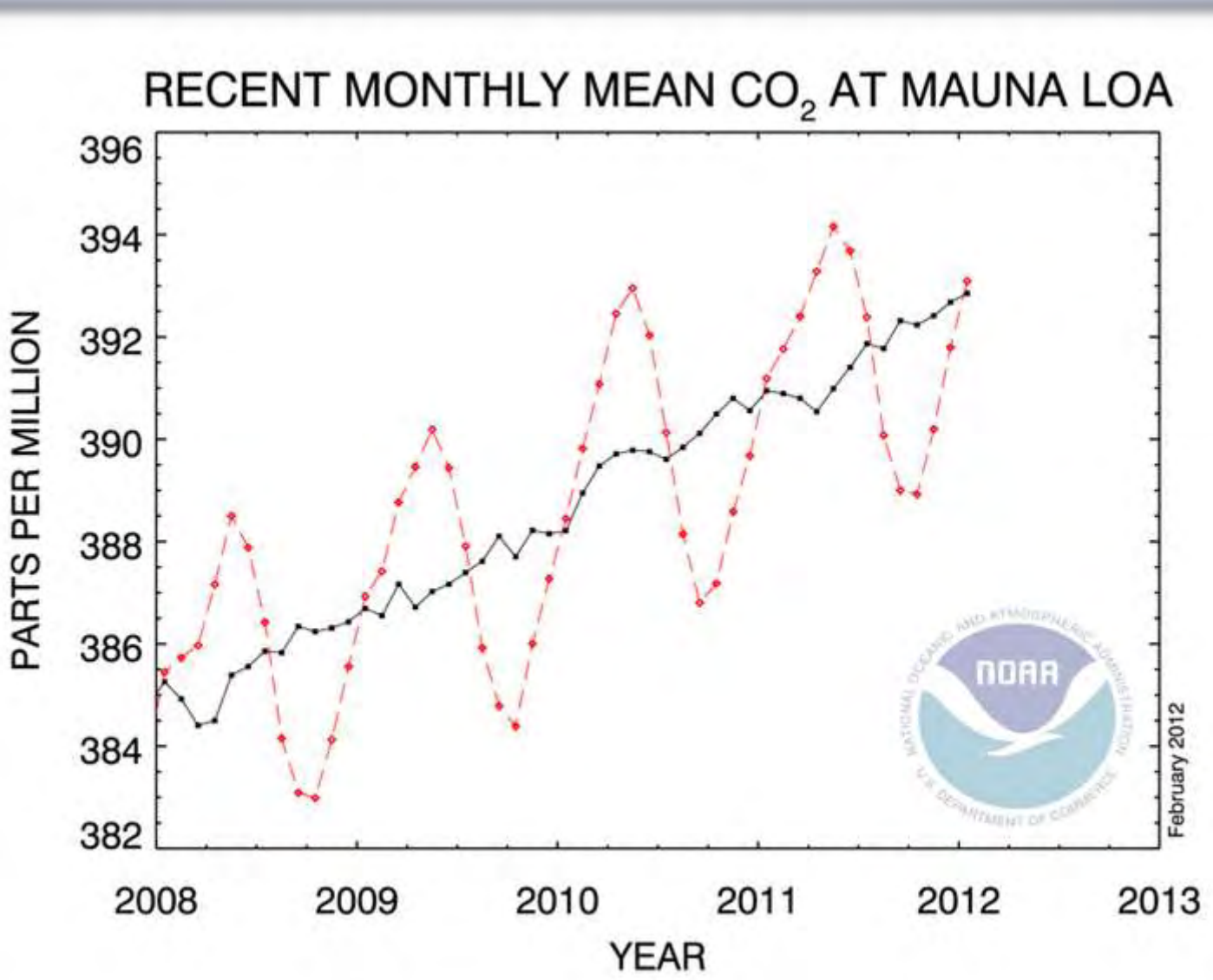
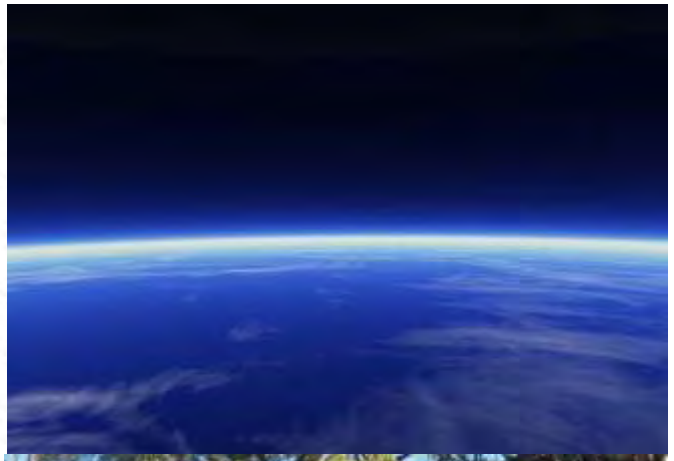

RECENT MONTHLY MEAN CO_2 AT MAUNA LOA
PARTS PER MILLION
396
394
392
390
388
386
384
382
2008
2009
2010
2011
2012
2013
YEAR
NOAA
February 2012

CO_2 emissions

Distribution (fraction)



Canadell et al 2007

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Royal Botanic Garden Edinburgh

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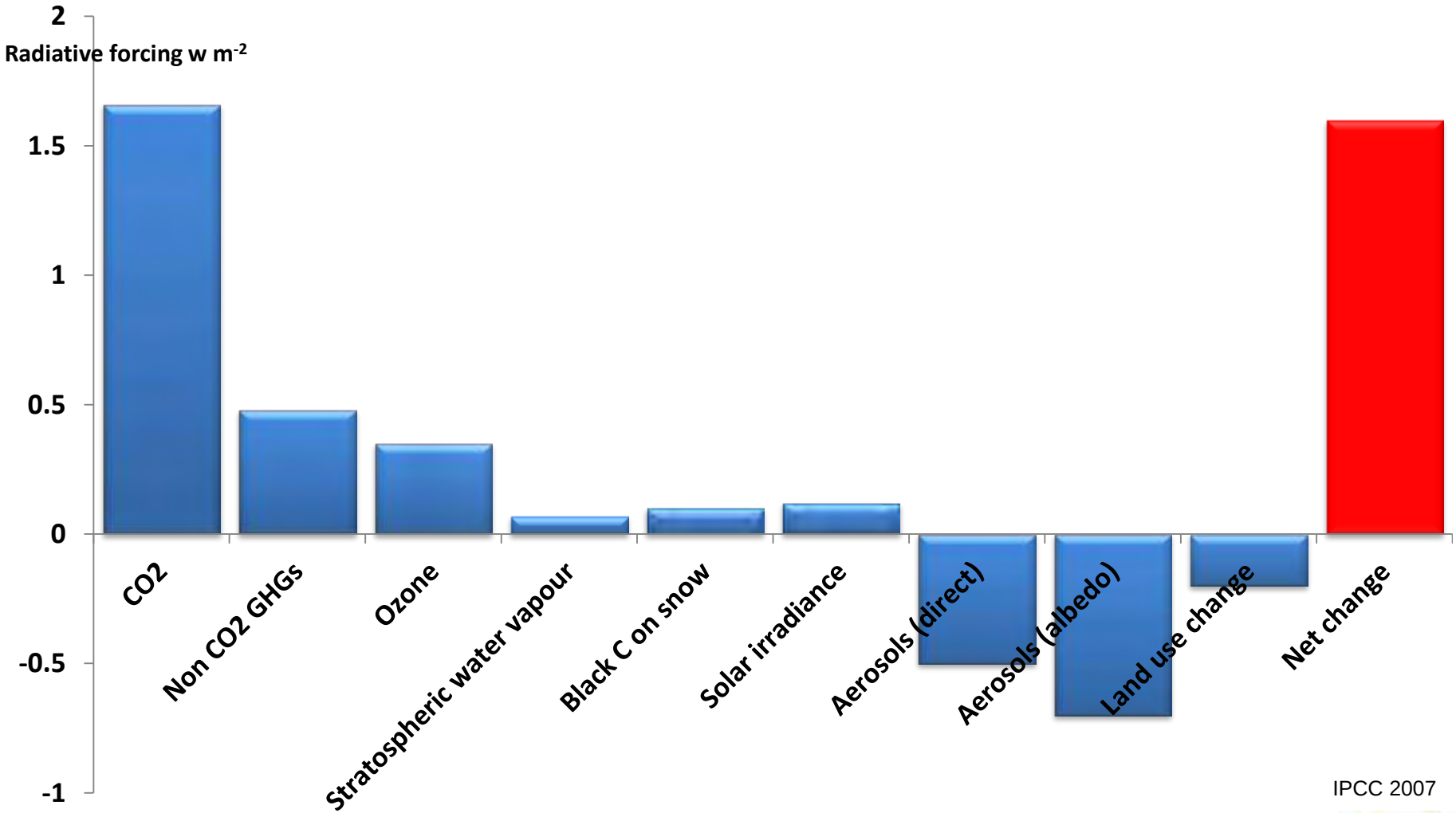
SAC

The Scottish Government

Warming of the climate



IPCC 2007

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The Scottish Government

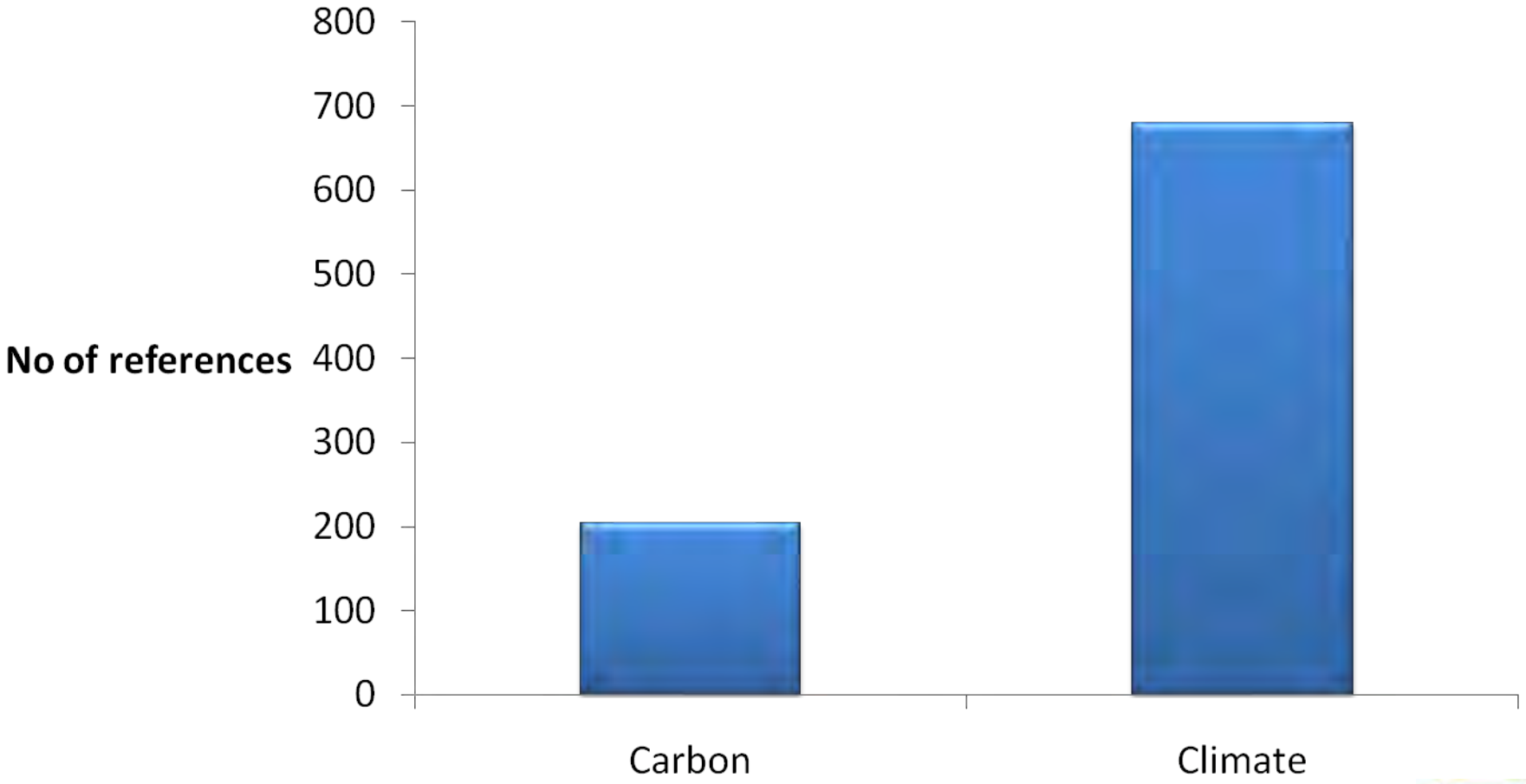
Overall Aim of the RESAS Strategic Programme

To build a platform of knowledge that informs issues related to climate change, land use and food security, while contributing to sustainable economic growth

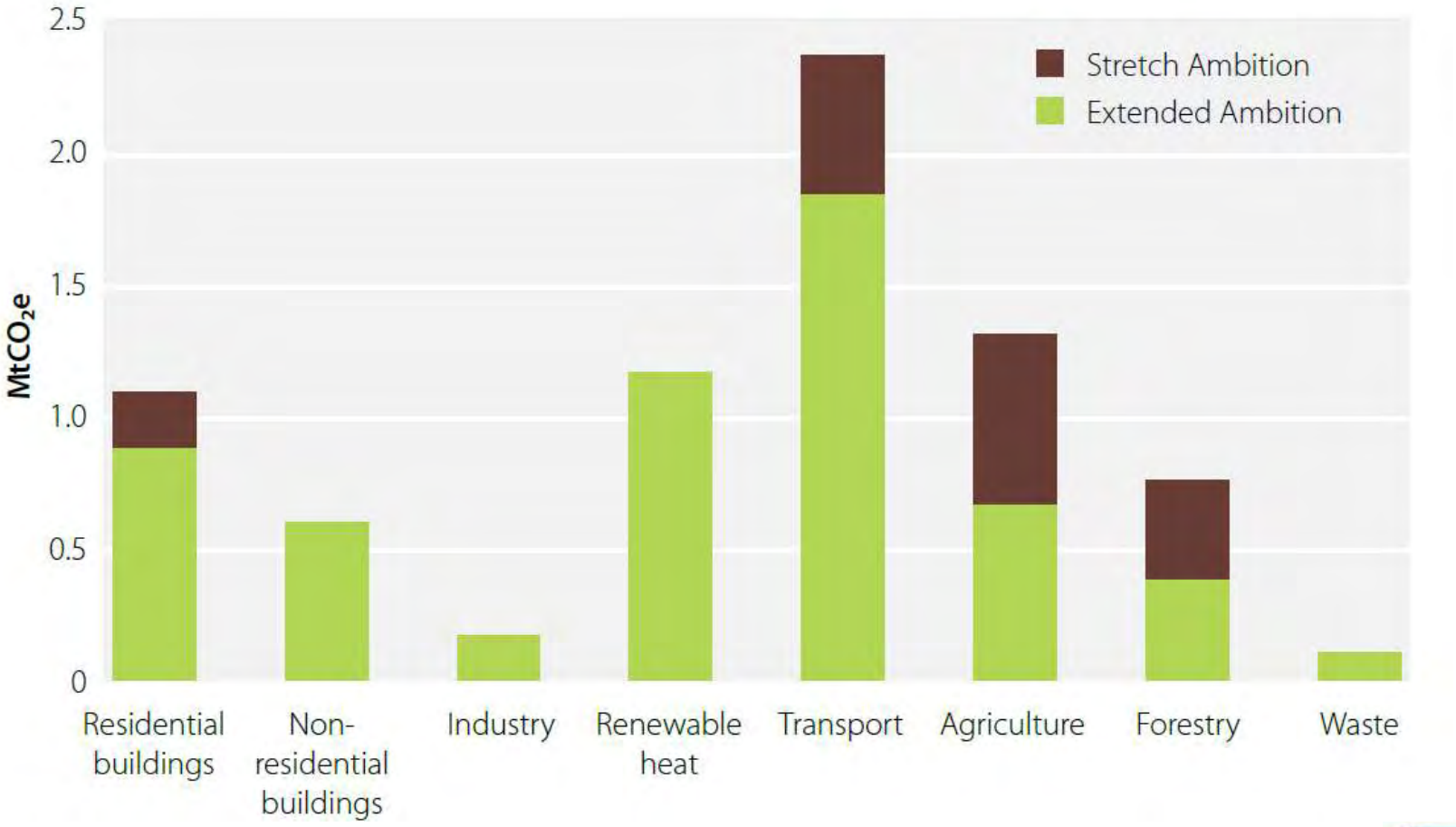
Aims of the workshop

- Explore the linkages between climate change and carbon management across the strategic research programme
- To identify areas where better collaboration and integration will help with the delivery of outcomes
- To assist with reporting

References to carbon and climate in the RESAS Theme documents



Scottish non traded abatement potential by sector (2020)



Committee on Climate Change, 2010

Optimising the programme

- How can we maximise the impact from the research that we are undertaking?
- Where are the synergies?
- Is there duplication?
- Can we be more joined up?

SAC's Carbon Management Centre

- To develop research education and advice on carbon management in the rural economy
- Contributing to SG policy led Centre of Expertise on Climate Change
- National research programme to improve inventory reporting and mitigatio
- International cooperation
- Farming for a Better Climate

Farming for a Better Climate

- Scottish Government funded initiative
  - Web resource
  - Focus farm network
  - Workshops and demo events
- Measures to reduce greenhouse gases also improve farm business efficiency

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Farming for a Better Climate focuses on five key action areas

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Locking up carbon in soils

- Increase carbon addition to soil
- Reduce carbon losses
- Reduce soil disturbance
- Maintain good soil structure

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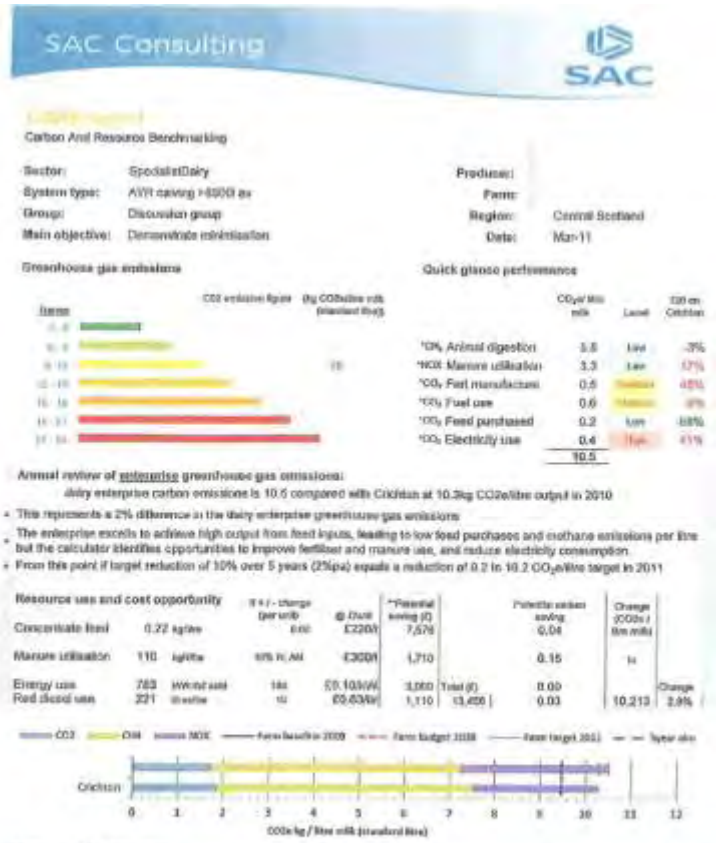
Monitoring change

- Baseline data collected at start of project
- Carbon footprint will be reassessed at the end of the project
- Individual management changes and achievements in the programme are continuously monitored

The SAC carbon calculator: AgriCARB

- One page summary for farmer
- Links CO_2 emissions with resource use and cost savings
- Compares performance against benchmarks and target



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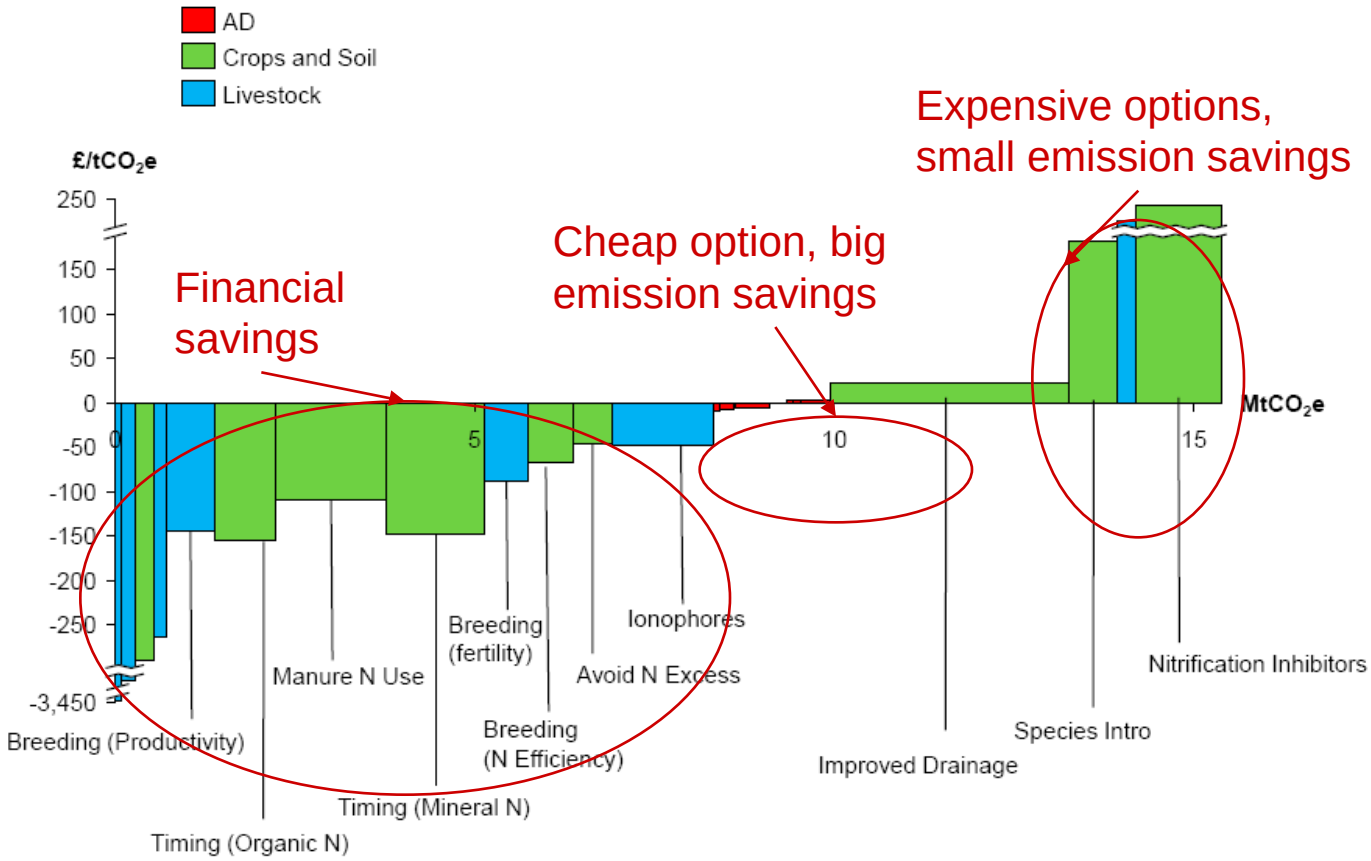
Mitigation Abatement Cost Curves



Source: CCC modelling

Notes: N = Nitrogen, AD = anaerobic digestion
Measures do not appear in exact cost-effectiveness order due to interactions between options. More details and a full measures list is available in the accompanying technical papers.

Building a low-carbon economy – The UK's contribution to tackling climate change. 1st Report of the CCC, Dec, 2008

Behaviour change

- Behaviour is very resistant to change. We are creatures of habit
- Knowledge does not necessarily work, e.g. smoking
- We are focused on the short-term not the long-term
- We do not necessarily respond well to being TOLD what to do
- Need to develop a balance between regulation and rewards

Kathryn Mearns, ClimateXChange 2012

Bringing it together

- Identify current collaborations
- To what extent do the outcomes from different Themes contribute to the Scottish Governments Strategic Objectives
- Identify areas where stronger links within the programme would help achieve the planned
- Identify research gaps and potential funding sources

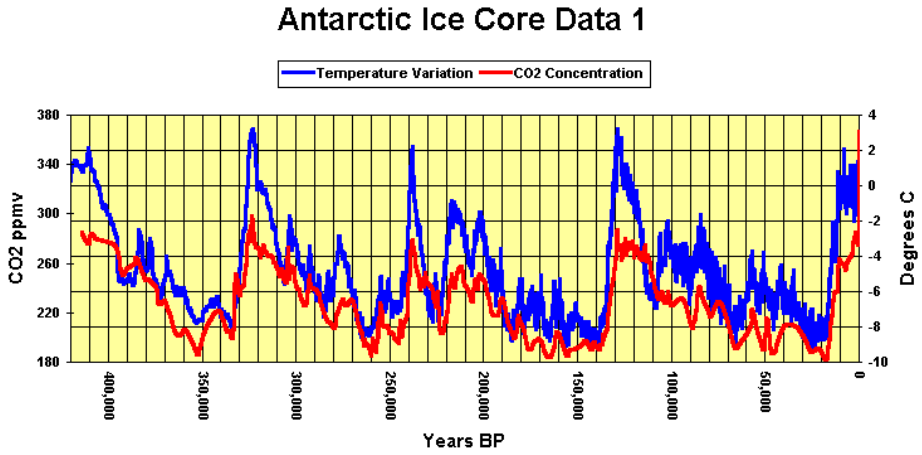
knowledgescotland
Science Policy Connections Online

RESAS Environmental Change Programme of Research: Local Responses to Global Change

LORNA DAWSON
Programme Advisor: Environmental Change

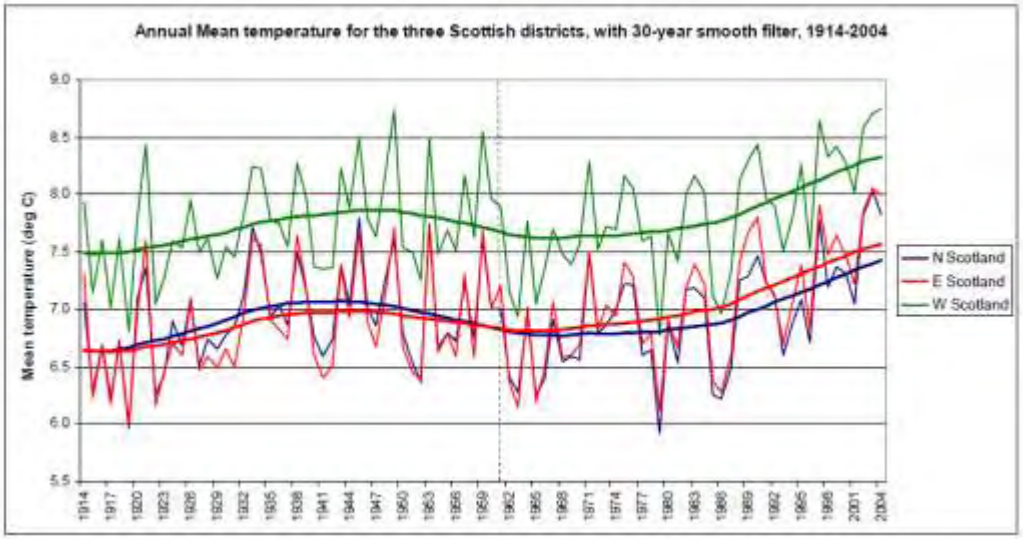
Topic-Climate Change & Carbon Management

Climate Change



Scotland's Climate Change

- Warming of average temperatures since 1914, but mostly since 1961
- 21st Century likely to be on average hotter, drier summers and warmer, wetter winters
- Extreme weather events will continue and the severity predicted to increase



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Expect the Unexpected

BBC News; http://www.digitalhen.co.uk/news/uk-scotland-south-scotland-15922080;
http://i.dailymail.co.uk/i/pix/2011/12/08/article-2071633-0F1B4D7000000578-392_964x642.jpg

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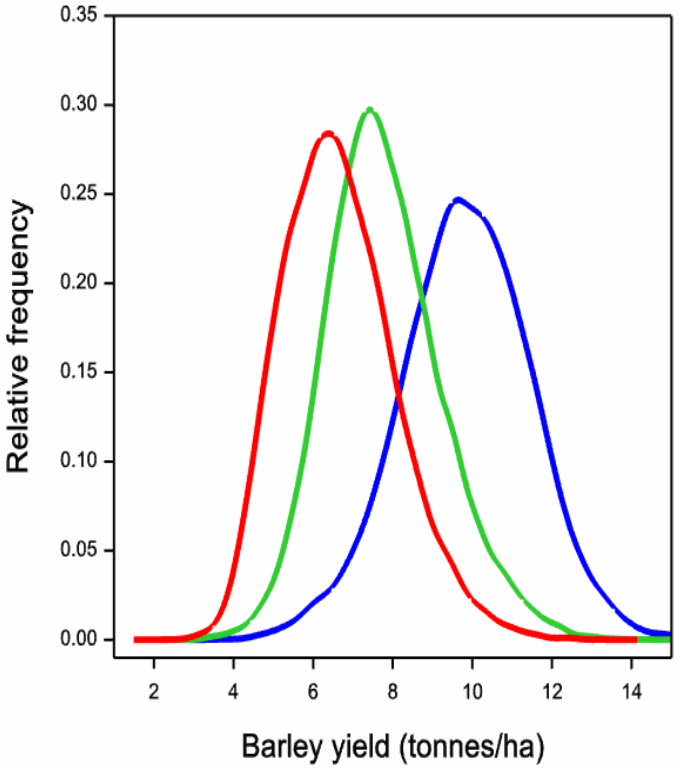
Reporting and interpretation of findings

"Temperature could rise by 11 degrees C[1]."

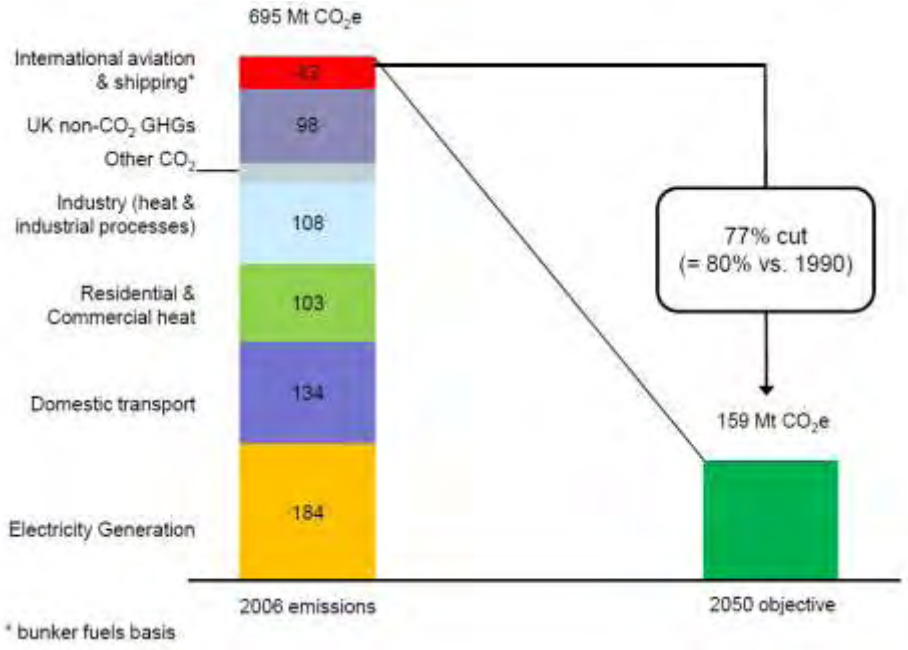
- One result from a model of climate sensitivity to rising CO_2 levels
- Model was run 2000 times, this outcome was generated once
- Most common result was a rise of 3 °C
- Whilst a 11 °C rise is possible, it is not the most likely

Context is everything. Like words, numbers and statistics mean different things in different contexts



[1] www.scidev.net/en/news/temperature could rise by 11 degrees says study. html (visited 26 April 2010)

UK emissions-policy targets



- Scotland is part of the global effort to reduce greenhouse gas emissions
- The Government Economic Strategy aims to reduce emissions by 80 per cent by 2050
- The Climate Change (Scotland) Bill sets a mandatory target of at least an 80 per cent cut in emissions by 2050

Source: UK Committee on Climate Change

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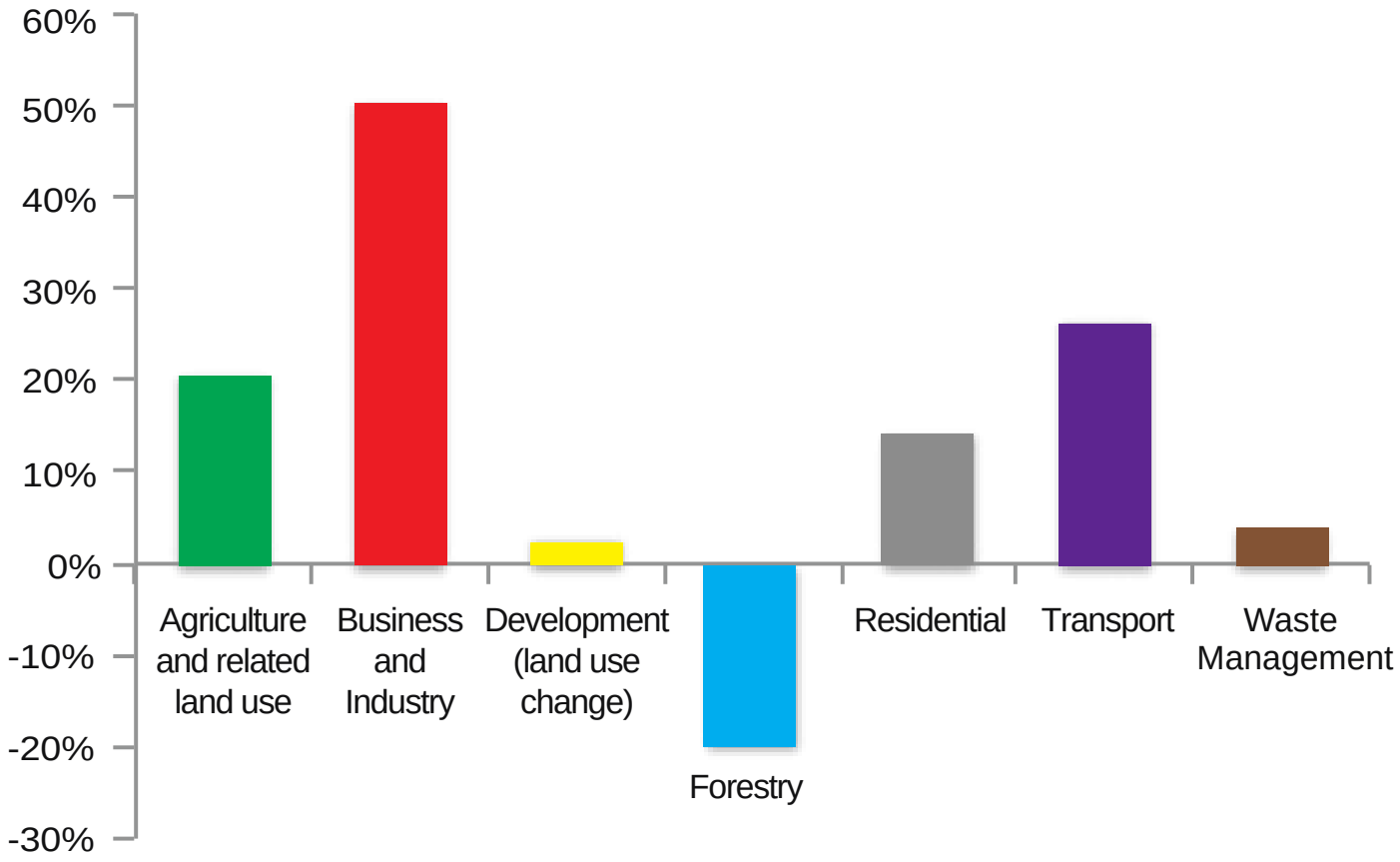
Sector emissions as % of total, 2009



Scottish Government Statistics, 2011

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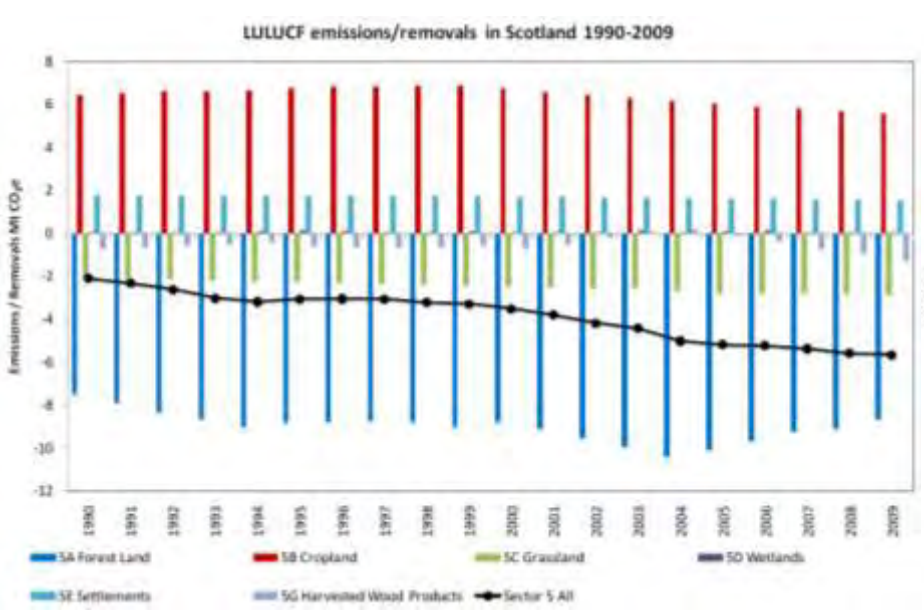
Summary of net emissions in Scotland from LULUCF

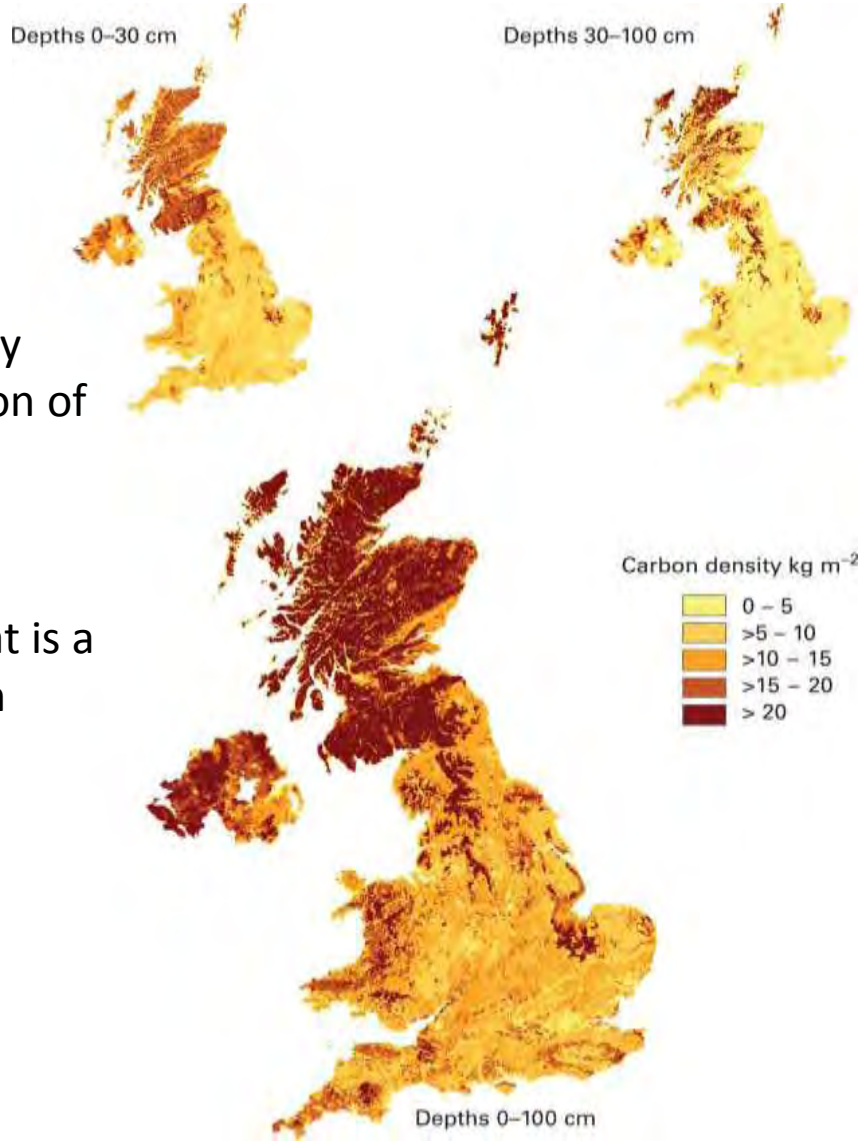


Source: Thomson, 2011

Scotland's Soil Carbon

- Cool, wet climate, a low pH and relatively young soils lead to a natural accumulation of Carbon from vegetation

- Protecting this Carbon and restoring peat is a potential route for Carbon sequestration with additional benefits for biodiversity, flood management etc



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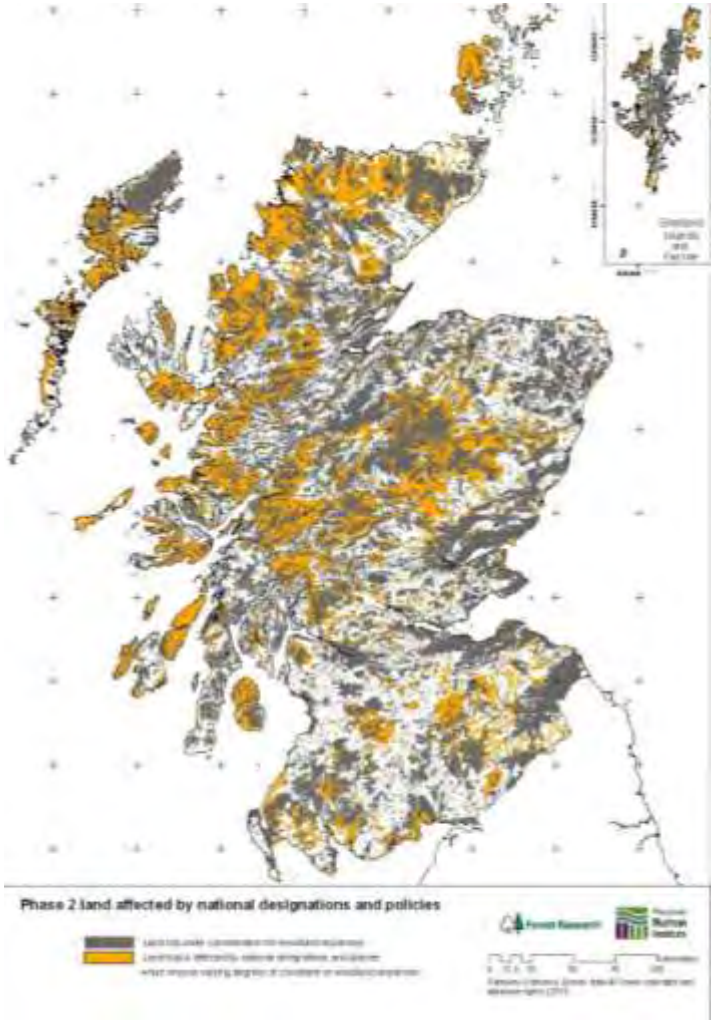
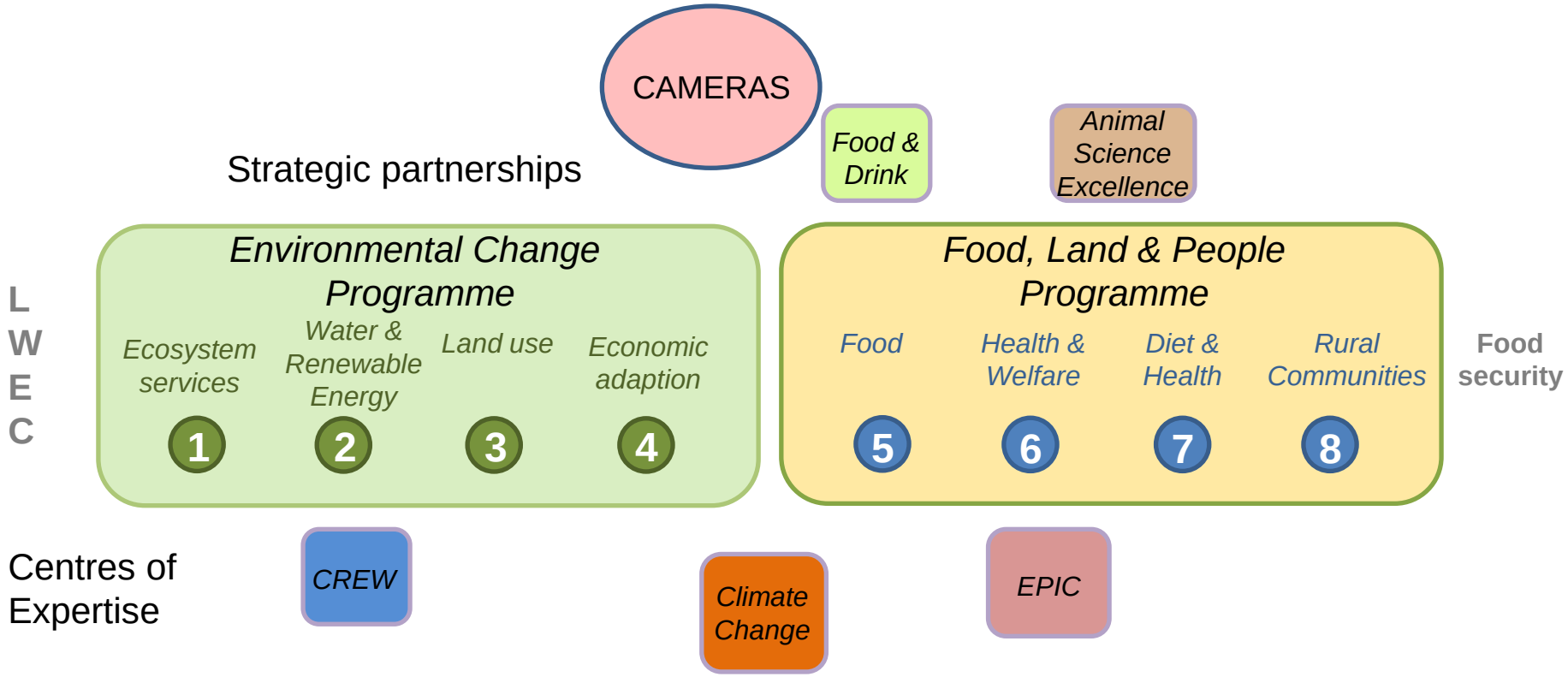
Land use change

- Target to increase woodland coverage by 100,000 ha over the next decade
  - Part of the SG Land use Strategy (Climate Change (Scotland) Act 2009)
  - Remains the biggest planned land use change over this period
- Longer term aspiration to increase cover to 25 % of Scotland
- On what type of land might this go?
  - Some land is unsuited
  - Some land is protected, e.g. areas of peat and prime agricultural land
  - Large areas of designated open ground habitat should remain



RESAS Environmental Change Programme of Research: Local Responses to Global Change



Global conventions/ UK & Scottish legislative targets/local responses & mitigation/adaptation options

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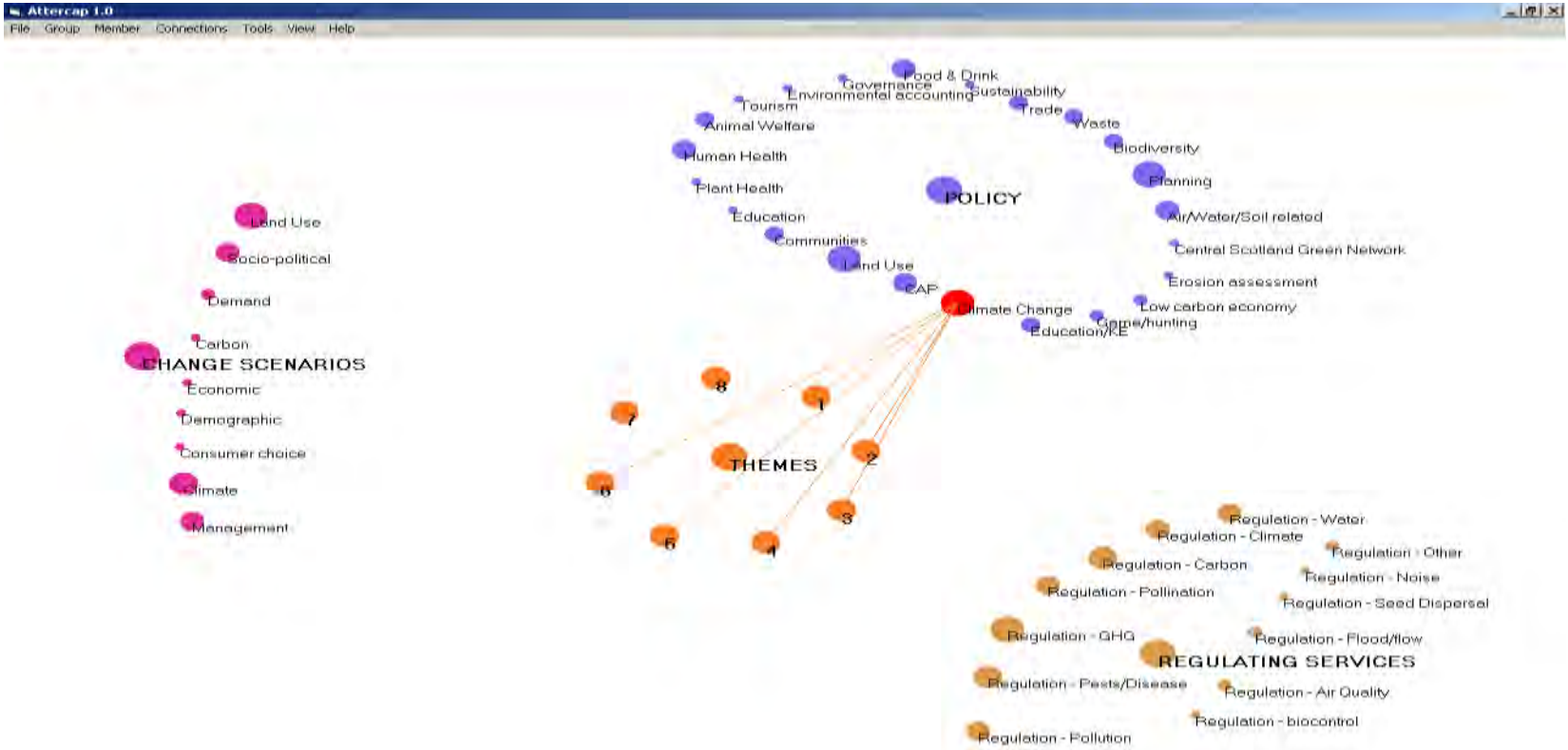
Linkage-
Climate change



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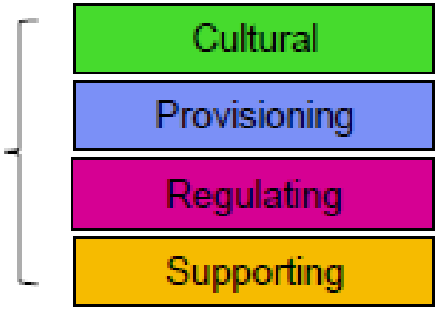
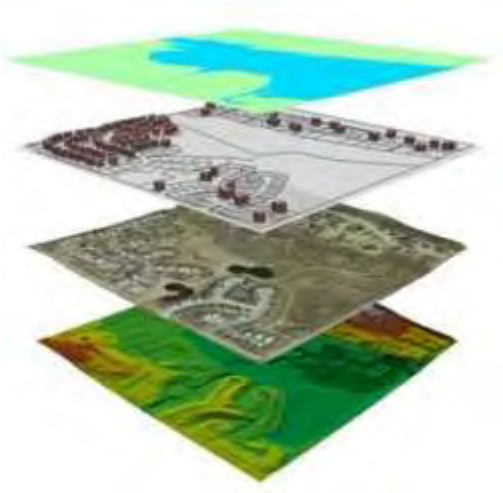
Ecosystem Services: Theme 1

Understanding multiple benefits from our natural resources, through:

- An integrating framework
- Contributing to the mapping of Scotland's Ecosystem Services together with an understanding of the dynamics of Ecosystem Services supply
- Assessing the monetary and non-monetary value of Ecosystem Services /multiple benefits
- Application of an integrated framework/ecosystem approach, covering environmental benefit trade-offs

Millennium Assessment categories





Policy: Objectives of the Land Use Strategy (LUS)2011. The LUS identifies the EA explicitly as the framework and approach to aid decision making on land use and inform how such considerations can inform changes to the Common Agricultural Policy

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Water & Renewable Energy: Theme 2

Research leading to a greater knowledge of the availability and supply of water and renewable energy resources, through:

- Investigating provision of renewable energy and water, including projected supply and demand both now and into the future
- Evaluating the sustainability of the supply chains for water and renewable energy and interactions between them
- Developing methods for mitigating and adapting to flood risk
- Greater understanding of the risks of diffuse pollution and how to manage water quality with climate and land use change

Policies: Directives- Water Framework, Habitats, Nitrate, Urban Wastewater Treatment, Floods, Shellfish-waters, Bathing-waters, Natura, Marine Strategy Framework, and IPPC. Nationally, the Flood Risk Management, Marine and Climate Change (Scotland) Acts, and the Scottish Planning Policy, National Planning Framework, Climate Change Adaptation Framework, Renewables Action Plan, Zero Waste Plan, Scottish Land Use Strategy, Scottish Soil Framework the ,River Basin Planning Strategy, 2020 Route Map for Renewable Energy in Scotland

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Land Use: Theme 3

Developing powerful technologies and management tools which will deliver multiple benefits from rural land use, while also providing an increased resilience to potential change

- Understanding uncertainties surrounding GHG emissions from soils and soil carbon changes
- Providing data on cost effectiveness of technical solutions for mitigation or adaptation to climate change for rural land use
- Investigation of the key soil functions to provide a quantitative understanding of ecosystem processes at the air, soil, water interface
- Assessing resilience of Scotland's biodiversity to climate and land use change
- Understanding multi functional land use and the many demands from different sectors and an understanding of land managers' attitudes and decision-making needs

Policies: Climate Change Scotland Act (2009), Scottish Soil Framework (2009), Air Quality Directive (2008), Land Use Strategy for Scotland (2011), Scottish National Planning Framework 2 and Scotland's Zero Waste Plan (2010). The SG target of 42% reduction in greenhouse gas emissions (GHG)

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Economic Adaptation: Theme 4

Preserving or enhancing the ability of Scotland's rural economy to adapt to changing circumstances

- Assess the options for, and viability of, transition to a low carbon rural economy
- Understanding responses needed to enable effective economic restructuring, diversification and adaptation
- Alternative behaviours, processes and technologies to reduce climate change emissions from land use and agriculture
- Identify and address market failures for business adaptation to a low carbon economy
- Develop and use systemic models to support Key Sectors

Policies: Land use planning policy , CAP Reform and Crop Policy , ensuring that SG objectives for rural communities are delivered. Climate Change Adaptation Vulnerability of land based or rural industries to climate change and/or the costs and benefits of adaptation options , Land Use Strategy, Strategy for Low Carbon Economy , help deliver the reduction in emissions /the CC (Scotland) Act.

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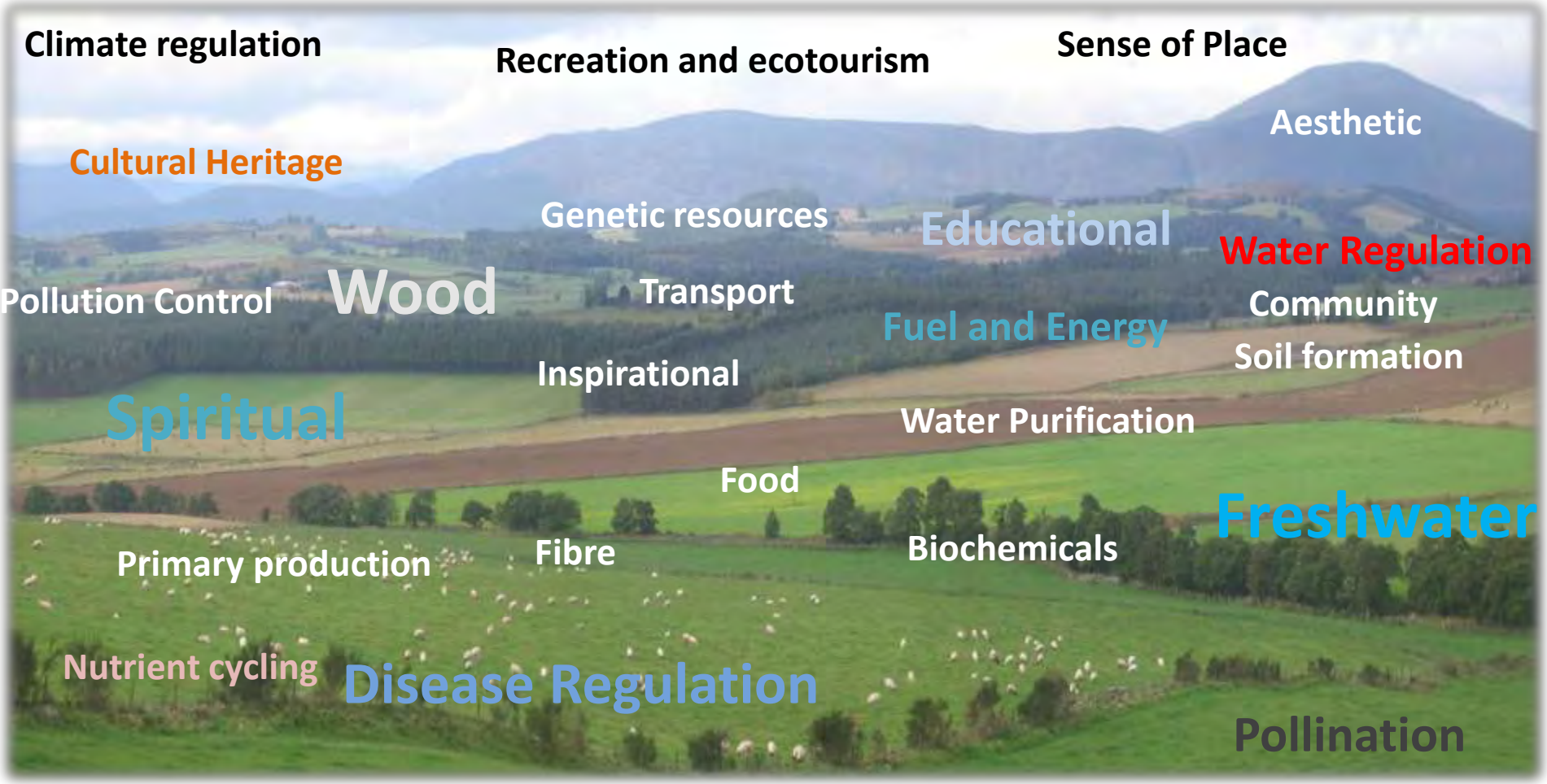
Multiple Benefits



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Outcomes of effective joined up delivery of the RESAS Strategic Research Programme

Sustainable economic growth

Resilient environment safeguarded

Sustainable supply chains

Increased well-being

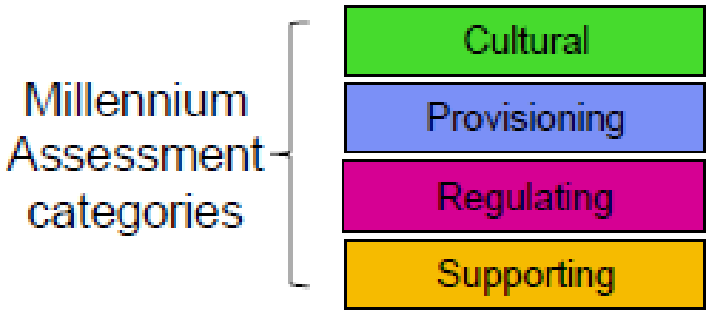
Internationally renowned

Protected ecosystem services

Robust monitoring and modelling capable of future predictions with environmental change

THEME 1: SCOTLAND'S ENVIRONMENTAL ASSETS, BIODIVERSITY AND ECOSYSTEM SERVICES ARE IDENTIFIED AND VALUED TO INFORM DECISION MAKING

ECOSYSTEM SERVICES THEME ("EST")



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Context for EST

- Policy is increasingly directed towards obtaining multiple ~~environmental~~ benefits
  - achieving a balance between human well-being and other outcomes;
  - dealing with the potential impact of global change, including climate change, and making use of the ability of environmental resources to mitigate and adapt to such change.

Use of resources

- Agriculture / fishing
- Conservation
- Forestry
- Energy production
- Tourism
- Recreation

Stakeholders

- Individuals
- Local communities
- National
- Global society

Sustainability

- Economic
- Environmental
- Social (commun

THEME 1: SCOTLAND'S ENVIRONMENTAL ASSETS, BIODIVERSITY AND ECOSYSTEM SERVICES ARE IDENTIFIED AND VALUED TO INFORM DECISION MAKING

ECOSYSTEM SERVICES THEME ("EST")

- Obtaining multiple benefits from our natural resources
  - Centred around the development and testing of an integrating framework to consider the interactions between resources, drivers, valuation methods and demands at different spatial and temporal scales.
    - Mapping ecosystem goods and services in Scotland
    - Valuing ecosystem goods and services in Scotland
    - Implications of different scenarios on outcome of decision-makin

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Ecosystem Approach

- a framework for assessment, planning and management of environmental resources (CBD, ME).
  - requires the consideration of the effects of actions based on the recognition that all elements of an ecosystem are linked.
  - promotes conservation and sustainable use in an equitable way
- substantial research needs identified to support implementation in decision-making.

EST = Research gaps

- WP1.1 Assessment of Scotland's ecosystem services
- WP1.2 Assessing the value of ecosystem services
- WP1.3 Application of an Ecosystem Approach at a range of scales

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EST Integrated Theme

- Integrating and interacting WPs
- Ecosystem Assessment Working Group (EAWG)
- Phase 1: Common topics relating to LUS
  - Sustainable agricultural productivity
  - Halting biodiversity losses
  - Sustainable water resources
  - Enhancing recreation
  - Low C economies
- Requires interaction with other Themes

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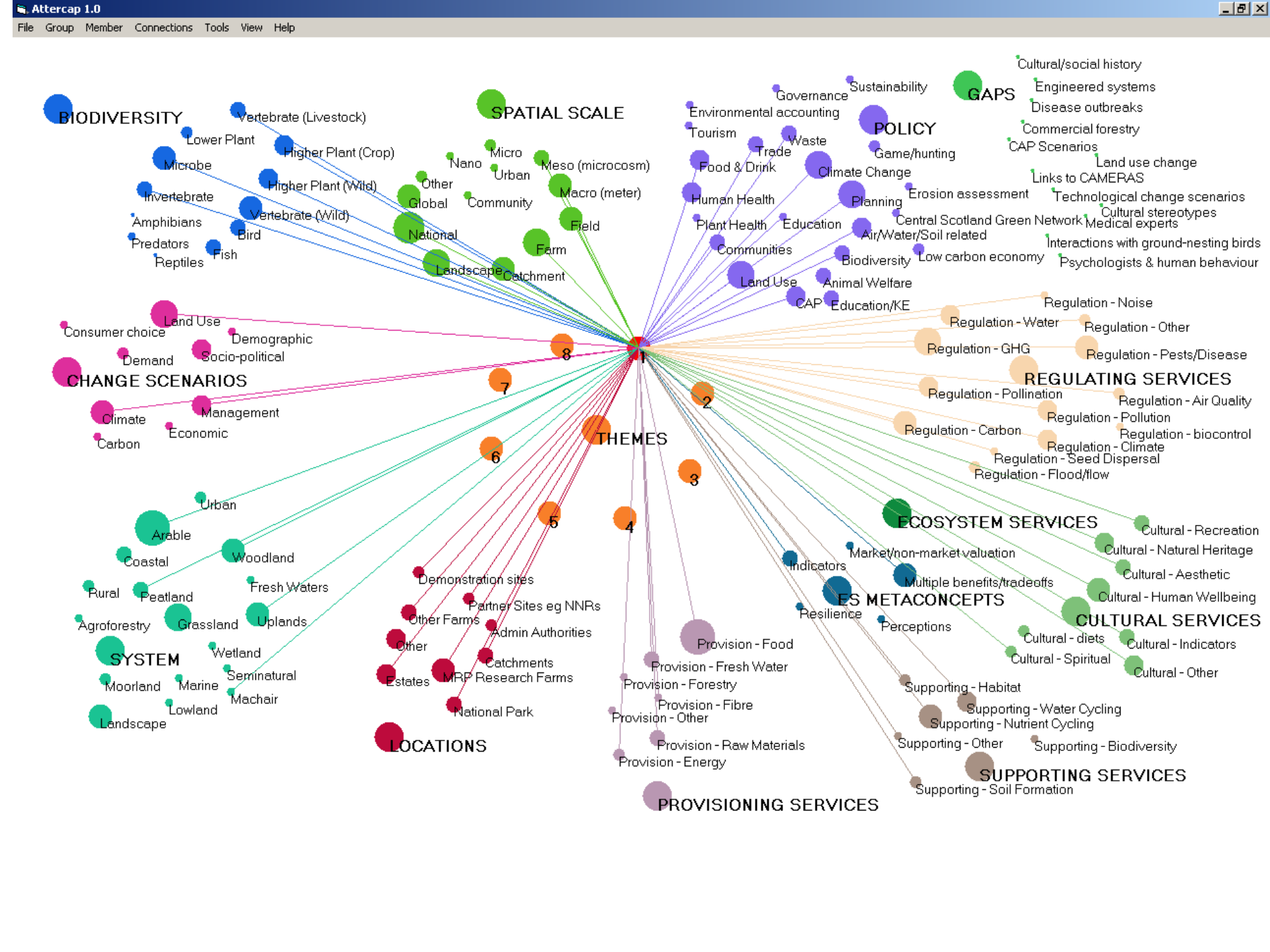
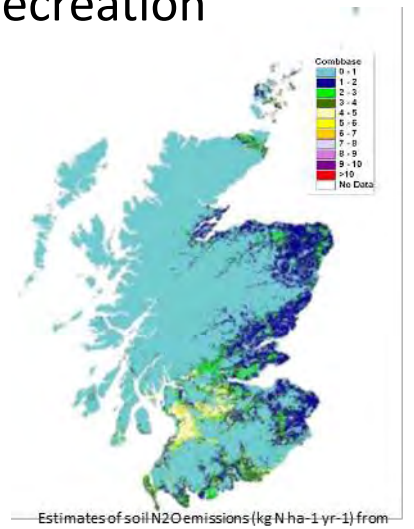
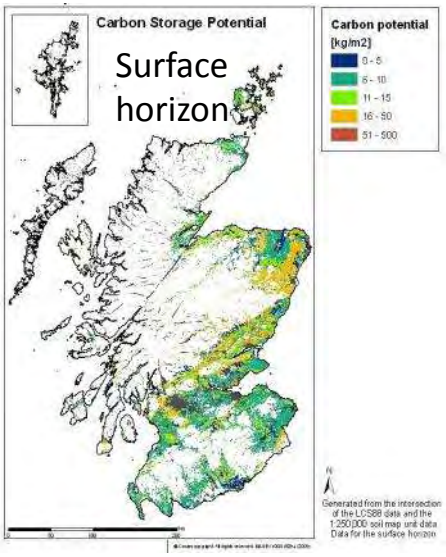

Attercap 1.0
File
Group
Member
Connections
Tools
View
Help
BIODIVERSITY
Vertebrate (Livestock)
Lower Plant
Higher Plant (Crop)
Microbe
Higher Plant (Wild)
Invertebrate
Vertebrate (Wild)
Amphibians
Bird
Predators
Fish
Reptiles
SPATIAL SCALE
Micro
Nano
Urban
Meso (microcosm)
Other
Global
Community
Macro (meter)
National
Field
Farm
Landscape
Catchment
GAPS
Cultural/social history
Governance
Sustainability
Engineered systems
Environmental accounting
Disease outbreaks
POLICY
Commercial forestry
Tourism
Waste
Trade
CAP Scenarios
Game/hunting
Food & Drink
Land use change
Climate Change
Links to CAMERAS
Human Health
Erosion assessment
Technological change scenarios
Planning
Cultural stereotypes
Plant Health
Education
Central Scotland Green Network
Medical experts
Air/Water/Soil related
Communities
Interactions with ground-nesting birds
Biodiversity
Low carbon economy
Psychologists & human behaviour
Land Use
Animal Welfare
CAP
Education/KE
Land Use
Consumer choice
Demographic
Demand
Socio-political
CHANGE SCENARIOS
Climate
Management
Economic
Carbon
8
1
7
2
6
THEMES
3
5
4
Regulation - Noise
Regulation - Water
Regulation - Other
Regulation - GHG
Regulation - Pests/Disease
REGULATING SERVICES
Regulation - Pollution
Regulation - Air Quality
Regulation - Pollution
Regulation - Carbon
Regulation - biocontrol
Regulation - Climate
Regulation - Seed Dispersal
Regulation - Flood/flow
ECOSYSTEM SERVICES
Cultural - Recreation
Cultural - Natural Heritage
Market/non-market valuation
Indicators
Cultural - Aesthetic
Multiple benefits/tradeoffs
Cultural - Human Wellbeing
ES METACONCEPTS
CULTURAL SERVICES
Resilience
Perceptions
Cultural - diets
Cultural - Indicators
Cultural - Spiritual
Cultural - Other
Urban
Arable
Coastal
Woodland
Fresh Waters
Rural
Peatland
Agroforestry
Grassland
Uplands
SYSTEM
Wetland
Moorland
Marine
Seminatural
Machair
Lowland
Landscape
Demonstration sites
Partner Sites eg NNRs
Other Farms
Admin Authorities
Other
Catchments
Estates
MRP Research Farms
National Park
LOCATIONS
Provision - Food
Provision - Fresh Water
Provision - Forestry
Provision - Fibre
Provision - Other
Provision - Raw Materials
Provision - Energy
PROVISIONING SERVICES
Supporting - Habitat
Supporting - Water Cycling
Supporting - Nutrient Cycling
Supporting - Other
Supporting - Biodiversity
SUPPORTING SERVICES
Supporting - Soil Formation

Relevance to carbon and climate change? WP1.1

- Mapping ecosystem services in Scotland
  - CARBON
    - Low carbon economy
    - Sustainable food production
    - Halting biodiversity losses
    - Sustainable water resources
    - Enhancing recreation



Estimates of soil N2O emissions (kg N ha-1 yr-1) from cultivated and uncultivated land across Scotland, derived from the Nitox model. Lilly et al 2009



Relevance to carbon and climate change?

➔Adaptive capacity under climate change

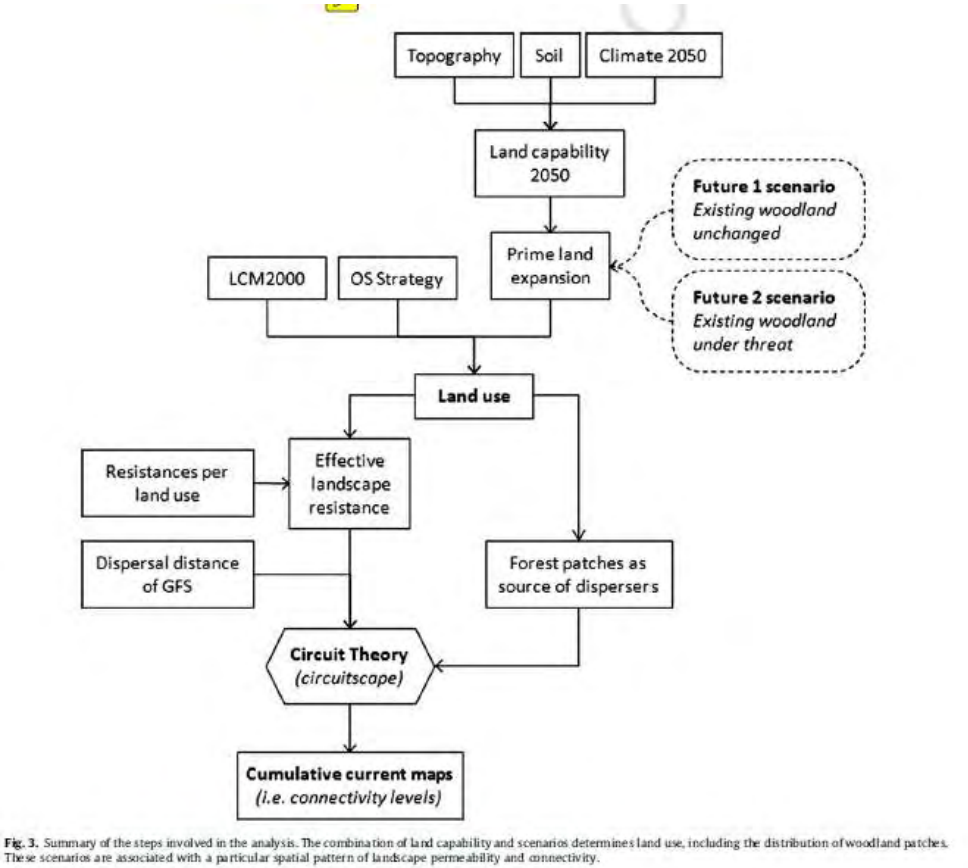
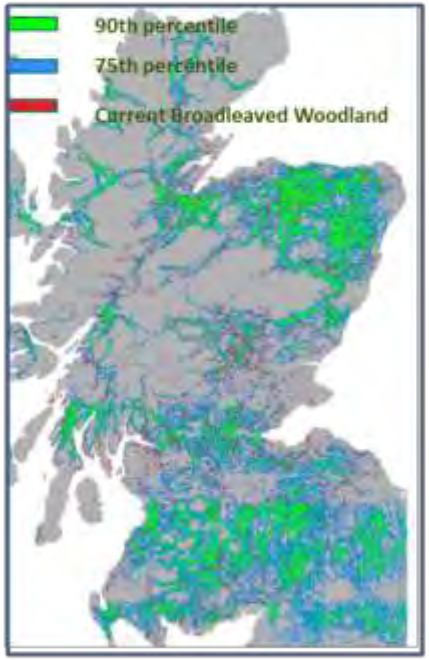
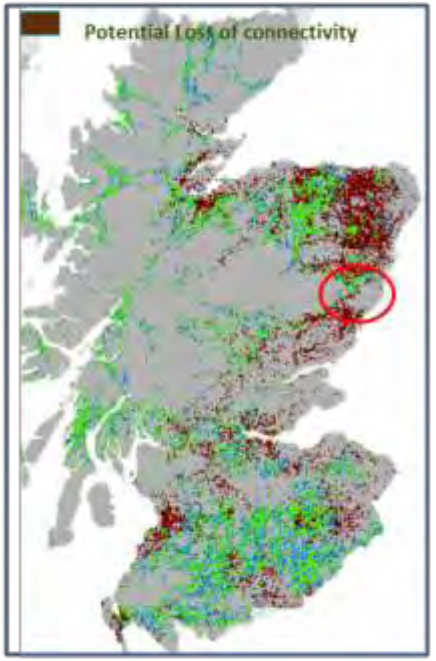


Fig. 3. Summary of the steps involved in the analysis. The combination of land capability and scenarios determines land use, including the distribution of woodland patches. These scenarios are associated with a particular spatial pattern of landscape permeability and connectivity.

Habitat Networks – Broadleaved woodlands



Present-day connectivity potential



2050s projection – Climate & Land Use Change

Gimona et al in press

Relevance to carbon and climate change? WP1.2

➔Value of carbon?

Cost / benefit category	Loss of soil organic matter / carbon	Ecosystem service impacted	Potential economic impact	Data Status
private cost	OM is a key in soil fertility; beyond a certain threshold, OM decline results in *yield losses*	provisioning	**	Y
mitigation cost	Restoration of higher OM levels / costs associated with *inorganic inputs*	provisioning	**	Y
social cost	*Reduced capacity for pollution retention* from OM decline can directly affect water quality and availability.	regulating	* - ***	N
social cost	OM loss equals a loss in carbon via GHGs with *impacts on atmospheric concentrations of GHGs*.	regulating	***	Y
defensive	Costs of defensive measures against *climate change impacts* (resulting from OM-related increases in GHGs)	regulating	* - ***	N
non-use private cost social cost	OM decline associated with losses in soil biodiversity (NC) and degradation of genetic resource reducing potential for *commercial/societal* use	provisioning	* - ***	N
non-use	OM decline can impact on *landscape/amenity values* (e.g., peat extraction/erosion)	cultural	* - **	N

Glenk et al in 2011 SEPA

Relevance to carbon and climate change?

➔ Willingness to pay for soil carbon storage

- Reduction in Scottish GHG emissions by 1% yr^{-1} **£12**
- Reductions in farm employment (by 2.5%) **- £24**
- Improvement of farmland bird habitat (undefined) **£37**

➔ Ancillary benefits maybe more “valuable”

Glenk, K. & S. Colombo, 2011

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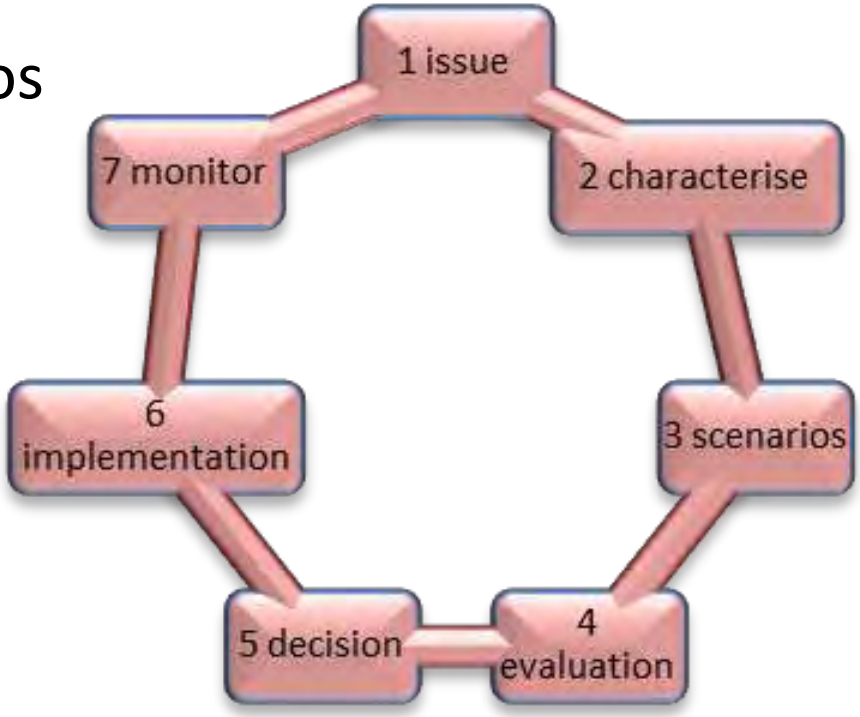
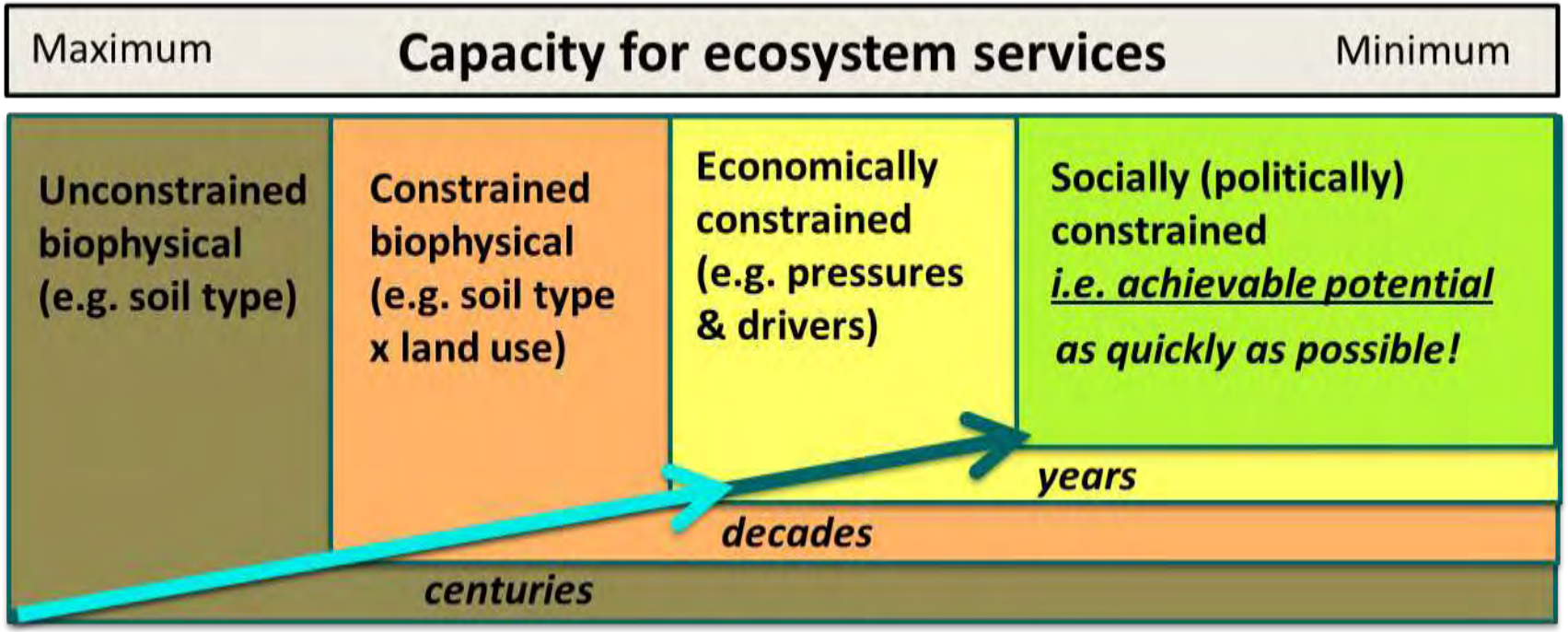
Relevance to carbon and climate change? WP1.3

- Implications of decision-making using EA framework
  - Social, economic and environmental trade-offs at a range of scales
  - Inc. climate change scenarios



EA Framework

- Manage within natural limits
- Manage for the long-term
- Manage across scales
- Account for values beyond just commodity values of goods
- Make trade-offs clear
- Involve all stakeholders



- Achievable capacity incorporates:
  - Improved knowledge on ecosystem's inherent capacity to sequester carbon
  - Vulnerability of ecosystem C to pressures and drivers
  - Uncertainty in scenarios of change e.g. likelihood of failure
  - Balancing trade-offs between multiple ecosystem services
  - Demand for change in relatively short timescales balanced against future implications

An ecosystem approach is successful if it preserves or increases the capacity of an ecosystem to produce the desired benefits in the future, and increases the capacity of society to fairly apportion benefits and costs.

➔ EST

- Mapping inc. indicators and relationships to biodiversity
- Approaches to valuation
- Implications of decision-making for multiple benefits

ecosystemservices@hutton.ac.uk

ESP

Worldwide Network to enhance the Science and practical Application of ecosystem services assessment

BioSS

The James Hutton Institute

Moredun

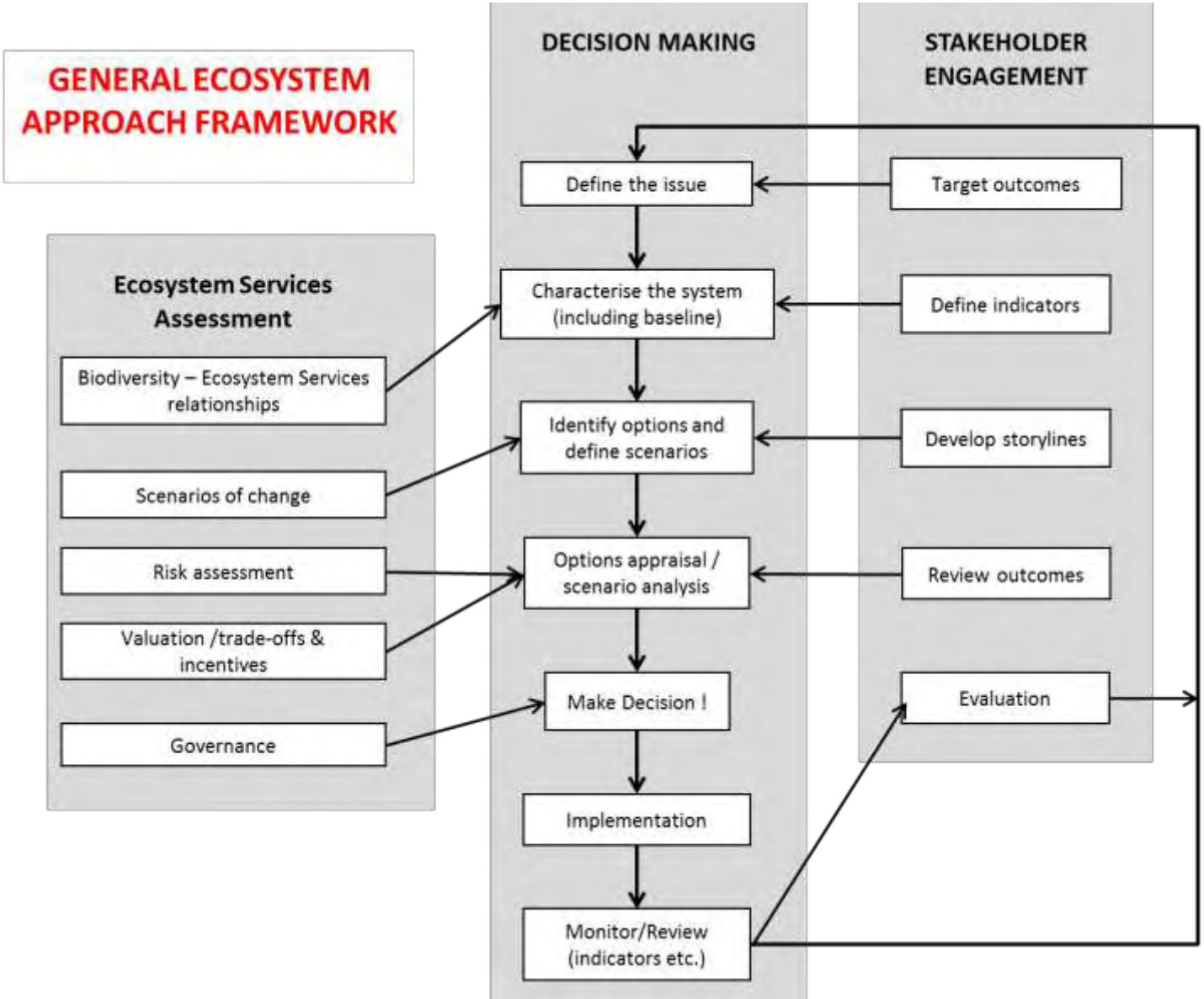
Royal Botanic Garden Edinburgh

Rowett Institute of Nutrition and Health

SAC

The Scottish Government

Relevance to carbon and climate change?



RESAS, Theme 2
Water and Renewable Energy

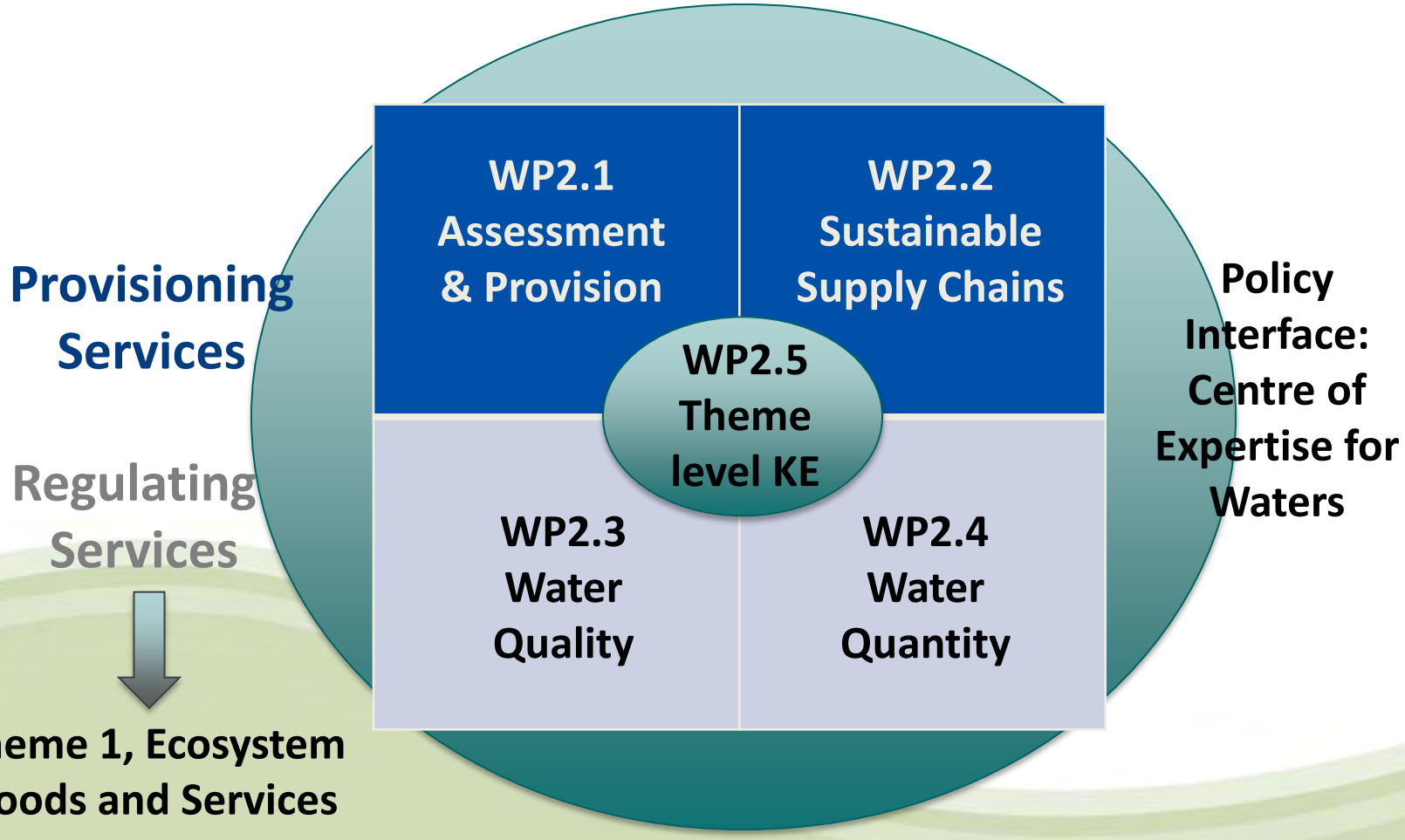
Marc Stutter

The James Hutton Institute

BioSS | The James Hutton Institute | Moredun | Royal Botanic Garden Edinburgh | Rowett Institute of Nutrition and Health | SAC | The Scottish Government

Theme 2 aims

- Led by JHI and involves staff across JHI, SAC and Moredun
- Broad aim: The assessment of multiple pressures and policy interactions in catchments using water quantity and quality as a 'common currency' in the provision of environmental goods and services



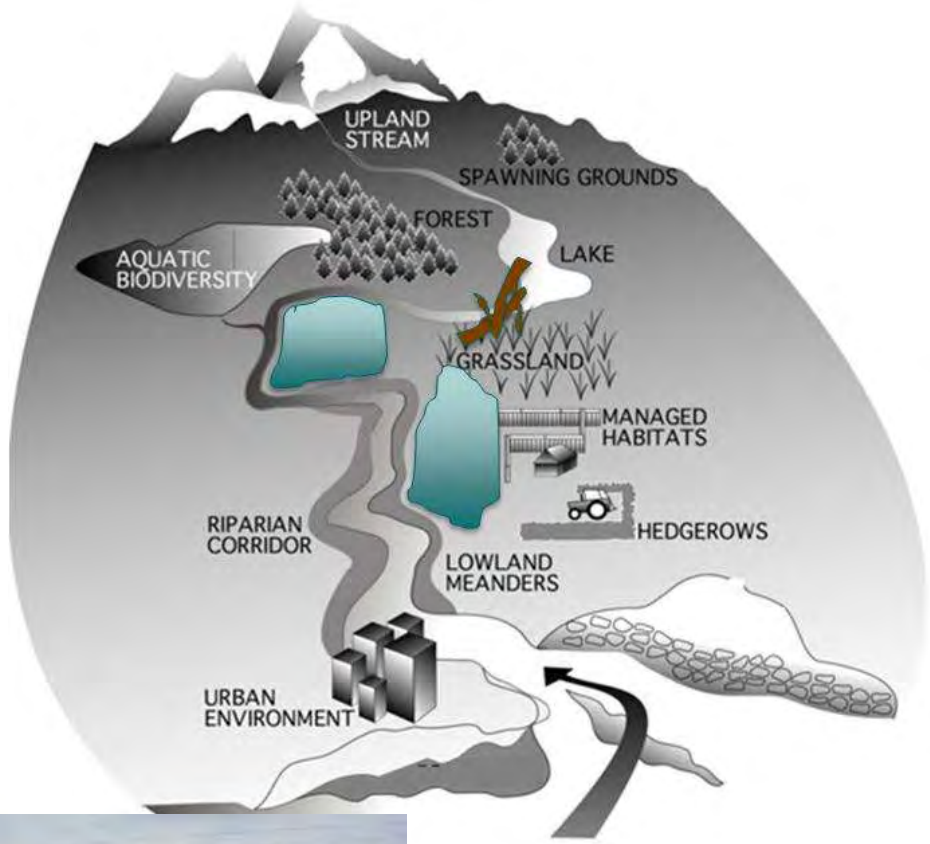
Environmental change and Carbon

- Landscape change - the interactions of 'low C' land use and technologies on the water environment
  - Woodland expansion
  - Wind farms and soil C disturbance
  - Hydropower and ecological impacts
  - Natural flood management and soil GHG measurements
  - Riparian buffer strips and carbon accumulation
- Generation of linked climate-hydrology-land use scenarios (linked with theme 3).

		Provisioning			Regulating		Cultural		Supporting	
	Policy *vs* ecosystem services	Water for drinking, industry & agriculture	Water for navigation & power	Aquatic biomass	Maintaining water quality	Buffering flood flows	Recreation & tourism	Health & well being	Nutrient & sediment attenuation	Biodiversity & ecosystem resilience
Water quality	EU WFD									
	EU Waste Water Dir.									
	EU Nitrates Dir.									
	EU Pesticides Dir.									
	Bathing waters Dir.									
Water quantity	EU Flood Dir.									
	Comm. On water scarcity & droughts									
Habitat	EU Habitats Dir.									
	EU Natura 2000									
Land use & energy	Scottish forestry strategy									
	2020 routemap for renewable energy									
	Climate change Act									
	UK Food security plans									

Given appropriate implementation positive impacts expected; Negative interactions expected; Unknown outcomes

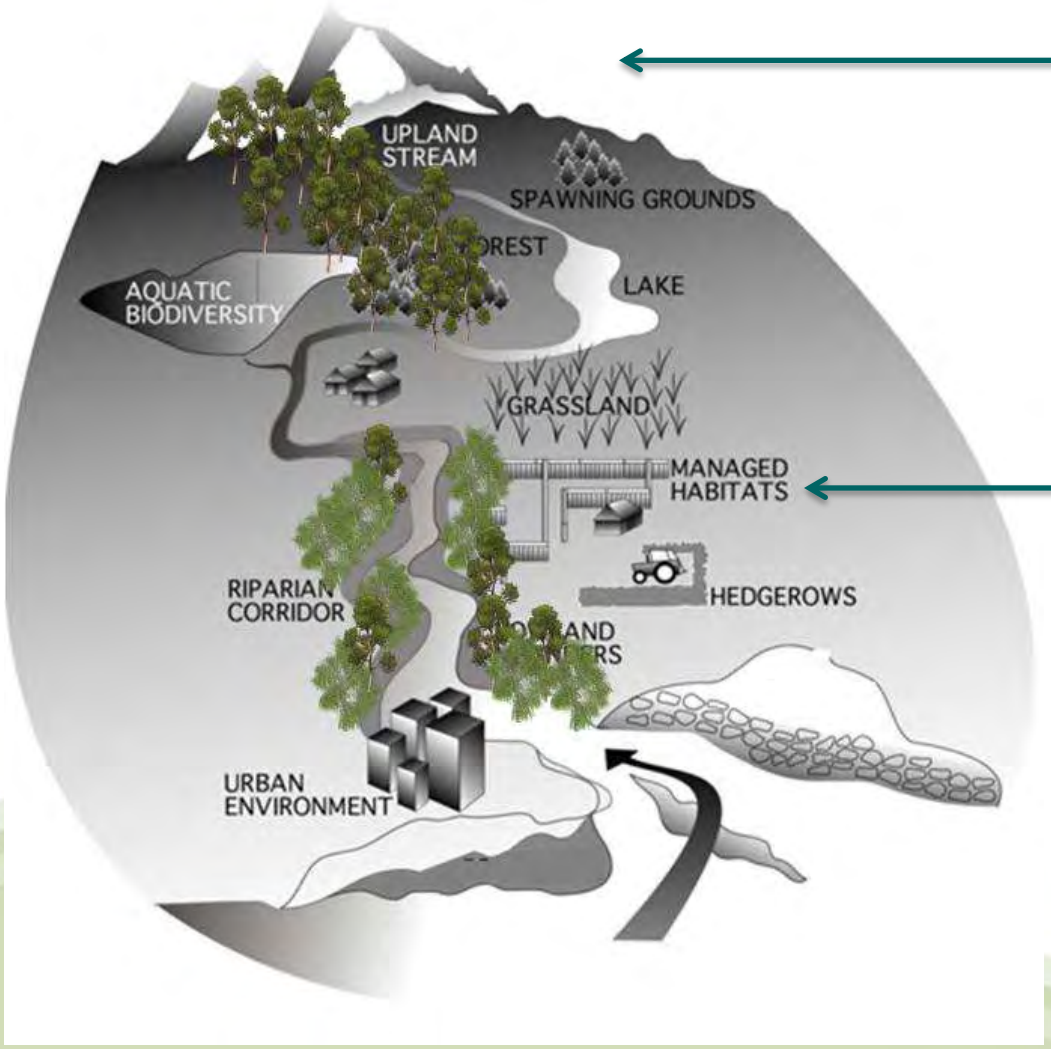
Promote natural flood management



- Pros
  - Protection of downstream areas from moderate storm peak flows
  - Biodiversity value of restored channel and wetland habitats
- Cons
  - Conflicts with traditional activities of draining farmland to increase production
  - Likely GHG emissions from wetter soils

Woodland expansion policy

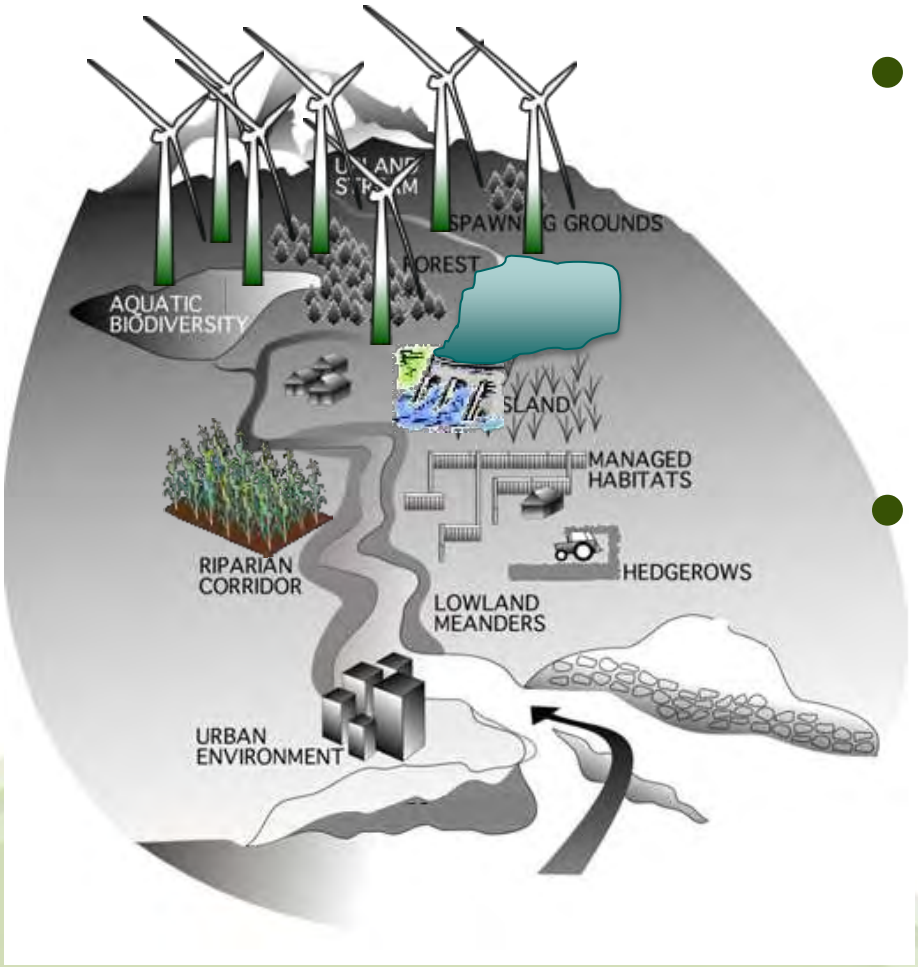
Policy goal: *Scotland needs to achieve 100 000 ha increase over the next decade*



- Conifer plantations in the uplands may:
  - Release C to waters if on organic soils
  - Incur transport costs of wood fuel to markets
- Targeted planting in riparian areas and silvopastoral systems would:
  - Protect rivers from erosion
  - Provide shade against temperature extreme
  - Increase farmland biodiversity and shelter stock
  - Provide local wood fuel

Promote renewable energy uptake

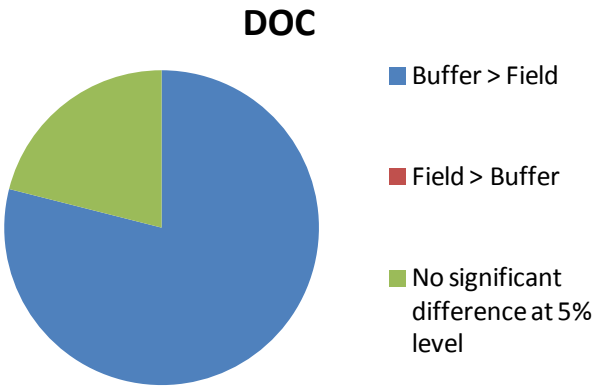
Policy goal: *Scotland's overall renewables target of 30% by 2020 (100% electricity demand and 11% heat) is the most ambitious in the EU*

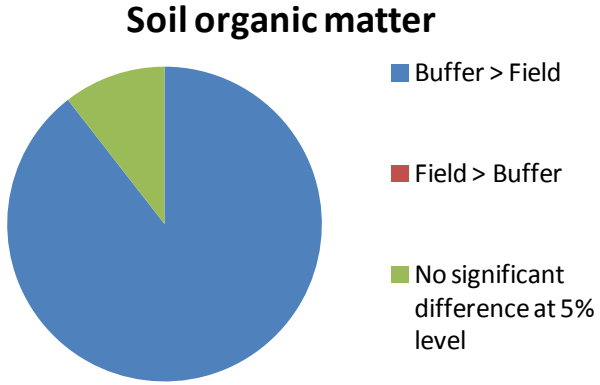


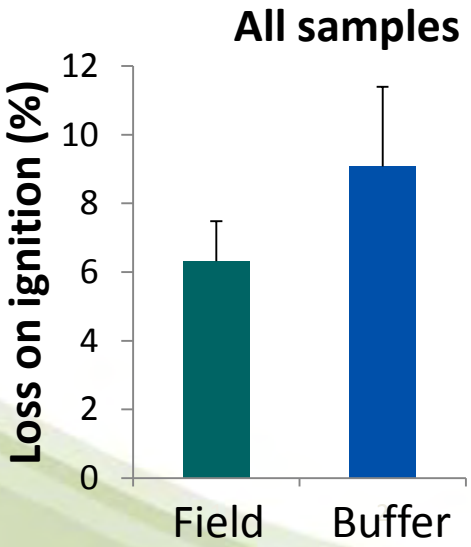
- Pros
  - Promotes employment in new technologies
  - Can be attractive carbon savings
  - Small-scale, on farm renewables benefit rural businesses
- Cons
  - Hydropower can be a barrier to fish migration, causes low flow extremes, recreation issues
  - Wind power is contentious in communities, site disturbance can cause erosion and soil C loss to waters
  - Biofuels take valuable space from food crops and use additional fertilisers

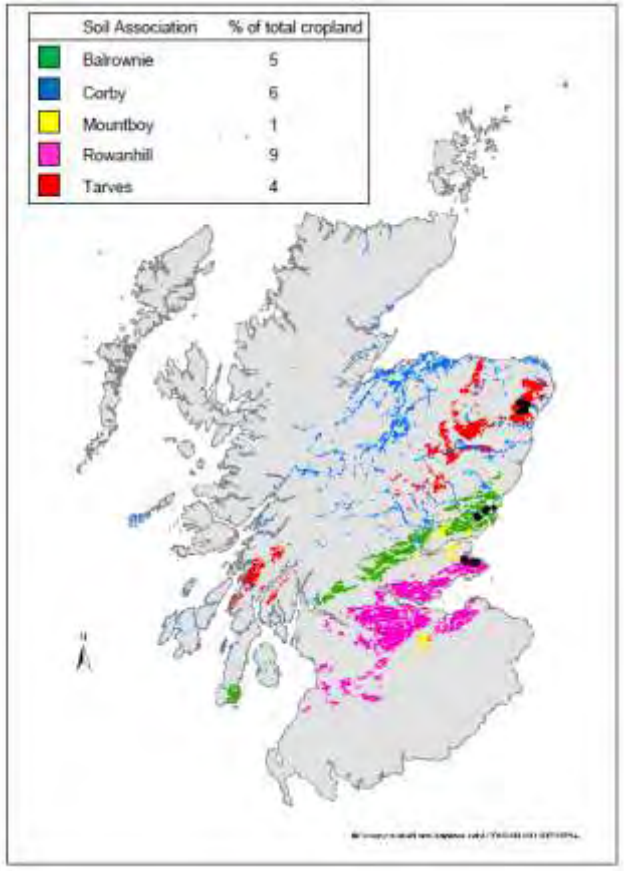
Soil C in buffer strips

25 sites buffer *vs* field soils:
t-tests for triplicate samples









Aquatic carbon processes

- SNIFFER report 'Aquatic carbon losses from UK peatlands
  - An online metadatabase of UK aquatic C data
  - Literature review
  - An analysis of pooled SEPA and Marine Scotland river DOC time-series trends and drivers
- Soil DOC trends in long term records from 3 ECN sites
- Bioavailability of aquatic C forms – microcosm experiments
- NERC Macronutrient Cycles Programme (JHI, Bangor, CEH, Reading)
- NERC MCP (JHI, CEH) – Terrestrial CN modelling
- Links to Theme 3 work (Julian Dawson's reviews, Benoit Demar's experiments)

SNIFFER ER18 Aquatic C fluxes

- Project report

- Metadatabase

http://www.clad.ac.uk/aquatic_carbon_database.htm

SNIFFER

The impact of aquatic carbon fluxes on carbon losses from UK peatlands

Project Title: Assessment of the contribution of aquatic carbon fluxes to carbon losses from UK peatlands

Project Code: ER18

Who this research is intended for: Environmental regulators, local authorities, UK central and devolved governments, and researchers.

Objectives of the project

The goal of this project was to provide outputs that could feed into future modeling efforts of carbon fluxes and influence the design of future monitoring efforts. The primary objectives were to:

- Develop a meta-database of existing data holdings relating to the aquatic pathway of carbon loss from peaty soils.
- Use existing data in combination with complementary data on parameters (e.g. the extent of peaty soils in a catchment, catchment area, land management regimes, atmospheric deposition, and changes in rainfall and snow cover) to illuminate the drivers for

concentrations are widespread is undisputed. However, the reasons for these increasing concentrations and the impact of these increasing concentrations on the global carbon balance are uncertain.

There are few sites within the UK where there has been long-term measurement of soil carbon, aqueous carbon fluxes from soils, and related parameters (e.g. greenhouse gas (GHG) fluxes) from soils. Most long-term monitoring of aqueous carbon involves collecting data at regular but infrequent intervals. This means that large fluxes during storm events may be missed. Recorded changes in climate and future predictions suggest that rainfall in areas with peaty soils is increasing in both in quantity and intensity. This may have implications for the size of the aqueous carbon flux from peaty soils.

Land-management practices (e.g. draining peatland for wind farms or agriculture) are thought to increase fluxes of organic carbon from soil to

CLAD | Carbon Landscapes and Drainage

Introduction | Project Details | Who We Are | Carbon & Water Guidelines | CLAD: Diary | Resources | Peat Levy

Aquatic carbon meta-database

This page provides access to an ArcGIS database showing the spatial distribution aquatic carbon flux datasets for the UK. It was created by researchers at the James Hutton Institute as part of a research contract commissioned by SNIFFER's Environmental Regulation Programme.
This meta-database was a key output of the SNIFFER project. However, the meta-data it contains is limited to those data holders who responded to a data solicitation survey. It provides information for the:

- Evaluation of the geographical distribution of data records from different sources at a national (UK) level.
- Identification of where simultaneous measurements of a range of aquatic C forms exist.
- Determination of the quality of the data sets for fulfilling various research and policy needs from the meta-data parameters provided (crucially, this includes the UK resource available to determine the role of aquatic C fluxes in the UK C budget).

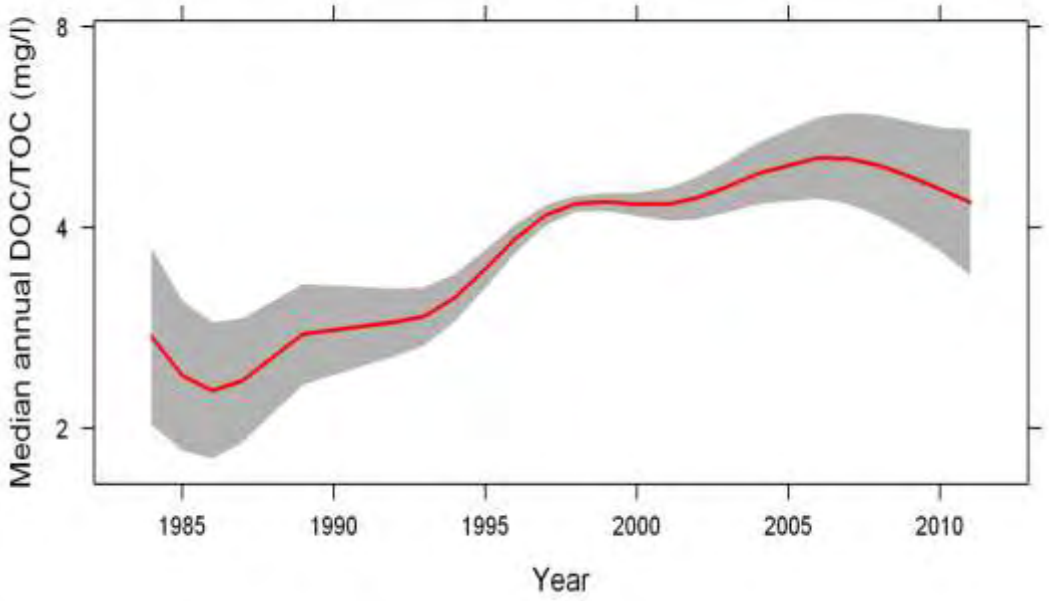
This information is thoroughly explored in the project report that was also produced as part of this research project. This meta-database is a useful tool for those conducting research or developing policy or guidance in the UK related to aquatic carbon fluxes and/or peatlands.
The meta-database is provided in two very different formats: here:

- A robust GIS meta-database.
- A basic spreadsheet (MS Excel) version (and two pdf files that explain the shortened column labels). (This Excel version can be downloaded from this website.)

Links

Database guidance notes
Column Key for Excel version
Excel version

National DOC trend analysis

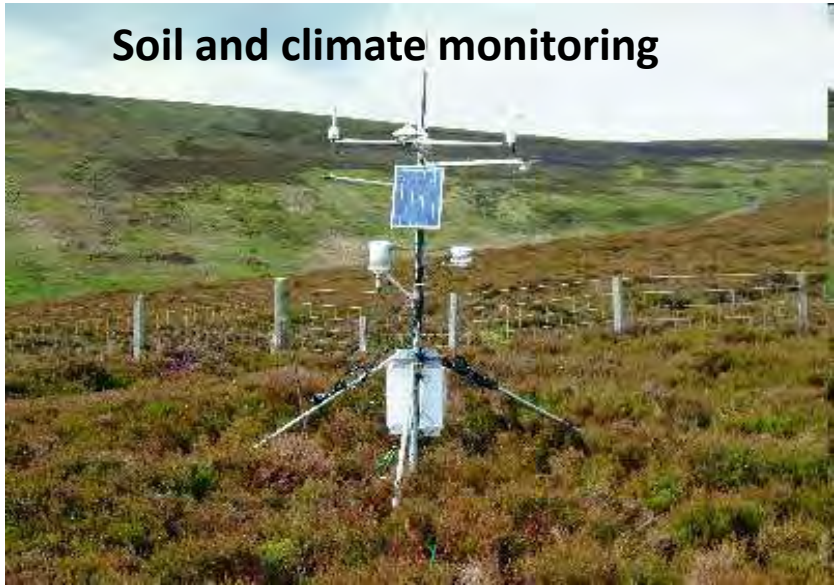


Common temporal smoother (p<0.001) fitted with GAM

- Non linear statistics used to fit a common smoother across 70 sites (>10 year DOC records)
  - Inference of common non linear trend for all sites
- Deviations from the common smoother were attributed to change in sulphate deposition (p=0.003), C stock (p=0.03) and catchment size (p=0.0001) plus 40% of unexplained variance
  - Inference of a common driver operating across catchments nationally

ECN long term records at Glensaugh

The James Hutton Institute



Evidence of rising DOC in podzols

The James Hutton Institute

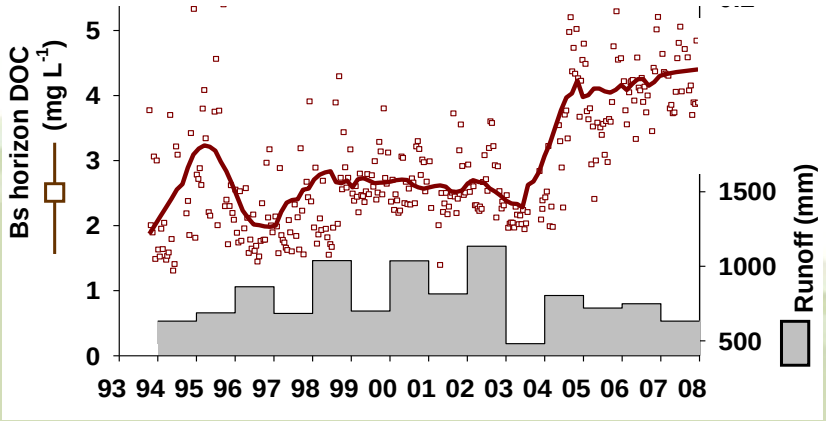
SIGNIFICANCE OF 14 YEAR LONG TRENDS AND %ANNUAL CHANGE IN DOC AND SO_4 DATA (Seasonal Mann - Kendall analysis)

		Glensaugh	Sourhope	Moorhouse
MK trend in DOC concentration	Soil 10 cm	3%	ns	ns
	Soil 30 cm	6%	- 2%	ns
	Stream water	ns	ns	ND
MK trend in SO_4 concentration	Soil 10 cm	- 8%	- 9%	- 7%
	Soil 30 cm	- 4%	- 9%	ns
	Stream water	- 1%	- 5%	ND

Significance of annual % change:

	p<0.01 increase		p<0.05 decrease
	p<0.05 increase		p<0.01 decrease
ns	no significant trend		p<0.001 decrease
ND	Not determined		

TEMPORAL CHANGE IN Bs HORIZON SOLUTES AND CATCHMENT RUNOFF AT ECN GLENSAUGH (fortnightly data with LOWESS smoothed trends)




Biogeosciences, 8, 3661–3675, 2011
www.biogeosciences.net/8/3661/2011/
doi:10.5194/bg-8-3661-2011
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Biogeosciences

Three representative UK moorland soils show differences in decadal release of dissolved organic carbon in response to environmental change

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[2]Centre for Ecology and Hydrology, Lancaster University, UK

Received: 5 July 2011 – Published in Biogeosciences Discuss.: 5 August 2011
Revised: 18 November 2011 – Accepted: 24 November 2011 – Published: 14 December 2011

Abstract. Moorland carbon reserves in organo-mineral soils may be crucial to predicting landscape-scale variability in soil carbon losses, an important component of which is dissolved organic carbon (DOC). Surface water DOC trends are subject to a range of scaling, transport and biotic processes that disconnect them from signals in the catchment's soils. Long-term soil datasets are vital to identify changes in DOC release at source and soil C depletion. Here we show that moorland soil solution DOC concentrations at three key UK Environmental Change Network sites increased between 1993–2007 in both surface- and sub-soil of a freely-draining Podzol (48 % and 215 % increases in O and Bs horizons, respectively), declined in a gleyed Podzol and showed no change in a Peat. Our principal findings were that: (1) considerable heterogeneity in DOC response appears to exist between different soils that is not apparent from the more commonly observed trends for streamwaters, and (2) freely-draining organo-mineral Podzol showed increasing DOC concentrations, countering the current scientific focus on soil C destabilization in peats. We discuss how the key solubility controls on DOC associated with coupled physico-chemical factors of ionic strength, acid deposition recovery, soil hydrology and temperature cannot readily be separated. Yet, despite evidence that all sites are recovering from acidification, the soil-specific responses to environmental change have caused divergence in soil DOC concentration trends. The study shows that the properties of soils govern their specific response to an approximately consistent set of broad environmental drivers. Key soil properties are indicated to be drainage, sulphate and DOC sorption capacity. Soil property driven representation in process-models is understood to predict the role of soils in catchments to global C budgets. Catchment hydrological (i.e. transport) controls may, at times, be the governing factor in river DOC concentration trends, but soil (i.e. source) controls provide the key to prediction of future C loss to waters and the atmosphere.

1 Introduction

Soils store large amounts of organic carbon (1100 PgC in the upper 1 m; Batjes, 1996), accumulated in three zones and mainly that as above ground biomass and atmospheric pools, respectively (Hamilton et al., 1993). Dissolved organic C (DOC) is a rapidly cycling component of the soil carbon (C) pool and an important indicator of changes in soil C stability, and in the contributing biogeochemical processes. At catchment scales the magnitude of soil DOC release relates closely to the soil C pool size (Hope et al., 1997). Upland areas with C rich soils are deemed sensitive indicators of environmental change and DOC release are governed by water-related physico-chemical and biological soil conditions, including the nature of the soil organic matter itself (Kalbitz et al., 2000). Space-temporal variability in DOC concentrations, transportation and release rates present an important challenge for modelling the implications for C budgets, stream and soil ecosystems. DOC is a key component of C fluxes (Hope et al., 1997) and influences many ecosystems processes, metabolism, transport and bioavailability of nutrients, metals and organic contaminants (Lawlor and Tipping, 2003).

There has been widespread evidence for increasing catchment DOC concentrations across UK, US and Europe (Freeman et al., 2001; Worrall et al., 2004a; Skjelkvåle et al., 2005; de Wit et al., 2007; Monteith et al., 2007). Positive monotonic trends are generally found for streamwater DOC (Monteith et al., 2007). As a result there has been considerable examination of the potential large-scale drivers (Evans et al., 2006), generally split between hypotheses of

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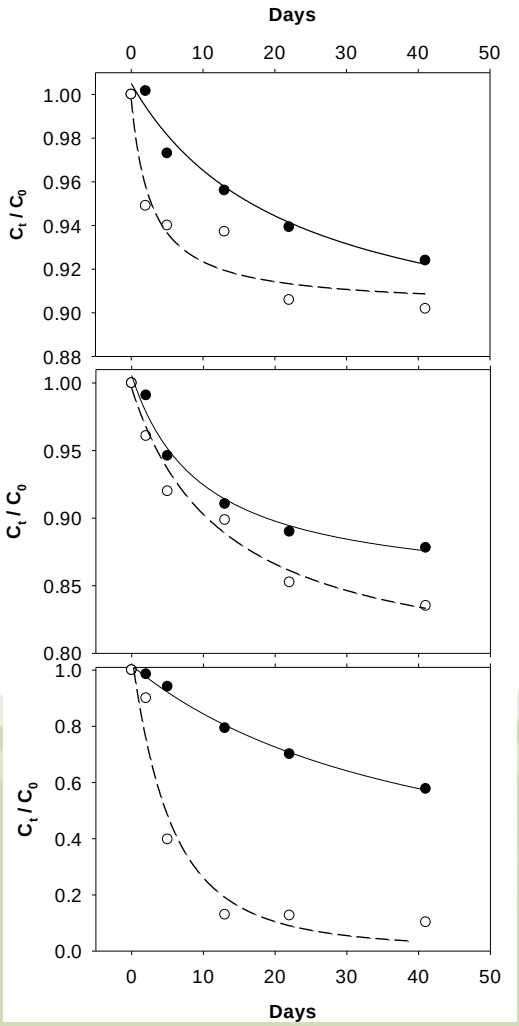
Published by Copernicus Publications on behalf of the European Geosciences Union.

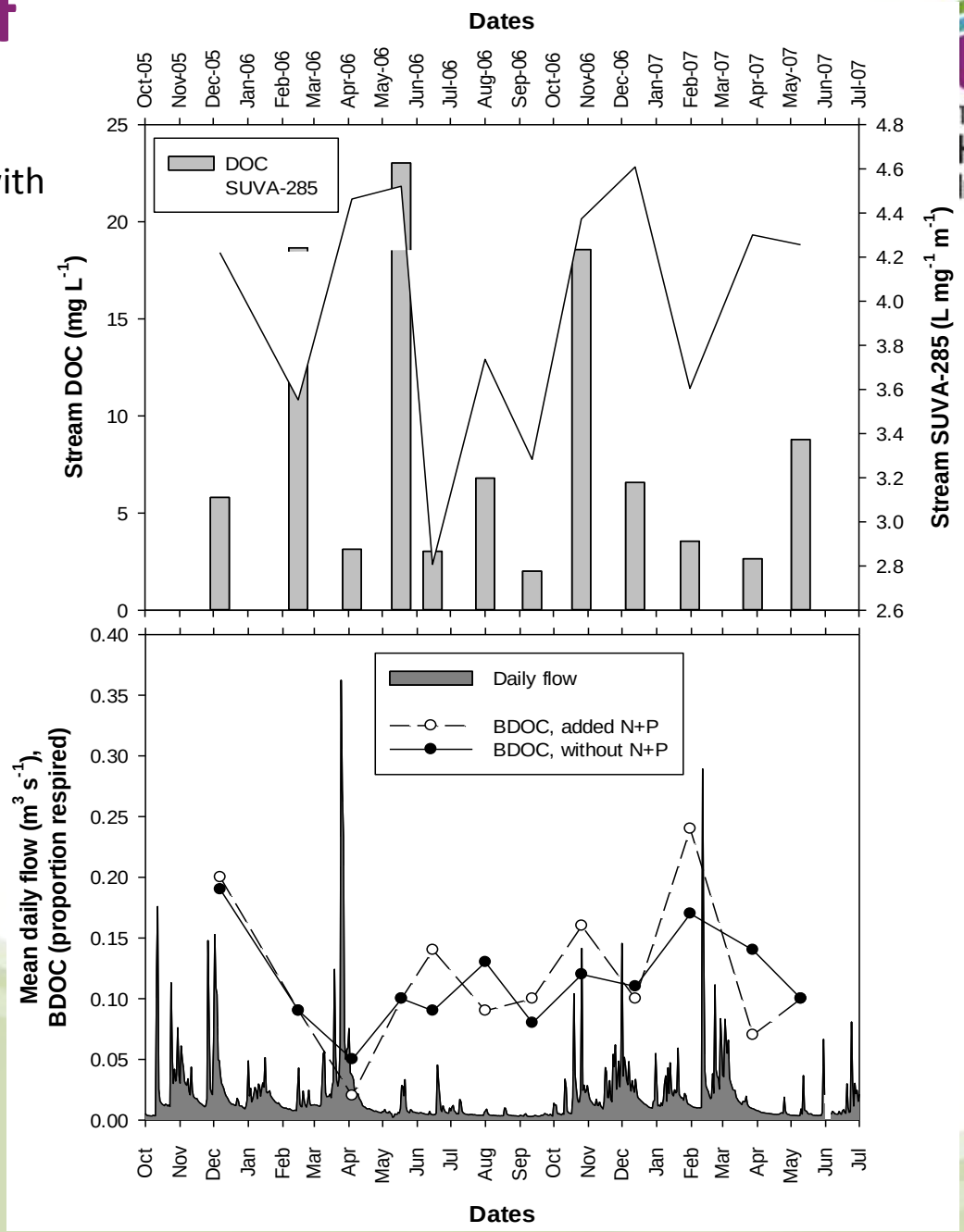
Dissolved organic carbon release from soils

……..a shift in interest

Biodegradation of stream DOC

41 day batch decomposition tests with stream sediment inoculum





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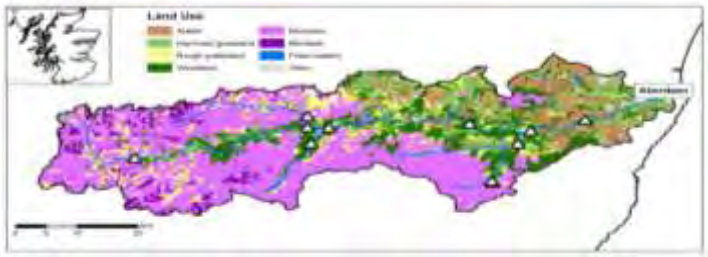
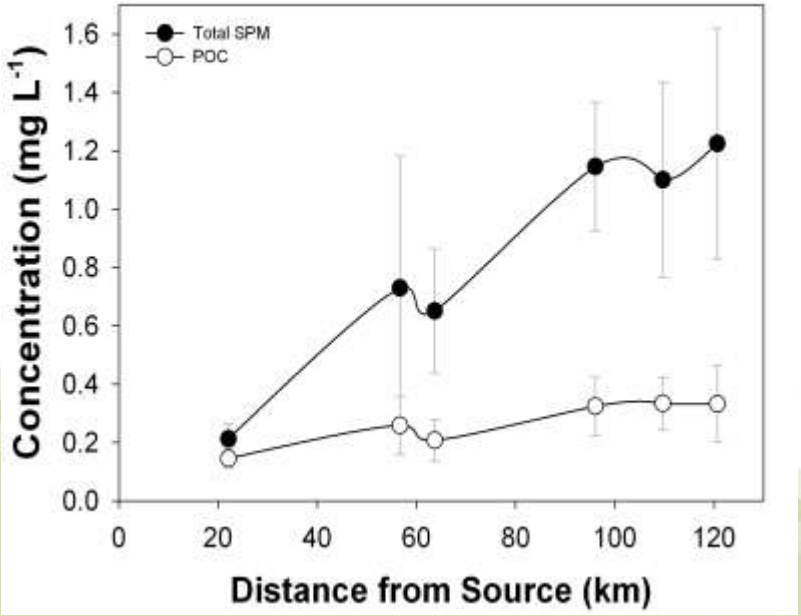
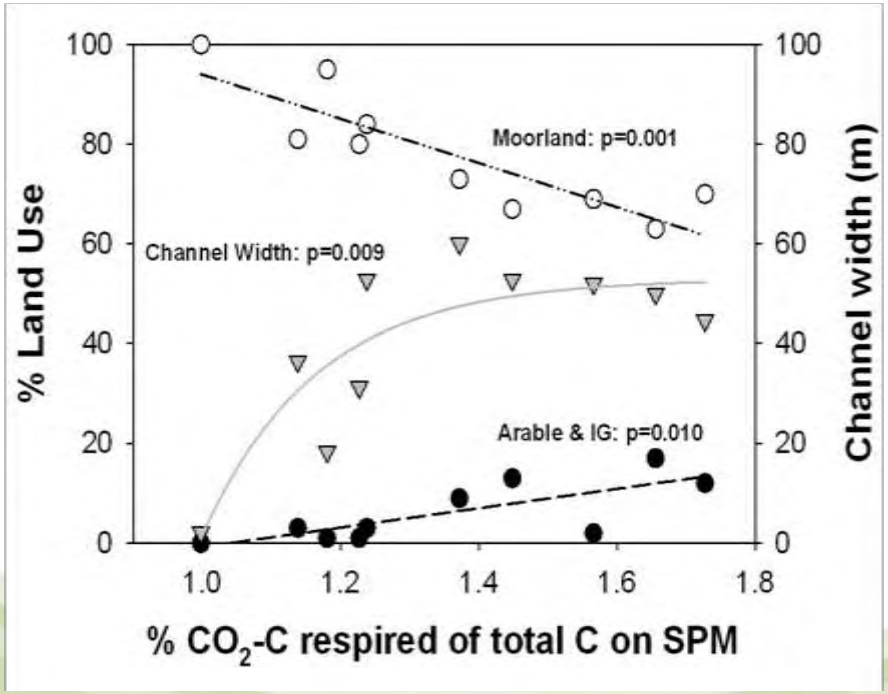
Particulate organic matter quality

- Decreasing proportion of C content on SPM as influence of moorland systems decreases





- An increasing proportion of C on SPM is respirable with changing land use and higher nutrient inputs



The National Waters Inventory Scotland

- Aims to determine the quality baseline of today's water resource nationally.
  - Natural Isotopes
    - Isotopic Tracers
    - Isotopic Fingerprinting
  - Organic matter characterisation & trace elements
    - Spectroscopic analyses of DOM
    - POM quality
    - Geochemical modelling interactions
  - Waters DNA archive
    - Molecular data on pathogens & microbial communities
  - Faecal Indicator Organisms (FIOs)

NERC macronutrient cycles programme

Aquatic C, N, P cycling:

(JHI, CEH, Reading, Bangor)

- Aim: to generate modelling ‘rate’ and ‘threshold’ data for ecological parameters (chlorophyll, nutrient cycling rates, respiration) under environmental parameters
- Parameters designed for testing C, N, P quantity and quality and cycling rates under different physical conditions:
  - Controlled conditions – light, temperature, flow rate, N and P
  - Natural aspects – real stream bed sediments, real DOC, algal grazers

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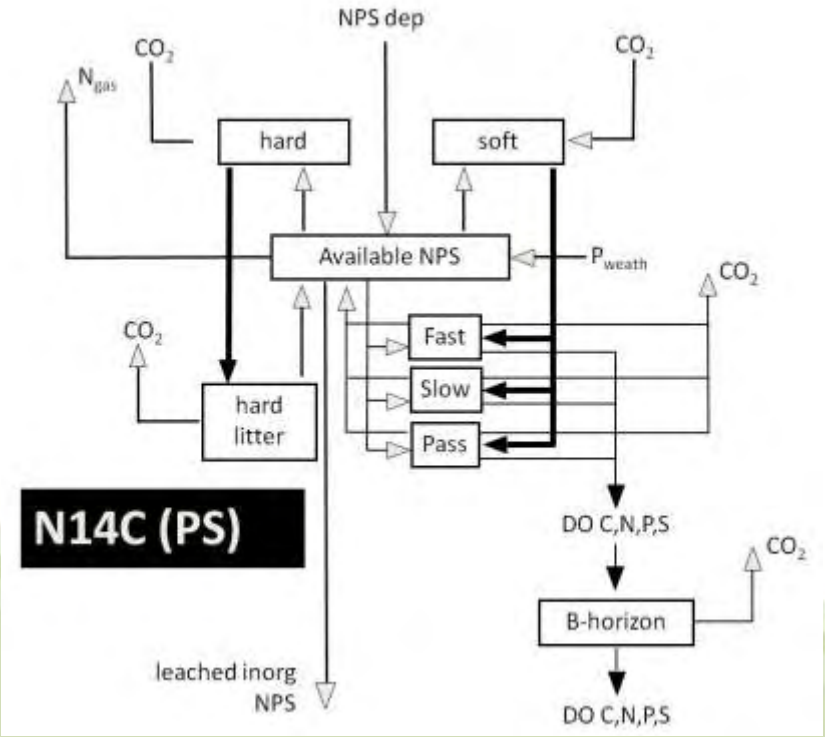
NATURAL ENVIRONMENT RESEARCH COUNCIL

Macronutrient C N P Cycles Programme

NERC macronutrient cycles programme

LTLS: Analysis and simulation of the Long-Term / Large-Scale interactions of C, N and P in UK land, freshwater and atmosphere (JHI, CEH)



Key questions

How have the temporal relationships between, and turnover times of, pools of C, N, P in terrestrial ecosystems changed over 200 years?

Have these changes altered the transfer of excess nutrients to freshwaters and the sea?

How have terrestrial and freshwater floristic biodiversity responded to the long-term changes in nutrient enrichment?

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NATURAL ENVIRONMENT RESEARCH COUNCIL

Macronutrient C N P Cycles Programme

Land Use Theme

Workshop on Climate change and Carbon Management

James Hutton Institute 1st March 2012 - - Allan Lilly

BioSS · The James Hutton Institute · Moredun · Royal Botanic Garden Edinburgh · Rowett Institute of Nutrition and Health · SAC · The Scottish Government

Land Use Theme Objectives

Context:

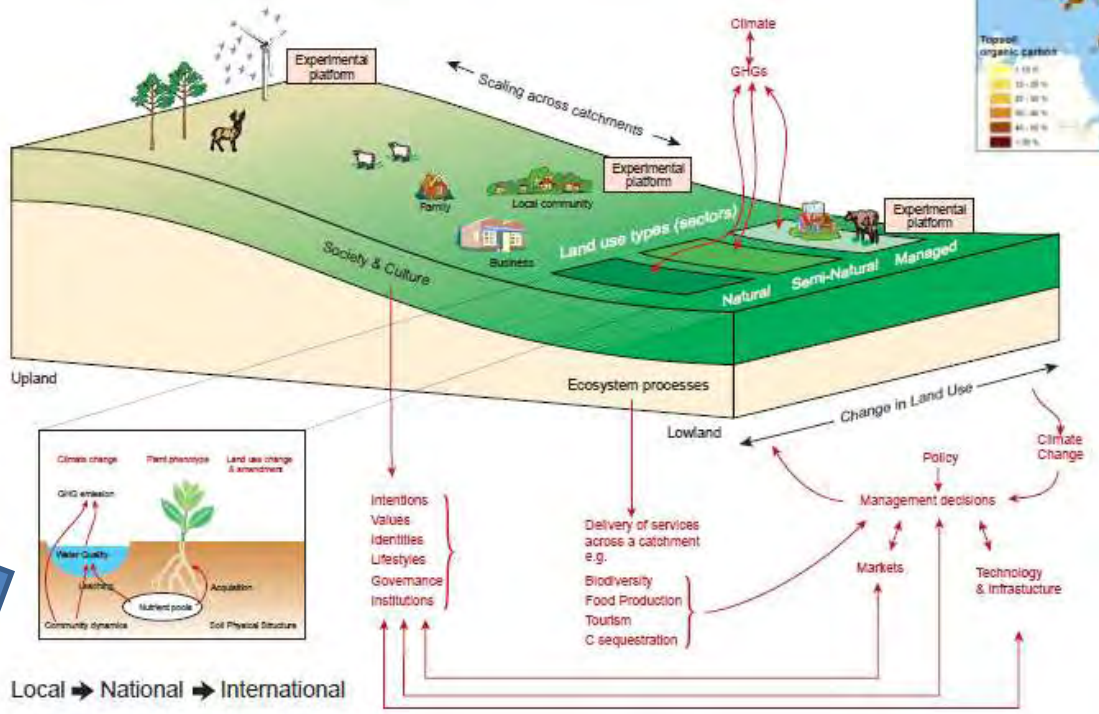
- Increased knowledge of how Scotland's environment might respond to predicted changes in climate and land use.

- Outcomes of the research contribute to:
  - improving management and resilience of Scotland's rural environment
  - ensuring land use is sustainable and withstands impacts of climate change (e.g. farming practices that reduce greenhouse gas emissions while protecting soils and biodiversity)

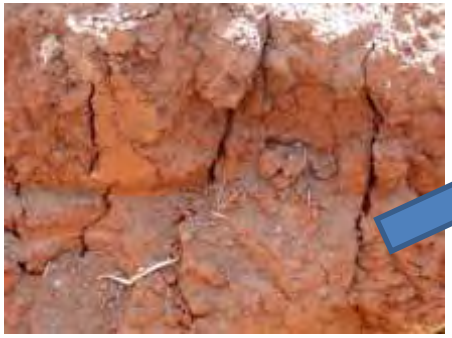
Multiples scales

National scale

Plot & catchment



Molecular & profile



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Molecular & profile scale

- Stable isotope methods are being used to resolve processes in soils mediating GHG balances and improve soil C models

• Identified a site at Ballogie to investigate the effects of land use change on soil C

➢ the establishment of trees (birch and Scots pine) on moorland.

➢ SG aiming for increase from 17 to 25% tree cover (up to approx 2M ha)

• Continuing development of isotope techniques to partition soil surface CO2 efflux.

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Molecular & profile scale

- Soil-only incubations do not replicate SOM mineralisation in natural, vegetated soils

- Microbial community composition affects plant-induced SOM mineralisation

- Plant species affects the extent of plant-induced SOM mineralisation

- Plant-induced and basal SOM-mineralisation have different temperature sensitivities

- Soil type affects the extent of plant-mediated SOM mineralisation

- **As these effects are quantitatively significant, they need to be built into current models**

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Plot & catchment scale

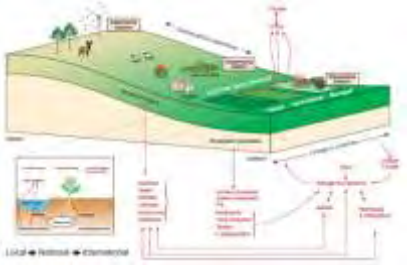
- Long term measurements of C exchange by eddy covariance on a grazed grassland

- Half of the field will be ploughed in April 2012

- Measurements will take place on ploughed and reseeded areas, with subplots planted with cereals

- Measurements of CO_2 exchange (micromet) and N_2O/CH_4 (static chambers) already underway

- Carbon stock changes (soil coring)



Monitoring GHG at Easter Bush field site

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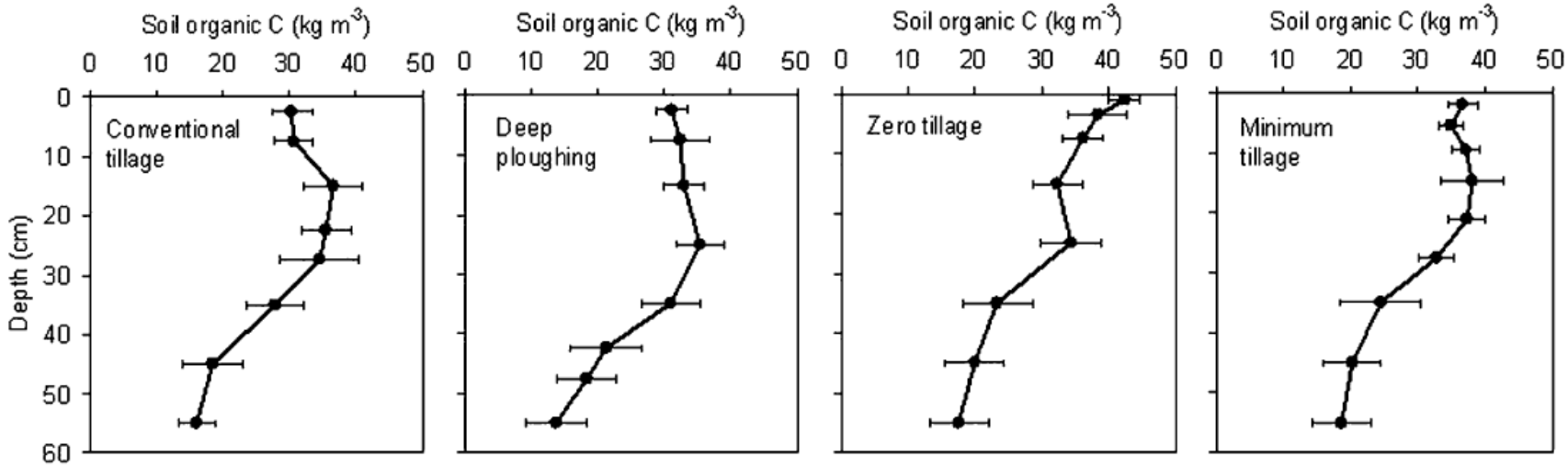
Plot & catchment scale

low carbon agriculture

- Less fuel and fertiliser input
- Increased carbon storage in soil



8 Year Tillage Trial at JHI Dundee – no difference in soil carbon

Sun et al., 2011, Plant and Soil, 338

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Plot & catchment scale

Peatland restoration

- RSPB peatland restoration chronosequence at Forsinard
- In-depth studies of C and N cycling
- Understand impact of restoration on biodiversity and on carbon sequestration
- Calculate time taken to restore bog to a ‘normal’ state
- Measure gaseous emissions with eddy covariance flux tower

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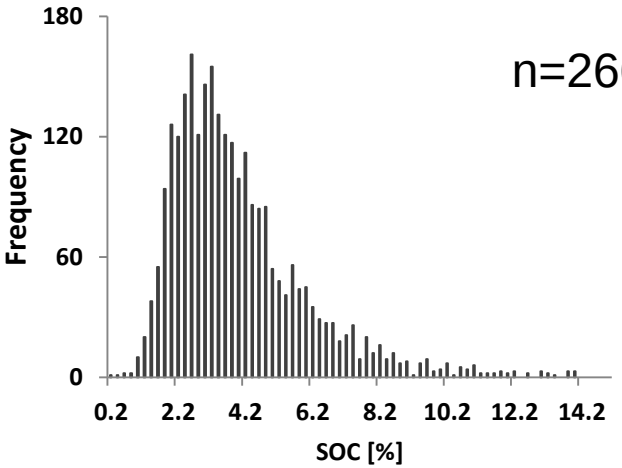
National scale – Legacy data



< 5%ile - 96% arable
>95%ile - 77% arable

- Collating meta-data for GHG emissions/sinks from previous studies in Scotland
- Reviewing existing soil data and identifying data gaps
- Reviewing soils data for afforested soils

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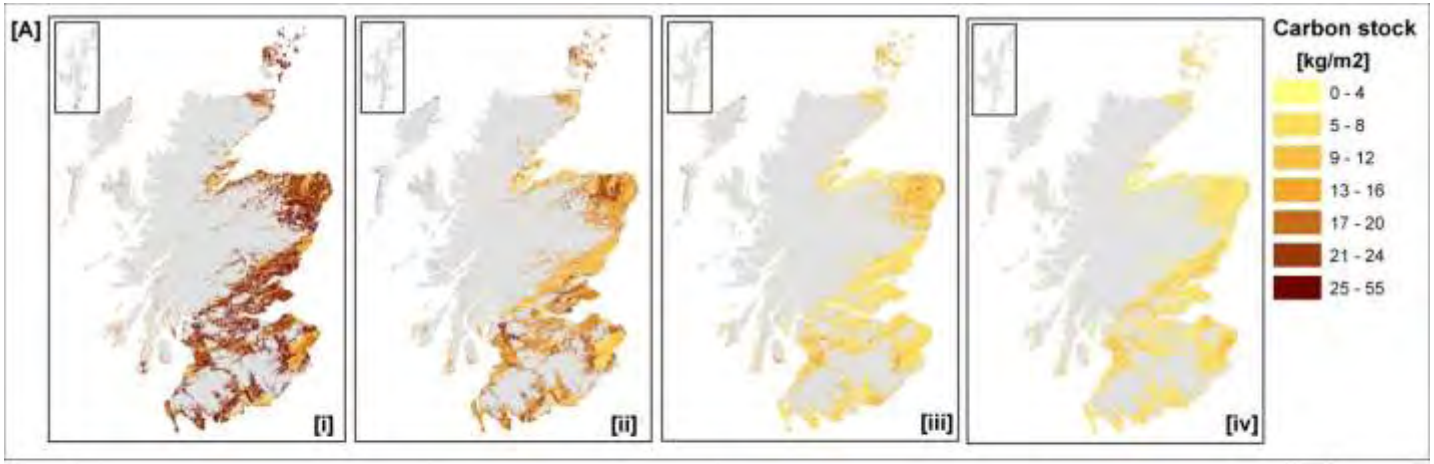
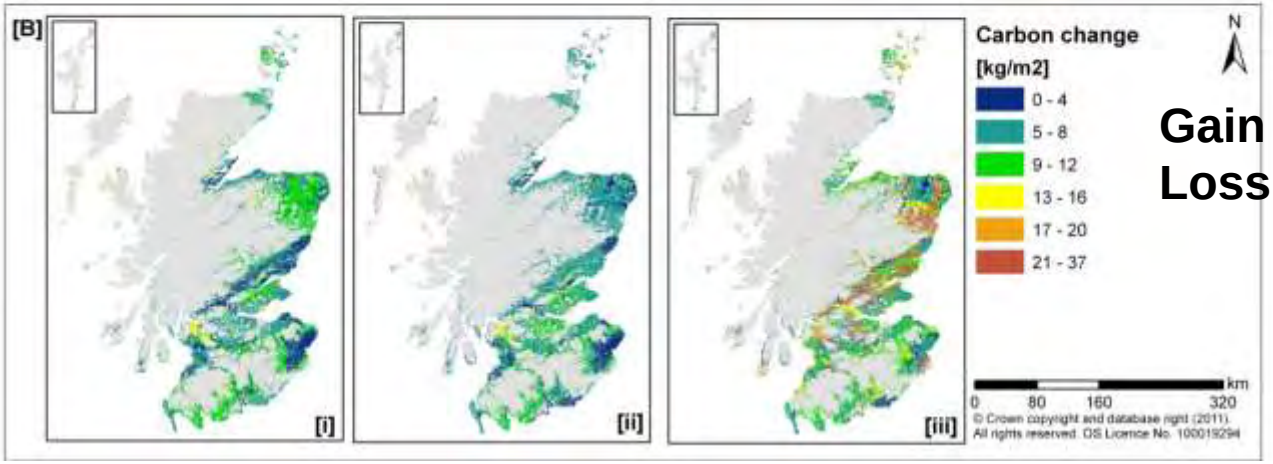
National scale – C loss/gain in Scottish cultivated mineral topsoils

maximum SOC median SOC observed minimum SOC SOC in <20µm mineral fraction.



Total stored =242 Mt

≅ 17 yr total emissions



Gain = Max-Med (212Mt)
Loss = Med-Min (111-128 Mt)

Potential loss; <20µm mineral fraction

observed minimum

Storage potential.

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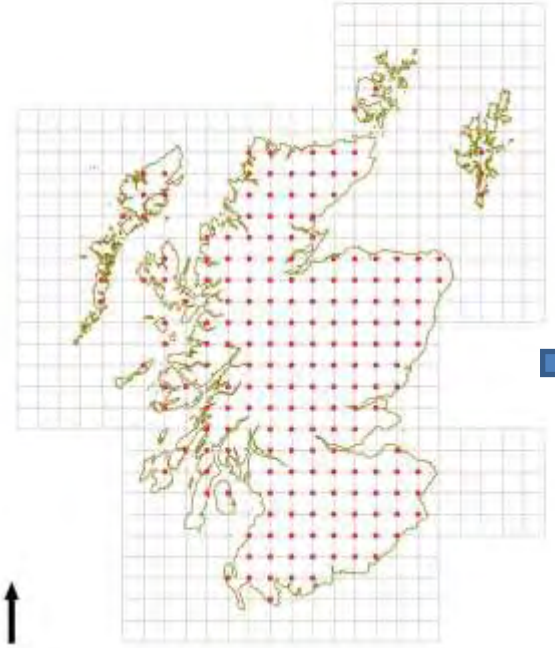
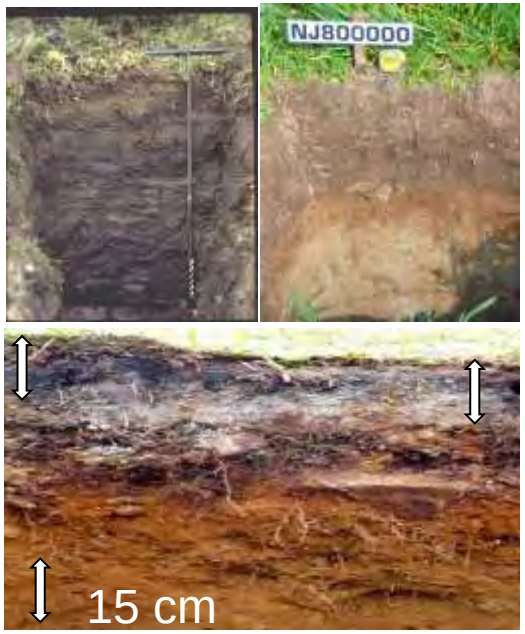
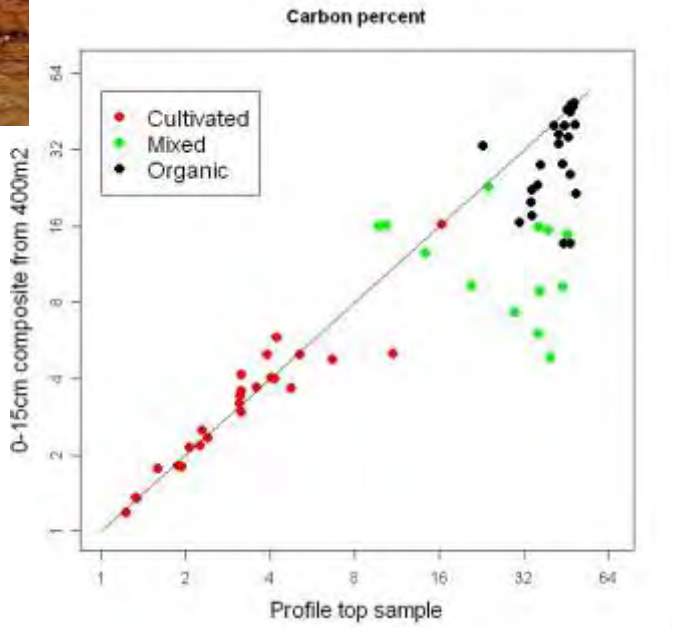
National scale - NSIS







2 sampling periods 1978-88 and 2007-9

- Detect change in soil C content
- Assess methods for soil monitoring

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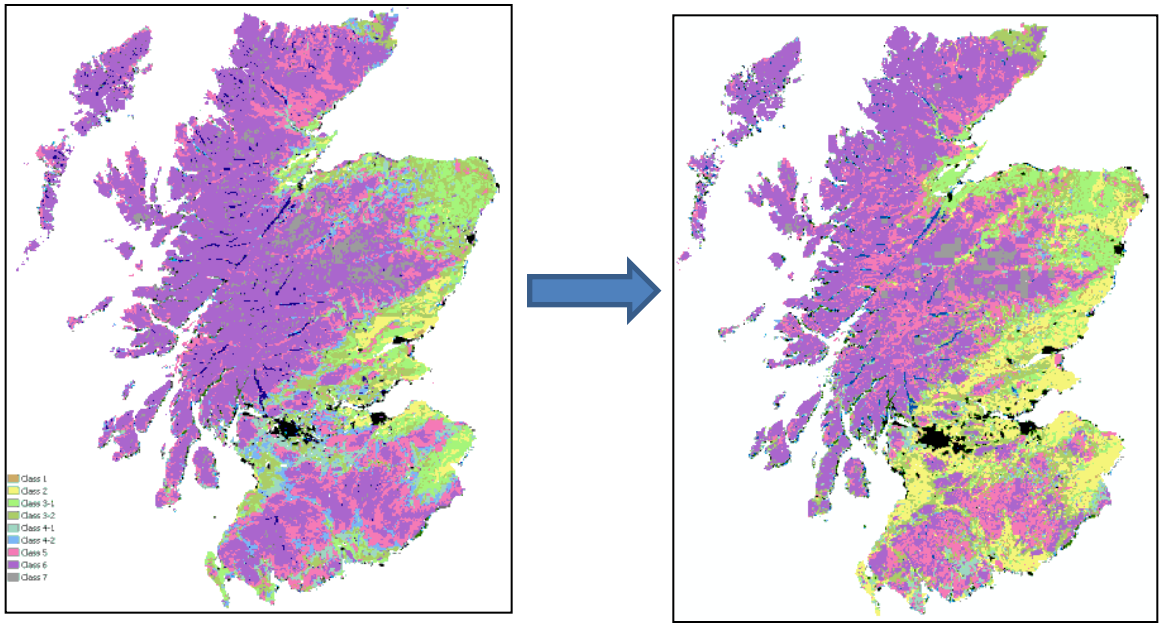
Climate Change impacts on land capability



Published maps (c.1984)

2050s

Modelling

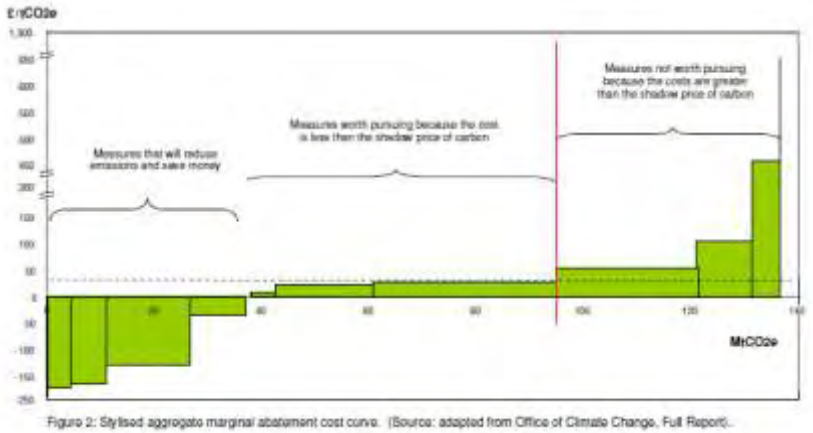


Figure 2: Stylised aggregate marginal abatement cost curve. (Source: adapted from Office of Climate Change, Full Report).

Development of Marginal Abatement Cost Curves (MACC) from management practices to farm systems

Process-based modelling:

- DNDC (DeNitrification-DeComposition)
- PALM (People and Landscape Model)
- ECOSSE (Estimating Carbon in Organic Soils - Sequestration and Emissions)

Identification of adaptation options in land use sector: agriculture through to tourism, forestry and game

- Costs
- Responsibility
- Acceptability
- Timing

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A rural economy resilient to local and global change

Overview of work related to climate change and carbon management

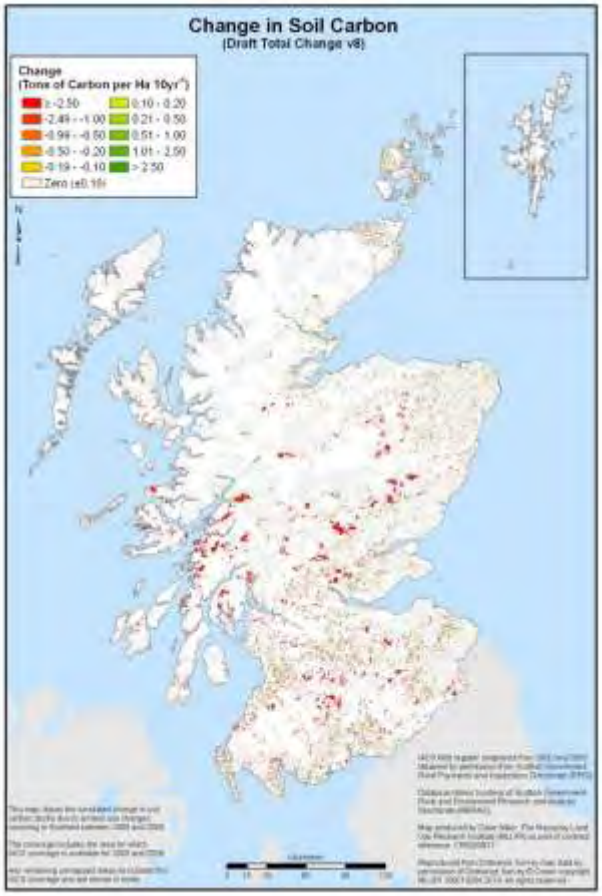
Resilience of Rural Areas

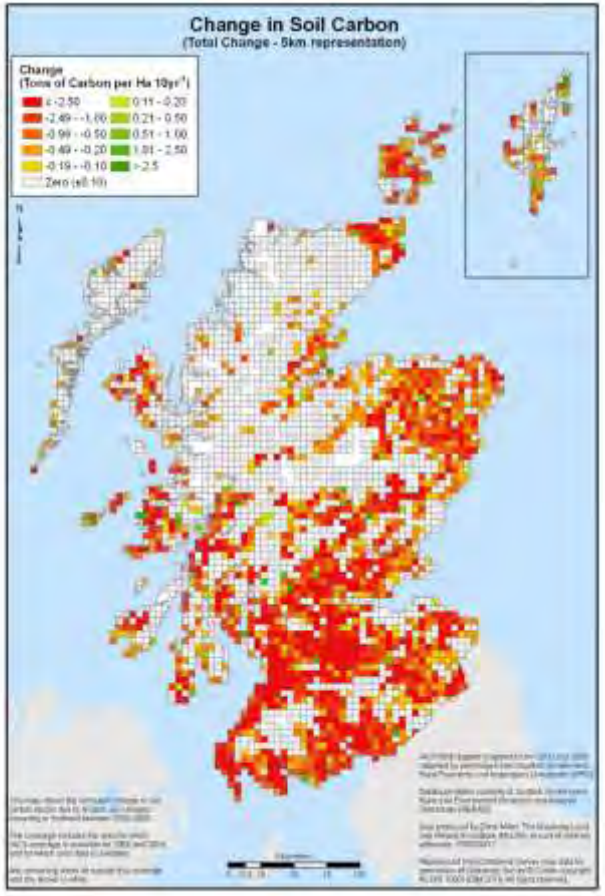
- Two workpackages
  - Adaptation to change in land-based and other rual industries
  - Low Carbon Rural Economy
- Highlight research questions
- Examples of research

Adaptation to change in land based and other rural industries: Case Study Approach

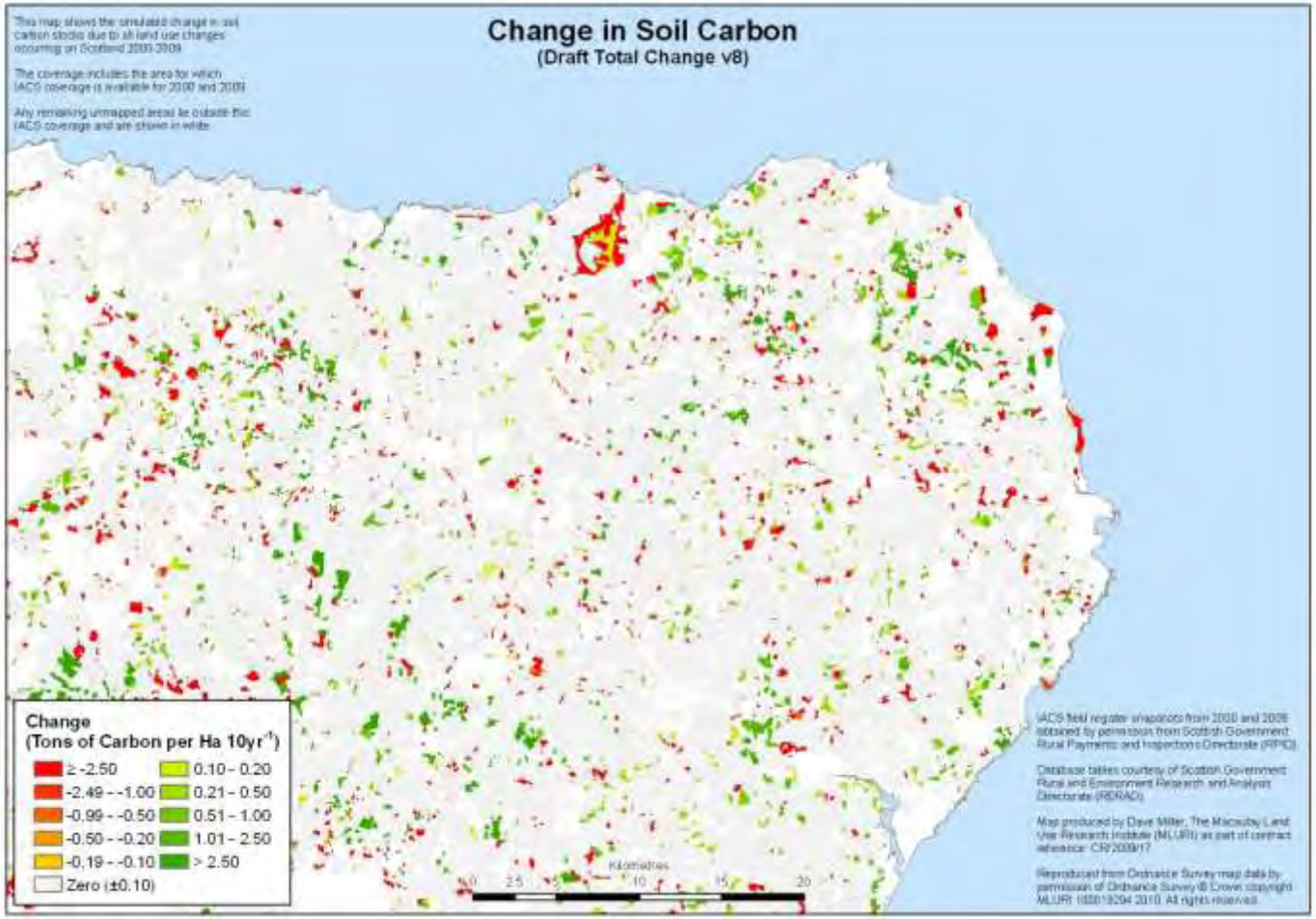
- Assessment of the impacts of CAP reform on traditional land based industries and identification of effective policies for enabling restructuring and other adaptations.
- Examination of how globalisation will affect trade, the movements of animals and plants and the implications for rural industries and the wider rural economy.
- Improving understanding of changes in the imports and exports of food, their impact on rural industries and the wider rural economy and effective policies for adaptation.
- Risk analysis of potential impacts of climate change on existing farm systems.
- Identification and evaluation of robust adaptation actions to climate change in a range of rural industries.

Change in Emissions LUC (100m grid)

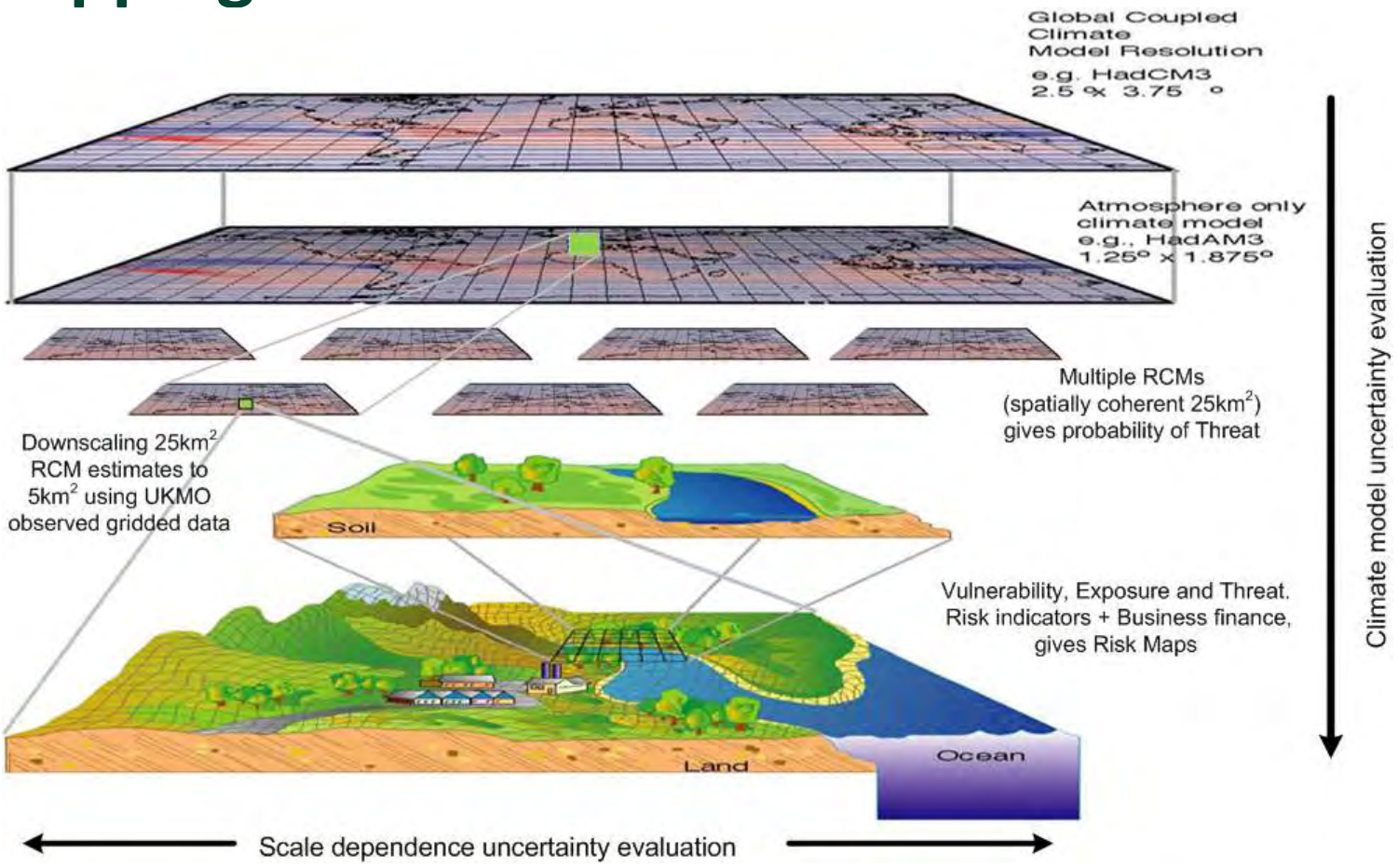




Nature of the Change

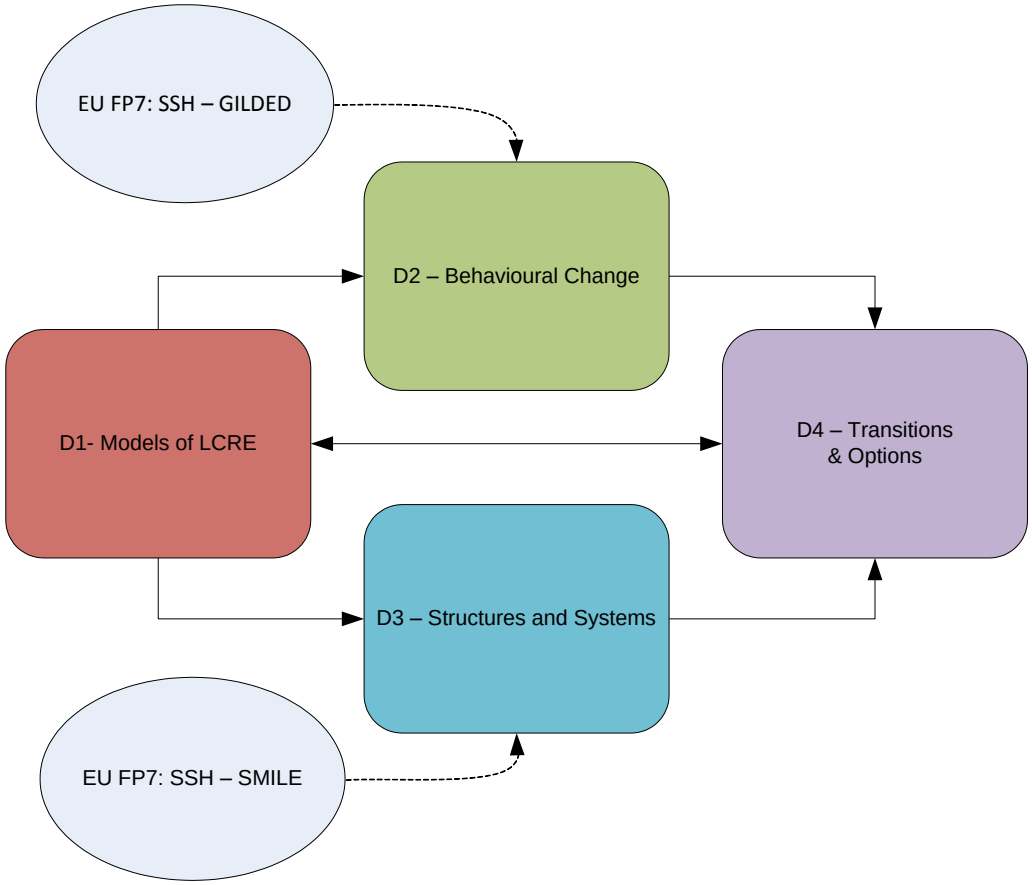


Climate projection uncertainty evaluation and risk mapping



Low Carbon Rural Economy

- Developing an understanding of the key components of a ‘low carbon rural economy’.
- Proposing potential pathways toward a ‘low carbon rural economy’ and examining the associated costs, benefits and acceptability of these;
- Identifying the key barriers and facilitators of a ‘low carbon rural economy’ at multiple scales, from individual through to national;
- Suggesting practical and appropriate ways to support rural Scotland in a transition toward a low carbon rural economy.


EU FP7: SSH – GILDED
D2 – Behavioural Change
D1- Models of LCRE
D4 – Transitions & Options
D3 – Structures and Systems
EU FP7: SSH – SMILE

Rapid review of literature

Matrix to scope existing SAC/JHI knowledge of information sources relevant to Low Carbon (Rural) Economy

Instructions:

1. Please enter any relevant literature into the appropriate cell of the matrix, providing Author, date, and brief summary (2 or 3 sentences). Entries need not be restricted to 'rural' publications.
2. Provide full reference below table.
3. If possible please upload full paper/report to the 'LCRE literature' folder on the Sharepoint site, here: http://share.sac.ac.uk/research/wp1116/1hd/workpackage4.2/Shared%20Documents/Forms/AllItems.aspx

Focus / Topic	Policy statements, strategies, programmes, plans, scenarios etc	Governance / institutional frameworks (How do governance structures - at multiple scales - influence what is being done? What are they, who is involved and what is needed?)	Behaviour, decision-making, attitudes
Energy production and consumption Inc. renewables, levels of consumption, energy source, efficiency etc			
Transport Inc. private, public, freight			
Forestry			
Agriculture			
Tourism			
Industry (other than agriculture, forestry, tourism)			
Housing Inc. new build, retro-fitting, current condition, etc			
Services & service delivery For example Post Offices, banking, healthcare, council services, role of broadband etc			
Other / General low carbon			

1

Matrix to scope existing SAC/JHI knowledge of information sources relevant to Low Carbon (Rural) Economy

			'carbon capable'? Introduction provides useful text on role of public in low carbon behaviours. Distinguishes between low-carbon consumer, low-carbon employee, and low-carbon citizen
Institutes, organisations, (with name of contact if known) which may be of use, particularly regarding LCE definition	Scottish Enterprise – Julian Pace		

REFERENCES

Whitmarsh et al, 2011. Public engagement with carbon and climate change: To what extent is the public 'carbon capable'? Global Environmental Change 21 (2011) 56–65

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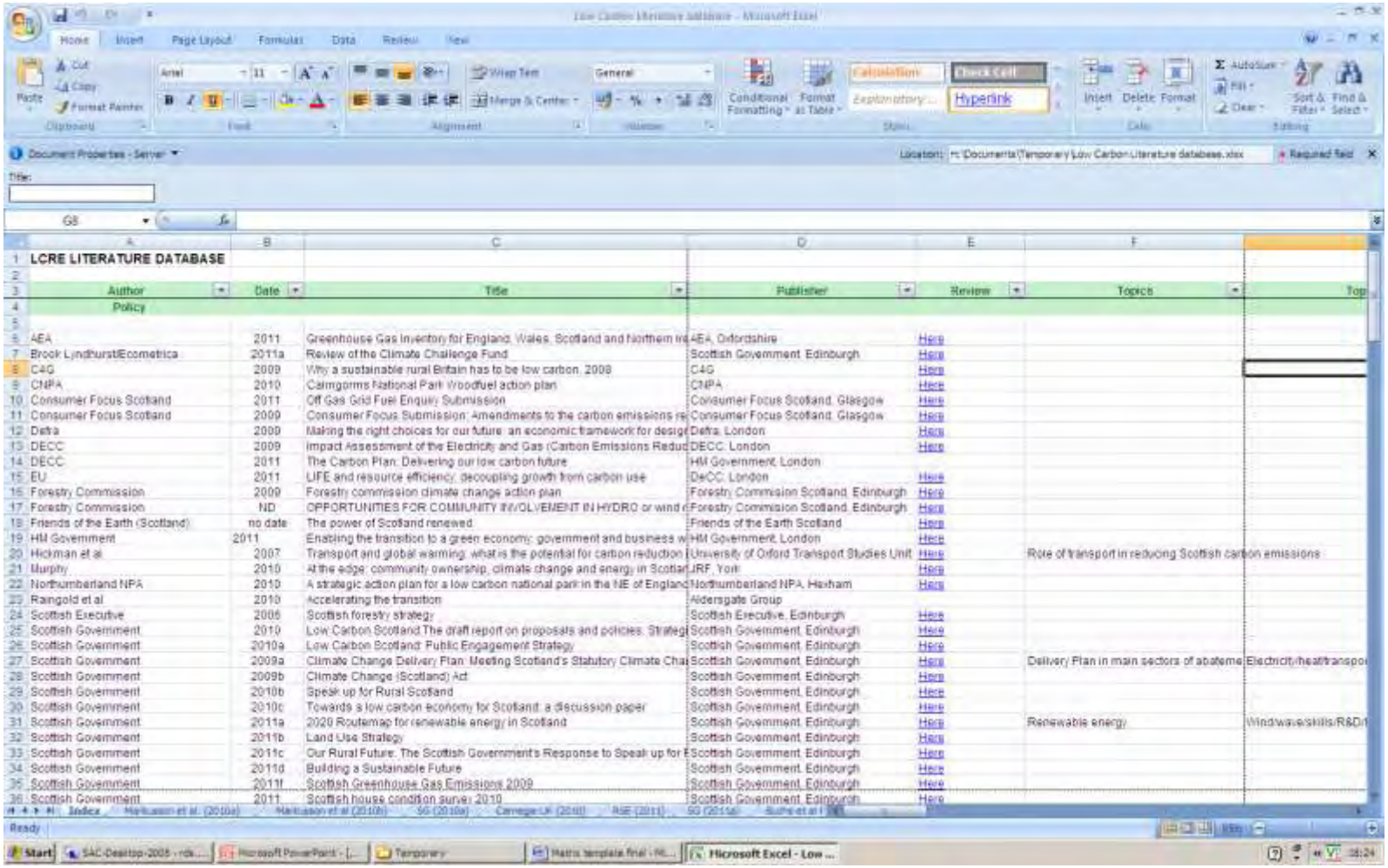


LCRE LITERATURE DATABASE

Author	Date	Title	Publisher	Review	Topics	Top
Policy						
AEA	2011	Greenhouse Gas Inventory for England, Wales, Scotland and Northern Ire	AEA, Oxfordshire	Here		
Brook Lyndhurst/Ecometrica	2011a	Review of the Climate Challenge Fund	Scottish Government, Edinburgh	Here		
C4G	2009	Why a sustainable rural Britain has to be low carbon. 2009	C4G	Here		
CNPA	2010	Cairngorms National Park Woodfuel action plan	CNPA	Here		
Consumer Focus Scotland	2011	Off Gas Grid Fuel Enquiry Submission	Consumer Focus Scotland, Glasgow	Here		
Consumer Focus Scotland	2009	Consumer Focus Submission: Amendments to the carbon emissions re	Consumer Focus Scotland, Glasgow	Here		
Defra	2009	Making the right choices for our future: an economic framework for desig	Defra, London	Here		
DECC	2009	Impact Assessment of the Electricity and Gas (Carbon Emissions Reduc	DECC, London	Here		
DECC	2011	The Carbon Plan: Delivering our low carbon future	HM Government, London			
EU	2011	LIFE and resource efficiency: decoupling growth from carbon use	DeCC, London	Here		
Forestry Commission	2009	Forestry commission climate change action plan	Forestry Commision Scotland, Edinburgh	Here		
Forestry Commission	ND	OPPORTUNITIES FOR COMMUNITY INVOLVEMENT IN HYDRO or wind	Forestry Commision Scotland, Edinburgh	Here		
Friends of the Earth (Scotland)	no date	The power of Scotland renewed	Friends of the Earth Scotland	Here		
HM Government	2011	Enabling the transition to a green economy: government and business w	HM Government, London	Here		
Hickman et al	2007	Transport and global warming: what is the potential for carbon reduction	University of Oxford Transport Studies Unit	Here	Role of transport in reducing Scottish carbon emissions	
Murphy	2010	At the edge: community ownership, climate change and energy in Scotlar	JRF, York	Here		
Northumberland NPA	2010	A strategic action plan for a low carbon national park in the NE of England	Northumberland NPA, Hexham	Here		
Raingold et al	2010	Accelerating the transition	Aldersgate Group			
Scottish Executive	2006	Scottish forestry strategy	Scottish Executive, Edinburgh	Here		
Scottish Government	2010	Low Carbon Scotland The draft report on proposals and policies: Strategi	Scottish Government, Edinburgh	Here		
Scottish Government	2010a	Low Carbon Scotland: Public Engagement Strategy	Scottish Government, Edinburgh	Here		
Scottish Government	2009a	Climate Change Delivery Plan: Meeting Scotland's Statutory Climate Cha	Scottish Government, Edinburgh	Here	Delivery Plan in main sectors of abateme	Electricit/heat/transpo
Scottish Government	2009b	Climate Change (Scotland) Act	Scottish Government, Edinburgh	Here		
Scottish Government	2010b	Speak up for Rural Scotland	Scottish Government, Edinburgh	Here		
Scottish Government	2010c	Towards a low carbon economy for Scotland: a discussion paper	Scottish Government, Edinburgh	Here		
Scottish Government	2011a	2020 Routemap for renewable energy in Scotland	Scottish Government, Edinburgh	Here	Renewable energy	Wind/wave/skills/R&D/
Scottish Government	2011b	Land Use Strategy	Scottish Government, Edinburgh	Here		
Scottish Government	2011c	Our Rural Future: The Scottish Government's Response to Speak up for F	Scottish Government, Edinburgh	Here		
Scottish Government	2011d	Building a Sustainable Future	Scottish Government, Edinburgh	Here		
Scottish Government	2011f	Scottish Greenhouse Gas Emissions 2009	Scottish Government, Edinburgh	Here		
Scottish Government	2011	Scottish house condition survey 2010	Scottish Government, Edinburgh	Here		

A Low carbon rural economy?

- Very few documents refer to a LCRE specifically
- None in Scotland
- In England, a small number of documents limited to RDAs and National Parks
    - •On and off-shore renewables
    - •Agricultural diversification
    - •Food
    - •Construction
    - •Digital infrastructure
    - •Community hubs and rural workspace
    - •Eco-tourism
    - •Low carbon transport

A more detailed picture of a ‘low carbon rural economy’ appears missing – for example:

- Business?

  Industrial and commercial energy use and sources.

- Residential?

  Domestic fuel combustion and energy use.

- Transport?

  Private and commercial.

Behaviour and Attitudes

- Range of work at both JHI and SAC
  - Re-analysis of existing data – Scottish Environmental Attitudes and Behaviours Survey (SEABS)
  - Development of surveys of rural businesses and households
  - Attitudes and Behaviour key components of a range of projects which are linked into LCRE

- GILDED: Governance, Infrastructure, Lifestyle Dynamics and Energy Demand: European Post-Carbon Communities
- LOCAW: Low Carbon at Work: Modelling Agents and Organizations to achieve Transition to a Low-Carbon Europe.

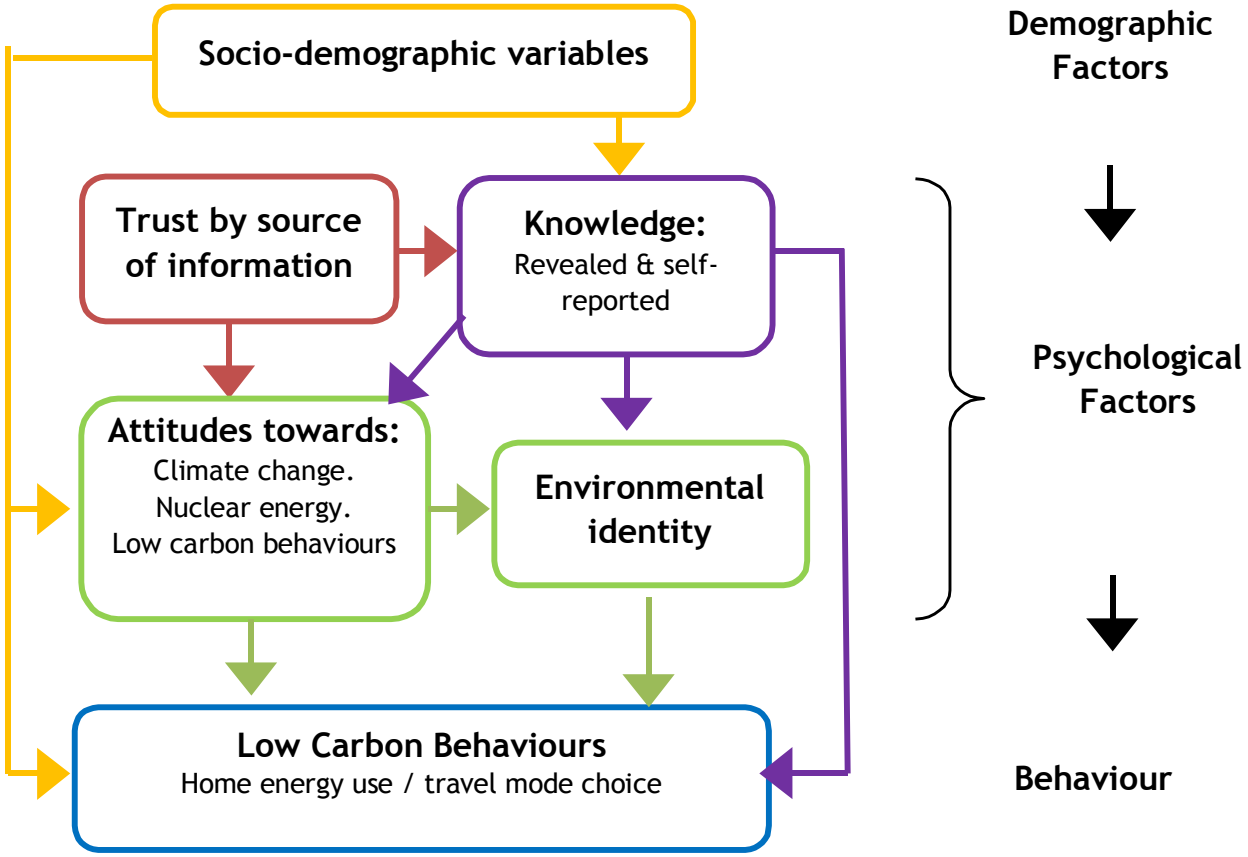
- NESEMP: North East Scotland Energy Monitoring Project (N=365)
  - (Building on some of the work carried out in GILDED)

- GCAP: Galloway Carbon Action Project (N=527).
  - (Links with WP7 work on diet, health and GHG emissions).

SEABS analysis

- Scotland-wide dataset from 2008.
- This analysis examines the antecedents of behaviours which can impact climate change:
  - Home energy use (8 carbon reduction behaviours: 5 habitual and 3 non-habitual)
  - Choice of travel mode for commuting and for grocery shopping (10 categories > 4 carbon intensive categories)
- Final sample size:
  - Carbon reduction behaviours at home: n = 1,877
  - Travel mode choice (to work/study): n = 1,008
  - Travel mode choice (to grocery shop): n= 1,803

The model


Socio-demographic variables
Trust by source of information
Knowledge:
Revealed & self-reported
Attitudes towards:
Climate change.
Nuclear energy.
Low carbon behaviours
Environmental identity
Low Carbon Behaviours
Home energy use / travel mode choice
Demographic Factors
Psychological Factors
Behaviour

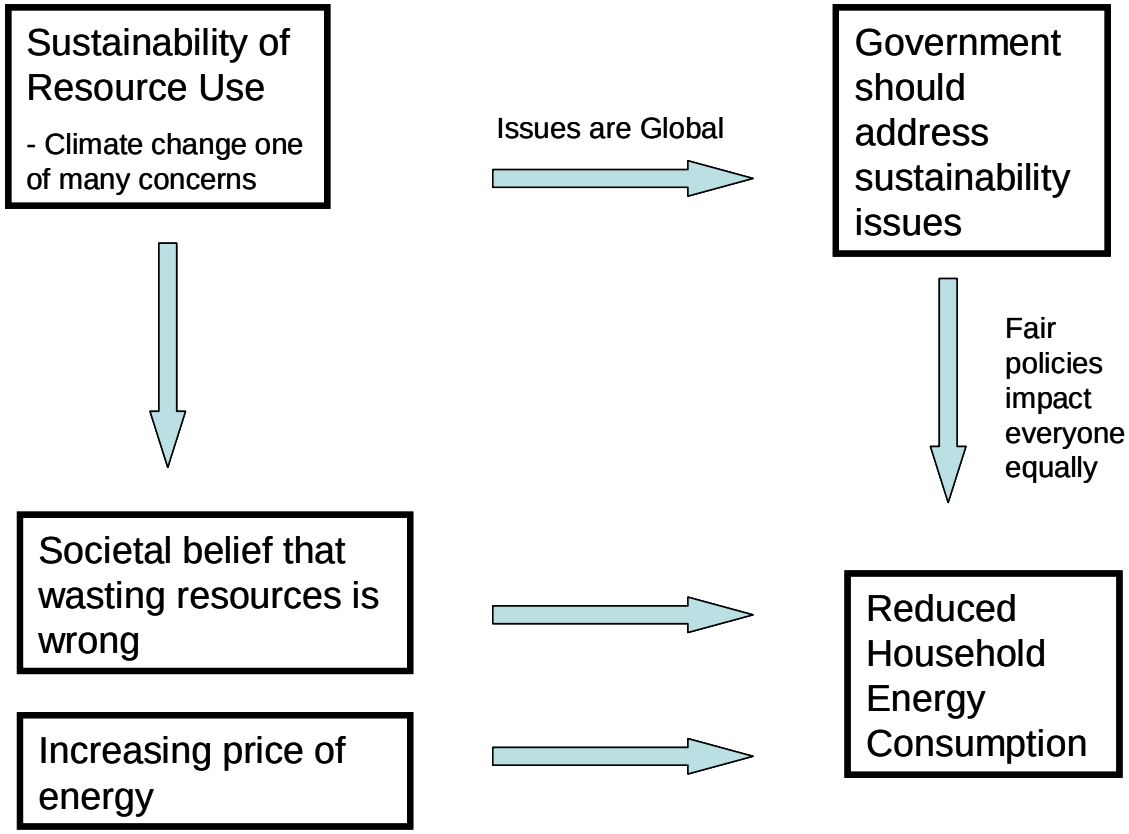
Example results

- The following variables are linked to more habitual carbon reduction behaviours
  - Having a pro-environmental identity
  - Having a positive attitude towards energy reduction behaviours
  - Having a higher level of self-reported knowledge
  - Being female
  - Living in a house or bungalow as opposed to a flat
  - Being in receipt of benefits
- The following variables are linked to less habitual carbon reduction behaviours
  - Having children under 16
  - Having higher income
  - Being a student

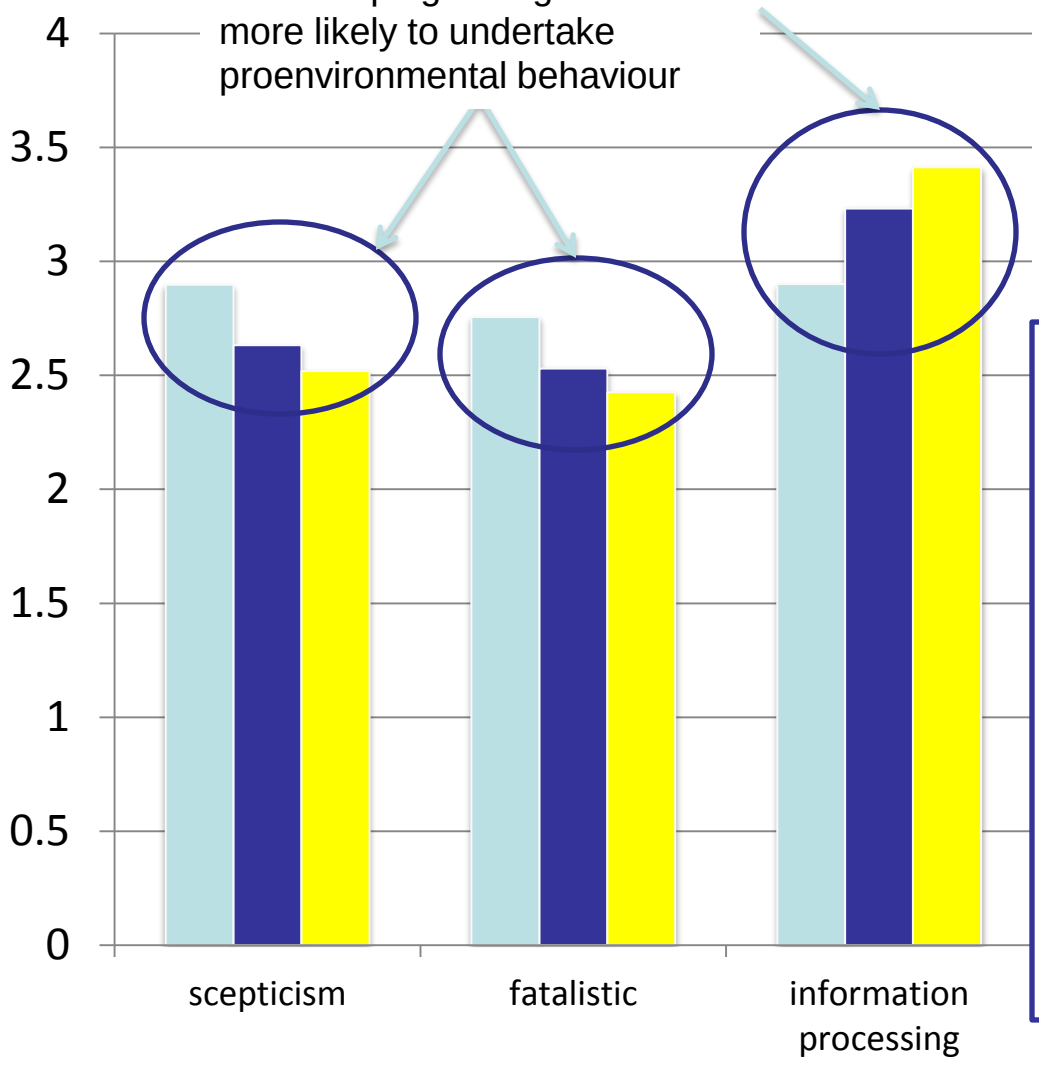
Analysis of stakeholder interviews (and stratified random sample survey) from GILDED

- Public tends to have inaccurate understanding of climate change, confusing it with other phenomena such as the hole in the ozone layer.
- “More information” is unlikely to be an adequate strategy. Despite fairly broad acceptance that climate change is real, there is also scepticism and feelings of powerlessness
- Focus on the importance of avoiding waste and generally unsustainable lifestyles may be more effective.
- However, there is a danger that people feel actions with minimal effect (e.g. recycling paper) mean they are “doing their bit”
- People in Scotland are accepting of government regulation but it needs to be perceived as fair and not favouring one section of society over another.
- Overall, environmental NGO’s are seen as the most effective intermediaries in implementing effective GHG and energy consumption reduction policies.

Issues impacting on household energy use



people who use information-based coping stategies are more likely to undertake proenvironmental behaviour



Three coping strategies:

- **Scepticism (9 items)**

  e.g. *"I doubt that climate change is occurring"*

- **Fatalism (5 items)**

  e.g. *"I feel powerless to do anything about climate change"*

- **Information Processing (6 items)**

  e.g. *"I try to read up on how climate change can be reduced"*

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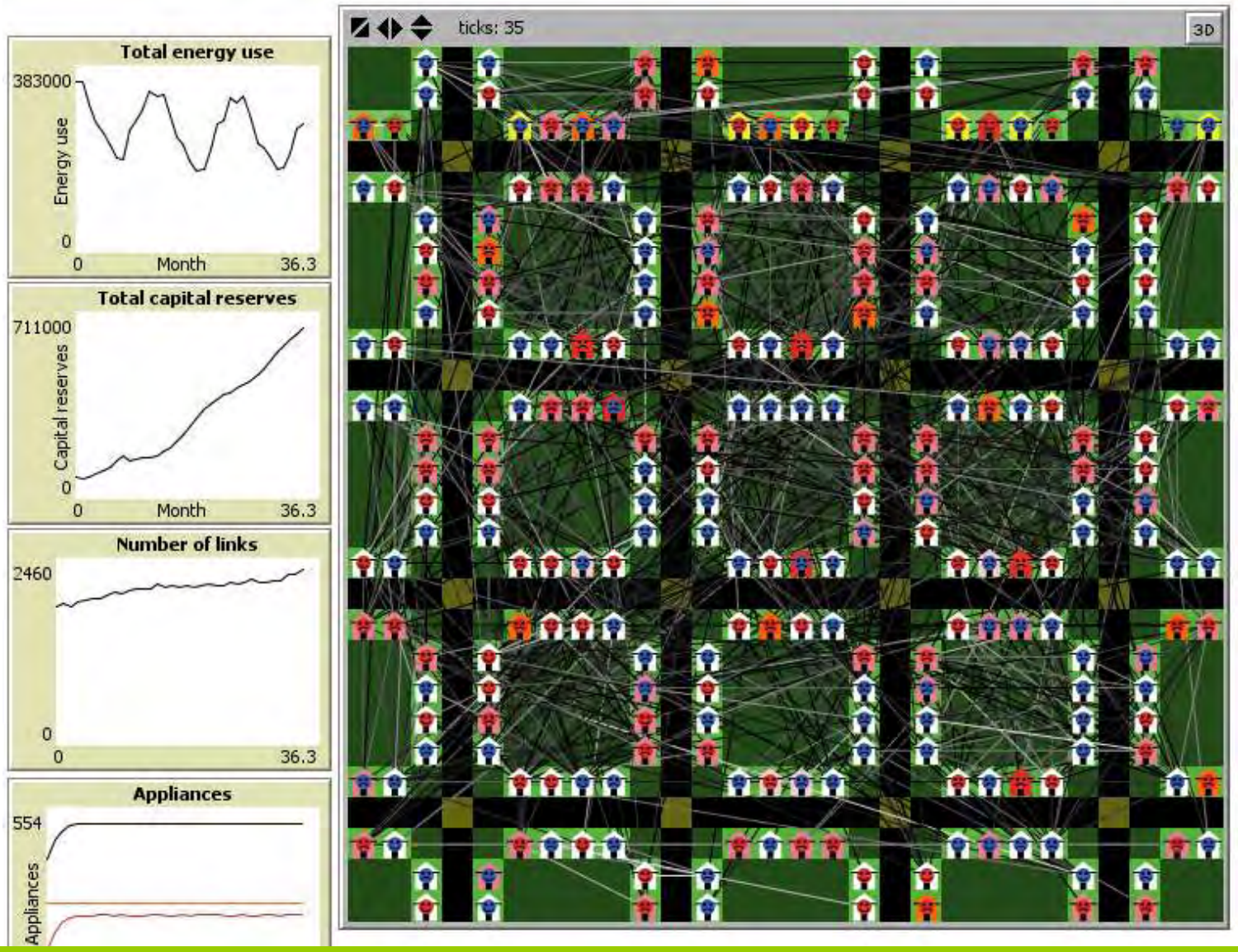
(house x)

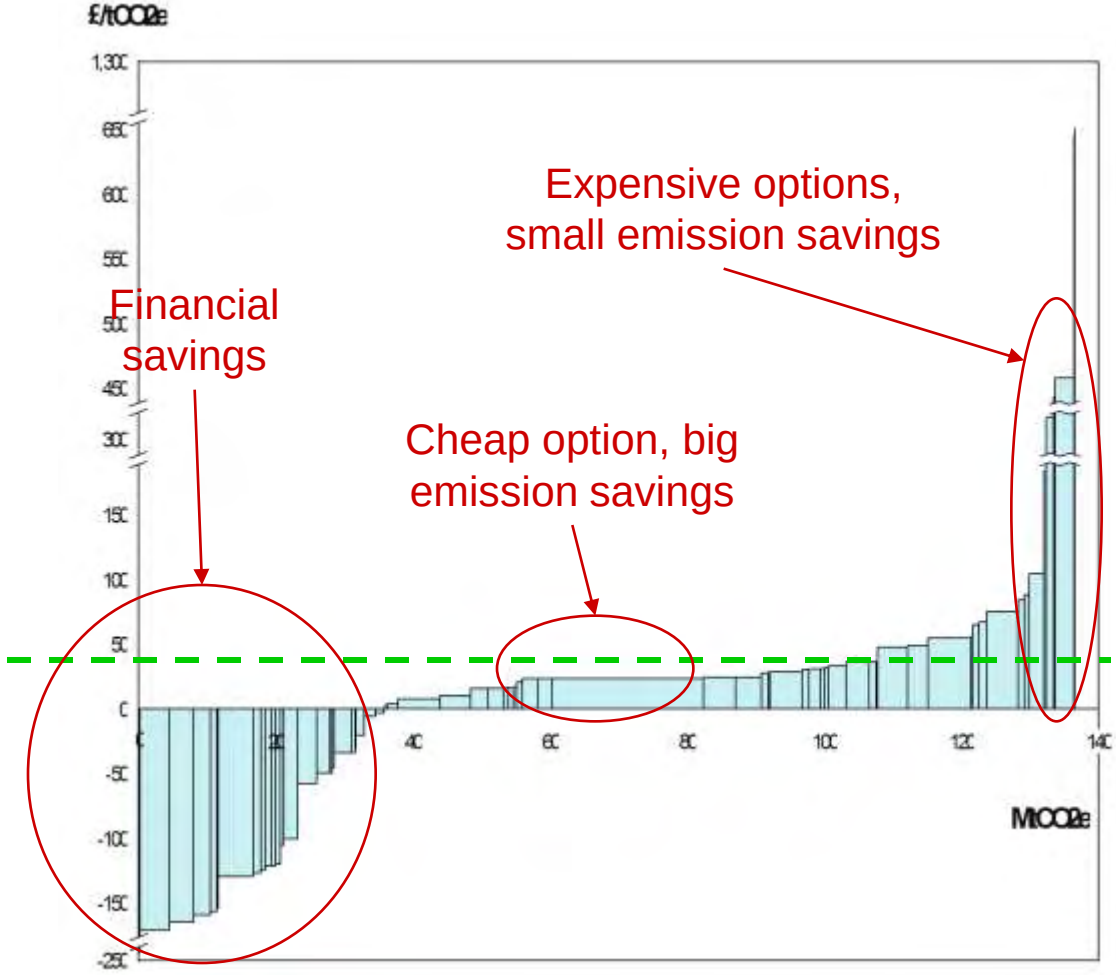
(house y)

Huge Amounts Of Data….


Total energy use
383000
Energy use
0
0
Month
36.3
Total capital reserves
711000
Capital reserves
0
0
Month
36.3
Number of links
2460
0
0
36.3
Appliances
554
Appliances
ticks: 35
3D

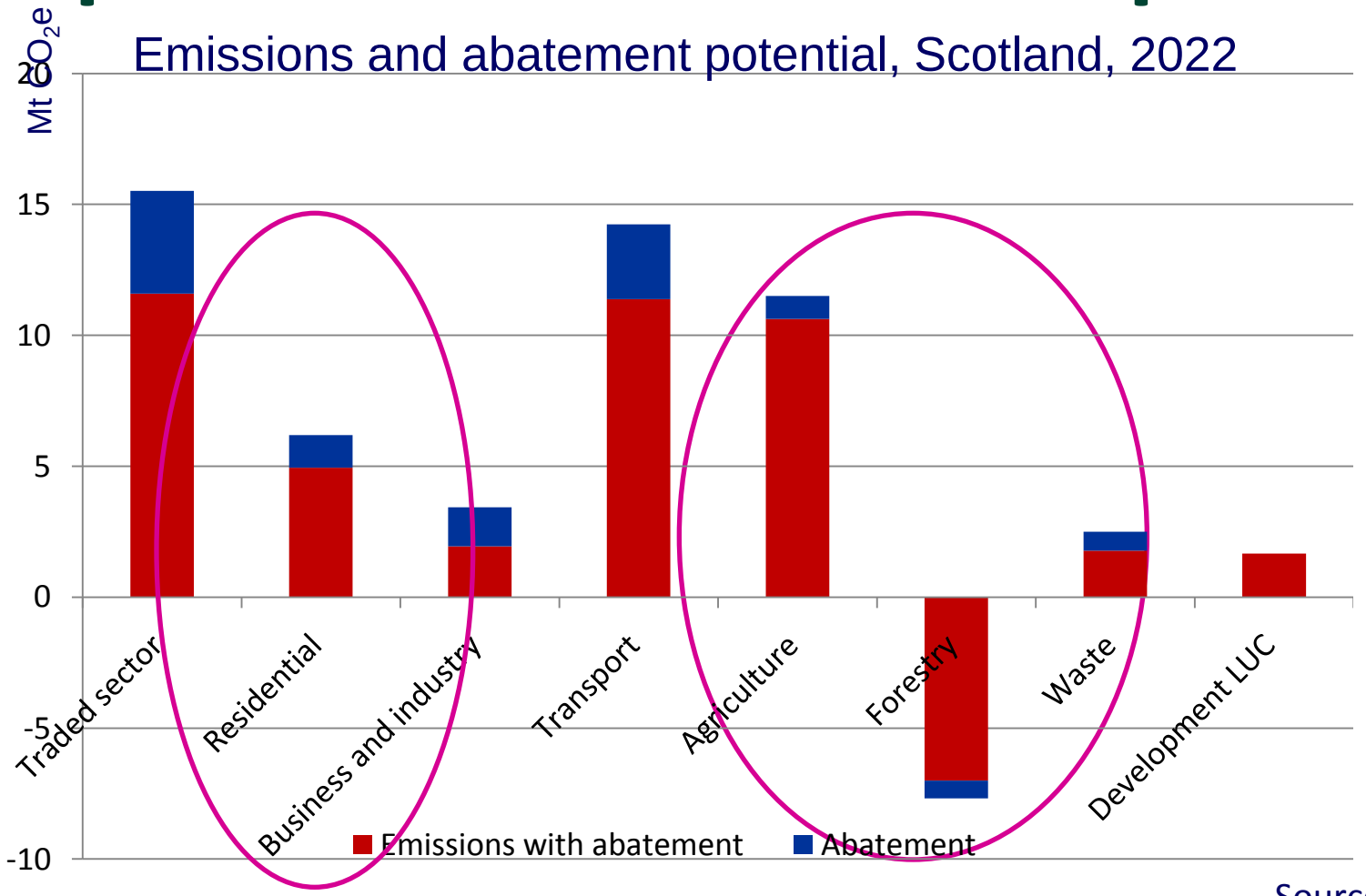
- Marginal Abatement Cost Curve
- Social Metabolism

What does a MAC curve tell us?



- Decreasing order of cost-effectiveness
- Width of bars: abatement potential
- Height of bars: cost-effectiveness

Report on Policies and Proposals



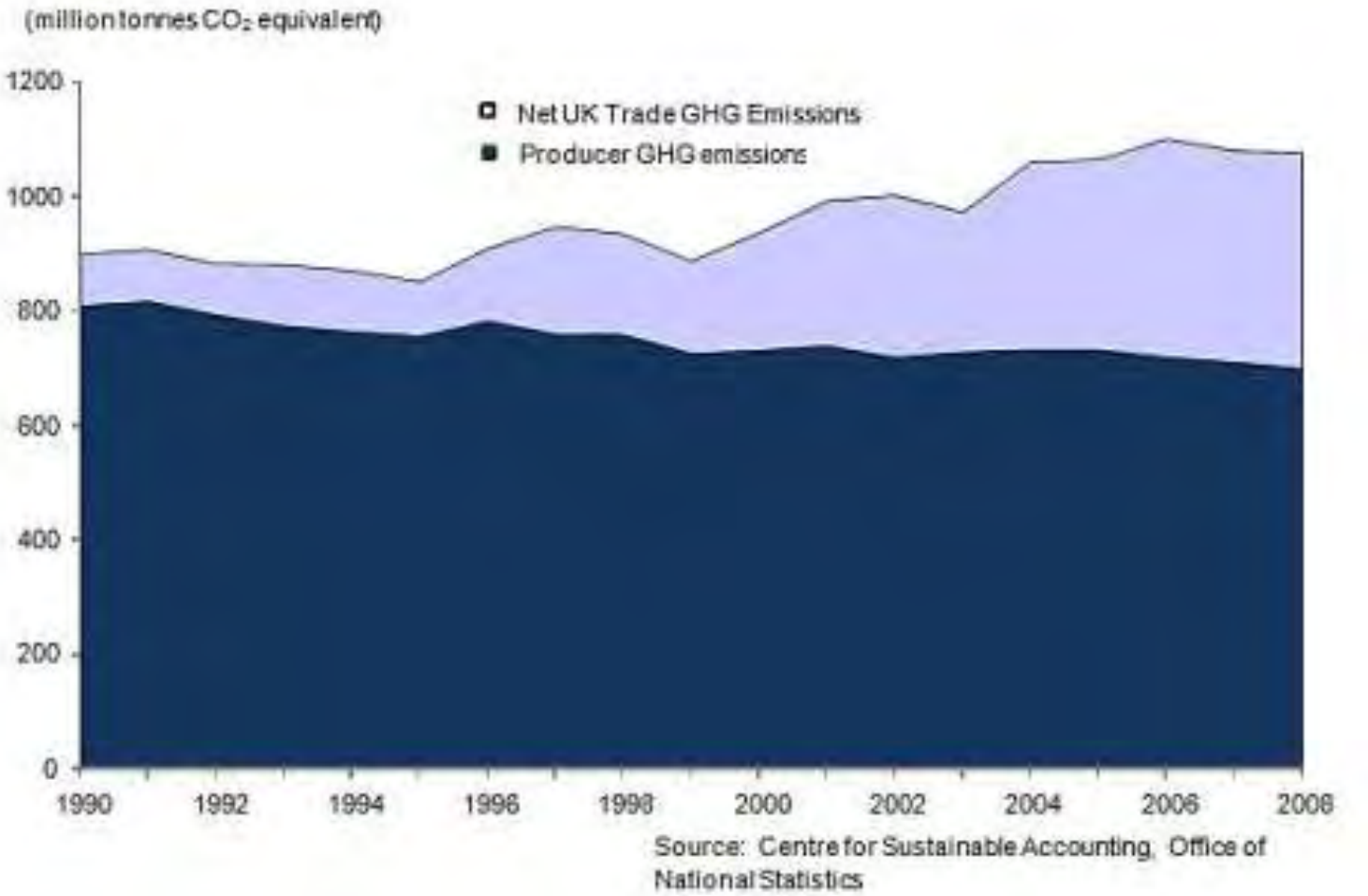
Source: RPP 2010

LCRE MACC approach

Find win-win or low cost ways to reduce carbon footprint of the rural areas

- List possible measures
- Cost-effectiveness data from literature
  - Check assumption against situation in the rural areas
- Calculate abatement potential data based on
  - Local statistics, local authorities reports, etc.
- Interaction of measures: adjusting AP and CE
- **Uptake barriers** and how to remove them
- Interactions with **rural resilience and environmental sustainability**
- Synergies and trade-off with **adaptation**

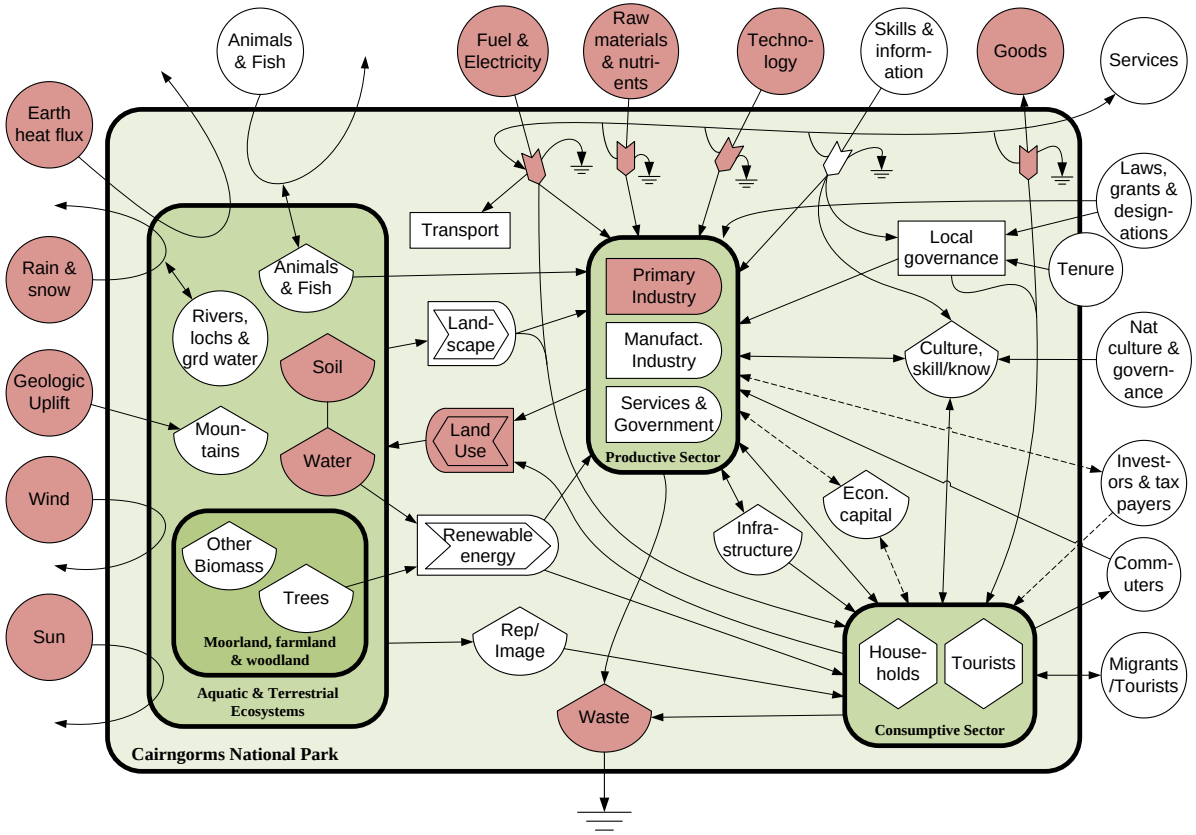
Consumption vs. production



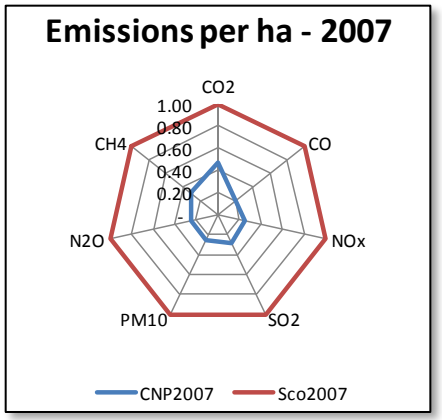
SUMMA Concepts

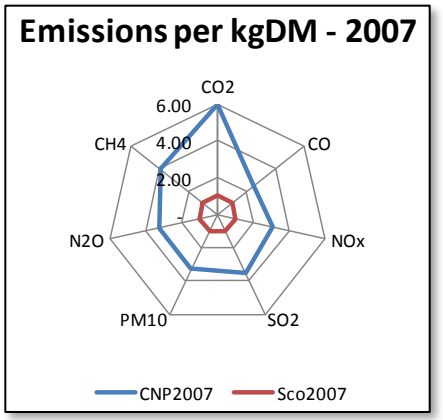
- Sustainability Multi-Method Multi-scale Assessment
- Model - Inputs - Outputs
- Life-cycle based - includes upstream (e.g. embodied labour and services) – and downstream (e.g. pollution)
- Stocks and Flows of materials – physical accounting (with financial)
- Same units – Emergy - solar equivalent joules (seJ)
- Technical coefficients convert x to y
- Extents (tonnes, ha, mJ) and Intensities (seJ per €, g, (ha), J)
- Indicators – returns on investment, renewables, global to local ratios, environmental loading (emissions or eco-toxicity)

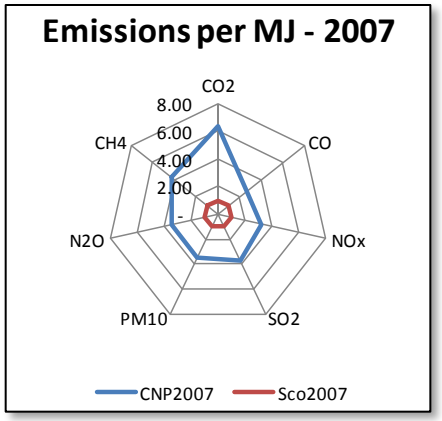
SUMMA – $Scot_{AG}$ and CNP_{AG}

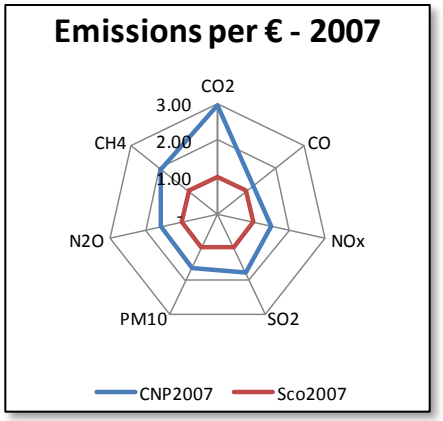


SUMMA Emissions Intensities – CNP_{AG} and $Scot_{AG}$



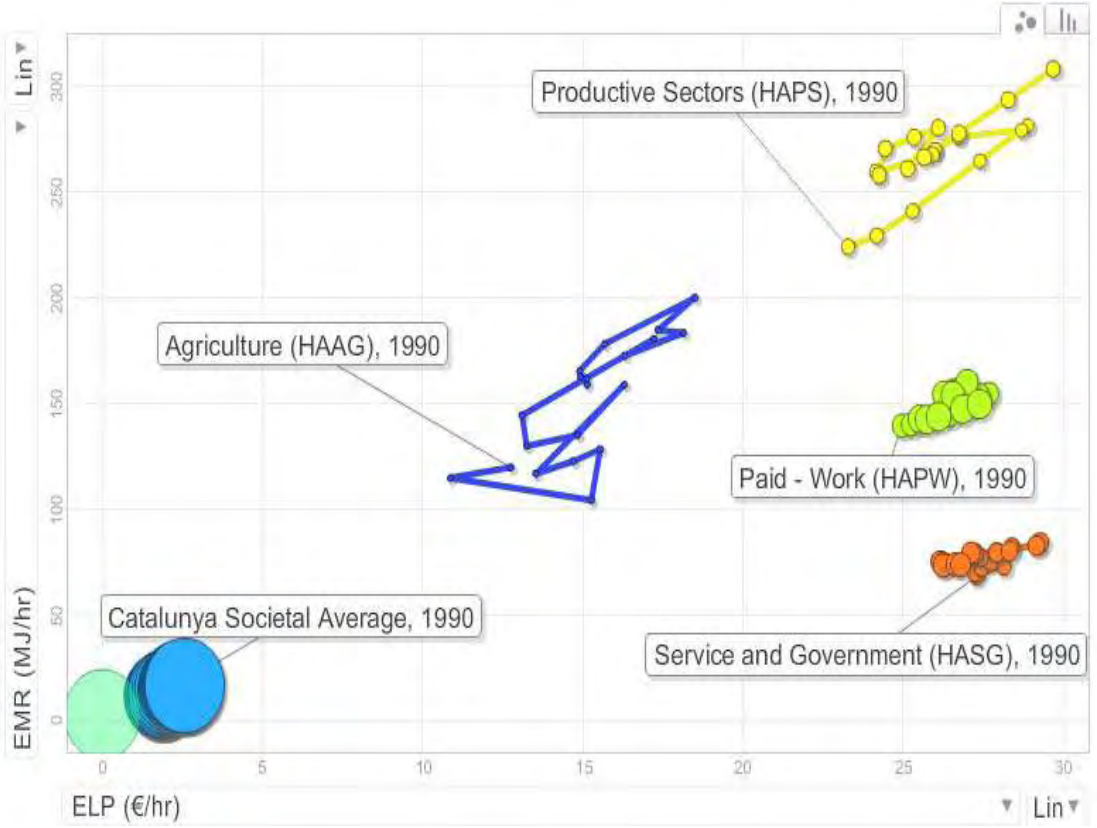






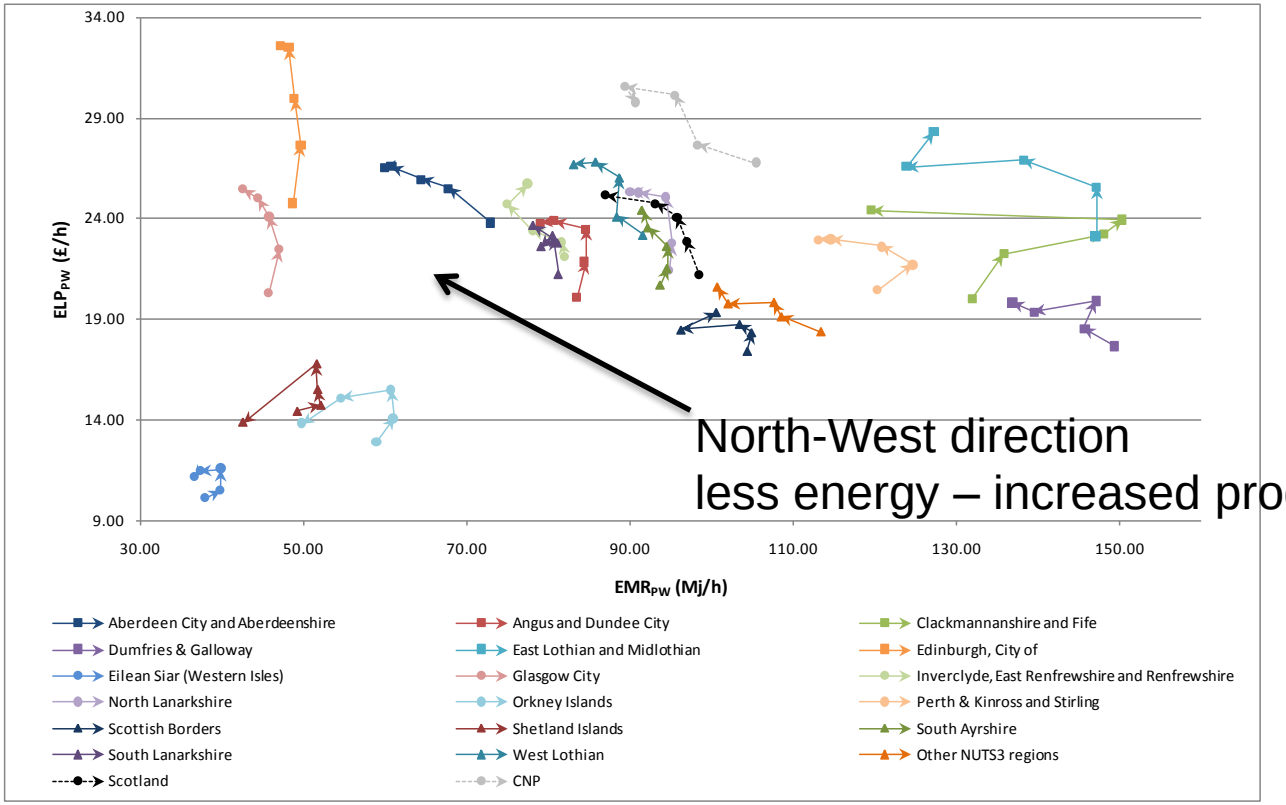
MuSIASEM Introduction

- Multi-scale Integrated Analysis of Societal and Ecosystem Metabolism (MuSIASEM)
- Autonomous University of Barcelona



MuSIASEM ELP v EMR - Paid Work (zoom)

Economic Labour Productivity - ELP = GVA/THA



Exosomatic Metabolic Rate - EMR = TET/THA

Governance

How are low carbon policy objectives being delivered?

What activity is occurring unsupported by policy?

Who is involved?

What is the place of ‘rural’ within this?

A rural economy resilient to global and local change

Developing a 'low carbon rural economy' 'Governance assessment'

The James Hutton Institute SAC

Who has commissioned this research and what will it deliver?

The research has been commissioned by the Scottish Government, as part of a larger programme of work. It takes place from April 2011 to March 2016, and is intended to be 'practical research' which provides outputs that are useful to policy-makers, practitioners, those in the public, private and third sectors, and rural communities.

What is the research about?

This five year programme of research is part of a wider theme of work exploring 'a rural economy resilient to global and local change' and, within this, 'the characteristics of, and potential routes of transition toward, a 'low carbon rural economy' in Scotland.

This 'governance assessment' strand of the programme aims to explore existing and novel approaches to governance and institutions which might support or hinder the transition to a low carbon rural economy in Scotland. Specifically, the strand seeks to identify what is being done, who is involved, how decisions are being made, and – fundamentally – how individual, community, third, public and private sector led initiatives are constrained or encouraged by governance structures at multiple scales.

Why focus on a 'low carbon rural economy'?

Increasing attention is being given to the ways in which individuals, communities and institutions might contribute to the lowering of greenhouse gas emissions in the context of ongoing concern about climate and environmental change. Ambitious targets have been set by the Scottish Government for the lowering of greenhouse gas emissions in Scotland. However there is limited understanding of the governance and institutional structures which may influence the nature and feasibility of any transition to a low carbon rural economy.

How is the research to be done and what will it identify?

Over the course of the five year duration of this research, it is planned for there to be three key phases:

Year one (2011 – 2012): Review

- As part of the wider research programme through review, modelling and discussion we aim to identify the characteristics of a low carbon rural economy.
- At the same time this component of the research programme will, in conjunction with key stakeholders, undertake a largely desk-based review of existing governance and institutional structures which may support or hinder transition to a low carbon rural economy in Scotland.

Years two - four (2012 – 2015): Case studies

- Years two, three and four will seek to build on the understanding of the components of a low carbon rural economy and the governance and institutional factors within this generated in year one. During this time we will explore through case studies of activity and decision making structures the barriers to, and facilitators of such activity.
- These case studies aim to explore what is being done; who is involved; how decisions are being made; and how individual, community, third, public and private sector led activity is constrained or encouraged by governance structures at multiple scales.
- Case study areas are likely to include (but are not limited to) Aberdeenshire; Dumfries and Galloway; Orkney and West Lothian.

Survey of governance and infrastructure, in Aberdeen and Aberdeenshire

- Strong evidence of environmental awareness in departments in both local authorities, each with engaged and committed staff.
- However, countervailing pressures for economic development and from oil industry, limited funds and powers.
- Rural residents mostly cannot use efficient mains gas boilers; woodfuel (pellets) seen as important renewable source by Aberdeenshire council.
- Existing housing stock hard to improve (particularly in private sector); residential areas not located close to areas providing employment.
- Aberdeen Renewable Energy Group (AREG), established 2001 by both councils, helps coordinate renewable energy initiatives in North-east Scotland.
- Implementation processes need to make better use of collaboration (e.g. between communities and local authorities).

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Food, Land and People

Utilising Scotland's Natural Assets:
Research across the food chain, through to economic output and environmental outcomes

Charles S. Bestwick

Advisor to Food, Land & People Programme

Food, Land and People

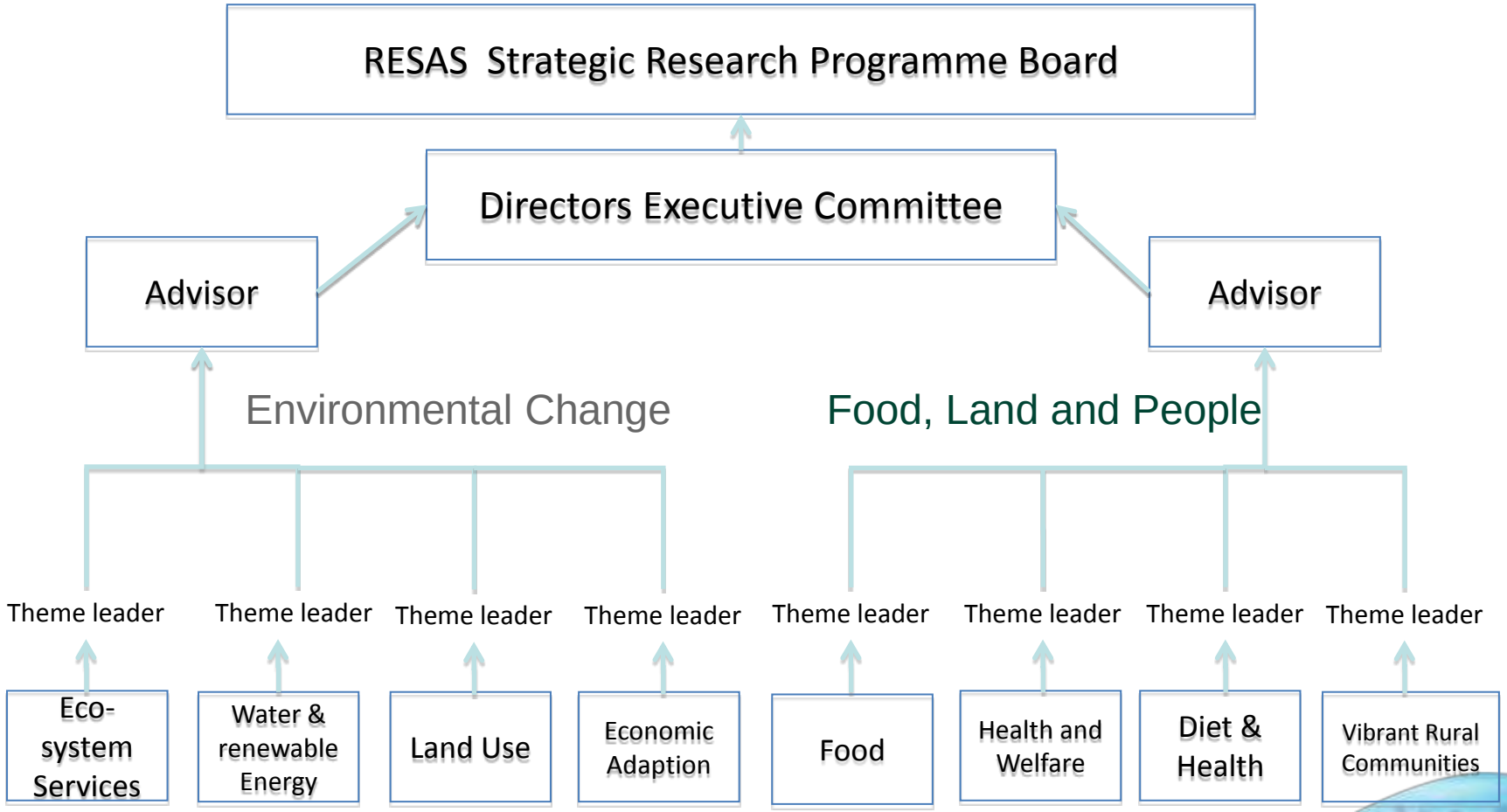
- An innovative multidisciplinary, cross-MRP research initiative
  - building a sustainable future in which economic and social activity is balanced with protecting and nurturing all of Scotland's valuable assets.
  - Key areas of food production, food consumption and land usage.

- Responds to the CAMERAS priority of Optimising the Use of Natural Assets.
- Aligned with the UK Global Food Security programme led by the Biotechnology and Biological Sciences Research Council (BBSRC).
- Interacting with stakeholders, including working with the Food and Rural Industries and Policy Makers.

Themed Research

- Food, Land and People Programme delivered through 4 research themes
- The expertise of The James Hutton Institute, The Moredun Research Institute, Rowett Institute of Nutrition and Health, Scottish Agricultural College and BiOSS.
- Natural and social sciences
- KTE integrated with research activity.

Programme structure



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Efficient and resilient supply chains for food: Theme 5

- Producing new evidence and tools to improve the efficiency, resilience and sustainability of food production and supply in Scotland.
- Providing food chain and food security analyses
- Development of crop and livestock products with improved nutritional qualities and greater resource efficiency and resilience to climate change.



Implemented through three research packages:

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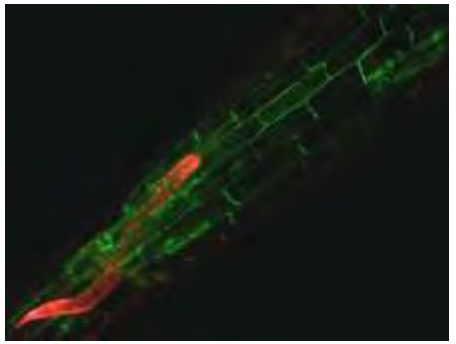
Animal/Plant Health and Disease and Animal Welfare: Theme 6

- Improving farm productivity and sustainability, through improvements to plant and animal disease control and enhancement of farm animal welfare.
- An emphasis on policy relevant research, knowledge exchange and the needs of a broad end user base, including Scottish businesses.



Healthy Safe Diets: Theme 7

- Producing the evidence and tools to improve the adoption of healthy, sustainable diets
- Links food produced across the food chain through to economic output and in relation to enhanced human health.
- Informed by emerging imperatives influencing food choice and behaviour, including consideration of carbon usage and sustainability.
- Significant industry relevance.

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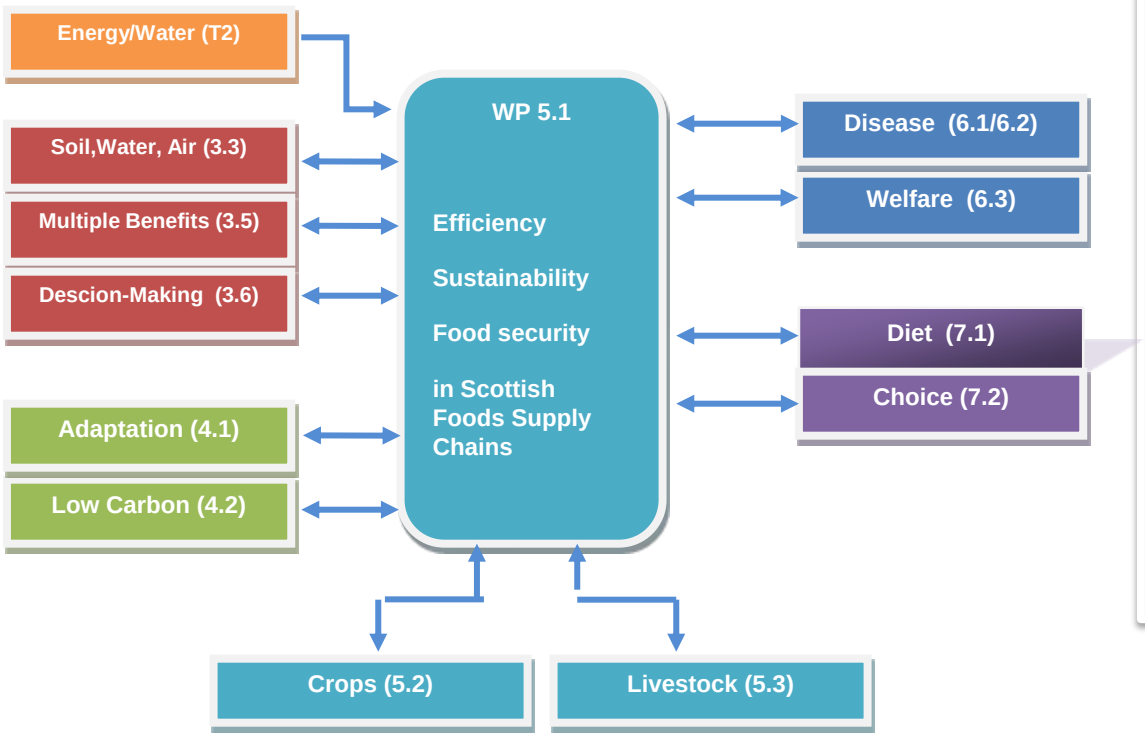
Vibrant Rural Communities: Theme 8

- Understanding the linkages between social and economic performance in rural economies
- Assessing mechanism for greater stakeholder empowerment through new governance frameworks
- Examining how greater social and economic synergies can be developed between urban and rural places.
- Understanding the drivers of differential economic performance.
- Designing and evaluating actions that deliver to the Scottish Government's overarching aim of sustainable economic growth.

The key role of research theme links

- Research Themes interlinked within Food, Land and People
- Research Themes interlinked with Environmental Change Programme

Maintaining , developing and exploiting research links



- Ensure links are recognised
- Focus KTE activity to specific audience
- Identify new synergies
- Enhance dialogue with Strategic Partnerships and Centres of Expertise
- Develop links with BBSRC (GFS)

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Knowledge Transfer/Exchange

Principal activity through which research outputs are shaped, shared and communicated with target audiences

Inter programme links a vital contribution to KTE strategy and programme profile

Examples of current Programme KTE

•National Food and Drink Conference-Cross Programme research targeted to the Food & Drink Industry

Global Food Security
Sustainable, healthy food for all

•Working with BSRC GFS to design interactive sustainable diet game-software

•Feeding the 7 Billion-Major Public Engagement Project

Programme strengths and opportunities

- International quality research
- Interdisciplinary collaboration
- Inter-theme and inter-programme collaboration
- Inter-MRP collaboration
- Interaction with Centres of Expertise and Strategic Partnerships
- Programme embedded two-way interaction with stakeholder groups
- Regular inter theme (KTE) assessment to indentify new research synergies

•Provides for multi-evidence based input into policy

•Identifying external and future core research opportunities

•Present public sector science in the most cohesive manner achieved to date within Scotland

Theme 5: Food

Dr Steve Hoad, SAC

Dr Andrew Barnes, SAC

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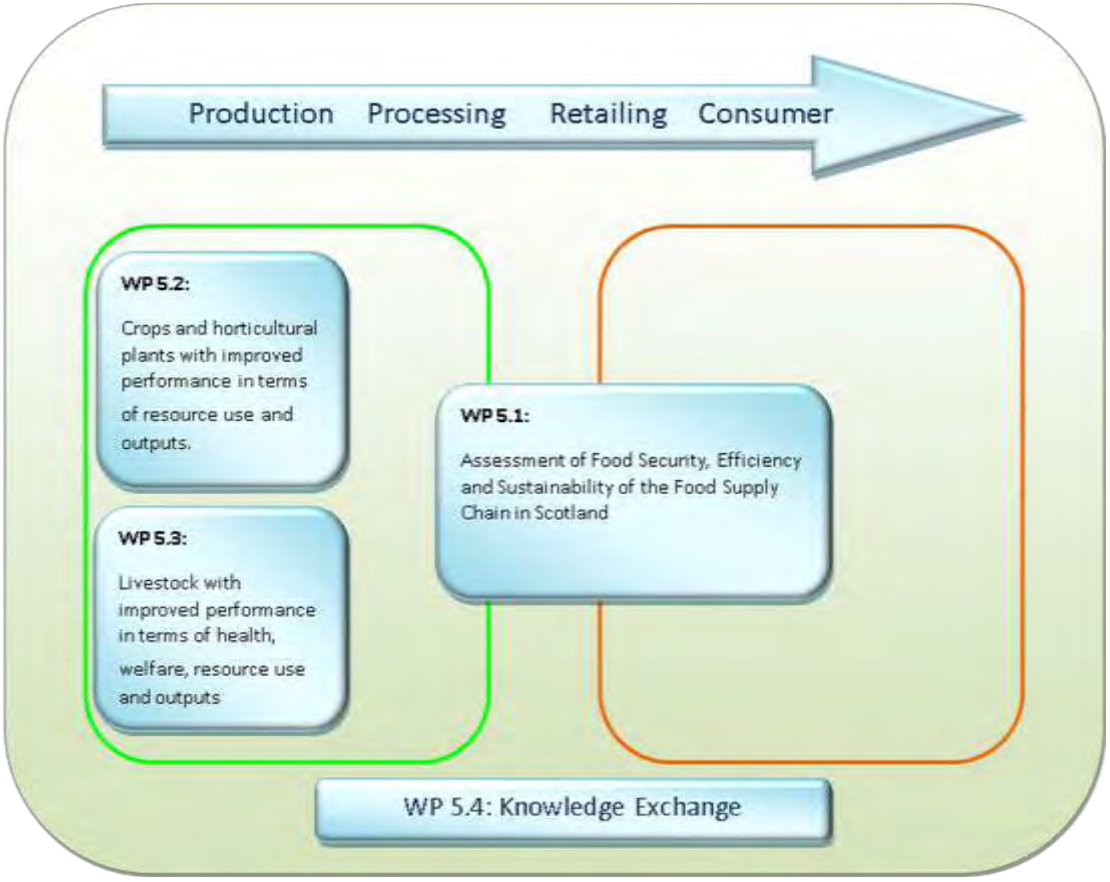
Structure of Food Theme



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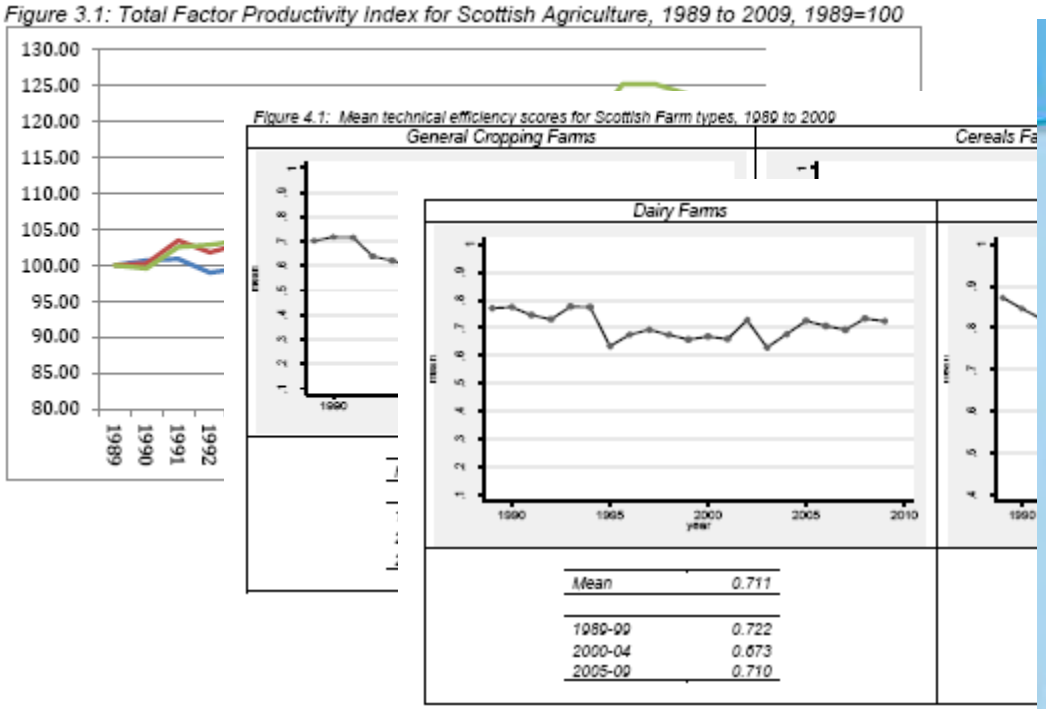
Resource Use Efficiency



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Next years…

- Resource use efficiency across supply chains
- Assess sustainability of several supply chains
- Test technologies developed in 5.2. (Crops) and 5.3 (livestock) in terms of productivity and sustainability impacts

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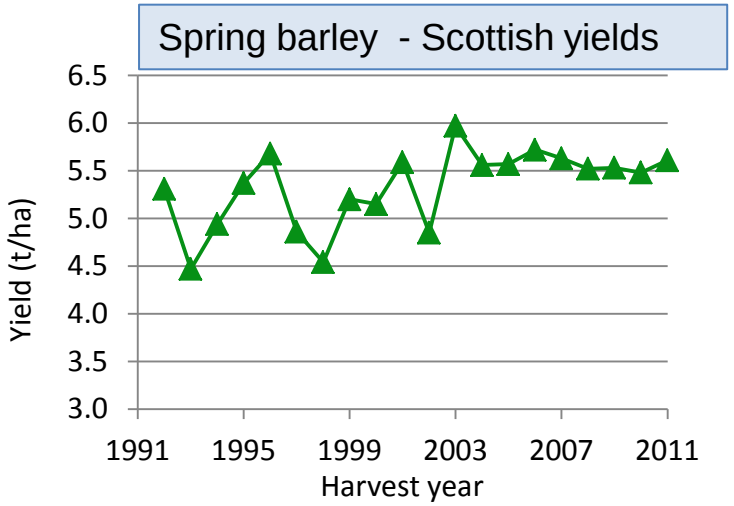
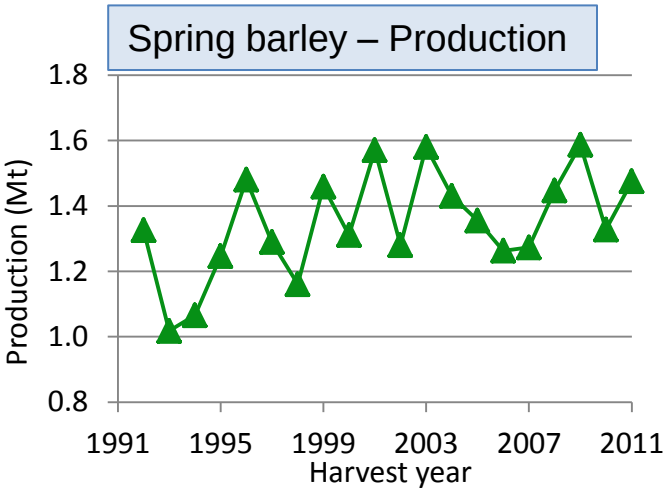
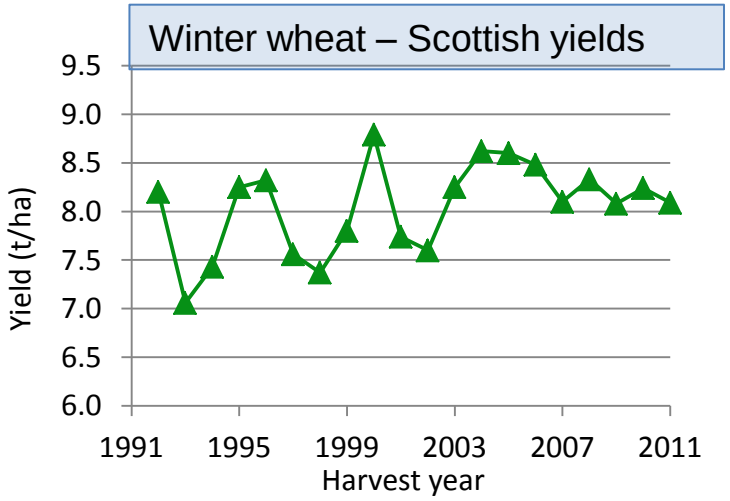
Developing technologies and strategies in Theme 5 – Crops

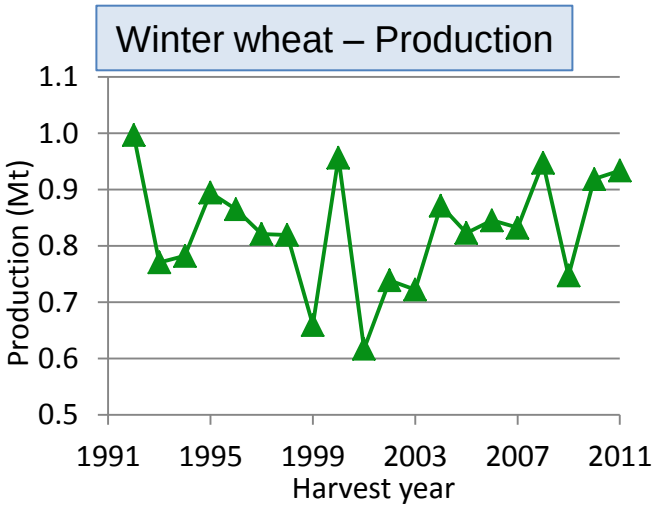
- Deriving indicators for efficiency
- Towards more sustainable farming systems and supply chains
- Crop sector deliverables:
  - Tools and technologies – towards improved varieties
  - Phenotyping and genotyping – towards desirable traits
  - Enhancing nutritional qualities
  - Modified agronomy – new genotypes and their management
  - Improving resource use in the face of climate change
  - Cropping systems – maintaining productivity with improved RUE

Context – the 'Scottish Crop'









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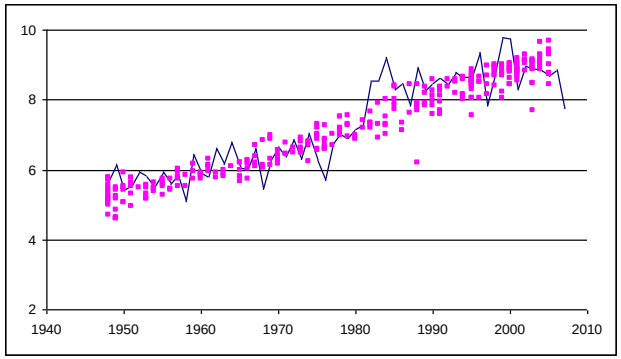
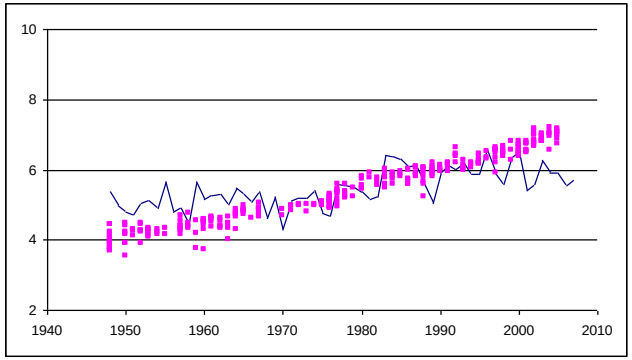
Improving crop performance and resource use

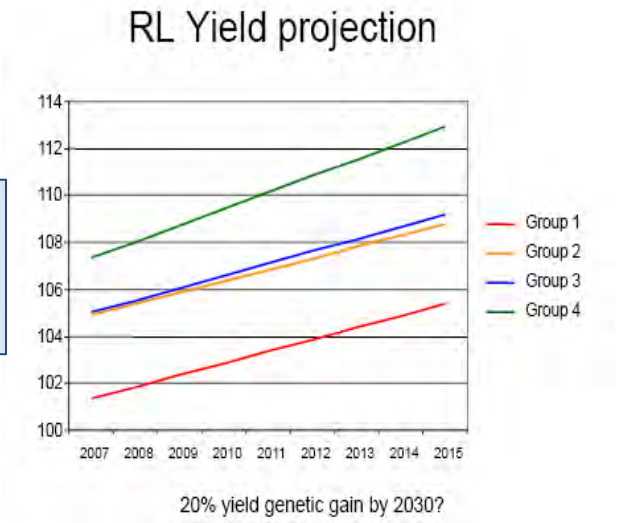
Wheat yields in trials



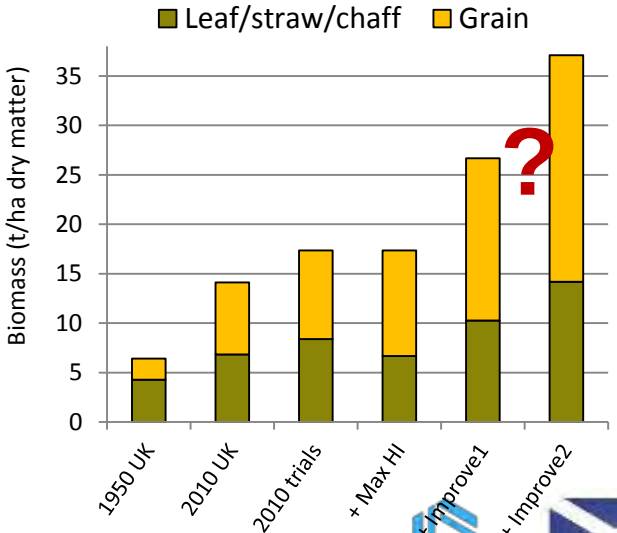
Spring barley yields in trials



Predicted yield trends in wheat



Crop genetic potential



Sources: MacKay et al. (2010); Summers (2008); WP5.2 2012

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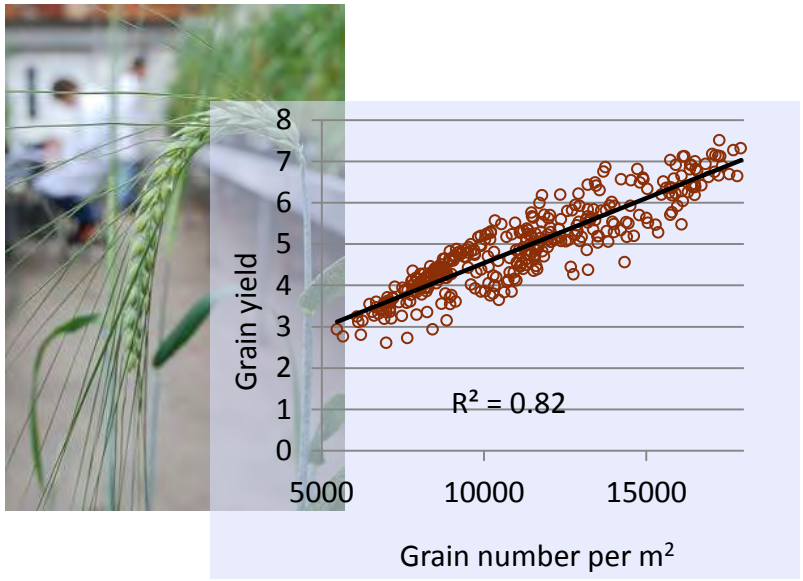
Crop improvement strategies

Crop design and physiology

Improving efficiencies for carbon assimilation

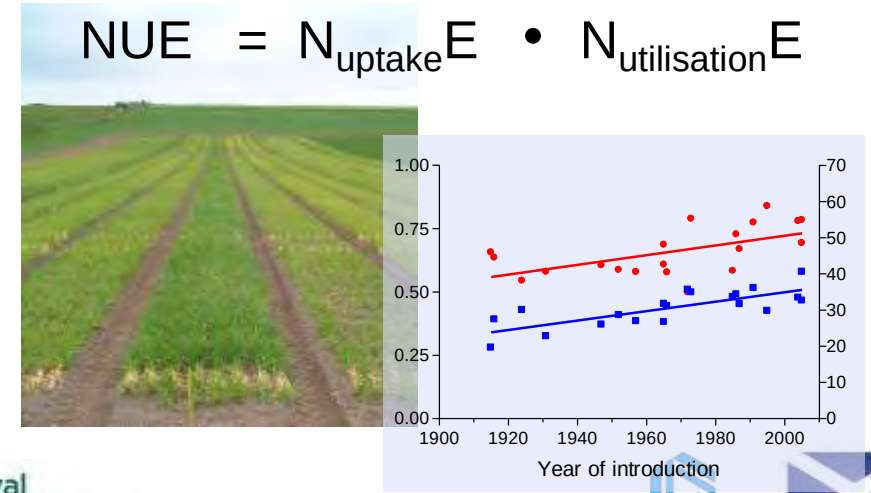
$$Yield = S_t \bullet 0.48 \bullet \varepsilon_i \bullet \varepsilon_c \bullet \varepsilon_p$$

Exploiting genetic diversity



Improving resource use efficiency

$$NUE = N_{uptake}E \bullet N_{utilisation}E$$



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Technologies for improving resource use efficiency: New genotypes and crop management

N fertiliser	N soil	N avail	N uptake	$N_{up}E$	Yield* t/ha	$N_{ut}E$	NUE	Grain* N%
				N_{up}/N_{avail}		$Yield/N_{up}$	$Yield/N_{avail}$	
Current Scottish crop								
120	60	180	90	0.50	5.0	55.6	27.8	1.44
Increase yield by 10% and dilute grain N%								
120	60	180	90	0.50	5.5	61.1	30.6	1.31
Increase N capture and yield by 10% (important for high N crops e.g. milling wheat or grain distilling barley)								
120	60	180	105	0.58	5.5	52.4	30.6	1.53
Reduce fertiliser by 25%; increase yield by 20%; increase N capture								
90	90	180	110	0.61	6.0	54.5	33.3	1.47

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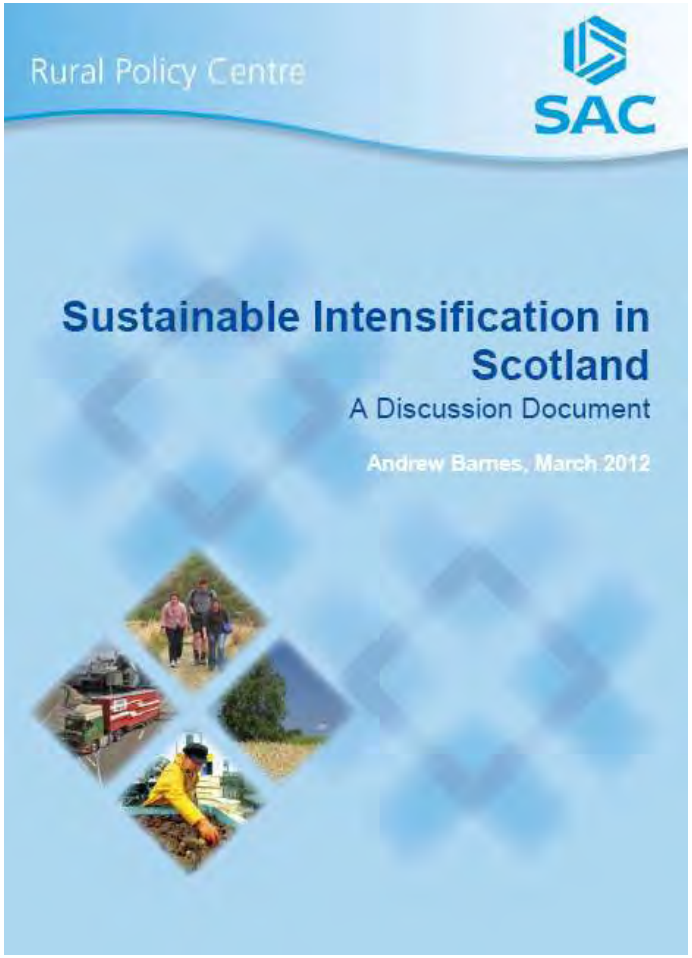
Technology Assessments



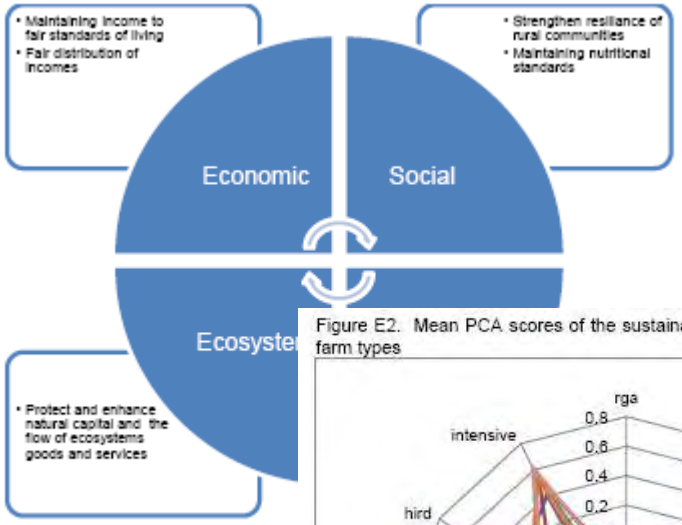
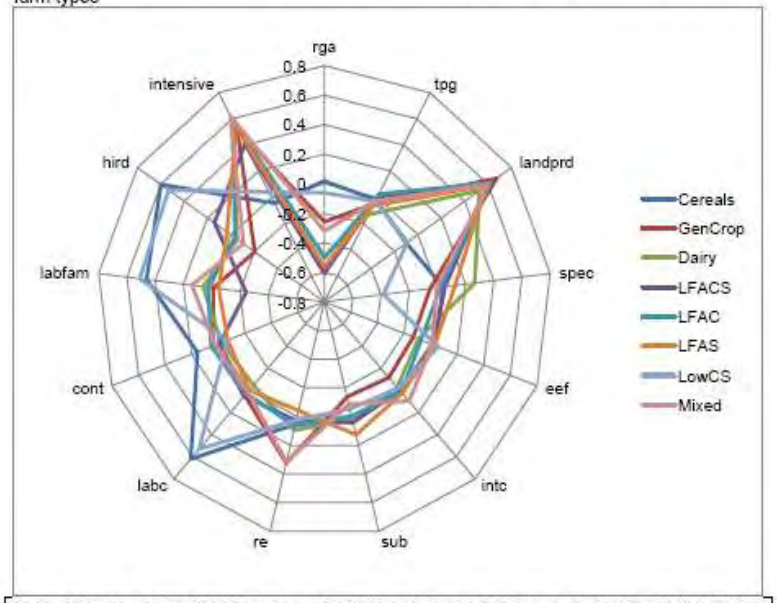


Figure E2. Mean PCA scores of the sustainable intensification component (SI) for the FAS farm types



Key: Cereals: Specialists Cereals; GenCrop: General Cropping; Dairy: Specialist Dairy; LFACS: LFA Cattle and Sheep; LFAC: LFA Cattle; LFAS: LFA Sheep; LowCS: Lowland Cattle and Sheep; Mixed: Mixed farming.

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Demand side as well

- Assessment of current food demand for Scotland
- Projections, including an assessment of the impacts that changes in key demand drivers (e.g. demographic change, adoption of health recommendations) may have on projected food requirements, consumer attitudes and behaviours
- Assessment of Mitigation Technologies – MACC, Workshops
- Perceptions of climate change

Theme 5: Food

Dr Steve Hoad, SAC
Dr Andrew Barnes, SAC

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PROGRAMME 2
Food, Land and People

THEME 6
Animal/Plant Health and Disease and Animal Welfare

Workshop on Climate Change and Carbon Management

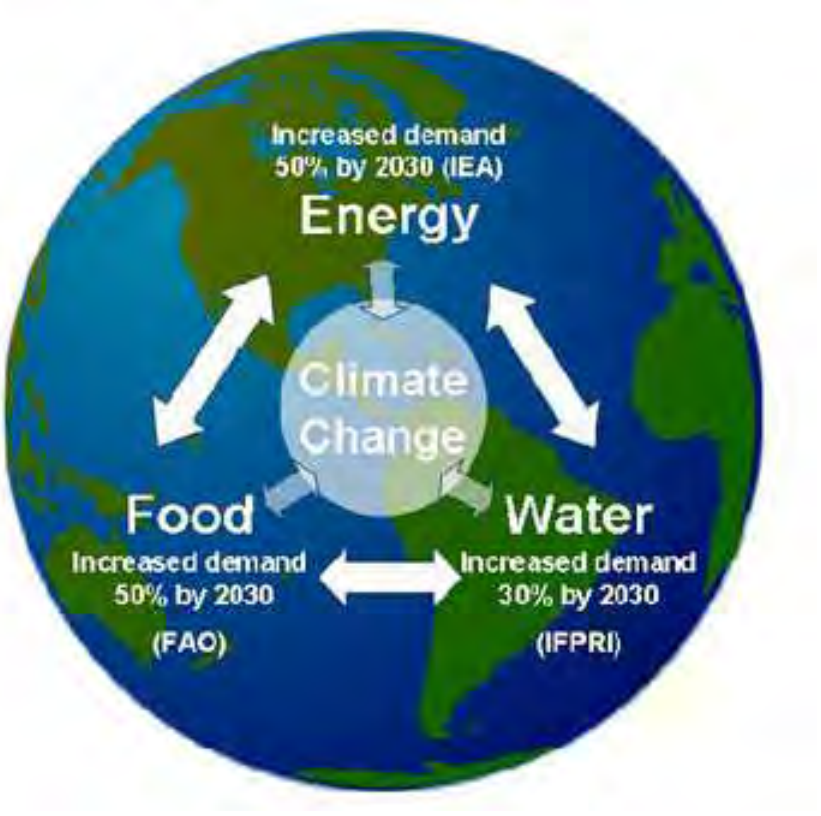
1st March 2012

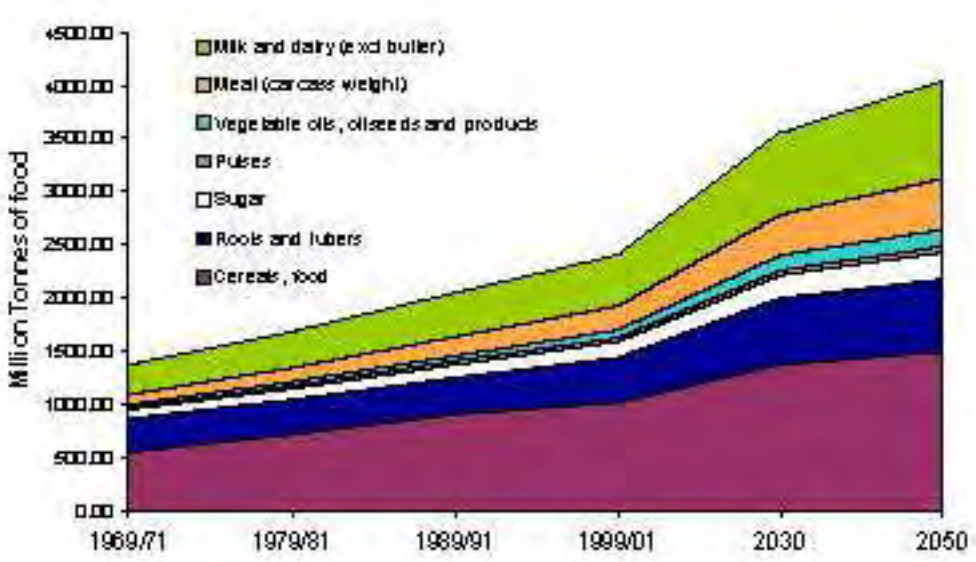
The Scottish Government | SAC | Moredun | The James Hutton Institute | Royal Botanic Garden Edinburgh | Rowett Institute of Nutrition and Health

Health and Welfare (Theme6)

- Aims to improve farm productivity and sustainability, through improvements to plant and animal disease control and enhancement of farm animal welfare.
- A focus for this Theme is that the local impact of climate change necessitates the development of novel approaches based on internationally recognised scientific research.

Food, Energy, Water and Climate Change: The Perfect Storm





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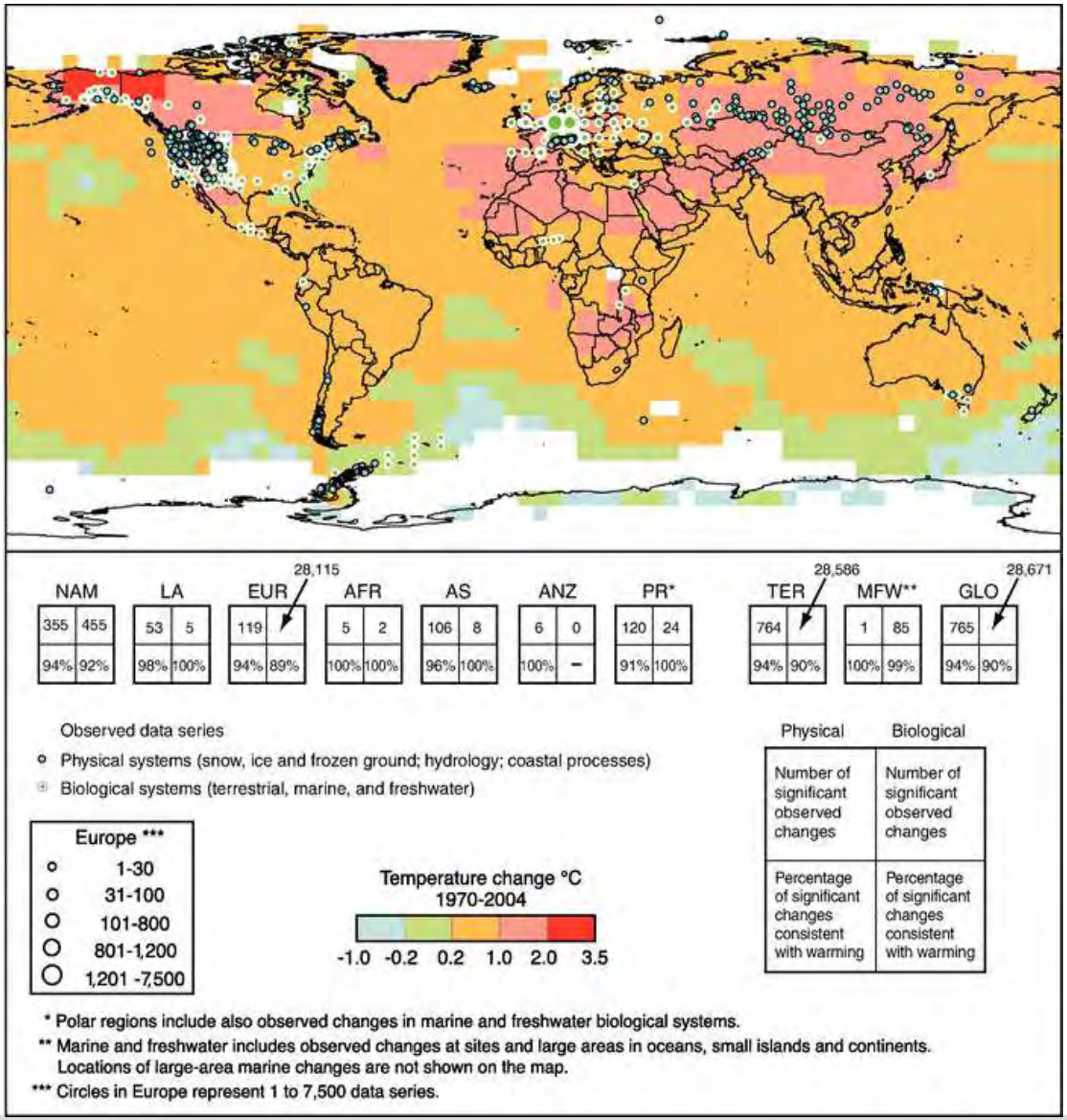
Global Temperature Changes



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WP6.1

- **SD6.1.5.3:** given the dominance of ruminant livestock in the carbon footprint of Scottish agriculture and the potential impact of decisions related to animal health we will investigate the variables (psychological, location and other) that influence farmer decision making relating to areas such as climate change adaptation, mitigation and biodiversity. One objective of the research will be to look at how trade-offs are made between different areas of farm management decision-making.

WP6.1

- **SD6.1.4.1**: Interface with stakeholders, including Scottish Government, to identify the main diseases for further research as exemplars to help develop a quantitative risk analysis system
- **SD6.1.4.2**: Work with stakeholders to determine the prevention strategies that might be adopted to minimise the identified risks (including economic) and provide periodic reports

WP 6.2

6.2.1: Improved control, monitoring and prevention strategies for important endemic diseases of livestock, including the use of new technologies, diagnostics and other innovative approaches.

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Production-limiting Disease Control

Diagnostics e.g.

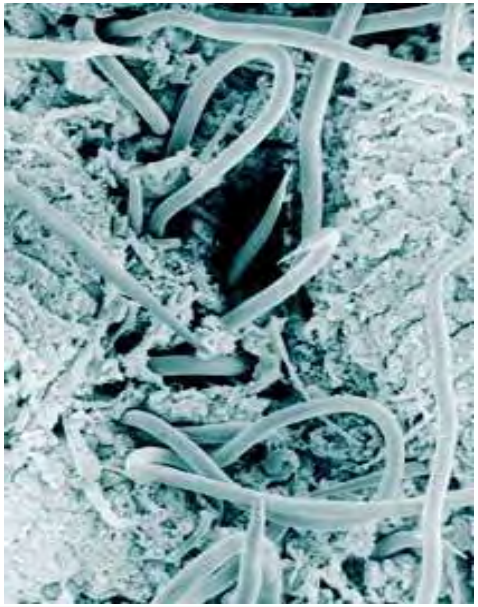
- BVDV – routine use
- CLA – on market
- Johne's Disease –development

Vaccines e.g.

- *Toxoplasma* – routine use
- *Haemonchus* – near market
- *Chlamydia* - development

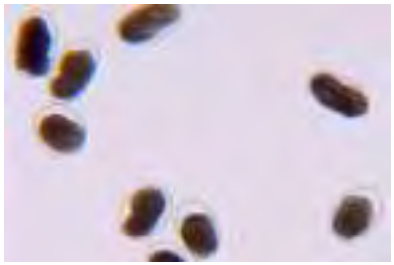
Climate Impact on Disease

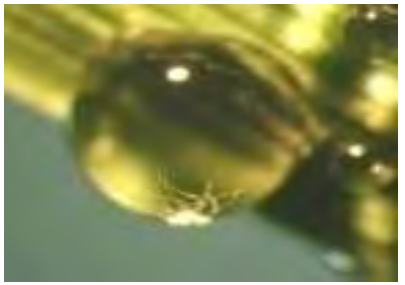
- **Climate Change in Scotland (Sniffer report, 2006)**
  - Increased temperature (ave, max & min)
  - Increased rainfall, more extreme events
  - Reduced frost days
  - Longer grazing seasons

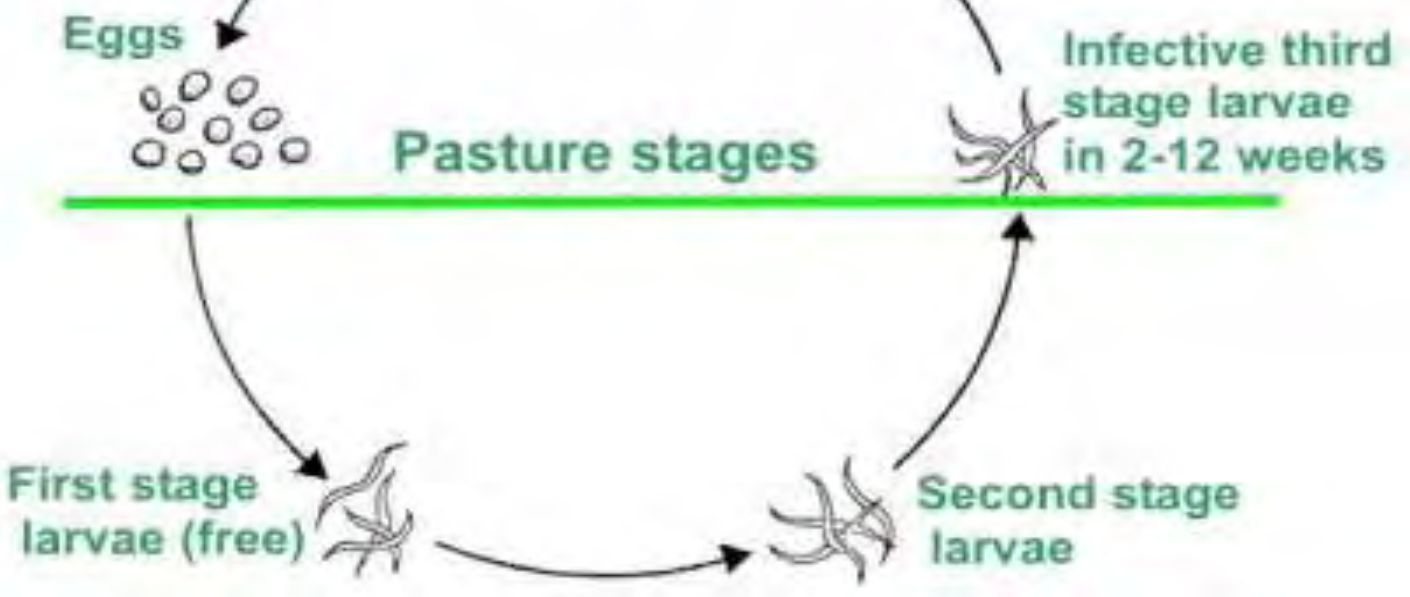


- **Disease change in Scotland?** – changes play into hands of pathogens with environmental life-cycle stages e.g. parasitic helminths (“worms”)

Climate and Parasites







Monitoring change

- Change in prevalence, geographical distribution & seasonality of major GI nematodes that contribute to parasitic gastroenteritis (PGE) e.g. *Teladorsagia & Nematodirus*

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Sheep helminth parasitic disease in south eastern Scotland arising as a possible consequence of climate change

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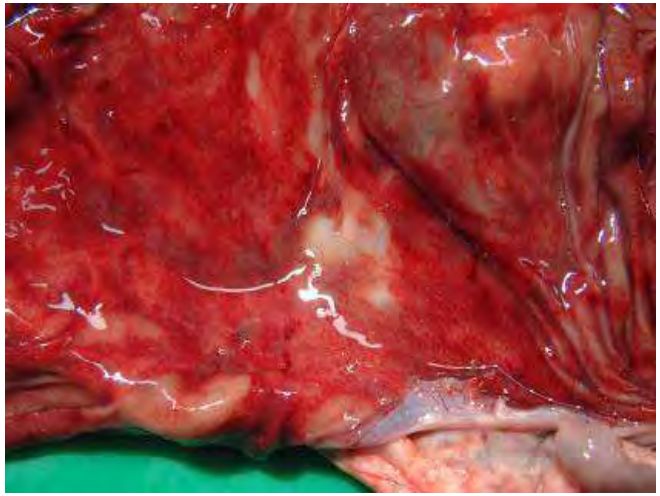
Emerging Disease Threats

Haemonchus contortus – the "Barber's Pole" worm

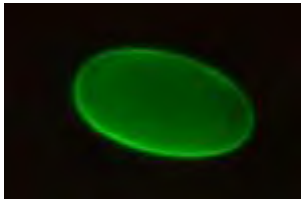
- Most important GI nematode of small ruminants in the world
- Highly pathogenic, blood-feeding parasite

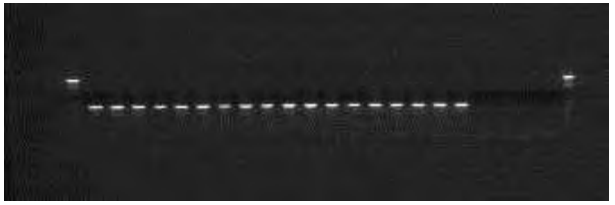


- Scourge of livestock industry in S. Hemisphere, esp. Australia, S. Africa & S. America

Haemonchus contortus in the UK

Survey of ~200 sheep farms:





	% Farms +ve for *Haemonchus*	
	Ewes	Lambs
England	66%	59%
Wales	42%	31%
Scotland	29%	22%
% *Haemonchus* in sample	0-58%	0-93%

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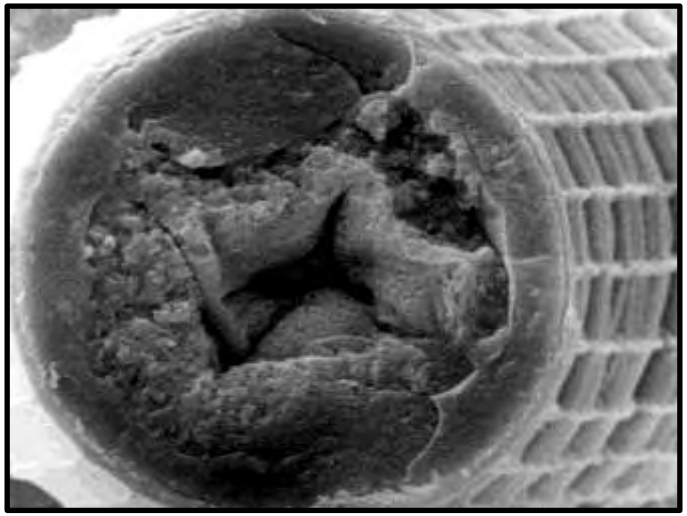
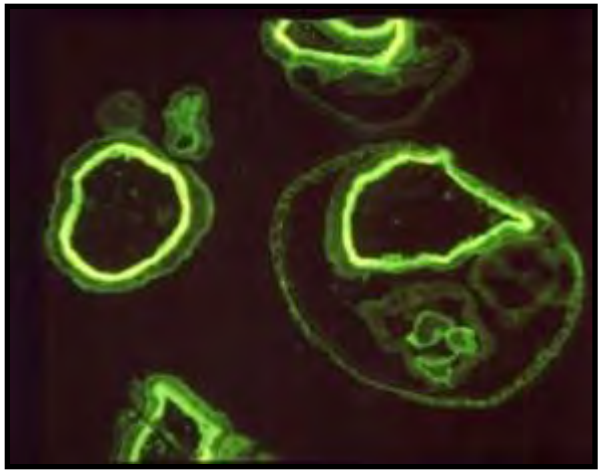
Adapting to Change –*Haemonchus* vaccine



1. Extract proteins from the parasite's gut

2. Inject into sheep, which make antibodies that circulate in the blood



3. When a vaccinated animal gets infected, the parasites ingest blood containing antibodies that bind to their intestines …

….leading to greatly reduced egg output and worm numbers!

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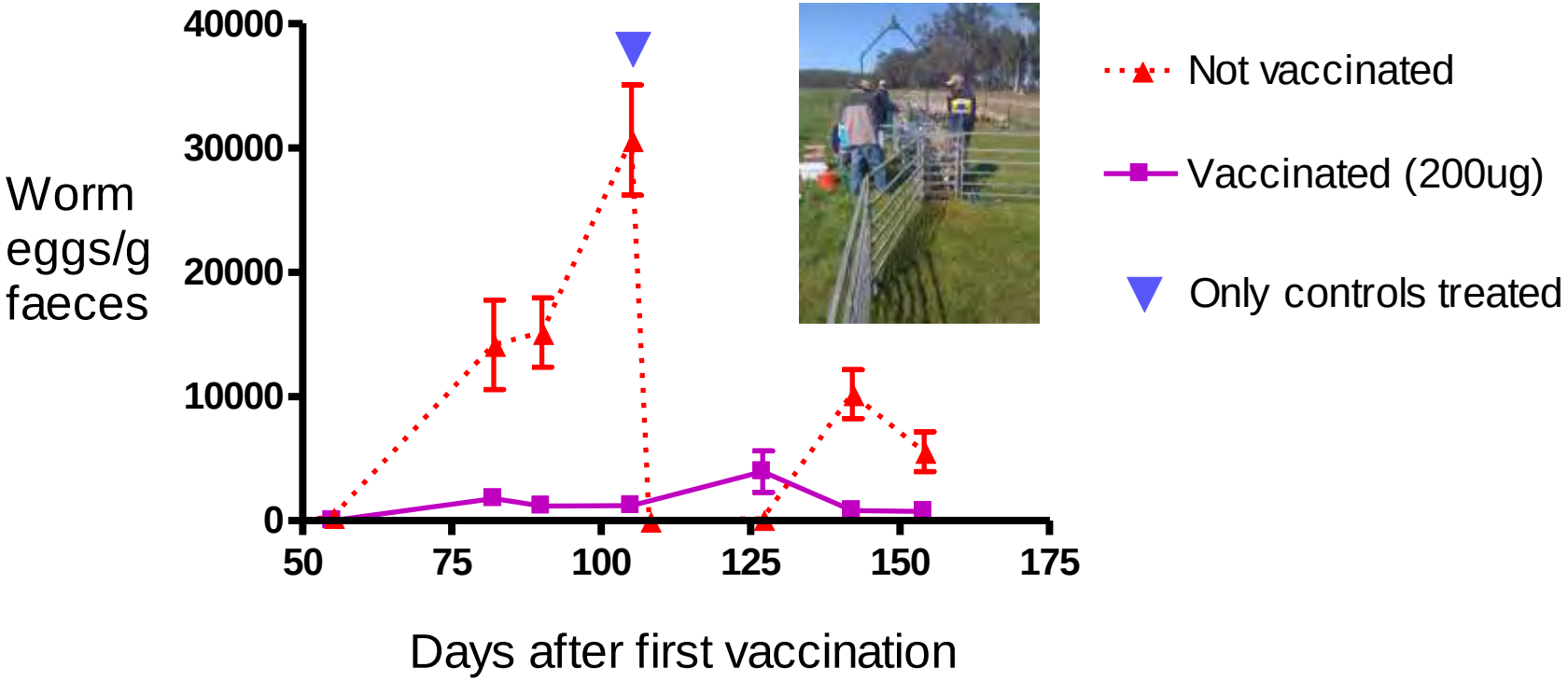
Field trials of *Haemonchus* vaccine

Effect of vaccine on grazing Merino lambs in NSW



Trialled in calves, grazing lambs & goats in S. Africa, Australia & Brazil

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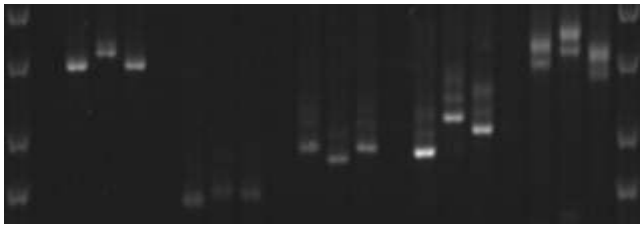
Cryptosporidium

- Protozoan parasite, common in cattle and sheep
- Also affects humans
- Molecular (DNA-based) typing tools developed to understand transmission and improve prevention
- Recent problem in cattle in Aberdeenshire -“CryptoBeef” project

Parasite diversity



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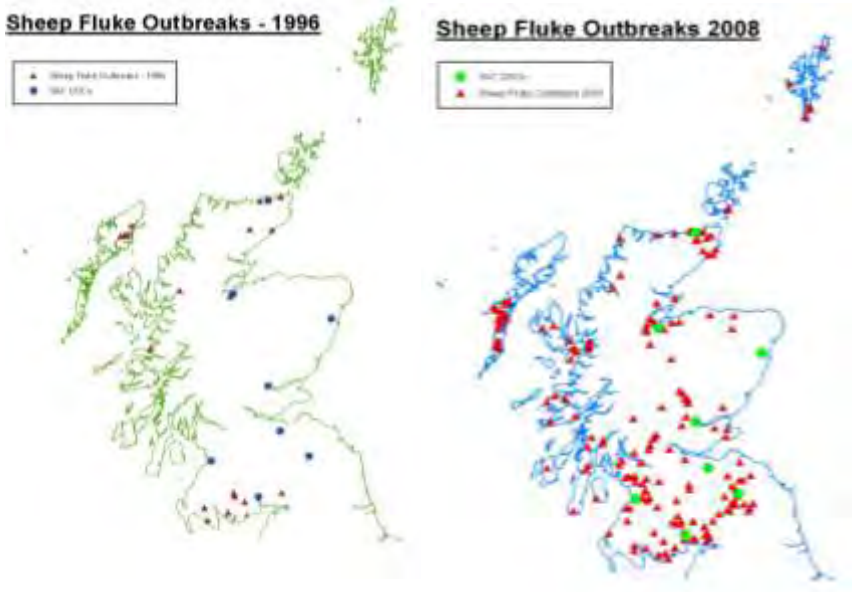
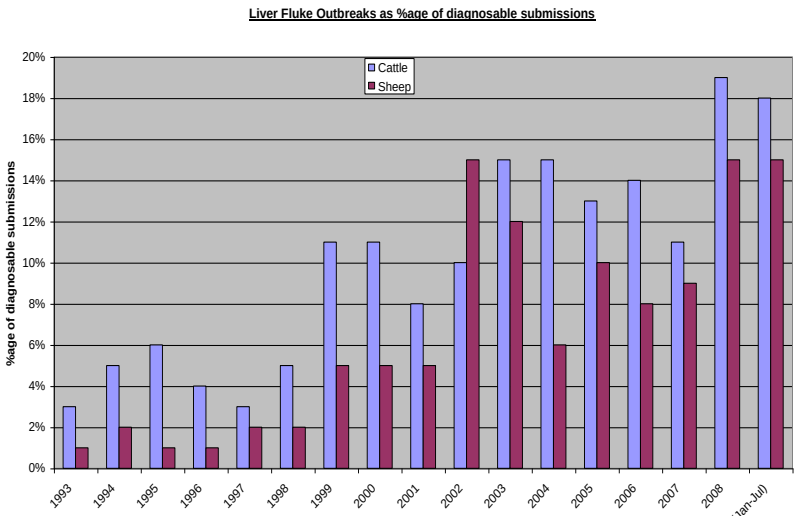
Adapting to change

Liver fluke, *Fasciola hepatica*

- Emerging disease during last Programme
- Need for improved control measures
- Focus of research in new RESAS Programme





QMS QUALITY MEAT SCOTLAND

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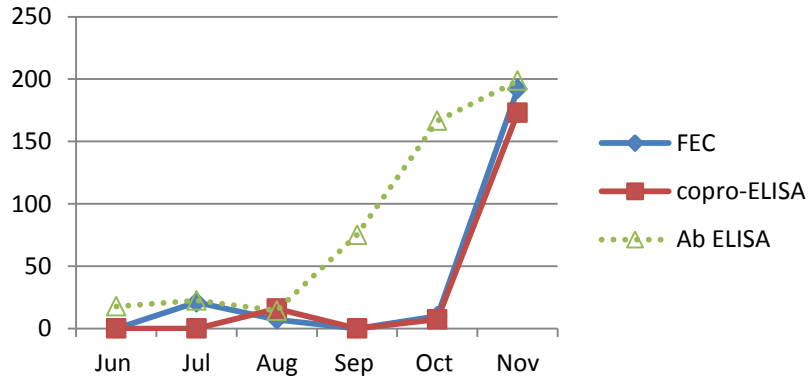
New Needs: Liver Fluke Diagnostics

- Live Animal
  - invasive (blood)
  - non-invasive (faeces)



- Treatment efficacy
  - Faecal egg count reduction test (FECRT)
  - Coproantigen reduction test (CRT)

- Environmental burden
  - fluke in snails
  - cysts on pasture

WP 6.3:
Carbon footprint vs. animal welfare

- **RD6.3.2: *Guidance on husbandry* approaches to improve farm animal welfare in new and existing systems**
- This will result in practical information to provide guidance to dairy farmers about the welfare effects of likely system or management changes. In addition to welfare and system measures, information for carbon footprinting (i.e. land types and area, animal numbers, inputs such as fuel and feed and outputs such as milk) and information which will enable a proxy assessment of biodiversity will also be collected on farm.

WP 6.3:
Carbon footprint vs. animal welfare

- It has been suggested that farm GHG production could be reduced by increasing animal efficiency. But what would the impact be on animal welfare?
- 30 Scottish dairy farms will be assessed for:
  - Animal health and welfare (EU Welfare Quality)
  - Carbon footprint (SAC's carbon footprint calculator)
  - Sustainability/profitability (inputs and outputs)
- Data collection completed in 2013
- Assess association between welfare and carbon footprint

The Crichton farm question

?

SAC Dairy systems – Two extremes

- By-products (Co-products)
  - No land (feed not normally used for human food)
  - Target yield 10500 l/cow/year

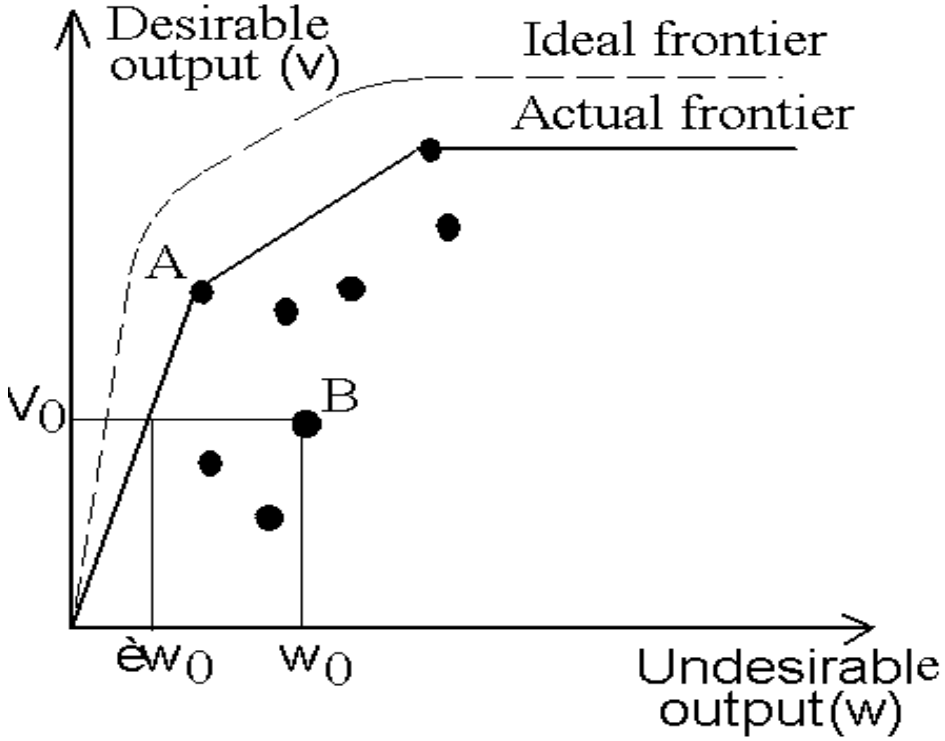
Long-run genetic lines
Selection vs control sires

Long-run GxE feed expt.
Low and high forage diets.

- Homegrown
  - No purchased feed
  - Maximum requirement for land
  - Target yield 7500 – 8000 l/cow/year

Long-run soil, carbon, nitrogen, cropping, met. and other land-based data

Benchmarking framework



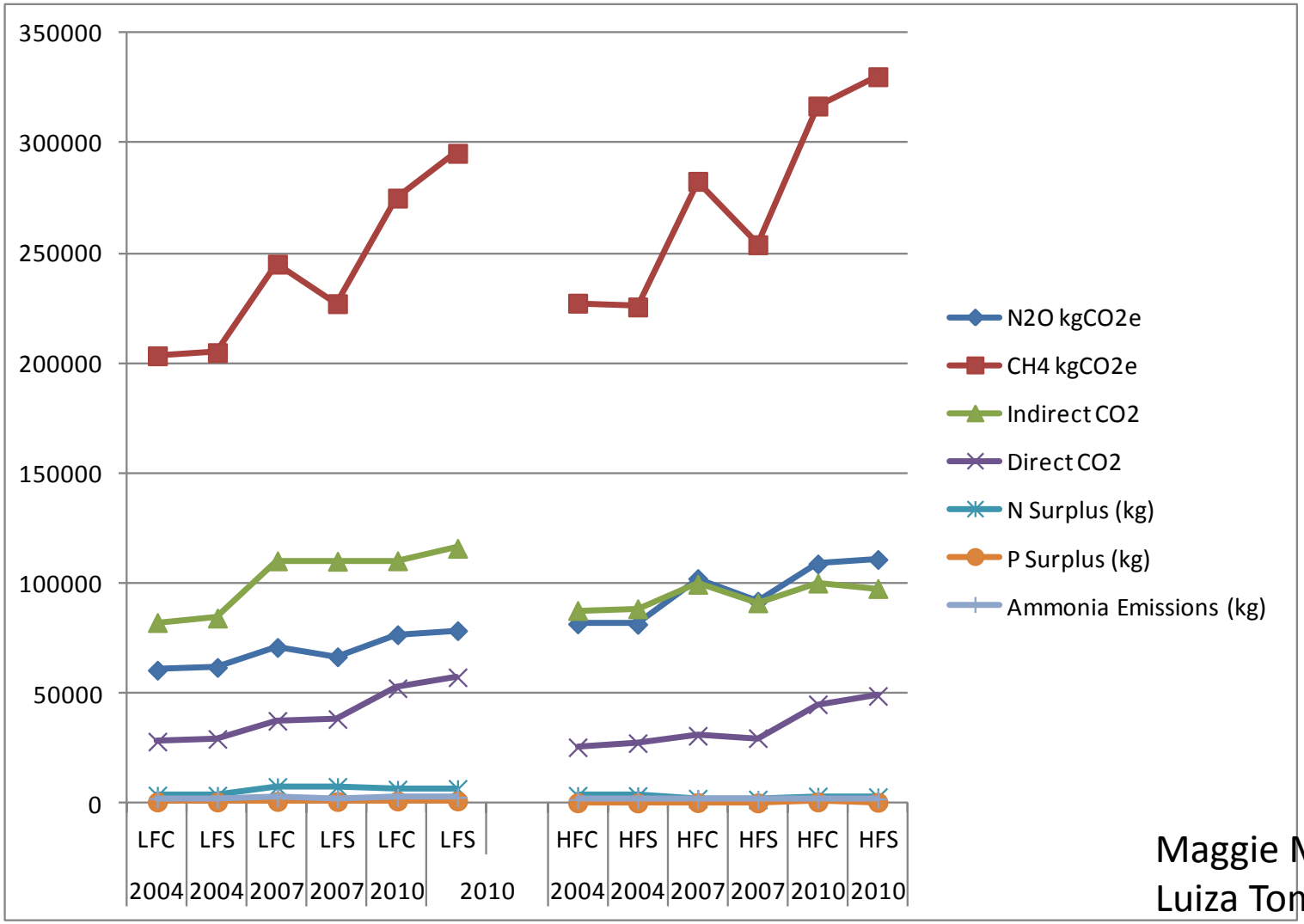
Tyteca, D. (1996), On the Measurement of the Environmental Performance of Firms - A Literature Review and a Productive Efficiency Perspective, Journal of Environmental Management, 46: 281-308.

Langhill Systems Variables

Type	Variable	Description			
Input	Harvest Grown & Used (Tonnes)	Grass Silage	Wheat	Maize	
	Imported Feed & Bedding (Tonnes)	Concentrates	Milk Powder	Distillery By-products & Straw	
	Land Required (Hectares)	Grazed Pasture	Pasture Cut & Grazed	Forage Crop Maize	Cereals: Wheat
	Fertiliser Application (Tonnes)	Nitrogen	Phosphate	Potassium	
	Energy Use	Petrol (litres)	Diesel (litres)	Electricity (kWh)	
Output	Milk Production	Fat Content (%)	Protein Content (%)	Yield (Litres)	
Undesirable Output	GHGs ($kgCO_2e$)	Nitrous	Methane	Carbon	
	Nutrient Budget	Nitrogen Surplus	Phosphate	Potassium	

Mitigation measures that have been applied on the farm can also be included.

Undesirable Outputs



Maggie March
Luiza Toma

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WP6.4

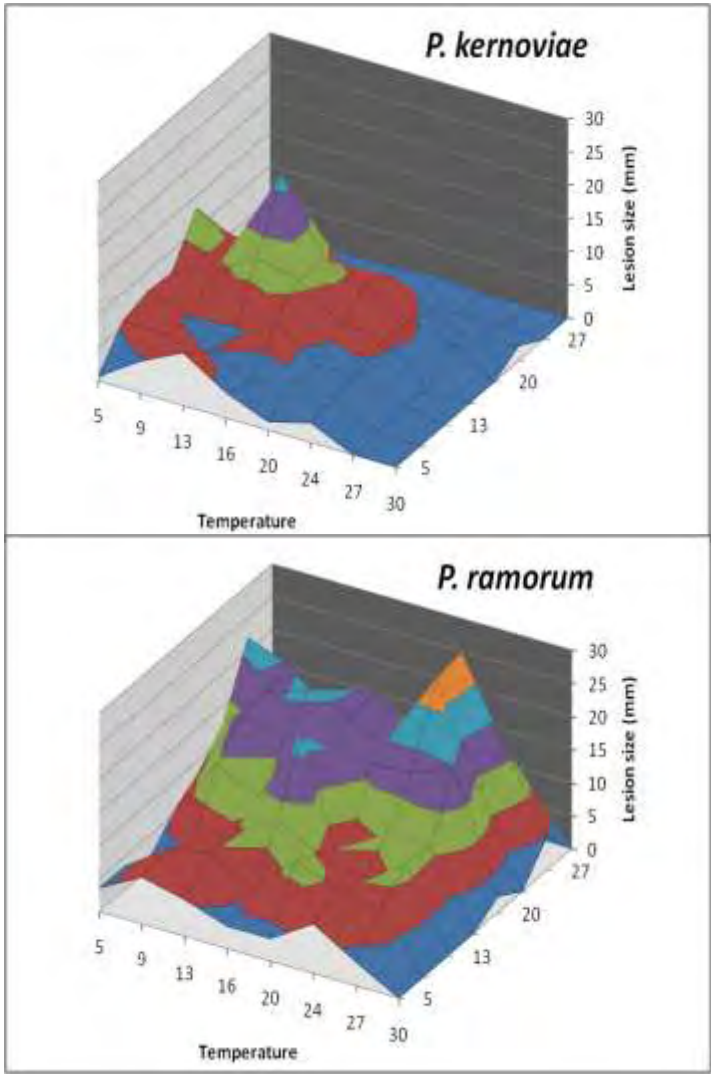
Prevention and Control Diseases of of Important Endemic and New Diseases Plants

- **SD2.1 Risk Assessment:** Identify key biological, agronomic and weather related risk factors to be used to model disease burden in WP3.2.
- **SD2.2 Science report:** Identify factors that increase the development of diseases and assess the prospect for pests/diseases to adapt to new climatic conditions.
- **SD2.3 Policy Report:** Policy report on possible disease scenarios arising from climate change and reduced pesticide availability.
- **SD2.4 KTE Report:** Provide advice to stakeholders on role of climate change and pesticide usage on pests/diseases.

WP6.4
Prevention and Control of Important Endemic and New Diseases of Plants

RD6.4.2: Risk assessment for new diseases and epidemiological modelling of the likely plant disease scenarios arising from climate change and reduced pesticide availability.

Plant pathogen species able to infect the same host may often show a differential response to temperature



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WP6.4.2 Example 1: Potato Cyst Nematode (PCN)

- In warm climates 2 generations of PCN can occur/crop cycle, greatly increasing final population levels.
- Also, more female potato cyst nematodes develop in and on the tubers introducing new risks for spread.
- Experiments have demonstrated an effect of increasing temperature on the emergence of juveniles and males

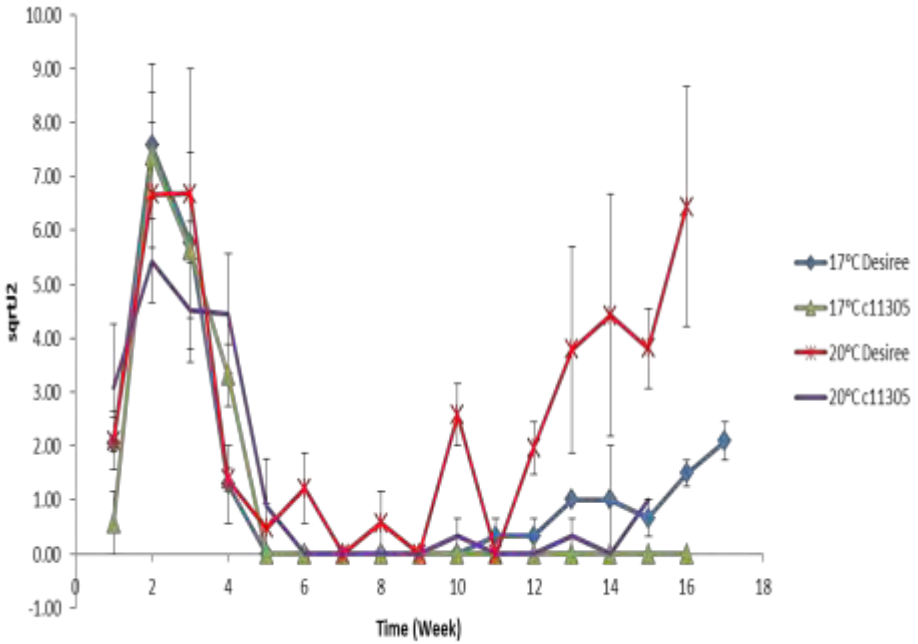

Figure c. Juveniles

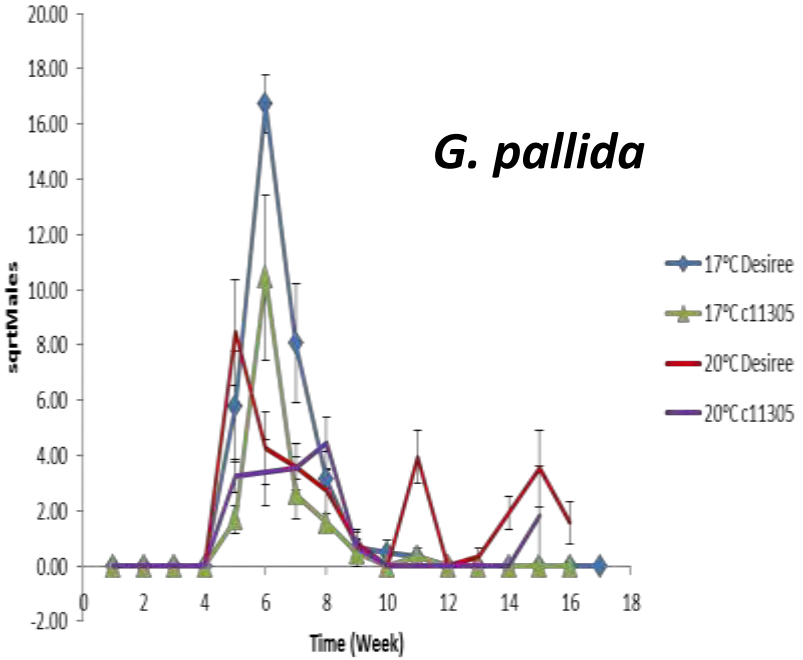

Figure d. Males

Vivian Blok, JHI

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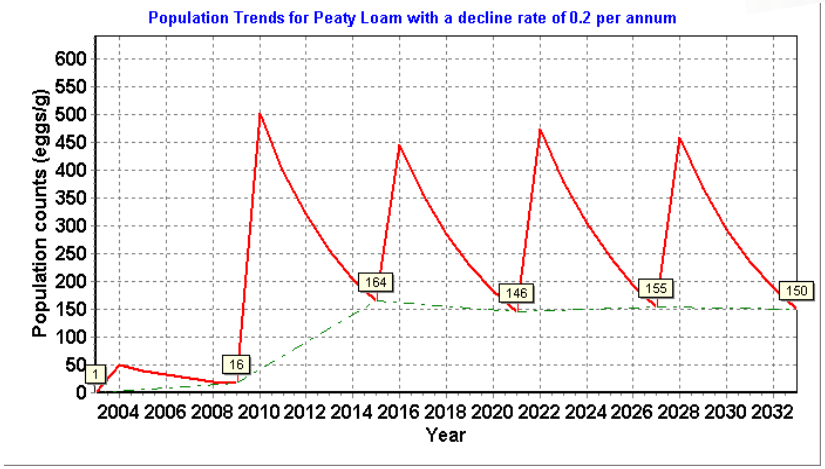
WP6.4.2 Example 1: Potato Cyst Nematode (PCN)

Field trials to examine relation between PCN population dynamics and soil temperature



Temperature information delivered to PCN management tool

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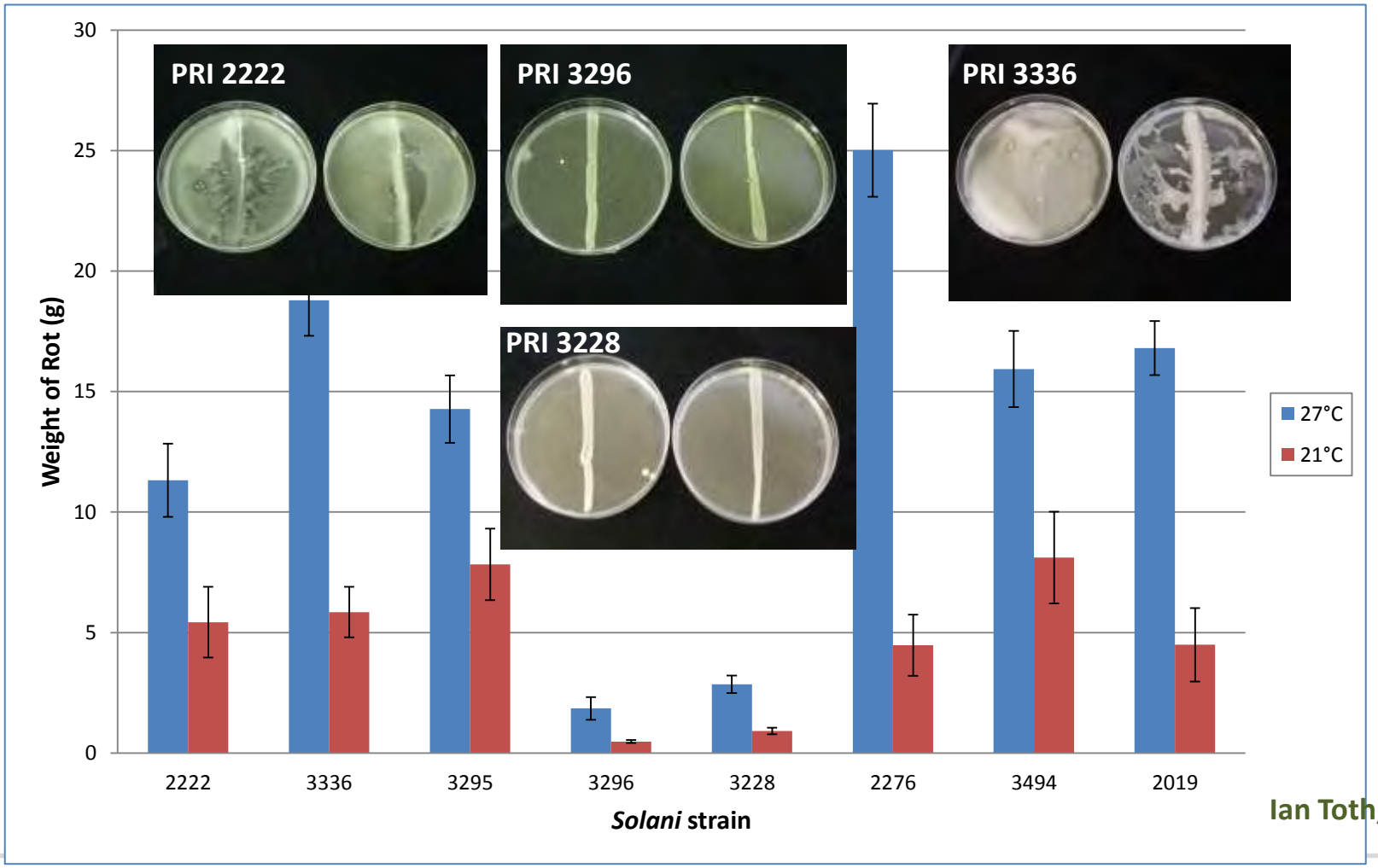
WP6.4.2 Example 2: Pathogenicity of *Dickeya solani* strains in potato tubers

The bacterial pathogens *Dickeya dianthicola* (Ddi) and "*D. solani*" (Dsol), are an increasing threat to Scottish seed potato production, for which climate change appears to be playing an important role

D. solani colonies at 28 days produce extracellular polysaccharide (EPS).

WP6.4.2 Example 2: Pathogenicity of *Dickeya solani* strains in potato tubers

A relationship between EPS production, temperature and virulence has been demonstrated



Ian Toth, JHI

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Summary

- Work has been progressing through first year
- Research activity mainly within Theme
- Aim to see more cross theme activity in subsequent years

Acknowledgements

- Colin McInnes, Philip Skuce, Ruth Zadoks, Alison Lees, Ian Toth, Rick D'Eath, Marie Haskell, Alistair Stott, George Gunn

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Diet and Health (Theme 7)

informing policy on the major issues of climate change, land use and food security

Professor Paul Haggarty

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Aims

Theme 7 is investigating the scope for improving the Scottish diet – in terms of both health benefits and sustainability – through:

- Production, processing and reformulation.
- Consumer choice.
- Identification of barriers to change in consumers, retailers, processors and producers.

Wealth Creation

Population Health

Sustainability Food Security

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An example of complexity: Sustainable fish as food

Complex links between food production, diet, health and sustainability and the need for research to inform policy

Aquaculture has the potential to take the pressure off wild fish stocks whilst meeting the dietary needs of the population for omega 3 fatty acids.

Reductions in fish stocks and catch quotas mean that farmed fish may have to be raised on vegetable oils.

This would have consequences for agriculture but it would also reduce the omega 3 content and the health giving properties of fish.

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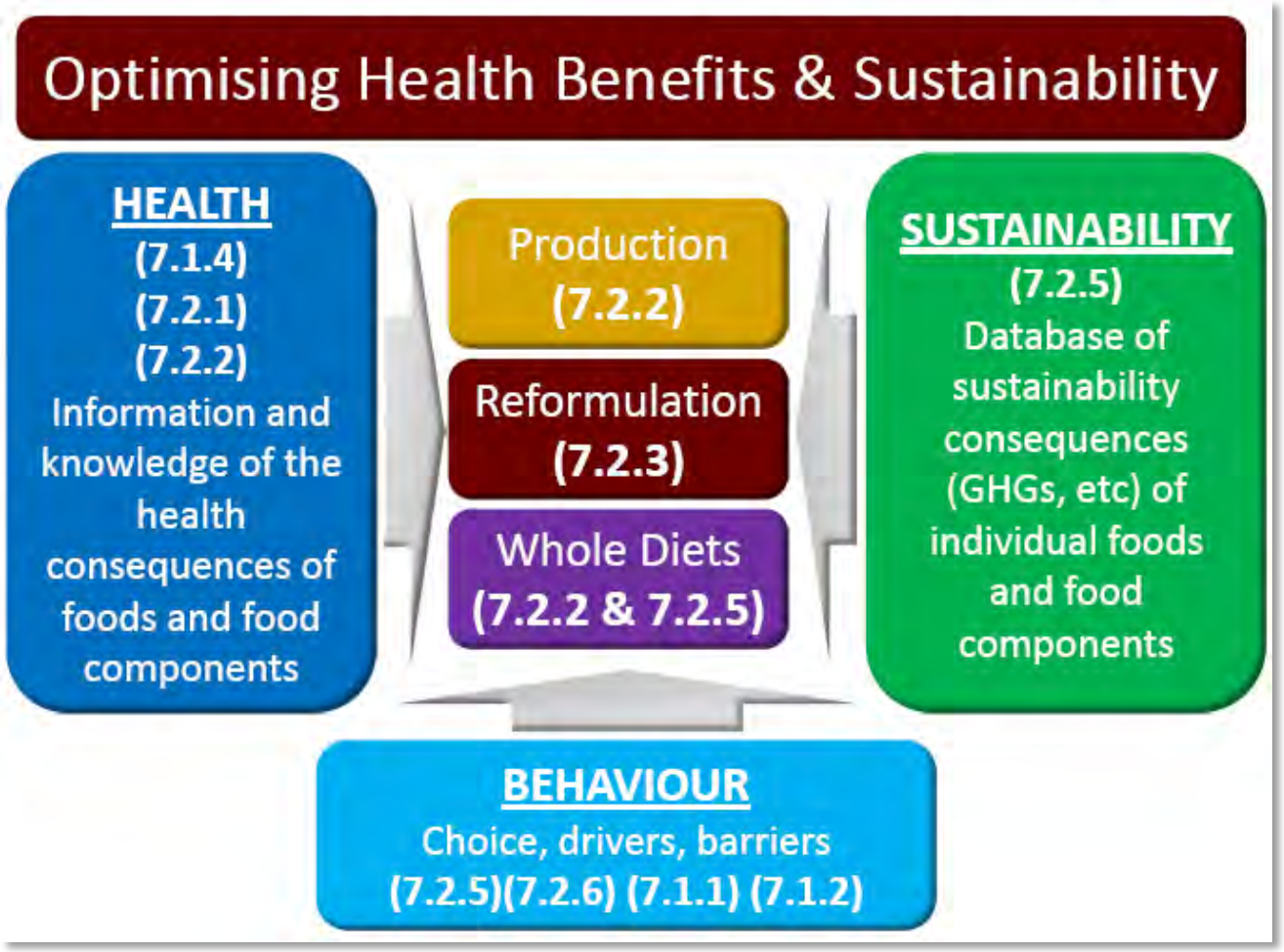
Optimisation of competing demands



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Production

- Analysing and improving the beneficial effects of crops and plant products
- Beneficial effects of crops and plant products as food:
- Sustainable sources of fish as food
- Optimising the beneficial effects of meat
- Beneficial effects of food mixtures and whole diets





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Processing and reformulation

Tools and technologies to enhance or preserve the safety and nutritional value of foods during processing

Improving safety through processing

Options to improve quality through processing

Processing and reformulation of fats

Processing and reformulation of convenience foods

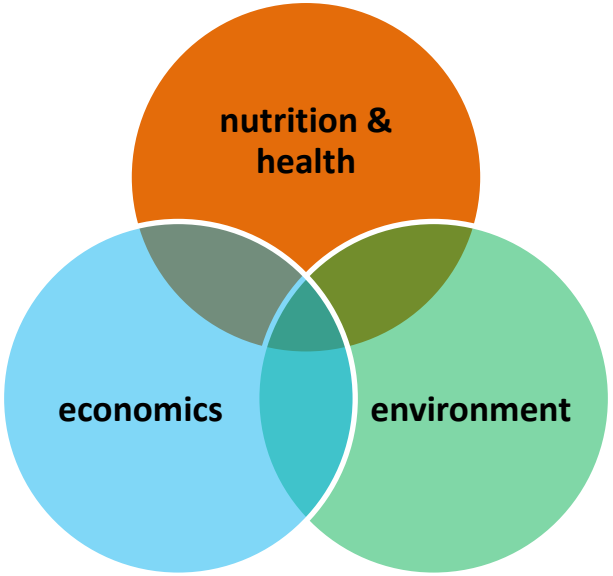
Bringing about change

Balancing health and sustainability;
GHG, Environmental degradation, etc

Barriers to change in consumers

Barriers to change in producers, processors and retailers

Healthy sustainable diets



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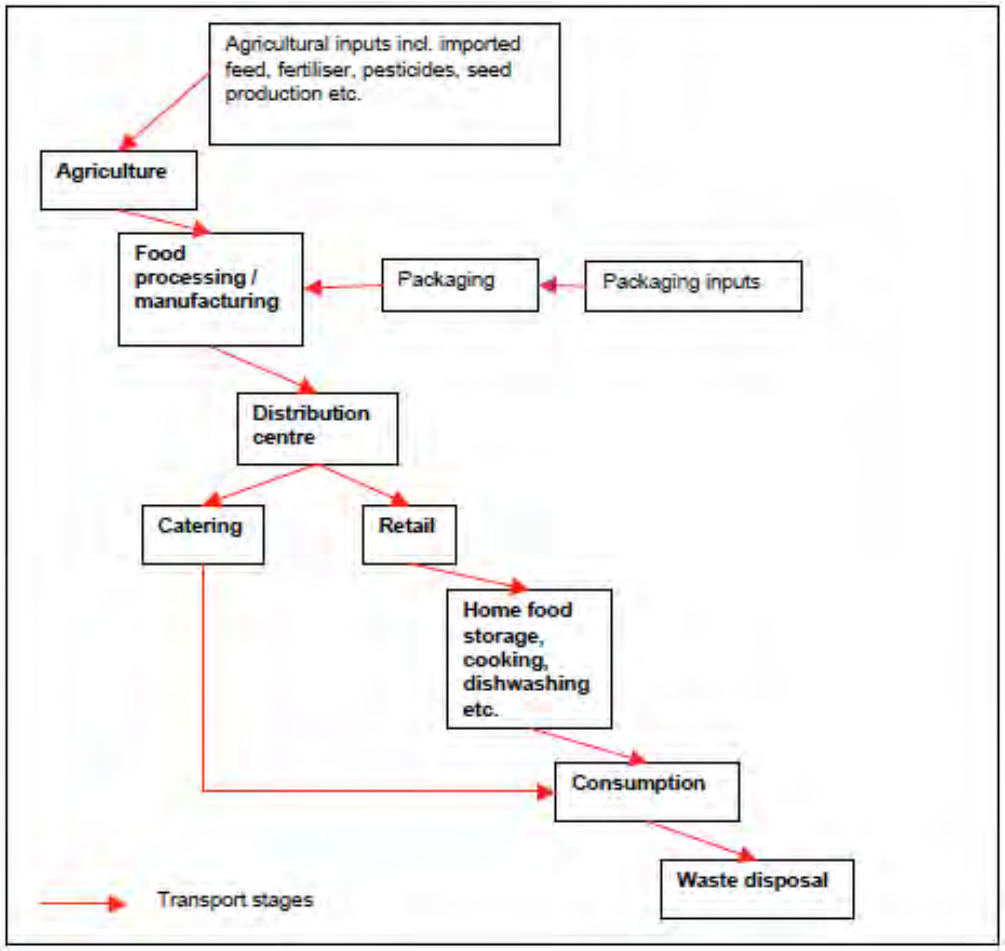
What is environmental sustainability?

- Sustainability
  - no agreed definition
  - many layers of complexity

- *One element* is greenhouse gas emissions (GHG)
  - 18-20% of total emissions comes from food
  - assessment of GHG using life cycle analysis

What is environmental sustainability?



Cooking up a storm, FCRN 2008

PSA 2050
- Carbon Trust
- Defra
- BSI

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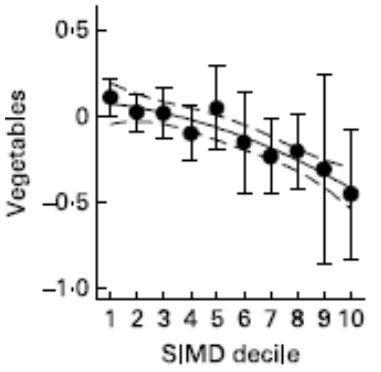
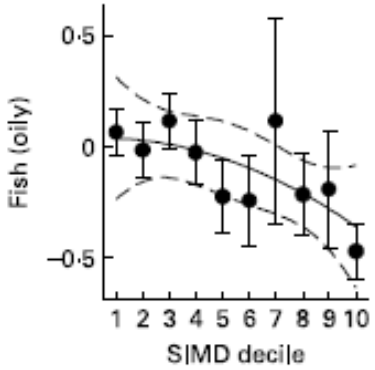
Social stratification

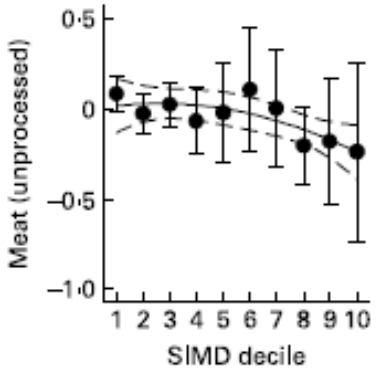
The SDAP targets were set for whole populations, even though it was clearly recognised that food consumption patterns are strongly influenced by deprivation, with more inadequate and/or inappropriate diets in low-income areas and poorer households.

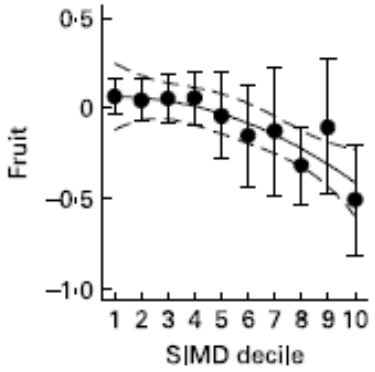
Food, climate, and health; heterogeneous impact

Natural Foods

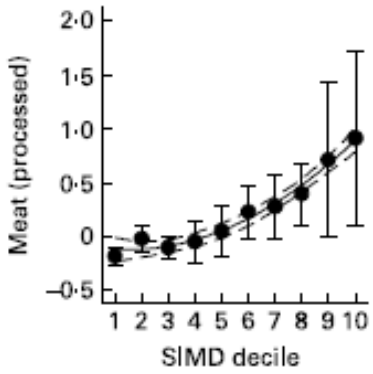


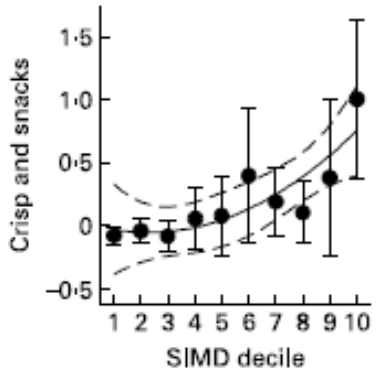


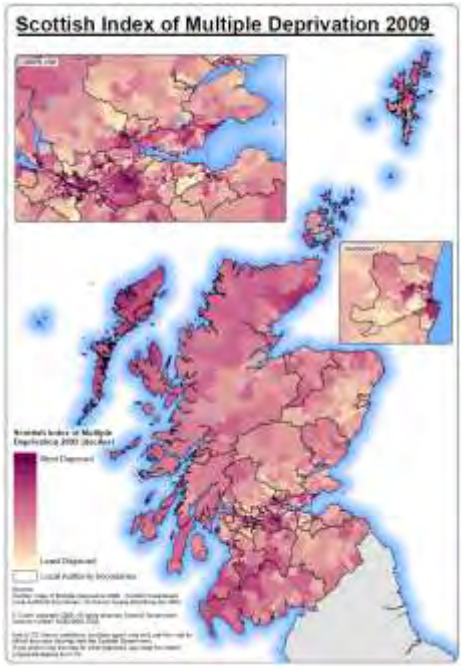




Processed Foods



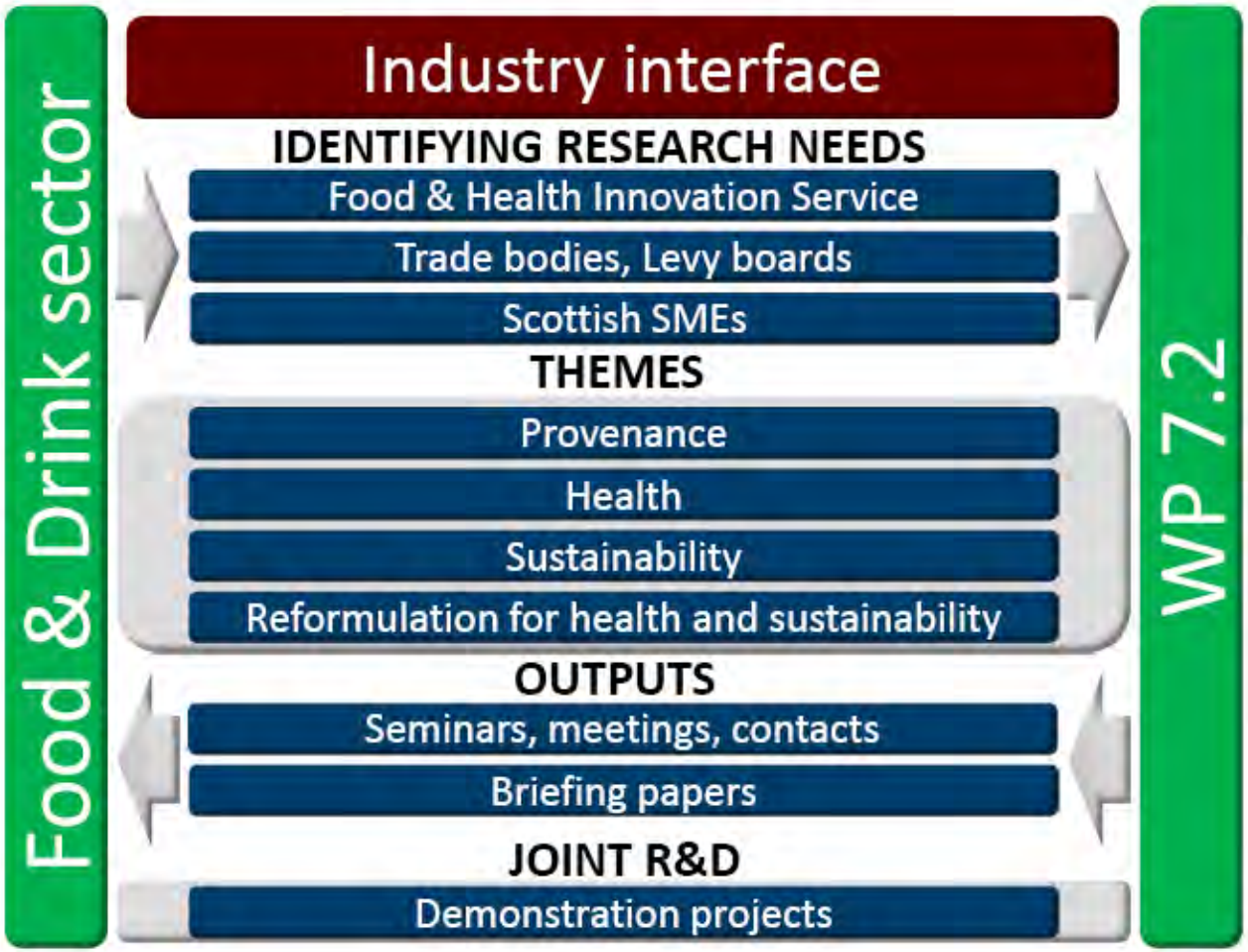




Opportunities for innovation

The development of a food supply chain which is sustainable and which meets the health needs of the population will also have economic benefits and innovation in the area of sustainability may provide new opportunities for the food industry.

Wealth creation



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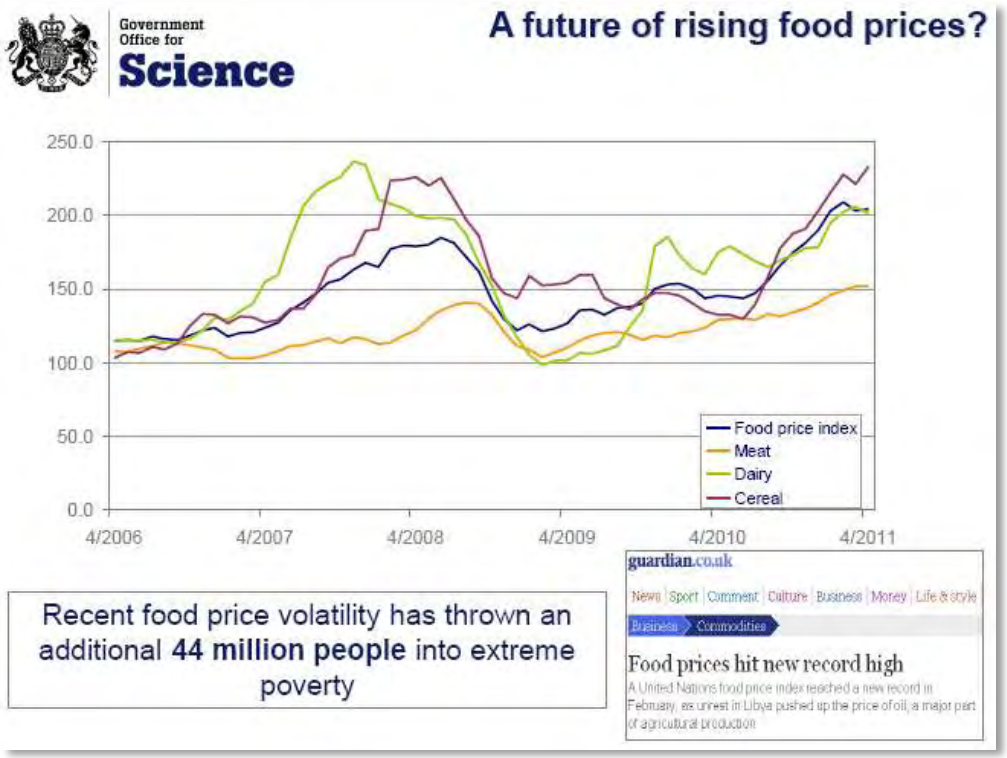
Food Security



John Beddington (2011)

Integration of Food Security with wider climate change considerations

Adaptation of existing knowledge to Scottish context

Implication for Scottish society and economy

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Key Theme 7 sustainability and food security links

Theme 1

Theme 5

Theme 8

Theme 7

climate change

Scotland's centre of expertise connecting climate change research and policy

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Climate Change and Carbon Management

A theme 8, Vibrant Rural Communities, perspective

JHI & SAC

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The context

The Climate Change (Scotland) Act 2009 is the principal driver

This act requires enormous changes in how we live and how we produce and consume products with the aim of significantly decarbonising life

- 42% emissions reduction across all sectors by 2020
- 80% emissions reduction by 2050
- Currently the UK food system alone accounts for c 20-30% of our emissions (WWF2010)
- So we need to decarbonise
  - The energy system
  - The food system
  - The transport and distribution system
  - Workplaces and everything associated with workplaces
  - The embodied carbon in all that 'stuff' that we buy

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Optimism from Report on Policies and Proposals RPP1

‘The development of a low carbon economy is the greatest opportunity for Scotland to develop and maintain a key competitive advantage in the long-term, and to lead Scotland out of recession. Low carbon sits at the nexus of the Scottish Government’s long-term economic strategy, encompassing the strategies for physical capital, human capital and competitive advantage.’

Scottish Government 2010

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Realism from a rural community perspective

- Wellbeing in most of rural Scotland is only modestly impacted by the rural land use sector –services dominate
- GHG emissions at household level in rural areas are very high, compared to urban Scotland
- Commuting is polluting, but it also explains a lot of 'rural' prosperity
- Some current policy 'rules' militate against rural Scotland being able to capture major benefits from the transition to a low carbon economy
- However, there are other policy elements that could be highly beneficial for rural Scotland

Theme 8 Vibrant rural communities

- WP8.1 The relationship between economic and social outcomes

- WP8.2 Governance and decision making for community empowerment in rural communities

- WP8.3 Understanding the linkages and dependencies between rural and urban areas

A theme built around the OECD vision for rural Scotland- with no explicit focus on climate change and carbon

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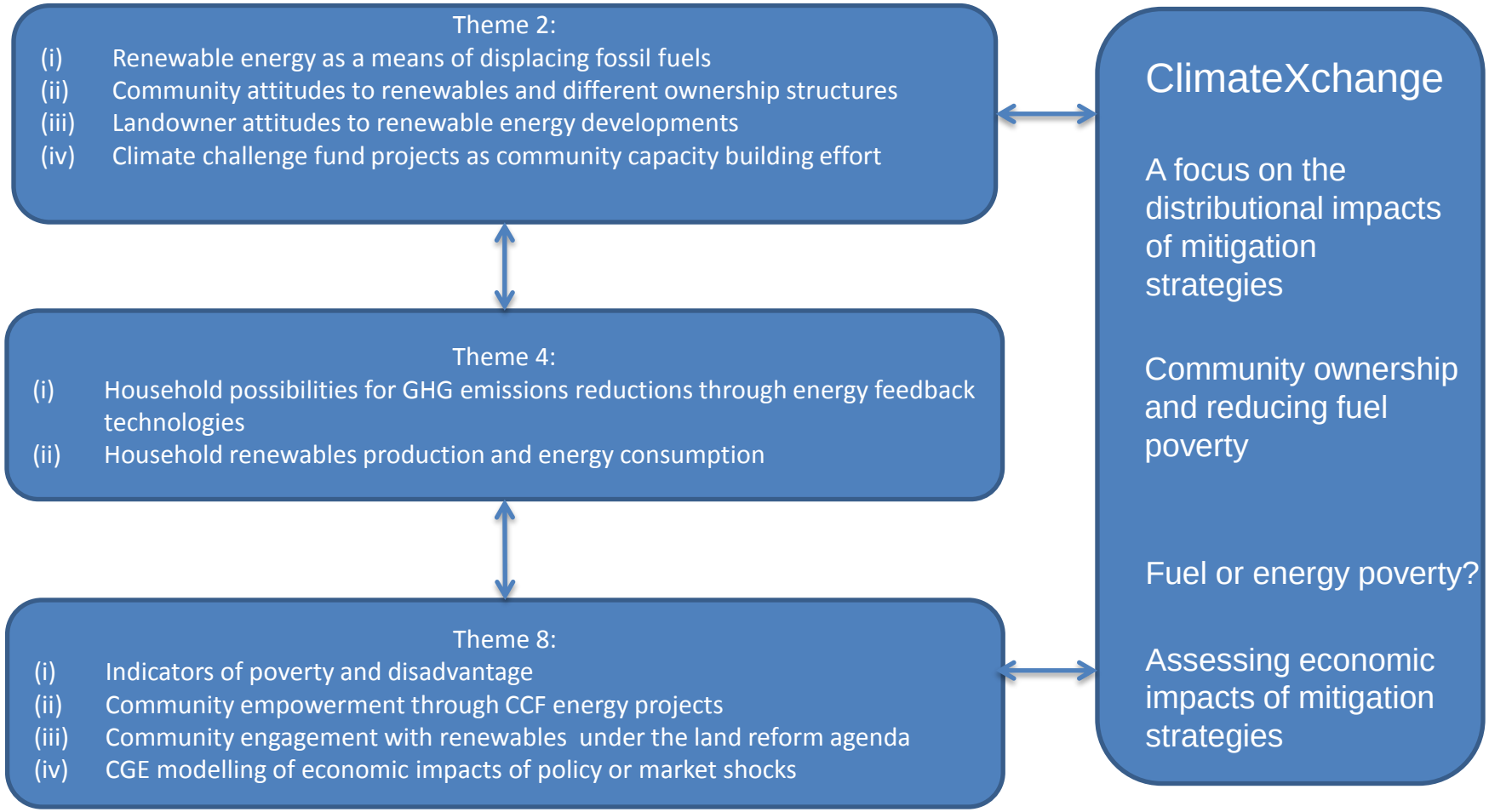
A joined up social sciences approach across work-packages and the CXC CoE



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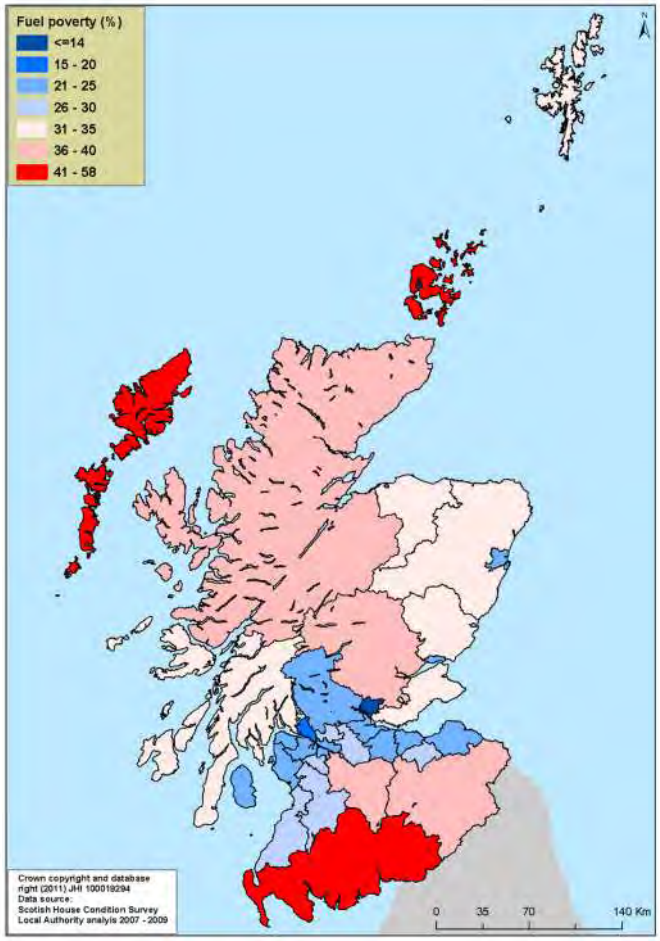
Theme 8.1

- Theme 8.1 builds a platform of understanding on the state of rural Scotland
  - The provision of spatial statistics of wellbeing
  - A shift share approach to exploring economic change (including the energy sector)
  - A platform CGE model to explore shocks both nationally and later at regional level

WP8.1 connects to ClimateXchange work

- Fuel poverty is a widely cited example of disadvantage
- It exhibits great spatial variability
- It is worse in remote rural areas
- Rising energy costs exacerbate the problem



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Theme 8.2

- Governance and decision making for community empowerment in rural communities
  - How governance and decision making differ
  - Assessing community vibrancy
  - Evaluating interventions
  - Understanding the capacity of institutions to facilitate change in community capacity

Theme 8.2: Community land trusts as renewables providers

- North Harris Trust (water turbine on river): http://www.north-harris.org/
- Galson (zero carbon office incubation units, and electric minibus for use as community transport): http://www.galsontrust.com/web/
- Gigha (3 wind turbines – 1st community-owned renewables scheme in UK): http://www.gigha.org.uk/
- Eigg (its own electricity grid): http://www.isleofeigg.org/

Theme 8.2 : OrkCEmP

A longitudinal research project looking at perceptions and experiences of living in Scotland's rural communities in terms of:

- Understanding how members of Orkney Housing Association Ltd. (OHAL) can be empowered or empower themselves
- Exploring how OHAL uses CCF funds to engage with its residents and manage and facilitate change in "Reducing Energy Growing Green"
- Providing know-how to OHAL to establish a CO2 footprint assessment of a selection of its residents and monitor changes over time

OHAL
REDUCING ENERGY GROWING GREEN

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Theme 8.3: Urban rural linkages and interdependencies

- Identify changing rural urban dynamics and assess impacts of change
- Conflict resolution in rural areas (See also theme 2)
- Service provision in rural and urban areas
- Understand interrelations between greenspace and wellbeing

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Greenspace, wellbeing and GHG emissions

- GHG footprint of activities associated with everyday life is very high
- Time spent in natural environments has mental health benefits
- Re-considering the time-map of everyday life can have large implications for GHG emissions
  - Commuting, Leisure Travel, Sleeping, etc..

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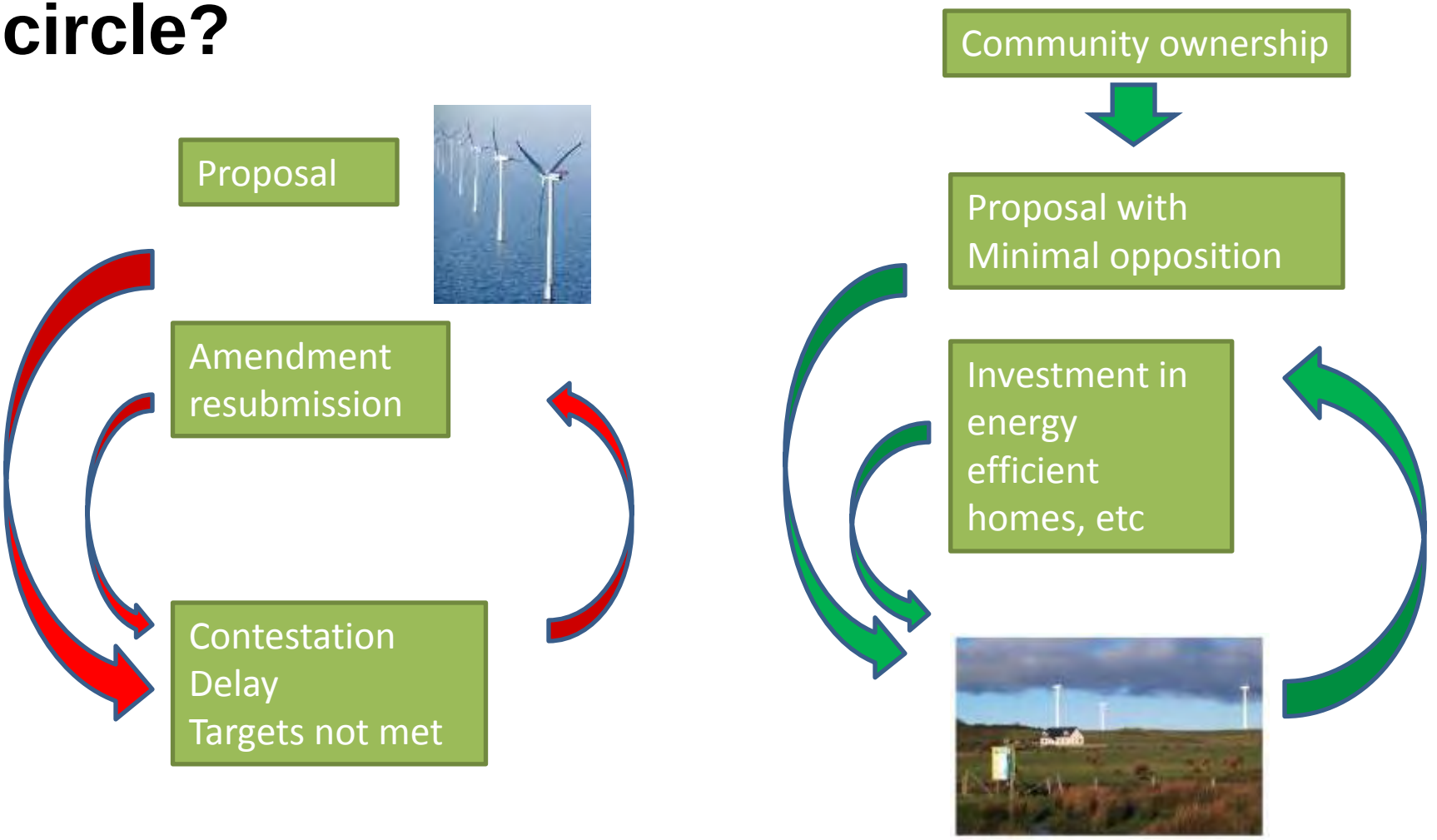
In summary

- 8.1. A focus on wellbeing and the spatial pattern of growth and decline
  - Energy use in the rural economy
  - Assessing impacts on wealth creation and wellbeing
- 8.2 A focus on organisational structures and governance
  - Community ownership as a vehicle for renewables production
  - CCF as a means of delivering change
- 8.3 A focus on urban rural interactions
  - Greenspace and energy use
  - Conflict resolution
  - Carbon footprint of rural living

Can we move from vicious to virtuous circle?



A way forward

- Explore (and seeks ways of removing) policy bottlenecks
- Recognise that there are economic, social and psychological elements to the shift to a low carbon economy (and there are research needs to better understand this)
- Recognise that we need more than ‘nudge’- the problem is just too big
- It needs a people not land focus to fully address the problem

Thank-you

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Knowledge Exchange Activities

Willie Towers

Why Knowledge Exchange?

- Science increasingly has to be relevant as well as excellent
  - We live in times of budget cuts
  - Science is viewed with scepticism by some
  - Climate change scepticism/denial in particular
- Climate change runs through both programmes
  - Particularly in the Environmental Change Programme
  - But also clearly the key part of the Climate Change Centre of Expertise (now ClimateXChange)
  - And some research within CREW (Centre of Expertise for Waters)

Knowledge exchange within Themes

- All Themes have a KE plan
  - Within each research Work Package
  - And a KE specific Work Package
- Plans have identified
  - Audiences
  - Priority outcomes
  - Approaches
  - Evaluation of impact
  - Alignment with National Performance Framework
  - Innovation
  - Engagement with SMEs and farming community

Programme level Co-ordinated KTE projects

- Four key areas:
  - Develop the Science Policy Interface
  - Public Engagement with RESAS science
  - Further developing the culture of Enterprise and Innovation
  - Developing robust methods for evaluating impacts of KE activities
- Where appropriate, Theme level KE activities should map onto these

Knowledge Exchange – to whom?

- 5 key audiences
  - Policy and politicians
  - Stakeholders: agencies, land based industries
  - Public (including education)
  - Commercial interests
  - Scientific community
- Different groups have different agendas and require different approaches

Knowledge Exchange – climate change and carbon management

- Carbon management can be interpreted in both narrow and wider contexts
- Work focussed on land management options e.g.
  - to manage soil carbon across a range of ecosystems
  - to manage above ground vegetation
  - Renewable energy opportunities and impacts
  - Trade-offs with other ecosystem services
  - Achieve multiple land use benefits
- Addresses many aspects of the Land Use Strategy

Knowledge Exchange – climate change and carbon management

- Theme 4 Economic adaptation
  - WP 4.2 Developing a low carbon rural economy
  - Investigates issues such as behaviour, governance and interdependencies in the rural sector
  - preferences, values and views of stakeholders i.e. is an intrinsic part of the research
  - Shared activity in part with Theme 8 (Rural Communities)
- The carbon footprint of supply chains
  - Development of footprinting tools
- Dominance of ruminant livestock in the C footprint of Scottish agriculture
  - Seek to improve the husbandry and health of domestic livestock

Knowledge Exchange – a range of mechanisms

Policy :

- Partnership working builds up trust and relationships; a key part of KE activities
- Policy briefs
- Direct contact

Other stakeholders:

- Farm Open Days
- Industry events e.g. Cereals in practice
- Stakeholder Groups
- Targeted publications

The public

- science festivals, RHS, Gardening Scotland
- Education networks
- the media
- visualisation tools
- social media……

ClimateXChange

- Is a collaborative initiative between sixteen of Scotland's leading research and higher education institutions undertaking work on climate change and the transition to a low carbon economy.
  - Three workstreams
    - Adaptation (4 workstrands)
    - Mitigation (4 workstrands)
    - Significance, Risk and Uncertainty (6 workstrands)
  - Call down service
  - 'ClimateXChange's work is all about supporting policy making'

Knowledge Exchange – Concluding remarks

- There is a lot going on…….quite a crowded landscape.
  - Individual MRP policy/discussion documents
  - Knowledge Scotland – Science Policy Connections online
  - ClimatexChange – 'is all about supporting policy'
  - PAWSA (Provision of Analytical Work in Support of Advice)
  - SPICe – MRPs engage here as well.
- So there is a need to ensure co-ordination of activities across the Programme and with ClimatexChange
- And to ensure that no mixed/contradictory messages are sent out
- We are very aware of this and taking appropriate steps to avoid problems