Groundwater flooding under extreme events: An integrated modelling study

Dr Andrew Hughes[+], Dr John Bloomfield*, Dr Chris Jackson* and Prof Denis Peach[+]

[+] British Geological Survey – Keyworth *British Geological Survey - Wallingford

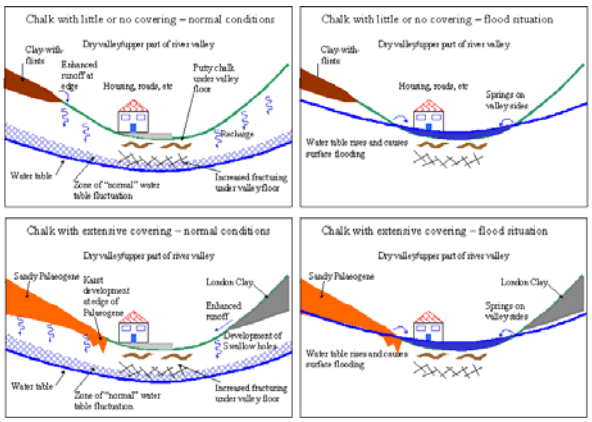
Key questions

- What are the processes that control groundwater flooding in Chalk catchments?
- Can they be quantified and simulated in a modelling system?
- Can the complex, process based models be represented by "simpler" statistical models?

Background to study

The costs and impacts of groundwater flooding in the UK are significant and almost certainly underestimated. Recent obvious examples include the widespread disruption and damage for many communities in southern England in the winter of 2000/2001 and the flooding of Chichester in 1993/94. The Chalk is the most vulnerable aquifer because its storage characteristics lead to rapid and large changes in groundwater levels, which can result in unexpected flooding events. Examples of different mechanisms found in Chalk catchments are illustrated below.

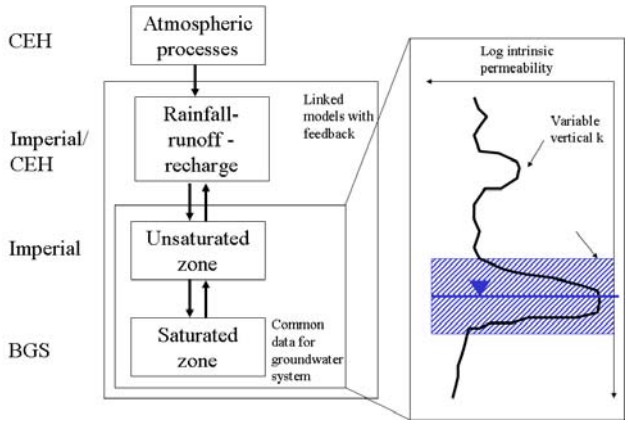
However, *there are no currently available methodologies applicable to any of the major UK aquifers that link rainfall to groundwater flood risk.*



Methodology

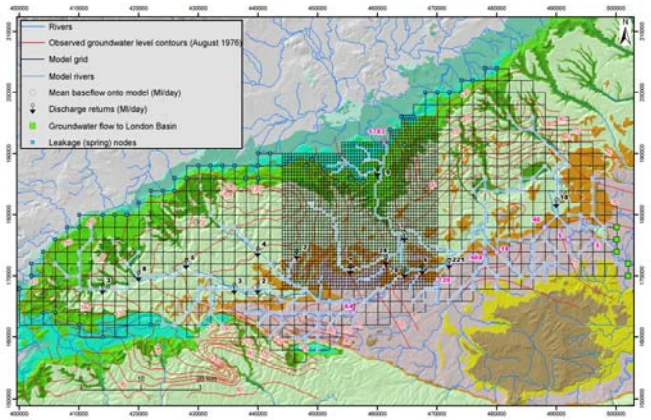
A 3D catchment scale modelling tool will be developed that will incorporate different levels of detail within an adaptive modelling framework using the object-orientated ZOOM groundwater modelling software. It will be developed and tested using detailed data sets available from the Pang and Lambourn catchments and Brighton. At the large (catchment) scale it will consist of the CEH JULES model of land surface and near-surface flow processes, linked to the groundwater model via a spatially-distributed unsaturated zone transfer function (see above diagram).

The models will be linked using the OpenMI interface, a EU funded modelling standard.



Groundwater modelling

A key issue is understanding and simulating the impact of the rise of the water table in response to high rainfall events. The Chalk in the UK is assumed to be layered with high hydraulic conductivity associated with the zone of water level fluctuation. As the water table rises it encounters Chalk with different properties, which will affect the rate of rise. The change in saturation over the UZ-SZ column is thought key to controlling the rate of rise of the water table and hence flooding. The challenge for the project is to encapsulate this mechanism into an existing groundwater flow model of the area (see below).



Simple time series modelling

Detailed numerical process modelling may not be appropriate or achievable over the whole of the Chalk, so another, simpler method is required. Statistical techniques can be used to quickly develop a simple model linking rainfall and groundwater level to predict groundwater level. The basic aim will be to identify transfer function models such as Box-Jenkins will be identified using historical rainfall and groundwater level time series. Having developed the model it will be used to predict (with specified uncertainty) groundwater level, prediction (with specified uncertainty) will be undertaken on groundwater level. The Rainfall sequences generated by the RCM/GCM will be used to undertake predictions both in the catchments studies and in areas of the Chalk where groundwater flooding has occurred.

Find out more…

Contact: Andrew Hughes aghug@bgs.ac.uk