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Effect of climate change on internal P loading in a reservoir system

KAREL S. AS[1], MELANIE MÜNCH[2], GABRIELE TROMMER[3], THILO BEHRENDS[2] AND **STEFAN PEIFFER**[1]

[1]University of Bayreuth
[2]Utrecht University
[3]Water Management Office Ansbach

Presenting Author: s.peiffer@uni-bayreuth.de

Lake warming as a result of climate change can have important consequences for reservoir nutrient dynamics and has frequently been addressed by modelling studies due to a lack of data sets that monitored important trends in nutrients and anoxia over significantly long periods of time. Here, we analysed monitoring data obtained between 2000 and 2020 in the Franconian Lake District (FLD), Germany, resulting in a highly detailed data set allowing the distinguishing of trends in nutrient concentrations, thermal stratification and anoxia. The FLD consists of a cascade of 4 inteconnected reservoirs starting with a highly eutropic, shallow reservoir receiving high nutrient loads form a uplake catchment. From here water is transfered to the other deep reservoirs, the trophic state of which being eutrophic or mesotrophic, respectively. For the deep reservoirs, an increase in temperature in the epilimnion was observed proceeding with a two times faster rate than the increase in air temperature. As a consequence, the period of stratification has been prolonging and anoxia became an increasingly persistent characteristic of the reservoir. During the stratified period, release rates of ortho-phosphate significantly increased as well as levels of ortho-phosphate in the entire lakes` volume albeit the input of P into the reservoirs remained constant. Especially for low-nutrient such shifts resulted in a strongly increased internal P loading from the sediments with implications for the N:P ratios in the lake water. Sequential extraction of sediment material underpinned these observations as redox sensitive P is the largest P pool in the surface layers of the sediments. Our study highlights the intricate coupling between physical and biogeochemical processes that need to be considered in the discussion about the response of surface water bodies on climate change.