Quantitative Mitigation of Surface Runoff Pesticides with Vegetative Filter Strips using VFSMOD

Foreword

On 21 may 2020, the online workshop titled *Quantitative Mitigation of Surface Runoff Pesticides with Vegetative Filter Strips using VFSMOD*, organized by INIA, took place with the participation of more than 40 experts, risk assessors and risk managers of the southern zone.

The Workshop consisted in two presentations. First one about the FOCUS SW Scenarios and PECsw calculations for the assessment of active substances and plant protection products under Regulation 1107/2009. The second one was about the use of the VFSMOD as a model to quantify the mitigation of surface runoff pesticide with the use of vegetative filter strips (VFS).

The workshop was welcome among participants and the final round table of the workshop generated several questions.

Summary of the workshop

Using the EU guidance documents was agreed by the Southern Member States Steering Committee (SMSSG, 2018)[1], to conduct the zonal risk assessment of Plant Protection Products in the Southern Zone. This includes using the FOCUS surface water models and scenarios (FOCUS 2001, 2015; FOCUS SW)[2] and the recommendations given in FOCUS Landscape and Mitigation Factors in Ecological Risk Assessment (FOCUS, 2007; FOCUS L&M)[3] to estimate predicted environmental concentrations of pesticides in surface water and sediment for use in aquatic risk assessment.

FOCUS L&M recognizes three mitigation options that are suited to regulatory assessments for runoff reduction loading:

1. A reduction in the application rate, giving a similar reduction in losses to surface waters via surface runoff or erosion;

2. A restriction in the application window, normally to avoid application during or immediately before periods when the risk of runoff is greatest.

3. The application of a vegetated filter strips (VFS) to intercept runoff water and eroded sediment prior to entry into surface water.

For the first two options, the principles are similar to approaches applied in many Member States (MMSS) to mitigate the risk of leaching to groundwater. Both options are broadly acceptable and there

[1] SMSSG, 2018 WORKING DOCUMENT ON THE WORK-SHARING OF THE SOUTHERN ZONE MEMBER STATES UNDER REGULATION EC 1107/2009 ver7.1 (August 2018)

[2] FOCUS (2001). "FOCUS Surface Water Scenarios in the EU Evaluation Process under 91/414/EEC". Report of the FOCUS Working Group on Surface Water Scenarios, EC Document Reference SANCO/4802/2001-rev.2. 245 pp.; FOCUS (2015) Generic guidance for FOCUS surface water Scenarios version .1.4.

[3] FOCUS (2007). "Landscape and Mitigation Factors In Aquatic Risk Assessment. Volume 1. Extended Summary and Recommendations". Report of the FOCUS Working Group on Landscape and Mitigation Factors in Ecological Risk Assessment, EC Document Reference SANCO/10422/2005 v2.0. 169 pp.
FOCUS (2007). "Landscape and Mitigation Factors In Aquatic Risk Assessment. Volume 2. Detailed Technical Reviews". Report of the FOCUS Working Group on Landscape and Mitigation Factors in Ecological Risk Assessment, EC Document Reference SANCO/10422/2005 v2.0. 436 pp.

are already good examples of such approaches being successfully applied at Member State level, where label restrictions are applied to limit runoff input at the point of entry.

In the case of the third point, FOCUS L&M Group reviewed the available literature on efficacy of VFS for reducing pesticide transport in surface runoff (FOCUS, 2007)[3]. The Group concluded that whilst there was considerable variability in the efficacy of buffers under the range of conditions that had been tested, it was possible to recommend conservative factors for the reduction in water, sediment and pesticide load transferring across a VFS. They recommended a set of empirical factors for use in exposure assessment with factors varying with (i) size of the VFS, and (ii) transport primarily in the aqueous or sediment phases (Table 1).

Table 1: 90th percentile worst-case values for reduction efficiencies for different widths of vegetated buffers and different phases of surface runoff

Buffer width (m)	10-12	18-20
Reduction in volume of runoff water (%)	60	80
Reduction in mass of pesticide transported in aqueous phase (%)	60	80
n (for aqueous phase)	*36*	*30*
Reduction in mass of eroded sediment (%)	85	95
Reduction in mass of pesticide transported in sediment phase (%)	85	95
n (for sediment phase)	*19*	*11*

Moreover, SWAN tool was developed by the European Crop Protection Association, to support the FOCUS SW Step 4 modelling with mitigation measures based on the FOCUS L&M recommendations.

Pesticide trapping efficiency is known to be event based and driven by the site characteristics. At the time that the FOCUS L&M Group undertook its work (2002-2004), there were no appropriate modelling tools available to simulate reduction in pesticide load in surface VFS. Subsequently, work was undertaken in the USA to develop and evaluate such tools. Several simulation models were developed to predict the amount of pesticide active ingredients and their metabolites removed from runoff flowing through these strips. In Winchell *et al*, 2011[4] predictions of four models (APEX, PRZM-BUFF, REMM, and VFSMOD) were compared on three data set in uncalibrated simulation mode. The VFSMOD simulations were generally closest to the observed pesticide reductions, followed by PRZM-BUFF, APEX, and then REMM. The low percent differences (between observed and simulated) in runoff, sediment, and pesticide reductions obtained using VFSMOD can be in part attributed to VFSMOD's method for calculating pesticide reduction as a function of infiltration and sediment trapping within the buffer (along with several other factors).

VFSMOD (Vegetative Filter Strip Modelling System) is a mechanistic simulation model created to study hydrology, sediment and pollutant transport through vegetative filter strips (VFS). The model comprises the following modules:

[4] Winchell, M.F., R.L. Jones and T.L. Estes. 2011. Comparison of Models for Estimating the Removal of Pesticides by Vegetated Filter Strips. In: Goh *et al*.(eds.), Pesticide Mitigation Strategies for Surface Water Quality. Chapter 17. Pp. 273- 286. ACS Series. American Chemical Society: Washington, DC.

- overland flow module
- infiltration module
- sediment deposition module
- Contaminant transport module.

VFSMOD allows for robust assessments of VFS quantitative mitigation under realistic field conditions because it considers a wide range of VFS processes (i.e., shallow water table, degraded vegetation with wide range of land use, soils, hydrological, vegetation channelization and agrochemical characteristics).

The software, users manual, and associated publications can be obtained from the author R. Muñoz-Carpena at http://carpena.ifas.ufl.edu/VFSMOD.

There is widespread interest in applying this model within regulatory exposure assessment. Brown *et al*, 2012[5], gave recommendations on the input parameters for European VFS scenarios for use in conjunction with the VFSMOD-W, for aquatic risk assessment. Subsequently, these parameters were included in the following versions of SWAN tool

During the MAgPIE workshop, (Brown *et al*., 2017)[6] indicated the following regarding the VFSMOD:

"The model is recommended for use here given its general validation status in the scientific literature and because it is able to reflect changes in buffer efficacy based on e.g. changes in antecedent moisture conditions. Additional work is recommended outside of the MAgPIE process to reach a conclusion on the regulatory acceptability of the model in the EU. A particular issue is evaluation of coupling of the basic VFSMOD code with the regression equation for pesticide transfer across vegetated filter strips reported by Sabbagh et al. (2009)[7]."

The validation recomended by MAgPIE was done and published in 2019 (Reichenberger, *et al*. 2019; Muñoz-Carpena *et al*, 2019)[8]. Validation with measured data showed good model performance and the combined work of Reichenberger *et al*. (2019) and (Muñoz-Carpena *et al*., 2019) fully address the MAgPIE issue of potential limitations introduced by semi-empirical VFS pesticide trapping algorithms.

On the other hand, the recent publication of Scientific Report on the repair action of the FOCUS Surface Water Scenarios by EFSA[9] includes the introduction of a 20 year assessment period, replacing the current 12-16 month assessment period. Surface water (SW) exposure concentrations that required some or no risk mitigation under the existing environmental risk assessment (ERA) framework

[5] Brown C. , Balderacchi M., van Beinum W., Capri, E., Trevisan, M. 2012 Definition of vegetative filter strip scenarios for Europe .Final report https://www.york.ac.uk/environment/pesticides/#tab-2

[6] Brown, B., V. Laabs, N. Mackay, A. Alix, R. Bradascio, J. Dyson, B. Golla, K. Knauer, D. Rautmann, B. Roepke, M. Röttele, M. Streloke, J. Van de Zande. 2017. Risk mitigation measures to protect surface waters. Mitigating the Risks of Plant Protection Products in the Environment, Proceedings of the MAgPIEWorkshop, 978-1-880611-99-9,Society of Environmental Toxicology and Chemistry (SETAC), Pensacola, Florida (2017).

[7] Sabbagh, G.J.. G.A. Fox, A. Kamanzi, B. Roepke, J.Z. Tang. 2009. Effectiveness of vegetative filter strips in reducing pesticide loading: quantifying pesticide trapping efficiency. J. Environ. Qual., 38(2):762-771

[8] Reichenberger, S., R. Sur, C. Kley, S. Sittig, S. Multsch. 2019. Recalibration and cross-validation of pesticide trapping equations for vegetative filter strips (VFS) using additional experimental data. Science of the Total Environment 647 (2019) 534– 550. doi:10.1016/j.sci.tot.env.2018.07.429; Muñoz-Carpena, R., A. Ritter, G. Fox. 2019. Comparison of empirical and mechanistic equations for vegetative filter strip pesticide mitigation in long-term environmental exposure assessments. Water Research. doi:10.1016/j.watres.2019.114983

[9] EFSA (European Food Safety Authority), Adriaanse P, Boivin A, Klein M, Jarvis N, Stemmer M, Fait G and Egsmose M, 2020. Scientific report of EFSA on the 'repair action' of the FOCUS surface water scenarios. EFSA Journal 2020;18(6):6119, 301 pp. https://doi.org/10.2903/j.efsa.2020.6119

to demonstrate safe use may require additional risk mitigation under the 80th and 90th percentile SW PECmax value derived from the multi-year analysis.

Summary of the discussion of the round table

FOCUS L&M approach based on fixed values was demonstrated no to be sufficient and there is a need to go forward in order to estimate Step 4 PECsw considering mechanistic models the scenario characteristics just before each runoff event during the time frame of FOCUS SW simulation.

From a regulatory point of view, there is a need of harmonize and to reach a consensus on which parameters to be introduced for FOCUS runoff scenarios. In this sense, the proposal of Brown *et al* 2012) and the need of going forward to adopt these scenarios at zonal level was mentioned. VFS -MOD model is more related to the reduction of pesticide loading to mitigate the risk. Therefore, it is a question if the MMSS can integrate this model in the evaluation of PPP to define the risk mitigation measures that should be implemented for the decision making.

The need of improving the risk communication in the label was highlighted, not only considering the width of the VFS, because the retention of pesticides depends on other parameters as it was shown during the presentations. There were concerns of the level protectiveness of the mitigation in the label and how to label the product. A detailed labelling was discussed with different alternatives.

With respect to the implementation of VFS, there was special interest of using the model on the implementation of runoff mitigation measures on typical Mediterranean crops associated with soil loss events (e.g olive, citrus, etc). VFS MOD is a mechanistic model, therefore it can be adapted to any scenario. It was discussed the need of data for the parametrization and validation of the model, being very relevant data related parameters within the buffer.

Finally there was a debate on the management of VFS: species to be used at each ecoregion (recommendations are given in the VFS MOD manual based on USDA work) and management of weeds. It was also mentioned the need of considering other non target species at the moment of the selection of the species.

Closing remarks

The mitigation of the exposure and harmonization of these mitigation measures at zonal level represent a challenge for regulators, the industry, risk assesors researchers and farmers.

VFS have been demonstrated to be efficient to reduce runoff and soil erosion and there is a need of implementation by farmers.

The reduction factors proposed by FOCUS L&M are not sufficient for risk mitigation. The VFS-MOD presented in the workshop is a good tool to be used by regulators and assessors to calculate different scenarios for risk mitigation measures, and these can be communicated to risk managers and authorities to take a decision Therefore, there is a need of integrating this knowledge in FOCUS models.

Good advance was made in the past in the harmonization of the risk assessment in the southern zone because the number of the national data requirements have been reduced. The risk regulators

/assessors need to go forward and implement these kinds of models at zonal level in order to advance in the harmonization of the risk mitigation measures that is one of the areas that are not harmonized.

As the VFS-MOD is already included in the SWAN-VFSMod package of FOCUSsw, SMS SC in their meeting on 12 May 2021 agreed that the use of this tool for the calculation of PECsw at SMS level and for the proposal of RMM at zonal level can be used by applicants in their proposal of DRR for the application of authorization of plant protection products. However the use of FOCUS Landscape Guidance (Table 1) is always mandatory, ZRMS when in its assessment will propose the risk mitigation measures established by the FOCUS Landscape Guidance (Table 1) and also the risk mitigation measures calculated with the VFS-MOD, the acceptance of the proposed risk mitigation measures for the authorization of the plant protection product is a competence of each MS.

WORKSHOP AGENDA

Quantitative Mitigation of Surface Runoff Pesticides with Vegetative Filter Strips using VFSMOD

Date: Thursday May 21, 2020, 09:00-13:15
Videoconference link: https://ufl.zoom.us/j/8920909024

Instructors: Rafael Muñoz-Carpena (University of Florida, Professor, USA)
David Kane (Knoell Iberia)

09:00-09:15 Organizer initial remarks, workshop presentation and objectives.

09:15-10:00 **Module 1 (part I) –** Introduction to the FOCUS Surface water models to predict environmental concentrations of pesticides in surface water in the EU
- Definitions: scenario, entry route, spray-drift, drainage, erosion, run-off.
- STEP 1 & 2 model, STEP 3 model - SWASH. Brief summary.

10:00-10:05 Break

10:05-11:00 **Module 1 (part II)**
- Important parameters and how they influence in the risk assessment: DT50 soil, DT50 water, DT50 sediment, Koc, 1/n, Plant Uptake Factor, wash-off factor.
- STEP 4 - SWAN: Mitigation measures. VFS with fixed efficiencies vs Mechanistic Analysis with VFSMod

11:00-11:05 Break

11:05-11:50 **Module 2** - Overview of VFSMOD:
- Introduction: complexity of pesticide mitigation with Vegetative filter strips (VFS)
- VFSMOD: VFS pesticide mitigation processes.
- VFSMOD Hydrology and sediment component: basis, program description, and inputs/outputs

11:50-11:55 Break

11:55-12:40 **Module 2 (part II)**
- VFSMOD pesticide trapping and degradation component: basis, program description
- Long-term exposure assessments with VFSMOD mitigation: framework, influence of processes and input factors and uncertainty

12:40-13:00 **Roundtable with participants**

13:00-13:15 Closing remarks