OR/16/033 Introduction

Stuart, M E, Ward, R S, Ascott, M, and Hart A J[1]. 2016. Regulatory practice and transport modelling for nitrate pollution in groundwater. *British Geological Survey Internal Report*, OR/16/033.
[1] *Environment Agency*

Background

The increase of nitrate in groundwater was first identified as a local issue for the Chalk of the Eastbourne area in the 1970s (Greene and Walker, 1970[1]). Awareness of the extent of high and rising nitrate in groundwater gradually increased, and it became clear that concentrations in public supply sources often exceeded the WHO values used at the time (Foster and Young, 1980[2]). By the late 1970s the importance of storage of nitrate in unsaturated zone porewater was becoming recognised (Foster and Crease, 1974[3]; Foster and Young, 1980[2]; Oakes et al., 1981[4]; Young et al., 1976b[5]). Pioneering work in understanding nitrate leaching to groundwater was carried out by drilling cored boreholes through the Chalk unsaturated zone to obtain profiles of porewater nitrate concentration as a function of depth (Foster et al., 1982[6]; Young et al., 1976b[5]) . At sites with good cropping records a relationship between historical land use and porewater nitrate concentration could be determined. This showed that retention in the unsaturated zone can retard the migration of nitrate for years or decades. Similar concerns about nitrate in water were raised across Europe and the Nitrates Directive (91/676/EEC) was ratified which sets out a series of requirements on Member States to assess and control the potential for pollution of waters with nitrogenous compounds generated from agricultural sources. In England, the Environment Agency has been asked to advise Defra on this matter and propose areas subject to pollution or at risk of pollution for designation as nitrate vulnerable zones (NVZs) in compliance with the relevant regulations.

For groundwater NVZs the Environment Agency have developed and published a numerical risk model which uses a range of risk factors including both nitrate concentration data and nitrate-loading data to assess the risk of nitrate pollution. The loading data are based on the NEAP-N algorithms developed by ADAS (Lord and Anthony, 2000[7]). The risk model considers both current and predicted future concentrations as well as current loadings.

However, this approach has a number of disadvantages including a lack of a specific term for the time of travel to the water table and emergence of pollutant both into groundwater and to groundwater discharge points that support surface water features. Instead, these issues are considered at the conceptual level in workshops with local EA hydrogeologists.

A key question for Defra and the Agency is how long it will take for nitrate concentrations to peak and then stabilise at an acceptable, lower level, in response to existing and future land management control measures. This is most important for soils, aquifers, lakes and groundwater-fed wetland systems that respond less quickly to changes in loading. Groundwater and lake catchment numerical models can provide first-order estimates of likely response times, but can be difficult and costly to set up for many different situations and are difficult to apply consistently at the national scale.

A previous review of nitrate vulnerable zones (ENTEC, 2009[8]) suggests a range of further needs:

- to understand the recent developments in nitrate pollution simulation and particularly the

potential to understand/characterise past nitrate loading from changing land management practices and correlate these with observed nitrate concentrations over time;
- to evaluate the retention of nitrate in catchments, particularly in unsaturated zone of soils and aquifers;
- to examine the recent and future anticipated decreases in nitrate loading by sectors within the UK;
- to understand the likely time taken for nitrate concentrations to peak and then stabilise at an acceptable, lower level, in response to existing and future control measures. Without evidence of how long it may take systems to recover, it is difficult to evaluate the effectiveness of existing measures or decide whether additional measures are necessary.

Project objectives

The aim of the project is to investigate the potential use of new numerical models to inform decision-making on nitrate pollution in groundwater and the potential for giving consideration to incorporating such models of unsaturated zone processes in the NVZ process. The work described here forms the first task of this project and aims to review NVZ methodology and recent designation experience. As part of this we will:

- collate information from the Agency on the recent application of the methodology;
- provide case study examples of designation in different time-lag settings and/or where these are not corroborated by water quality.

References

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