National Scale Hydrological Modelling for benchmarking and for quantifying regional differences in catchment processes within an uncertainty framework

Supervisors: Dr Jim Freer (University of Bristol), Dr. Thorsten Wagener (Penn State), and Dr. Sim Reaney (University of Durham).

Value of studentship: Standard NERC tax free stipend (£13590 p.a. in 2010/11), University fees plus Research Training Support Grant (£9700 over three years).

Description of the project

Quantifying hydrological catchment behaviour and understanding why different catchments exhibit different runoff characteristics are fundamental to improving the science of hydrology. Hydrologists are beginning to realise there may be new opportunities to evaluate multiple characteristics (or signatures) of catchment behaviour in a comparative framework analysing many catchments rather than focusing on limited process intensive studies from headwater research catchment sites [Wagener et al., 2007]. This could be seen as a top down approach to hydrological understanding. There is potential that we will begin to learn more about general differences in catchment behaviour that can be effective in regional and national improvements in our predictive capability [i.e. see Oudin et al., 2008; Zhang et al., 2008]. Furthermore we need to think about how to conceptualise these differences within models and how to identify the dominant process representations needed that improve predictions locally. We aim to build on these concepts of catchment similarity by explicitly considering the uncertainties in data and models that are used as tools to understand
differences in catchment behaviour [Bai et al., 2009]. The motivation is to quantify the amount of dissimilarity we can identify from multiple catchments by applying competing models of hydrological behaviour and to explore jointly the worth of data and flexible model structures within the Generalised Likelihood Uncertainty Estimation (GLUE) framework [Beven and Freer, 2001; Krueger et al., 2010; Liu et al., 2009]. We shall utilise some >200 catchments from the UK National River Flow Archive (NRFA) and have at our disposal additional high resolution data sets (on elevation, landuse, rainfall, etc.) to describe multiple catchment characteristics and which quantify and enable us to simulate hydrological responses. Benchmarking predictions in this way will provide a greater understanding of the appropriate modelling tools we need for flood forecasting, for low flow prediction, and for ecological flow indicators. This understanding will be critical to assess how sensitive different catchments are to climate change impacts and to improve the prediction of water quality changes regarding our river systems under legislative frameworks such as the Water Framework Directive (WFD).

Research training will be provided by the School of Geographical Sciences, University of Bristol by Dr. Jim Freer with external supervision from Dr. Thorsten Wagener and Dr. Sim Reaney. The student will receive training in uncertainty analysis techniques (for data analysis and modelling), the development of concepts of hydrological similarity, and understanding of the dominant processes that control hydrological response. Furthermore skills will be developed in computer coding (Matlab and R), Digital Terrain Analysis techniques, the numerical evaluation of complex datasets and the writing of high impact journal papers and presentations at major international meetings. An ability to work in a team atmosphere will be key to the development of this PhD.

At Bristol the student will work in the Hydrology research group currently consists of 4 full time academic staff, 5 Postdoctoral researchers and 10 PhD students. Of these, 8 people are currently engaged in hydrological modelling projects funded by NERC, EPSRC and industry and will be available to provide a network of support and skills for the project.

The School of Geographical Sciences, Bristol is an RAE 6* Department with a formal Graduate School and excellent facilities for doctoral research including high performance computing, software and logistic support essential to the success of such a project.

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**References:**


