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Modelling real VFS experiments with a new VFSMOD version – calibration and uncertainty analysis with DREAM-ZS

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The most widely implemented mitigation measure to reduce transfer of pesticides and other pollutants to surface water bodies via surface runoff are vegetative filter strips (VFS). To reliably model the reduction of surface runoff, eroded sediment and pesticide inputs into surface water by VFS in a risk assessment context, an event-based model is needed. The most commonly used dynamic, event-based model for this purpose is VFSMOD. While VFSMOD simulates reduction of total inflow (ΔQ) and reduction of incoming eroded sediment load (ΔE) mechanistically, the reduction of pesticide load by the VFS (ΔP) has until recently been calculated exclusively with the empirical Sabbagh equation. The latest version of VFSMOD (v.4.4.0) includes further pesticide trapping options, notably the Sabbagh equation with user-defined regression coefficients and a regression-free mass-balance approach.

The new VFSMOD version was systematically tested against real experimental data. Four studies with 16 hydrological events and 31 combinations of hydrological event and compound were selected from the experimental data compiled by Reichenberger et al. (2019), representing different levels of data availability and uncertainty. A first set of simulations was conducted with parameterization according to SWAN-VFSMOD and the three pesticide trapping options mentioned above. The Sabbagh equation with optimized coefficients from Reichenberger et al. (2019) and the original Sabbagh equation overestimated pesticide trapping efficiency ΔP for the low range of measured ΔP, while the mass balance approach yielded the most conservative results. These observations were due to an overestimation of ΔE with the SWAN-VFSMOD parameterization. The simulation results suggest that the SWAN-VFSMOD parameterization of saturated hydraulic conductivity is too conservative, while the parameterization of sediment filtration is too optimistic.

In a second step, a maximum-likelihood-based calibration and uncertainty analysis was performed for each hydrological event and the target variables ΔQ and ΔE with the DREAM-ZS algorithm. One aim of the DREAM analysis was to help improve the parameterization methodologies for the infiltration and sediment filtration modules for regulatory VFS scenarios. Subsequently, the three pesticide trapping equations were applied in predictive mode to elucidate which equation performs better in which situation (e.g. soil type, Kd, characteristics of runoff/erosion event).