Spatiotemporal variation in groundwater nitrogen and phosphorus in two agricultural river catchments

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In agricultural river catchments with permeable soils there is evidence that sub-surface pathways need to be considered for both diffuse nitrogen (N) and phosphorus (P) transfer. Stream water chemistry is reflected by groundwater chemistry not only during baseflow conditions, but also during event flow when a major fraction of both N and P loads were interpreted to be delivered from sub-surface pathways. In order to minimize N and P transfer from groundwater to surface water we need to understand how sub-surface water may vary in time and space, as well as how it may be linked to sources, water recharge and temporal changes in land management. The Agricultural Catchments Programme (ACP) is providing scientific evidence needed to support Irish agriculture in meeting the requirements of the Water Framework Directive (WFD). A 'nutrient transfer continuum' from source, through pathways, to delivery and impact in a water body receptor is used as a framework for evaluation of the European Union Nitrates Directive regulations and the Surface and Groundwater regulations. In this study we present one and a half years of data of N and P concentrations in groundwater of different strata, monitored through multilevel monitoring wells on four hill-slopes within two c. 10 km2 agricultural catchments with permeable soils. One with arable land overlying slate bedrock and the other with intensively managed grassland on sandstone. We investigate possible links between sources, groundwater and surface water to support mitigation action. The grassland catchment was more hydrologically and chemically buffered than the arable catchment. The latter showed a relatively quick response and transfer to the stream via strata of weathered bedrock. Effects of temporary changes in management were observed in the groundwater quality but with a delay of c. five months. The grassland had elevated nitrate-N concentrations and showed more spatiotemporal variability. The nitrate-N was highest in the near-stream shallow strata and there were indications of denitrification with depth. One site was N buffered in the near-stream zone, but this zone was bypassed with high nitrate-N content water from the uplands via subsurface drains. Even though the soils were not P saturated the groundwater was elevated in orthophosphate concentrations in both catchments, and mostly so in the near-stream groundwater. The processes of P enrichment of groundwater needs further investigation however soil permeability and/or P saturation alone are insufficient indicators of the risk of P delivery to streams. Current monitoring patterns in Ireland have detected instances of elevated P in locally important aquifers. We stress the need to understand the integrated effects on groundwater quality caused by spatiotemporal variability in recharge and land management.