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Comparative simulation of the nitrogen dynamics using the INCA model and a neural network analysis: implications for improved nitrogen modelling

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Abstract. Continuing deposition of nitrogen in forested catchments affects stream and groundwater quality. However, the dependence of nitrogen dynamics on climatic and hydrological boundary conditions is still poorly understood. These dynamics have been investigated by applying the process-oriented Integrated Nitrogen in CAtchments (INCA) model and an artificial neural network to the data set from the forested Steinkreuz catchment in South Germany. The data comprise daily values of precipitation, air temperature and discharge of the catchment runoff. The INCA model simulated the mean nitrate concentration in the stream as well as seasonal fluctuations but it underestimated the short-term variance of the observed stream water nitrate concentration, especially the pronounced concentration peaks in late summer. In contrast, the artificial neural network matched the short-term dynamics using non-linear regressions with stream discharge and air temperature data. The results provide strong evidence that the short-term dynamics of stream nitrate concentration during storm-flow were generated in the riparian zone, which is less than 1% of the catchment area, and is not considered explicitly in the INCA model. The concentration peaks have little effect on the catchment's nitrogen budget and the shallow groundwater data suggest that the short-term hydrological dynamics also govern groundwater recharge in the upland parts of the catchment. This substantial underestimate by the INCA model parameterisation is balanced by a corresponding underestimate of denitrification in clayey layers of the deeper aquifer. A better understanding of these processes is necessary to improve long-term risk assessments.

Keywords: catchment, runoff, nitrogen, INCA, artificial neural network, flushing

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