Geophysical Research Abstracts
Vol. 13, EGU2011-9153, 2011
EGU General Assembly 2011

High frequency variability in nutrient transfer in surface water dominated catchments

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Accurate quantification of contaminant transfers at catchment and sub-catchment scales is essential in assessing the extent to which management strategies are effective in improving the quality of surface waters. For economic and logistical reasons however, most monitoring programmes are limited to intermittent, instantaneous grab sampling as a basis of assessing water quality and estimating pollutant budgets for river systems.

The validity of these estimates and the extent to which change in a catchment can be detected is dependent on adequate spatial coverage by monitoring networks and a sampling frequency that reflects the variability in the system under study. Catchments with a flashy hydrology, resulting from combinations of steep slopes, impermeable soils and high rainfall, pose a particular challenge as intense short duration rainfall events may account for a significant portion of the total diffuse transfer of pollution from soil to water in any hydrological year. This can also be exacerbated by the presence of strong background pollution signals from point sources during dry periods.

A range of sampling methodologies and load estimation techniques are applied to phosphorus data from a surface water dominated river system in Ireland; instrumented at 3 sub-catchments with high frequency (sub-hourly) monitoring stations. A Monte Carlo approach is applied to simulate grab sampling using multiple strategies and nutrient loads are estimated for each hydrological year. Comparison with the load calculated for each monitoring station reveals significant inaccuracies for all feasible sampling approaches with underestimation of loads of up to 60%.

Analyses of the time series provides an insight into these observations and point to the underlying complexity of the system; revealing power-law scaling in the distributions of P concentration, discharge and flux associated with surface runoff and background transfers. The results indicate that only near-continuous monitoring at a frequency which reflects the rapid temporal changes in these river systems is adequate for comparative monitoring and evaluation purposes.