2021_11: Conceptual modelling of global groundwater variability and change

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Groundwater is the World's largest distributed store of fresh water and the primary water source for over 2 billion people worldwide1. Water storage dynamics of groundwater systems are directly influenced by climate variability through groundwater recharge processes2. Even so, aquifers are more resilient to climate extremes than surface water systems, making them strategically important in meeting global water demand as climate extremes intensify over the coming decades3. Our understanding of regional variations in global groundwater response to climate variability and change is currently limited. This is partly because the mechanisms that underpin groundwater response to climate variability are highly site-specific and difficult to generalise across large scales4.

This project will investigate global groundwater response to climate variability through developing a network of conceptual groundwater models across the World's principal aquifers. The network will be underpinned by a flexible and parsimonious groundwater model code developed at the BGS which simulates groundwater level time series at observation boreholes5. The code can be used to test different conceptualisations of groundwater processes (soil hydrology, unsaturated flow and saturated groundwater flow) across a range of climate and hydrogeological settings.

The project will make use of groundwater level data from a number of sources including: 1) the Environment Agency and BGS groundwater level monitoring archive; 2) data made available through the European Groundwater Drought Initiative project6; and 3) data from the Global Groundwater Information System. It is envisaged that the project will consist of three main stages. The first stage will implement a range of conceptual models of soil hydrology, unsaturated flow and saturated groundwater flow in the groundwater model. These models will be calibrated for a small number of boreholes with covering different climate and hydrogeological settings with the aim of automating this calibration approach. After this, a global network of models will be calibrated for a larger number of boreholes (100s to 1000s) with the aim of evaluating regional differences in model structure and parameter suitability, thereby providing new process understanding. Finally, the extended global network of conceptual groundwater models will be used to investigate regional variations in groundwater level response to climate variability. This could, for example, include the use of climate change scenarios to evaluate how global groundwater levels respond to climate change over the coming decades.

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[4] Cuthbert, M.O., et al. 2019. Nature. 572, 230-234.

[5] Mackay, J.D., et al. 2014. Environmental Modelling and Software. 61, 229-245.

[6] Brauns, B., et al. 2020. Proc. IAHS, 383, 297–305.