Geophysical Research Abstracts,
Vol. 11, EGU2009-4662, 2009
EGU General Assembly 2009

Identification of nitrate sources in a chalk water supply catchment in Yorkshire, UK

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Diffuse nitrate pollution poses a serious threat to water quality with agriculture being the predominant source. For drinking water the EU statutory limits are 11.3 mg/l nitrate N and 50 mg/l total N. Throughout Europe agricultural intensification over the past 50 years has seen widespread increases in N application to agricultural soils resulting in excess N in many soils. If this N is leached or lost from the soil it can result in high N concentrations within water bodies. Within the Yorkshire region of the UK intensive arable agriculture and subsequent diffuse pollution has resulted in high nitrate N concentrations within rivers. Although nitrate can be removed from raw water prior to supply this is an expensive process. Catchment management offers the potential to reduce some of these 'end of pipe' treatment costs associated with diffuse nitrate pollution by dealing with the problem at source. A key part of this approach is the identification of 'hot spots' at which to target actions.

The River Hull is a significant source of drinking water within the eastern part of the Yorkshire region with 85 % of the baseflow of the River Hull coming from the spring flow from the Yorkshire Chalk aquifer. Over the past 30 years nitrate N concentrations within the River Hull have steadily increased and are now routinely close to or above 11.3 mg/l, with almost the entire catchment being designated as both a surface water and groundwater nitrate vulnerable zone (NVZ). The purpose of this study was to identify key sources of nitrate within the catchment in order to help decide whether catchment management approaches could be used to reduce the high nitrate concentrations. Over a one year period, monitoring of nutrient (N and P) concentrations was undertaken at eight key surface water sites to identify the sources of nitrate and any seasonal variability that might indicate significant inputs from surface runoff. Sites were selected to represent key subcatchments and also included locations close to their source. Groundwater samples were also obtained from five boreholes at three locations across the catchment.

Nitrate N concentrations in surface waters varied temporally and spatially but were routinely high (mean 10.3 mg/l) with groundwater being the dominant source. Highest surface water concentrations were observed in the north east, concentrations typically decrease downstream with the site located furthest downstream having the lowest mean nitrate N concentration. Groundwater concentrations were also high but varied spatially, being highest in the unconfined aquifer towards the north (mean 12.39 mg/l) and lowest in the zone overlain by Quaternary deposits in the south (mean 6.88 mg/l), concentrations also varied with aquifer depth being lowest in the deeper part of the aquifer. No evidence was found that surface runoff is a major source of nitrate; indeed runoff related increases in discharge were actually associated with decreases in nitrate at surface water sites. Moreover samples from surface drains during a period of major surface runoff generation had much lower nitrate concentrations than are routinely observed. The spatial variability in nitrate concentrations across the aquifer and the increasing importance of surface input further downstream are the key reasons why nitrate N concentrations decrease downstream. However, despite this, concentrations remain high at the site located furthest downstream and close to where water is abstracted for supply (mean 9.41 mg/l). It is estimated that there is a 30 year transit time for nitrate within the aquifer and concentrations may yet get worse. Therefore, even if nitrate input was stopped now problems would still exist for decades. As a result catchment management approaches are unlikely to resolve the nitrate problem witnessed in the River Hull in the short to medium term.