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Effect of Remobilization of Pesticide Residues in Vegetative Filter Strips for Mitigation in Higher-Tier Pesticide Exposure Assessments with VFSMOD

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Vegetative filter strips (VFS) are commonly implemented in the field to mitigate runoff pesticide inputs into surface waters and protect aquatic ecosystems. The efficiency of this mitigation practice can be evaluated within the current regulatory high-tier, long-term environmental risk assessments (ERA) in combination with VFSMOD, an established and commonly used numerical model for the analysis of runoff, sediment, and pesticide transport in VFS. For every rainfall/runoff event in the long-term time series, VFSMOD takes the PRZM calculated edge-of-the-field surface runoff, eroded sediment yield, and dissolved and particle-bound pesticide load. It then calculates infiltration, sedimentation and pesticide trapping in the VFS during the event, and the outflow into the downslope aquatic body for further calculations and risk analysis. Importantly, at the end of each event, VFSMOD calculates the amount of pesticide residue retained in the filter (sediment-bound and infiltrated in the liquid phase), its degradation until the next event in the series, and the fraction of pesticide residue that is remobilized and added to the next runoff event. In earlier VFSMOD versions, full remobilization of the pesticide residue sorbed to sediment and that dissolved in the soil surface mixing layer (typically the top 0.5-5 cm) was calculated conservatively. Recent VFSMOD ERA applications for very highly-sorbed (i.e. pyrethroids) or persistent pesticides indicate that the full remobilization scheme might be too conservative in some cases. In this work, we evaluate new alternative partial remobilization schemes in VFSMOD, i.e. no remobilization of adsorbed residues, but full remobilization of dissolved residues in the mixing layer, or alternatively just a fraction of the mixing layer by diffusive exchange with the runoff. We evaluate the effects of the alternative remobilization schemes on observed total VFS pesticide reductions from available field data. In addition, employing global sensitivity analysis, we assess the relative importance of the alternative remobilization model structures in the context of the expected field variability of other known drivers of VFS efficiency (hydrology, soils, vegetation, pesticide chemical characteristics). The study provides science-based recommendations for future high-tier pesticide ERA with VFS mitigation.