

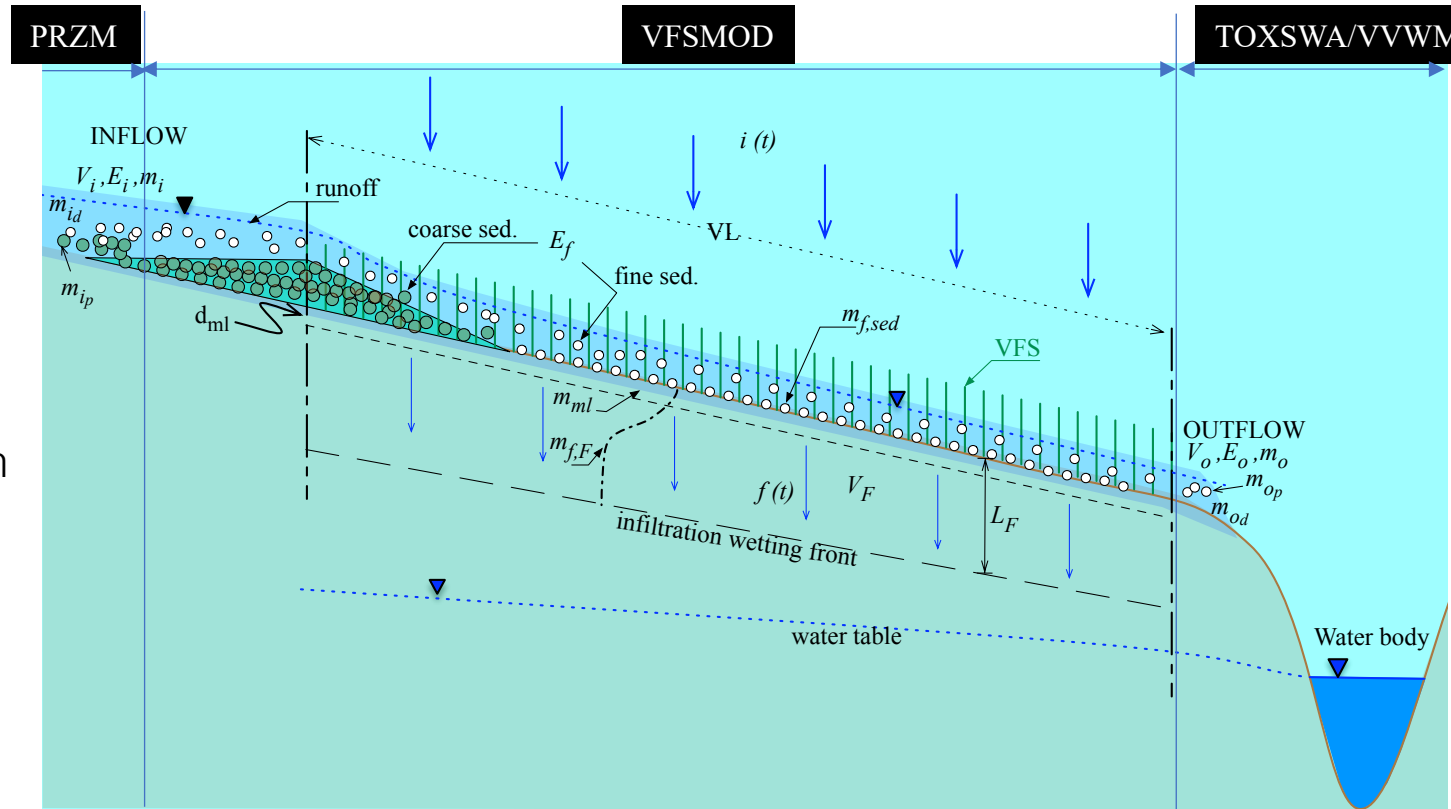


*Fate of pesticide residues in vegetative filter strips in
long-term exposure assessments:
VFSMOD development and analysis*

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Motivation

- Inclusion of quantitative mitigation of pesticides in regulatory environmental risk assessments (ERA) using common agricultural field conservation practices is a critical need recently identified by experts in North America and EU.
- Currently, mitigation by vegetative filter strips (VFS) is available by coupling the event-based model VFSMOD in continuous simulations within long-term higher-tier surface water ERA frameworks (EU FOCUS SWAN, US EPA PWC, PRMA Canada, California CDPR PREM, etc.).
- The field management and resulting surface runoff (water, sediment and pesticides) at the edge of the field is calculated by the model PRZM and VFSMOD routes these from the edge of field through the VFS to estimate load reductions before entering the water body simulated by the receiving aquatic model (FOCUS TOXSWA, EPA VVWM).



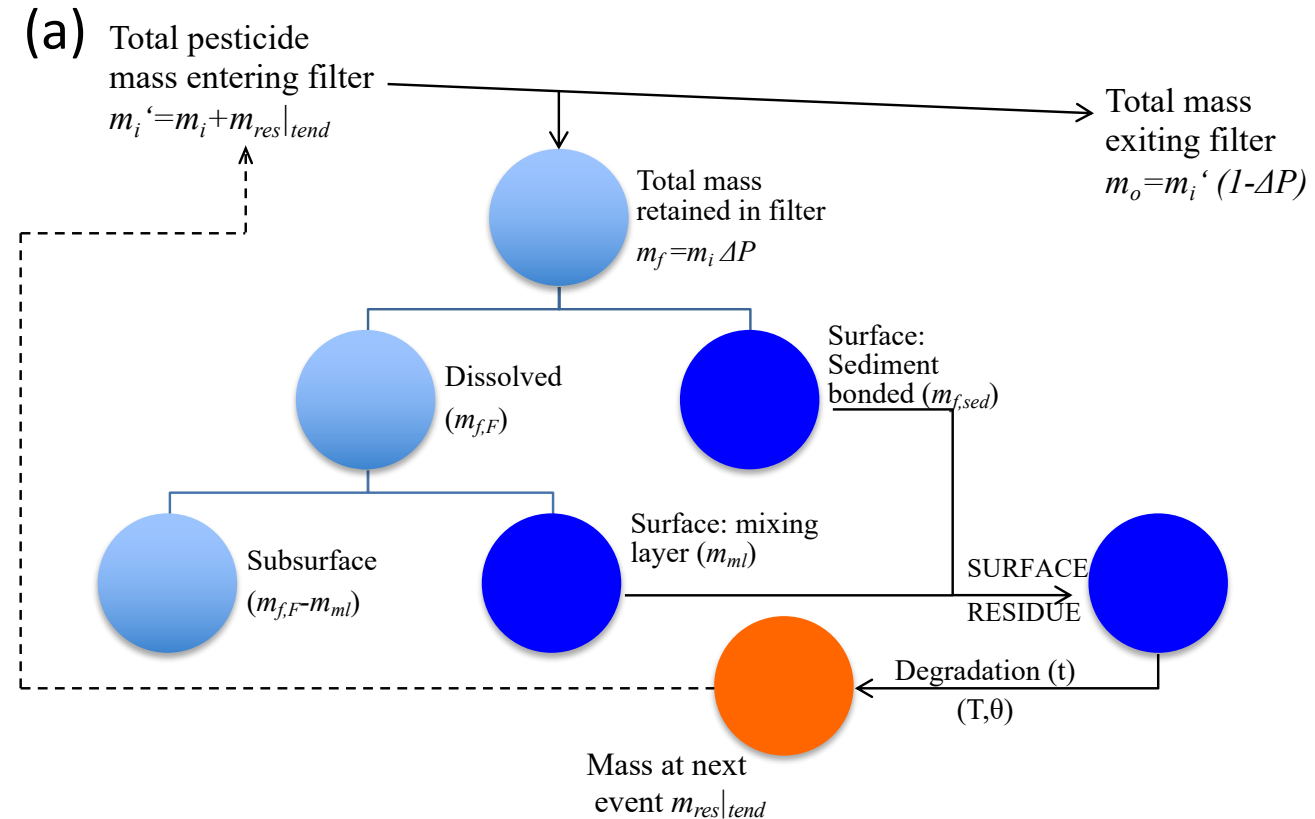
While under appropriate settings VFS could effectively reduce pesticide concentrations in surface water below thresholds of concern- **what happens to the residues trapped in the VFS?**

Objective

- Develop a comprehensive modeling component to quantify the fate of VFS pesticide residues between runoff events for VFSSMOD to 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 are discussed.

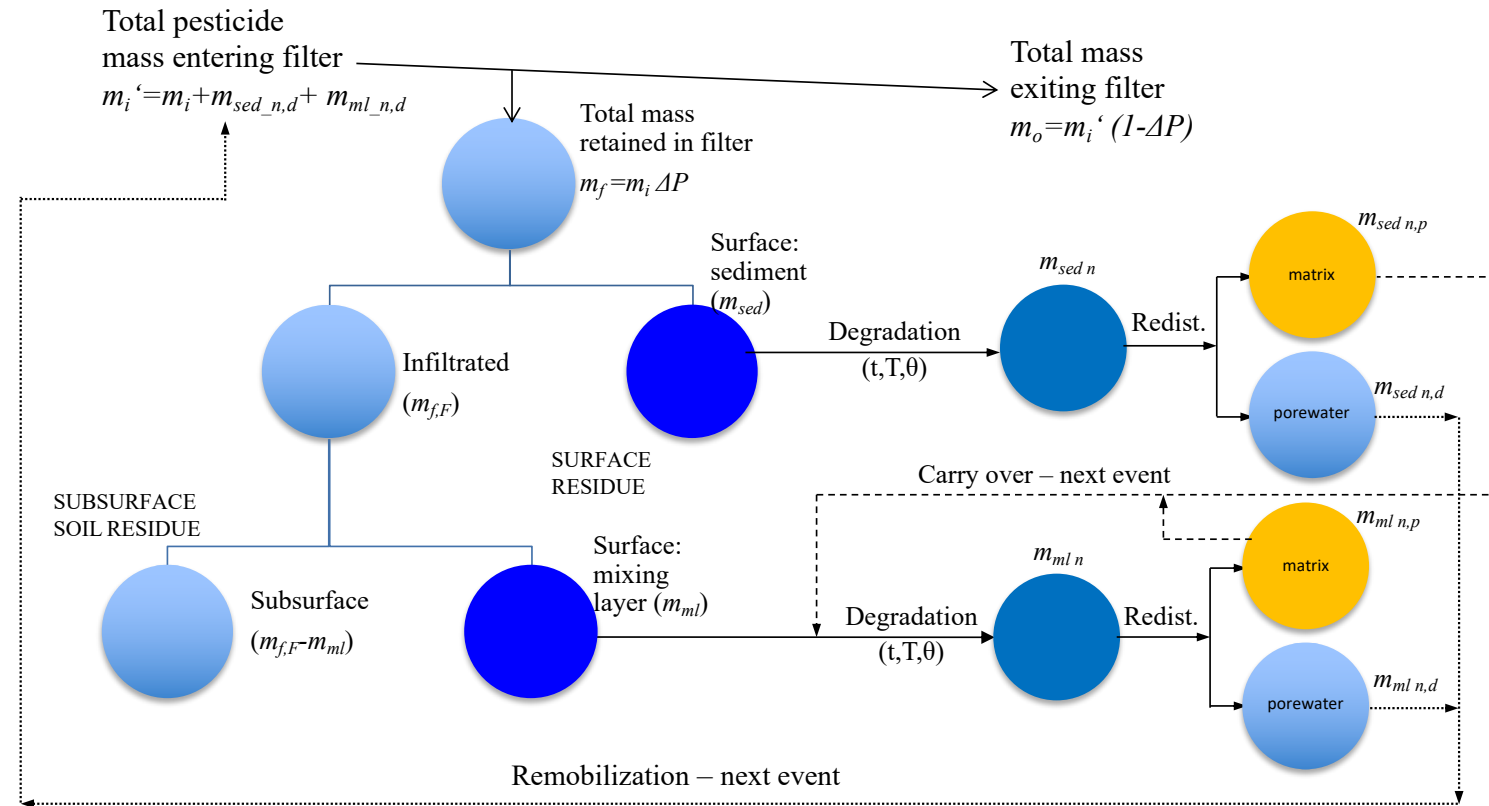
Current approach for pesticide residues in VFS

- The current ERA VFSSMOD-based framework uses a highly risk-conservative assumption
- 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.
- This initial approach is not consistent with nonuniform pesticide redistribution over the soil depth and can be too conservative for highly sorbed compounds (pyrethroids, etc.)



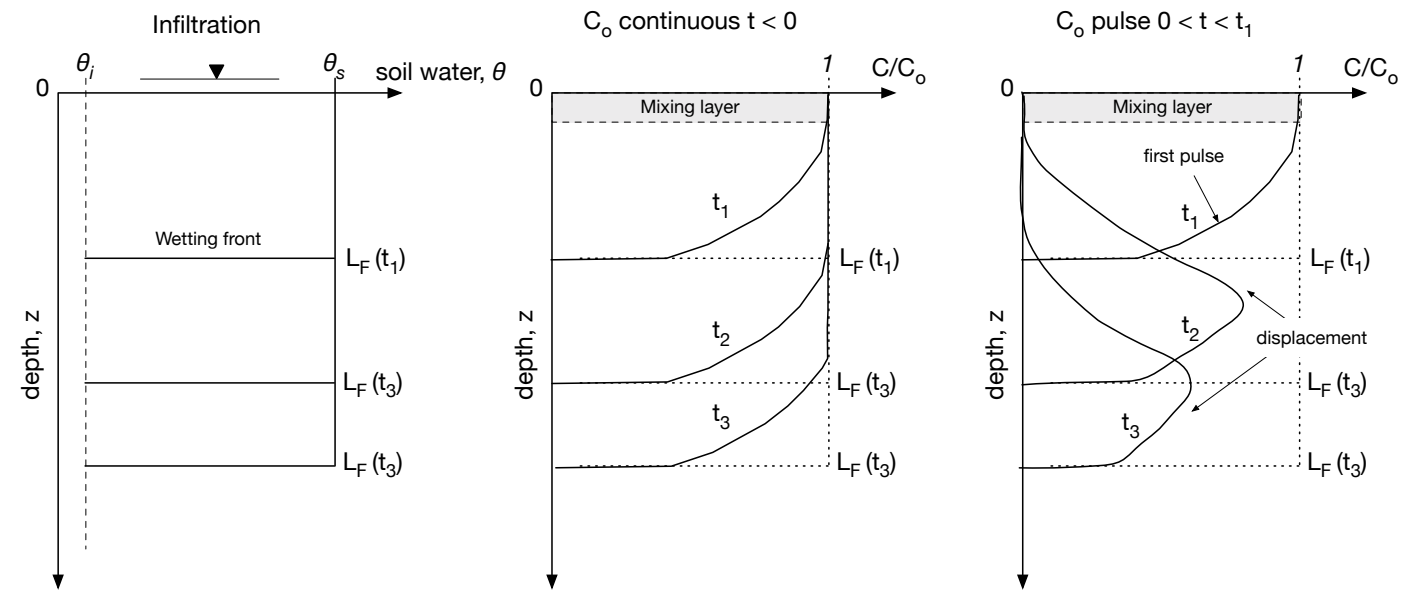
Revised approach for pesticide residues in VFS

- Phase redistribution of incoming pesticide mass is calculated from the total incoming mass (m_i [M], from PRZM) assuming runoff mixing and linear adsorption equilibrium between dissolved and sediment phases.
- For each event, VFS pesticide mass (m_f) is estimated from the total filter trapping efficiency ΔP [-] calculated from mechanistic mass-balance of reductions of sediment (solid phase) and infiltration (liquid phase) during the event
- m_f is partitioned as the sum of the mass sorbed on the sediment trapped in the filter ($m_{f, sed}$ [M]), and dissolved mass infiltrated in the soil during the event ($m_{f, F}$ [M]).
- Mass infiltrated is separated into runoff mixing layer (m_{ml}) and subsurface residues).
- Degradation of surface residues ($m_{f, sed} + m_{ml}$) during rainfall hiatus
- Redistribution before next event and remobilization: pore water residue is added to incoming pesticide mass for next event
- Sorbed surface residue retained as carry-over.



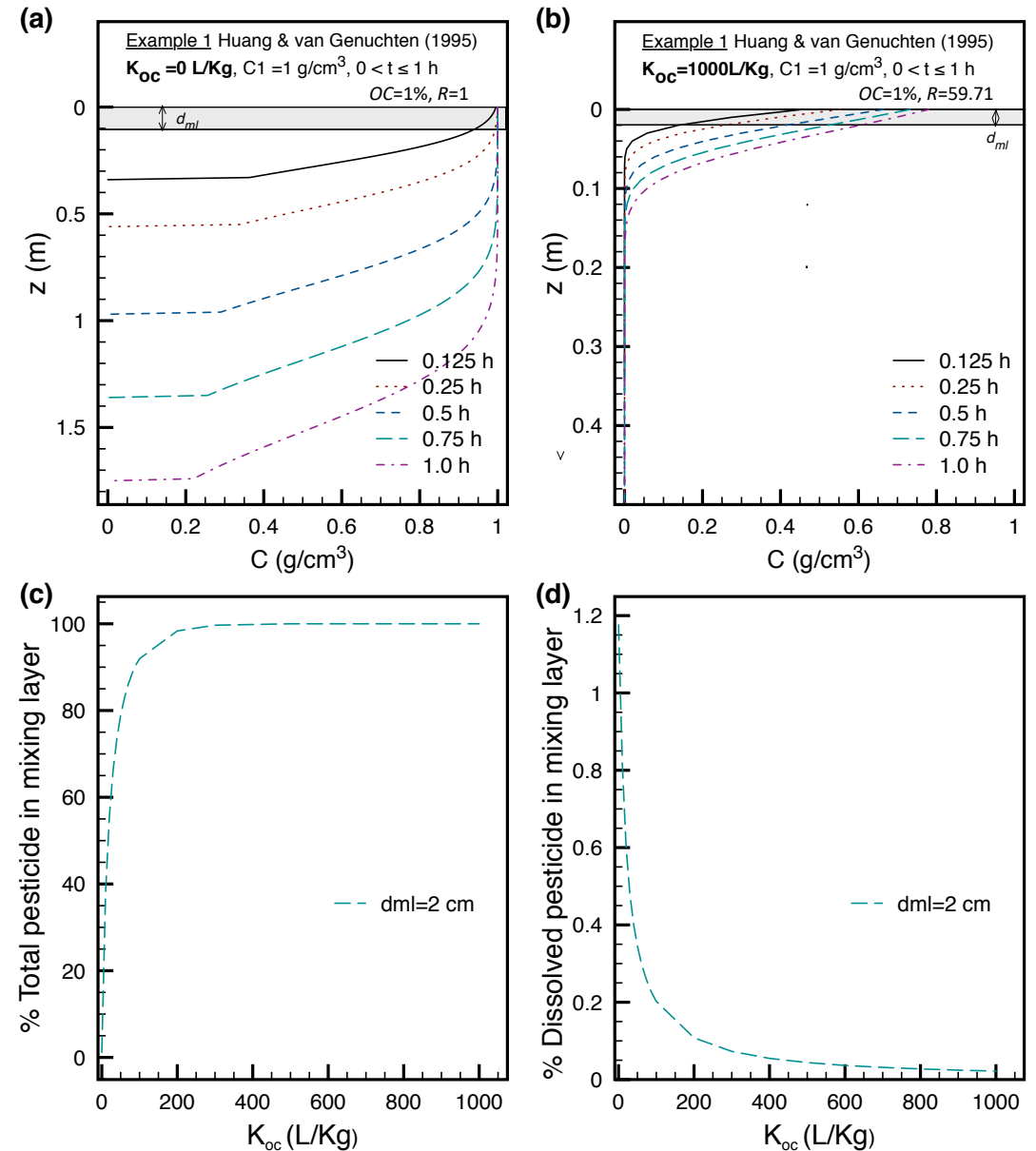
Mixing layer residue: non-linear redistribution

- Analytical solution of the chemical transport convective-dispersive equation (CDE) with non-linear sorption with depth within the Green-Ampt infiltration wetting front (Huang & van Genuchten, 1993).
- Considers the average concentration of pesticide entering the soil ($C_o = C_F = m_{f,F} / V_F$, and V_F =infiltration volume) and the depth of the wetting front (L_F) at the end of the unsteady rainfall runoff event.
- Integrating the chemical redistribution profile between the soil surface and the bottom of the mixing layer ($d_{ml}=2$ cm) we obtain the total pesticide mass trapped within the **mixing layer** (m_{ml} [M]) as the sum of its dissolved ($m_{ml,d}$ [M]) and sorbed ($m_{ml,s}$ [M]) fractions.



Results

- VFS pesticide soil redistribution profiles for two products (no/high sorption, $K_{oc} = 0$ ($R=1$) and 1000 L/Kg ($R=59.7$) (Fig. a,b) with a single pulse of pesticide ($C_f = 1 \text{ g/cm}^3$) during 1 hr Green-Ampt infiltration event.
- Figure c-d depicts the effect of pesticide sorption ($K_{oc} = 0$ to 1000 L/Kg) on the fraction of total and dissolved pesticide mass retained in the mixing layer for the sample 1 hr event, with increasing total and decreasing dissolved (porewater) masses with K_{oc} as expected.
- Importantly, this provides a physically based and realistic quantification of non-uniform pesticide redistribution with depth under this front and mixing layer content after the event



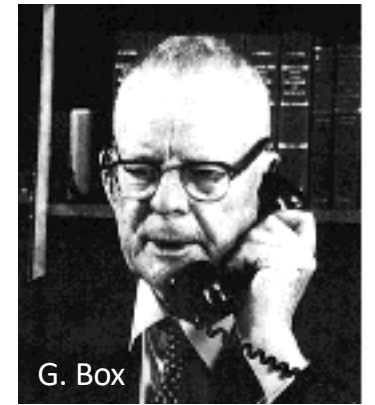
Outlook

- The new VFS pesticide residue component provides a realistic description of the long-term fate of trapped pesticide residues that is consistent with higher tier ERA assumptions.
- New experimental work under controlled laboratory conditions is starting to provide detailed data to test the model using state-of-the-art parametrization and model evaluation techniques.

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‘...all models are wrong, some are useful’
‘... and remember – GIGO!!’



W.E. Deming

Thank you for your attention