

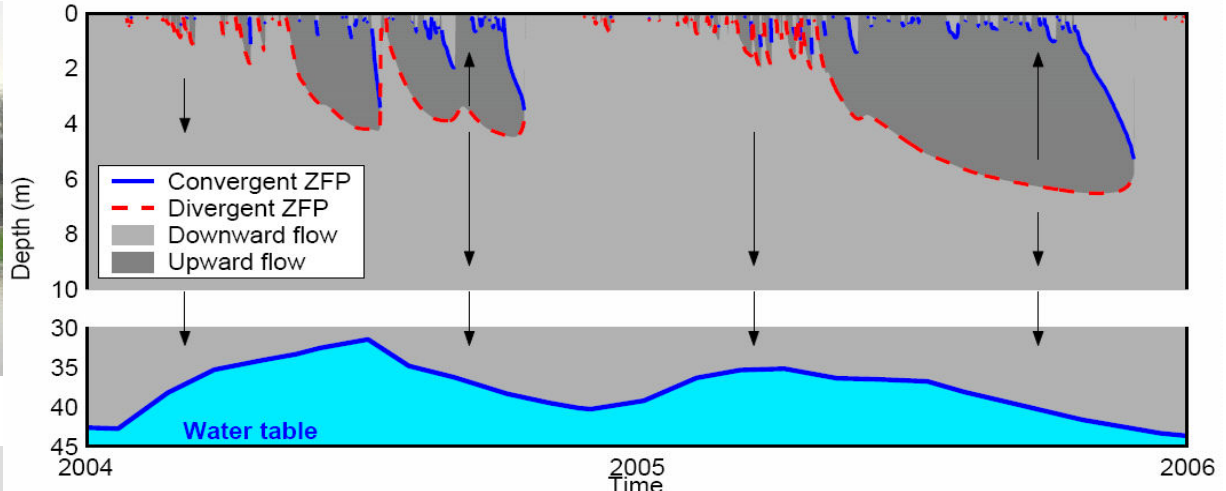
Flood Risk from Extreme Events (FREE): Groundwater flooding

A collaborative project between Imperial College London¹, the British Geological Survey² and the Centre for Ecology and Hydrology, Wallingford³

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Groundwater flooding in 2000, in Farringdon, Hampshire (Jacobs, 2006)



Simulated seasonal flow patterns throughout the entire unsaturated Chalk profile, showing how recharge to the water table is likely to be continuous

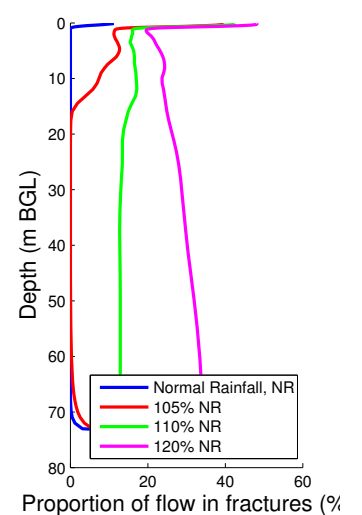
Research objectives

Groundwater flooding poses a serious risk to property, infrastructure and social disruption, and is a particular problem for the Chalk of South East England. A collaborative project is being undertaken by Imperial College London, BGS and CEH, which aims to:

- Develop an improved conceptual model of the processes occurring in groundwater flooding in Chalk catchments.
- Develop a methodology for linking existing and new models within an integrated decision support system.
- Use case studies to test the conceptual model, investigate system response, and demonstrate the utility of model integration.
- Use the modelling system with GCM/RCM scenarios to assess likely future groundwater flooding frequency.
- Develop and evaluate simpler methods for forecasting and regional assessment of groundwater flood risk.

Recharge sensitivity to rainfall

The period studied (2004-5) received unusually low rainfall. To examine the impact of higher rainfall, a sensitivity study was carried out whereby the total volume of rainfall was increased by up to 20%. Activation of rapid flow pathways in the fractures was highly sensitive to rainfall. Under normal rainfall conditions, fracture flow only occurred in the very near surface. An increase in rainfall of 10% leads large amounts of fracture flow throughout the entire profile (see right) and to significant changes in the recharge patterns over time (see below). This is a non-linear process, where relatively modest increases in rainfall may result in radically different recharge, and hence water table responses.



The Chalk unsaturated zone (CUZ)

The CUZ plays a crucial role in the transmission of rainfall to the water table. Chalk is a fractured porous medium. Understanding of the flow processes in the CUZ is incomplete. In this research, these processes are investigated using a 1D, dual permeability model developed at Imperial under the LOCAR programme. The model represents CUZ fracture and matrix flow based on a Richards' equation formulation, with fully coupled soil and weathered Chalk layers. The model has been successfully verified against observed soil moisture data from the top 4 m of the profile.

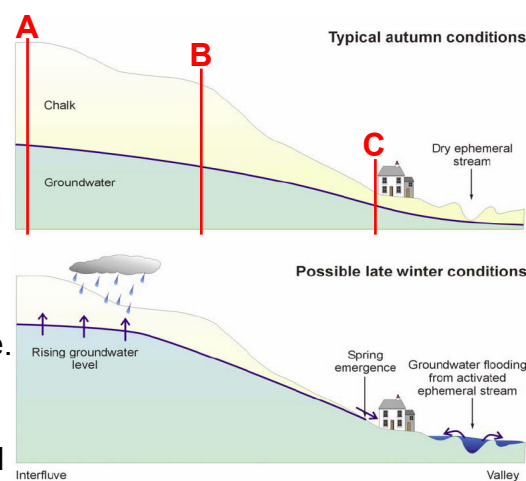
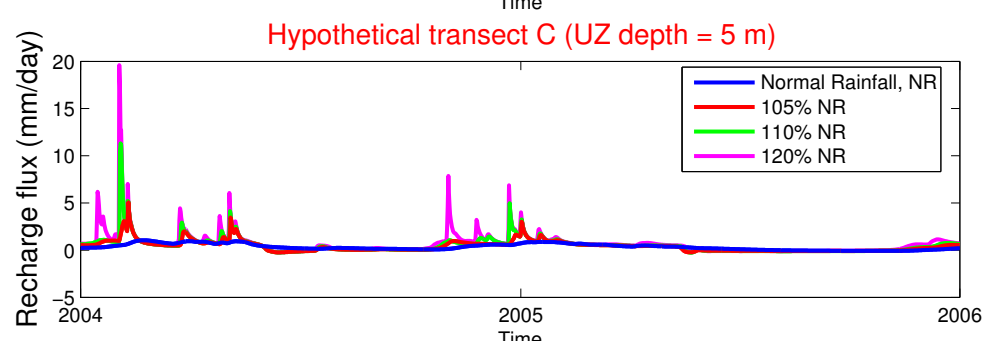
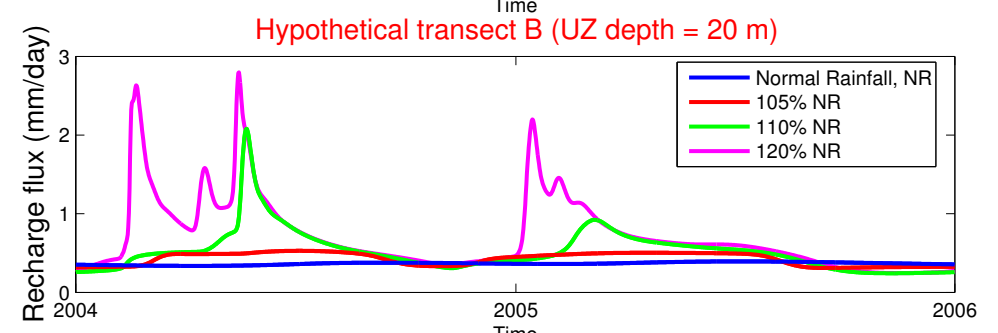
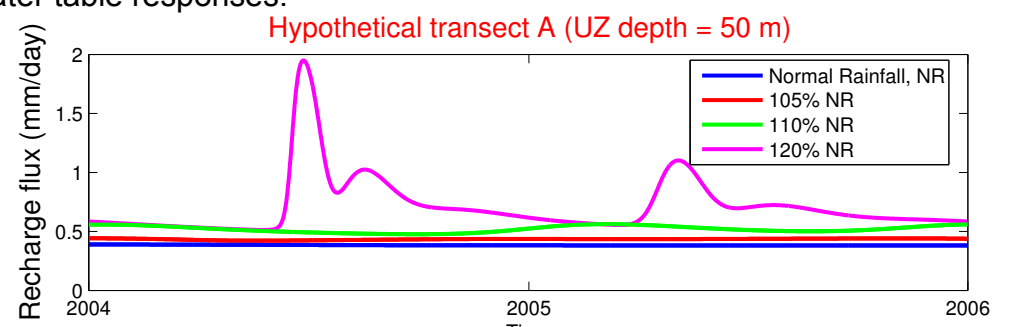


Illustration of the mechanism of groundwater flooding in response to prolonged rainfall (Jacobs, 2006)



Flow through the profile

The model simulates flows throughout the profile over time. For the period studied, flow was predominantly transmitted through the matrix pores. In the summer, zero flux planes developed to significant depths. As a result:

- Evaporative demand is likely to be satisfied (i.e. $AE \approx PE$);
- Significant recharge is likely to occur throughout the entire year, even during summer, and the concept of soil moisture deficit is redundant;
- Calculations of specific yield of the saturated zone should account for drainage from the unsaturated zone, which is likely to be significant.

Future work will seek to corroborate the model with data collected during wetter conditions (2006/7) and extend it to represent a 2D hill slope, with a coupled unsaturated/saturated zone. This will enable us to simulate the water table response to rainfall, gain insights into groundwater flooding, and inform the development of risk assessment tools.

Find out more...

Ireson, A.M., Wheater, H. S., Butler, A. P., Finch, J.W., Cooper, J.D. and Mathias, S. A. (2006) Hydrological processes in the Chalk unsaturated zone - inferences from an intensive monitoring system *J. Hydrol.*, 330, 29-43.
Jacobs (2006) *Making space for water - Groundwater flooding records collation, monitoring and risk assessment (reference HA5): Extended report (Chalk aquifers)*, Environment Agency
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