C3 Land Use Transformation – Climate change influence on Resilience and Adaptation

Mike Rivington, Mohamed Jabloun, Emmanuel Udugbezi

Scottish Government RESAS Strategic Research Programme

Project C3 Land Use Transformation

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The James Hutton Institute

WP3.3 Change, Resilience and Adaptation

Research context – climate as a driver of and barrier to land use transformation. Need to better understand spatially and temporally:

- How land use might respond to climate change.
  - How does this impact mitigation and adaptation.
  - Consequences on ecosystem services – climate regulation.
- How the resilience of land use systems can be enhanced.
  - Identifying areas of opportunity and vulnerability.
- The degree to which there will be the need to adapt to climate change that is already entrained or the indirect consequences of changes elsewhere.

Dimbleby 2021
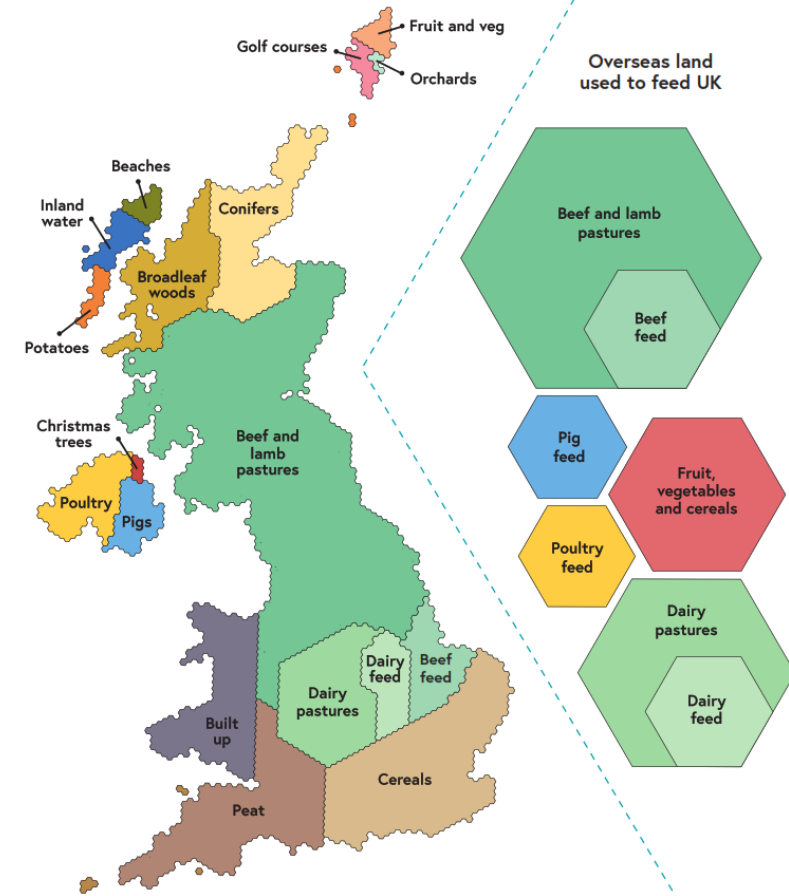
Future Projections

Climate change signal for the 12 projections used to generate the future maps (UKCP18 RCP 8.5).

Top: Annual precipitation and temperature anomaly for 2030-2049 ('2040') and 2060-2079 ('2070') with respect to a 1994-2015 baseline.
Bottom: Comparison of the Scotland arable area-wide mean climate change signal in the growing season only (March to September).
Hence large spatial and temporal variation in the projections.

Although emission scenario is 'High end' RCP8.5, the 12 projections contain precipitation and temperature changes that also represent lower emissions as well (e.g. 15, 07, 06).
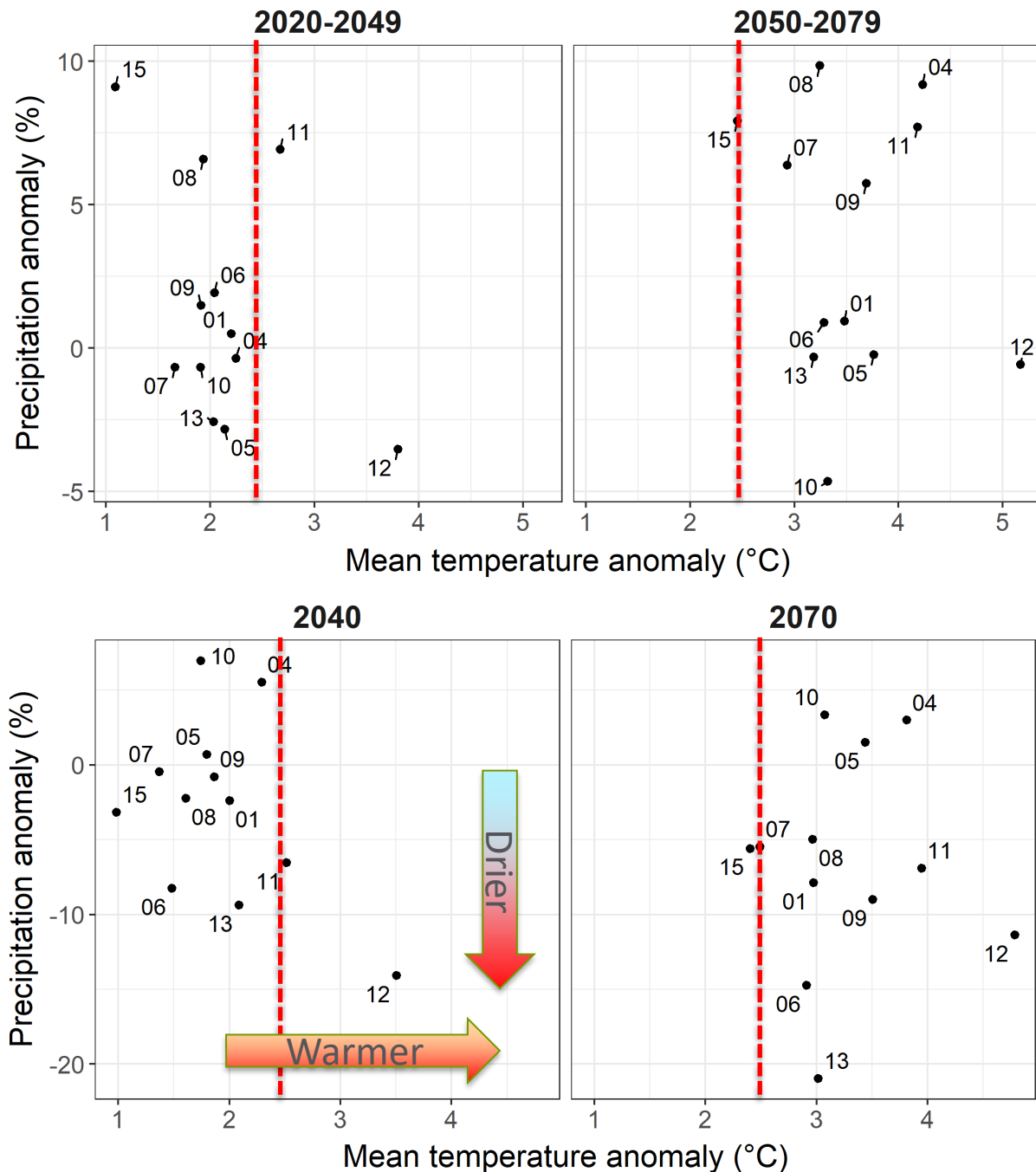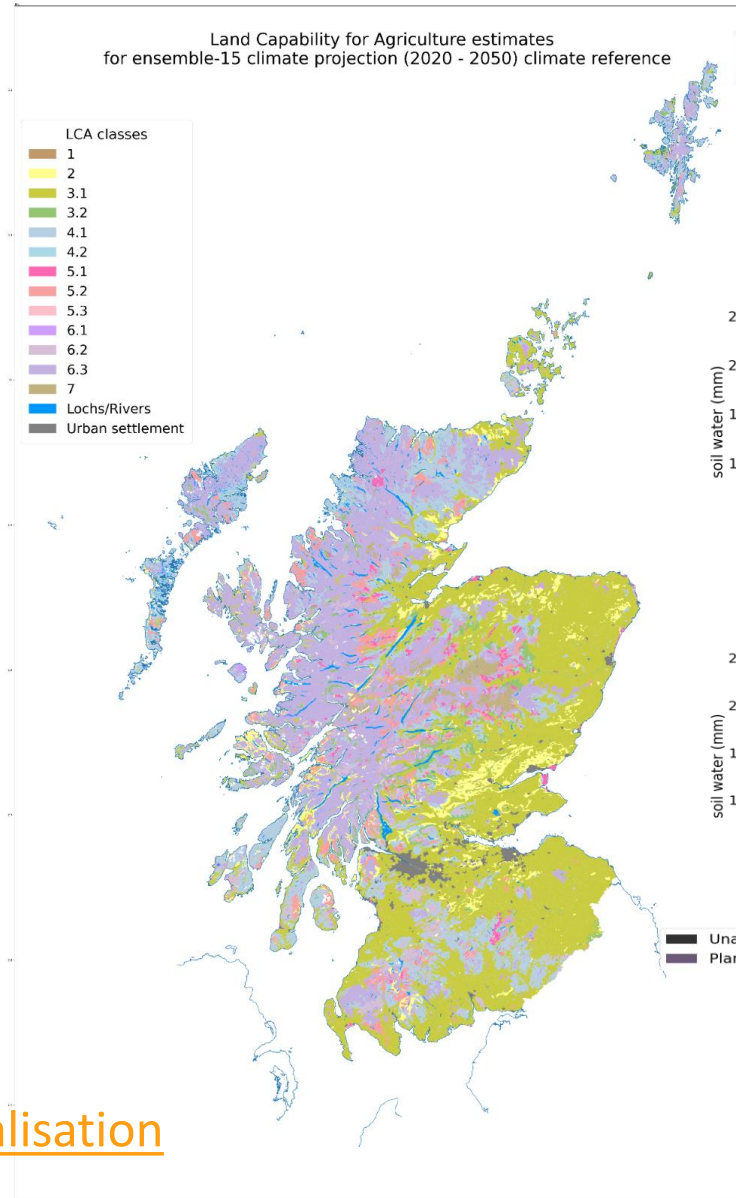
- - - - - - approx. temperature increase based on current global mitigation commitments to 2050
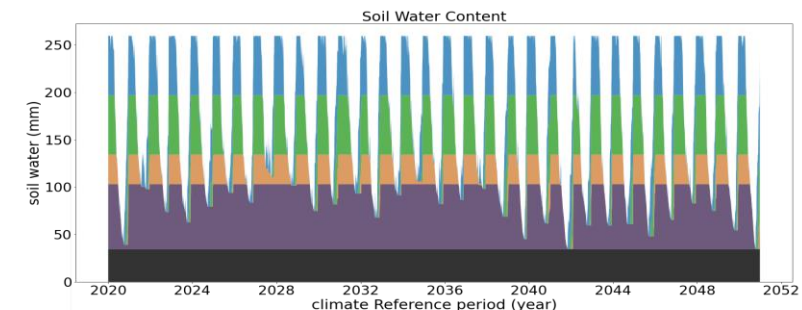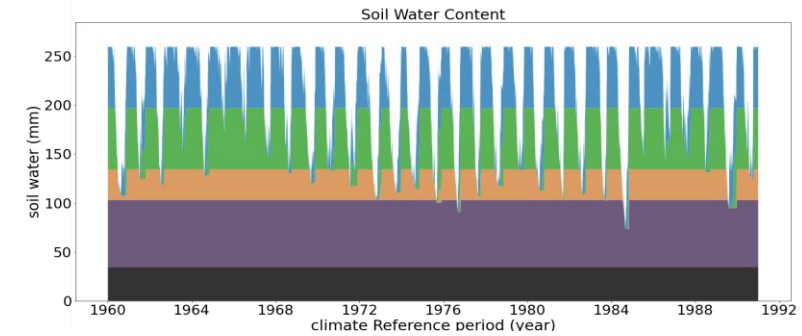
Land Capability for Agriculture

- Updating the LCA approach using a new research platform and new soils and climate data.

- Improving the spatial resolution and methods for estimating constraints.
  - 1km daily climate, 1:25k soils
  - Estimation of Evapotranspiration
  - Soil Water Balance modelling

- Generating future LCA maps using multiple plausible climate change projections

New Agrometeorological Indicators website:
The James Hutton Institute Climate Data Visualisation

Land Capability for Agriculture estimates
for ensemble-15 climate projection (2020 - 2050) climate reference

LCA classes
1
2
3.1
3.2
4.1
4.2
5.1
5.2
5.3
6.1
6.2
6.3
7
Lochs/Rivers
Urban settlement

Importance of changes in soil water

Unavailable water
Plant unavail. water @ 25% ETo
Plant avail. water @ 25% ETo
Plant avail. water @ 50% ETo
Plant avail. water @ 100% ETo
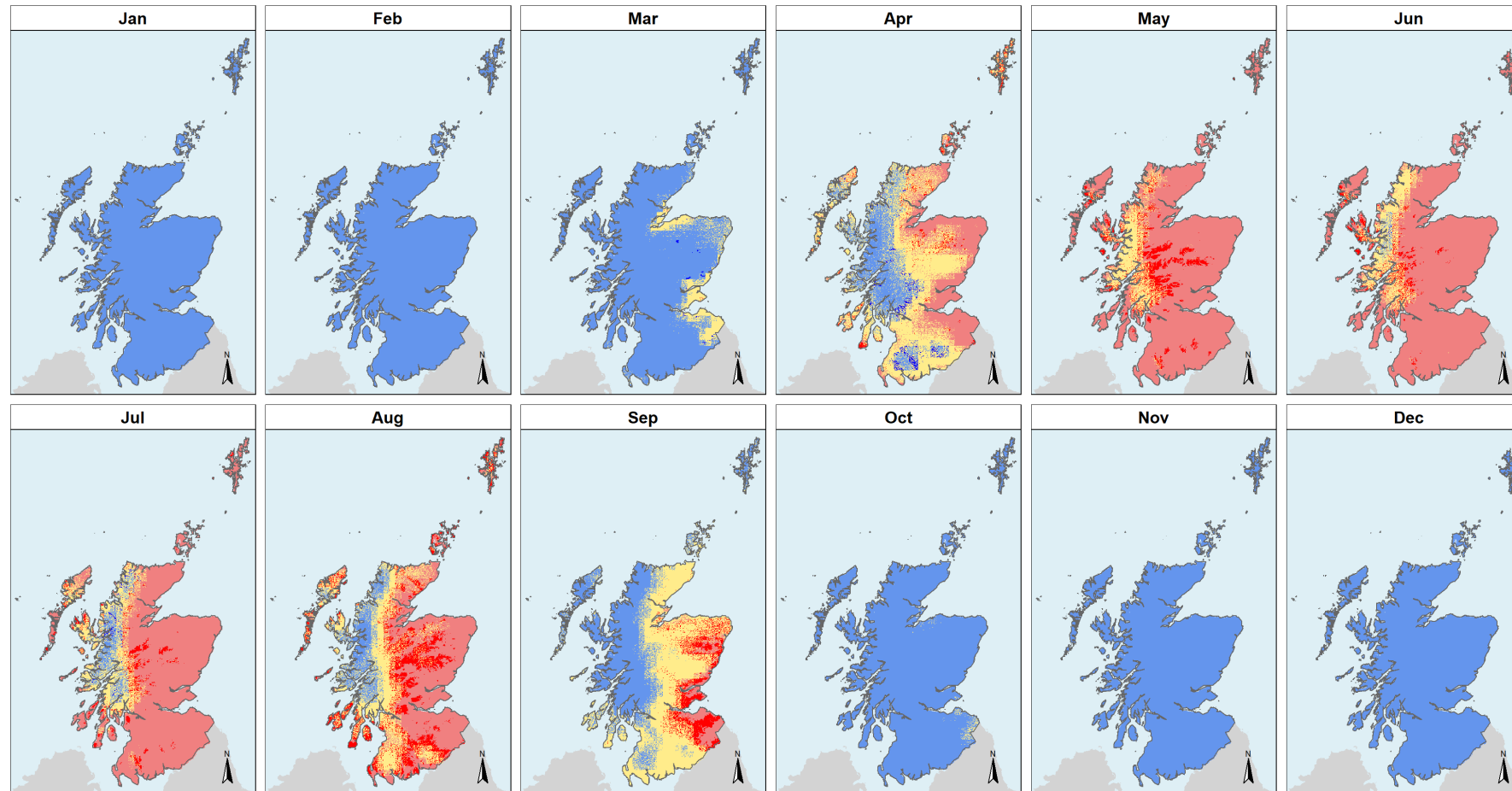Surface water

- Climate-Soil scenarios
  → Story Map

Future Climatic Water Balance (Precipitation – Evapotranspiration) agreement map

Change direction agreement for mean monthly climatic water balance over the period 2020-2049
for at least 12 ensemble members

Change direction

- **Surplus to deficit** (red)
- **Surplus to surplus** (light blue)
- **Deficit to deficit** (pink)
- **Deficit to surplus** (dark blue)
- **Uncertain** (yellow)

Habitats and land uses that exist in the areas that are projected to experience a shift from water surplus to deficit (dark red) are likely to experience higher levels of water stress.
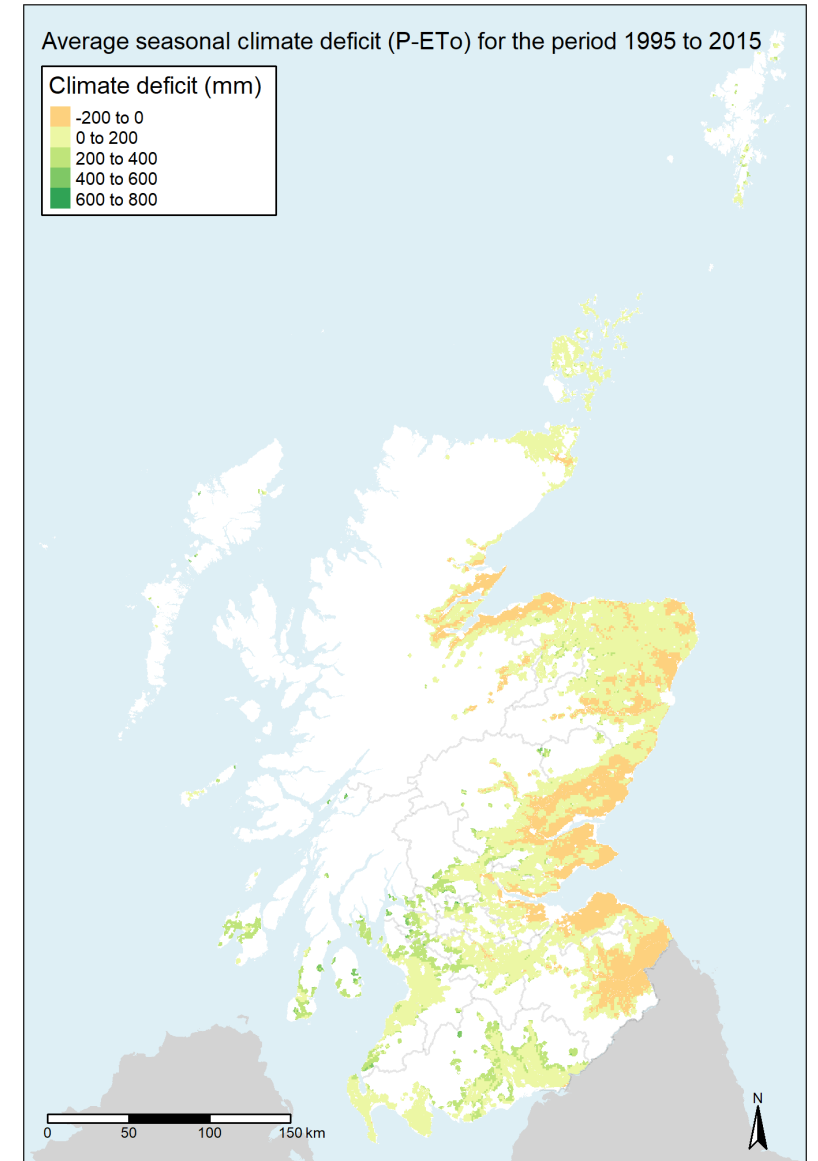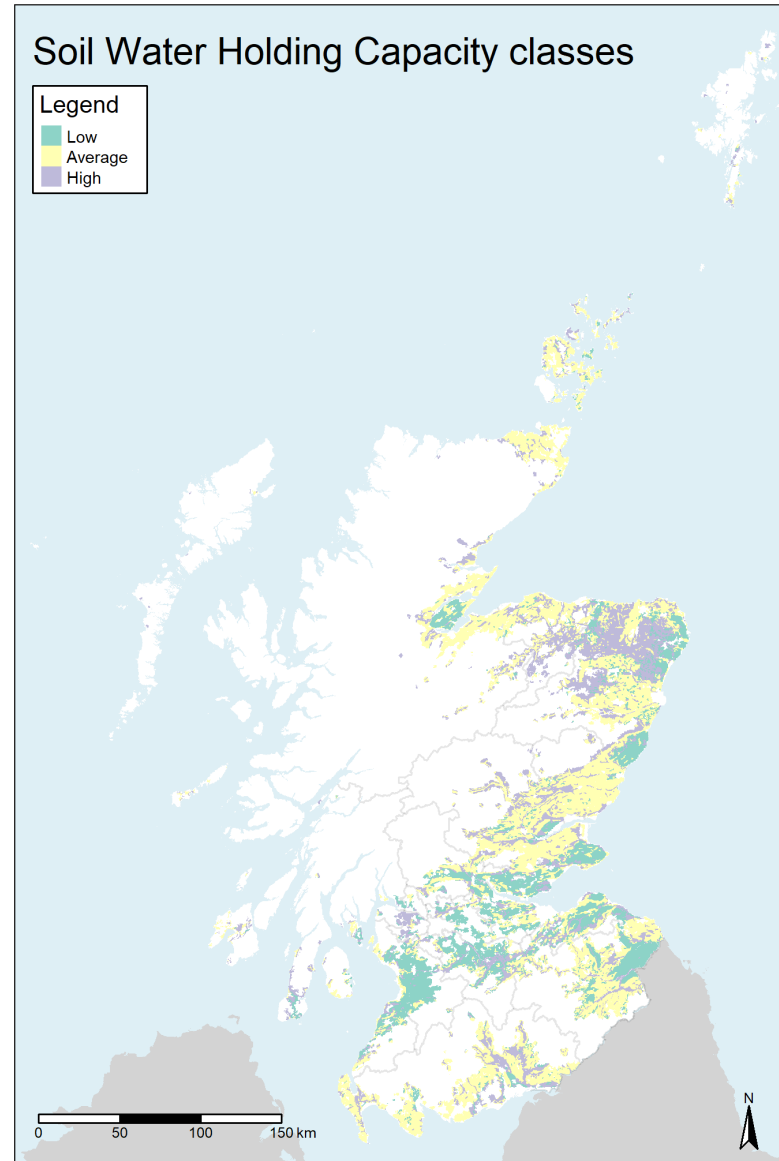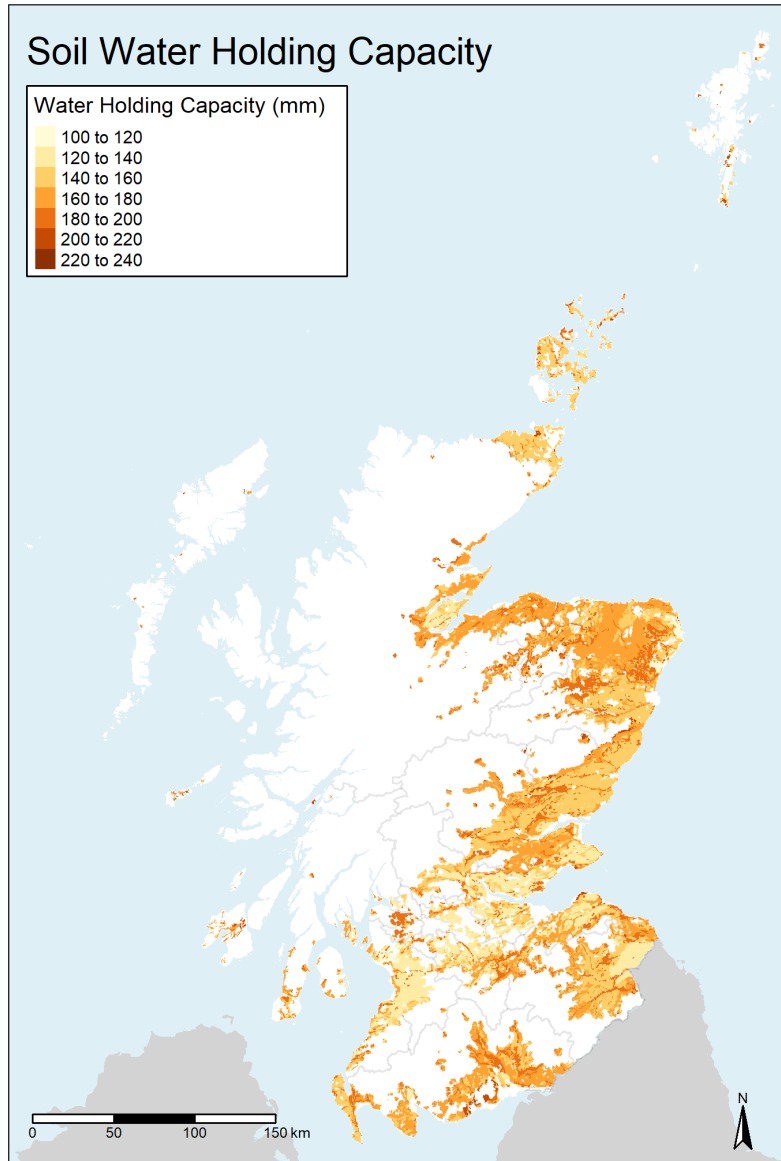Unknowns: role of occult precipitation (i.e. dew), ground water, hydrological flows.

(Output from D5-2 Climate Change Impacts on Natural Capital project)

Soil Water Holding Capacity

Soil Water Holding Capacity

Water Holding Capacity (mm)
- 100 to 120
- 120 to 140
- 140 to 160
- 160 to 180
- 180 to 200
- 200 to 220
- 220 to 240

0 50 100 150 km

Soil Water Holding Capacity classes

Legend
- Low
- Average
- High

0 50 100 150 km

Average seasonal climate deficit (P-ETo) for the period 1995 to 2015

Climate deficit (mm)
- -200 to 0
- 0 to 200
- 200 to 400
- 400 to 600
- 600 to 800

0 50 100 150 km

Climate-driven changes in LCA classes

- Analyse allows us to explore the changes is LCA classes

- Diagonal (greens lines) indicates where LCA remains the same (though distributions round that value may have shifted).

- Where LCA is improved (greater flexibility) the values are above the diagonal

- Where below there is reduced flexibility.

- Using class 3.1 as an example, 87% of this class land space is projected to remain as 3.1. However, 58% of land classed as 3.2 under the baseline (1960-1990) conditions are estimated to be classed as 3.1 under the future climate projection.
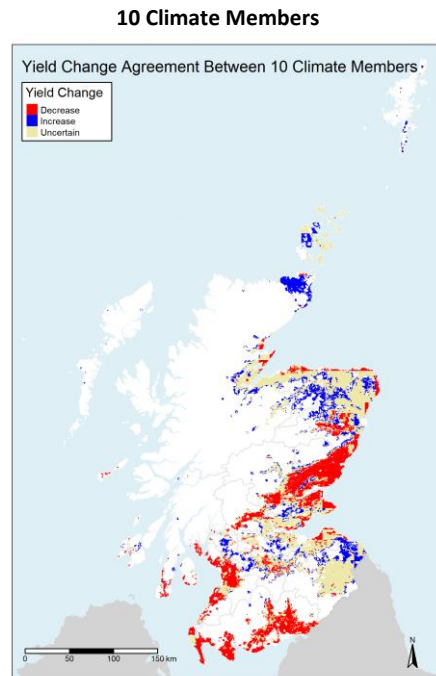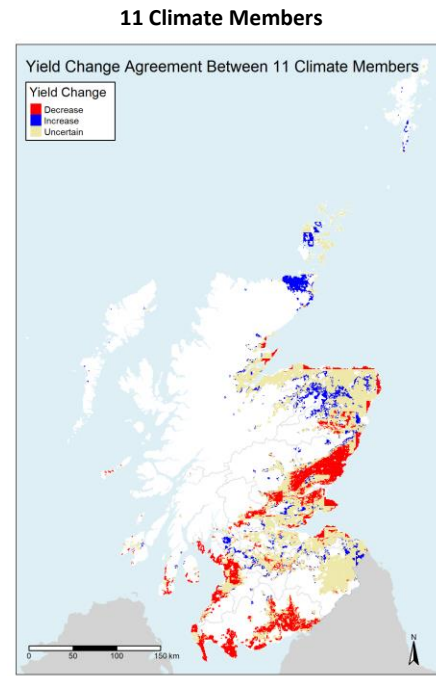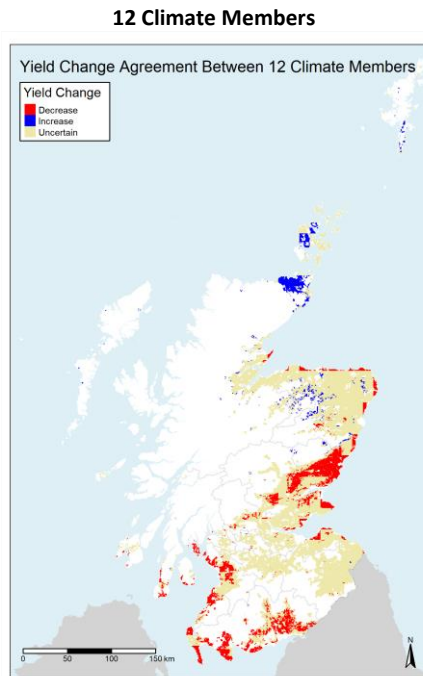

Climate projection 15

Normalised confusion matrix

Barley yield change direction in Scotland in the 2040s

Agreement maps of where barley yield is modelled (DSSAT) to increase (blue), decrease (red) or outcomes are uncertain (yellow)
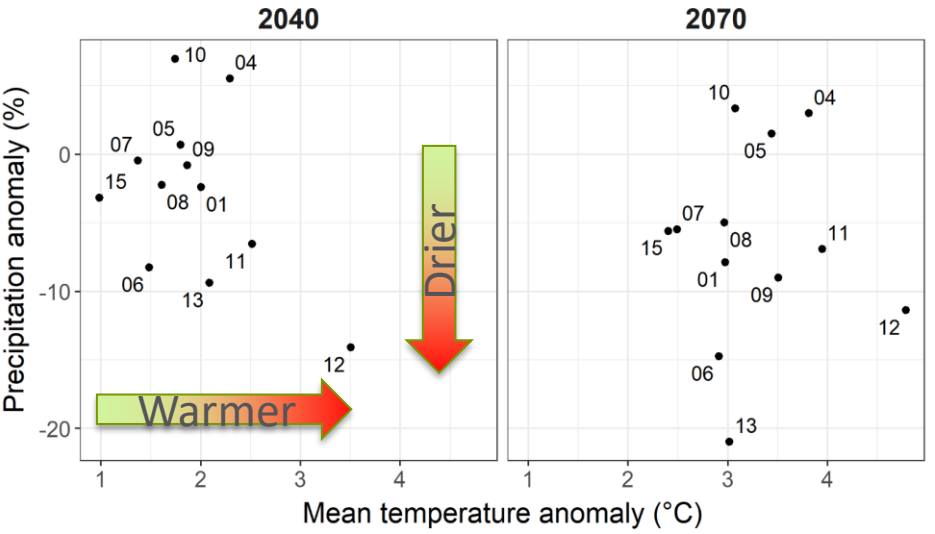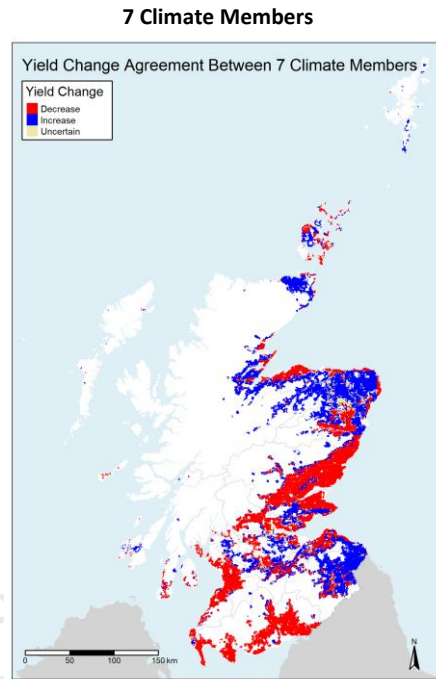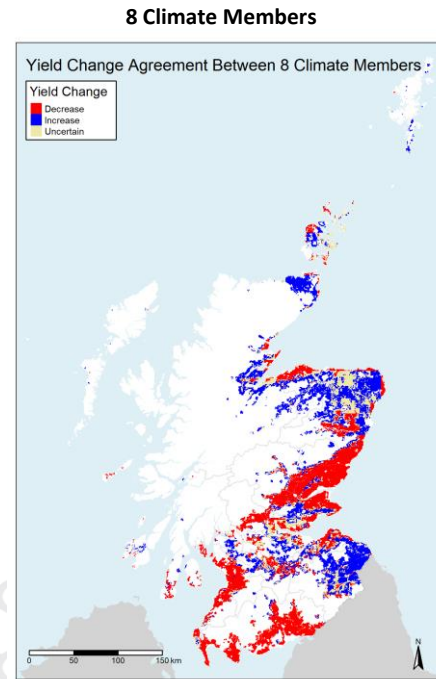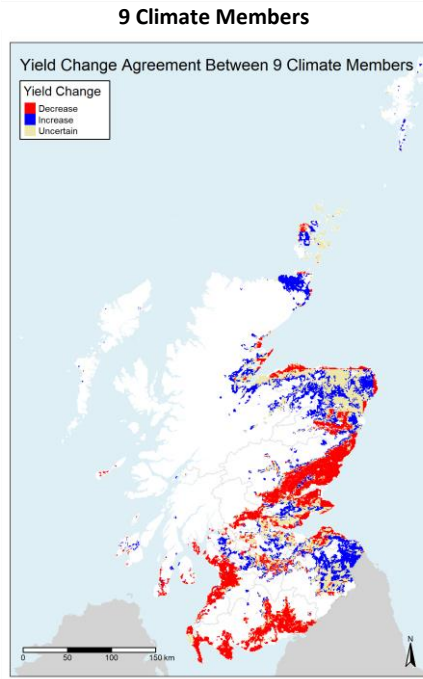
Growing season precipitation and temperature anomaly from observed baseline (1994-2015) from UKCP18 RCP8.5

Next steps – Integration and Interpretation (Phase 3)

- Integrating multiple spatial data sets:
    - Opportunities and Risk mapping
    - Damage Screening
    - Climate indicators, summaries
    - → Further visualisations: detailed story map.
- LCA analyses: future projections and land use alignment
- Alignment with / consideration of other drivers e.g. food system transformations.