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Nitrate source apportionment in the complex Nyando tropical river basin in Kenya

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Abstract

Excess nitrate (NO_3^-) discharge into fresh water resources poses detrimental effects on ecosystems and human health, yet the understanding of its potential sources is lacking in many parts of Sub-Saharan Africa. This study integrated hydrochemistry, multi-isotope tracers ($\delta^{15}N\text{-}NO_3^-$, $\delta^{18}O\text{-}NO_3^-$, $\delta^{11}B$) and a Bayesian mixing model (mixSIAR) to improve on the apportionment of multiple NO_3^- sources in the Nyando River basin of Lake Victoria, Kenya. River water was monitored spatially in the basin for hydrochemical and isotopic parameters from July 2016 to May 2018. The data shows that NO_3^- concentrations in the basin are governed by the predominant land use. Mixed agriculture (MA) land use recorded significantly higher NO_3^- concentrations (8.8 ± 10.6 mg L^{-1}), compared to other land use zones: residential & industrial (RI) 3.4 ± 2.2 mg L^{-1}, sugarcane (S) 3.2 ± 1.5 mg L^{-1} and tea & forest areas (TF) 3.0 ± 1.1 mg L^{-1}. Stable isotope data and hydrochemistry complemented each other in identifying the potential NO_3^- sources and their spatial–temporal variation in the basin. Boron isotope ($\delta^{11}B$) data was categorically helpful in overcoming the limitations of $\delta^{15}N$-, $\delta^{18}O\text{-}NO_3^-$ to discriminate between manure and sewage sources. $\delta^{11}B$ specifically identified manure as the dominant source of river NO_3^- input in the MA, RI and S land