Fine Colloids 'Carry' Diffuse Water Contaminants from Grasslands

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Introduction The transport of diffuse pollutants from grassland has traditionally been described by the operationally defined threshold of greater, or smaller than a nominated membrane filter size. Most commonly this has been a 0.45 μm threshold to define 'solute' and 'particulate' transport. In this paper we shall use phosphorus (P) to help provide an example of the importance of colloid-facilitated transport.

Materials and methods Phosphorus transport from grassland soils in different hydrological pathways was investigated using a series of laboratory and field experiments (for fuller details see Heathwaite *et al*., 2005). In the first instance, a simple laboratory shaking 'batch test' was developed, to provide preliminary information on the propensity of different soils to release P attached to soil colloids. In the second part of the work, the relative contribution of different particle size fractions in transporting different P forms in agricultural runoff from grassland soils was evaluated using a randomised plot experiment, involving various types of P amendment and hydrological pathways.

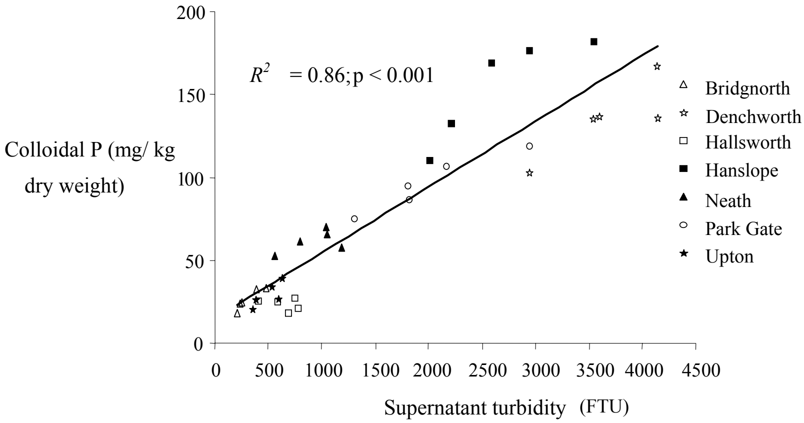

Figure 1 Scatter plot and linear regression between 'colloidal P' (H_2O - $CaCl_2$ extracts) and turbidity for a range of soils subjected to a 'batch test' (the legends refer to different soil series under the England and Wales system)

Results and discussion In the colloidal P 'batch test', the relationship between turbidity of soil extracts and total P (TP) was significant (r^2=0.996, p<0.001) across a range of grassland soils, and a strong positive relationship (r^2= 0.86, p<0.001) was found between 'colloidal P' (H_2O - $CaCl_2$ extracts) and turbidity (Figure 1). Linear regression of the proportion of fine clay (<2 μm) for each soil type evaluated against the (H_2O-$CaCl_2$) colloidal P fraction gave a weak but positive relationship (r^2=0.38, p=0.082). In the second randomised plot experiment, a significant difference (p=0.05) in both TP and reactive P (RP) forms in subsurface flow was recorded for different particle size fractions, with most TP transferred either in association with the 2-μm fraction or with the 0.001-μm or smaller fractions. Total P concentrations were higher from plots receiving P amendments compared with the zero-P plots, however, these differences were only significant for the >0.45-μm particle size fractions (p=0.05), and may provide evidence of surface applications of organic and inorganic fertilisers being transferred through the soil either as intact organic colloids or attached to mineral particles.

Conclusions Our results highlight the potential for drainage water to mobilise colloids and associated P during rainfall events, with wider implications for the transport of pathogens, fine sediment and persistent organic pollutants.

References

Heathwaite, A. L., P. M. Haygarth, R. Matthews, N. Preedy & P. Butler, P. (2005). Evaluating colloidal phosphorus delivery to surface waters from diffuse agricultural sources. *Journal of Environmental Quality* (in press).