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Recalibration and cross-validation of pesticide trapping efficiency equations for vegetative filter strips (VFS) using additional experimental data

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Vegetative filter strips (VFS) are widely used for mitigating pesticide inputs into surface waters via surface runoff and erosion. To simulate the effectiveness of VFS in reducing surface runoff volumes, eroded sediment and pesticide loads the model VFSMOD (Muñoz-Carpena and Parsons, 2014) is frequently used. While VFSMOD simulates infiltration and sedimentation mechanistically, the reduction of pesticide load in surface runoff by the VFS (deltaP) is calculated with the empirical multiple regression equation of Sabbagh et al. (2009). This equation uses the following inputs: predicted reduction of total inflow (deltaQ) and eroded sediment load (deltaE), absolute surface runoff volume and eroded sediment load entering the VFS, linear adsorption coefficient Kd of the pesticide, and the clay content of the field soil (as a proxy for the clay content of the eroded sediment). The Sabbagh et al. (2009) equation, the coefficients of which were obtained by calibration against 47 data points, has not been widely accepted by regulatory authorities, on the grounds that its reliability has not been sufficiently established yet. Hence, evaluation against additional experimental data is necessary. Chen et al. (2016) proposed an alternative regression equation with a different structure based on 181 experimental data points. This equation uses fewer independent variables, but has more parameters than the Sabbagh equation.

The objective of the present study was to improve the predictive capability of the Sabbagh et al. equation by broadening the underlying experimental data. For this aim, additional experimental VFS datasets were compiled from the available literature and thoroughly checked for their suitability. Moreover, existing errors in the calibration and validation data points of Sabbagh et al. (2009) were corrected. The consolidated experimental dataset (n = 244) was used to recalibrate the Sabbagh and Chen equations. Moreover, a k-fold cross validation analysis was performed to assess the predictive capability of both models. The Sabbagh equation fitted the whole dataset slightly better than the Chen equation ($r^2 = 0.82$ vs. $r^2 = 0.79$) and performed consistently better in the cross-validation exercise (with respect to the prediction performance indicators Q^2, predictive r^2, and RMSEP). Finally, a maximum-likelihood-based calibration and uncertainty analysis were performed for the Sabbagh equation using the DREAM algorithm.