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The 'fine structure' of nutrient dynamics in rivers: ten years of study using high-frequency monitoring

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A complete appraisal of material fluxes in flowing waters is really only possibly with high time resolution data synchronous with measurements of discharge. Defined by Kirchner et al. (2004; Hydrological Processes, 18/7) as the high-frequency wave of the future and with regard to disentangling signal noise from process pattern, this challenge has been met in terms of nutrient flux monitoring by automated bankside analysis. In Ireland over a ten-year period, time-series nutrient data collected on a sub-hourly basis in rivers have been used to distinguish fluxes from different catchment sources and pathways and to provide more certain temporal pictures of flux for the comparative definition of catchment nutrient dynamics. In catchments where nutrient fluxes are particularly high and exhibit a mix of extreme diffuse and point source influences, high time resolution data analysis indicates that there are no satisfactory statistical proxies for seasonal or annual flux predictions that use coarse datasets. Or at least exposes the limits of statistical approaches to catchment scale and hydrological response. This has profound implications for catchment monitoring programmes that rely on modelled relationships.

However, using high resolution monitoring for long term assessments of catchment mitigation measures comes with further challenges. Sustaining continuous wet chemistry analysis at river stations is resource intensive in terms of capital, maintenance and quality assurance. Furthermore, big data capture requires investment in data management systems and analysis. These two institutional challenges are magnified when considering the extended time period required to identify the influences of land-based nutrient control measures on water based systems. Separating the 'climate signal' from the 'source signal' in river nutrient flux data is a major analysis challenge; more so when tackled with anything but higher resolution data.

Nevertheless, there is scope to lower costs in bankside analysis through technology development, and the scientific advantages of these data are clear and exciting. When integrating its use with policy appraisal, it must be made clear that the advances in river process understanding from high resolution monitoring data capture come as a package with the ability to make more informed decisions through an investment in better information.