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Multi-isotope approach to identify sources and fate of nitrate in the Plateaux Region of Togo

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The presented study is conducted in the Plateaux Region of Togo (West Africa), which boarders in the west the Volta Region of Ghana and in the east three departments of Benin. Togo had an agriculture expansion of both cash and subsistence crops, averaging 6.4 %, during the last four decades. Land use changes occur mainly in the Plateaux Region where cropland and plantations already dominated the landscape. In addition, the region has become a center of transhumance and pastoral activities since 1970's droughts in the Sahel. These dynamics of land use are known to cause water quality degradation. Previous studies indicate significant contamination of groundwater by nitrate ($>$ 500 mg/L) in the Plateaux Region, which is underlain by a weathered basement aquifer system with low productivity. Hence, to ensure the security and the sustainability of drinking water supply in the region, one issue is to constrain the sources and fate of nitrate contamination.

The objective of this study is to identify anthropogenic and natural controls on nitrate concentrations in groundwater in the Plateaux Region of Togo. Groundwater samples were taken between 2015 to 2017 and the isotopic compositions of water stable isotopes (δ^{18}O; δ^{2}H), nitrate (δ^{15}N, δ^{18}O), boron (δ^{11}B), sulfate (δ^{34}S, δ^{18}O) as well as major ions were determined. In addition, synthetic fertilizers, manure, and septic tanks were sampled for nitrate isotopes.

Nitrate in combination with boron isotopes indicated that the main sources of nitrate are manure and village sewage. In selected wells, isotopic compositions of nitrate, as well as nitrate concentrations show a seasonal variation, suggesting that nitrification and denitrification may occur in response to the variation of hydrological and therefore also biogeochemical conditions. A clear denitrification line of plotted nitrate isotopic compositions is supporting this assumption. Moreover, the potential of denitrification by sulfides minerals in the aquifers systems has been evidenced by cases of decreasing δ^{34}S values coupled with increasing sulfate concentration.

This study showed that the use of a multi-isotope approach is useful to understand the sources and dynamics of nitrate. Moreover, the study highlights that nitrate dynamics in soil and groundwater are less understood in tropical regions where pronounced dry and wet seasons may influence nitrate accumulation and removal more than in temperate regions.