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The transformations and fates of deposited N in an N saturated subtropical forested catchment, SW China

Jing Zhu, Jan Mulder, and Peter Dörsch
Norwegian University of Life Sciences, Aas, Norway (jing.zhu@nmbu.no)

Subtropical forests in south China are receiving long-term elevated nitrogen (N) deposition. Previous field observations in the N-saturated forested headwater catchment at Tieshanping (TSP), Chongqing, SW China, found apparent fast NH4+ disappearance in the top soil on the hillslope, but lab incubation for nitrification potentials did not support such disappearance. Meanwhile, large unaccounted N sinks were suggested by fast NO_3- disappearance along the flow path in the groundwater discharge zone (GDZ), possibly due to denitrification and subsequent N2 emission.

In this study, we investigated the fates of deposited N (mainly in the forms of NH4+ and NO_3-) and the nature of the N transformations using isotopic tracer approach. 15N-labeled NH4+ or NO_3- (99 atom% 15N) were amended to repacked surface soil columns from the hillslope and GDZ of TSP. The changes of the N forms of NH4+, NO_3-, dissolved organic N, microbial biomass N and bulk N in soil were traced in a period of 15 days, representing transient (0.5 hr, 6 hr and 1 day) and mid-term (5 days and 15 days) N transformations. The soil moistures were kept at the typical field conditions (55% and 95% WFPS for hillslope soil and GDZ soil, respectively).

Opposite to the field observations, the amount of added NH4+ decreased gradually on hillslope. 85% and 30% of the added 15N-NH4+ kept in the form of NH4+ after 1 day and 15 days. 15N-NO_3- was produced gradually on hillslope, up to 26% of added 15N-NH4+ after 15 days incubation. About half of the added 15N-NH4+ was incorporated to organic N. The added 15N-NO_3- showed a similar picture, with 55% left in the soil of hillslope after the whole incubation. Interestingly, although soil in GDZ had much higher WFPS, the nitrification rate of it was much higher than that on hillslope. Apparently the added 15N-NH4+ was incorporated immediately into organic matter in GDZ soil and being denitrified gradually along the time. The incorporation of the added 15N-NO_3- into soil organic matter was much lower compared to 15N-NH4+. Most probably, denitrification removed most of the added or produced 15N-NO_3-. The changes in sterilized soils suggested that nitrification of both hillslope and GDZ were controlled by microbial activities, whereas denitrification of hillslope and GDZ was controlled by microbial activities and chemo-denitrification, respectively. Process-based modelling will be applied to further analyze the transformations of N.