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Parameter sensitivity analysis and prediction error in field-scale NO_3-N modelling

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Abstract

The hydrologic and nitrate (NO_3-N) leaching dynamics of a maize field were respectively modelled with DRAINMOD and DRAINMOD-N. Experimental data of a 3-year period were available for model calibration and evaluation. Data from the first two years were used for model calibration whilst data from the remaining year were used for an initial evaluation. Data collected before the 3-year experiment, during a 23-year period, were used for further "backward" (in time) evaluation. The hydrologic module was calibrated through a trial and error approach. The NO_3-N leaching module was calibrated and evaluated with a Monte Carlo simulations based approach. Nine parameters describing the leaching process were studied. In total, 10,000 parameter sets were tried out. The analysis revealed an acceptable prediction of the observed drainage and NO_3-N leaching time series throughout both the 3-year experimental period as well as the prior 23-year "backward" evaluation period. Nevertheless

the analysis revealed that no single set of optimal parameter values could be identified. It was found that the model performance is only sensitive to the rate of denitrification. Narrow NO_3-N prediction intervals were obtained, even in the longer 23-year ("backward") evaluation period. Apparently, the behavioural DRAINMOD-N simulations were able to acceptably reproduce the limited to moderate NO_3-N leaching fluctuations that occur in the modelled system.

Highlights

▸ We modelled the hydrologic and nitrate leaching dynamics of a maize field. ▸ Two evaluation periods (prior and posterior to the calibration one) were considered. ▸ A deterministic–stochastic approach was used based on the GLUE (Generalised Likelihood Uncertainty Estimator) methodology. ▸ Predictions of drainage and NO_3-N leaching time series are acceptable. ▸ Model performance is only sensitive to the rate of denitrification.

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Keywords

Hydrology; Water quality; NO_3-N leaching; DRAINMOD-N; Sensitivity analysis; Prediction error; GLUE (Generalised Likelihood Uncertainty Estimator)

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