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Improving the representation of surface-groundwater and human-water interactions in a coupled surface-subsurface water model

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Groundwater is a vital component of the hydrologic cycle and also the largest human and ecosystem accessible freshwater storage, which plays an important role in many hydrological processes. However, in groundwater-dominated catchments where inter-catchment groundwater flow through subsurface flow pathways, most hydrological models lack explicit representations of these transboundary surface-subsurface interactions, resulting poor performance in hydrological predictions. Additional complexity introduced by intense groundwater abstractions and management schemes are also poorly represented in current hydrological models, which hinders accurate hydrological simulations. Therefore, developing integrated modelling frameworks for simulating the interactions between surface water, groundwater and human influences is needed for accurate hydrological predictions in these regions.

DECIPHeR is a flexible hydrological modelling framework, which has demonstrated its good performance across a diverse range of catchments in Great Britain. However, in groundwater-dominated catchments, enhancements are needed in representing surface-subsurface water interactions for better model performance. This study integrates a national-scale groundwater model into DECIPHeR. We will utilize observational hydro-meteorological data to calibrate and validate the coupled model across 475 catchments. Additionally, a large sample of groundwater level data (over 3000 sites) in England will be used to further evaluate the model. Initial tests show that the coupled model outperforms DECIPHeR in Chalk catchments and also performs well (KGE>0.6) in other geology. The coupled models enable the assessment of surface-groundwater impacts, facilitating the potential quantification of human-water interactions, i.e. groundwater abstractions, on hydrological simulations. This analysis aims to support effective water supply and demand management strategies across Great Britain by providing insights into the influence of surface-groundwater interactions on the hydrological system.