A model to predict soil P depletion to achieve agronomic and environmental objectives

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Management of the soil P reserve is one of the key measures to reduce the risk of diffuse P transfer from agricultural soils with the aim of mitigating the eutrophication of freshwaters. In Ireland soluble P levels in grassland, above the agronomic optimum of Index 3 (Morgan P 5.1mg L^{-1} to 8.0mg L^{-1}), have been identified as one of the dominant pressure factors for P-loss in runoff (Tunney, 2000). The Nitrates Directive National Action Programme therefore requires soils that are above index 3 to have zero mineral P amendment following offtake where a soil P test exists and to assume index 3 for replacement P where there are no soil test data. In terms of meeting Water Framework Directive targets for water quality, the time taken to deplete the soil P reserve to index 3 is therefore important to guide the expectations of farmers and policy makers. In this study an exponential decline of the available soil P following zero P amendment was noted from plot study data (three P-fertiliser treatments on four soil-P indices over eight common soil associations) (Schulte and Herlihy, 2007). The decline parameter, *c*, was subsequently modelled using step-wise regression of a range of soil parameters. The P balance (inputs minus offtake) and total P concentration of the soil created the most parsimonious model (R^2 = 0.63). This model was applied to a number of soil P and P balance scenarios assuming zero mineral P amendment to predict the rate decline of index 4 fields to the boundary condition of index 3. For very high starting points (high Morgan and total P concentrations) the average time to the boundary was 7 to 15 years depending on the P balance. Uncertainty analysis indicated this range to be 3 to >20 years. Expressed as a landscape mosaic with some fields having index 4 soils and with different initial conditions and P balances, this could mean between 25% and 90% of those soils remaining in index 4 by 2015 and 3% to 45% by 2021.

Schulte, R.P.O. and Herlihy, M. (2007). Quantifying responses to phosphorus in Irish grasslands: interactions of soil and fertiliser with yield and P concentration. European Journal of Agronomy 26, 144-153.

Tunney, H., (2000). Phosphorus needs of grassland soils and loss to water. In: Steenvoorden, J., Claessen, F., Willems, J. (Eds.), International Conference on Agricultural Effects on Ground and Surface Waters. International Association of Hydrological Sciences, Wageningen, Netherlands, pp. 63-69.