Quantifying the impacts of climate change on freshwater ecosystems

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The problem to be solved

There is uncertainty in the model-based assessment of the impacts of climate change on freshwaters. This arises from the spatial and temporal uncertainties in Regional Climate Model (RCM) predictions, the use of these predictions at the catchment scale, and parameter and structural uncertainty in impacts models. This work focuses on quantifying the uncertainty in RCM predicted precipitation and how this translates to uncertainty in modelled predictions of the hydrochemical – ecological response.

Methodology

Hydrologically effective rainfall (HER) is the major driving input for the hydro-chemical impacts model, INCA-N. However, RCM predictions for rainfall are known to be unreliable. Therefore, uncertainty shall be addressed by focusing on and comparing two different approaches to simulating daily rainfall data (Fig.1).

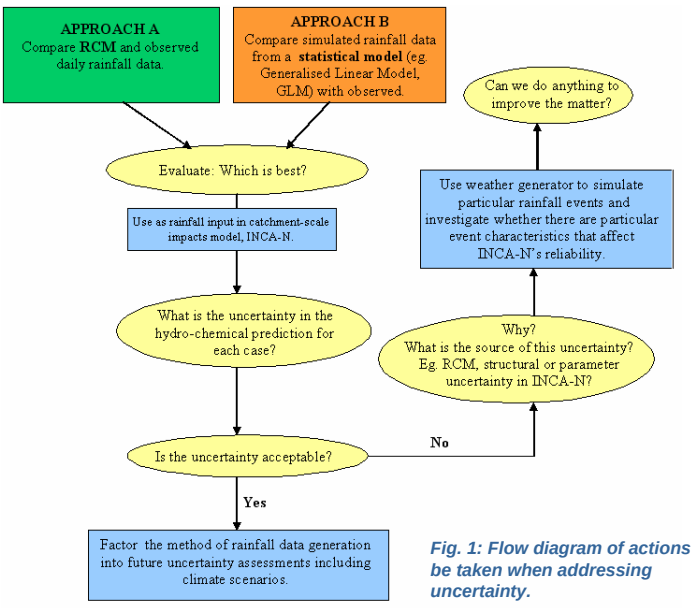

Fig. 1: Flow diagram of actions to be taken when addressing uncertainty.

The Integrated Catchment (INCA) family of models will be used in conjunction with the modelled precipitation, derived from Approach A and B, to model the changes in the freshwater chemistry and ecology in the Kennet river-system.

Study Area – The River Kennet

A chalk stream (1200 km²) in southern England and a major tributary of the River Thames.

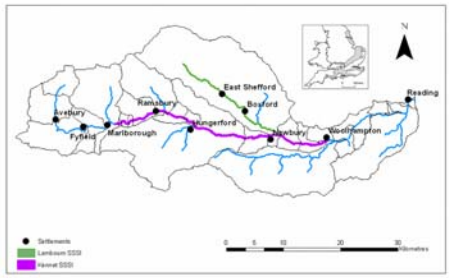

Fig. 2: The River Kennet catchment.

Within the Kennet catchment there is concern about the water quality and ecology due to groundwater abstraction and nutrient inputs, and how climate change may compound these impacts. There is a long history of hydrological, water quality and ecological monitoring in the catchment.

Insight into Approach B – Daily rainfall

Preliminary work was done using data for Tete, Mozambique but the method is general and will be applied for the Kennet next;

- Two Generalised Linear Models (GLMs), 'Probability of rain' and 'Amount of rain per rainy day', were constructed.
- A zero-order Markov Chain model (with no climate change effect taken into account) was considered suitable to estimate the mean amount of rain per rainy day for Tete over the course of a year (Fig.3).
- The amount of rain conditional on probability of rain could then be simulated for a particular day.

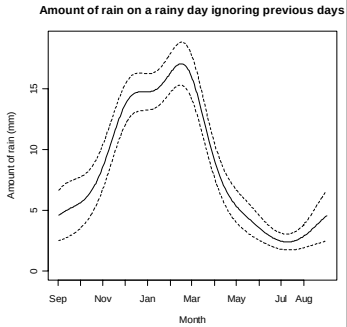

Fig. 3: Predicted amount of rain per rainy day over the course of a year for Tete with 95% confidence intervals.

Work to be completed in Year 1

- Analyse spatial and temporal patterns in observed precipitation data across the Kennet.
- Develop statistical models building on the GLMs for Tete, to account for levels of variation in a Bayesian framework for application to the Kennet.
- Assess whether Approach A or B in conjunction with INCA-N gives the best fit to the observed water quality data for a test period from 1997-2007.

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