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Sediment filtration can reduce the N load of the waste water discharge – a full-scale lake experiment

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European commission has obliged Baltic states to reduce nitrate load, which requires high investments on the nitrate removal processes and may increase emissions of greenhouse gases, e.g. N2O, in the waste water treatment plants. We used ecosystem-scale experimental approach to test a novel sediment filtration method for economical waste water N removal in Lake Keurusselkä, Finland between 2014 and 2015. By spatially optimizing the waste water discharge, the contact area and time of nitrified waste water with the reducing microbes of the sediment was increased. This was expected to enhance microbial-driven N transformation and to alter microbial community composition.

We utilized 15N isotope pairing technique to follow changes in the actual and potential denitrification rates, nitrous oxide formation and dissimilatory nitrate reduction to ammonium (DNRA) in the lake sediments receiving nitrate-rich waste water input and in the control site. In addition, we investigated the connections between observed process rates and microbial community composition and functioning by using next generation sequencing and quantitative PCR. Furthermore, we estimated the effect of sediment filtration method on waste water contact time with sediment using the 3D hydrodynamic model.

We sampled one year before the full-scale experiment and observed strong seasonal patterns in the process rates, which reflects the seasonal variation in the temperature-related mixing patterns of the waste water within the lake. During the experiment, we found that spatial optimization enhanced both actual and potential denitrification rates of the sediment. Furthermore, it did not significantly promote N2O emissions, or N retention through DNRA. Overall, our results indicate that sediment filtration can be utilized as a supplemental or even alternative method for the waste water N removal.