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# Streamwater nitrate dynamics across decadal to sub-daily timescales in an upland system in mid-Wales

Sarah Halliday (1), Richard Skeffington (1), Andrew Wade (1), Colin Neal (2), Dave Norris (3), James Kirchner (4,5)

(1) Department of Geography and Environmental Science, University of Reading, Reading, UK, (2) Centre for Ecology and Hydrology, Wallingford, Oxon, UK, (3) Centre for Ecology and Hydrology, Bangor, Gwynedd, UK, (4) Swiss Federal Research Institute WSL, Zürcherstrasse 111, 8903 Birmensdorf, Switzerland, (5) Department of Environmental Systems Science, ETH Zürich, Universitätsstrasse 16, 8092 Zürich, Switzerland

Streamwater nitrate dynamics in the River Hafren, Plynlimon, mid-Wales were investigated over decadal to sub-daily timescales using a range of statistical techniques. The river has a long history of environmental monitoring which started in earnest in the early 1980s. Long-term data were derived from weekly grab samples (1984–2010) and high-frequency data from 7-hourly samples (2007–2009) both measured at two sites: 1) a headwater stream draining moorland, dominated by Calluna vulgaris and Eriophorum spp.; and 2) a downstream site below first-generation plantation forestry, consisting of mainly Picea sitchensis (Sitka spruce). This study is one of the first to analyse upland streamwater nitrate dynamics across such a wide range of timescales and report on the principal mechanisms identified. Through the analysis of both the short-term high-frequency data and the long-term monitoring data, it has been possible, in combination with other environmental data, to investigate the processes which control the nutrient dynamics over a range of temporal scales.

Within the Hafren catchment, nitrate was the dominant form of streamwater nitrogen, accounting for approximately 52 % of the total dissolved nitrogen, and streamwater nitrate concentrations were low, with a mean concentration of 0.15 mg/l-N at both sites between 2007 and 2009. Long-term declines in streamwater nitrate concentrations were found to be not solely driven by declining atmospheric deposition. Nitrogen deposition first increased and then decreased during the study period, whereas streamwater nitrate concentrations showed a consistent decline. Streamwater nitrate concentrations may have declined due to faster N uptake rates as a result of increasing streamwater temperature, and also increased denitrification, possibly caused in turn by increasing dissolved organic carbon concentrations. At both sites the streamwater nitrate time series were dominated by a strong seasonal cycle, with concentration minimums in the summer when flows were at their lowest and catchment biological activity was at its greatest. Diurnal nitrate dynamics were observed at both monitoring sites. Although the structure of the diurnal dynamics varied between the sites, at both sites a cycle with a single diurnal peak was observed, with diurnal dynamics most evident in the spring and summer. At the moorland site, a regular daily cycle was evident, with minimum concentrations in the early afternoon, indicating the importance of instream biological processing. At the downstream site, the diurnal dynamics were a composite signal, resulting from advection and dispersion of the moorland signal and additional nitrate processing in the lower catchment. Enhanced diurnal nitrate cycling observed in the catchment in spring 2007 was attributed to the conditions experienced in the post-drought period, with high temperatures, low flows and increased nitrate availability. These results will be placed in the context of other catchment studies to consider commonality and differences in nitrogen processing.