Climate Change, Land Capability and wider implications

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Including contributions from Marie Castellazzi, Laura Poggio, James Sample, Alessandro Gimona, David Miller, Gillian Donaldson-Selby

1. Introducing LCA
2. Present and Future Climate Change
3. Soil-Climate Interactions – Dryness/Wetness
4. Wider Implications – Water Quality etc.
5. Climate Variability

Land Capability for Agriculture (LCA)

- Official land classification system for Scotland after 30 years
- Widely used and familiar to planners and land managers
- Classifies land according to physical constraints that restrict its use
    - Soil, climate, topography and vegetation
- Agricultural use – potential productivity and cropping flexibility
- Land is assumed to be maintained by *'reasonable management'*

LCA classes

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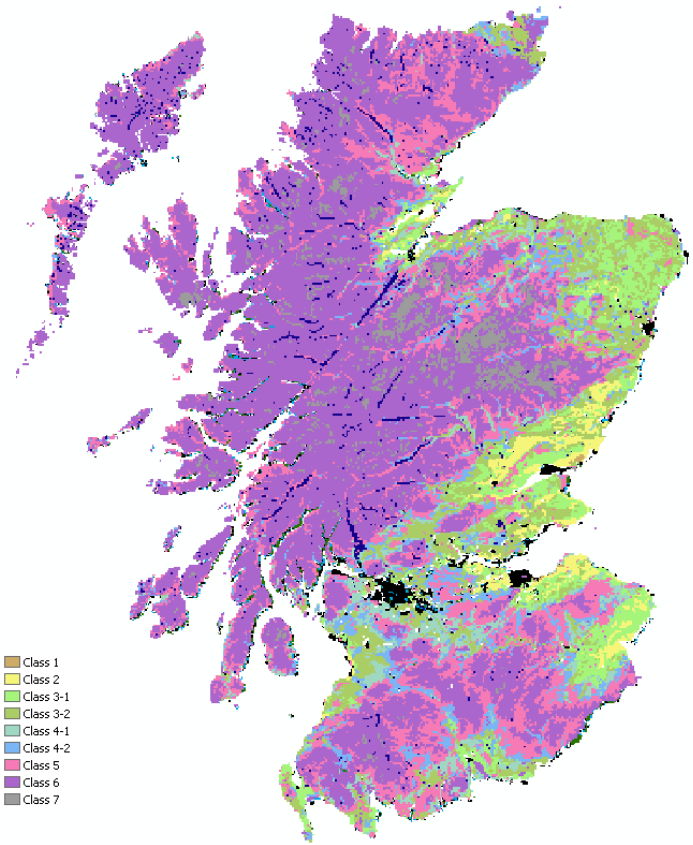
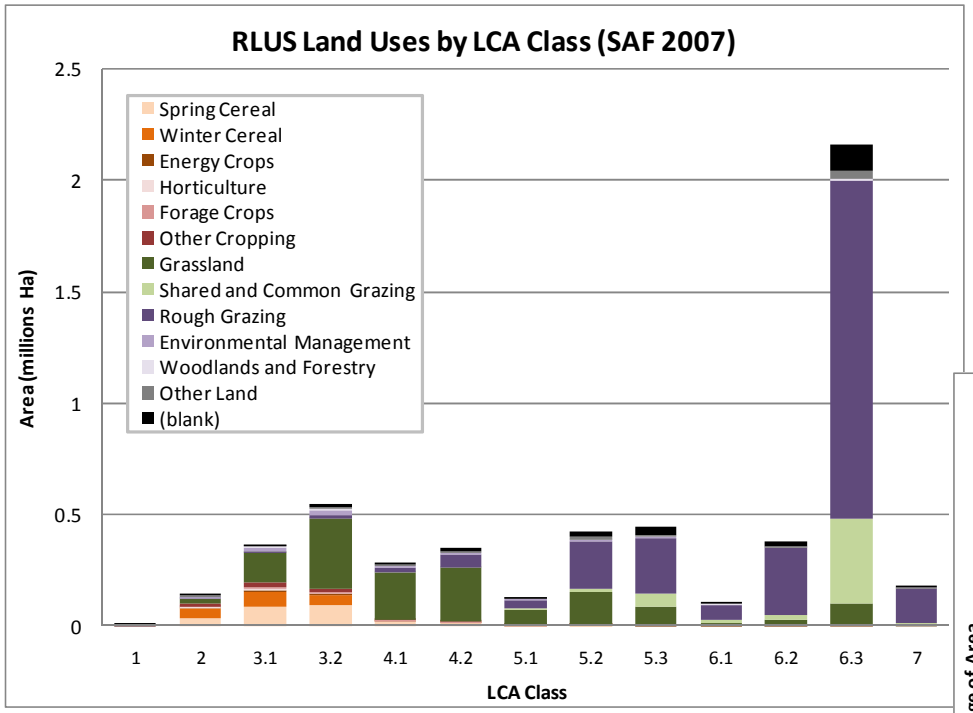
- Class 1 - very wide range of crops
- Class 2 - wide range of crops
- Class 3.1 - moderate range of crops
- Class 3.2 - moderate range of crops
- Class 4.1 - narrow range of crops
- Class 4.2 - narrow range of crops
- Class 5 - improved grassland
- Class 6 - rough grazing
- Class 7 - very limited agricultural value

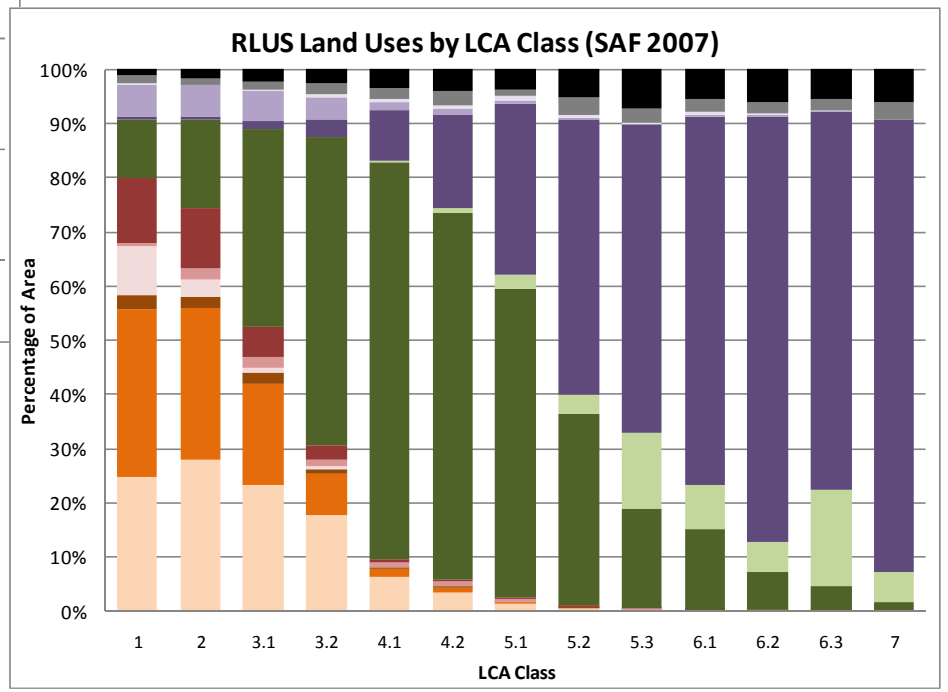
Prime land

Capable of being 'improved land'



Scotland's Land Use by LCA class





Source: K. Matthews

HOW DOES LCA WORK?

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Factor	Site Characteristics	LCA Classification
Climate	**Class 4 (from climatic guidelines)**	**4**
Topography	**4 degrees**	**2**
Soil	**Freely drained brown earth on stony gravel**	**3.2**
Wetness class	**I**	**1**
Drought risk	**Slight**	**1**
Pattern	**5-10% wet hollows**	**3**
Vegetation	**N/A**	**N/A**
Final LCA classification		4

Soil-climate interactions

Now implemented by a new digital method for LCA

ORKNEY: LIMITED BY CLIMATE NOT SOILS

Class 4 land

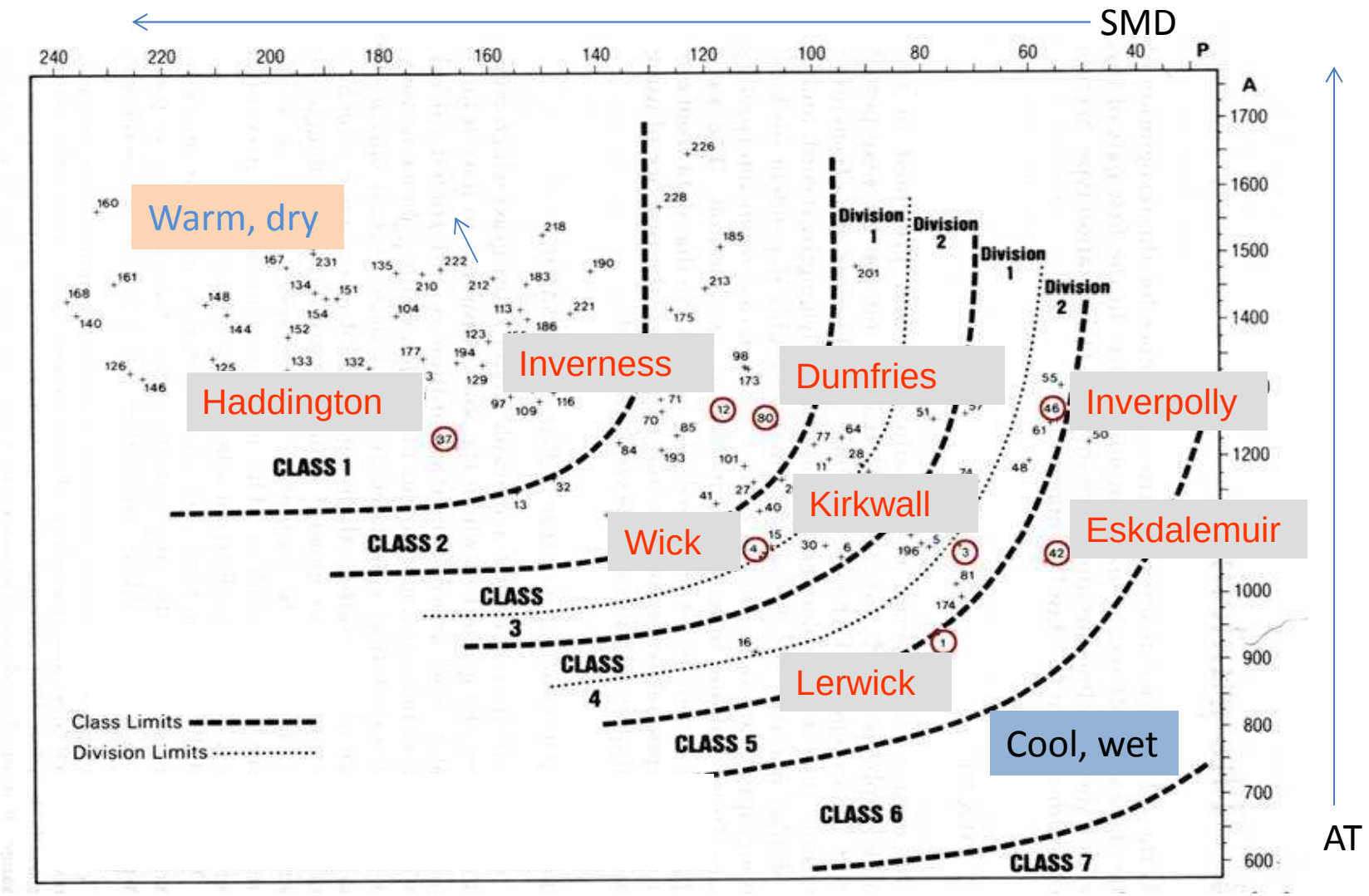
NW HIGHLANDS: LIMITED BY SOILS & TOPOGRAPHY NOT CLIMATE

Class 6.3 land

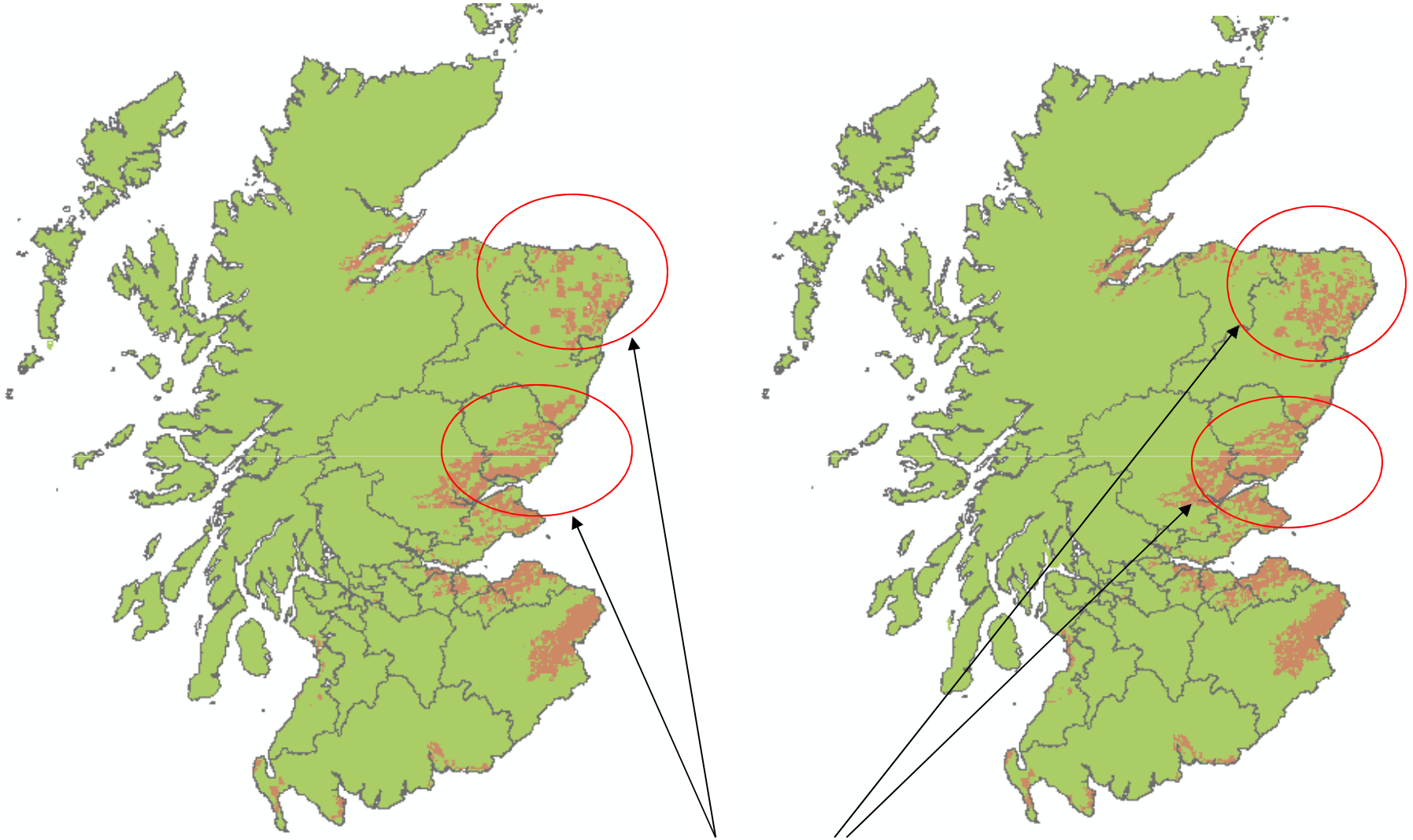
LCA uses 2 main CLIMATE CRITERIA

AT - 'Accumulated temperature' - measure of growing season

SMD - 'Soil moisture deficit' – measure of wetness/dryness



Results: Recent Climate Change



More ‘prime’ land

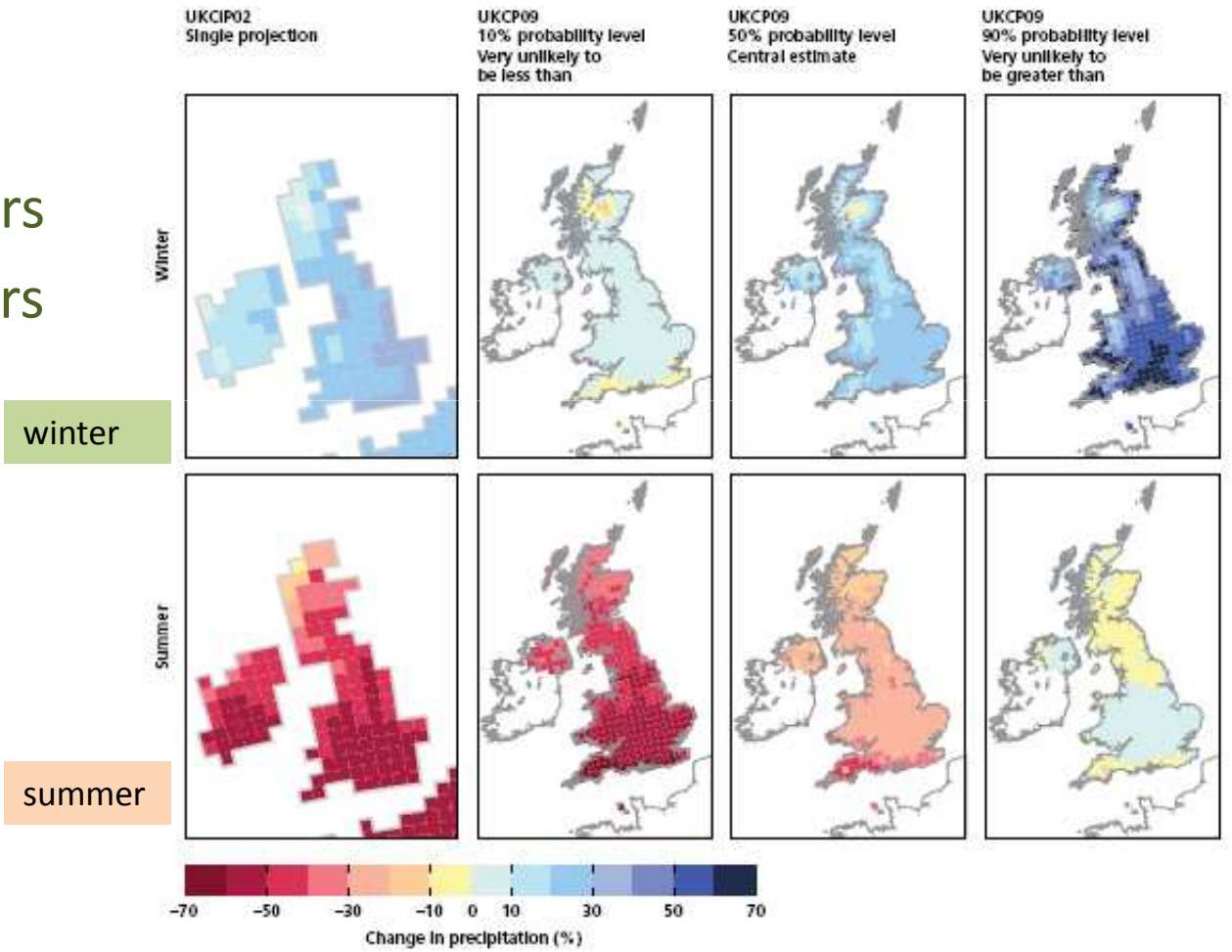
Prime land 1961-1980

Prime land 1981-2000

Future climate change - UKCP09

Increased likelihood of:

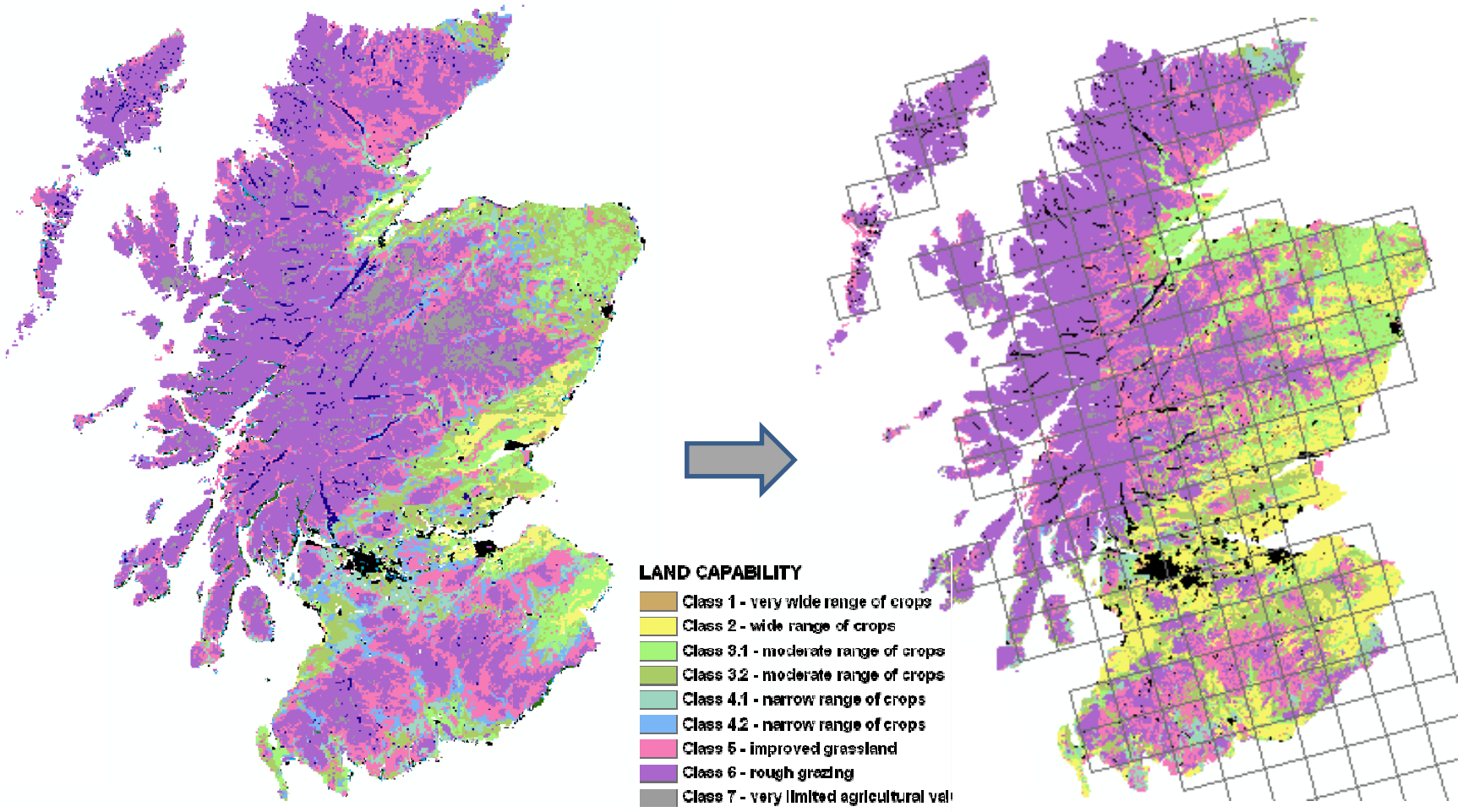
- Warmer wetter winters
- Warmer drier summers



Average change in Precipitation for 2080s (high emissions)

Future Changes in LCA

- excluding soil/climate interactions



Published version [1982]

2050s projection [UKCP09 q3]

Source: Brown et al. (2008, 2011)

- Increase in extent of prime land
- Potential improvement in 'marginal areas'

→ Opportunities for agriculture

What about soil/climate interactions?

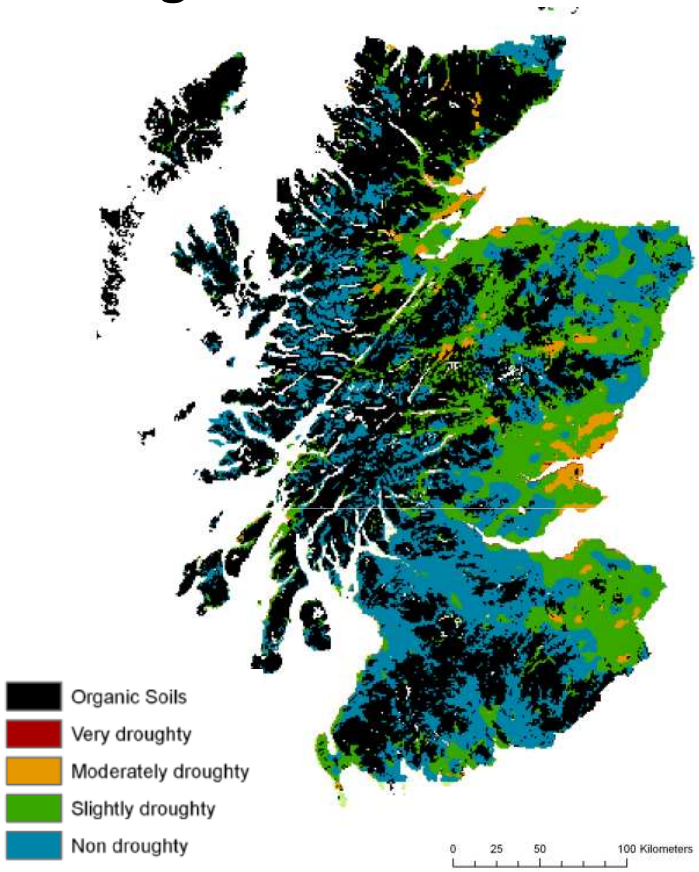
Dynamic changes in soil conditions due to weather during the year

- Drought risk and need for irrigation

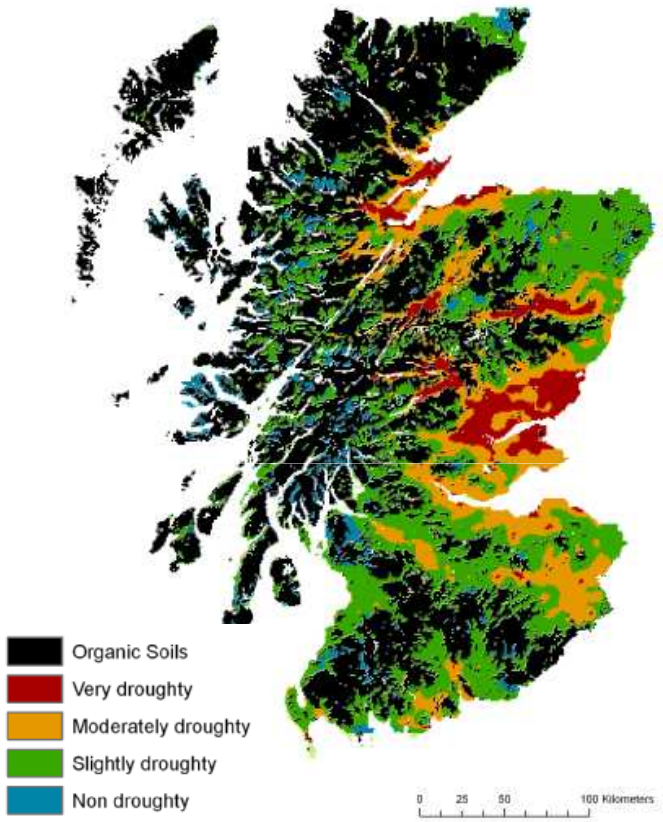
- Wetness limitations on accessibility

Drought Risk for Indicator crops

e.g. wheat



1981-2000 baseline



2050s projection[UKCP09 q3]

Source: Brown et al (2011)

Shift to warmer, drier summers significantly increases future drought risk

NEED TO ADAPT TO MINIMISE RISKS AND MAXIMISE OPPORTUNITIES

Irrigation? New Crops and crop varieties? Changes in management?

Drought risk & irrigation demand

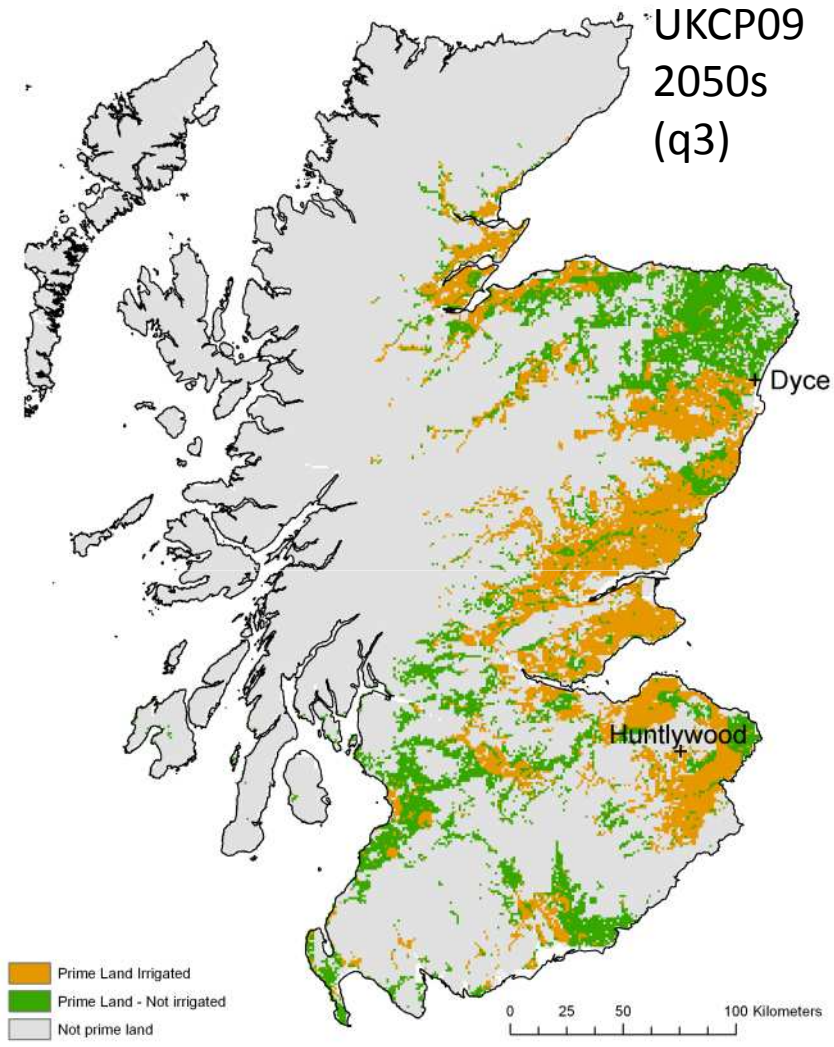
LCA guidelines:

• PRIME LAND requires that land must be no less than ‘slightly droughty’ for one of the indicator crops (potato, wheat, barley)

• Irrigation can be included if this is ‘feasible’ (cf. ‘reasonable management)

To maintain/expand ‘prime land’ may require major increase in irrigation supply

Or alternative adaptation strategies –
• improve water efficiency
• change cropping patterns,
• change varieties etc.

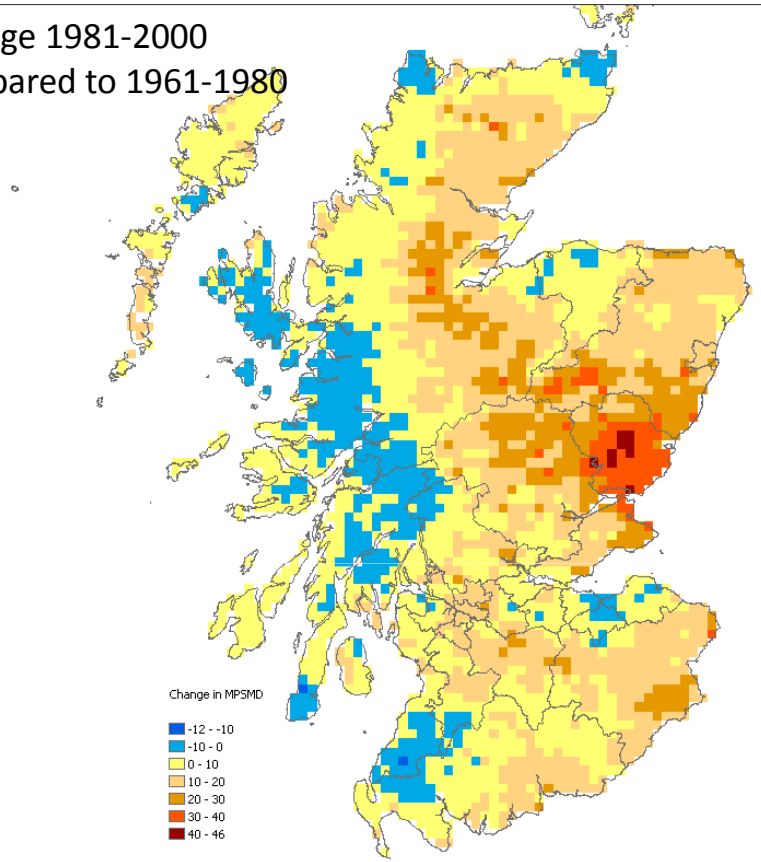


Source: Brown et al (2011)

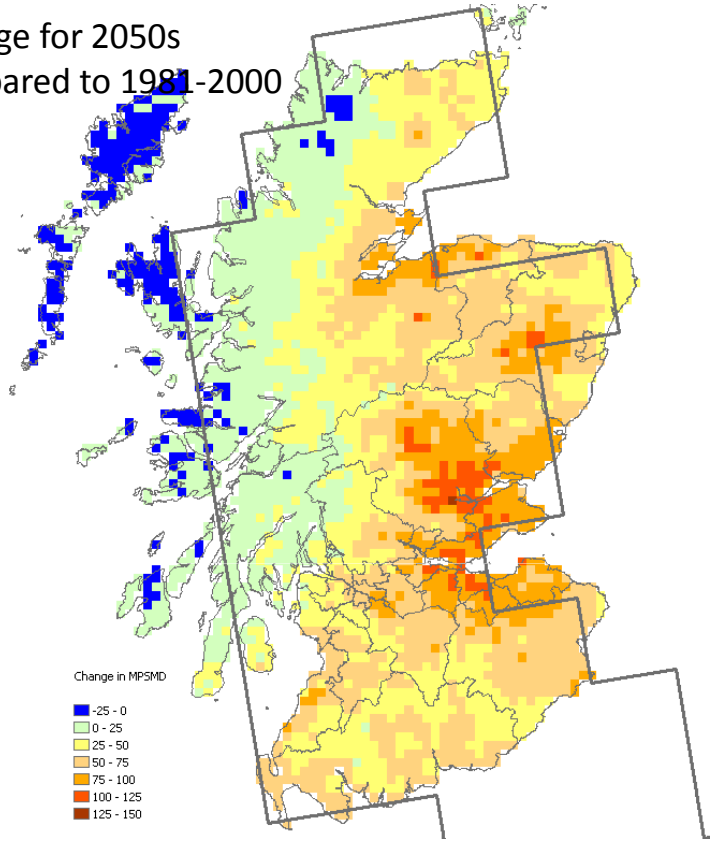
NB water demand already increasing for socio-economic reasons

Wetness

Change 1981-2000
compared to 1961-1980

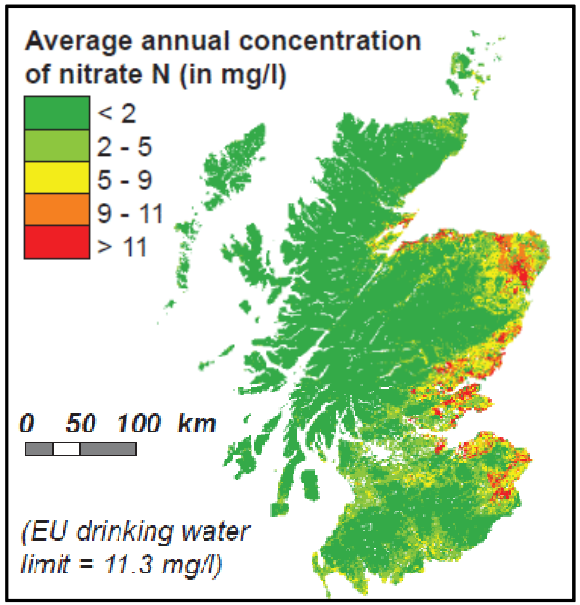


Change for 2050s
compared to 1981-2000

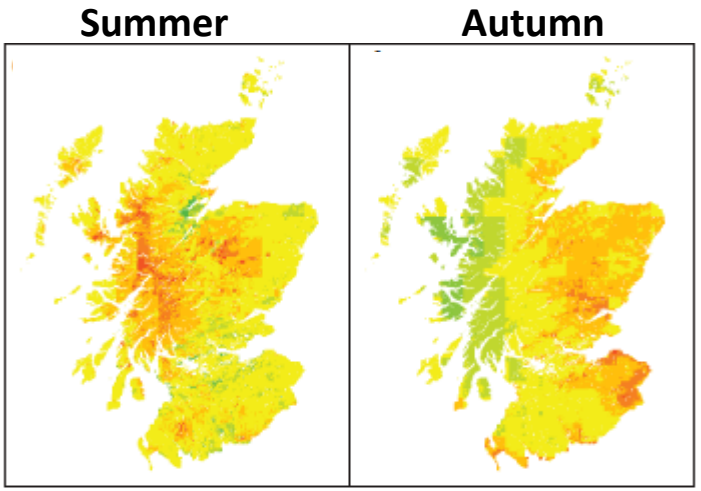


- Possible future improvement for some areas – but may still restrict some marginal areas
- Uncertainty over changes in spring and autumn
- LCA Guidelines probably need revising here

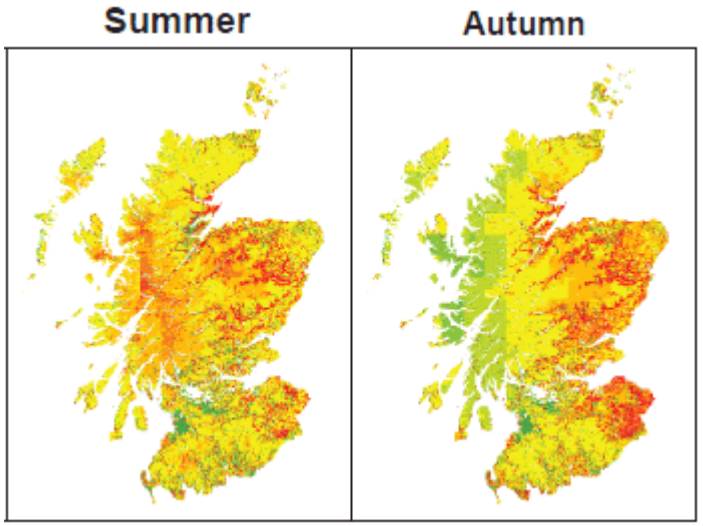
Implications for Water quality – Nitrates



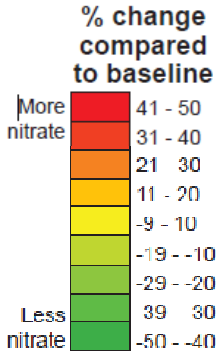
Baseline



Climate change (UKCP09 q3)



Climate change + Land Use scenario (prime land> arable)



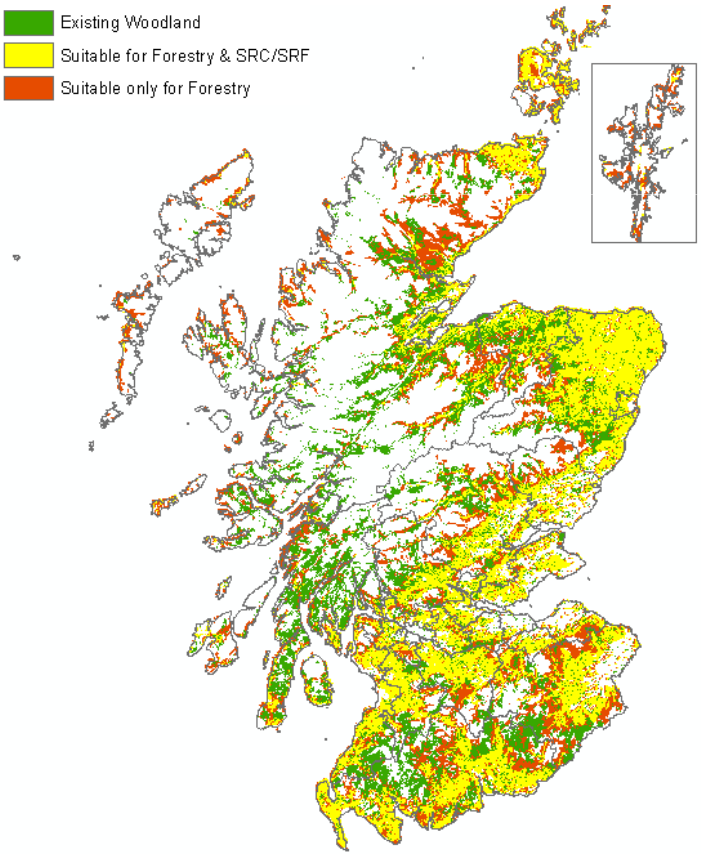
- Indirect effects of climate change (via land use) may be as great as direct effects

Source: Dunn et al. (2011)

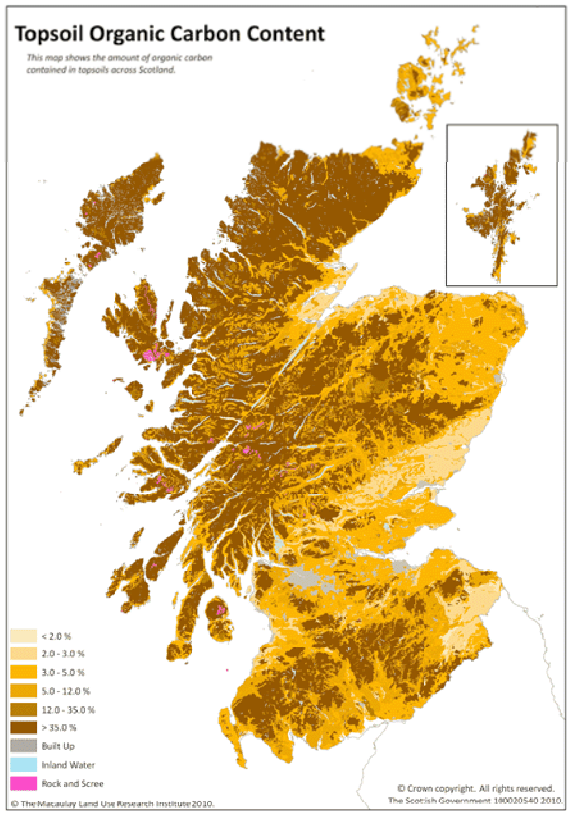
Wider implications of land use change

Food, water resources and ……..

(Bio) Energy

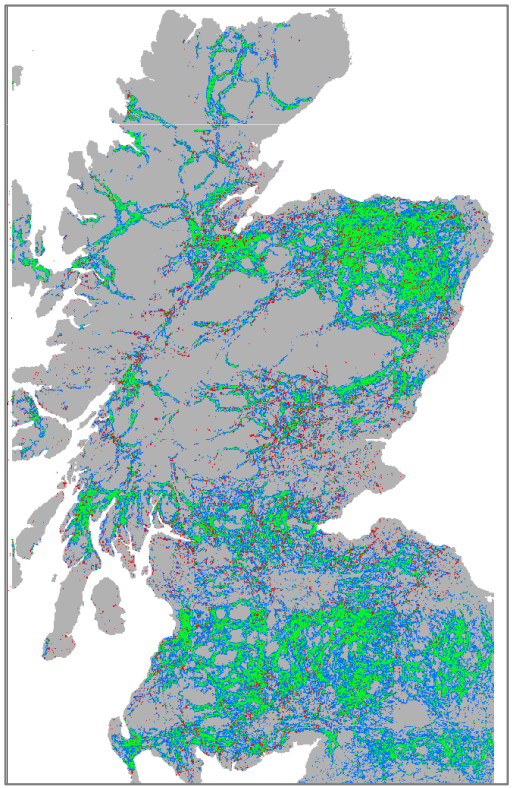


GHG emissions



Biodiversity

e.g. woodland habitat networks



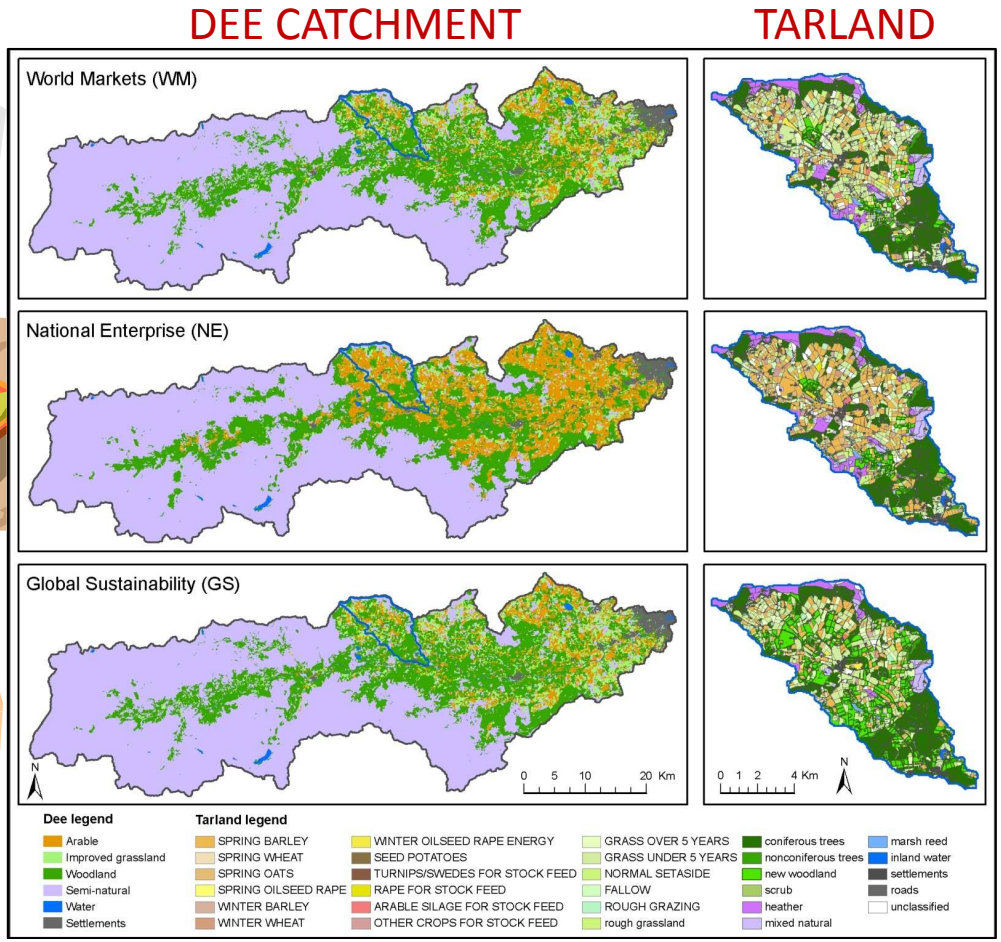
Land Use Change Scenarios

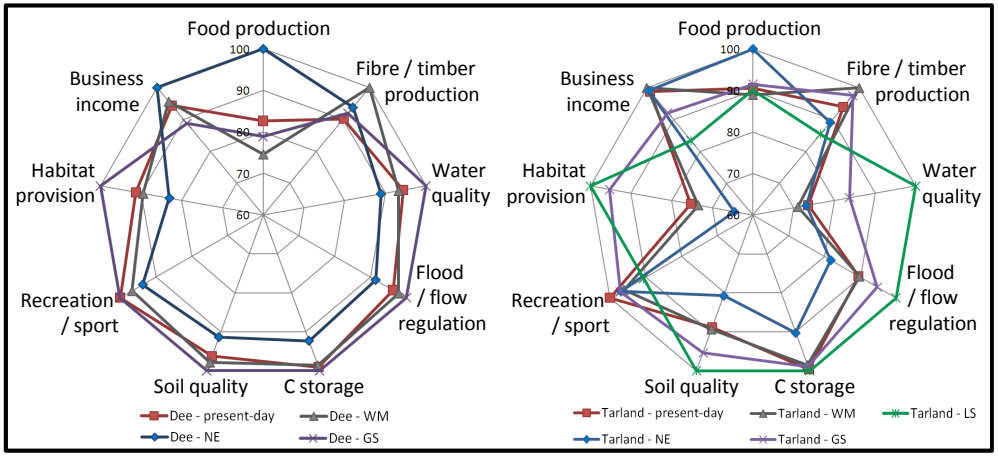
World Markets – economic growth

National Enterprise - food & energy security

Global sustainability – strong regulation

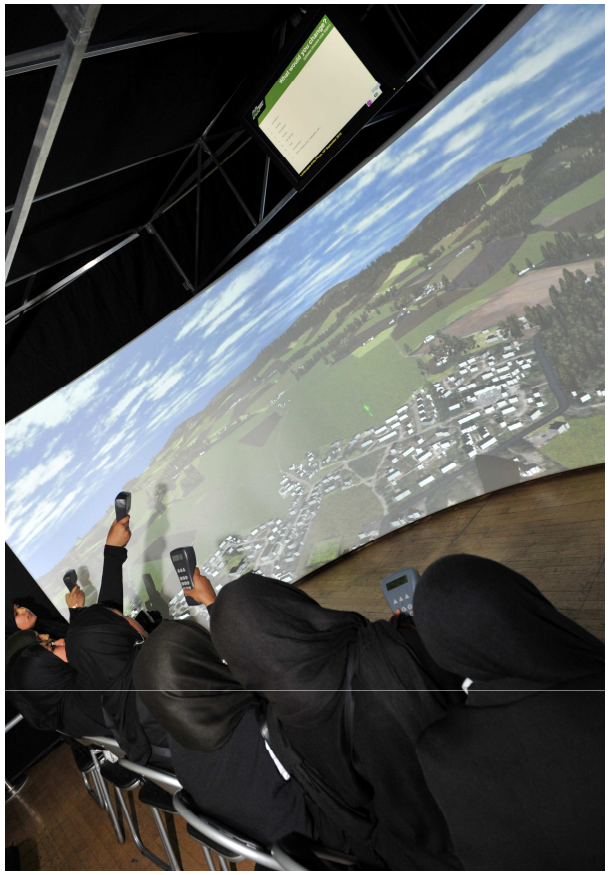
Implications for Ecosystem Services





Visioning Exercises

Local opinion - Ballater Primary School



Remote opinion: Birmingham

- Understand future change, choices and decisions
- How to make best use of our land
- Make climate change less ‘abstract’

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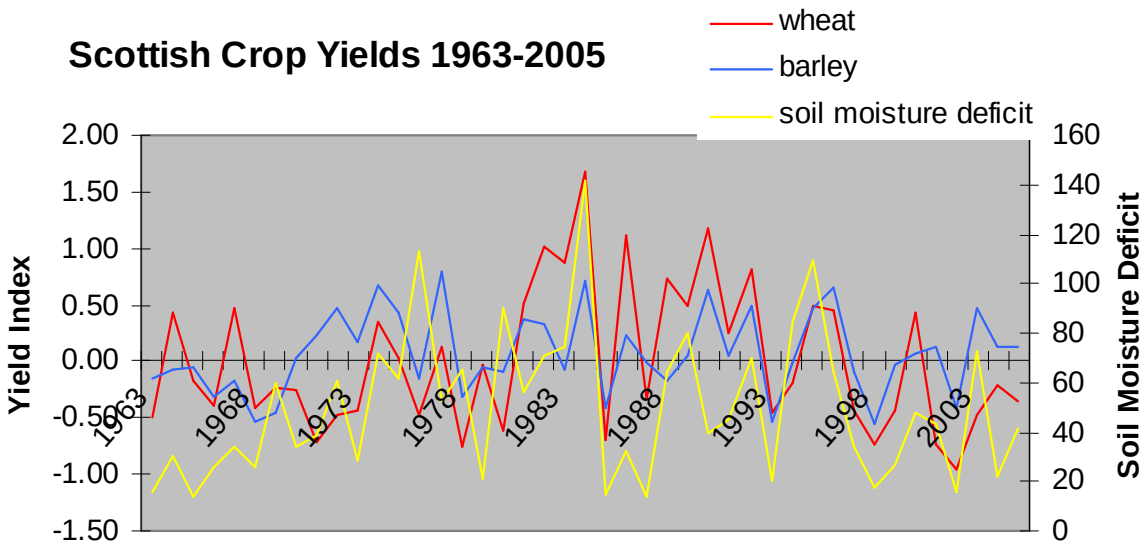
Climate variability

Need to consider variability in addition to long-term average trends

Especially so for Scotland !



Key climate predictors of crop yields (1963-2005)

Crop Yield	Soil Moisture	Sunshine	Mean Temp.	Precipitation
Wheat	**	June**, July**, Annual**		Nov*, Jun**, Jul**, Annual**
Barley	**	April**, May**, June**, Annual**		Jul**
Oats	*	April**, Annual**		Jul *, Annual**
Potatoes	**	March**, Annual**	Apr*	Apr**

Statistical relationships: ** strongly significant * moderately significant

- Evidence also suggests that crops have become more sensitive to climate in recent decades (last 20yrs compared to previous 20 yrs)

Summary

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- Climate is changing land capability
  - Prime land – changes in extent
  - Marginal areas – some will become less marginal?

- Land use patterns will respond to this [reactive adaptation]

- Opportunities AND risks – need for planned adaptation

- Implications for food, water, energy, biodiversity, emissions

- LCA can link adaptation/mitigation and spatial planning

- Need indicators/outcomes for 'reasonable management'

Ongoing work

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- Updated version of LCA with a baseline of 1991-2010
- Land use changes in context of changing LCA
- Scenario analysis of potential future changes

Links with:

- Climate Change Policy (e.g. CCRA, Adaptation Framework)
- Land Use Strategy

- Policy Advice via Centre of Expertise