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Integrated climate-chemical indicators of diffuse N and P loss from agricultural land to European rivers

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Despite being partially driven (in some cases predominantly driven) by meteorological conditions and events, diffuse pollution mitigation measures and reviews rarely account for seasonal and long-term trends in climate patterns. It is also uncommon to link water quality conditions to weather patterns since these are often studied at different scales. To consider these processes this study developed climate-chemical indicators of diffuse pollution in 13 highly monitored rivers draining agricultural catchments in Ireland, Norway and North Western France over a seven-year period. The interactions between nitrate (NO_3) and reactive phosphorus (RP) concentrations in rivers and large, oceanic scale climate and weather patterns during an upward trend in the North Atlantic Oscillation (NAO) index (2010-2016). In north-western Europe a positive phase in the NAO index is generally associated with elevated air temperatures in summer and more frequent large rain events in winter, compared with long-term averages. These conditions are likely to promote soil nutrient lability and subsequent mobilization and delivery to water. Using detailed datasets that captured all river discharges including base-flows and storm runoff periods, annual catchment-scale NO_3 and RP concentrations in rivers were in some cases found to be correlated to the influence of larger, oceanic-scale climate patterns defined by the intensity of the NAO. These correlations were catchment-specific showing positive, negative or no correlation according to a catchment typology. Upward trends in these decadal oscillations may show either greater or lesser potential benefits of local diffuse pollution mitigation management, in some catchments and years. The study suggests that a new and important component to diffuse pollution and water quality management objectives is to develop integrated climate-chemical indicators into catchment response indicators. While simple mean catchment residence time is often acknowledged in process and modelling studies, it will also be necessary to consider the hydro-biogeochemical sensitivity of diffuse pollution prone catchments to climate variations.