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Soil Phosphorus limits- Is it time to be more specific?

Noeleen. T. McDonald (1), Karen Daly (2), David. P. Wall (2), Sara Vero (1), Per-Erik Mellander (1,2)

(1) Teagasc, Agricultural Catchment Programme, Environment, Soils and Land Use, Johnstown Castle Environment Research Centre, Wexford, Ireland (noeleen.mcdonald@teagasc.ie), (2) Teagasc, Environment, Soils and Land Use, Johnstown Castle Environment Research Centre, Wexford, Ireland

Phosphorus (P) loss from agricultural soil to waters is identified as a trophic pressure to achieving good to high water quality status in Ireland. Since 2006, measures to manage P loss by restricting P at the farm and field scale according to crop, animal and soil nutrient build up requirements were introduced on a whole-territory basis, under the EU Nitrates Directive (ND). For agronomic advice, soil test P (STP) concentrations, using Morgan's reagent, are categorized into four bands/indices; deficient (index 1), low (index 2), optimum (index 3) and excessive/legacy (Index 4). However, agronomic P tests alone don't provide enough information on soil characteristics that influence P solubility and mobilization from the field to hydrologically active pathways. The objectives of this study were to i) evaluate if ND measures limiting legacy STP soils are providing dual benefits of optimum agronomic production and improved water quality, and ii) demonstrate the relevance of considering additional soil chemical and physical properties for water quality risk assessment at catchment scale.

In this study, STP was determined on soils samples taken to 10 cm depth from six Irish agricultural catchments (ranging from 7.5 to 30km2) at c.2ha. Changes in STP with time were assessed by repeating sampling campaigns every 3-4 years, between 2009 and 2018. Ancillary topsoil properties (e.g. bio-available and total P concentrations and related metals) were assessed in an initial survey that used a c.30 point grid-sampling campaign. Water quality at each catchment outlet has been measured since 2009/2010 using high temporal resolution monitoring of water discharge and P concentration.

Since the baseline year, recent soil census from each catchment has shown that the proportional areas with legacy STP levels have declined in four catchments by between 3 and 12%, and increased by between 1 to 4% in two catchments. However, within all catchments >50 % of soils had sub-optimum (P index 1 and 2) agronomic STP levels. However, water P concentrations are complex and a poorly-drained grassland catchment with the lowest STP concentrations of all the catchments i.e. 3% P Index 4 and 89% sub-optimum soils, has consistently reported total reactive P (TRP) above the environmental quality standards (EQS) threshold (0.035mg/l), indicating that losses were driven by physical mobilization of P via hydrological pathways. Soil P sorptive properties in some catchments indicated good-high P sorption/binding properties, in particular the well-drained Arable dominated catchment with high concentrations of extractable aluminum (mean 1115 mg/kg). In this catchment, TRP has mostly been below the EQS threshold, suggesting low chemical mobilization of P from the soil influenced relative lower P losses from this soil type.

Additionally, factors such as management, climate and drainage also influence P losses. However the findings within this study and of other recent research on Irish soils concur, that soils vary in dynamics of P storage, mobility and loss. Therefore perhaps future soil P limits for the achievement of both agronomic optimum and water quality goals should be more soil specific, perhaps at catchment scale, by integrating key P mobilization indictors.