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How to improve the representation of nitrate processes and their dynamics in eco-hydrological models?

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Nitrate is one of the most important nutrients in agriculturally dominated catchments. The transport of nitrate and its transformations are influenced by many interacting processes, which are driven by different eco-hydrological processes. To understand the dynamics of nitrate processes, complex eco-hydrological models can be used. Acknowledging the current research in hydrological consistency, the different hydrological and nutrient processes need to be considered at the same time in the model calibration.
To achieve this, a two-step procedure is provided consisting of a temporally resolved sensitivity analysis of discharge and nitrate parameters and a joint multi-calibration of discharge and nitrate. For these analyzes, the eco-hydrological model SWAT (Soil Water Assessment Tool) is used in an agricultural dominated catchment (Treene river, Northern Germany). A better understanding of the modelled nitrate processes can be achieved by analyzing the temporal variations of dominant nitrate parameters with a temporal parameters sensitivity analysis (TEDPAS). TEDPAS provides daily sensitivities for the nitrate parameters. The temporal sensitivity analysis shows that the dominant parameters vary in the annual cycle due to seasonal varying dynamics in nitrate transport and plant uptake.
Following an improved understanding of dominant nitrate parameters and related processes, a new calibration method is proposed which takes all relevant processes controlling nitrate loads into account. For this, a nitrate duration curve (NDC) is constructed and used in addition to the flow duration curve (FDC) in the calibration method. Separate performance metrics are calculated for five segments of FDC and NDC to examine the different magnitudes of discharge and nitrate loads separately. Through this separate assessment of discharge and nitrate segments, a model run is detected that represents all phases simultaneously well.
The combination of a better understanding of the modelled nitrate processes by a temporal parameter sensitivity analysis and an adequate representation of all processes through a segmented calibration of discharge and nitrate leads therefore to a better control of how nitrate dynamics are represented in models. With this knowledge, eco-hydrological models could be used in a very constrained way in studies for a sustainable management.