Statistical downscaling in practice: Recent applications and future directions

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Climate change scenarios: The ultimate challenge?

Source: http://culter.colorado.edu/NWT/site_info/site_info.html

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An overview of downscaling methods: the why and how?

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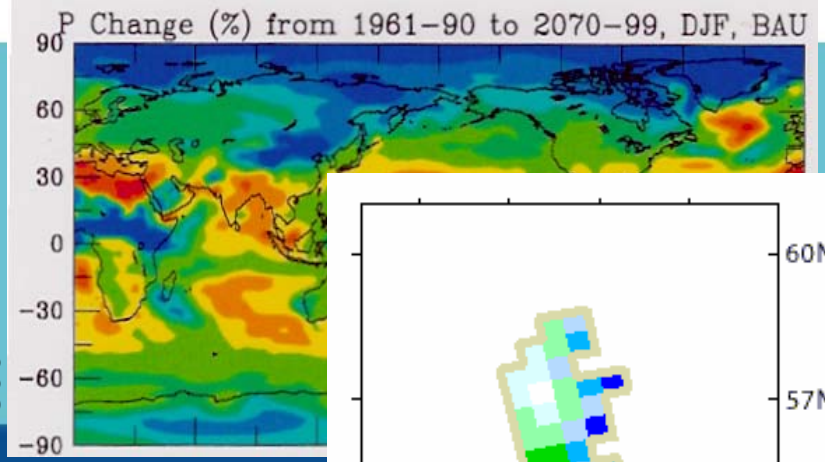
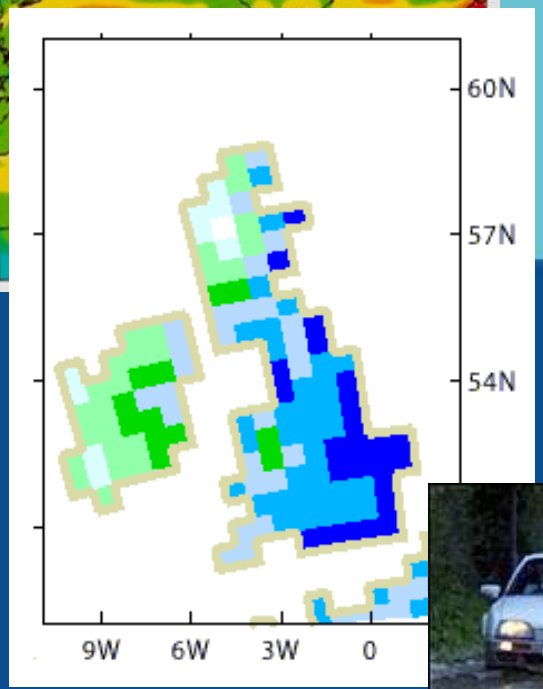
What the climate model centres provide…



300km



50km

10km

1m

Point

downscaling

…what the climate impacts community needs.

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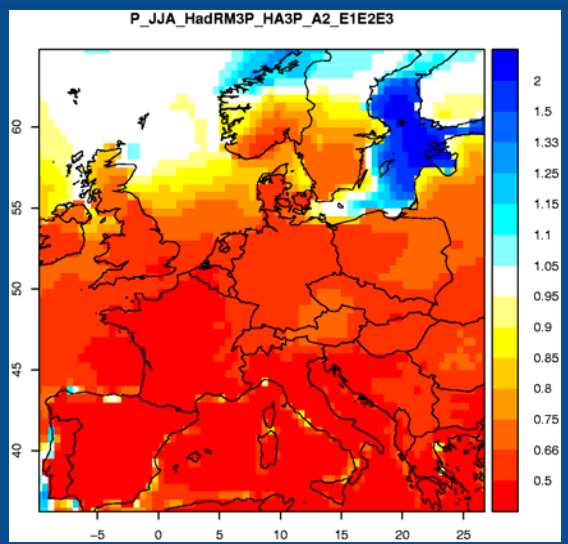
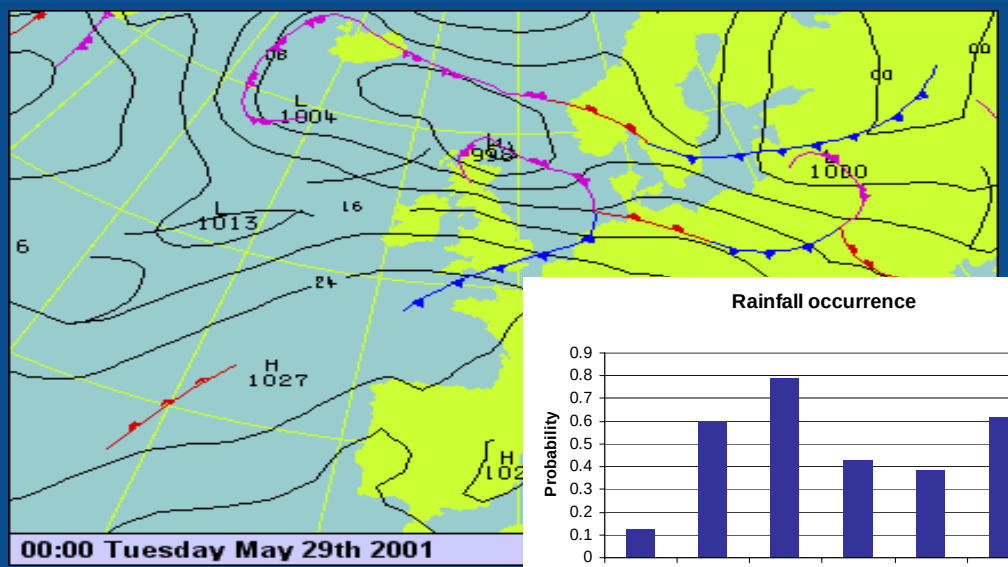
Four main approaches

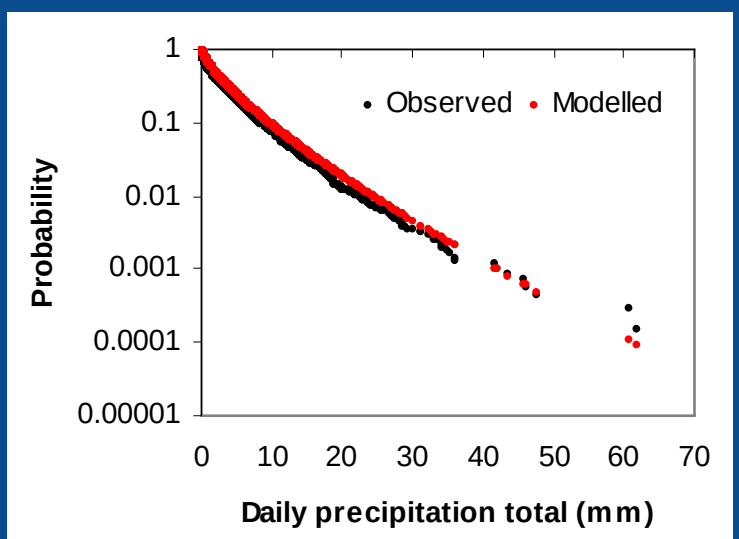
Dynamical downscaling



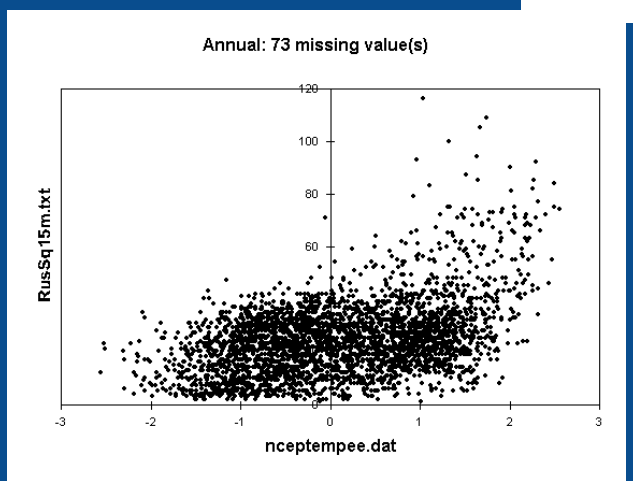
Weather classification



Weather generators



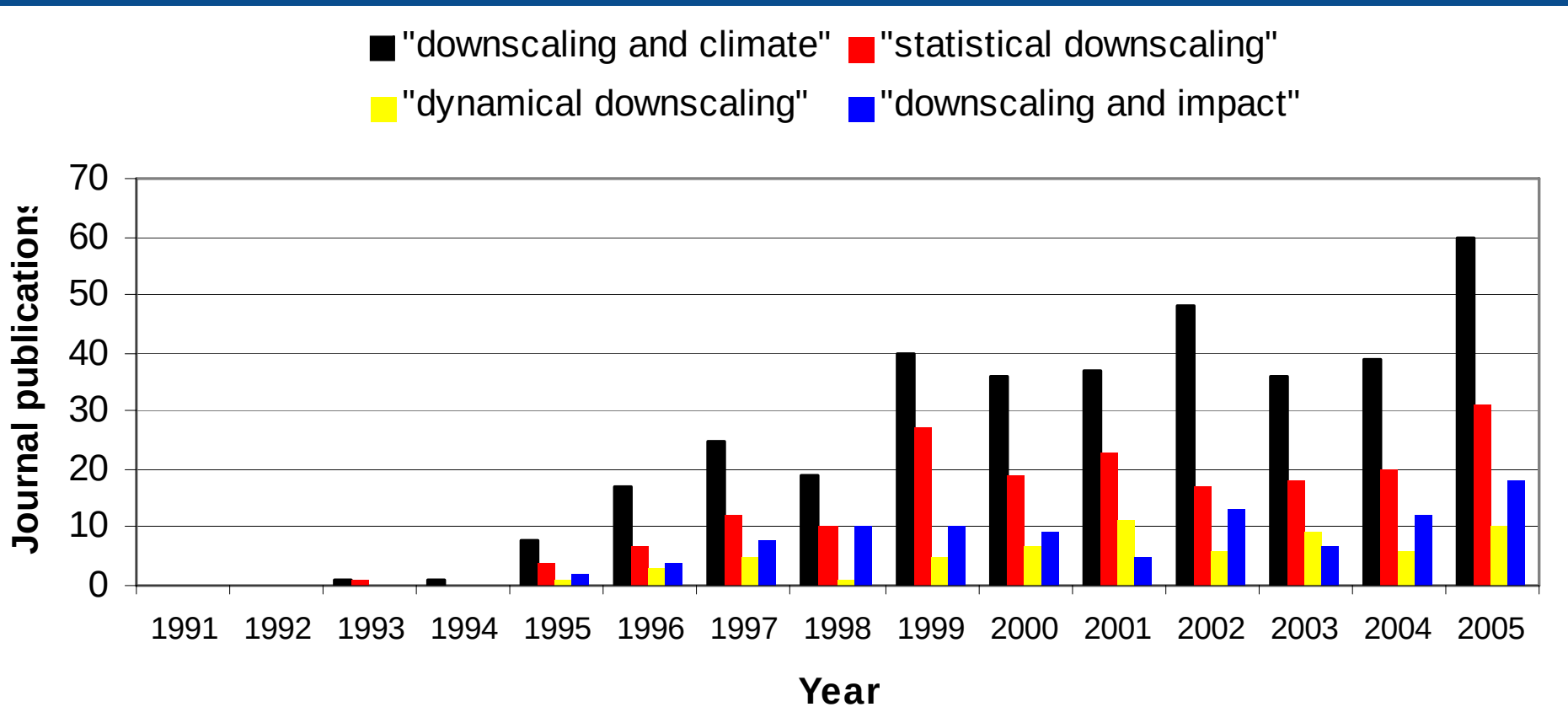
Transfer functions



What have we learnt so far?

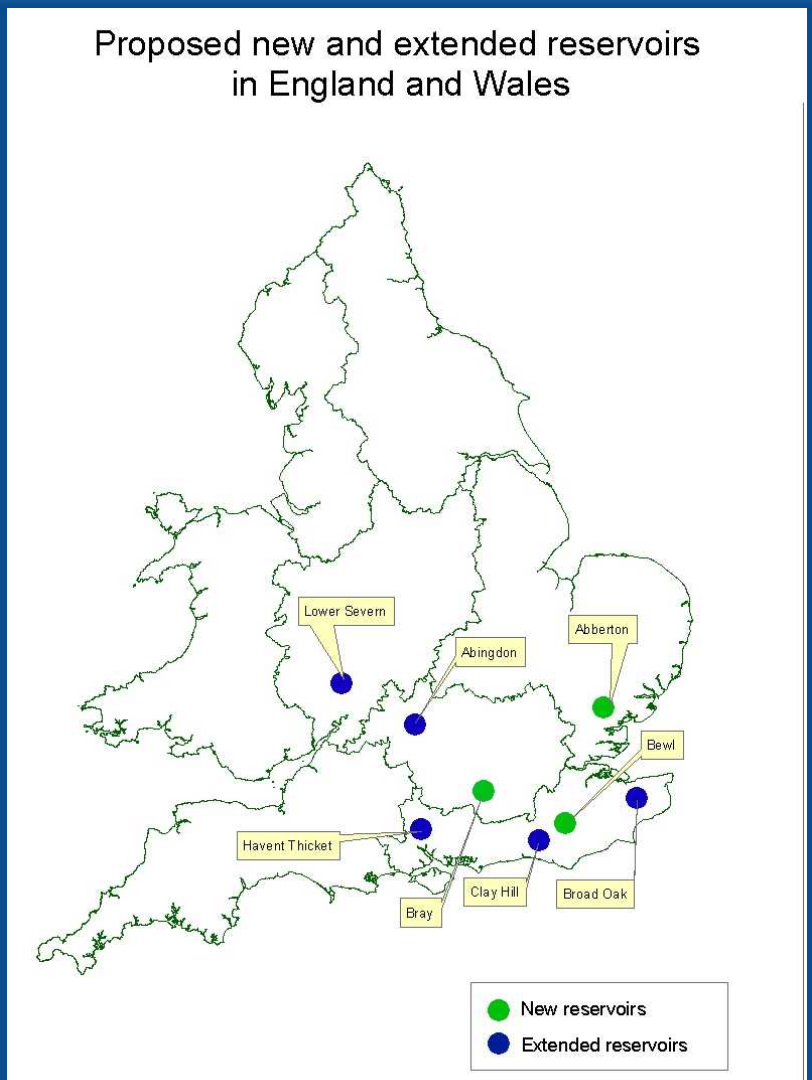
- GCM boundary conditions are the main source of uncertainty affecting all downscaling methods
- Statistical and dynamical downscaling have similar skill
- Different downscaling methods yield different scenarios
- There are no universally “optimum” predictor(s)/domains
- Downscaling extreme events is highly problematic (for example summer rainfall predictability is very low)
- Traditional skill measures for current climate may not be the best guide to future scenarios of *change*

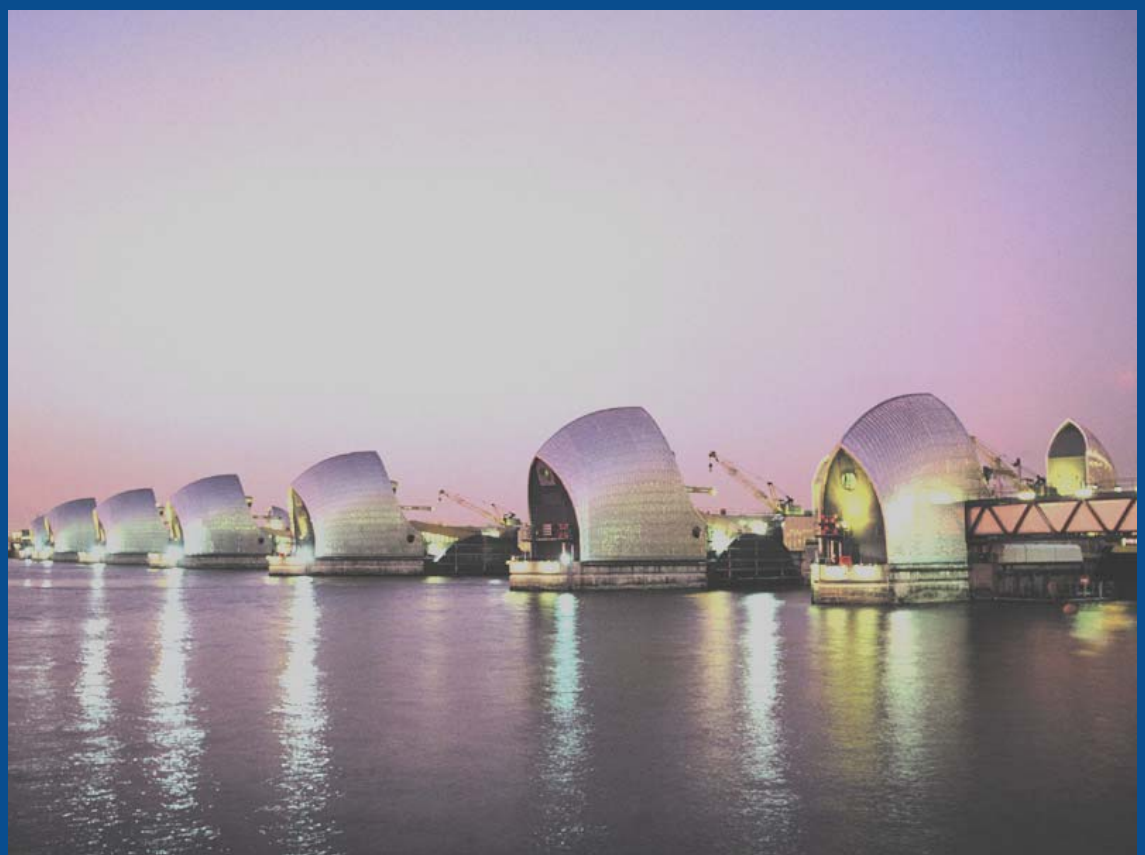
Downscaling is a growth industry...



Peer reviewed journal publications listed on the Web of Science

…with no shortage of big adaptation questions...





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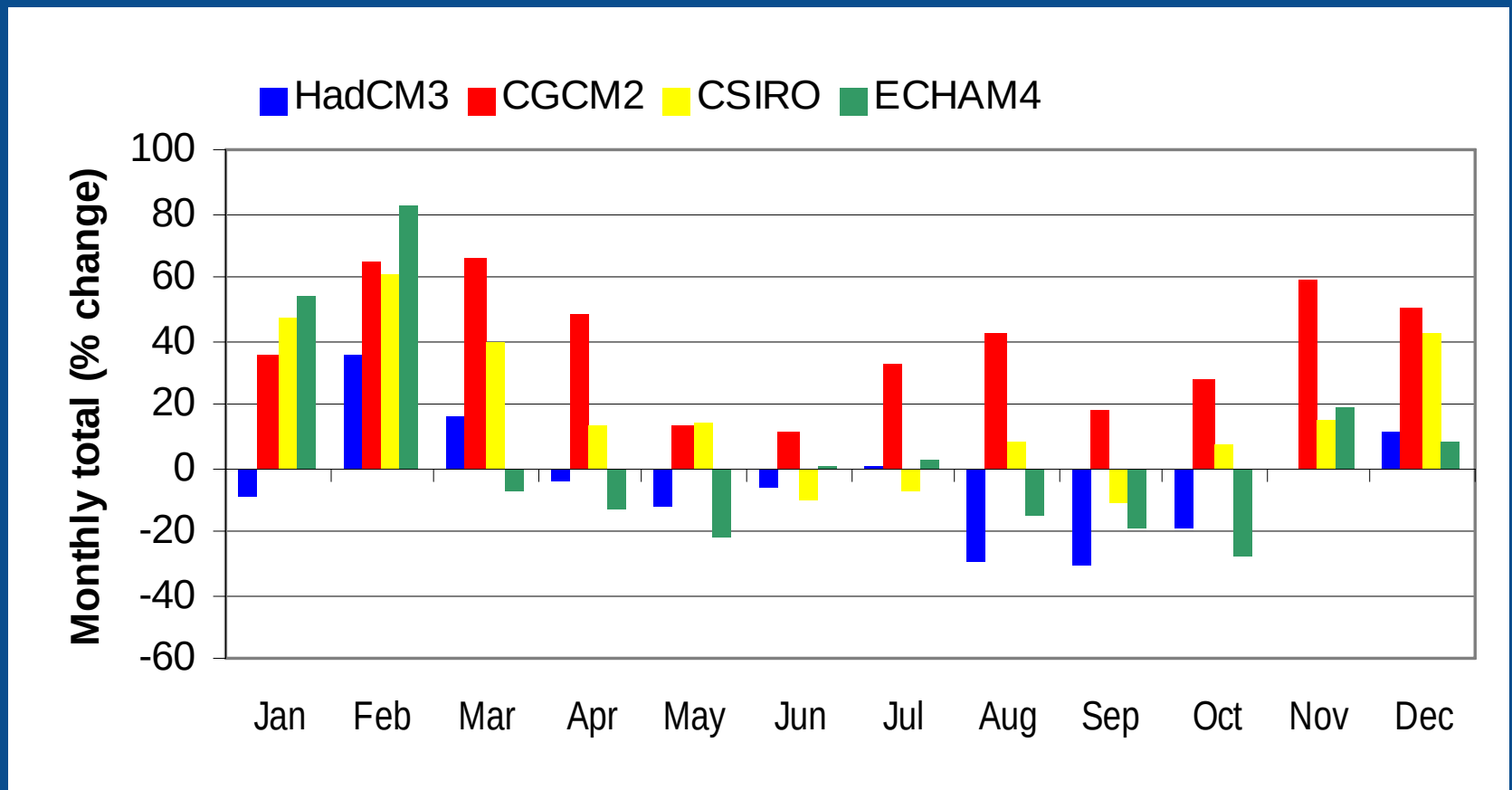
…couched in deep uncertainty...



Precipitation scenarios downscaled for the River Thames under A2 emissions in the 2050s

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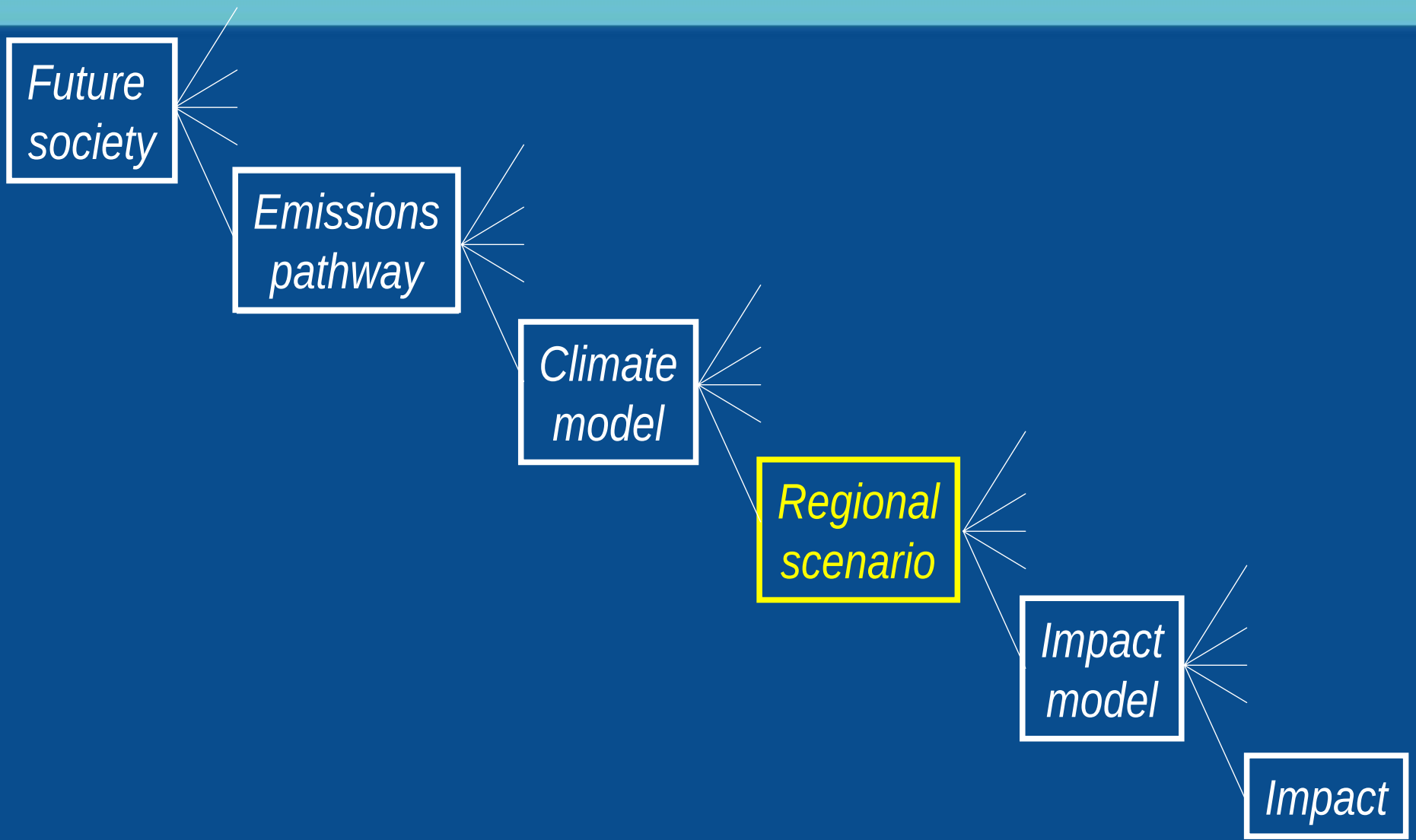
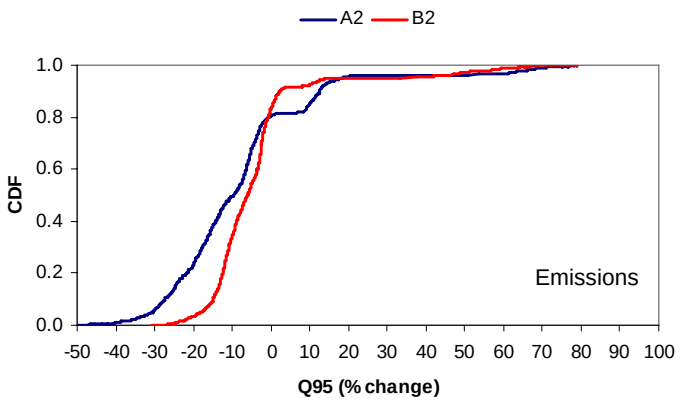
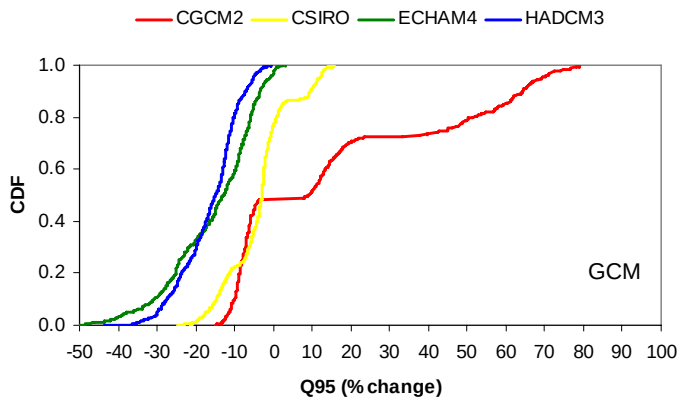
Preparing for the probabilistic paradigm

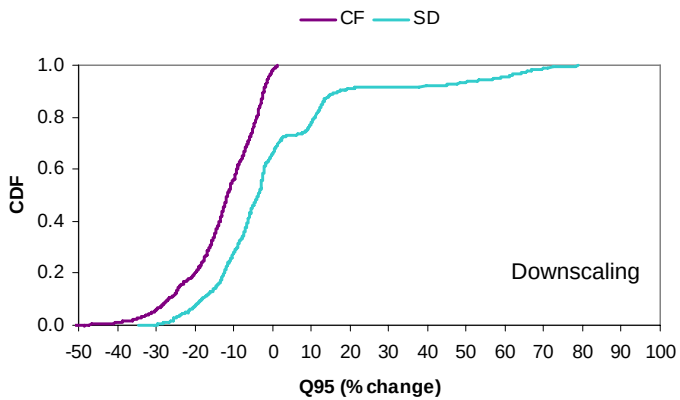
Downscaling is at the heart of the uncertainty cascade

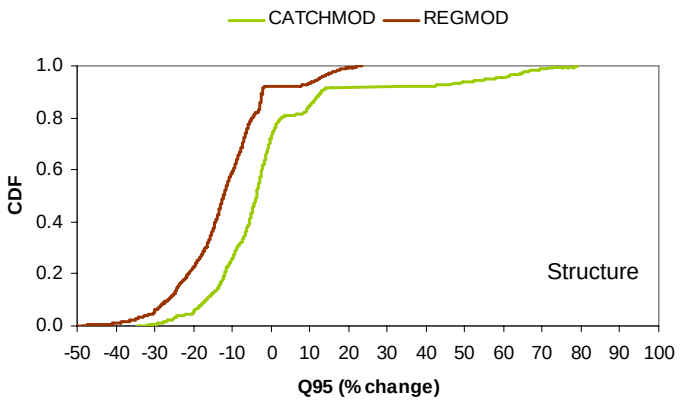


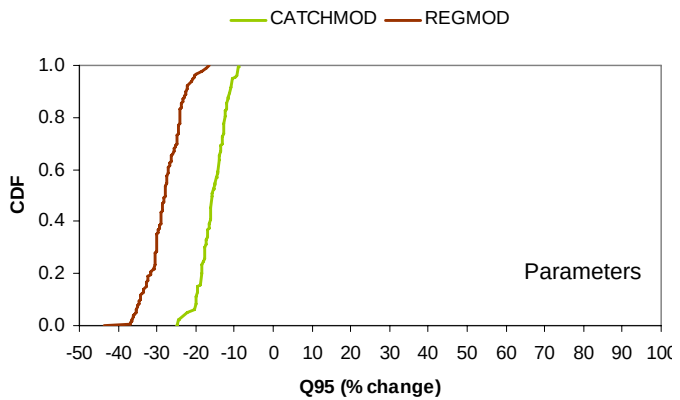
End-to-end uncertainty through Monte Carlo analysis

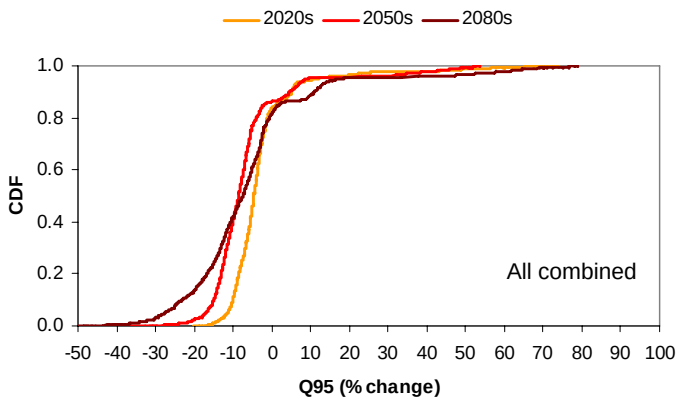






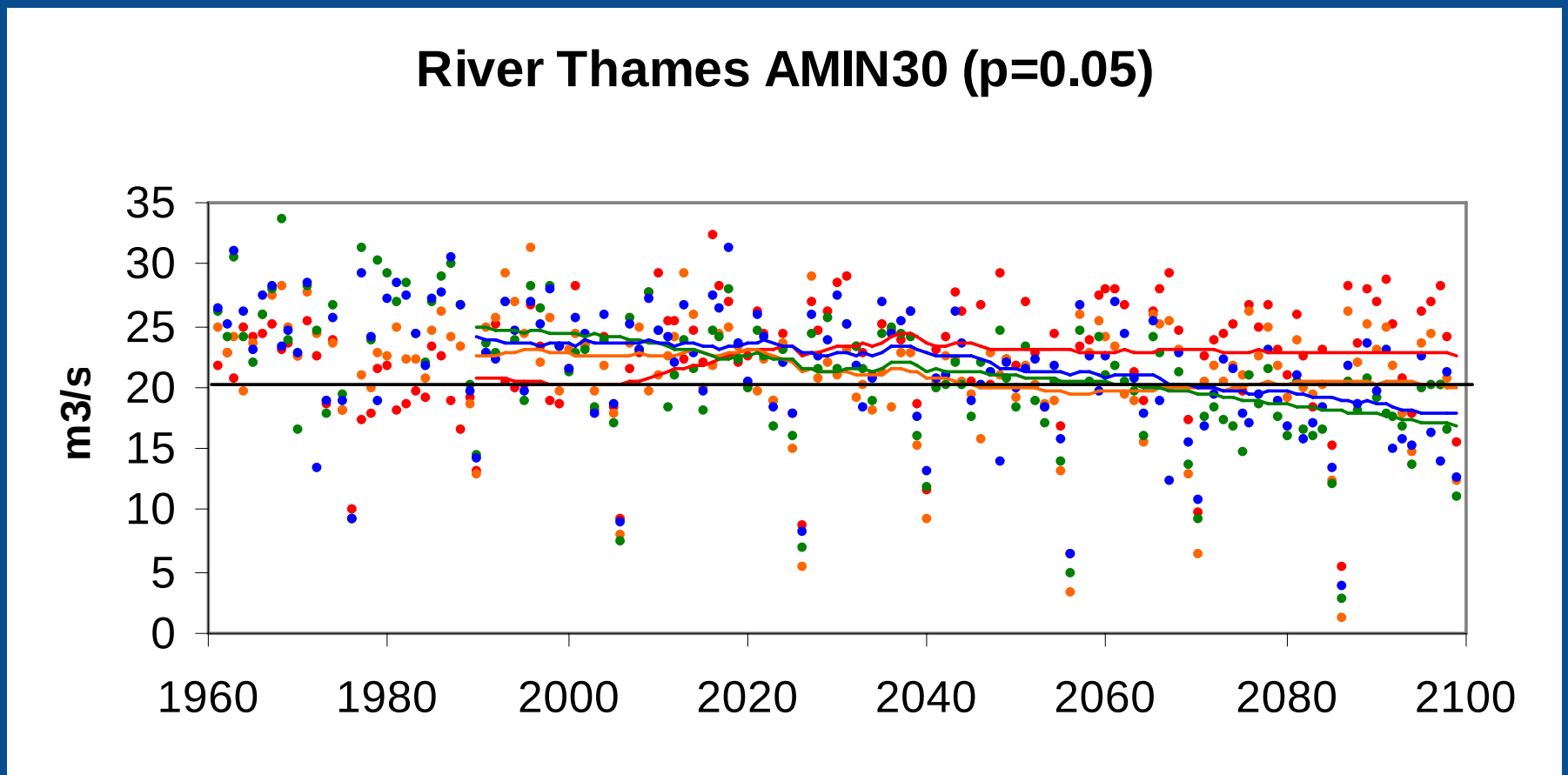






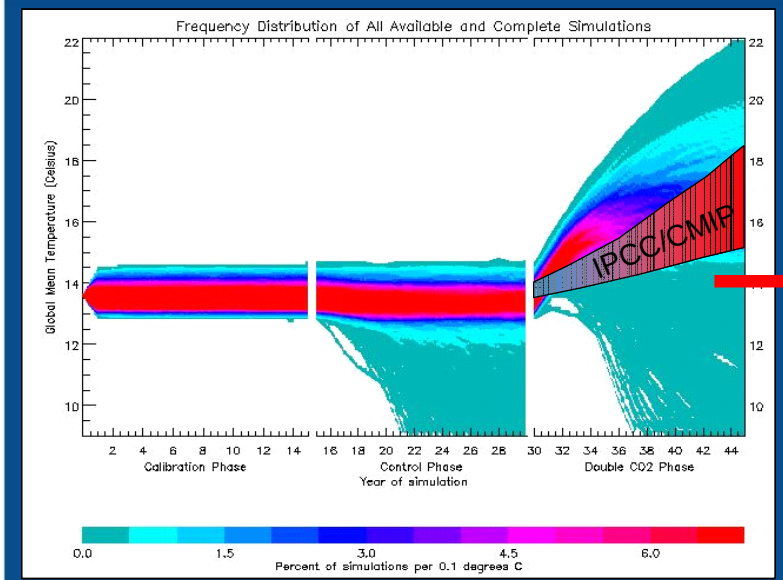
Conditional probabilities of lower summer flows in the River Thames by the 2020s, 2050s and 2080s. Source: Wilby and Harris (2006)

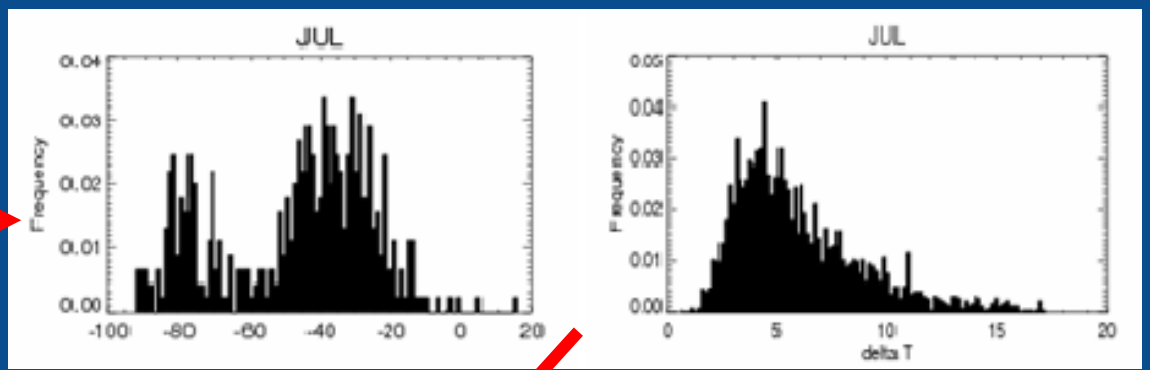
Transient scenarios inform decisions on *timing* of adaptation

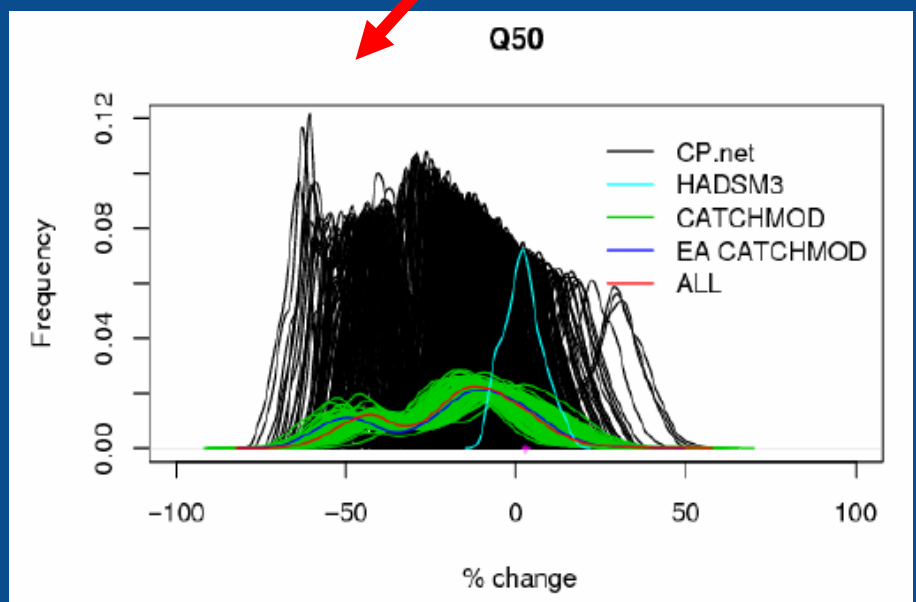


30-day annual minimum flow series in the River Thames reflecting uncertainty due to GCM boundary forcing 1961-2100

Downscaling from large ensemble experiments

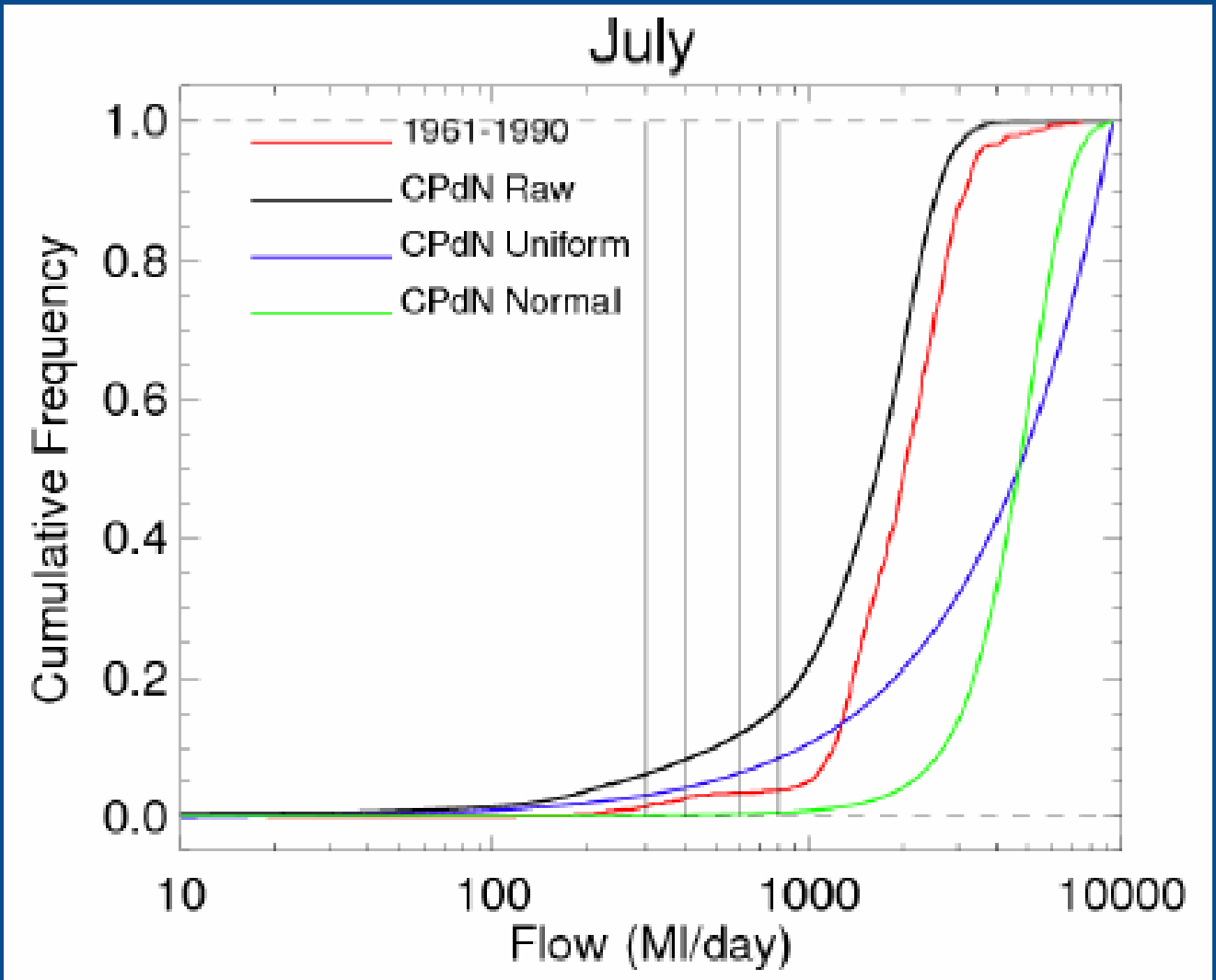






Changes in average (Q50) flows when combining uncertainty in CATCHMOD parameters with CP.net climate scenarios for the Thames grid-box. Source: New et al. (2006)

Risk expressed in terms of environmental standards



Cumulative frequencies of July monthly discharge for the River Thames in relation to environmental flows (300, 400, 600 and 800 Ml/day) for different reservoir capacities.

Source: New et al. (2006)

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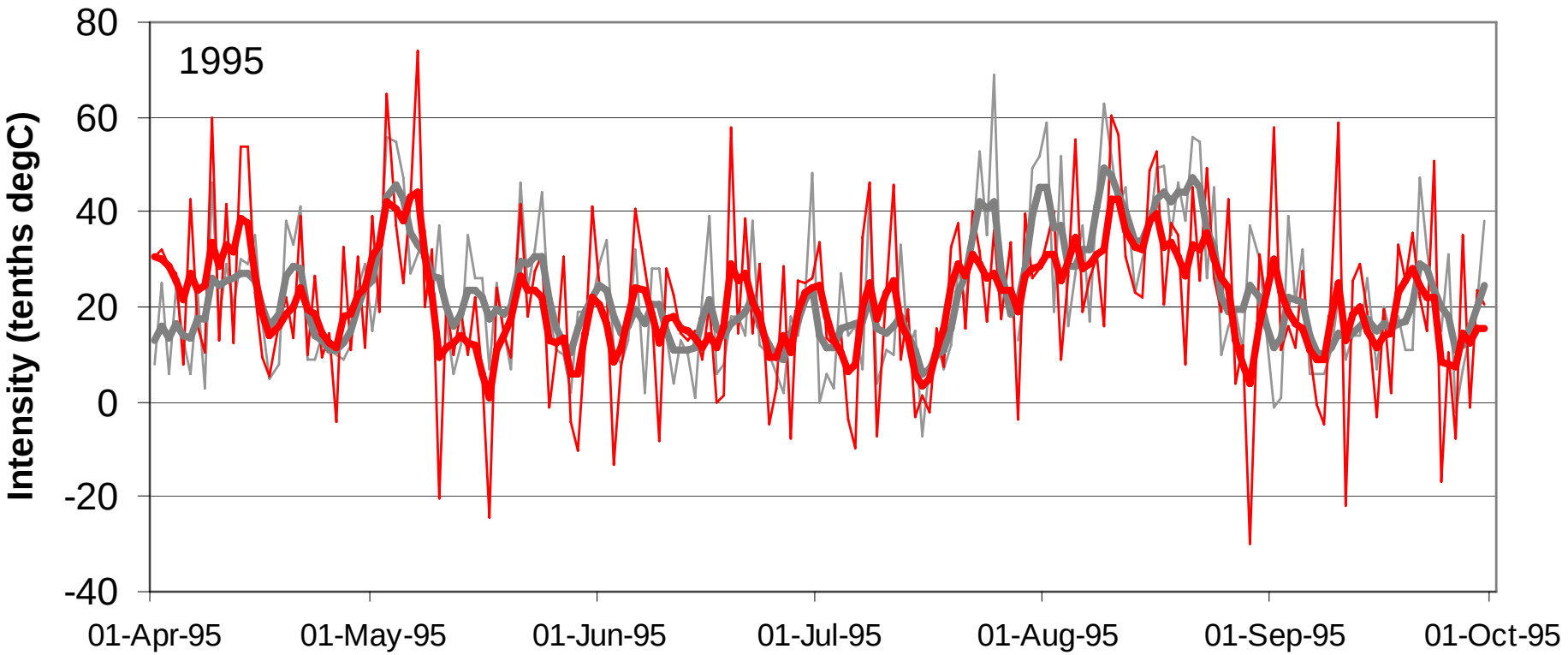
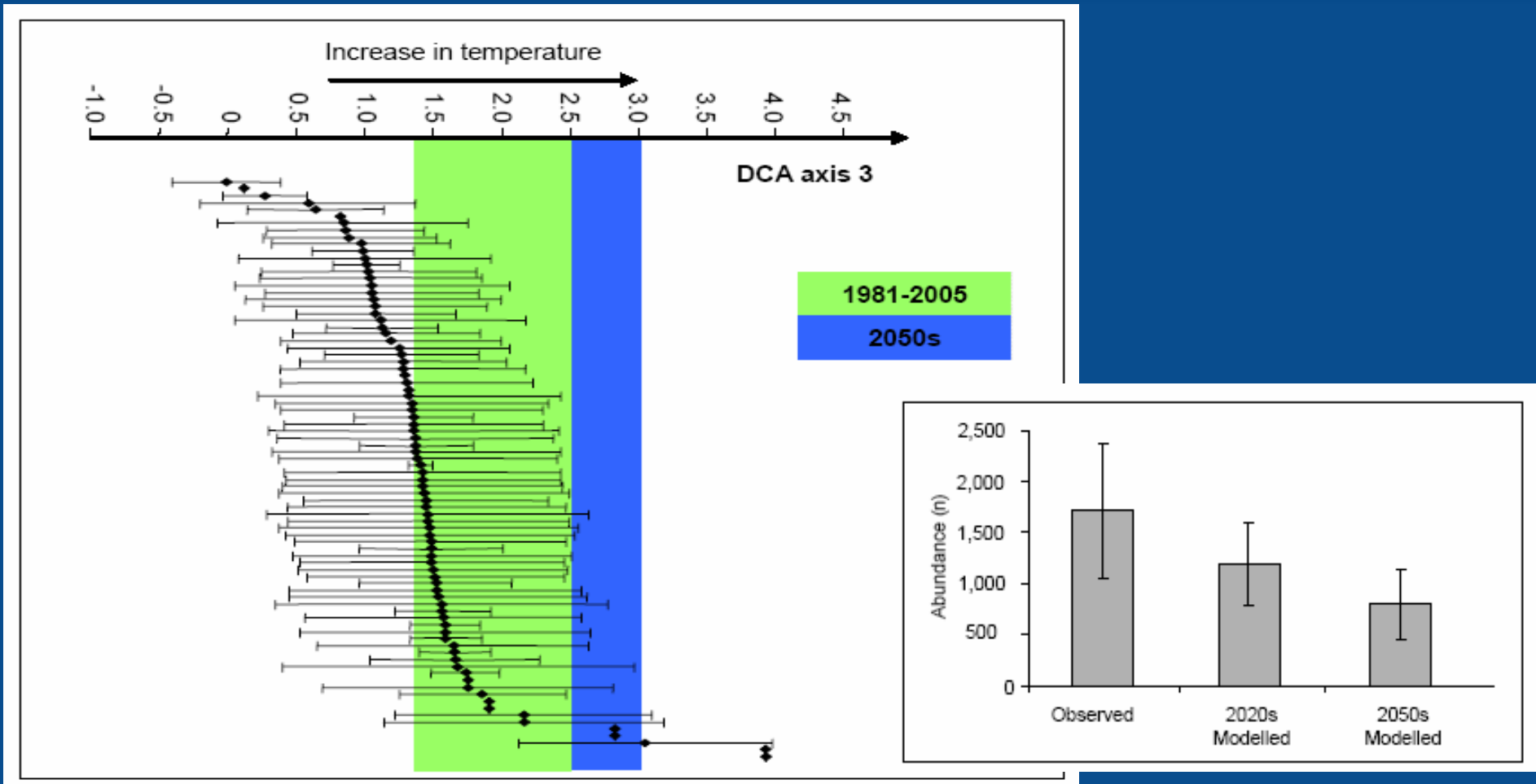
Five examples of downscaling applications

1. Building design and London's nocturnal heat island intensity

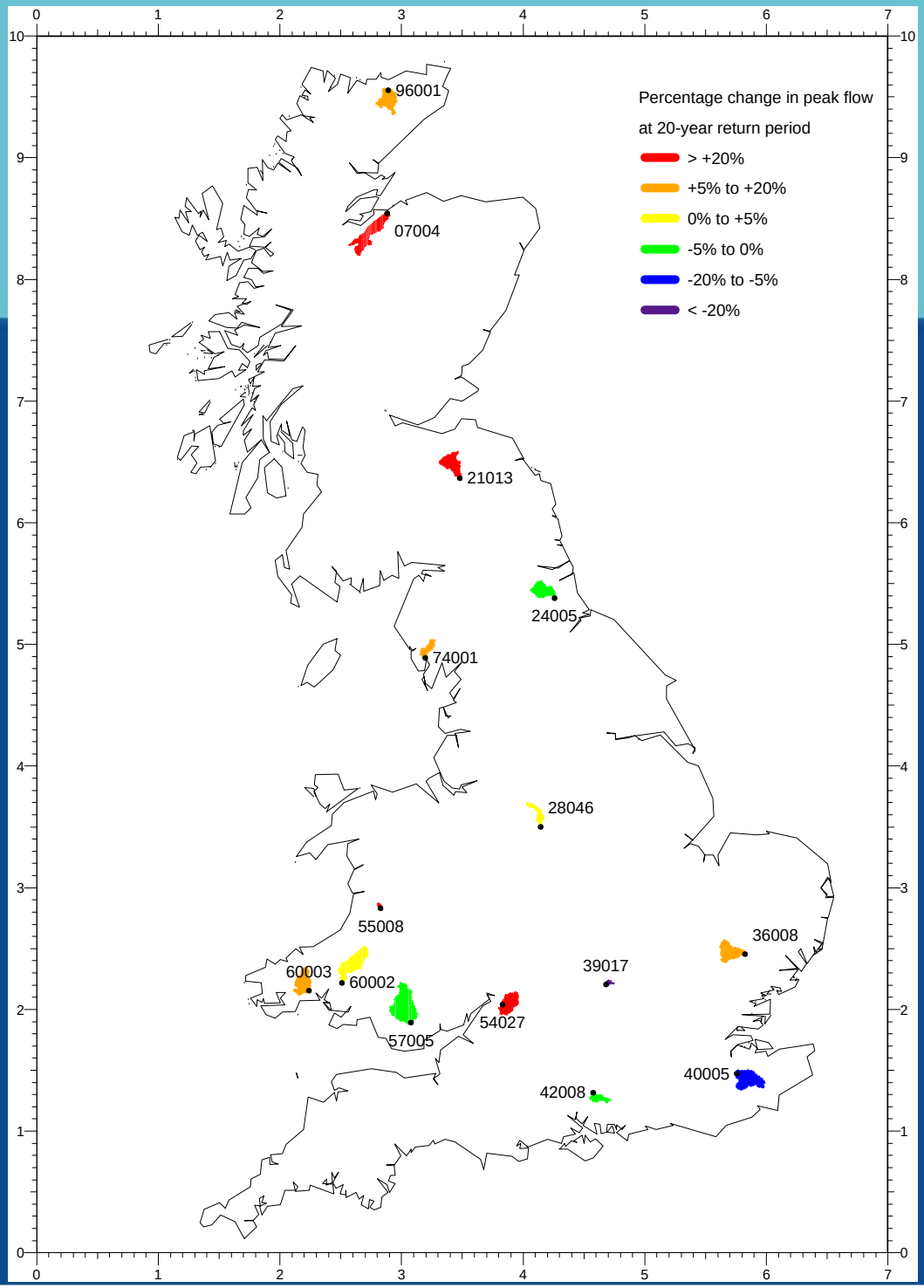


Validation of downscaled nocturnal UHI intensity in London for the summer of 1995:
Grey lines denote observations, **red** the modelled UHI

2. ‘Classic’ impact assessments



Response of invertebrates in the upper Tywi, Wales to increasing temperatures in terms of preferred ranges (left) and abundance (right). Source: EA (under review)



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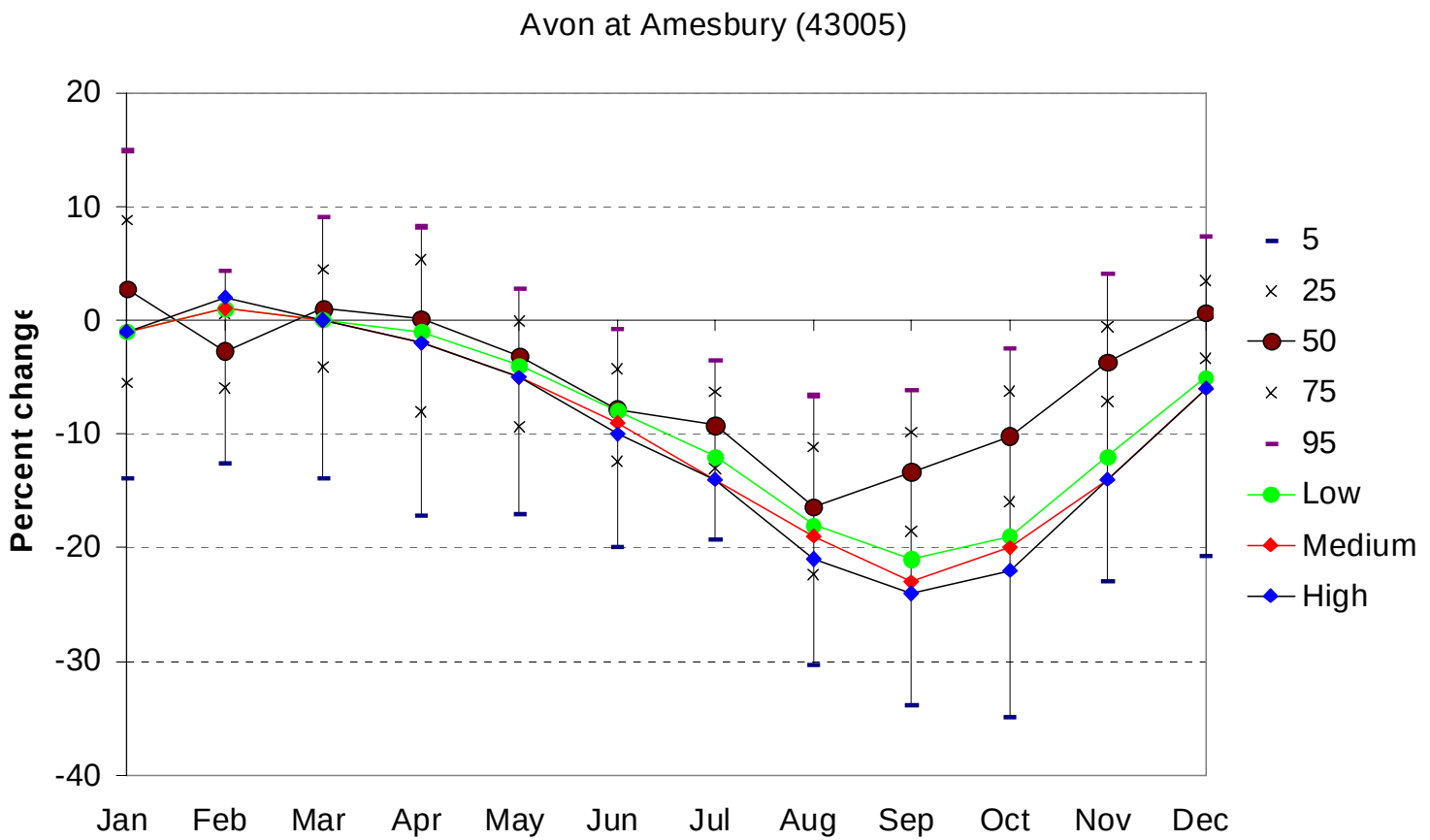
3. Reviewing Defra's 20% sensitivity test for future flood risk

Variations in the 20-year flood by the 2050s under the UKCIP02 Medium-High emissions scenario

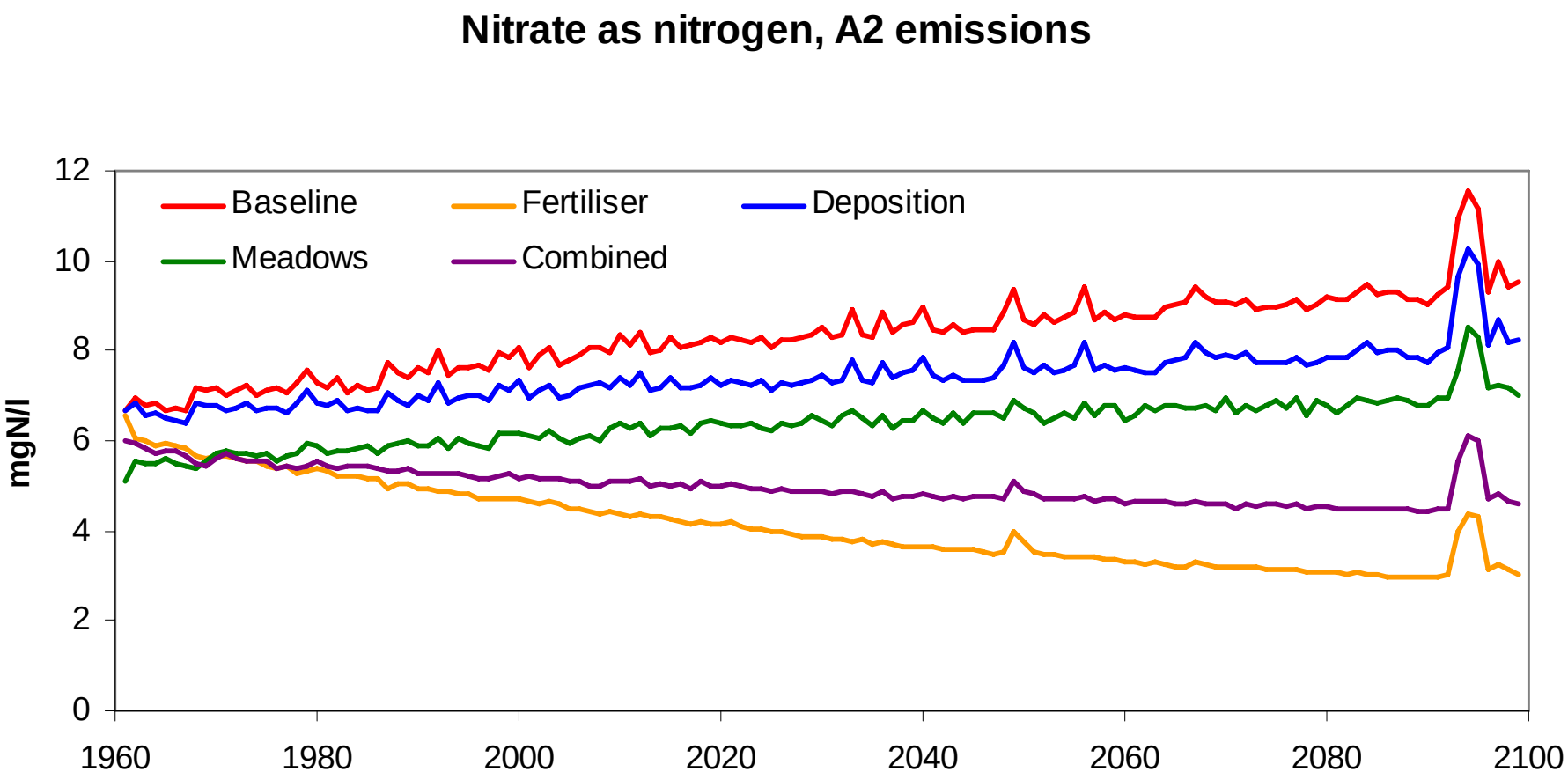
Source: Reynard et al. (2004)

4. Practical methodologies for incorporating climate change in water planning



Example climate change factors for river flow by the 2020s. Source: UKWIR/EA. (2006)

5. Appraisal of adaptation measures



Nitrate concentrations exceeded 5% of the time in the River Kennet modelled by INCA using scenarios downscaled from the HadCM3 A2 emissions run. Source: Whitehead et al. (2006)

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What still needs to be done?

Extreme events: Waves, winds and surge in estuaries

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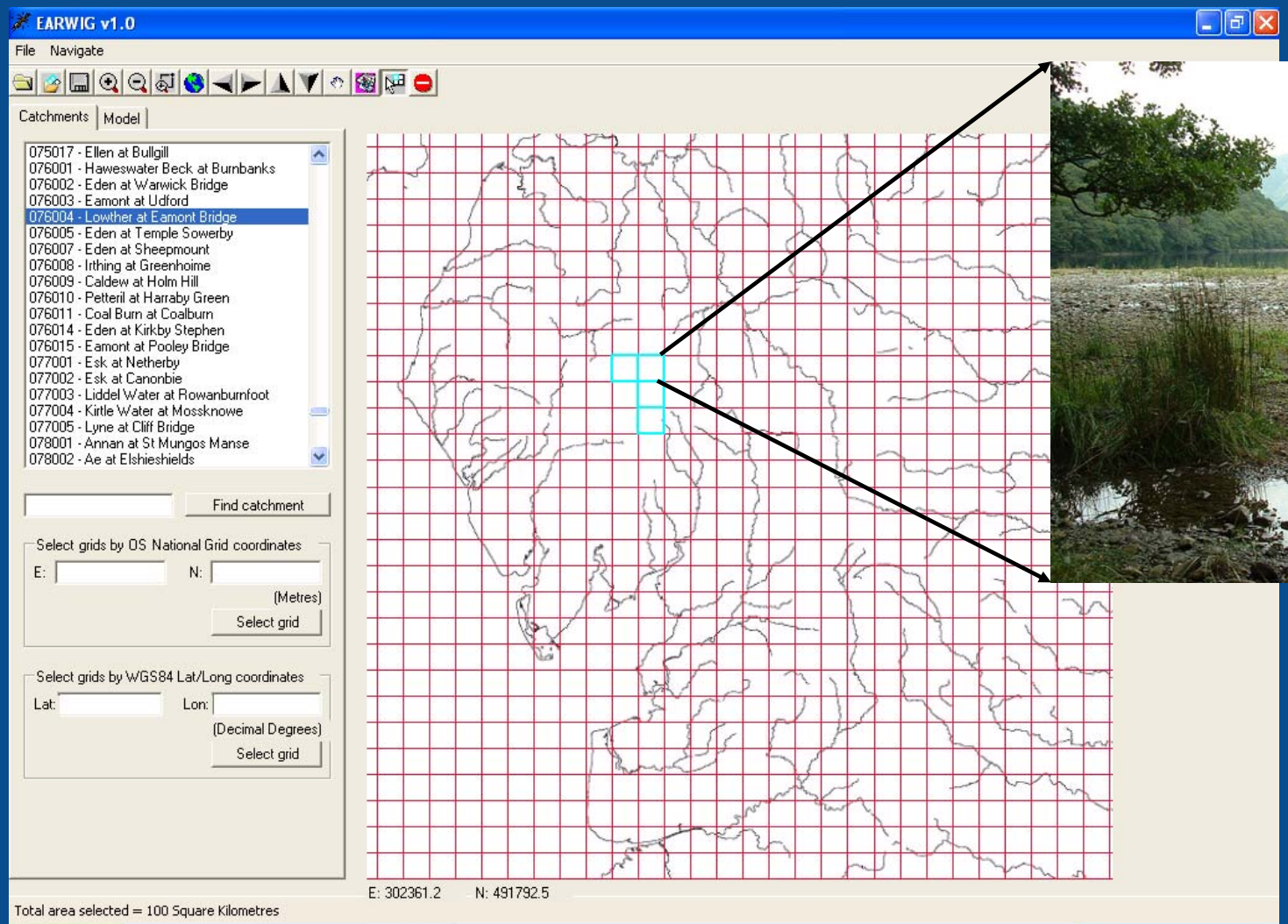
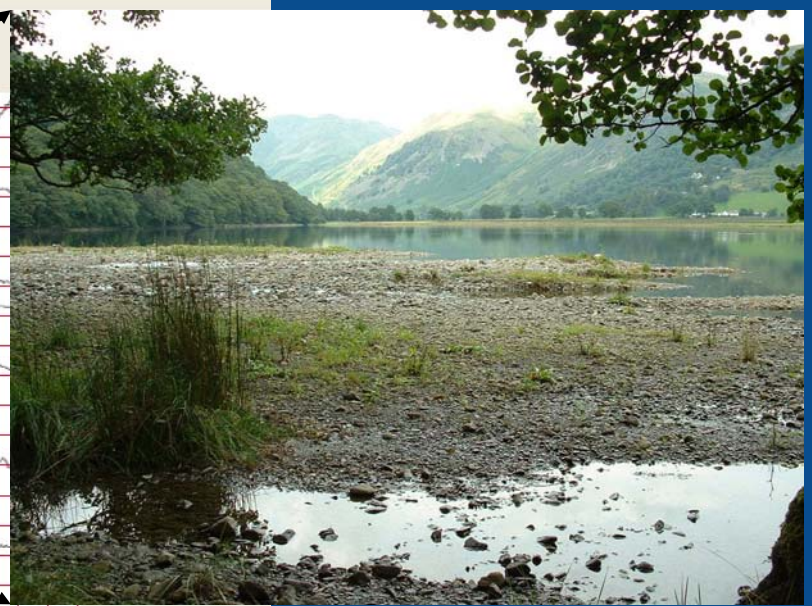
Tools for regional climate change impact assessments





Example screen for the Environment Agency Rainfall and Weather Impacts Generator (EARWIG)

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Concluding remarks

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Six challenges ahead

- Shifting from theoretical downscaling studies to support for climate change adaptation
- Promoting best practise and case studies where downscaling is actually shaping decision-making
- Downscaling within probabilistic frameworks
- Representing uncertainty in terms of *timing*
- Addressing technical challenges of extreme events
- Translating new insights of uncertainty into *practical* guidance for decision-making

Bibliography

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