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Influence of land use change on nitrate sources and pollutant enrichment in surface and groundwater of a growing urban area in Tanzania

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Abstract

In the present study, 3-year (1997, 2008 and 2017) satellite images as well as different hydro-chemical parameters, nitrogen and oxygen isotopic composition of nitrate were used to examine the impacts of land use and land cover change on surface and groundwater quality. Through isotopic composition, sources of surface and groundwater pollutants were also elucidated. The results showed significant land use transition whereby land use changed from forest and bare land to agricultural land and built-up areas. A slight reduction in the size of areas covered by water bodies was also observed. Results indicate differences in nitrate concentration that mirror land use changes. Samples with elevated levels of nitrate above 10 mg/L were located near agricultural fields and areas with intensive livestock keeping activities. In groundwater, $\delta^{15}\text{N}$ -nitrate and $\delta^{18}\text{O}$ -nitrate ranged from 3.2‰ to 20.1‰ with a mean value of 11.7 ± 1.8 ‰ and from 2.1‰ to 12.0‰ with mean value of 5.4 ± 1.8 ‰, respectively. In surface water, $\delta^{15}\text{N}$ -nitrate and $\delta^{18}\text{O}$ -nitrate ranged from 2.4‰ to 19.3‰ with mean value of 4.9 ± 1.4 ‰ and from 1.5‰ to 21.9‰ with a mean value of 13.5 ± 2.8 ‰, respectively. Isotopic composition data suggest sources of nitrate in both ground and surface water dominated by synthetic and organic fertilizer application and to a lesser extent a natural soil nitrate source.

Keywords

Groundwater isotopic composition; Land use change; Land cover change; Surface water quality; Sources of nitrate contamination; Sustainable cities of tomorrow