



Nutrient mobility within river basins: a European perspective[☆]

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Received 30 November 2003; revised 1 May 2004; accepted 1 July 2004

Abstract

The research presented in this special issue of the *Journal of Hydrology* is brought together with associated information of relevance to the thematic area in this concluding paper. Some of the important gaps in our current knowledge are outlined with a view to identifying future research needs for the development of an integrated analysis of nutrients in river basins and their management. Identification of these needs is important if we are to meet the defined set of catchment management objectives specified under the EU Water Framework Directive that must be delivered against a specified timetable. The Directive raises wider concerns such as how to define ‘good ecological status’ and pertinent to this special issue: what role nutrients have in framing this definition. In this paper, the importance of nutrient pressures on receiving waters is evaluated in the context of the key scientific uncertainties and options for characterising the biological, physico-chemical and hydro-morphological parameters necessary to meet the science needs of the Directive. An assessment of the significance of nutrient mobility within river basins for current understanding of freshwater systems functioning on a catchment and basin scale is made together with an evaluation of where research on nutrient pressures should be focussed in order underpin effective management.

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Keywords: Nutrients; Nitrogen; Phosphorus; Silicon; Carbon; Effluent; Agriculture; River; Lake; Groundwater; Eutrophication; Water framework directive

1. Introduction

The EU Water Framework Directive has offered a huge challenge to our science in bringing together issues of nutrients and their mobility in the environment within the context of ecosystem health and environmental protection (Heathwaite et al., 2005a). Across Europe, there is a major opportunity to study nutrient dynamics and

[☆] This special issue is dedicated to the memory of Joop Steenvoorden who worked unstintingly as a co-editor on this special issue and who sadly died before he could see his efforts brought to fruition. Joop was on the staff at Wageningen University and Research Centre, Alterra, The Netherlands and was president of the International Commission on Water Quality (ICWQ), part of the International Association of Hydrological Sciences. Joop edited many books in his long research career including most recently: *Agricultural Effects on Ground and Surface Waters: Research at the Edge of Science and Society* (IAHS Press 2002) and with Louise Heathwaite: *The Impact of Land-Use Change on Nutrient Loads from Diffuse Sources* (IAHS Press 1999). We all will remember his generosity and encouragement in the field of water quality research.

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their impacts for a wide range of typologies. Given the extensive investment in field measurements, process-based initiatives and modelling work, this secures a baseline ability to translate current environmental science research into decision support frameworks for managing and improving aquatic ecosystem health.

Here, we highlight the research findings of the papers in this special issue concerning *Nutrient Mobility Within River Basins: A European Perspective* (Heathwaite et al., 2005a) as well as associated work. The aim is to provide an overview of what the critical issues are in terms of nutrient mobility in drainage basins and what strategies have been taken to date. This overview will help set the research agenda that is needed to allow us to move forward in identifying the new science and the management strategies to take our understanding further and to improve our freshwater environment.

Various European directives place a legal requirement on regulatory authorities to control the availability of nutrients in water, including in addition to the Water Framework Directive, the Urban Waste Water Directive and the Nitrates Directive. Within the context of the Water Framework Directive, diffuse nutrient input to surface and groundwaters are considered a pressure that may result in an increased risk of eutrophication, in the case of phosphorus, and of failing nitrate standards for drinking waters in the case of nitrate. Nitrates resulting from agriculture and point sources also contribute to risk of eutrophication in transitional waters.

The Water framework Directive requires member states to collect and maintain information on the type and magnitude of a number of environmental pressures and their impacts, as part of the risk assessment process in River Basin Management. Many of the papers presented in this special issue form part of the science case towards improving our understanding of these environmental pressures. Specific pressures highlighted in the Directive include point source and diffuse pollution of substances that contribute to eutrophication, in particular, nitrates and phosphates. This special issue consequently has a strong bias towards the consideration of the importance of these two nutrients in terms their implications for ecosystem health. Additionally, the Directive has a requirement to identify the susceptibility of surface water bodies to the identified pressures—the

assessment of impact. The information on pressures and susceptibility is then to be used to carry out the assessment of risk of failing to meet the environmental quality objectives—the *risk of failing to achieve good status*. A number of papers in this special issue address the impact and risk assessment needs through the development of modelling and decision support tools to evaluate and mitigate nutrient pressures on receiving waters.

1.1. Definitions

Within this special issue, there are several names used to define the same nutrient form. This is particularly the case for phosphorus where soluble reactive P (SRP) with *phosphate*, *dissolved reactive phosphorus*, and *molybdate reactive phosphorus*. There has been considerable debate in phosphorus research as to the most appropriate terminology (see, e.g. Haygarth and Sharpley, 2000). Here for consistency and simplification we use SRP. Other measures include total dissolved P (TDP) which refers to the inorganic and organic dissolved fraction and the total P (TP) which refers to TDP plus total particulate P (PP). Comparable terminology is used for N as well (e.g. TDN, TN and PN).

With regards to the dissolved nutrient forms, for both N and P there are issues of what the dissolved fractions actually represent as they are operationally defined both in terms of filtration and analytical protocols. This is particularly problematical in terms of P, as is its analysis in general (Jarvie et al., 2002). There are two issues. Firstly, ‘dissolved’ fractions are taken as those that pass through standard filters that typically have a 0.45 µm cut-off. However, within this fraction there are both molecular and colloidal fractions and the proportions of each are rarely determined (Heathwaite et al., 2005b). Secondly, the methods for determining dissolved and particulate P fractions are operationally defined, usually on the basis of methodologies involving reactions with molybdate and where oxidation or UV treatment to breakdown the more dissolved—refractory and the particulate fractions. There is no certainty that exact fractionation is occurring. For example acid persulphate or UV treatment will not dissolve all the solid phases in most suspended sediments. This aspect is not considered further in this paper but it needs to be borne in mind

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