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SUMMARY OF FINDINGS

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Testing a new technology for monitoring nutrients in rivers

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Key Words: Water, Water Framework Directive Freshwater Monitoring, Passive Sampling, Eutrophication, Nutrient Enrichment, Low Cost.

Abstract
Over enrichment (eutrophication) of water bodies by nutrients is a persistent problem in Ireland. The Environmental Protection Agency (EPA) is the statutory authority in Ireland for the protection of the environment and along with other competent authorities, such as the River Basin Districts (RBDs) and the local authorities, is charged with monitoring the ongoing chemical and biological state of water bodies. This is in alignment with the implementation of the Water Framework Directive (WFD) and the associated Programmes of Measures (POMs). Water monitoring of phosphorus (P) and nitrogen (N), the two principle chemical nutrients causing eutrophication, is undertaken by the Environmental Protection Agency (EPA) and other authorities. This project reports on a method which could aid and add value to current water monitoring programmes by using a low cost, passive system that can be deployed over different periods and which collects nutrients under both low and high river flow conditions. The results from the 'passive samplers' were evaluated using high-resolution analysers at river sites and a number of laboratory trials.

Background

Phosphorus and N nutrients can be lost from a variety of municipal, domestic and agricultural sources and can cause eutrophication of receiving water bodies. Each loss, or transfer, can have impacts specific to season and/or water body type and is a particularly persistent problem in Ireland and many other developed countries. Diffuse losses from agricultural land tend to be of low frequency but high magnitude due to a dependency on heavy rainfall events, and are difficult to monitor using traditional sampling techniques that extract samples on a monthly, or less, basis. Point source losses from domestic or municipal origins tend to dominate background low river flows; these are of low magnitude and high frequency and traditional sampling may be

biased towards these. This project, tested a new passive sampling system that had been designed to account for changes in flow and so able to deal with point and diffuse nutrient transfers. The passive samplers consist of a cartridge with an adsorbant to collect P and N and a known mass of salt that dissolves according to flow rates through the sampler. These were deployed in flowing water. The resulting extracted P and N mass and change in salt mass results were designed to give a flow-proportional mean concentration of the nutrients in rivers over the deployment time.

Key points

- Passive samplers were deployed at a number of river stations in Ireland where there were established high-resolution monitoring infrastructure.

- This equipment gave 'true' flow-proportional concentrations of P and N parameters which could be compared with the extracted data from passive sampler deployment periods over 3 to 5 weeks.

- There appeared to be under and over-estimation of 'true' flow-proportional concentrations of P and N using the passive sampler data over 14 separate deployments but the estimates between high resolution and passive sampling were generally within the same order of magnitude despite a significant difference in technology.

- Hydrodynamic modelling of cartridge design indicated probable flow divergence around the cartridge and this questioned, with the current design, the efficacy of the flow-proportionality of extracted data and especially at high flows.

- Detritus and biological deposition in the cartridge openings exposed to flow was also observed and this would also interfere with flow ingress and possibly with nutrient dynamics.

- Laboratory tests of both nutrient adsorbance and salt dissolution were carried out – the two principle methods of flow-proportional mean estimation. Adsorbance was variable but salt dissolution rates appeared accurate under pump flow conditions.

Findings/Recommendations

- Passive sampling technologies remain a good cost-effective compromise between data poor (and spatially rich) grab sampling and data rich (and spatially poor) high-resolution sampling using automated equipment. Resolution of what appear to be design issues in the high nutrient flux gradients of Irish rivers would compliment current monitoring and add to a suite of 'smart' technologies for forward WFD monitoring.

For Further Information

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The full report - *''Testing a new technology for monitoring nutrients in rivers''* *''Flow-Proportional passive sensor validation of phosphorus and nitrogen in Irish rivers (Flow-Pro)* by Katrina Macintosh et al. is published by the Environmental Protection Agency and is available from link.
http://www.epa.ie/downloads/pubs/research/water/

Publications and associated readings connected to this work

Jordan, P., Cassidy, R., Macintosh, K. and Arnscheidt, J. (2013) Field and Laboratory Tests of Flow-Proportional Passive Samplers for Determining Average Phosphorus and Nitrogen Concentration in Rivers. Environmental Science & Technology, 47 (5). pp. 2331-2338.

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