

Evidence

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Modelling of nitrate and phosphorus for river catchments

Project summary SC0080041/S

Nutrients from sewage and agriculture are major sources of river pollution. Deciding on the actions we can take to manage nutrients requires information about the effects at a catchment level rather than for individual sites. This project investigated changes in river nutrient concentrations in relation to land use and other factors. It provides greater understanding of the importance of different nutrient sources which will help the Environment Agency, its partners and stakeholders to target investigations and actions to improve river quality.

Working with the Environment Agency, statisticians at the University of Glasgow have developed models to assess space and time trends, including seasonal patterns, on a river catchment basis in concentrations of nutrients (nitrogen and phosphorus) in rivers in England and Wales over the past 20–30 years. During this period there have been major changes in the loading of nutrients to catchments, including changes in the amounts of manure and inorganic fertiliser used by farmers, population changes, and additional treatments by sewage works to remove phosphates from their discharges.

Previous modelling of nutrients in English and Welsh rivers has used data from individual monitoring stations to investigate trends over time and the effect of the contributing land. The development of models that incorporate information about the spatial characteristics of catchments is required to provide a better scientific basis for policy decisions. We also need to understand how the historical patterns in river water quality are affected by catchment-scale influences such as different land uses, human and agricultural sources of nitrate, and variations in rainfall.

The project sought answers to two questions:

- How has the overall pattern of nutrient concentrations in rivers changed over the past 20–30 years?
- Can the differences in nutrient concentrations in surface waters within and between catchments over time be explained by information on catchment variables?

The Environment Agency provided data on nitrate and phosphate concentrations in English and Welsh rivers. The monitoring locations included in the analysis were associated with Water Framework Directive water bodies within each of the 59 large hydrological areas (LHAs) in England and Wales.

The project focused on three chemical measures of nutrient levels:

- orthophosphate-P (OP)
- total oxidisable nitrogen (TON)
- total nitrogen (TN).

Variables that can explain sources of variation in nutrient concentrations were used to model trends over time and space in the three measures. Because the sources of OP, TON and TN in rivers are similar, a common modelling approach could be used.

Initially, trends over time and space and seasonal patterns in nutrient concentrations were determined for each LHA grouped by Environment Agency region. Models that could help to explain possible catchment-scale influences on these trends were then fitted to three selected LHAs (Severn, Lune and Trent). Finally, the modelling approach was extended to incorporate interactions between variables and illustrated on an example LHA (Coquet, Wansbeck, Blyth).

In most LHAs, phosphate concentrations have generally decreased over time, the exception being a combined LHA covering Wales where the trend is fairly flat. In general, the seasonal pattern showed low values in the winter, with a peak in the summer months. For TON and TN, trends over time and seasonal patterns were very similar across all LHAs in England and Wales. Total nitrogen generally had high values in the winter, with a trough in the summer months. There was more variation in trends for TON and TN than for OP, while the seasonal patterns were more varied for OP.

The improved evidence and greater understanding possible through the use of these models will enable the Environment Agency and others to make decisions on nutrient management policy based on information from catchments rather than on an individual site basis.

This summary relates to information from project SC080041, reported in detail in the following output(s):

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