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Testing conceptual models of nitrogen and phosphorus transport risk from agricultural catchments

Alice Melland, Per-Erik Mellander, Phil Jordan, David P Wall, Sarah Mechan, and Ger Shortle
(alice.melland@teagasc.ie)

Qualitative predictions of high to low risk of nitrogen (N) or phosphorus (P) water pollution from c.3-12 km2 agricultural catchments, established by the Agricultural Catchments Programme in Ireland, were tested using observed flow-weighted mean nutrient concentrations and loads from high resolution data.
The predictions were made based on conceptual models developed to meet EU Water Framework Directive obligations and estimate the dominant hydrological pathway as water moves from surface to subsurface with increasing soil and geological permeability. In the presence of agricultural source pressures, the risk of N loss was assumed high for catchments dominated by subsurface flow pathways and the risk of P loss was assumed high for catchments dominated by surface flow pathways. Data used to develop these predictions were indicative soil and geology maps interpolated to 50 m grid resolution.
Flow-weighted mean concentrations and loads of total oxidised N and total P in streamflow from five catchments were compared with the percentage of catchment area predicted to be at high N and P loss risk, respectively. Nitrogen and P loads in streamflow were calculated from sub-hourly concentration and discharge measurements for storm and inter-storm periods during autumn months – a high source and transport risk time of year. Despite their parsimonious nature, the conceptual models were generally effective in predicting the comparative differences in flow-weighted monthly mean nutrient concentrations in streamflow. An exception was that N risk in an arable catchment was under-predicted –possibly because soil type was observed to be more permeable than predicted and because variation in seasonal source intensity (such as high availability of residual soil N after crop harvest) was not considered with the soils data. For these reasons, and because total streamflow doesn't reflect the proportion of baseflow to quickflow, N loads were poorly correlated with N risk predictions. An exception for P risk predictions was evidence for high P concentrations in a grassland catchment predicted to have low P risk. However, despite the high P concentrations, P loads were low in this catchment. These observations can be explained by low streamflow relative to rainfall following the dry summer and a commensurately high relative influence of surface runoff events on the flow-weighted P concentration. This paper will extend these preliminary validation data to longer time series and discuss departures from the conceptual models in terms of pathways of loss, hydrological connectivity, nutrient sources and meteorological data. If validated, these conceptual models can provide useful tools for policy decisions and application.