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Catchment monitoring technologies to identify critical source areas and times for nitrate transfer to streams

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Farm nutrient management policies under the Nitrates Directive in Europe are most effective in improving stream water quality where they target farm nutrient sources that are highly connected with streams. A suite of technologies and sampling protocols were used to measure spatial and temporal interactions between farms, farm practice and stream water chemistry in two temperate catchments (Arable A, 11.16 km2 and Arable B, 9.48 km2) with intensive cereal cropping and medium to high intensity grassland. Arable A consisted of well drained soils and layers of permeable geology whereas Arable B was underlain by a heterogeneous mix of moderate to poorly drained soils and geology. Sub-hourly measures at end-of-catchment and monthly longitudinal surveys of total oxidized nitrogen (TON) concentrations and other analytes in streams, monthly groundwater samples in spatially representative multi-level monitoring wells and field-scale farm nutrient management activities were recorded over two water years (October 2009 to September 2011). Annual loads of TON in streamflow ranged from 15.5 to 34.7 kg ha-1 yr-1 across years and catchments. Flow-weighted mean TON concentrations were 5.68 and 6.18 mg L-1 in Arable A and 5.04 and 5.39 mg L-1 in Arable B in the first and second water years, respectively. Total oxidised nitrogen concentrations became diluted by quickflow during storms in both catchments. In Arable A baseflow TON concentrations at the catchment outlet varied little throughout the year whereas in Arable B TON concentrations were similar to Arable A during winter but decreased by about 40% during summer, indicating disconnection and/or transformation of TON sources during the concomitant lower flows. Spatial analysis identified that diffuse TON sources in a localised, critical source area of the catchment were responsible for the high stream TON concentrations during winter. Processes of TON transfer to streams differed between the catchments with discharge of groundwater N, enriched by leached N, to streams hypothesized as ubiquitous throughout Arable A, but discharge of nitrate-poor groundwater that was enriched by interaction with near-surface N sources hypothesized in Arable B. The relative efficacy of N loss mitigation policies on minimising these transfer processes will be discussed.