

Evidence

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Uncertainty Assessment of Phosphorus Risk to Surface Waters

Summary SC050035/S

Phosphorus (P) is a driver of eutrophication in freshwater, however the relationship between P, eutrophication and ecological status is complex and this makes decisions on the regulation of P difficult. To achieve the Water Framework Directive's (WFD) objectives for 'good ecological quality' we need to assess the risk to surface waters from P.

An initial P risk analysis carried out by the Environment Agency (EA) for the first WFD River Basin Characterisation highlighted the uncertainties. This project was designed to review the knowledge and information we have to target further research and monitoring.

The project aims were to:

- identify and assess the scale of the principal uncertainties in factors that determine the risk from elevated P levels to the ecological status of lakes and rivers;
- identify key areas of academic agreement and disagreement;
- provide a consensus on an appropriate conceptual model for P risk assessment under the WFD;
- evaluate the consequences of uncertainty for P management;
- identify P research priorities.

The study used structured one-to-one interviews with experts who were asked to provide information in a variety of quantitative/qualitative ways describing their understanding of P processing. Scale-dependent conceptual models were developed with the experts and the interview information was combined with a literature review to make recommendations for WFD modelling and risk analyses.

Diffuse Sources of P

Considering the risks posed by intrinsic catchment characteristics and agricultural practice, the model components chosen were dominated by physical factors that control hydrological pathways and connectivity of landscape units to surface waters together with livestock management. There was

generally good agreement between the experts, but often the supporting evidence was based only on small scale studies, leading to uncertainty at larger scales.

Point Sources of P

P pressure from point sources was considered for wastewater treatment works (WWTW) and septic tanks. The uncertainty of point source estimates due to data availability should improve as we rely less on generalised, back-calculated per capita export coefficients and make greater use of measured WWTW daily flow data coupled with P concentration data.

WFD research priorities

EA requirements include setting and refining standards to be ecologically relevant. The causal relationship between elevated P and ecological status is unclear, particularly for shallow lakes and rivers, so some degree of precaution should be part of a risk-based approach. We also need to consider other controls on ecological status (e.g. nitrogen or river flows) that may explain some of the variation.

Specific recommendations

- Consideration of ecologically sensitive periods (e.g. use of growing season bioavailable P concentrations);
- Development of holistic methods of estimating ecological status that allow for system variability;
- More focus on defining the sensitivity of the receiving waterbody;
- Understanding sources, processes, pathways and effects for rivers and for lakes, to inform control measures at different scales;
- Determining minimum monitoring and model data requirements;
- Identifying the best models for catchment decision-making.

We have a good understanding of sources, processes and pathways but cannot predict well how they interact in time and space and manifest as P pressure. Without intensive data collection the determination of P pressure will be limited. Quantitative uncertainty estimation will help to inform future monitoring and modelling strategies by highlighting the value of different types and resolution of

information in reducing uncertainties. Models can then be part of an ongoing process of refining our understanding of catchments.

Research priorities

Applied priorities:

- Detailed modelling and data collection in a few catchments.
- Scale-dependent evaluation of mitigation measure efficacy.
- Reach-scale studies of in-stream processes during ecologically sensitive periods and for a number of stream typologies.
- Comprehensive model evaluation including uncertainty analyses for models used in risk analyses and source apportionment.
- Scale-dependent determination of P transport.

Fundamental science priorities:

- Greater understanding of the functioning of wetland and hyporheic zone processes.
- Research into pathways for P into groundwaters, e.g. fluxes from septic tanks and unlined farm slurry pits.
- Understanding the interacting roles of flow-regime, biofilm grazing and nutrient status on periphyton communities.
- Quantifying internal P loads in shallow lakes and mixing of hypo- and epi-limnetic waters for deep lakes.

This summary relates to information from project SC050035, reported in detail in the following output:

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