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Input-output budgets and internal fluxes of dissolved materials in tropical rainforest catchment of Malaysian Borneo

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The neutralisation of dissolved materials from rainfall to streams in catchments is poorly understood in tropical rainforests with complex biogeochemical and hydrological processes. To investigate the status of neutralisation process and factors controlling streamwater chemistry, input-output budgets and internal fluxes of dissolved materials have been observed in the Baru forested catchment near the Danum Valley Field Centre (DVFC), Sabah, Malaysian Borneo.

The study catchment is covered by 'lowland dipterocarp rainforest'. We collected streamwater from the bottom of the Baru catchment for 3 years and 9 months, from April 2008 to December 2011. To examine the effect of the plant-soil system on the streamwater chemistry, soil solutions were collected several times during 4 months from May to August 2010 using a tension lysimeter (porous cup), and the vertical ion fluxes via the rainfall, the throughfall, the litter and the soil layer were determined using an ion-exchange resin column (IER column) for 2 years, which were divided into four periods from March 2009 to February 2011. Soil solutions using a porous cup were used to examine the temporal change of the concentrations, whereas the vertical fluxes determined by the IER column clarified the vertical distribution of ion fluxes through the plant-soil system; we used IER data to calculate the vertical fluxes from the rainfall to the soil.

In streamwater, the pH was relatively high, and over one year, it fluctuated temporally within a small range between 6.5 and 7.6. The streamwater pH was not directly correlated with water discharge, which controlled most other dissolved materials in the streamwater. The pH did not change over time with strong acid (NO_3^- and SO_4^{2-}); rather, it was affected by the dissolved organic carbon (DOC) and HCO_3^-/DOC in this tropical stream. In the plant-soil system, the mean precipitation pH value of 5.3 declined to 4.8 in the surface soil solution and increased to 5.9 in the subsoil and 7.1 in streamwater. A principal component analysis of the soil solution and the streamwater chemistry revealed that the solute pH value declined due to the high concentration of NO_3^- in the surface soil and increased due to low NO3- and high base cations in the streamwater.

The annual vertical fluxes of almost all ions rapidly increased from the canopy to the surface soil. The NO_3^-, NH_4^+ and K^+ fluxes markedly decreased from the surface soil to the stream, whereas the Na+, Ca2+ and Mg2+ fluxes remained high in the subsoil and the stream. We concluded that significant chemical weathering between the subsoil and the stream played an important role in the relatively high and stable streamwater pH value and ANC because exports of Na^+, Ca^{2+} and Mg^{2+} to the stream greatly exceeded the input via atmospheric deposition and because HCO_3^- was significantly correlated with SiO_2 and base cations over the year. In this tropical rainforest catchment, the streamwater had a low acid sensitivity to the fluctuation of NO_3^- or SO_4^{2-} leaching due to the constant high HCO_3^- leaching derived from chemical weathering, whereas DOC, including organic acids, may cause temporal variations in water acidification. A comparison with other studies suggested that regional variations in the streamwater pH of tropical forest might be controlled by the leaching balance of base cations and SO_4^{2-}, which were derived from the chemical weathering.

Keywords: Tropical rain forest, Catchment study, Stream water, Soil solution, Atmospheric deposition