Phosphorus transport in shallow groundwater in peri-urban Kampala, Uganda: Results from field and laboratory measurements

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Abstract

To understand Phosphorus (P) sources and transport processes in the subsurface in Bwaise III Parish, Kampala, P attenuation and adsorption capacities of soils were studied in situ and from laboratory measurements. Relationships between sorption parameters and soil matrix properties, rates and mechanism of the adsorption process and soil P fractions were also investigated. P was generally higher in the wet than the dry season, but for both seasons, the maximum was 5 mgP/l. P transport mechanisms appeared to be a combination of adsorption, precipitation, leaching from the soil media and by colloids with the latter two playing an important role in the wet season. The sorption process comprised two phases with the first stage rate constants being about fourfold those of the second stage. The Langmuir isotherm described the sorption data well ($R^2 \geq 0.95$) with the second soil layer exhibiting the highest sorption maximum (Cmax) (average value 0.6 ± 0.17 mgP/gDW). The best prediction of Cmax had organic carbon, Ca, available P and soil pH. Residual P consisting mostly of organics was the main fraction in all the layers followed by inorganic HCl-P and NaOH-P in the top and middle layers, respectively. Loosely bound P (NH_4Cl-P) was the least fraction (<0.4% of total P) in all layers indicating the high binding capacity of P by the soils. The study results suggest that P dynamics is related to Ca, Fe and organic carbon content of the soils.

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