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Evaluation of nitrate source in the Xijiang River based on stable isotopes of nitrate and Bayesian mixing model

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Extensive anthropogenic activities have resulted in increased delivery of reactive nitrogen to rivers and streams, which can cause aquatic pollution and increase human health risks. Thus, it is important to identify the sources and fate of nitrate for water quality management. Stable isotopes of nitrate have been widely used to evaluate biogeochemical behavior of nitrate in aquatic ecosystem. However, isotopic fractionation and low-resolution monitoring limit the accurate estimation of nitrate sources.

Here, we collect river water and conduct a high-time resolution measurement of isotopic analysis (δ15N-NO_3- and δ18O-NO_3-) in the Xijiang River, Southwest China. The Xijiang watershed covers approximately 77.8% of the drainage basin area of the Pearl River watershed. It has abundant water resources, with an average discharge of 2.30 $\times$ 1011 m3 yr^{-1}. The studied watershed belongs to a subtropical humid monsoon climate with annual air temperature changing from 14°C to 22°C. The mean annual precipitation varies from 1,200 mm to 2,200 mm with mainly concentrated from April to September (wet season).

The contribution ratios of nitrate sources are calculated using a Bayesian isotope mixing model (SIAR) by incorporating isotopic fractionation. The δ15N-NO_3- and δ18O-NO_3- vary seasonally with higher δ15N-NO_3- (+8.4 $\pm$ 1.6‰ and lower δ18O-NO_3- (+2.0 $\pm$ 1.4‰ in the dry season compared with those of wet season (+7.6 $\pm$ 1.6‰ for δ15N-NO_3- and +2.7 $\pm$ 1.4‰ for δ18O-NO_3-). The isotope values of NO_3- vary greatly under different discharge conditions in the wet season, highlighting the importance of high-time resolution measurement especially in the wet season. The outputs of Bayesian model indicate that soil organic nitrogen and chemical fertilizer contribute the most (72−73%) in the wet season; whereas approximately 58% of nitrate is derived from manure and sewage wastes and chemical fertilizer in the dry season. This study combines hydrochemistry, stable isotopes with multi-statistical method, and make important progress in accurate estimation of nitrate dynamics in river.