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Implementation of shallow water table effects on pesticide runoff mitigation efficiency by vegetative filter strips within SWAN-VFSMOD

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Quantitative mitigation of pesticides entering surface water using vegetative filter strips (VFS) is currently available within the regulatory SWAN tool for EU FOCUS STEP 4 simulations. For the VFSMOD model option, field estimates of surface runoff, sediment and pesticide loads simulated with the model PRZM are routed through the VFS where VFSMOD estimates the reductions of total inflow (dQ), eroded sediment (dE) and pesticide (dP) loads before the remaining runoff enters the waterbody. The reduced runoff is handed over to the TOXSWA aquatic model to calculate predicted environmental concentrations in surface water (PECsw). Brown et al. (2012) proposed VFSMOD parametrization rules including the selection of VFS soils and other characteristics for use in the FOCUS R1 to R4 (Rx) SWAN scenarios. The rules apply to free-draining soils, described in VFSMOD by the Green-Ampt model extended for unsteady rainfall. However, in some EU regions, the presence of a seasonal shallow water table (sWT) is common. In these cases, the VFS efficiency can be limited, depending on water table depth (WTD) and soil type. VFSMOD incorporates a sWT mechanistic infiltration component that has proven successful to predict sWT effects in VFS experiments. This component requires soil hydraulic characteristics, described by e.g. the Mualem-van Genuchten (MvG) equations.

The main objective of this study is to identify Rx representative VFS soils to study the effects of sWT on pesticide mitigation for a combination of illustrative storms and pesticides, as well as on PECsw from long-term SWAN simulations.

The selection and testing of the Rx VFS soils seeks to reflect a 90th-percentile worst case in space of dP. The multicriteria adopted in the soil selection evaluate not only dP, but also the percentile of important soil parameters for noWT (K_s, S_{av}) and sWT infiltration conditions (fillable pore volume f_{pv}). The framework consisted of 4 steps: (a) soil spatial soil database analysis for VFS Rx mitigation scenarios; (b) selection of VFS candidate soils; (c) analysis of effects of sWT and sorption on dP for individual storm events; (d) Effect of sWT on long-term STEP 4 SWAN VFS mitigation simulations. For (a), representative soil profiles and area coverage for each of the EU Rx were obtained by combining the latest EU JRC soil profile databases SPADE2 and SPADE14. Each multilayer soil was

aggregated into single-layer depth-weighted profiles, and MvG parameters were estimated using HYPRES pedotransfer functions (PTF). Water table depths (WTD) were set at equilibrium with TOXSWA median surface water level, and S_{av} and f_{pv} were calculated by numerical integration from MvG characteristics. For (b), 10644 VFSMOD simulations were run for all combinations of soils, T=1 and 10 yr storms, high/low Koc pesticides, and sWT/noWT conditions. Candidate Rx VFS soils were selected for the most conservative case (low Koc=100 Kg/L pesticide, T=10 yr storm) and noWT to achieve the target spatial 90^{th} percentile worst case of pesticide load reduction by the VFS.

The implementation of the new sWT VFS mitigation component provides a more realistic description of pesticide reduction in accordance with STEP 4 EU FOCUS objectives.