Phosphorus Transfer to River Water from Grassland Catchments in Ireland

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Introduction In Ireland it is estimated that at least half of phosphorus (P) loss to water is from agricultural sources and National and European Union policy and legislation aim at reducing phosphorus (P) loss to water in order to reduce eutrophication. In Ireland, the average soil test P (STP) levels increased ten-fold, from less than 1 to over 8 mg Morgan P per l soil over the past 50 years, reflecting increased P inputs in fertiliser and animal feed. One of the main objectives of this three-year research programme, started in 2001, was to investigate P loss to water in grassland catchments.

Materials and methods Phosphorus loss to water was studied in three catchments (with nested sub-catchments), one in the north (Oona, Co. Tyrone; shale soil), centre (Clarianna, Co. Tipperary; limestone soil) and south (Dripsey, Co Cork; old red sandstone soil) of the island. This involved setting up field stations for the collection of hydrological and water chemistry data in the nested catchments at different scales (Table 1), investigating the loss of different P fractions and suspended solids in the river water (runoff) under various seasonal, meteorological, hydrological and soil conditions. The mean intensity of grassland farming and STP were broadly similar in the smaller subcatchments of the three catchments.

Results The differences in hydrology, rainfall and soil types between the three catchments were reflected in runoff and P export to water.The Dripsey and Oona catchments had broadly similar total P (TP) exports, of the order of 2 kg P/ha per year (Table 1). This level of loss is higher than the level of about 0.5 kg TP/ha that is considered compatible with good water quality. In general Oona had higher SS than the other two catchments, probably reflecting soil type and more intensive runoff. In contrast, Clarianna had a several fold lower P export per unit land area despite having broadly similar STP levels and agricultural intensity as Dripsey and Oona. The Clarianna had less runoff and has mainly thick calcareous Quaternary deposits which retain P more effectively than the other two catchments. Losses of P per unit area were influenced by catchment size and STP.

Table 1 Rainfall, evapotranspiration (ET), catchment area, runoff, and mean values in the river water for P fractions and corresponding loss per ha (load) for total P (TP), particulate P (PP) and dissolved reactive P (DRP) for the three catchments from 1 Jan. to 31 Dec. 2002. The error statistics (%E) were calculated for loads from the 95% confidence limit least squares regression equations used to gap fill time series water chemistry data

Basin	Rain	ET	Area	Runoff	TP			PP			DRP		
	mm	mm	km^2	mm	mg/l	kg/ha	%E	mg/l	kg/ha	%E	mg/l	kg/ha	%E
Dripsey	1833	362	0.17	1206	0.22	2.66		0.049	0.60		0.15	1.85	
			2.11	1080	0.23	2.48		0.099	1.07		0.11	1.14	
			14	1037	0.15	1.60		0.057	0.59		0.08	0.81	
Oona	1366	352	0.15	611	0.39	2.40	2.89	0.239	1.46	3.57	0.08	0.51	3.45
			0.62	894	0.27	2.41	2.07	0.157	1.40	3.57	0.06	0.52	3.57
			88.5	817	0.38	3.13	6.40	0.203	1.66	5.77	0.11	0.90	4.62
Clari-anna	1091	493	0.8	603	0.11	0.69	3.77	0.078	0.47	3.62	0.02	0.15	4.00
			7.3	435	0.07	0.30	1.67	0.049	0.21	1.43	0.01	0.06	5.00
			13.6	416	0.04	0.17	5.88	0.021	0.09	6.67	0.01	0.06	8.33
			29.8	434	0.05	0.23	8.26	0.021	0.09	10.0	0.03	0.11	6.36

Conclusions Hydrology and soils in some catchments (e.g. Clarianna) can minimise the loss of P compared with other catchments (Oona and Dripsey) with broadly similar mean STP and grassland farming practices and these factors are important determinants in P transfer from catchments. The relative importance of factors influencing P transfer from grassland to water will help in agreeing the most appropriate management practices to help reduce loss to water.