Imperial College London

Natural Environment Research Council

2023_03_BGS_Mackay: Conceptual groundwater modelling of global groundwater datasets: learning through large-sample comparative hydrogeology

Supervisors: Dr Jonathan Mackay (mailto:joncka@bgs.ac.uk); Prof Adrian Butler, Dept of Civil and Environmental Engineering; Dr Christopher Jackson, British Geological Survey; Dr John Bloomfield, British Geological Survey

Department: British Geological Survey

Choosing a model of appropriate type and complexity is an inherent problem in environmental modelling, and one which remains a major area of hydrological research [1]. This is because our knowledge of the structure and properties of real systems, the processes operating within them, and our ability to observe them is limited. Many hydrological models have been developed that translate different perceptual models (i.e. descriptions of system features and processes) of the water cycle into conceptual models (i.e. representation by equations), and then modelling code, to simulate a component of the system – most often river flow. These various models can be thought of as representing hypotheses about the real system, but the differences between them are not well-understood. By comparing the performance of multiple conceptual hydrological models the hypotheses can be tested, and knowledge about the processes operating gained; this is an active area of research in rainfall-runoff modelling [e.g. 2]. In contrast, within hydrogeological science the application of more physics-based modelling methods, in which underlying governing equations describing continuity of mass and momentum are solved, has been more common. The application of conceptual modelling methods to groundwater systems, as a means to advance process understanding, has had limited attention. However, their use in hydrogeology is becoming more common, for example, to simulate and forecast groundwater level time-series [3,4], and their further development, evaluation, and application to UK, European and global aquifers is the focus of this PhD project.

The project will investigate the structure, complexity and performance of conceptual groundwater models in simulating observations of groundwater systems, using groundwater level time-series and river flow data. The aim is to identify appropriate model structures in a range of hydrogeological and climate settings. The project will use groundwater level data from a number of sources including: i) the Environment Agency and BGS groundwater level monitoring archive; ii) data made available through the European Groundwater Drought Initiative project [5]; and iii) data from the Global Groundwater Information System.

In addition to examining whether the application of a range of model structures in many locations and settings can improve knowledge of hydrogeological processes and properties, the project will investigate model forecast skill and predictive uncertainty over a range of time-scales. It is envisaged that the resulting models will be incorporated into operational forecasting systems [e.g. 6], and improve assessments of the impact of climate change on groundwater resources.

1. https://doi.org/10.1111/gwat.12554
2. https://doi.org/10.1029/2019WR025975
3. https://doi.org/10.1016/j.jhydrol.2015.10.018

4. https://doi.org/10.1029/2020WR028056
5. https://doi.org/10.5194/piahs-383-297-2020
6. https://doi.org/10.1080/02626667.2017.1395032

For more information on how to apply to us please visit: *https://www.imperial.ac.uk/grantham/education*