Modelling runoff mitigation capability of vegetated filter strips

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Introduction

Vegetative filter strip (VFS) effectiveness in reducing pesticide loading is directly related to reduction in runoff and sediment loading. Recently, a numerical simulation model capable of predicting both runoff reduction and sediment trapping (VFSMOD-W) was linked with a new pesticide trapping equation (Sabbagh et al., 2009). Here, the extended VFSMOD-W was interfaced with the models FOCUS-PRZM and FOCUS-TOXSWA to consider dynamic VFS effectiveness in pesticide trapping as an alternative to the width-based water, sediment and pesticide load reduction factors that are currently used in FOCUS higher tier surface water exposure assessment.

Background on VFSMOD-W

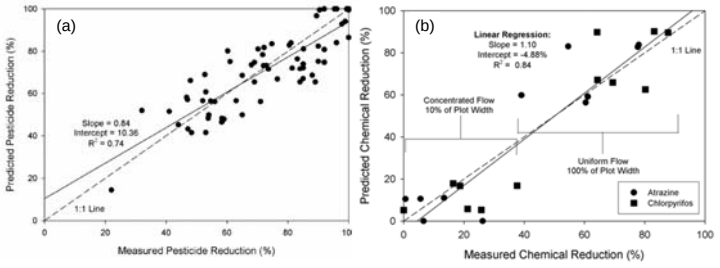
The Vegetative Filter Strip Modeling System, VFSMOD-W, is a field-scale, mechanistic, storm-based model developed to route the incoming hydrograph and sedigraph from an adjacent field through a VFS and to calculate the resulting outflow, infiltration, and sediment trapping efficiency (Muñoz-Carpena and Parsons, 2004). Recent work has extended the model to successfully calculate pesticide trapping efficiency (Sabbagh et al., 2009; Poletika et al., 2009).

Pesticide trapping efficiency equation in VFSMOD-W:

$$\Delta P = 24.79 + 0.54(\Delta Q) + 0.52(\Delta E) - 2.42\ln(F_{ph} + 1) - 0.89(\%C)$$

where ΔP = pesticide reduction by VFS (%)
ΔQ = runoff volume reduction by the VFS (%)
ΔE = reduction in eroded sediment by VFS (%)
F_{ph} = ratio between the mass of pesticide in water relative to the mass of the pesticide sorbed to sediment (dimensionless, based on volume of water and mass of sediment entering the VFS as well as the linear sorption coefficient
%C = percent clay

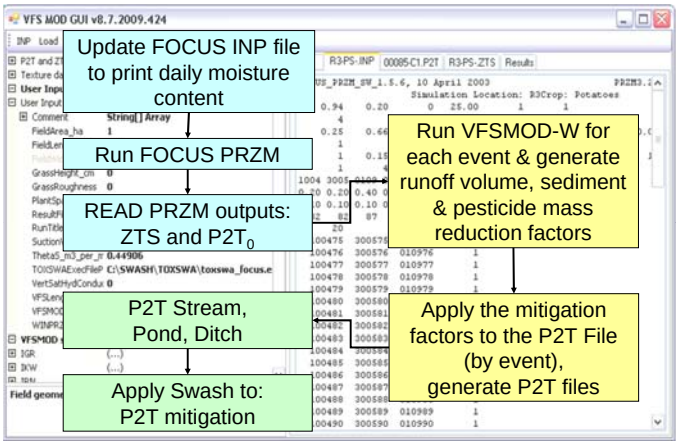
VFSMOD-W performance in calculating pesticide trapping efficiency was evaluated by Sabbagh et al. (2009) and Poletika et al. (2009), and the tool was able to reasonably predict pesticide removal efficiency under both uniform and concentrated flow conditions. Additional sensitivity analyses indicated that saturated hydraulic conductivity is the major control factor for predicting infiltration, sedimentation and pesticide trapping.



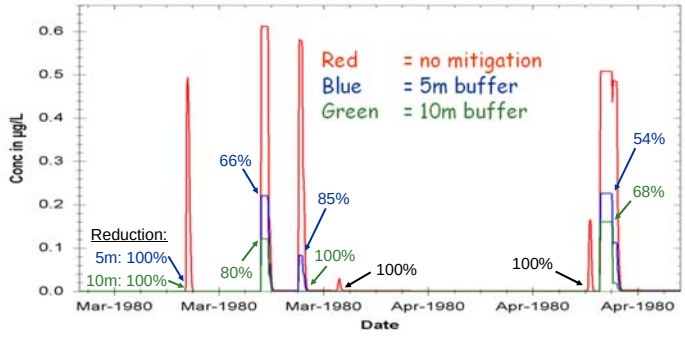
Linear regression between measured and VFSMOD-W predicted pesticide reduction: data from (a) Sabbagh et al. (2009) and (b) Poletika et al. (2009)

FOCUS-PRZM / VFSMOD-W / FOCUS-TOXSWA modelling system

The modelling system was developed as part of the ECPA Advancing Intelligent Mitigation (AIM) initiative. It estimates the reduction of runoff, sediment and pesticide loading by the VFS for each individual PRZM runoff/erosion event and the subsequent exposure of the aquatic system under a graphical user interface:



The modelling system proved capable to predict trapping efficiency and mitigation of surface water exposure for a range of active substances and application scenarios.



Conclusions

VFSMOD-W is capable of predicting hydrology, sediment transport and pesticide trapping through VFS in numerous hydrologic settings. A modelling system combining PRZM, VFSMOD-W and TOXSWA facilitates higher tier surface water exposure assessments within a FOCUS Step 4 framework. The current mitigation approach of FOCUS landscape & mitigation is based on static reduction factors related to buffer width. In contrast, the proposed modelling system estimates VFS trapping efficiency dynamically for single runoff events.

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