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Analysis of high-resolution data reveals land use effect on nitrate dynamics in East African tropical montane catchments

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Changes in nitrate inputs and land management as a consequence of land use change affect the nitrogen cycle and hydrological flow paths. Despite the high rates of deforestation and land use change in the tropics, there is little evidence on how this affects nitrogen cycling. This study investigates the effect of land use on stream water nitrate dynamics in the Mau Forest Complex, Kenya's largest remaining indigenous tropical montane forest. A 3-year dataset was generated with automatic measurement stations located at the outlets of three sub-catchments (27–35 km^2) with different land use (i.e. natural forest, smallholder agriculture and commercial tea plantations) within a 1021 km^2 catchment. Each station measured nitrate concentration using UV-vis spectroscopy and water level with a radar sensor at a 10-minute interval. The *in situ* sensors were calibrated with weekly to biweekly grab samples. The flow-weighted mean nitrate concentration was highest in the tea plantation sub-catchment (2.08 ± 0.18 mg N l^{-1}), followed by the smallholder agriculture (1.15 ± 0.13 mg N l^{-1}) and natural forest sub-catchments (0.42 ± 0.042 mg N l^{-1}). Time series analysis revealed a seasonal pattern in nitrate concentrations in all sub-catchments, except in the natural forest. These seasonal patterns were closely related to seasonal changes in discharge, which was reflected by the moderate log-linear relationships between nitrate concentration and discharge in the smallholder agriculture and tea plantation sub-catchments (R^2 = 0.728 and R^2 = 0.748, respectively). This is most likely caused by leaching of fertilizer inputs to deeper soil layers and increased connectivity of these soil layers to the stream during the rainy season. The shape and direction of hysteresis loops of selected storm events suggested shallow sub-surface flow in the natural forest sub-catchment, resulting in an increase in nitrate concentrations during storm events, while surface runoff caused reduced nitrate concentrations during events in both agricultural sub-catchments. This study shows how land use affects the timing and magnitude of nitrate fluxes in a tropical montane area through increased nitrate inputs and changes in flow paths, and emphasizes the use of *in situ* sensors to increase our understanding of the consequences of land use change for nitrate dynamics.