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Phosphorus concentration changes in hydrological flows and pathways

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To reach goals of sustainable food production, targeted schemes designed to attenuate pollution from agricultural sources to water are needed. Such approaches require insight into temporal and spatial variability in the most representative flows and active pollution transfer pathways. Interpreting changes in total stream flow may be misleading since some changes may only be apparent in specific flows or pathways. In this study we present concentrations of reactive phosphorus (RP) in apportioned flows and pathways in four small (ca. 10 km2) intensively managed, Irish agricultural river catchments with different land use (arable and grassland) and soil permeability (poorly drained and well drained). Seven years of sub-hourly stream water RP concentration and discharge were analysed for RP concentrations in different flow percentiles (high, intermediate and low flow) and in apportioned transfer pathways (quick flow, interflow and slowflow) estimated from hydrograph and loadograph separation techniques. The results were viewed in the light of catchment hydrological flashiness (Q10:Q90), management and the influences of short-term changes in weather.

There were intra-annual and interannual changes in the apportioned monthly and seasonal RP concentrations and some of these changes did not fully correspond to changes in RP concentrations in total stream flow. Even if monthly average RP concentrations were highest in summer quick flow (QF) pathways (e.g. Arable A: QF = 0.184 mg/l in July) the low flow conditions produced higher stream RP concentrations than the high flows in the arable catchments (e.g. Arable A: 0.044 mg/l compared to 0.029 mg/l). Two catchments responded positively to current mitigation measures with a successively reduced RP concentration in QF pathways between the winters (e.g. Grassland A: 0.275mg/l to 0.085 mg/l). However, in that catchment and the other grassland catchment the low flow RP concentrations consistently increased relative to similar low flow discharges (Grassland A: 0.04 mg/l to 0.11 mg/l and Grassland B: 0.06 mg/l to 0.16 mg/l).

The response in stream water quality to management, mitigation measures and short-term changes in weather may not be apparent when interpreting the total stream P concentrations. Apportioning flows and pathways provided information on delivery times which, together with information on critical source areas, can facilitate targeted mitigation measures.