

Project Title: Development of a national groundwater flood inundation modelling and forecasting platform

Lead Institution/Department: British Geological Survey and University of Bristol, School of Geographical Sciences

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Summary

It has been estimated that 4.7 million properties are susceptible to flooding from groundwater within the UK; 1.5 million from clearwater flooding and 3.2 million from rising groundwater in permeable superficial deposits. Whilst we have estimates of susceptibility, we do not currently possess tools to simulate and forecast the spatial extent of groundwater flooding, nor groundwater flood risk, nationally. Current groundwater flood forecasts are based on models of groundwater levels at observation boreholes, which use 'trigger levels' to initiate groundwater flood warnings. Consequently, the spatial extent of a forecasted groundwater flood has to be inferred from point data. A small number of studies have developed approaches to integrate the modelling of groundwater discharge at the land surface, resulting surface water flows, and flood inundation, but these have all been applied over small areas.

This study will investigate approaches to develop a national scale groundwater flood modelling system, which integrates distributed groundwater and surface water flood modelling codes, to simulate and forecast the spatio-temporal extent of flood events. The research will aim to support the flood hazard modelling and forecasting community e.g. the operational flood forecasting and warning service of the Met-Office-EA Flood Forecasting Centre, and wider FLOOD-CDT partners and stakeholders.

Methods

The British Groundwater Model (BGWM; Bianchi et al., 2024) will provide the underpinning tool to simulate groundwater levels and emergence across Britain. We will assess the limitations of the BGWM and implement required changes (e.g. relating to spatial and temporal resolution, structure / parameterisation) considering performance metrics focusing on simulating peak groundwater levels. The student will investigate model errors and consider approaches to correct for these when coupling it to a surface water flood inundation model; potentially involving machine learning methods.

Approaches to model surface water flood inundation, driven by groundwater, will be investigated. This could involve the transfer of simulated groundwater discharges (i.e. data) between models, or potentially the integration of groundwater and surface water flood inundation modelling *code* (e.g. as done by Collins et al., 2020, who integrated Bristol's Lisflood-FP code into a BGS groundwater code). The use of Fathom's national surface water flood inundation model (Bates et al., 2024), and its linkage to the BGWM, will be explored.

Performance of the modelling framework in forecasting groundwater flooding will be quantified. This will make use of historical observations of groundwater floods, such as groundwater level time-series, and field observations and aerial imagery (e.g. as collected by the EA) of flood extents.

Background reading and references

Bates PD, Savage J, Wing O, Quinn N, Sampson C, Neal J, Smith A. (2023). A climate-conditioned catastrophe risk model for UK flooding, *Nat. Hazards Earth Syst. Sci.*, 23, 891–908, <https://doi.org/10.5194/nhess-23-891-2023>.

Bianchi M, Scheidegger J, Hughes AG, Jackson CR, Lee J, Lewis M, Mansour M, Newell A, Ó Dochartaigh B, Patton A, Dadson S. (2024). Simulation of national-scale groundwater dynamics in geologically complex aquifer systems: an example from Great Britain. Submitted to *Hydrological Sciences Journal*.

Collins SL, Christelis V, Jackson CR, Mansour MM, Macdonald DM, Barkwith AK. (2020). Towards integrated flood inundation modelling in groundwater-dominated catchments. *Journal of Hydrology*, 591:125755. <https://doi.org/10.1016/j.jhydrol.2020.125755>

How to Apply: The deadline for this position is 8th April 2024. The studentship will begin in September 2024. Please apply to the “PhD in Geographical Sciences (Physical Geography)” at <https://www.bristol.ac.uk/study/postgraduate/apply/>