State of the Environment and Impacts, Research Perspectives

May 2011

5 year research programme

- Approximately £40 million
- 8 Research Themes
- Ring-fenced monies for collaborative Centres of Expertise and strategic partnerships
- Centre of Expertise on Climate Change

Scottish Government 2011-2016

- **Environmental Change (Local Responses to Global Change)** Theme 1: Ecosystem Services
  Theme 2: Strong and resilient sources and supply chains for water and energy (Water and Renewable Energy)
  Theme 3: Technologies and management tools to deliver greater benefits from rural land use and increased resilience to change (Land use)
  Theme 4: A rural economy resilient to global and local change (Economic adaptation)
- **Food, Land and People (Optimising the Potential of Scotland's natural assets)**
  Theme 5: Efficient and resilient supply chains for food (Food)
  Theme 6: Animal/plant health and disease and animal welfare (Health and Welfare)
  Theme 7: Healthy safe diets (Diet and Health)
  Theme 8: Vibrant rural communities (Rural Communities)

Centre of Expertise on Climate change

- MRP & University collaborations e.g. through shared studentships and postdocs
- Large emphasis on policy needs and knowledge exchange

- Looking beyond land-based sector
- 3 work streams : adaptation, mitigation, risk
- Centre directorate

Mapping SG research

Climate change key research challenges

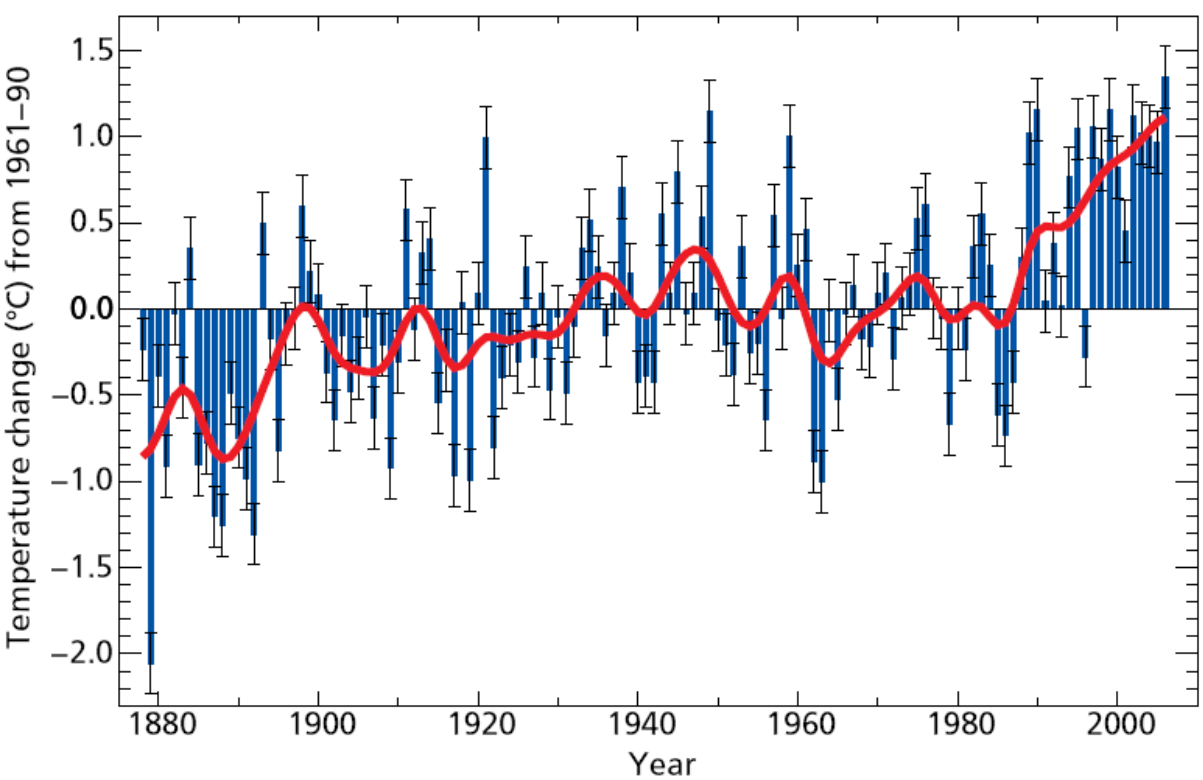
- Understanding impacts
- Selection adaptation strategies
- Identifying mitigation strategies
- Effectiveness, efficiency and equity
- Understanding synergies& trade-offs between responses
- Behaviours
- Inventory (re mitigation)

UK climate is already changing

- Rainfall: heavier bursts in winter
- Sea level: rising >1mm/yr
- Seasons: spring now arrives 11 days earlier than in 1970s
- Many trends accelerating

UK climate is already changing

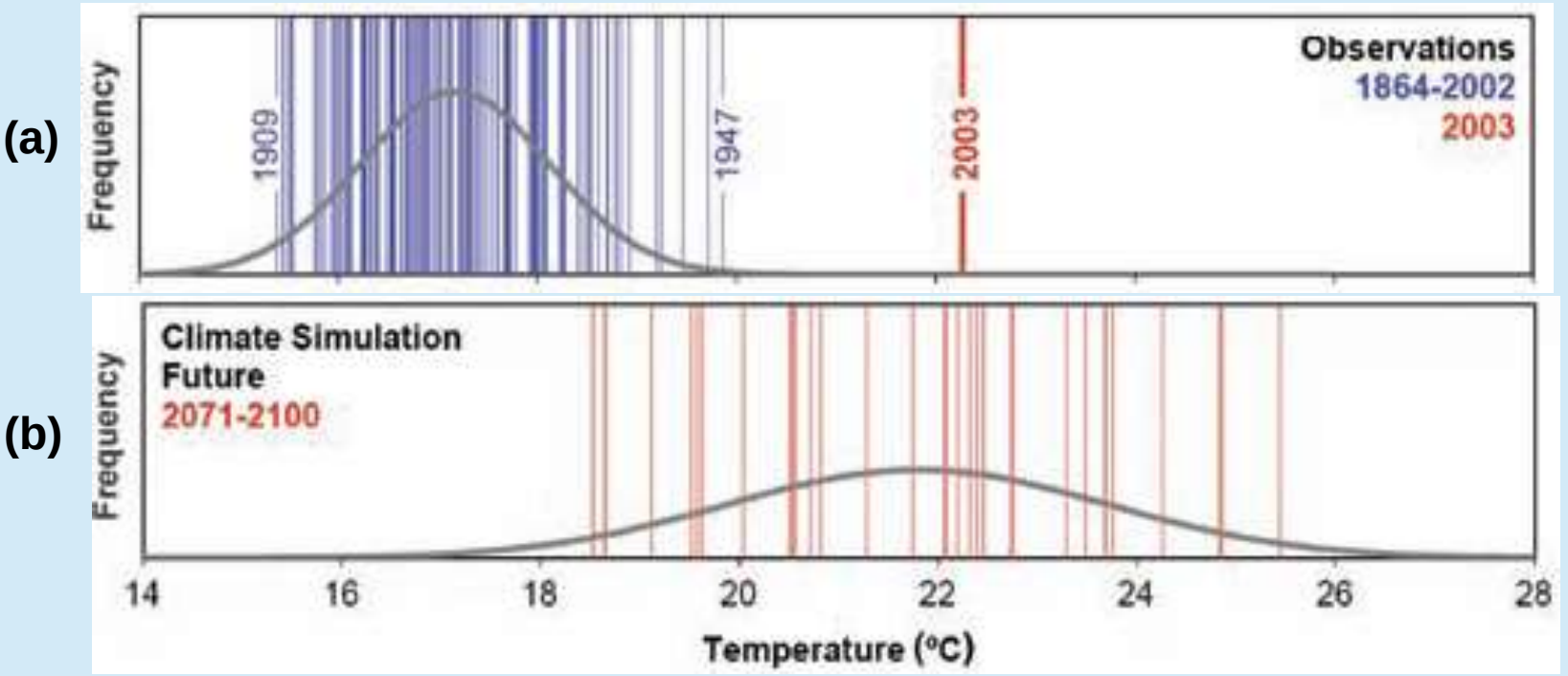
- Even if the most ambitious global mitigation targets are achieved, the world has 50% chance of warming by 2°C or more by 2100.
- Adaptation involves responding to the unavoidable consequences of climate change to which the world is already committed.



Central England Temperature: 1°C rise in 40 years

Extreme weather events are likely to intensify and become more frequent

Events like the 2003 European heatwave are likely to become the norm by the end of this century (under a medium emissions scenario)



(a) Observations in Switzerland 1864 - 2002

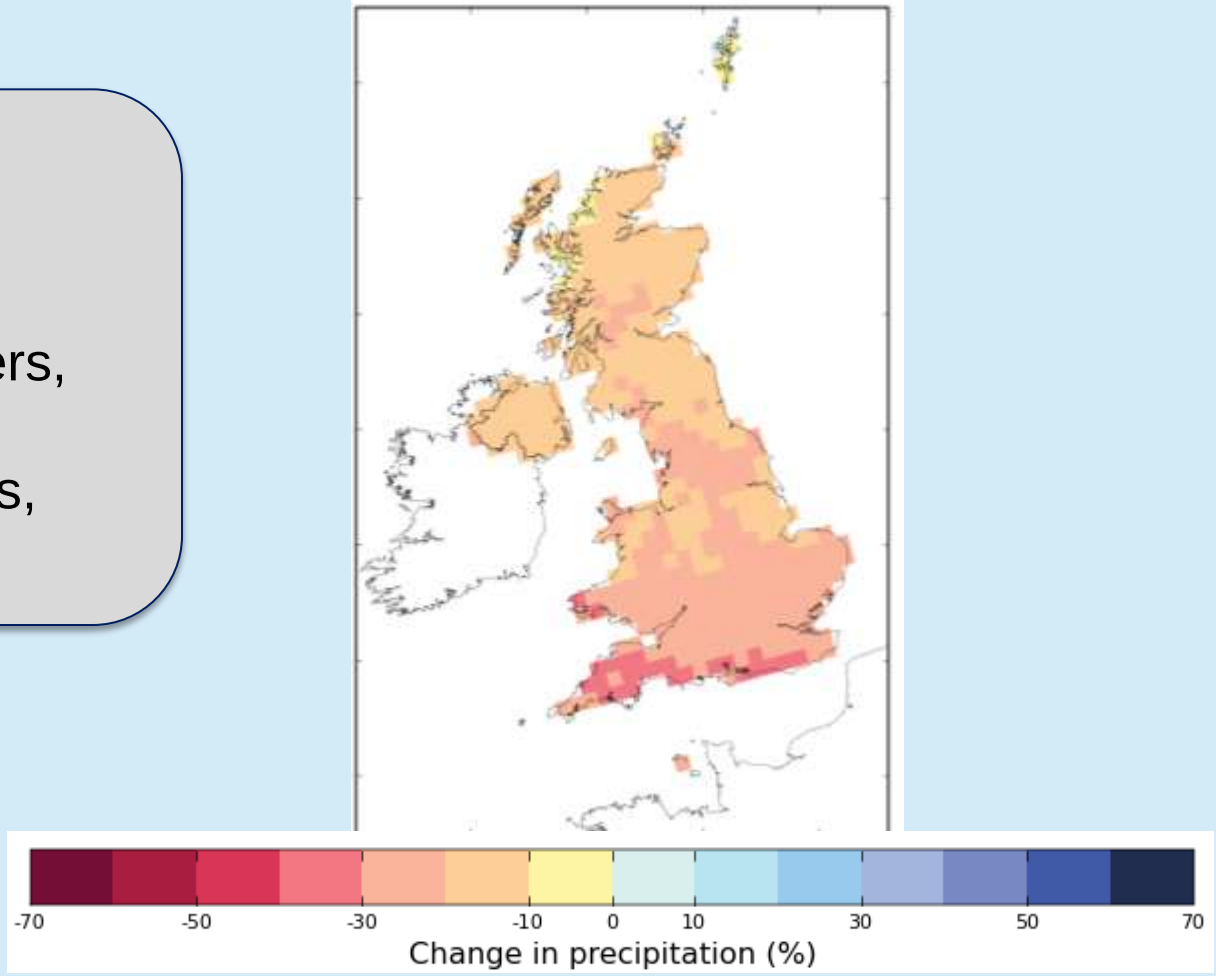
(b) Model simulation 2071 – 210

Adapted from Schar et al. (2004

Models give an indication of future UK climate – UKCP09

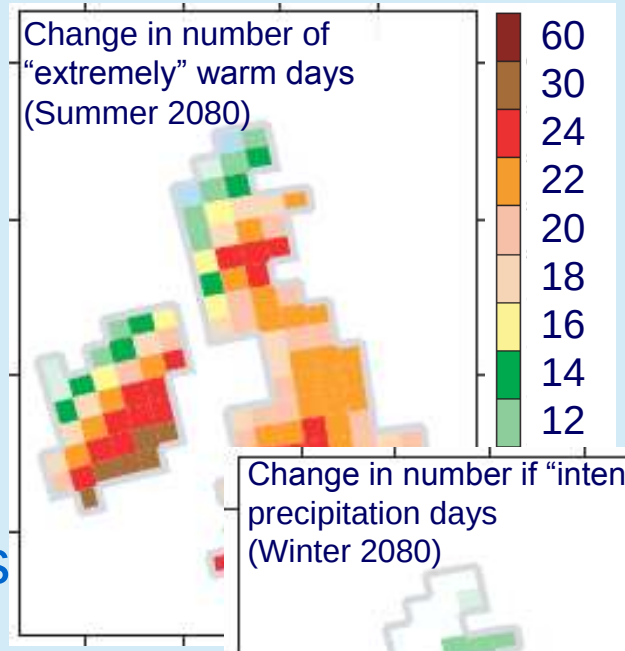
- Higher annual temperatures
- Sea level rise
- Warmer, wetter winters, especially in the West
- Hotter, drier summers, especially in the East

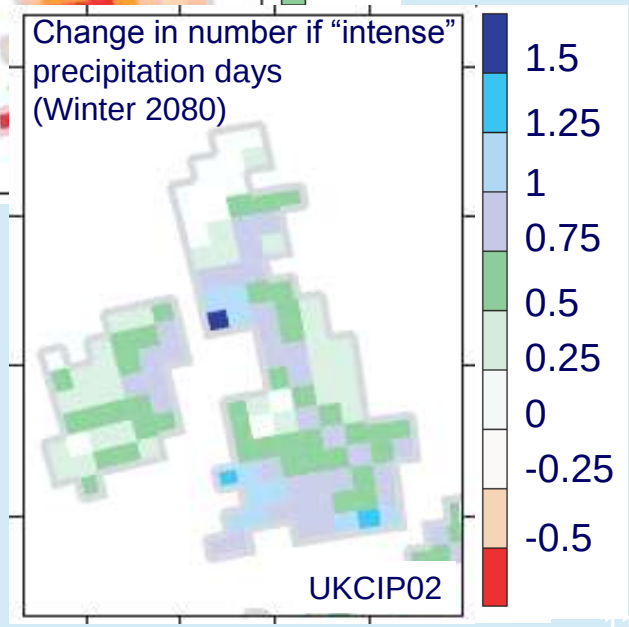
2080 summer precipitation
(50% probability, central estimate)



Climate Change and agriculture

- Temperature and rainfall changing
  - Varies with region & season
  - Change in growing seasons (beneficial in places)
- More extreme events
  - Floods, droughts, heat waves high winds
  - Agricultural systems need to be resilient to deal with multiple stressors (including climate change)





Key challenges/**opportunities** for farming

…consider the ***global food system*** *from* ***production to plate****.*

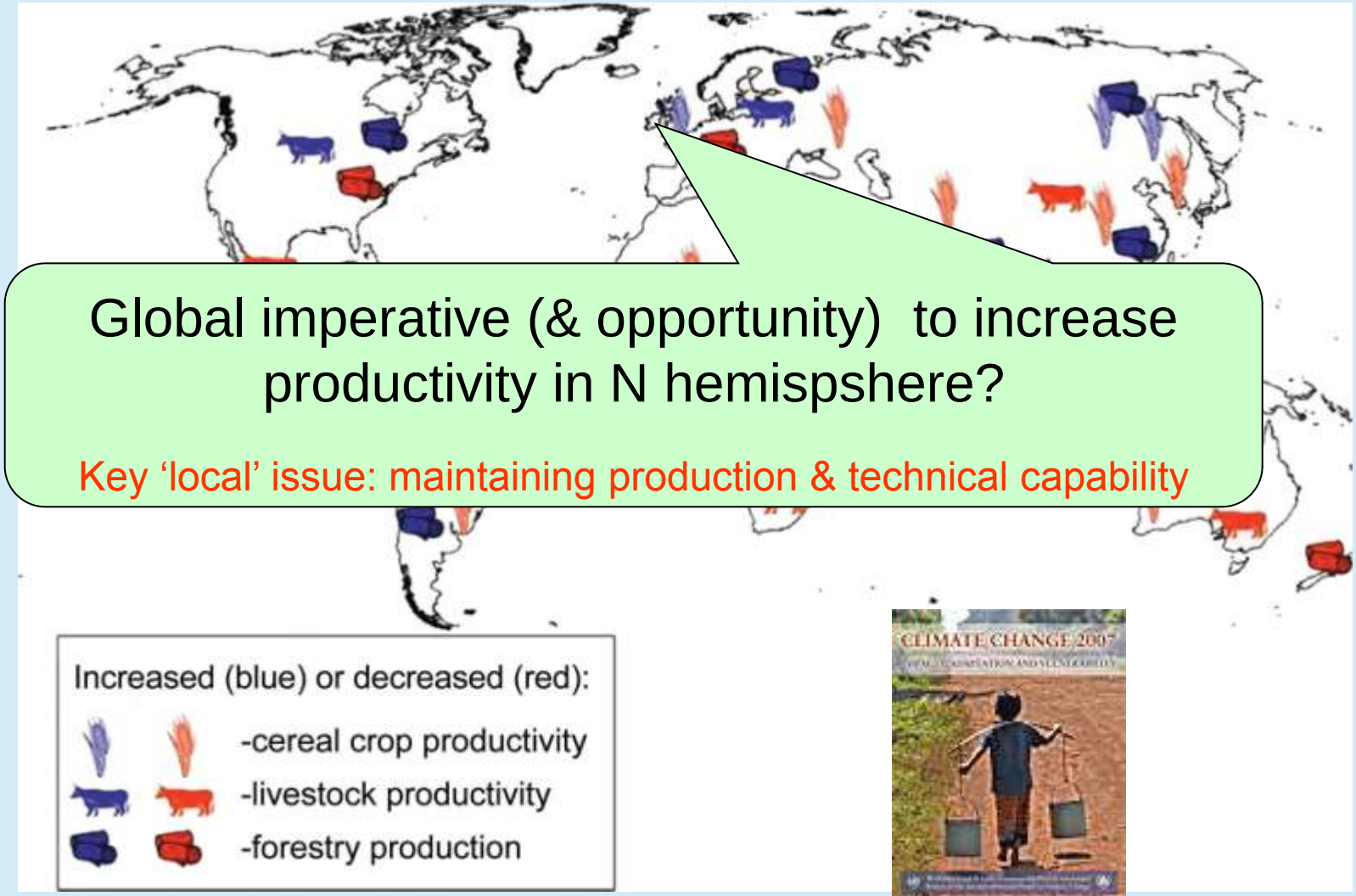
…adopt a ***broad view of food*** *that goes far beyond narrow perspectives of nutrition, economics and food security.*

This is a unique time in history – decisions made now and over the next few decades will disproportionately influence the future

Food security *is one of this century's* ***key global challenges****…This must be done in the face of* ***changing consumption patterns****, the impacts of* ***climate change*** *and the* ***growing scarcity of water and land.***

Biological science…, must play a leading role …in providing a ***range of scientific solutions to mitigate potential food shortages****. This will require significant funding of* ***cross-disciplinary science for food security.***

Predicted climate change impacts by 2050 (IPCC, 2007)



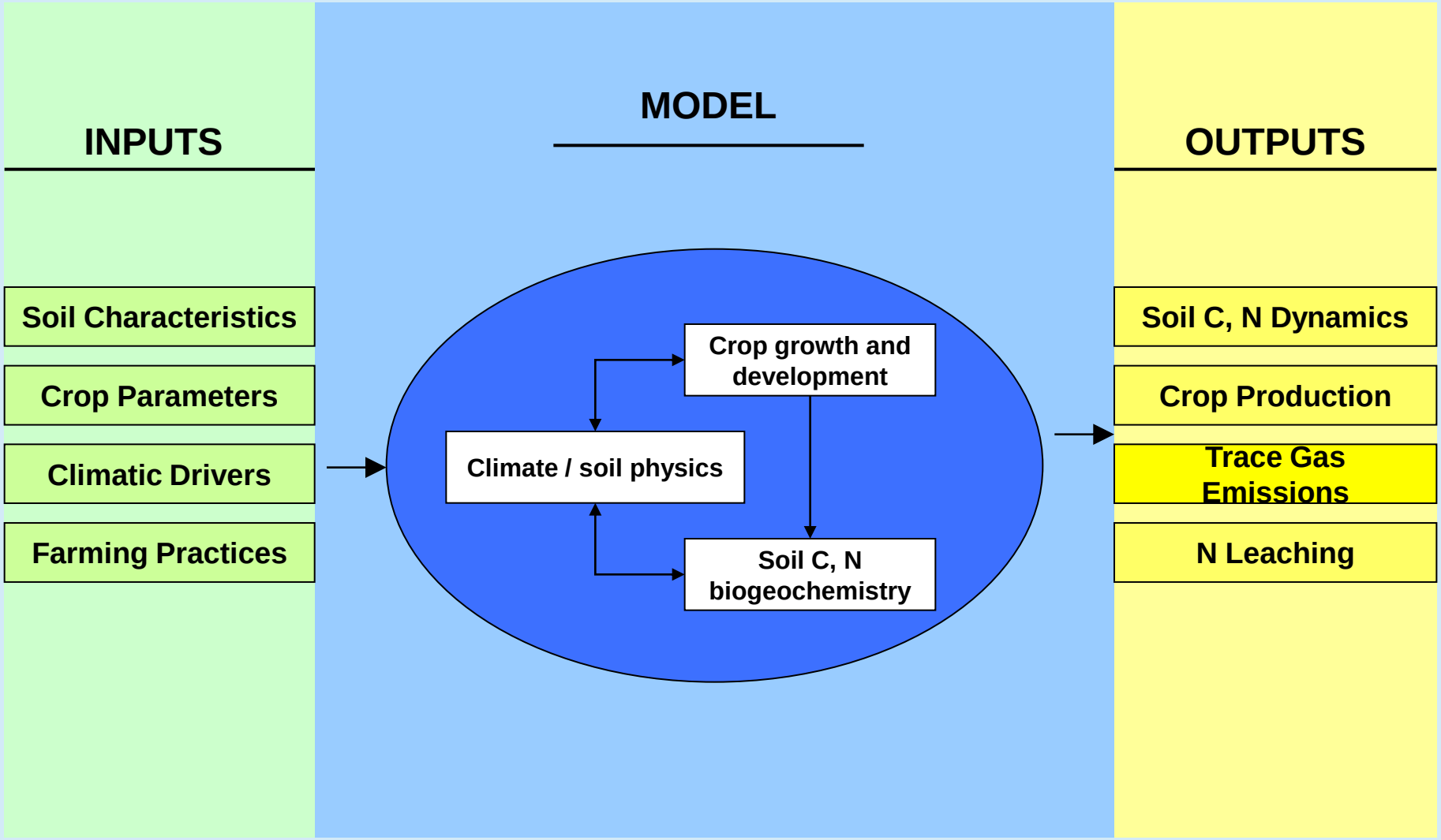
Understanding downscaled projections

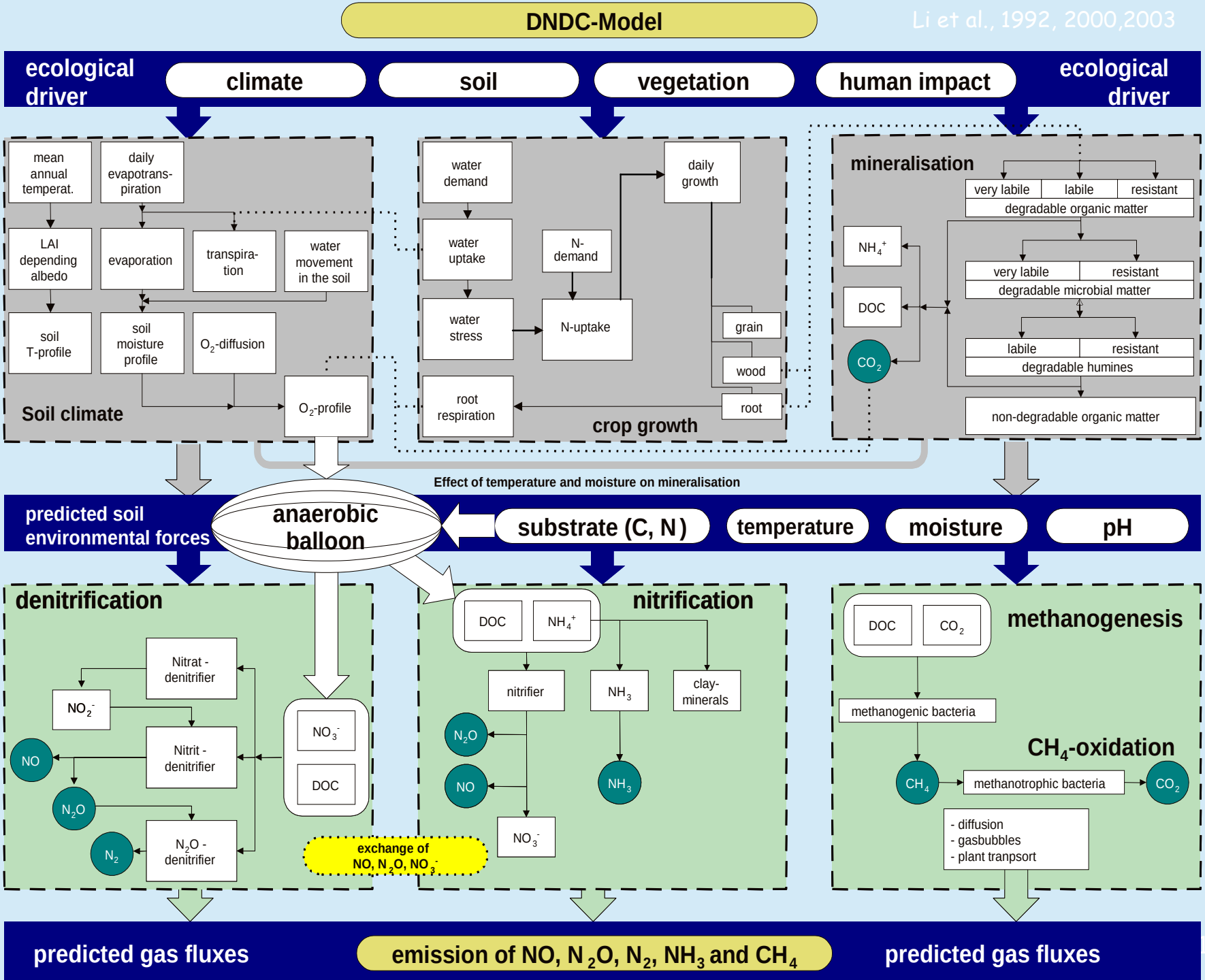
- Assessment of the UKCP09 scenarios
- Applied to agriculture (plants, animals, diseases & pests), biodiversity, forestry water, transport, housing …..etc.
- Various research projects being undertaken to understand impacts and responses

  e.g. biophysical modelling

  - Range of sites across Scotland
- Costs and benefits of warming

Understanding local impact: Biophysical modelling DNDC

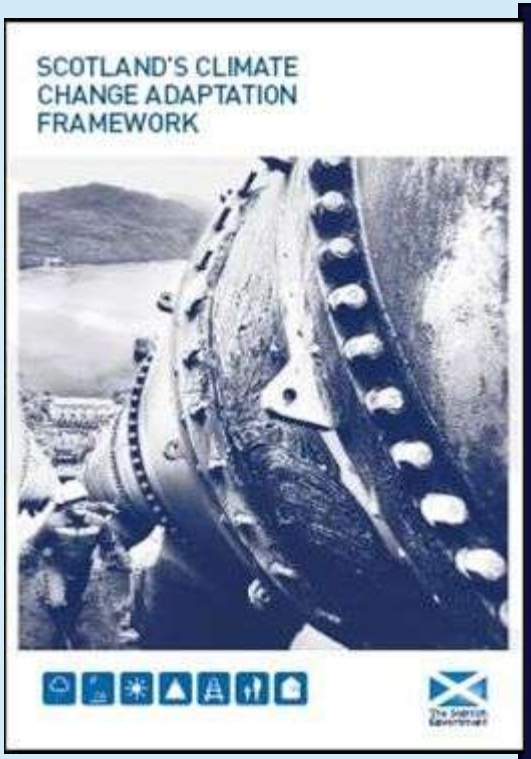


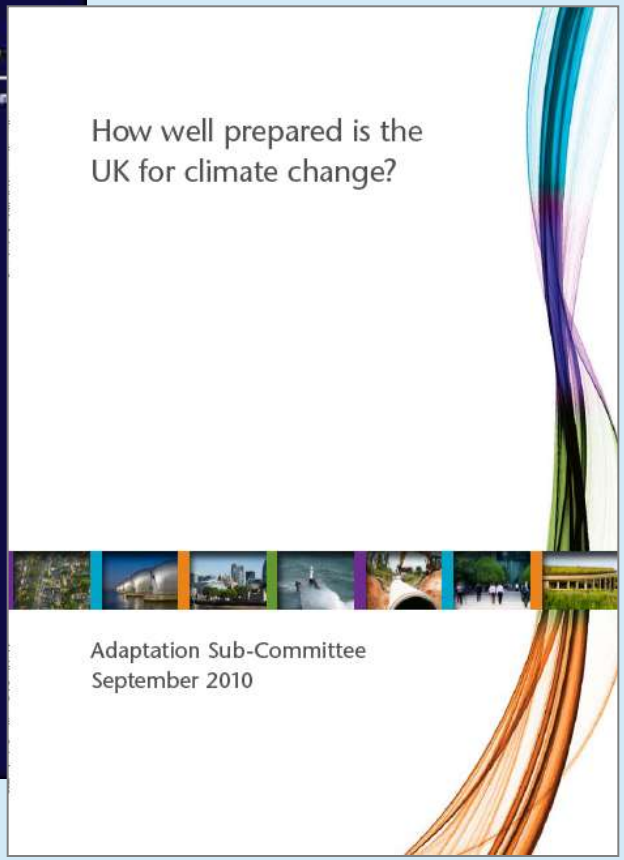

DNDC-Model
Li et al., 1992, 2000,2003
ecological driver
climate
soil
vegetation
human impact
ecological driver
mean annual temperat.
daily evapotrans-piration
LAI depending albedo
evaporation
transpira-tion
water movement in the soil
soil T-profile
soil moisture profile
O2-diffusion
O2-profile
Soil climate
water demand
daily growth
water uptake
N-demand
water stress
N-uptake
grain
wood
root respiration
root
crop growth
mineralisation
very labile
labile
resistant
degradable organic matter
NH4+
very labile
resistant
degradable microbial matter
DOC
CO2
labile
resistant
degradable humines
non-degradable organic matter
Effect of temperature and moisture on mineralisation
predicted soil environmental forces
anaerobic balloon
substrate (C, N)
temperature
moisture
pH
denitrification
Nitrat - denitrifier
NO2-
Nitrit - denitrifier
NO
N2O
N2
N2O - denitrifier
NO3-
DOC
exchange of NO, N2O, NO3-
nitrification
DOC
NH4+
nitrifier
NH3
clay-minerals
N2O
NO
NO3-
NH3
methanogenesis
DOC
CO2
methanogenic bacteria
CH4-oxidation
CH4
methanotrophic bacteria
CO2
- diffusion
- gasbubbles
- plant tranpsort
predicted gas fluxes
emission of NO, N2O, N2, NH3 and CH4
predicted gas fluxes

Crops/grassland – longer growing season

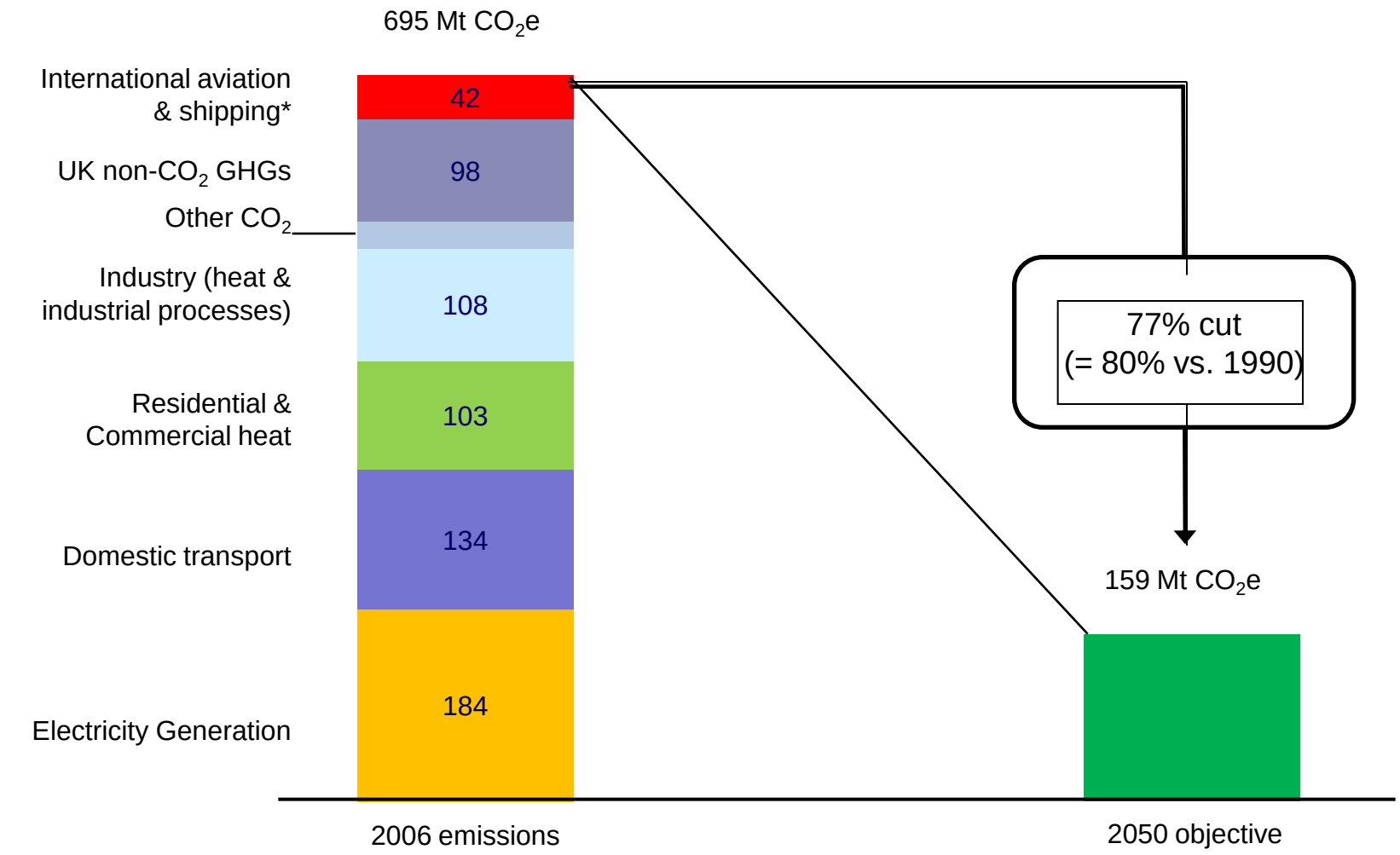
- Increased grass production → increased grazing period
  - 5 wks for cattle, 7 wks for sheep, north vs south
- Potential welfare and disease exposure consequences
  - longer grazing season extending the exposure to environmental parasites and pathogens
- GHG balance changes with longer grazing period

Policy direction





Mitigation: The Climate Change Act (2008)



* bunker fuels basis

Welcome to the Committee on Climate Change (CCC)

The Committee on Climate Change (CCC) is an independent body established under the Climate Change Act to advise the UK Government on setting carbon budgets, and to report to Parliament on the progress made in reducing greenhouse gas emissions.

Carbon Budgets

The CCC (Committee on Climate Change) has proposed levels for the first three carbon budgets from 2008-2022...

Topics

Includes information about climate science and the environment, economic and social impacts, global and UK targets...

Sectors

There is potential for emissions to be reduced across all sectors of the economy. To find out about some of the opportunities and technologies required read on...

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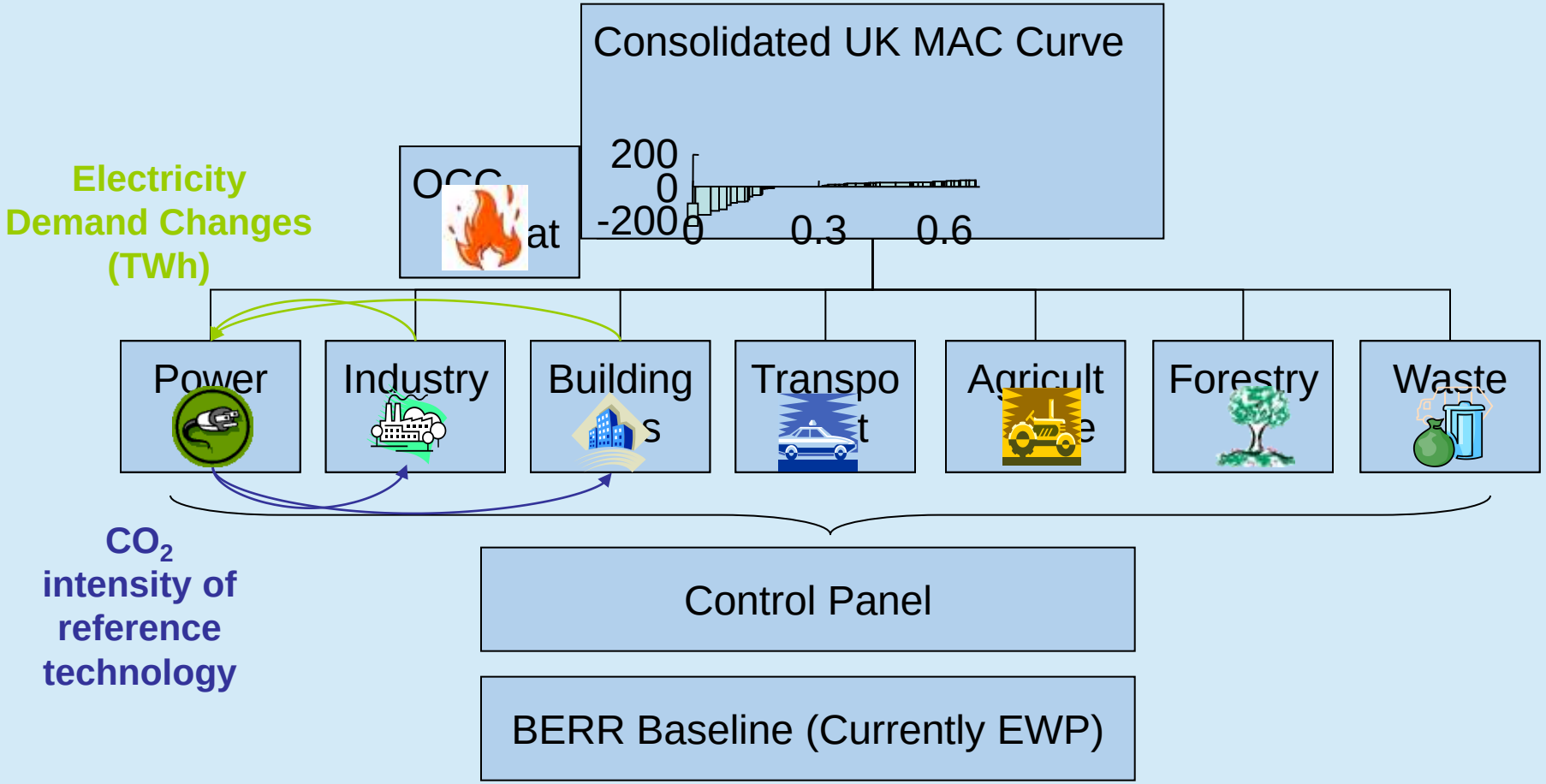
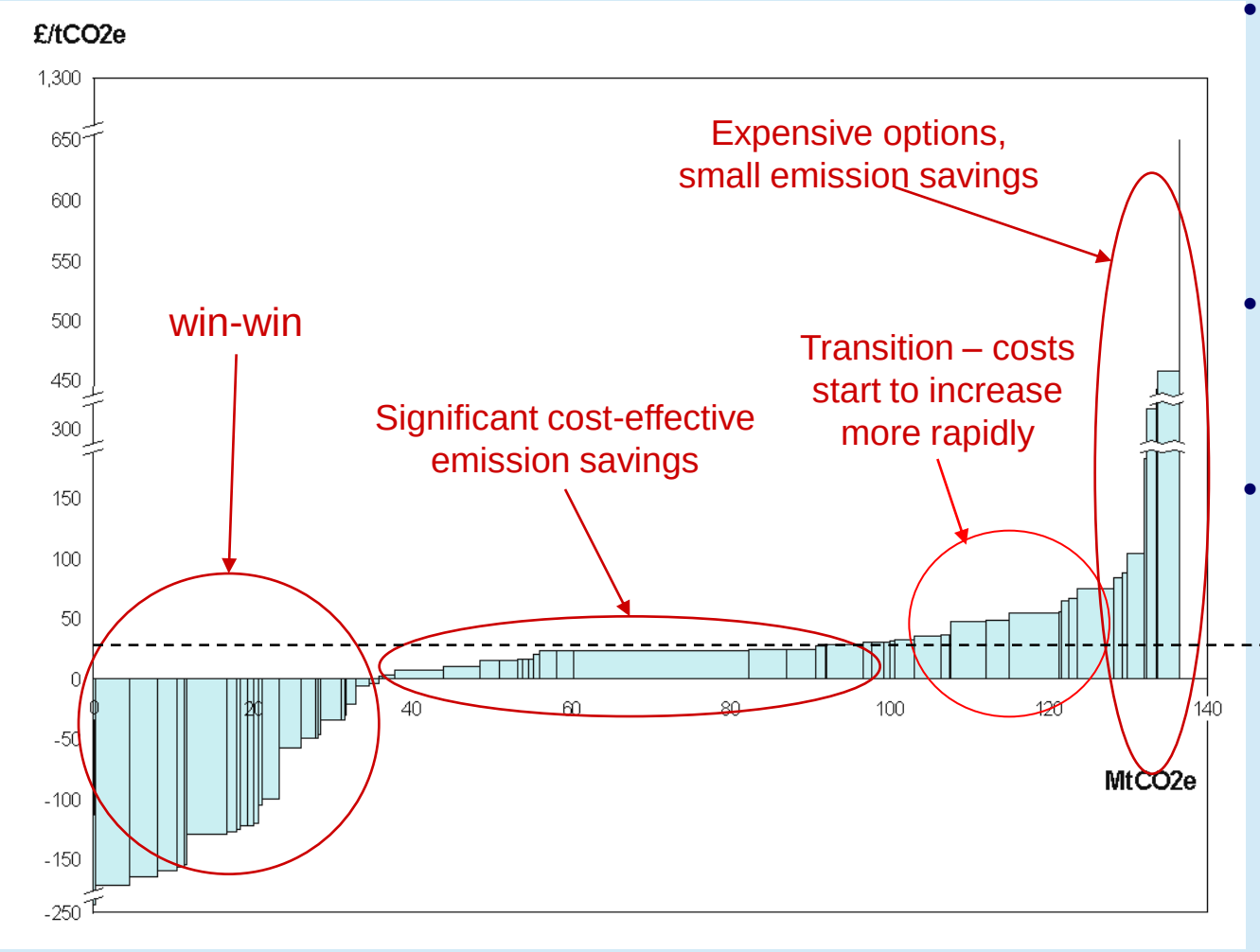
Cost effective abatement potential determined through sectoral based assessment



Committee on Climate Change

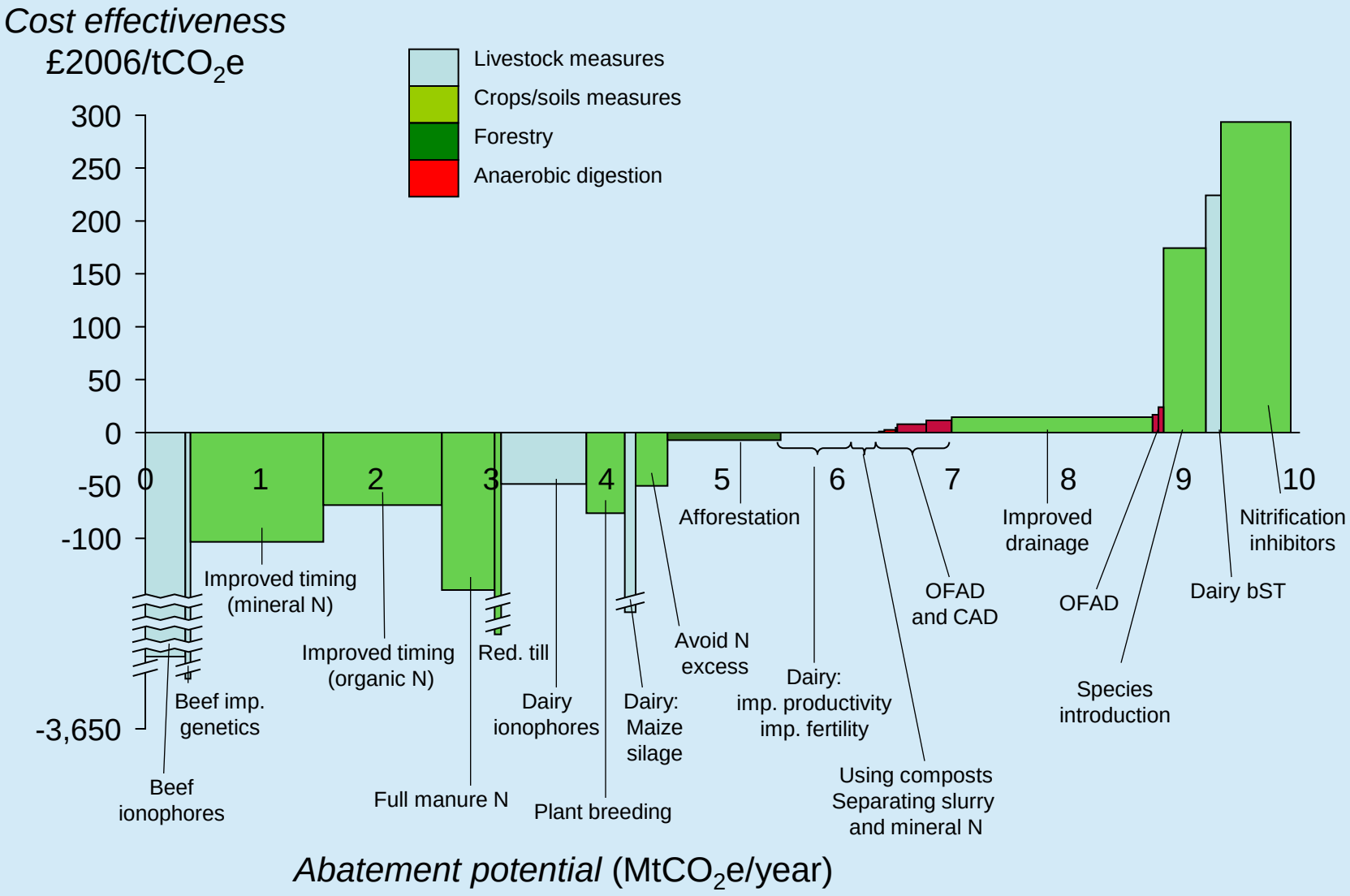
Source: McKinsey UK MAC model

Methods – Marginal abatement cost curves ("bottom-up")



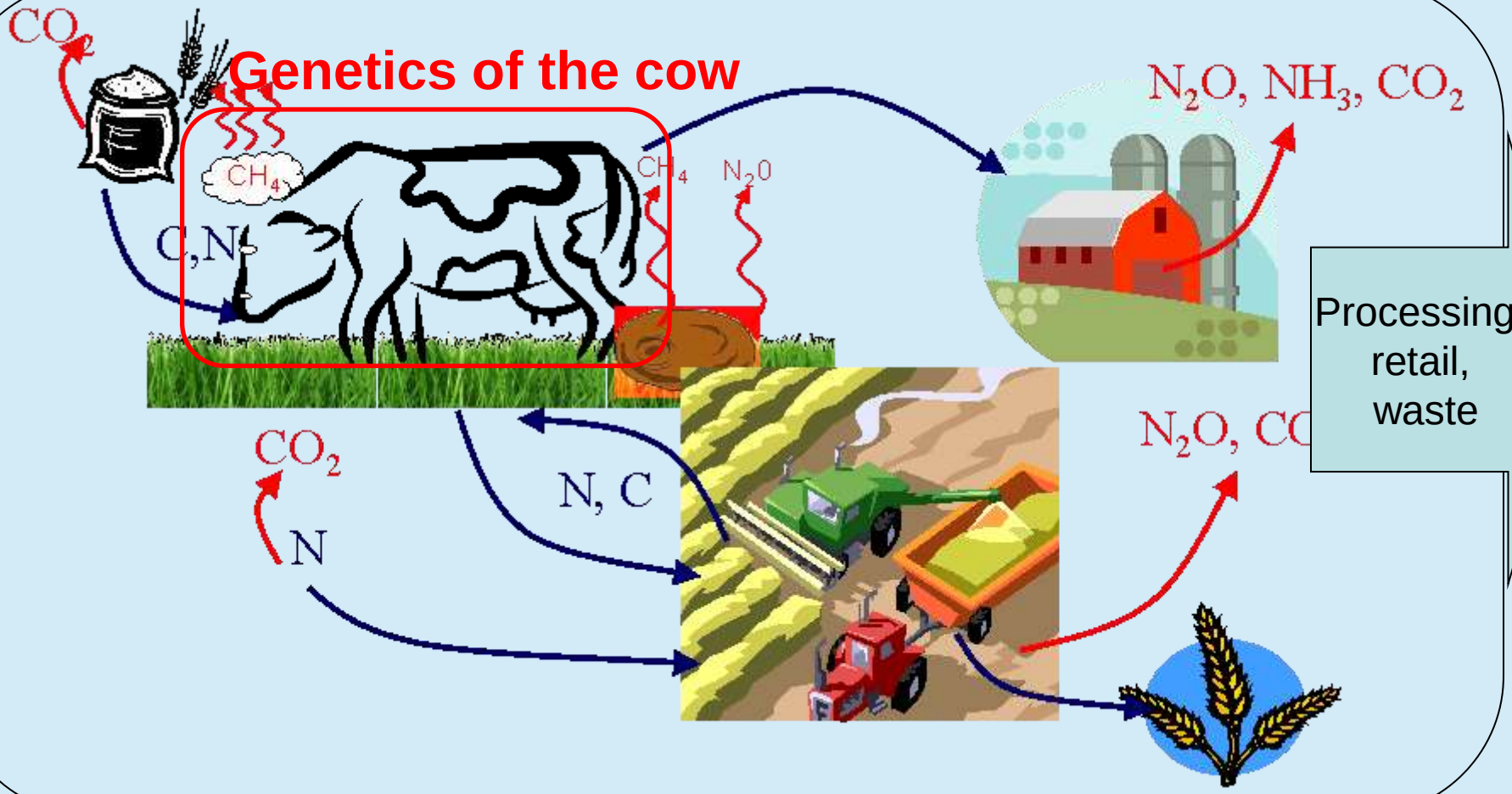
- Options ranked in decreasing order of cost-effectiveness from L to R
- Width of each bar: abatement potential
- Height of each bar: cost-effectiveness

MACC for ALULUCF (2022, CFP, 3.5%)



Greenhouse Emissions from Dairy Systems

Interacts with the system



Mitigation and Adaptation

Adaptation involves responding to the unavoidable consequences of climate change to which the world is already committed.

	Mitigation	Adaptation
Targets	Clear national target: 80% by 2050	No agreed national-level targets for adaptation
Indicators	Standard metric exists to measure progress across all sectors (CO_2-equivalent emissions)	No agreed final metric across sectors
Knowledge and uncertainty	Most emission sources identified, being monitored & addressed	Uncertainty in local and regional climate projections, not all risks identified
Context	Global	National, regional and local

Behaviours

- What instruments or incentives to affect mitigation and adaptation?

- Production versus consumption side accounting