Navigating uncertainty in climate change impacts on hydrological drought risk

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Climate change poses a severe threat to the environment, and it is essential to be able to evaluate climate-related risk and provide appropriate guidance to decision-makers. In the UK Climate Change Risk Assessment 2017[1], one of the top risks prioritized for further action was “Risk of shortages in the public water supply, and for agriculture, energy generation and industry”. Although there might seem to be no shortage of rain in the UK, there is rapidly increasing demand for water, and storage capacities in some parts of the country are limited.

In the growing world of “big data”, typical assessments of climate change risks involve creating large datasets of potential futures derived from multi-model ensembles. For studies of climate change effects on precipitation or temperature, this involves just climate models; however, when further impacts such as environmental or economic factors are considered, a modelling chain develops. At each stage in this chain, uncertainty is introduced in multiple forms and propagates, creating a “cascade of uncertainty”; see Fig 1. Analyzing all sources of uncertainty is an overwhelming task for most decision makers, so there are increasing calls for smarter approaches to navigate this cascade efficiently, whilst maintaining a probabilistic range of potential future impacts.

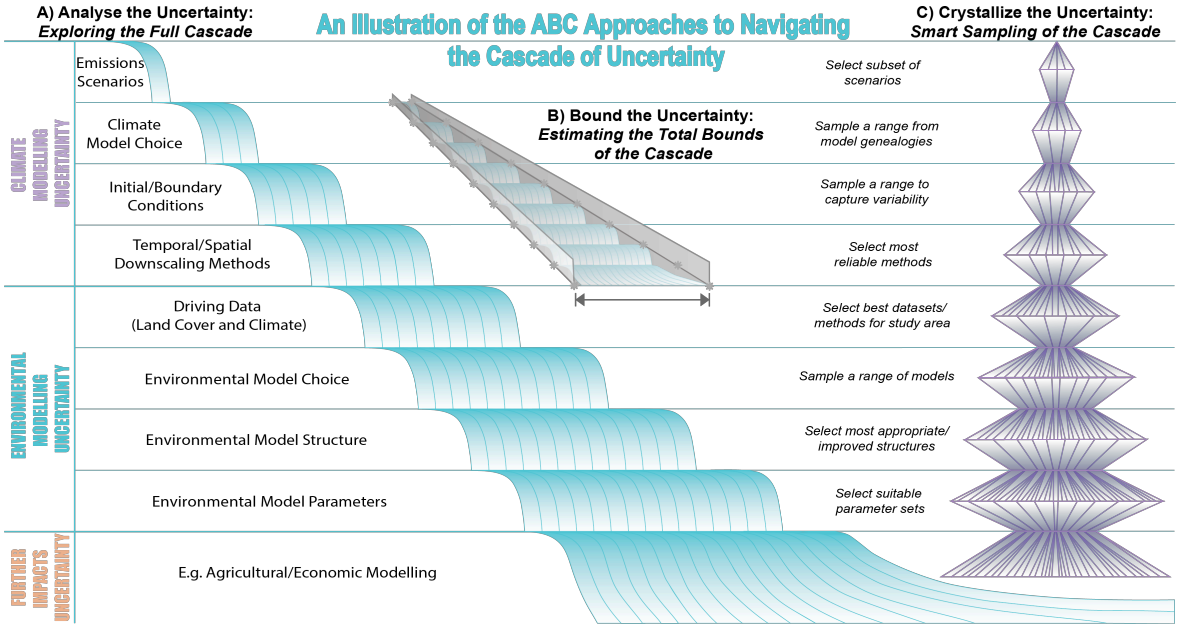

Figure 1 An illustration of the “Analyze”, “Bound” and “Crystallize” approaches to navigating the cascade of uncertainty in environmental impacts of climate change[4].

This project seeks to address this challenge by developing hydrologic storylines[2] of drought risk in the UK, with the help of the supervisory team, who span the modelling chain from meteorology, through hydrology to water resource management. Storylines are physically plausible pathways through the modelling chain without any assumed prior knowledge of probabilities of occurrence[3]. Storylines can crystallize, or more simply bound, the uncertainties in a modelling chain making them easy to interpret, and therefore providing an ideal platform for exploring uncertainty at the science policy interface.

UK climate projections 2018 (UKCP18) will contain probabilistic projections, as well as ensembles of simulations, at global, regional, and national scale. In this project, using expertise from supervisors at the University of Reading and the Centre for Ecology & Hydrology, the storyline approach will be applied to these climate projections and propagated through hydrological models. Working with Anglian Water, these results will then be applied to water resources and reservoir yield models in order to stress test current water resource management plans, and develop drought risk assessments. This work has the potential for direct application in policy via drought risk management plans in the Anglian region, and can provide widely transferable methods to help better manage climate change impacts on drought risk across the UK.

Training opportunities:
This project provides the unique opportunity to work in both research and operational environments, with two work placements. An extended placement of up to 12 months is available at the Centre for Ecology & Hydrology (CEH) Wallingford, working alongside hydrological experts specializing in hydrological modelling and drought analysis. Furthermore, this student is offered a placement with Anglian Water in their Cambridge or Peterborough offices working with water resource managers in the hydrology and supply-demand strategy teams.

Student profile:
This project would be suitable for students with good quantitative skills, including data analysis and basic programming. Interest in numerical modelling and statistical techniques including uncertainty analysis is essential.

Funding particulars:
The project has CASE funding from Anglian Water.

References: [1] **Defra, 2017**, UK Climate Change Risk Assessment, https://www.gov.uk/government/publications/uk-climate-change-risk-assessment-2017. [2]**Clark *et al.*, 2016,** Characterizing uncertainty of the hydrologic impacts of climate change. *Curr. Clim. Change Rep.*, **2**, 55–64, doi: 10.1007/s40641-016-0034-x [3]**Shepherd *et al.* 2018,** Storylines: An alternative approach to representing uncertainty in physical aspects of climate change. *Climatic Change*, in press. [4]**Smith *et al*. 2018**. Navigating cascades of uncertainty – As easy as ABC? Not quite… *J. of Extreme Events, **5**, 1, 1850007.*

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