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Nutrient impacts and pathways in two high N-risk catchments in Ireland

Per-Erik Mellander (1), Alice Melland (1), David Wall (1), Ger Shortle (1), Phil Jordan (1,2)

(1) Agricultural Catchments Programme, Teagasc, Johnstown Castle Environmental Research Centre, Wexford, Co. Wexford, Ireland, (2) School of Environmental Sciences, University of Ulster, Coleraine, Co. Derry, Northern Ireland

A 'nutrient transfer continuum' from source, through pathways, to delivery and impact in a water body receptor describes the different phases of diffuse pollution and is, within the Agricultural Catchments Programme, being used as a framework for evaluation of the European Union Nitrates Directive regulations and the Surface and Groundwater regulations in Ireland. The linkages between sources, groundwater and surface water are investigated in two c. 10 km2 potentially high N-risk catchments, one with spring tillage and one with intensive grassland management on permeable soils overlying slate and sandstone geology respectively. Pathways and impacts are monitored through multilevel monitoring wells, and chemical end-member studies on two representative hill slopes per catchment. Sub-hourly monitoring of water levels, monthly low-flow sampling and campaign sampling during events are carried out in the monitoring wells. Also stream water discharge and water quality (NO3- as TON) are monitored on a sub-hourly basis at the catchment outlets, and weather parameters are measured within each catchment. Groundwater quality was compared with hydrology and farming activity and the dominant water/nutrient pathways were analysed. The groundwater in the near-stream zone was more chemically mixed than at the upslope well sites, it was directly linked to the stream water chemistry and had a relatively quick chemical and hydrological response to events. In the near-stream zone of both catchments the groundwater NO3- levels were compliant with respect to the groundwater threshold and maximum acceptable concentrations (8.5 and 11.3 mg NO3- N L-1, respectively). The groundwater of the middle and upper slopes was less buffered and had occasionally higher NO3- concentrations than the recommended thresholds. In the tillage/slate catchment, baseflow stream water chemistry was reflected by the near-stream shallow groundwater, i.e. in the highly and moderately weathered bedrock on top of the strong bedrock. In the grassland/sandstone catchment, baseflow stream water chemistry was mostly reflected by the near-stream intermediately deep groundwater, in the moderately weathered and strong bedrock. In that catchment there were more seasonal changes with regard to NO3- concentrations in the near-stream zone, with a winter-time shift from low to relatively high concentrations in the deep groundwater, and high to low in the shallow groundwater. The NO3- concentrations in the tillage/slate catchment peaked during spring/summer rain events whereas in the grassland/sandstone catchment there was a gradual increase toward autumn/early winter. This is also when major pathways were in shallower layers, with higher saturated conductivity than the deeper layers. The vertical distance from source to groundwater will be shorter during these periods and the more vulnerable upper slopes will be more efficiently connected to the near-stream pool where a mixing and flush out to the stream occurs. These data will be used to develop a conceptual model of biochemical transformation and lag times between farm inputs and delivery of N to stream and groundwater.