

Nitrate discharge from an N-rich forest in central Japan: A preliminary isotopic diagnose of rainfall events

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Tracing nitrate (NO₃⁻) losses from highly polluted forests is directed to understanding ecosystem N cycles in response to anthropogenic N inputs. Stable isotopes of NO₃⁻ (d¹⁵N, d¹⁸O and D¹⁷O) are well-suited tools to differentiate atmospheric-deposited and soil-derived NO₃⁻ leached into streams of forested catchments, thus provide diagnostic evidences on the plant-soil N status and forest N saturation. However, our understanding of the mechanisms that regulate the temporal and hydrological variability of stream NO₃⁻ isotopes is rather limited. It has not been well characterized how the source and flux of stream NO₃⁻ will change across rain events, and how stream NO₃⁻ isotopes record the response of short-term soil NO₃⁻ dynamics to rainfall and/or direct hydrological losses of soil NO₃⁻.

A high-temporal resolution collection and flow monitoring of the headwater stream was conducted across two rainfall events in 2011 in an N-rich forest of Karasawayama, the northern Kanto district of Japan. All samples were analyzed for NO₃⁻ concentration ([NO₃⁻]) and part of samples has been analyzed for stable isotopes (d¹⁵N, d¹⁸O and D¹⁷O). Using the flow rate and [NO₃⁻] of regular flows, annual NO₃⁻ discharge was estimated. In the same way, total NO₃⁻ discharge in the whole event was calculated using event-based flow and event-based [NO₃⁻]. Then using D¹⁷O of stream NO₃⁻, atmospheric-derived NO₃⁻ (atm-NO₃⁻) can be differentiated in annual and event NO₃⁻ discharge. According the differences of soil-derived NO₃⁻ and atm-NO₃⁻ in regular and event discharges, it can be quantified how much soil NO₃⁻ was washed out by the rain event.

The D¹⁷O of stream NO₃⁻ ranged between 0.8-1.5 permil, showing no substantial difference between event-based and regular flows. On average, 5.0-5.8% of stream NO₃⁻ was derived directly from precipitation. Annually, 3.0-4.0 kg-N in total 60?80kg-N discharge was directly from precipitation. This annual discharge did not include influences from rain events. Actually, in a rain event, ca.95% of NO₃⁻ is soil-derived, in which only 18?30% was discharged in the regular pathway, 70-82% of soil NO₃⁻ was flushed out by rain water. For regular flow, d¹⁵N and d¹⁸O of stream NO₃⁻ co-varied with a slope closing to 1:1 and did not change with [NO₃⁻], suggesting little influence from denitrification and the mixing of atm-NO₃⁻. However, according to the event of September, the temporal variations of D¹⁷O and fatm were weak and the fatm was actually low, simple atm-NO₃⁻ mixing could not explain the d¹⁸O fluctuations (by 4-12 permil). Altered soil nitrification/denitrification dynamics, not the mixing of atm-NO₃⁻ (fatm), were suspected fluctuating the d¹⁸O but keeping a low D¹⁷O signal of stream NO₃⁻ during the rain event.

キーワード: N saturation, N deposition, Nitrate leaching, Stable isotopes, 17O anomaly, Rainfall event

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