EGU21-7812, updated on 28 Sep 2022
https://doi.org/10.5194/egusphere-egu21-7812
EGU General Assembly 2021

Towards Application of StorAge Selection Functions in Large-Scale Catchments with Heterogeneous Travel Times and Subsurface Reactivity

Tam Nguyen[1], Fanny Sarrazin[2], Stefanie R. Lutz[1], Rohini Kumar[2], Andreas Musolff[1], and Jan H. Fleckenstein[1,3]

[1]Department of Hydrogeology, Helmholtz-Zentrum für Umweltforschung GmbH - UFZ, Germany
[2]Department Computational Hydrosystems, Helmholtz Centre for Environmental Research - UFZ, Leipzig, Germany
[3]Bayreuth Center of Ecology and Environmental Research, University of Bayreuth, Bayreuth, Germany

StorAge Selection (SAS) functions describe how a catchment selectively removes water and solute of different ages via discharge, thus controlling transit time distributions (TTDs) and solute composition of discharge. Previous studies have successfully applied SAS functions in a spatially lumped approach to capture catchment-scale transport phenomena of (non-)conservative solutes. The lumped approach assumes that water and solutes within a water parcel of a specific age are well-mixed. While this assumption does not cause any changes in the age of water, the spatial heterogeneity of solute concentrations within this water parcel is lost. In addition, in large catchments, headwater sub-catchments and lowland sub-catchments could behave in different ways, e.g., the transit times (TTs) and reaction rates between headwater and lowland sub-catchment could be of different magnitudes. This, in turn, might not be sufficiently represented in a lumped approach of SAS functions.

In this study, we applied the mHM-SAS model (Nguyen et al., 2020) with a semi-distributed approach of SAS functions. The nested mesoscale catchment (Selke catchment, Germany) with heterogeneous land use management practices, TTs, and subsurface reactivity was used as a case study. In addition to spatial variability, a functional relationship between the parameters of the SAS functions and storage dynamics was introduced to capture temporal dynamics of the selection preference for discharge. High frequency instream nitrate data were used to validate the proposed approach. Results show that the proposed approach can well represent nitrate export at both sub-catchment and catchment levels. The model reveals that catchment nitrate export is controlled by (1) the headwater sub-catchment with fast TTs and a high denitrification rate, and (2) the lowland sub-catchment with longer TTs and a low denitrification rate. In general, the proposed approach serves as a promising tool for understanding the interplay of transport and reaction times between different sub-catchments, which controls nitrate export in a mesoscale heterogeneous catchment.

Nguyen, T. V., Kumar, R., Lutz, S. R., Musolff, A., Yang, J., & Fleckenstein, J. H. (2020). Modeling Nitrate Export from a Mesoscale Catchment Using StorAge Selection Functions. Water Resources

Research, 56, e2020WR028490