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Response of current phosphorus mitigation measures across the nutrient transfer continuum in two hydrological contrasting agricultural catchments

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Effective assessment of National Action Programme (NAP) measures introduced under the EU Nitrates Directive (ND), to manage nutrient use and risk of loss to waters from agriculture, is best achieved when examined across the nutrient transfer continuum at catchment scale. The Irish NAP measures are implemented on a whole-territory basis for both nitrogen (N) and phosphorus (P), with P being the key trophic pressure. The aim of this research was to observe the efficacy of P regulation measures and P source management across the transfer continuum and resultant water quality status (i.e. source to impact), in two contrasting agricultural catchments over a four year period. The catchments are ca. 11 km2 and are located in the south-east of Ireland. One is well-drained and arable dominated, while the other is mostly poorly-drained and grassland dominated. In 2009 and 2013 soil surveys for plant-available P were carried out (<2 ha sample areas) in both catchments. Concurrently, high temporal resolution monitoring of water discharge and P concentration was conducted at each catchment outlet across four hydrological years (April to March). Ecological impact surveys were carried out at four sites within each catchment in May and September across the observed four year period (2009-2013).
Importantly, the proportion of farmland with excessive soil P concentrations decreased in both the arable (20% to 11.8%) and grassland catchments (5.9 to 3.6%). However, soil P concentrations also declined critically in both catchments, as proportional areas below the national crop agronomic optimum thresholds (grassland; <5 mg P l-1, arable; <6 mg P l-1) increased from 57% to 68% in the arable catchment and 75% to 87% in the grassland catchment. This decline in plant available P strongly indicates a reduced or sustained level of P inputs in both catchments. Indications of responses to soil P change in the surface waters of these catchments appeared to be highly influenced by their hydrological differences and the impact that annual and inter-annual climate and hydrological processes have on nutrient delivery. In the arable catchment total reactive P (TRP) concentrations in interpreted pathways declined across the quickflow, interflow and shallow groundwater of the slowflow, while TRP concentrations in the deeper groundwater, mostly contributing to baseflow, remained the same. However, the complexity of the flow pathways in the grassland catchment made it difficult to determine any trends in P concentrations as a result of changes in P source pressures. Additionally, although there were some inter annual trends, there was no clear indication of improvement in the ecological quality status in either catchment. Overall, a positive response to NAP measures (high soil P declines) was more clearly observable in the source component of the P transfer continuum for both catchments over the study period. This highlights the careful balance required for consideration between lag-time (policy implementation and water quality response) and agronomic sustainability (soil P fertility) in agricultural catchments.