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Modelling of catchment nitrogen concentrations response to observed varying fertilizer application intensities

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Eutrophication is a serious environmental problem. Despite numerous experimental and modelling efforts, understanding of the effect of land use and agriculture practices on in-stream nitrogen fluxes is still not fully achieved. This study combined intensive field monitoring and numerical modelling using 30 years of surface water quality data of a drinking water reservoir catchment in central Germany. The Weida catchment (99.5 km2) is part of the Elbe river basin and has a share of 67% of agricultural land use with significant changes in agricultural practices within the investigation period. The geology of the Weida catchment is characterized by clay schists and eruptive rocks, where rocks have low permeability. The semi-distributed hydrological water quality HYPE (Hydrological Predictions for the Environment) model was used to reproduce the measured data. First, the model was calibrated for discharge and nitrate-N concentrations (NO_3-N) during the period 1997-2000. Then, the HYPE model was validated successfully for three different periods 1983-1987, 1989-1996 and 2000-2003, which are charaterized by different fertilizer application rates (with lowest discharge prediction performance of NSE = 0.78 and PBIAS = 3.74%, considering calibration and validation periods).
Results showed that the measured as well as simulated in-stream nitrate-N concentration respond quickly to fertilizer application changes (increase/decrease). This rapid response can be explained with short residence times of interflow and baseflow runoff components due to the hardrock geological properties of the catchment. Results revealed that the surface runoff and interflow are the most dominant runoff components. HYPE model could reproduce reasonably well the NO_3-N daily loads for varying fertilizer application, when detailed input data in terms of crop management (field-specific survey) are considered.