British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Demonstration Test Catchments — the role of hydrogeological conceptual modelling

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Introduction

Agricultural diffuse pollution, particularly from nitrate and phosphate, is a significant problem in the UK and is the focus of the national Demonstration Test Catchments (DTC) study — a UK Government initiative.

The DTC programme is providing evidence for investigating how on-farm mitigation measures can reduce the impact of agricultural diffuse water pollution on ecological function. This will involve studying how such measures affect pollutant concentrations in so-called receptors, such as the streams which drain the catchments. It is therefore important to investigate how water moves from the land surface to the receptors and in particular to quantify the amounts and timescales involved in the different water flow routes.

The DTC catchments are the Eden, the Avon and the Wensum and groundwater flow is a significant component of main river flow in all of the catchments, ranging in overall terms from around 50% of river flow in the Eden to 90% in the Avon. It is therefore important that robust conceptual models of the groundwater flow systems of the catchments — and in particular of the monitored sub-catchments — are developed.

BGS is contributing to the creation of DTC groundwater conceptual models in all three study catchments. The BGS work is funded principally by NERC and by DEFRA.

Conclusion

- BGS is helping to construct conceptual models of the groundwater flow systems of DTC sub-catchments.
- As a result of geological variations, groundwater is significant in many of the sub-catchments and the subsurface flow systems are commonly complex, with a spectrum of travel times (Figure 6).
- This result is important for understanding both pollutant behaviour and for catchment management, because it implies that groundwater flow systems can strongly influence both the degree and the timing of the impact of on-farm mitigation measures on river receptor pollution.

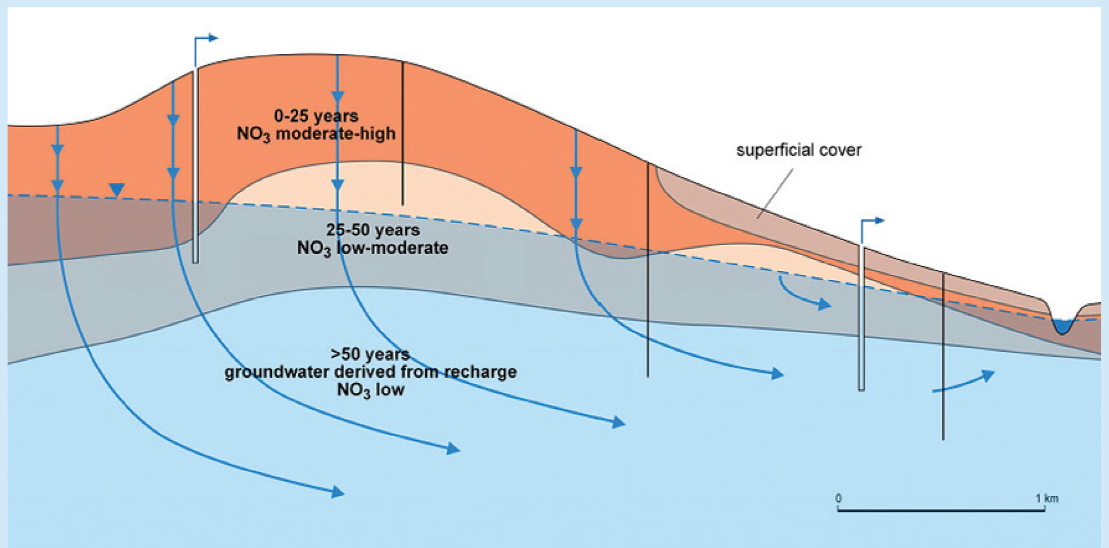

Figure 6 Example of variable groundwater flow paths and travel times.

Eden DTC

In the Eden DTC, the nature of glacial deposits (till) can have a significant effect on groundwater flow routes to streams. Drilling in one of the DTC sub-catchments has shown that while the till sequence mainly consists of clay it also contains layers of sand and gravel (Figure 1). These sands are likely to be permeable and are known to provide subsurface drainage pathways to a stream (Figure 2). Further work, in conjunction with Lancaster University, will investigate the timescales of water movement from the ground surface to the stream.

Figure 1 Borehole core sample showing sand and gravel within the till (scale lines at 5 cm intervals).

Figure 2 Drainage from sands in the till to a stream.

Wensum DTC

The Chalk aquifer in Norfolk is overlain and confined by a thick and complex sequence of Quaternary deposits laid down by glacial activity. BGS has undertaken work in conjunction with the University of East Anglia to obtain and examine pore waters from drilling core from the Quaternary deposits. Analyses of the pore waters (Figure 5) provides information on the processes occurring in these deposits which assists understanding of groundwater movement through the sequence into the underlying Chalk aquifer.

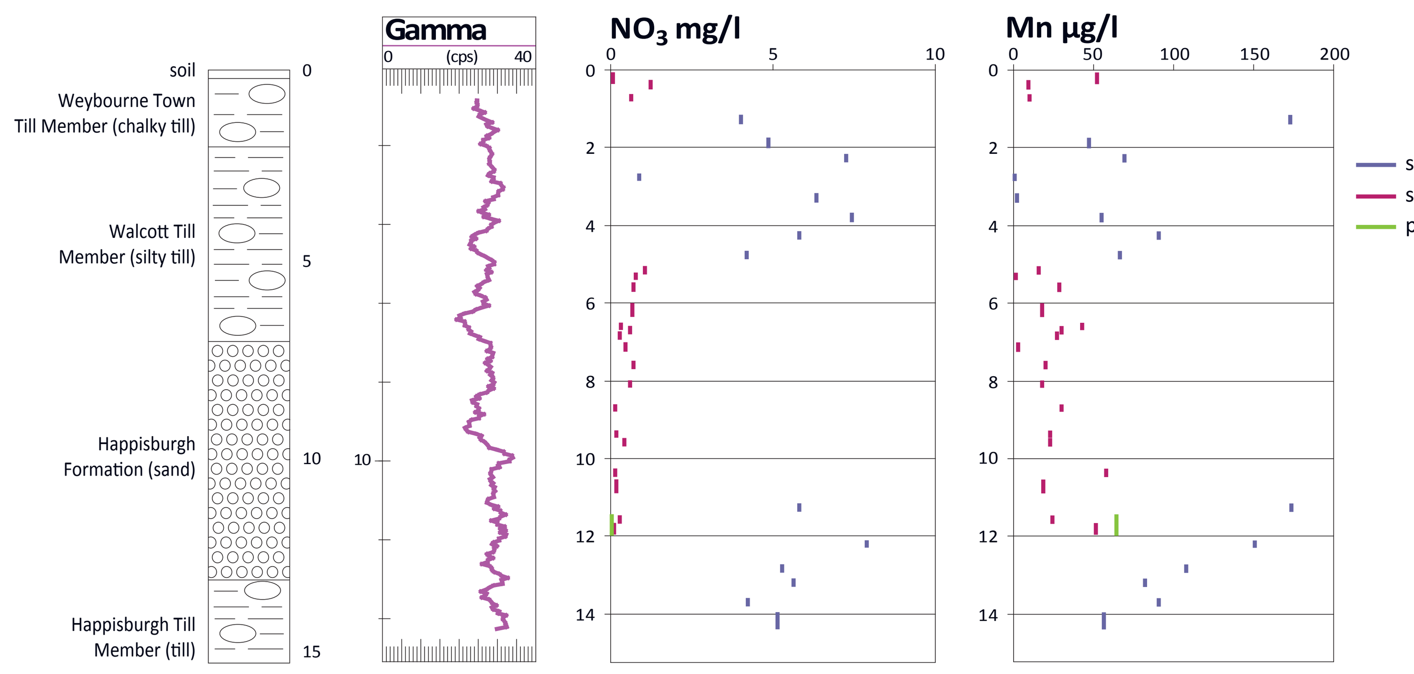

Figure 5 Lithology, gamma log and nitrate and manganese pore water profiles form a Wensum DTC borehole.

Avon DTC

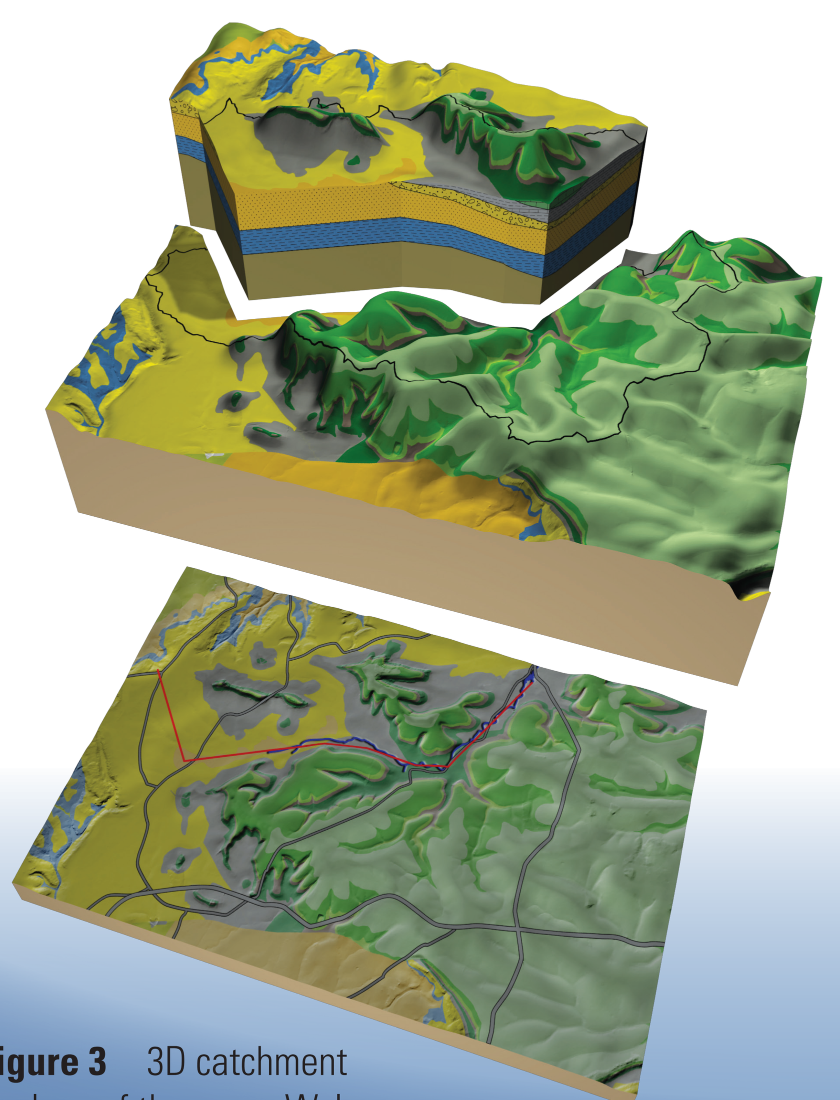

Figure 3 3D catchment geology of the upper Wylye.

Geological variations in the Avon DTC have a significant effect on how stream flows change along a river's course. For example, in the Wylye sub-catchment around 90% of river flow is supplied by groundwater and the hydrogeology is dominated by the Chalk and Upper Greensand aquifers (Figure 3). Variations in the physical properties of these aquifers result in complex groundwater systems, with the river supported by springs whose locations are strongly controlled by the geology (Figure 4). It is likely that the groundwaters feeding the river will have followed a variety of subsurface flow routes and have a range of residence times, which will affect the nature of pollutant loads.

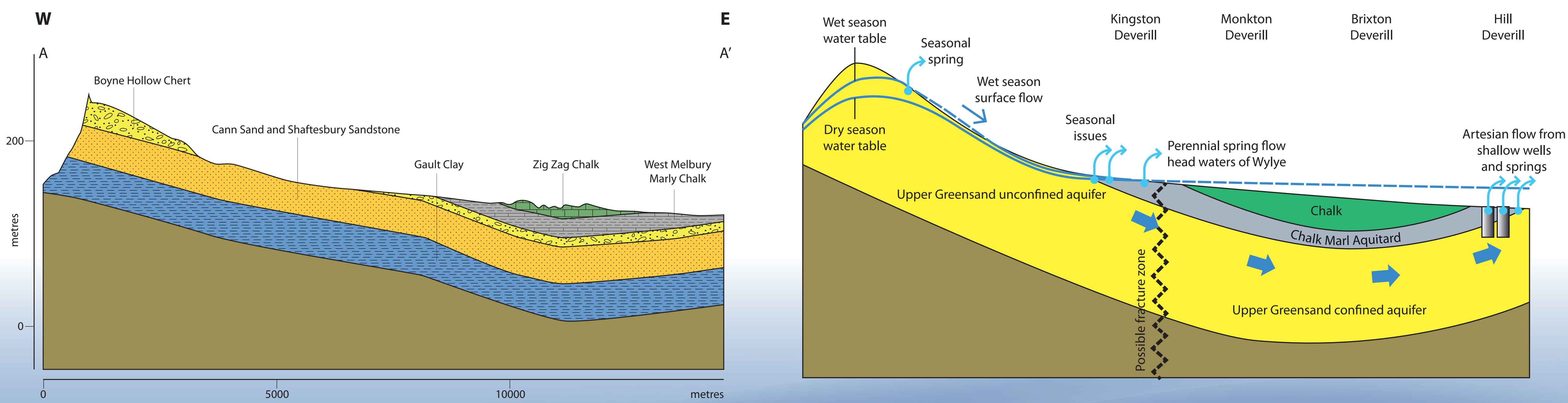

Figure 4 Conceptualisation of geological control on groundwater flow in the upper Wylye.

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