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Assessing nitrate dynamics in freshwater using $\Delta^{17}O$ tracer

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Nitrate is an essential nutrient for primary production in aquatic ecosystems. However, anthropogenic activities since the pre-industrial times have more than doubled the input of biologically-available nitrogen to the terrestrial biosphere [1], and posed risks to water quality across the globe. High nitrate levels in water have implications in both environmental degradation and human health issues [2,3]. Despite the vulnerability of N-cycle to anthropogenic-stresses, studies on nitrate dynamics in freshwater lacustrine settings are limited. Here, we investigated the nitrate dynamics in Feitsui Reservoir: a well-preserved and second largest water reservoir in Taiwan, using multiple isotope tracers ($\delta^{15}N$, $\delta^{18}O$, and $\Delta^{17}O$) measured in dissolved nitrate along with other biophysical parameters such as chlorophyll a, dissolved oxygen, and community respiration. Emphasis was laid on $\Delta^{17}O$ ($=\delta^{17}O-0.52\times\delta^{18}O$) because of its mass-conservative behaviour during partial assimilation and denitrification.

Results show elevated $\Delta^{17}O$ values (12.6 to 30.1 ‰) in atmospheric nitrate as compared to reservoir nitrate (~0 to 4.6 ‰) [4]. Using $\Delta^{17}O$, a seasonal pattern of higher nitrification and nitrate uptake/removal rates was observed during summer as compared to winter. These rates peaked after typhoons as a consequence of increased supply of suspended particles and nutrients. Our estimates showed annually-averaged nitrification rate of 55±11 mmol m^{-2} d^{-1} and removal/uptake rate of 57±11 mmol m^{-2} d^{-1} (or a nitrate turnover time of ~2.5 months), indicating the active nature of N-cycling in this reservoir that is relevant for sustaining the water quality. We also attribute the temporal and depth-bound nitrate variation to primarily nitrate assimilation by phytoplankton and supply via in situ nitrification.

In view of nitrate as a pollutant in several water bodies across the world and the need for effective techniques to decipher nitrate dynamics in these systems, the present study demonstrates $\Delta^{17}O$ method as a novel tool to quantify the nitrate cycling, in particular the gross components.

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[2] NRC. 1978. Nitrates: An Environmental Assessment. *The National Academies Press*. [3] Schaider, L.A. *et al.* (2019) *Environ. Health* 18, 3. [4] Kaushal, R. *et al.* (2021*) Sci. Total Environ*. 753, 141836.