Researchers quantify ecosystem-scale nitrification rate

April 7 2020, by Zhang Nannan

Human-caused increases in gaseous nitrogen (N) emissions to the atmosphere have accelerated terrestrial ecosystem N deposition over the past half-century. As forest productivity is usually N limited, accelerated N deposition can promote the growth of forest trees. But long-term excessive N input may negatively affect forest ecosystems, leading to soil acidification nutrient loss, plant nutrient imbalance, greenhouse gas emissions increase and biodiversity loss.

Nitrification is the process by which microbes convert ammonium-N or soluble organic N to nitrate-N. Both ammonium- and nitrate-N can be directly used by plants and microorganisms. But nitrate-N is prone to be leached to lower reaches of water bodies, thereby causing loss of soil nutrients and eutrophication. Nitrate-N is the substrate of denitrification (the process of NO_3-N being converted to N_2). Higher amounts of Nitrate-N enhance denitrification.

Nitrification and denitrification are important microbial processes influencing greenhouse gas N_2O emissions, N availability and composition, and the ecosystem N cycling. Quantifying soil nitrification rate on catchment scale is a necessary step to quantify denitrification. However, due to the spatial and temporal heterogeneity of forest soil nitrification, it has been a difficulty in quantifying ecosystem-scale nitrification rate.

In 2015, FANG Yunting and others determined for the first time the annual nitrification rate of a forest ecosystem by quantifying the oxygen

isotope $\Delta^{17}O$ of nitrate-N in rainfall and streams. However, because the quantification must rely on the measurement of the nitrate-$\Delta^{17}O$, only a few laboratories in the world have test capabilities. Therefore, there is still little such research and it is currently unknown about the seasonal and inter-annual changes in forest soil nitrification and the drivers controlled these changes.

In view of this, the researchers (HUANG Shaonan, FANG Yunting et al.) from the Stable Isotope Ecology Group of the Institute of Applied Ecology (IAE), Chinese Academy of Sciences (CAS), collected rainfall and stream water samples from a 536 ha forest catchment near to the CAS Qingyuan Forest Ecosystem Research Station from 2014-2017.

They measured $\Delta^{17}O$ of nitrate-N in the samples and quantified the nitrate-N input, loss and ecosystem-scale gross nitrification rate. The results showed that the nitrate-$\Delta^{17}O$ in rainfall is greatly diluted when it enters the soil. The soil nitrification showed wide inter-annual variations. But the study didn't find that there was a clear relation between the monthly dynamics of soil nitrification and precipitation or soil temperature. The amount of loss of nitrate-N was higher than the critical value marking the N-saturation of temperate forests. The loss of gaseous N accounted for 35% of total N loss, while the total N output was 56% of the total N input from bulk precipitation.

The researchers thus preliminarily confirmed that the forest ecosystem has been N-saturated. The study on catchment-scale nitrification will be beneficial to understanding N cycling and N status of forest ecosystems.

The study, titled "Multiyear measurements on $\Delta^{17}O$ of stream nitrate indicate high nitrate production in a temperate forest," has been published in *Environmental Science & Technology*.

More information: Shaonan Huang et al. Multiyear Measurements on

Δ17O of Stream Nitrate Indicate High Nitrate Production in a Temperate Forest, *Environmental Science & Technology* (2020). DOI: 10.1021/acs.est.9b07839