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Land use interacts with changes in catchment hydrology to generate chronic nitrate pollution in karst waters and strong seasonality in excess nitrate export

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Without careful land management, agricultural land in karst systems can pollute water courses, with polluted waters travel quickly to and through the sub-surface in karst systems. However, detailed understanding of how rapidly nitrate moves within the karst critical zone (from soils to aquifers) is limited by low resolution sampling for this highly-transmissive system. To understand nitrate behavior and its controlling factors, we deployed sensor technology at five sites to generate autonomously high-resolution time series of discharge and $[NO_3-N]$ in a farmed karst catchment in SW China. The $[NO_3-N]$ time series exhibited rapid response to rainfall-induced increases in discharge and a large magnitude in $[NO_3-N]$, ranging from 0.72 to 16.3 mg/L. The highest mean $[NO_3-N]$ and normalized annual fluvial export were observed in one headwater catchment with well-developed conduit structure. Elsewhere this was less-pronounced due to buffering by the karstic aquifer network as the contributing catchment area increased with distance downstream. Clear seasonal variation in NO_3-N export occurred in response to source availability, most notable in catchments with valley agriculture: up to 97% of nitrate was exported from the headwater catchment in the wet season, with much of that loss occurring in only a couple of months, compared to 61% of nitrate exported at the larger catchment scale. The sensor time series showed that the aquifers were chronically polluted with nitrate.