EGU2020-10912
https://doi.org/10.5194/egusphere-egu2020-10912
EGU General Assembly 2020

Nutrient and organic matter retention in the hyporheic zone during drying and rewetting in a mesocosm experiment.

Matthias Pucher[1,2], Thomas Hein[1,2], and Gabriele Weigelhofer[1,2]
[1]University of Natural Resources and Life Sciences, Institute of Hydrobiology and Aquatic Ecosystem Management, Department of Water - Atmosphere - Environment, Wien, Austria (matthias.pucher@boku.ac.at)
[2]Wassercluster Lunz Biologische Station GmbH, Lunz, Austria

In intermittent streams, microbes in the sediments are challenged by extremely low water availability during dry periods. Microbes are responsible for the retention and degradation of nutrients. Reduced retention in headwaters can lead to nutrient and DOM accumulation in receiving downstream water bodies and can lead to eutrophication and algal blooms. Some research was done in Mediterranean regions, but we found little studies from temperate regions. There, droughts and water abstraction increased over the last years and caused sensitive headwater streams to shift from perennial to intermittent. In an experiment, we measured the effects of desiccation and re-wetting on nutrients (N, P) and dissolved organic matter (DOM) uptake by biofilms in the hyporheic zone. By that, we address two questions: (1) how do intermittent and perennial reaches differ in their response to desiccation and (2) which parameters can strengthen the resilience of hyporheic processes towards desiccation?

We performed a mesocosm experiment with sediments collected from 20 streams of 4 different regions in Austria. Both historically perennial and intermittent streams were sampled in each region. The sediments were filled into up-flow reactors and connected to a water supply to mimic conditions in the hyporheic zone. After an acclimatisation phase of 2 weeks and a dry period of 7 weeks, the sediments were rewetted. During the acclimatisation and the rewetting phase, we performed N, P and DOM plateau additions to measure the retention behaviour and the influence of drying on that behaviour. N was measured as NH_4, NO_2 and NO_3, P as soluble reactive phosphate and DOM as dissolved organic carbon, via absorption parameters and via fluorescence parameters including a PARAFAC analysis. Additionally, we monitored the extracellular enzymatic activity, the water content and other sediment parameters.

We found that the low moisture content, that is left in sediments of temperate streams even after long drought periods, is sufficient for microbes to recover quickly afterwards. We measured a peak of nutrients and DOC right after rewetting. Nutrient and DOC retention was reduced immediately after rewetting, but recovered fast. We could not see any microbial adaption of historically intermittent streams to desiccation. Thus, differences between regions were much larger than those between perennial and intermittent streams. We can verify the results from our experiment by field data we collected in parallel.

Our study clearly highlights the necessity to protect hyporheic microbes from desiccation effects by ensuring enough moisture content during dry periods. Management methods, such as shading or a reasonable amount of residual flow, can ensure healthy biofilms and reduce effects of prolonged drought periods on in-stream nutrient retention.