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Fate of pesticide residues in vegetative filter strips in long-term exposure assessments: VFSMOD development and analysis

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Inclusion of quantitative mitigation of pesticides in regulatory environmental risk assessment (ERA) using common agricultural field conservation practices is a critical need recently identified by experts in North America and EU [1]. Currently, mitigation by vegetative filter strips (VFS) is available by coupling the event-based model VFSMOD in continuous simulations within current long-term higher-tier surface water ERA frameworks (EU FOCUS SWAN, US EPA PWC, PRMA Canada, California CDPR PREM, etc.). In this case, the field management and pesticide-laden surface runoff at the edge of the field is calculated by the model PRZM and VFSMOD routes it from the edge of field through a VFS of desired characteristics to estimate potential load reductions before entering the aquatic environment, simulated by the receiving water body model (FOCUS TOXSWA, EPA VVWM). While under proper settings VFS could effectively reduce pesticide concentrations in surface water below thresholds of concern- what happens to the residues trapped in the VFS? The current ERA VFS framework uses a highly risk-conservative assumption, whereby the pesticide trapped in the VFS undergoes degradation between storm events and the surface residue (soil mixing layer and adsorbed to trapped sediment) is remobilized in full and added to the incoming pesticide load in the next event in the series. While risk conservative, this initial approach is not consistent with the nonuniform pesticide redistribution and extraction with depth used in the model PRZM within current ERA, and it has also been found too conservative for highly sorbed compounds with high specific toxicity like pyrethroids and others. The objective of this study is to develop a complete VFSMOD component to quantify the fate of VFS pesticide residues between runoff events for use in long-term ERA simulations. This includes realistic assumptions of the fate of the residues, including non-linear pesticide redistribution in the soil, mass balance of the VFS soil mixing layer and sediment trapped, degradation between runoff events, and partial remobilization and carryover of the remaining residue to the next event. Initial sensitivity and limited testing with existing field data are discussed.