Quantifying in-stream nitrate uptake at river network scale: a parsimonious approach deriving from high-frequency sensor measurements

Xiaoqiang Yang, Department of Aquatic Ecosystem Analysis and Management, Helmholtz Centre for Environmental Research-UFZ, Brückstrasse 3a, 39114 Magdeburg, Germany

Seifeddine Jomaa, Department of Aquatic Ecosystem Analysis and Management, Helmholtz Centre for Environmental Research-UFZ, Brückstrasse 3a, 39114 Magdeburg, Germany

Michael Rode, Department of Aquatic Ecosystem Analysis and Management, Helmholtz Centre for Environmental Research-UFZ, Brückstrasse 3a, 39114 Magdeburg, Germany

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Higher spatiotemporal accuracy of in-stream nitrate uptake estimates is increasingly required for better understanding the functional heterogeneity of river networks and improving management decisions at different levels. The objective of this study is to quantify nitrate uptake by gross primary production at the reach scale using high frequency sensor measurements and, with a parsimoniously designed approach, to upscale these findings to the whole river network with a fully distributed nitrate catchment model.

Newly available high-frequency sensor measurements offer a new perspective for process-based modeling, in terms of process description and parameterization. Daily in-stream nitrate assimilatory uptake (due to primary production) have been determined from reliable daily gross primary production data and high frequency nitrate measurements in the nested Selke catchment (456 km²) in central Germany. Five years of continuous uptake data have been calculated in an agricultural and a forested reach of the study catchment. Results show that shading effect depending on varying riparian vegetation strongly varies the nitrate uptake patterns. Here, we propose a parsimonious approach, which takes into account the driving force (global radiation, corrected with measured photosynthetically active radiation data), riparian vegetation interception (leaf area index) and the potential uptake rate (a general parameter). The five-year's data are used to validate the new approach and determine the GPP based uptake parameter value. Results show that this parsimonious approach reproduces well the seasonal patterns in both riparian conditions (agricultural and forested reaches). For upscaling these findings to the whole river network we used the new mHM-Nitrate model, which was recently developed by authors at UFZ. Besides the detailed spatial information of the terrestrial processes, the mHM-Nitrate model provides comprehensive instream information throughout the whole river network. Since all required information for the new approach is easily accessible and can be provided by the input data/catchment information of the mHM-Nitrate model, a more precise nitrate uptake from the whole river network can be obtained. This new approach can also reduce the complexity of parameterization, thereby reducing the parameter uncertainty of the model.