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The water quality of the River Thame in the Thames Basin of south/south-eastern England

Colin Neal *, Margaret Neal, Linda Hill, Heather Wickham

Centre for Ecology and Hydrology, Maclean Building, Crowmarsh Gifford, Wallingford, OXON, OX10 8BB, UK

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Abstract

The water quality of the River Thame, a tributary of the River Thames in the Thames basin, is described in relation to point and diffuse contaminant inputs and runoff from permeable and impermeable bedrock geology with their own characteristic water quality. The data is examined to see if the market town of Aylesbury in the upper part of the catchment influences water quality. Previous studies highlighted the influence of Aylesbury sewage treatment works (STW) on soluble reactive phosphorus (SRP) concentrations in the river before and after phosphorus (P) stripping at the STW. Variations in water quality along the river are described and the study indicates that, apart from SRP, water quality determinants seem to be relatively unaffected by Aylesbury. The Thame water quality is compared with other catchment typologies and it is very similar to that of the main stem of the Thames even though the Thames is mainly Chalk groundwater fed. Differences in water quality largely link to the amount of STW effluent within the rivers and to the endmember compositions of the groundwater and near surface water sources.

Keywords: Water quality; Nutrients; Phosphorus; Major ions; Trace metals; Aluminium; Barium; Iron; Strontium; Dissolved oxygen; Carbon dioxide; Clay; Chalk; Aylesbury; Thame; Thames; Sewage; Agriculture; Fractal; Water framework directive; Urgent

1. Introduction

The issue of the impacts of urban systems on the environment is an important one, and there has been added impetus for research with community programmes such as the urban regeneration programme to stimulate the regeneration of the urban environment through understanding and managing the interaction of natural and man made processes (URGENT; http://www.urgent.nerc.ac.uk). Within the subject of urban systems, be they expanding remaining static or even deteriorating, there are connections to the maintenance and improvement of freshwaters both in terms of ecological status and amenity value. This is the case because many cities and towns are located near river courses. Historically, the rivers provided water supplies for the population and industry, a means of waste disposal and, in some cases, a transport route for materials and commerce. Many of the urban and industrial rivers declined in water quality due to these activities, especially during the period known as the industrial revolution. Improvements in water quality for UK Rivers following the two World Wars as (a) the UK moved to a post industrial society, (b) there were increasingly stringent regulation of contaminant discharges to rivers and (c) there were considerable improvements in the efficiency of sewage treatment works (Neal, 2001). For freshwaters, the region of concern is thus of a far greater aerial extent than the town or city boundaries where urban change is progressing. Urban wastewater,

* Corresponding author.
E-mail address: cn@ceh.ac.uk (C. Neal).

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particularly from sewage treatment works (STWs) effluent sources, can provide a major source of phosphorus to river courses (Mainstone and Parr, 2001). Indeed, there are issues of phosphorus (P) stripping from STWs to allow improvements in aquatic biology with regards to nuisance epiphytic growth and eutrophication that are central to the requirements of the European Water Framework Directive. Presently, there are major requirements for phosphorus stripping for STWs over a population size of 10,000 population equivalents (CEC, 1991; Mainstone and Parr, 2001), and this requirement encompasses much of the urban centres. Recent research has questioned the benefits of 'broad brush' P stripping and points to the need for focussed remediation (Daldorph and Wheater, 2003; Wheater and Daldorph, 2003; Jarvie et al., 2005). Focussed remediation is needed to target the situations where aquatic biology is at risk as:

- The dilution of effluent is particularly low and high phosphorus concentrations occur during the critical spring and summer low flow periods; i.e. when dilution potential is at its lowest and biological activity is at its highest.
- Phosphorus release from contaminated sediments may sometimes be significant for the water column and the contaminated bed sediments themselves may adversely affect the riverbed ecosystem.
- Biological feedback mechanisms adversely affect the ecosystem functioning.

The ecological and environmental management concerns with respect to P and eutrophication are not simply tied to issues of point source inputs. There are also diffuse inputs from agriculture which will still be present when point source reductions are in place. Good discussion on the relative importance of point and diffuse sources to eutrophication is provided by Mainstone and Parr (2001). However, it must be noted that reductions in P from point sources do not necessarily result in improvements in river ecology and a return to 'pre-impact' ecological status, rather there may be a transition to a new state that has been 'sensitised' to contaminant inputs (Jarvie et al., 2004).

Here, the water quality variations for the River Thame, in the Thames Basin of south/south-eastern England, are studied to examine the influence of the main town in the area, Aylesbury. Earlier studies for the Thame have described well the P flux for this catchment, the relative balance between diffuse and point sources including the effect of P stripping from Aylesbury STW within monitoring, process understanding and modelling contexts (Cooper et al., 2002a,b; Gardner et al., 2002; House and Denison, 2002; Jarvie et al., 2002b). Here a more general hydrochemical approach is taken to extend the analysis with new field data, examine P and other key water quality determinands and their inter-relationships, and to link the findings to other studies within the Thames Basin (Neal and Whitehead, 2002) including a companion study of the adjacent Cherwell catchment (Neal et al., 2005a). A critical point here is to consider the urban dimensions, which is central to rural landscapes where there are important pressures of housing and infrastructure development and the need for sustainability including issues of water and sewerage (Evans et al., 2003).

2. Study area

The Thame is a tributary of the River Thames in south/south-eastern England (Fig. 1). It has a rural/agricultural catchment with the main populations being at the towns of Aylesbury and Thame (population approximately 100,000 and 10,000, respectively). Much of the area is in agricultural use with arable crops and set-aside contributing the major part. The Thame supports a good course fishery and there are many sites of Special Scientific Interest within the Thame catchment.

The Thame and its tributaries are mainly lined with a thin covering of alluvium and terrace gravels and the bedrock comprises mainly clays and sandstones with some limestone/Chalk. The geology forms a gently inclining sequence northeast–southwest with exposure

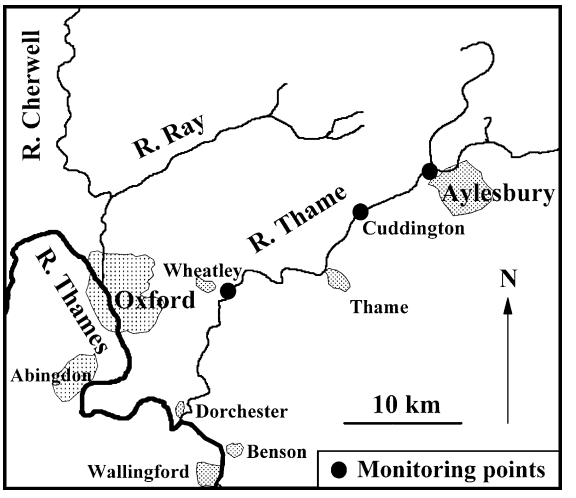

Fig. 1. The Thame catchment.