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Regional climate change impact and selected response studies in the UK

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http://www.silsoe.cranfield.ac.uk/iwe/expertise/climate_change.htm

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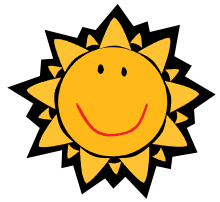
Overview

- Modelling approaches
- Example of an Integrated Assessment (RegIS and RegIS2)
- Some outstanding issues
- Conclusions

Modelling approaches

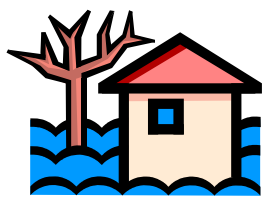
Many studies have tended to be sectoral assessments

Climate change



Sector

Impact (effect)



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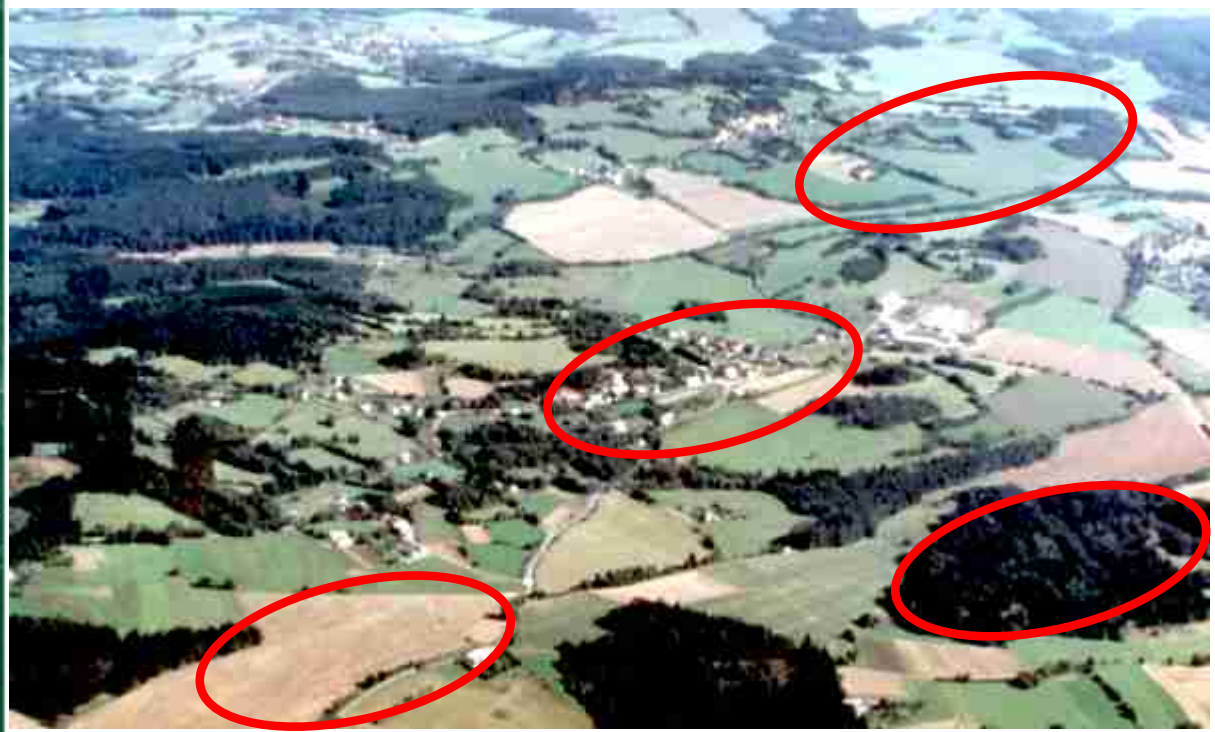
Landscape representation



Spatially & temporally varying cropping

Different 'natural' vegetation

Expanding/ contracting towns and villages

Planting, growth and felling of trees

From sectoral studies to Integrated Assessments

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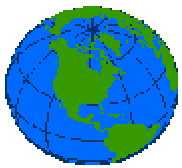
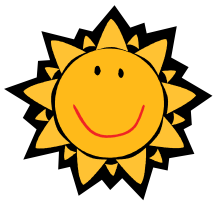
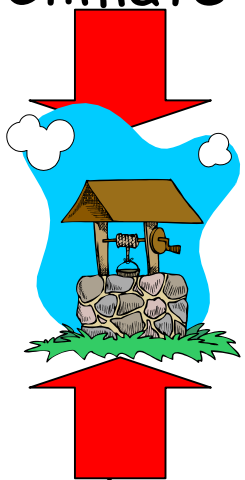
A better representation of 'reality'?





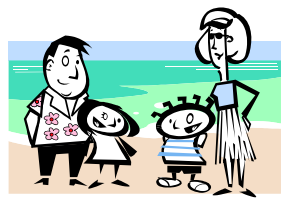
Climate

Policy

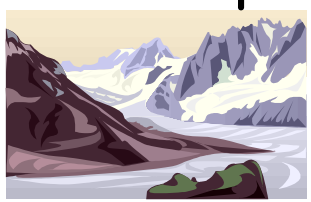


Society

£ $ €



Landscape



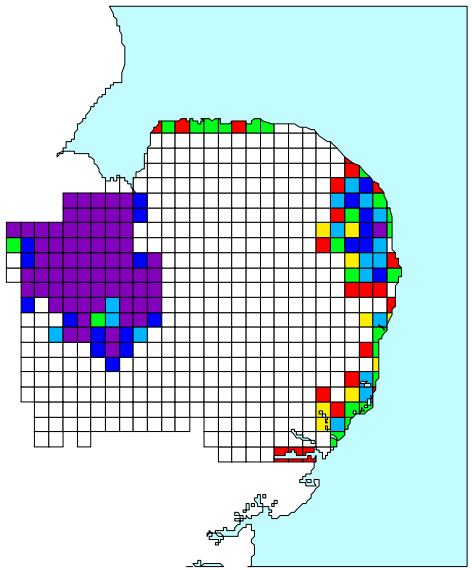
RegIS: Regional Climate Change Impact & Response Studies

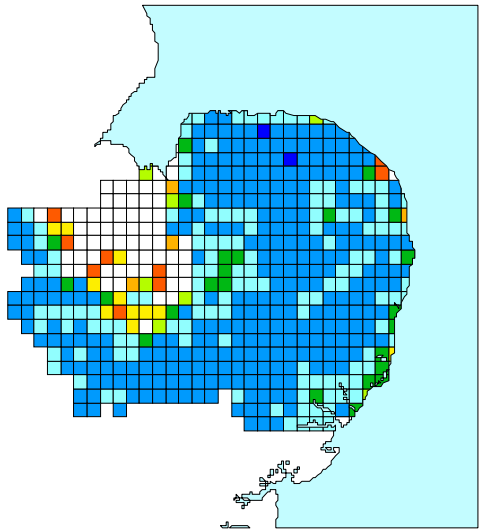
- 1st integrated assessment of climate change in UK
- Considered socio-economic and climate change
- Interactions between sectors through linked models
- Two contrasting regions- North West & East Anglia
- 5 km x 5 km

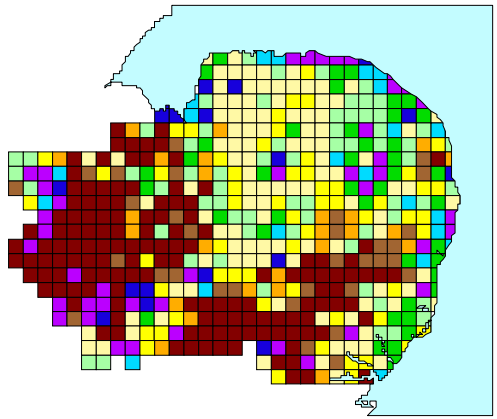
http://www.silsoe.cranfield.ac.uk/iwe/projects/regis/

Example results (from RegIS1)

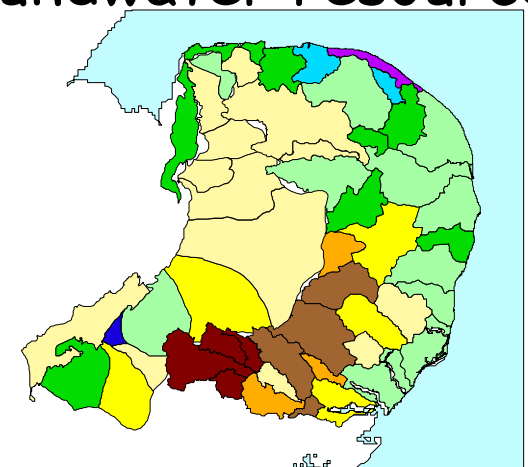
Flooding → Agriculture → Recharge + run-off



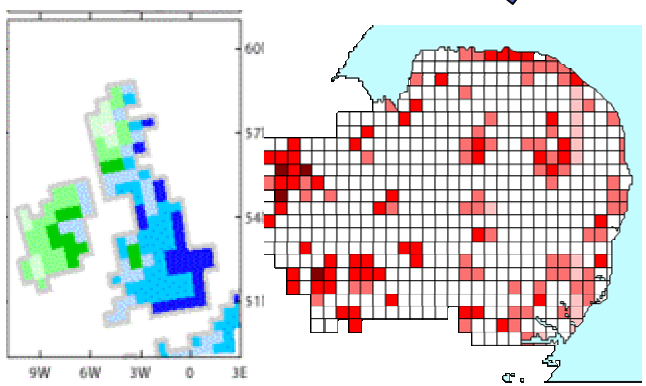




Hydrology & groundwater resources



Scenarios



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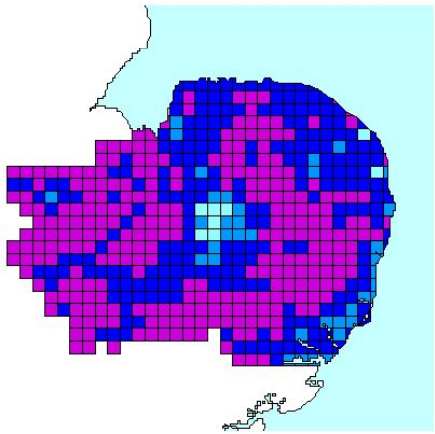
Agriculture (winter crops)

2050 Low climate effect only



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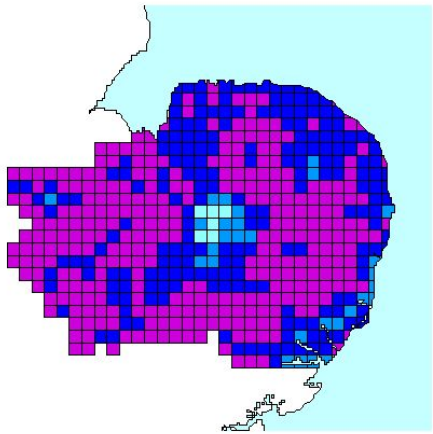

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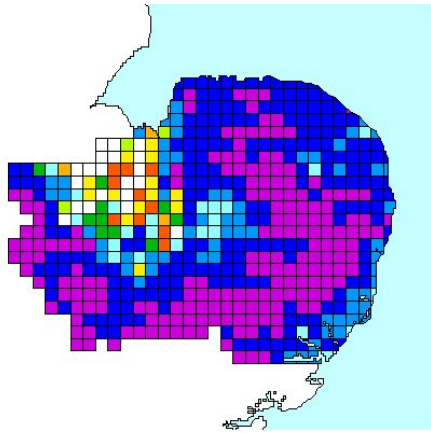

Winter crops (ha/grid ha)

- 0
- 0 to 5
- 5 to 10
- 10 to 25
- 25 to 50
- 50 to 100
- 100 to 250
- 250 to 500
- 500 to 1000
- 1000 to 1750
- 1750 to 2500

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Agricultural landscape is shaped by non-climate factors

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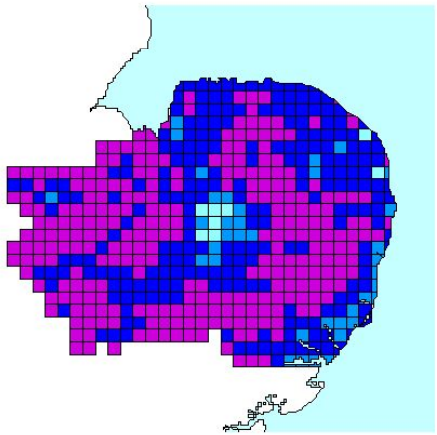
2050 Low climate effect only



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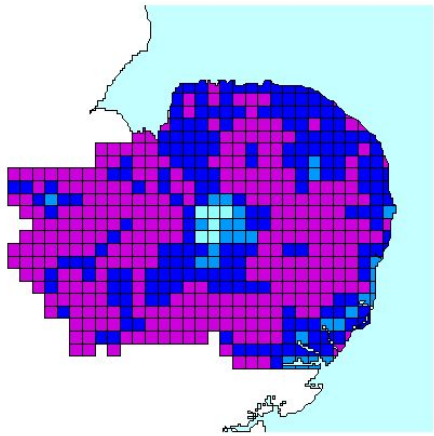
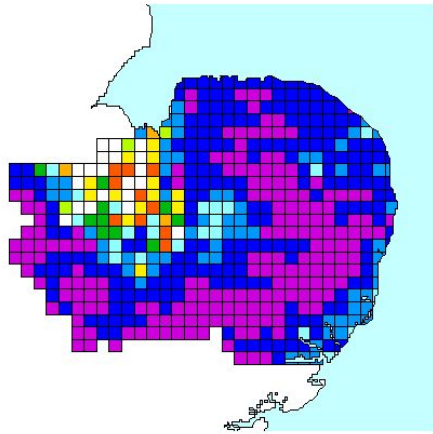
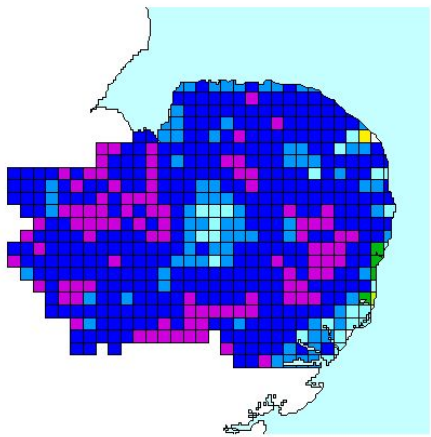


2050 High climate effect only



2050 Low climate and GS economic scenario



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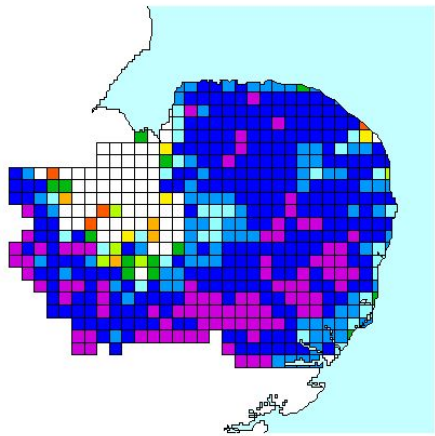
- 250 to 500
- 500 to 1000
- 1000 to 1750
- 1750 to 2500

2050 High climate and RE economic scenario



Average Annual Hydrologically Effective Rainfall

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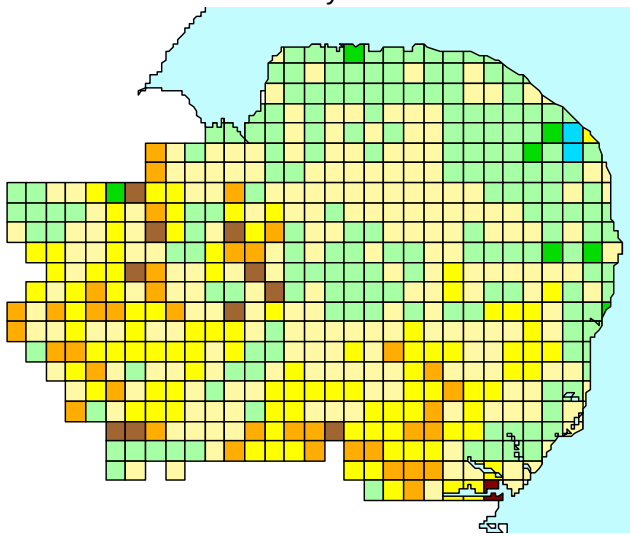
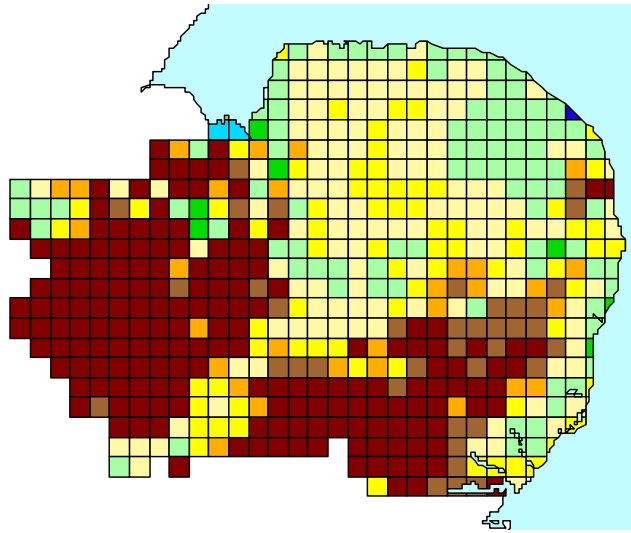
2050 Low

Climate scenario effect only

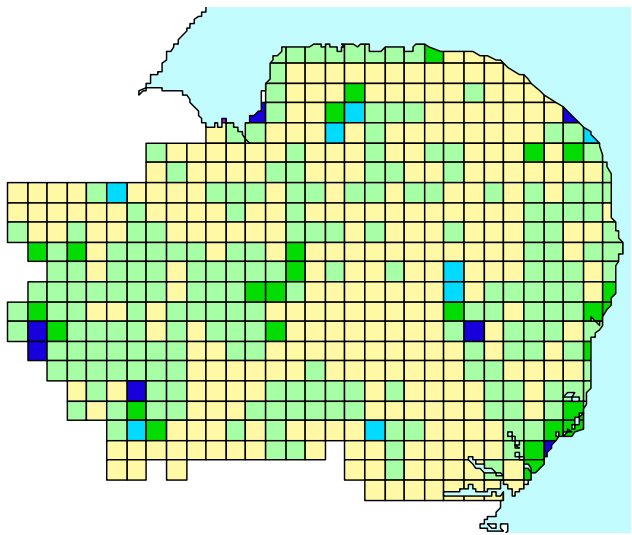


2050 High

Climate scenario effect only



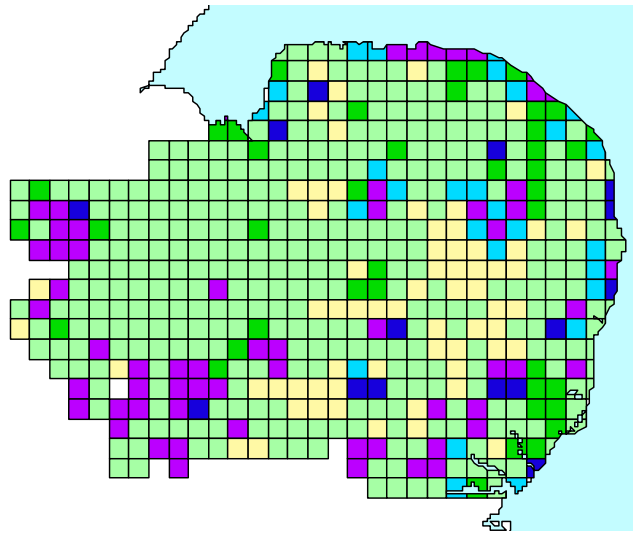
Socio-economic (GS) scenario effect only



Average Annual HER Change (%)

- 20 to 91
- 15 to 20
- 10 to 15
- 5 to 10
- 0 to 5
- -5 to 0
- -10 to -5
- -15 to -10
- -20 to -15
- -57 to -20

Socio-economic (RE) scenario effect only



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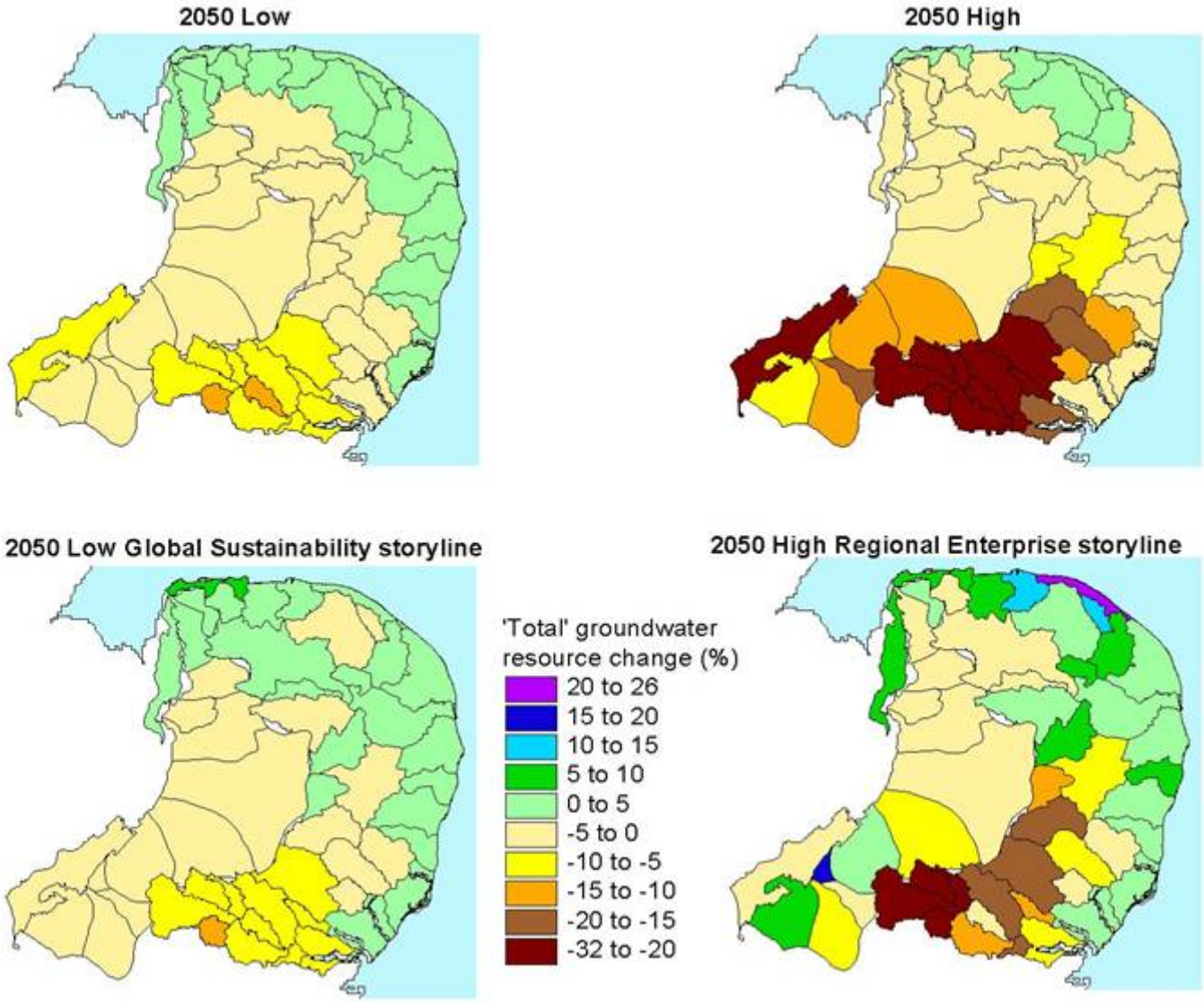
Gross groundwater resource (not just in aquifers)



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Changes in groundwater nitrate concentration

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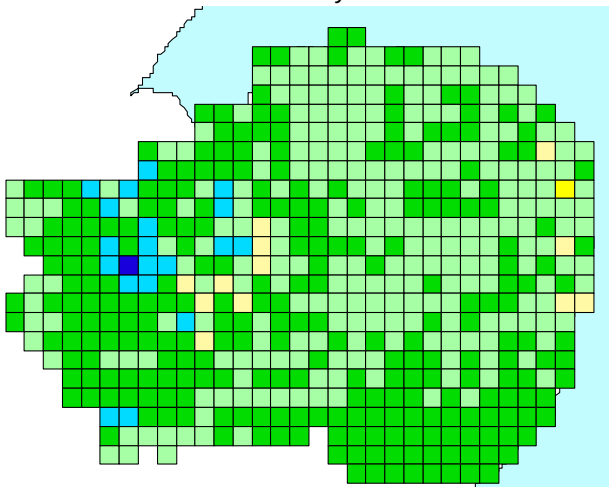
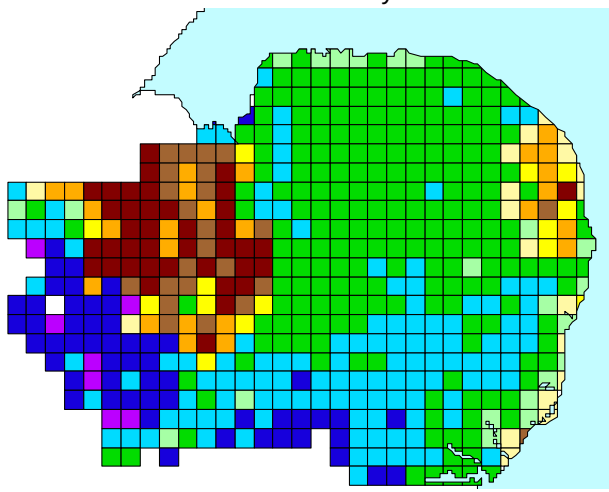
2050 Low | **2050 High**

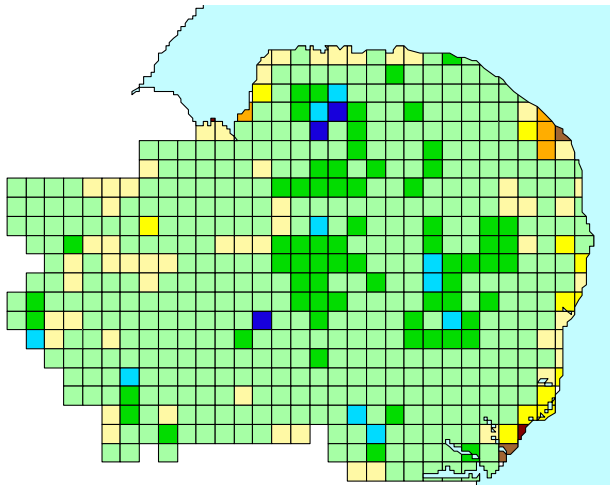
Climate scenario effect only



Climate scenario effect only



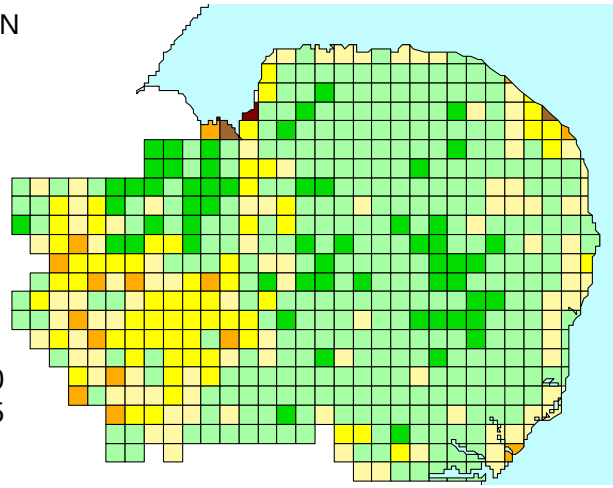
Socio-economic (GS) scenario effect only



Median nitrate-N concentration Change (mg/l)

- 5 to 7
- 2.5 to 5
- 1 to 2.5
- 0 to 1
- -1 to 0
- -2.5 to -1
- -5 to -2.5
- -10 to -5
- -15 to -10
- -32 to -15

Socio-economic (RE) scenario effect only



Climate & GS scenario effects

Climate & RE scenario effects

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Water (conclusions)

Increased agricultural demand, more houses

Climate change:

- Decrease in gross groundwater resource
- Increased groundwater nitrate concentrations

Socio-economic change

- Landuse change moderates some impacts
- Extensive NVZ restrictions required
- Likely demand effects **outweigh** climate impacts on water resources

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Anthropogenic change vs 'natural' change

- Predicted maximum decrease in annual gross groundwater resource is about -8% (RegIS)

- Scenario Alpha (conceptual space of Regional Enterprise)
  - Spray irrigation demand +42%
  - Household water demand +33%
  - Industrial & commercial (direct +12%; PWS +13%)

- Scenario Gamma (Global Sustainability)
  - Spray irrigation demand -14%
  - Household water demand -28%
  - Industrial & commercial (direct -54%; PWS -29%)

Outstanding issues

- Allowance for climate model uncertainty
- Scenario 'surprises'
- Scenario linkage

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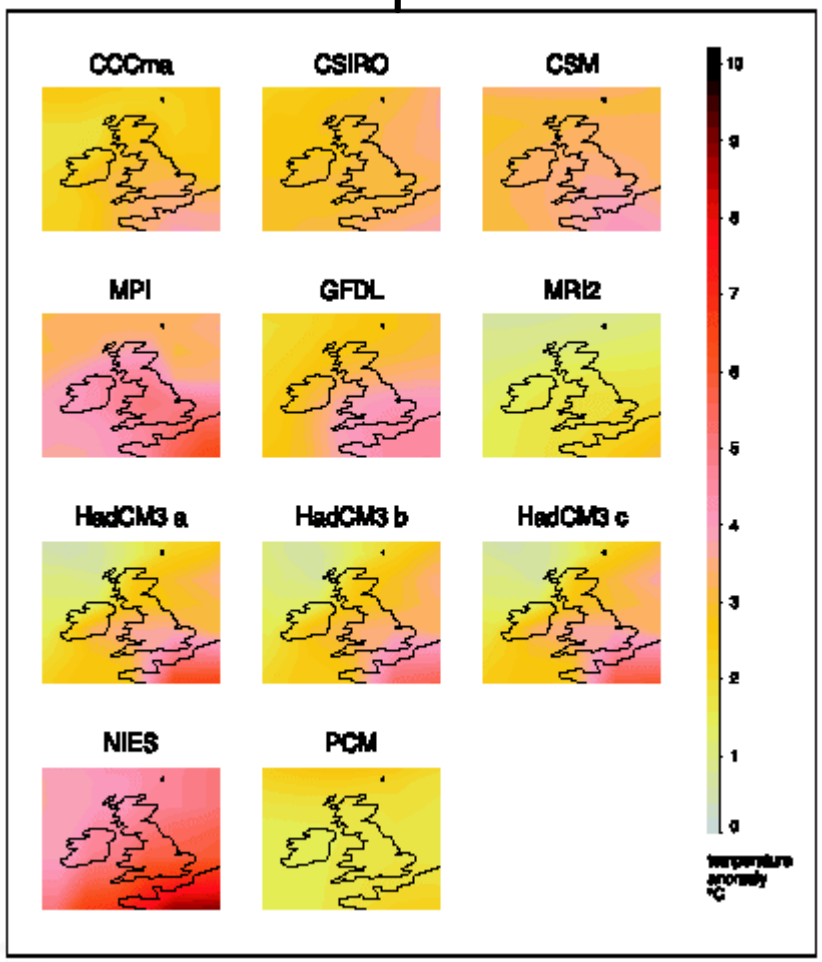
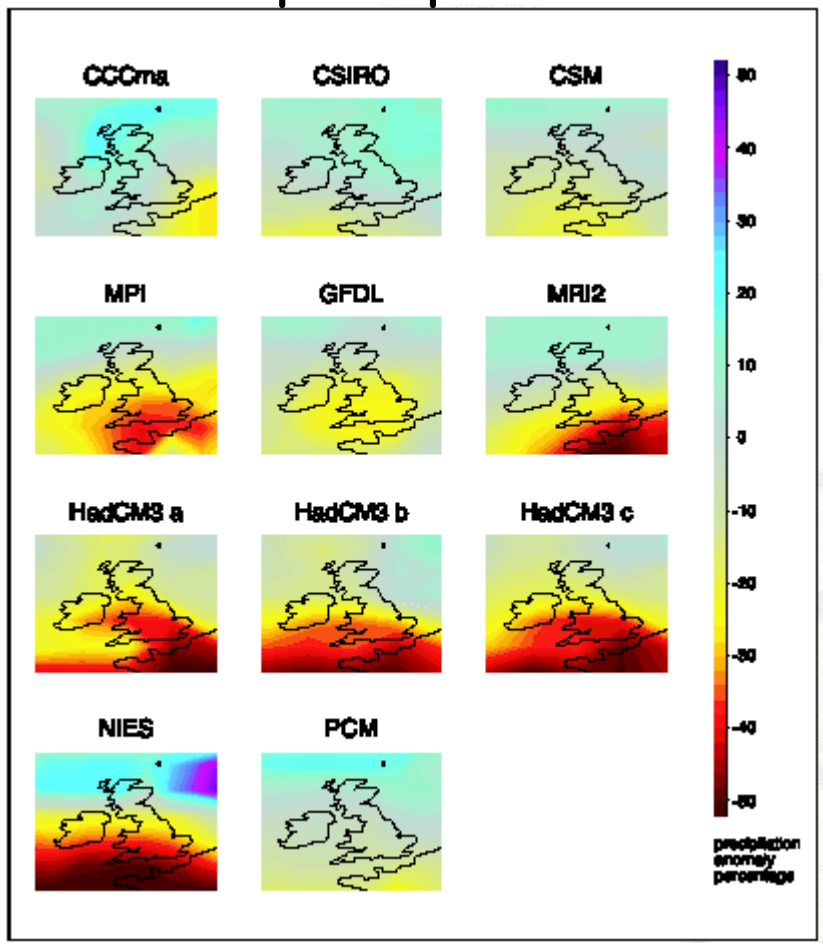
Climate model uncertainty

Summer temperature



Summer precipitation



Different climate models give different outputs!

(UKCIP 2002)

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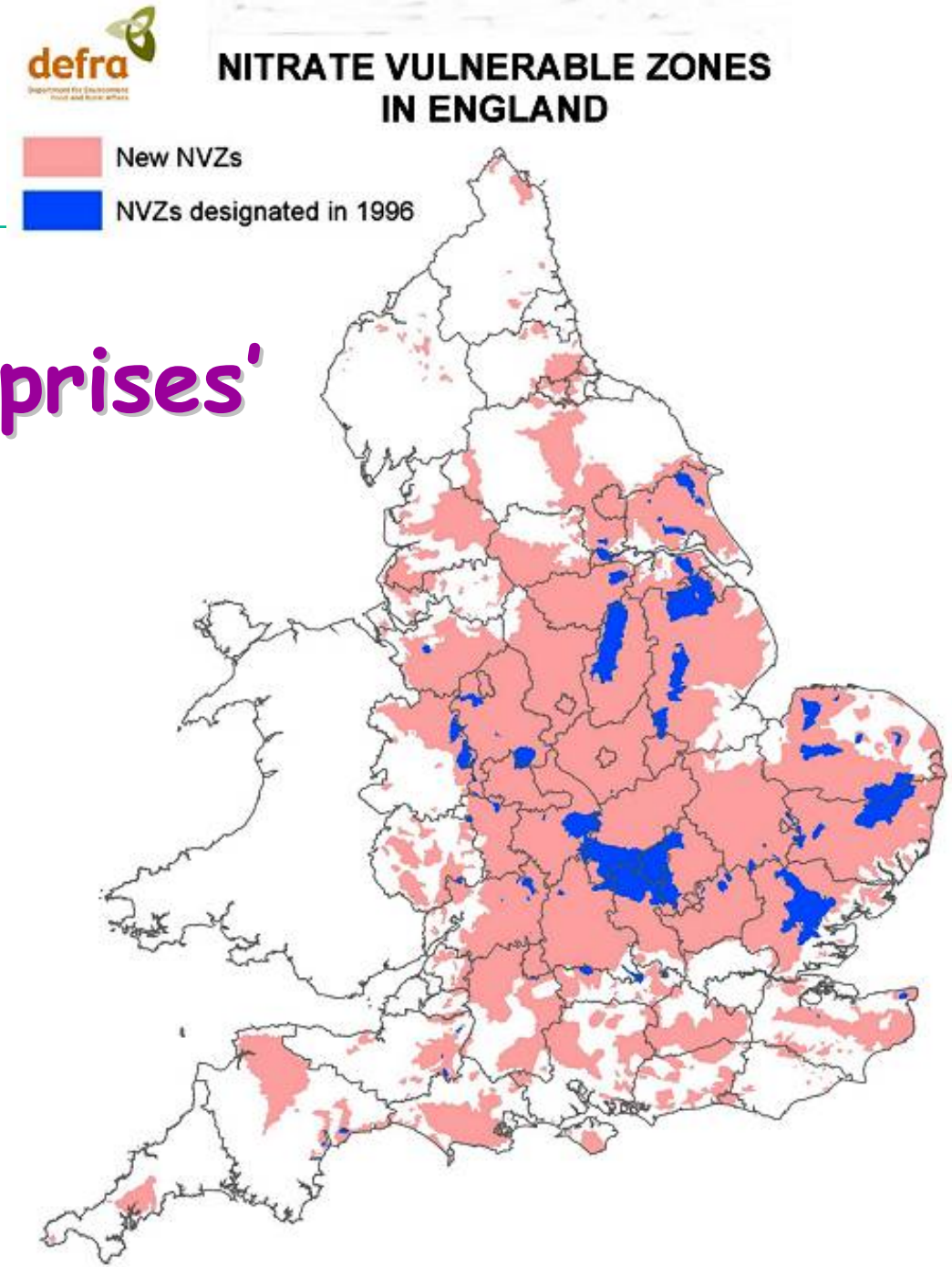
Uncertainty allowances

For the UKCIP02 suggested uncertainty margins are given:

	Low Emissions	Medium-Low Emissions	Medium-High Emissions	High Emissions
Average Temperature				
Winter (°C)	±0.5	±1.0	±1.5	±2.0
Summer (°C)	±0.5	±1.0	±1.5	±2.0
Average Precipitation				
Winter (per cent)	± 5	±10	±15	±20
Summer (per cent)	+10	+15	+30	+40

Scenario 'surprises'

- Scenarios are not predictions!



Scenario linkage

In RegIS and RegIS2 there are:

- 4 climate change scenarios
  (Low, Med.-Low, Med.-High & High);
- 5 socio-economic scenarios
  (including the Baseline);
- 4 Timeslices
  (2020s, 2050s & 2080s);

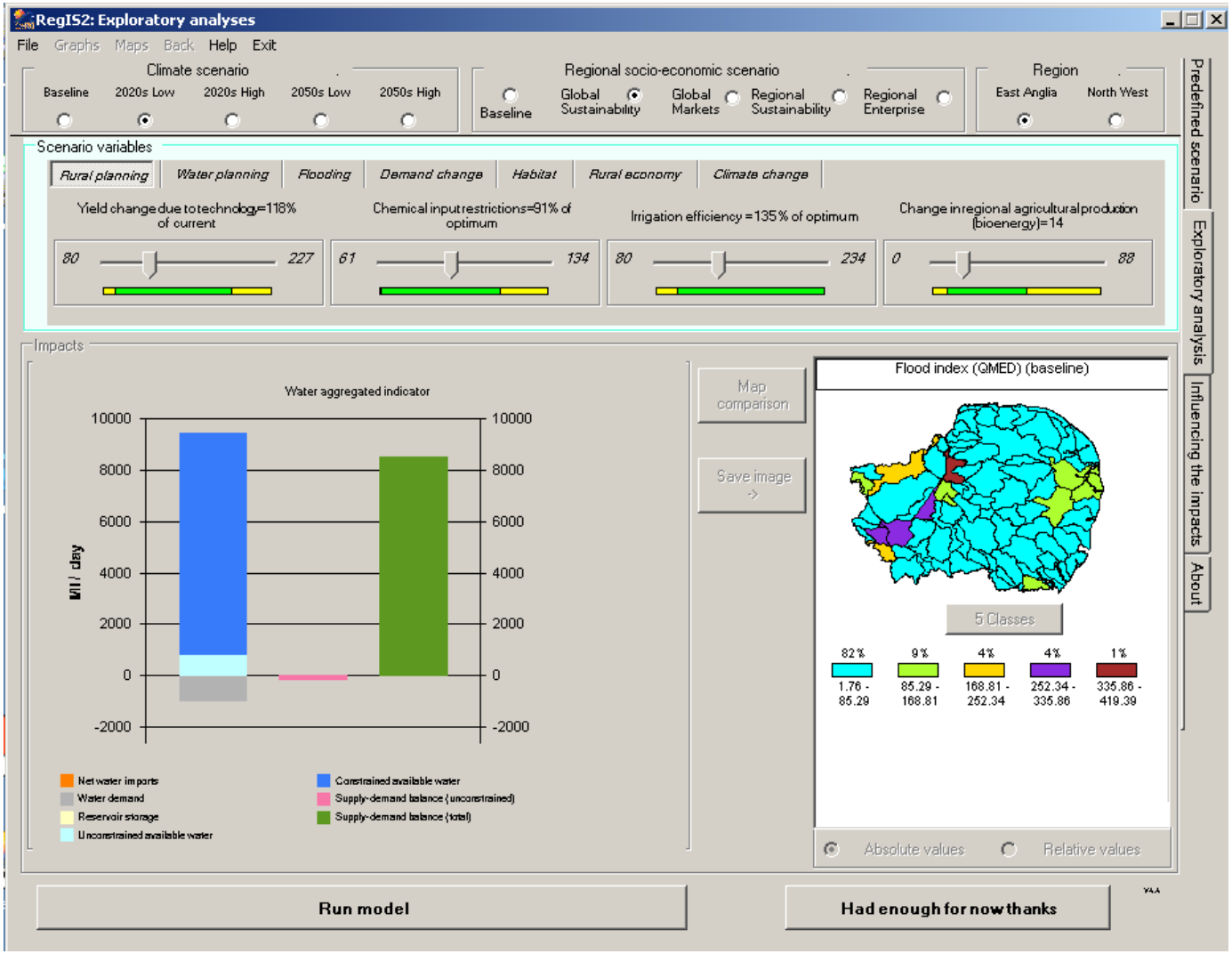
This is a ***LOT*** of potential combinations.

Scenario linkage

Do you….

- Link scenarios to produce 'internally consistent' visions of the future
  - The carbon emissions of the socio-economic scenario are consistent with the CO_2 increases in the climate change scenario
- Or allow 'internally inconsistent' visions of the future?

RegIS2 Regional Impacts Simulator



Drivers

Pressures

State / Impact

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Conclusions

- Evapotranspiration; fertiliser usage; water demand are all determined by the landscape
- The landscape is (largely) a function of policy and economics
- We need to investigate the impacts of climate and socio-economic change to get a more complete understanding
- There is still (and will remain to be) significant uncertainty in input scenarios to models

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Thank you!

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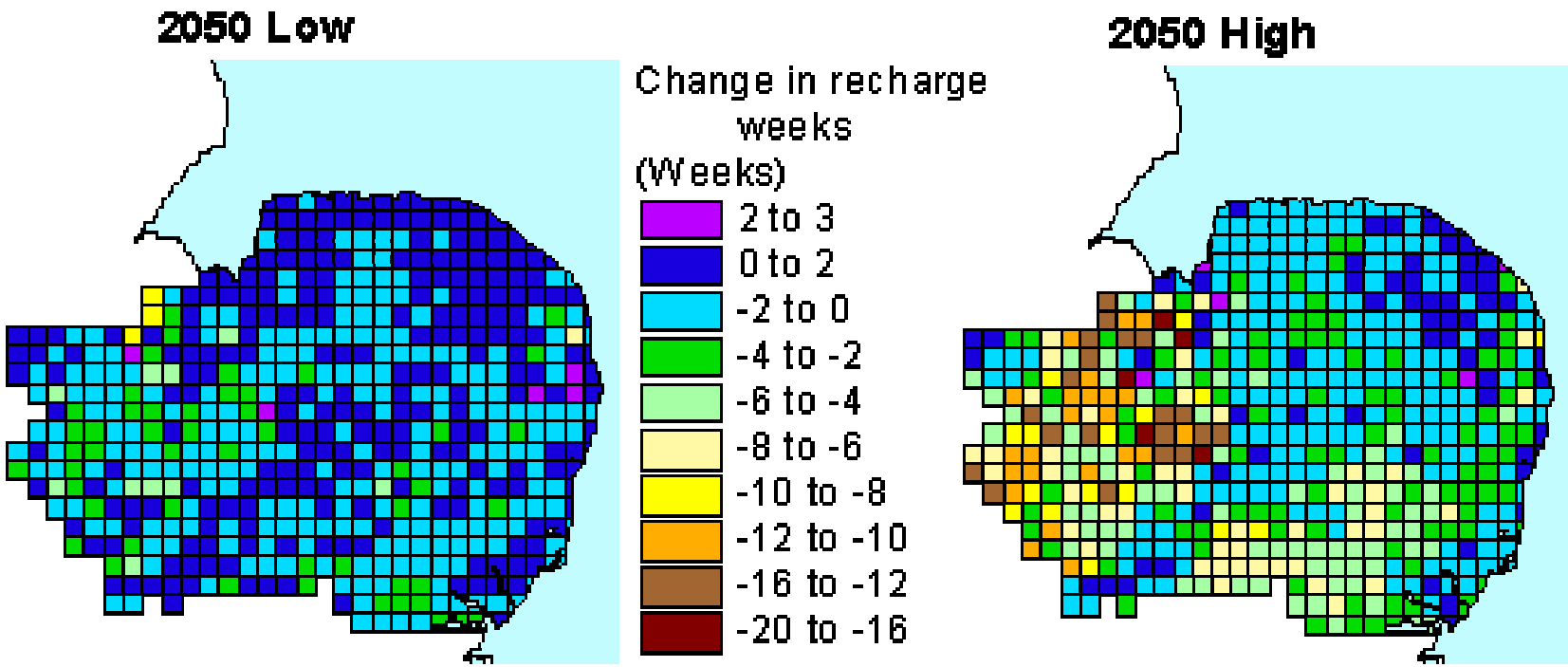
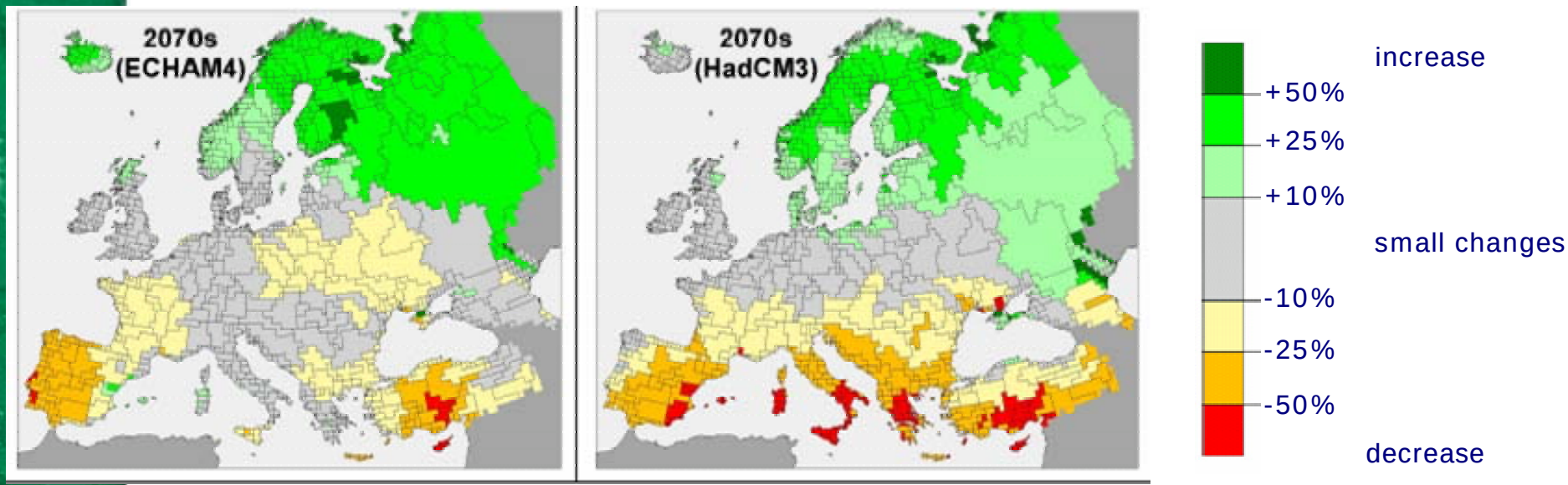
http://www.silsoe.cranfield.ac.uk/iwe/expertise/climate_change.htm

Change in recharge period (climate change only)



Implications (surface water)

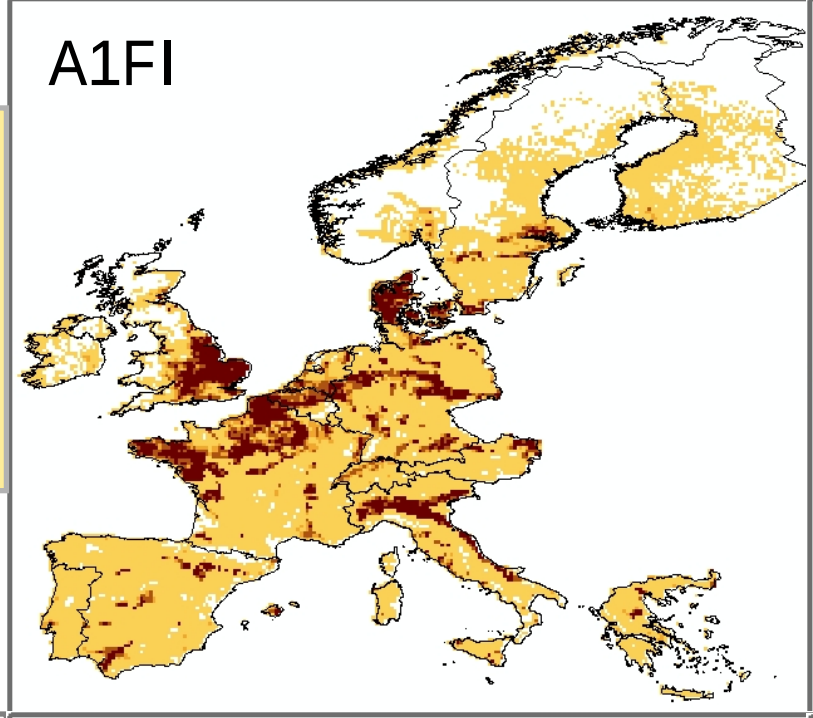


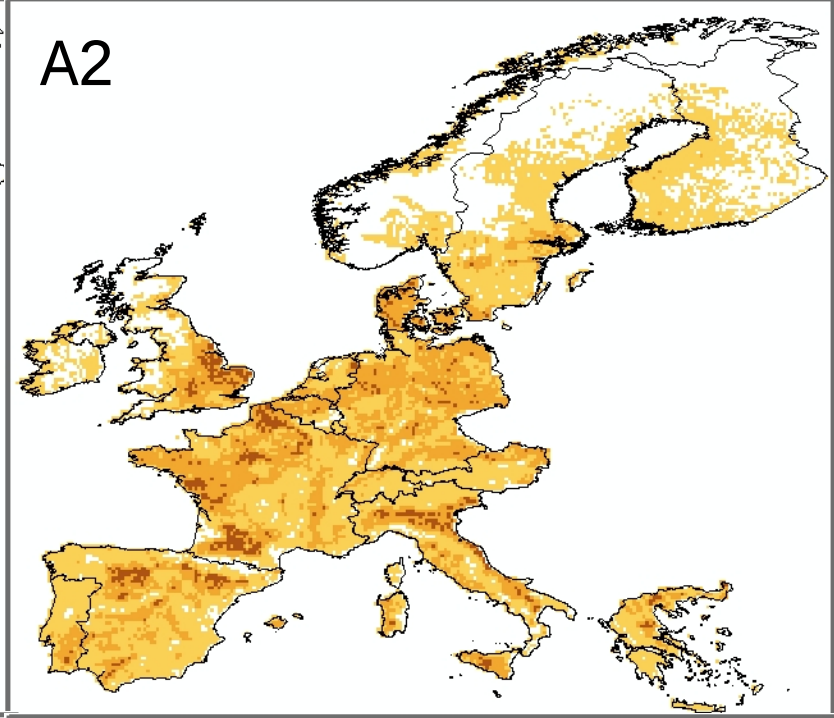
- Baltic countries, Poland
- Italy, southern Spain

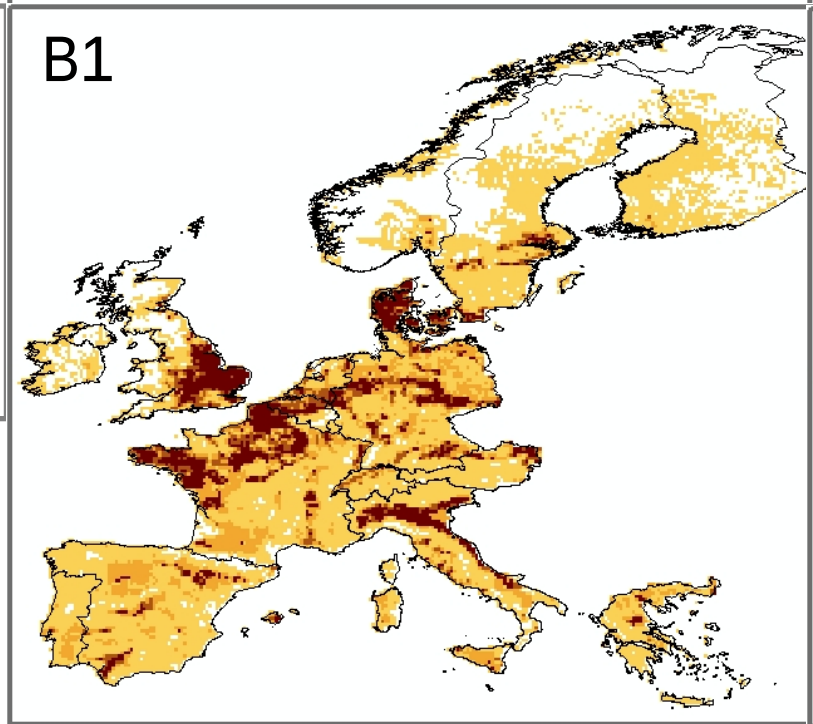
Data-sources: Erhard (2003); Center for Environmental Systems Research, national institutions

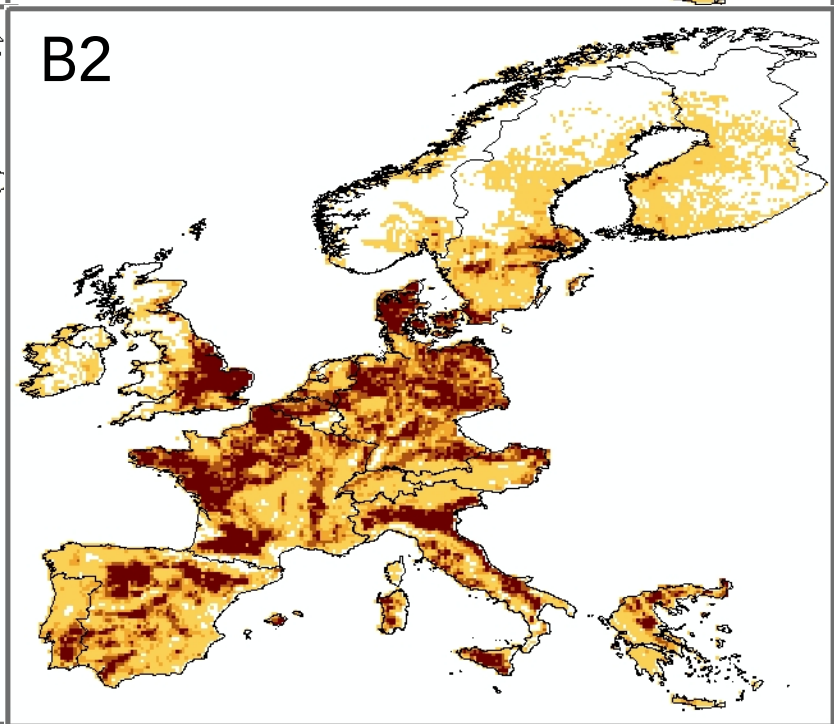
Crop land in 2080

(HADCM3)









Percentage of arable land per ATEAM cell

- 0
- 1 - 25
- 26 - 50
- 51 - 75
- 76 - 100

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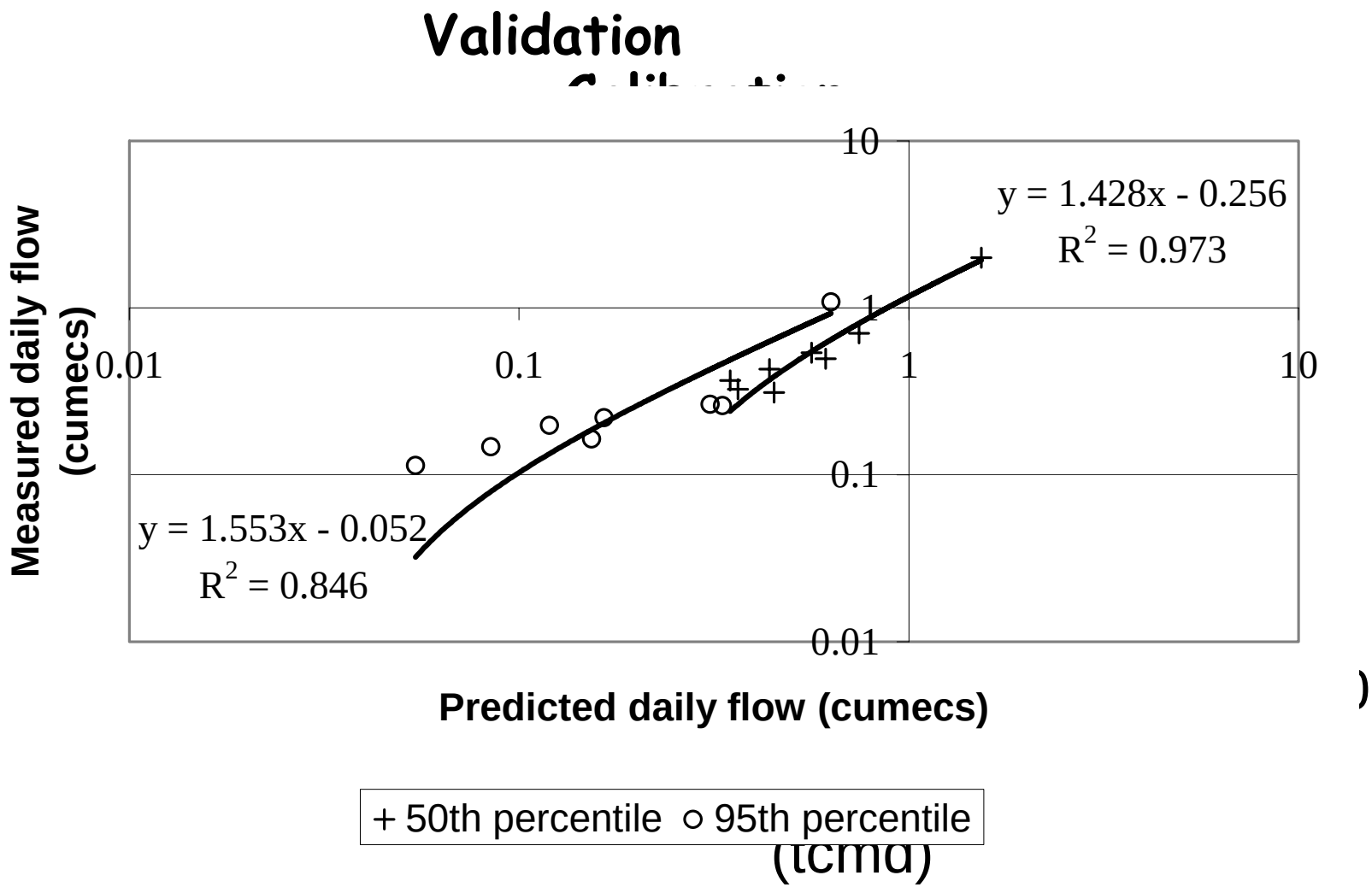
Baseline results



(tcmd)