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Distributed nitrate transport and reaction routines (NTR) inside the mesoscale Hydrological Model (mHM) framework: Development and Application in the Selke catchment

Sumit Sinha (1,2), Michael Rode (2), Rohini Kumar (3), Xiaoqiang Yang (2), Luis Samaniego (3), and Dietrich Borchardt (2)

(1) Durham University, Department of Geography, Durham, United Kingdom (sumit.sinha@durham.ac.uk), (2) Department of Aquatic Ecosystem Analysis, Helmholtz Centre for Environmental Research-UFZ, Magdeburg, Germany (sumit.sinha@ufz.de), (3) Department of Computational Hydrosystems, Helmholtz Centre for Environmental Research-UFZ, Leipzig, Germany

Precise measurements of where, when and how much denitrification occurs on the basis of measurements alone persist to be vexing and intractable research problem at all spatial and temporal scales. As a result, models have become essential and vital tools for furthering our current understanding of the processes that control denitrification on catchment scale. Emplacement of Water Framework Directive (WFD) and continued efforts in improving water treatment facilities has resulted in alleviating the problems associated with point sources of pollution. However, the problem of eutrophication still persists and is primarily associated with the diffused sources of pollution originating from agricultural area. In this study, the nitrate transport and reaction (NTR) routines are developed inside the distributed mesoscale Hydrological Model (mHM www.ufz.de/mhm) which is a fully distributed hydrological model with a novel parameter regionalization scheme (Samaniego et al. 2010; Kumar et al. 2013) and has been applied to whole Europe (Rakovec et al. 2016) and numerous catchments worldwide. The aforementioned NTR model is applied to a mesoscale river basin, Selke (463 km2) located in central Germany. The NTR model takes in account the critical and pertinent processes like transformation in vadose zone, atmospheric deposition, plant uptake, instream denitrification and also simulates the process of manure and fertilizer application. Both streamflow routines and the NTR model are run on daily time steps. The split-sample approach was used for model calibration (1994-1999) and validation (2000-2004). Flow dynamics at three gauging stations located inside this catchment are successfully captured by the model with consistently high Nash-Sutcliffe Efficiency (NSE) of at least 0.8. Regarding nitrate estimates, the NSE values are greater than 0.7 for both validation and calibration periods. Finally, the NTR model is used for identifying the critical source areas (CSAs) that contribute significantly to nutrient pollution due to different local hydrological and topographical conditions. Postulations for a comprehensive sensitivity analysis and further regionalization of key parameters of the NTR model are also investigated.

References:

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