Nutrient mobilisation and transfer pathways

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Introduction

Understanding nutrient mobilisation and transfer pathways is useful for finding solutions for best management practice and for interpreting the effectiveness of mitigation measures aimed at reducing nutrient losses from diffuse agricultural sources to water bodies. The objective of this work is to link nutrient sources with the movement of water in order to determine the contributions of water and nutrients that reach the stream via the various pathways (surface and subsurface). Another objective is to understand how nutrient transfer pathways may vary over time and space and in their connection to nutrient sources and the potential effects of temporal changes in weather and land management. The challenges are the complexities of scale involved that arise from the spatial variability of soil physical properties and the geology that determine the pathway and residence time, as well as the temporal variability of rainfall, land management and the nutrient transformations that occur in the soil.

Materials and Methods

Nutrients are monitored in sources, storage and delivery points in six agricultural catchments with different hydrological settings. Mobilisation and transfer pathways can be described using methods facilitated by high frequency monitoring of water quality and discharge in streams, water quality in a network of piezometers, mapping of soil nutrient sources and landscape information from high resolution LiDAR Digital Elevation Models. Detailed pathway studies from focused study sites (Fig. 1) are combined with catchment integrated studies in the stream outlet.

The output from this task contributes to the scientific evaluation of the effectiveness of the measures through an improved understanding of the pathways and will also provide a basis for any modifications to the measures.

Figure 1. Focused study site for nutrient mobilisation and transfer pathways in the Castledockerell catchment, Co. Wexford.

Results and Discussion

Analytical methods such as hydrograph and nutrient loadograph separation, nutrient/discharge hysteresis, end-member mixing analysis, development of a critical source area index, allowed the: i) identification and quantification of nutrient loads and concentrations in pathways, ii) elucidation of mobilisation processes of nutrients, iii) understanding of nutrient retention along pathways, iv) identification of where in the nutrient transfer continuum the response to measures are, v) identification of when and where in the landscape the critical delivery points are, and vi) linking of nutrient mobilisation, transfer and retention at catchment scale to regional/global weather changes.For example, for phosphorus (P) it was found that: i) hydrology overrides source pressure but P flux was larger between years than between catchments (Mellander et al., 2015), ii) the mobilisation mechanisms, explained by soil chemistry, influenced leaching and loss to rivers (Mellander et al., 2016), iii) a revised assessment of retention potential along pathways in a karst reduced the previous vulnerability map and highlighted 2% of the land at high risk for transfer to water (Mellander et al., 2013), iv) despite an increased agricultural productivity a reduction of P transfer to rivers was identified (Murphy et al., 2015), v) temporal and spatial information on delivery points can facilitate targeted mitigation measures (Thomas et al., 2016), and vi) amplified weather patterns may override positive benefits of mitigation measures in some years or indicate greater benefits in other years, and this will be catchment specific due to components such as mobilisation/transfer processes and hydrological connectivity.

Conclusions

A clearer understanding of the relative influence of soils, geology, farm practice, landscape and weather, on the propensity for nutrients to be lost to water, is needed to reshape the thinking on future nutrient management.

Acknowledgements

These studies were funded by the Department of Agriculture, Food and the Marine. We thank farmers, staff at the Environment, Soils and Land Use Department.

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