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Nitrogen loss in river and erosion banks in form of reactive dissolved nitrogen and nitrous oxide via microbial nitrification in permafrost-affected soils in the Lena Delta in the Siberian Arctic

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Permafrost affected soils store a huge amount of organic matter including carbon and nitrogen. But especially permafrost is expected to degrade significantly through deepening and erosion processes with important consequences for freshwater systems. Although Arctic ecosystems are strongly limited by bioavailable nitrogen (N), the loss of vegetation by thermokarst and lack of vegetation on riverbanks probably establish conditions for imbalance in the nitrogen cycle, therefore higher N-availability for microbial transformations and in consequence loss of reactive nitrogen.

Here we present data from expeditions in 2008 and 2019, where we found indeed relatively high concentrations of dissolved inorganic nitrogen, mainly as ammonium (up to approx. 10 µg N g dw^{-1}) in the active layer of dry no vegetated carbon poor mineral soils of the riverbank and cliff (recently eroded by the Lena river). In the stratified permafrost-affected soils of the riverbank nitrate accumulated during the summer period, especially in more organic silty layers (4 % SOM) to extremely high concentrations (up to approx. 90 µg N-nitrate g dw^{-1}). Decreasing ammonium and increasing nitrate concentrations during the vegetation period hint to the aerobic nitrification process, which is the main source of nitrate in terrestrial ecosystem. Together with high nitrate concentrations in the field, these soil layers showed high potential nitrification rates in aerobic incubation experiments (max. 14.4 µg N g dw^{-1} d^{-1}, 21,6 g N m^{-3} d^{-1}, 5 °C) combined with high varying but significant N_2O production rates (max. 150 µg N-N_2O m^{-3} d^{-1}, 5 °C). Since nitrification rates positively respond to temperature (max. Q_{10} of 4) and ammonium availability, climate change may cause an increasing release of gaseous N-loss (N_2O) or leaching of nitrate and dissolved organic nitrogen (DON) to aquatic ecosystems with further consequences. Hot spots of high N-availability in no vegetated river and erosion banks likely influence the microbial induced C cycle as C-mineralization but also atmospheric methane oxidation, which might be the interest of future studies.