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Timescales and controls on phosphorus loss from a grassland hillslope following a cessation in P application.

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Despite the implementation of EU regulations controlling the use of fertilisers in agriculture, reserves of phosphorus (P) in soils continue to pose a threat to water quality. Mobilisation and transport of legacy P from soil to surface waters has been highlighted as a probable cause of many water bodies continuing to fail to achieve targets under the Water Framework Directive. However, the rates and quantities lost from farmland, and the timescales for positive change to water quality, following cessation of P inputs, remain poorly understood.

Monitoring data from an instrumented grassland research site in Northern Ireland provide some insights. The site is located in a hydrologically 'flashy' landscape characterised by steep gradients and poorly drained soils over impermeable bedrock. Between 2000 and 2005 soil Olsen P concentrations were altered in five 0.2 ha hydrologically isolated grazed grassland plots through chemical fertiliser applications of 0, 10, 20, 40, 80 kg P $ha^{-1}yr^{-1}$. By 2004 this had resulted in soil Olsen P concentrations of 19, 24, 28, 38 and 67 mg P L^{-1} across the plots, after which applications ceased.

Subsequently, until 2012, changes in soil Olsen P across the plots and losses to overland flow and drainage were monitored, with near-continuous flow measurement and water samples abstracted for chemical analysis. Runoff events were sampled at 20 minute intervals while drainage flows were taken as a weekly composite of 4-hourly samples. Overland flow events were defined by at least 24 hours without flow being recorded at the respective plot outlets. Drainage flow was examined on a weekly basis as it was continuous except during prolonged dry periods. To examine the hydrological drivers of overland flow and drainage losses the dissolved reactive P (DRP) and total P (TP) time series were synchronised with rainfall data and modelled soil moisture deficits.

Results demonstrated that from 2005-2012 there was no significant difference among plots in the recorded TP and DRP time series for either overland flow or drainage flow despite the large variation in soil Olsen P. Flow-weighted mean concentrations for overland flow losses declined slightly over the period but remained in excess of the chemical Environmental Quality Standard in all plots (EQS; 0.035 mg/L). In individual events the plot receiving zero P fertiliser inputs since 2000 often lost as much, or more, P than the plot which received 80 kg ha^{-1} yr^{-1} up to 2005. Annual loads also reflect this. Drainage losses showed no decline over the period. The hydrological drivers, particularly the antecedent dry period and soil moisture, were observed to have a greater influence on P loss from the plots than soil P status. Given that Olsen P often forms the basis of nutrient management advice this raises questions on the environmental sustainability of current nutrient advice for some soil types under similar geoclimatic conditions.