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Drivers and inter-seasonal trends of nutrient losses from contrasting agricultural river catchments in Ireland and UK

Golnaz Ezzati[1], Per-Erik Mellander[1], Simon Pulley[2], and Adrian Collins[2]
[1]Department of Environment, Soils and Landuse, Teagasc, Johnstown Castle Environmental Research Centre, Wexford, Ireland (golnaz.ezzati@teagasc.ie)
[2]Sustainable Agriculture Science, Rothamsted Research, North Wyke, UK

Current multi-stressor pressures on water quality in agricultural catchments will be exacerbated by the more frequent occurrence of extreme weather events resulting in multi-stressor environments. Managing surface water under future climatic conditions will require adaptations and targeted mitigation strategies that consider individual catchment characteristics. Assessing the impacts of recent extreme weather events can allow for the better understanding of, and insight into, the key drivers of elevated pollutant losses and point to the possible future challenges for water quality management.

As a part of the Irish EPA funded WaterFutures project, changes in the impact of climatic drivers on nutrient losses from field to small stream scale catchments of different typologies are being investigated using long-term and high-frequency water quality datasets. The trends of daily nitrate-N, and phosphorus (TP) concentrations and loads over 11 years were interrogated in two agriculturally-dominated catchments in Ireland, and in both a permanent pasture and arable field in the southwest UK (ca. 0.38– 12 km^2). The trends in nutrient losses and the significance of discharge, precipitation, potential evapotranspiration (PET), soil moisture deficit, air temperature, and soil temperature, were investigated using Mann-Kendall Trend and Generalised Additive Model, respectively.

Significant inter-seasonal trends were identified in both countries and similar fluctuations of nutrient concentrations and loads in October and November 2018 were observed following an exceptional summer drought. All study sites responded to daily rainfall exceeding 10mm, although in different ways due to the different site characteristics. The soil and air temperature in the two geographically-close Irish catchments revealed a significant upward trend from June to September. During this period, these two drivers, along with discharge and PET, were key drivers of N-losses in the well-drained and arable dominated catchment. The increasing trend of monthly average N-concentrations were significant in April and November (from 5.6 in 2009 to 8.9 nitrate-N mg L^{-1} in 2018, Kendall-tau= 0.424). On the other hand, a catchment dominated by poorly-drained grassland showed an increasing trend in TP concentrations during January, May, September, and October (from 0.79 in 2009 to 6.72 TP mg L^{-1} in 2020, Kendall-tau= 0.455). Here, changes in air temperature, precipitation, and discharge were the key drivers for P losses.

Changing weather patterns, consequent changes in nutrient concentrations and load trends, and precipitation-discharge responses can be detected using long-term water quality records and should be considered for future climate smart mitigation strategies.