Environment Agency

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Phosphorus cycling in rivers

Project summary SC120037

A new report for the Environment Agency by consultants, Atkins, describes the development of a decision support tool to help screen rivers in England for the likelihood and extent of sediment-bound phosphorus being released back to the river water.

Soluble reactive phosphorus (SRP) is one of the parameters used to determine the ecological status of a river. The impact of high concentrations of SRP in rivers includes a shift in the composition and abundance of plant species present, which has an impact on the river's overall ecology. This is one of the most significant causes of water bodies such as rivers not achieving good ecological status under the Water Framework Directive.

The screening tool described in this report will help the Environment Agency and its partners to target resources and identify measures to reduce phosphorus levels in rivers to meet water quality standards.

The first part of the project involved a comprehensive literature review to understand the fate and behaviour of sediment-bound phosphorus in relation to phosphorus loading, river flow and the variability of equilibrium phosphorus concentration (EPC_0). The EPC_0 value is the concentration of phosphorus in water at which there is no net adsorption or desorption when in contact with sediment.

Key findings from the literature review were incorporated in the development of the risk screening tool for potential impacts on sediment phosphorus. These were used to develop risk scores and weighting factors for different aspects of sediment accumulation and potential phosphorus release.

The phosphorus available in a river is determined by the different sources of phosphorus inputs in the river's catchment. Sources of phosphorus included in the screening tool are:

- sediment loads from the catchment
- diffuse sources such as farming
- point sources such as discharges from wastewater treatment works

Accumulation of sediment within a river can potentially increase the amount of phosphorus available for water–sediment equilibrium reactions. The screening tool includes an estimate of where phosphorus 'sinks' are within a river by considering:

- river velocity data
- scouring or removal of material from the bed and banks of the river from streamflow data
- flow based on a plant community's preference for flow conditions

Sediments downstream of a wastewater treatment works act as a sink for phosphorus discharged in waste water. Introducing phosphorus removal at the wastewater treatment works makes these sediments vulnerable to phosphorus release because reduced phosphorus concentrations in the overlying water cause phosphorus to be released from the heavily phosphorus loaded sediments. An estimate of this phosphate source forms part of the screening tool.

To test the importance of the river cycling processes in relation to other sources of phosphorus, the equilibrium phosphorus concentration model for sediment phosphorus exchange was tested by incorporating the algorithms into an existing dynamic river quality model of the River Nene. This indicated that, while phosphorus losses to sediment are substantial, releases from sediment are unlikely to be significant in relation to other sources of phosphorus. Given these initial findings, further investment in model development is difficult to justify until there is better confidence in the formulation of the phosphorus sediment exchange model, and quantification of the interaction between phosphorus in the water column and in the sediment.

The report discusses options for further developing the screening tool and time series models, along with ways to improve the supporting evidence. However, scientific understanding of the key processes of sediment phosphorus dynamics is poor. While the screening tool provides information on the relative risk of phosphorus sediment impacts, it does not provide a measure of the magnitude of this risk.

This summary relates to information from project SC120037, reported in detail in the following output(s):

Report: SC120037
Title: Phosphorus cycling in rivers

March 2015

Internal Status: Released to all regions
External Status: Publicly available

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This project was funded by the Environment Agency's Evidence Directorate, which provides scientific knowledge, tools and techniques to enable us to protect and manage the environment as effectively as possible.

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