Surface runoff of pesticides in Sweden – risk assessment and mitigation

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Introduction
Environmental monitoring reveals that pesticides enter surface waters regularly in Sweden [1]. Mitigating measures against point sources and spray drift have successfully reduced concentrations, but pesticide concentrations still exceed ecotoxicological guideline values. Additionally, the EU directives for water (2000/60/EC) and for sustainable use of pesticides (2009/128/EC), and the regulation regarding placing plant protection products on the market (EC 1107/2009) stipulate that mitigation strategies should be developed against diffuse sources, such as surface runoff and drainage. The current project is a knowledge compilation to support authorities in the implementation of runoff mitigation in regulatory and subsidy systems. The aim is to determine:

- The importance of surface runoff in Sweden
- The relevance of the FOCUS R1 scenario for Sweden
- Possible mitigation strategies for Sweden

Results
In Sweden, the majority of surface runoff occurs during snowmelt, when pesticide loss is unlikely. The temporal and spatial frequency of runoff events during the growing season and the amount of pesticides transported in this way are currently unknown. Phosphorus models estimate that up to 33% of total yearly water flow enters water courses as surface runoff in the worst cases and around 10% on average, but the lack of data for calibration renders these estimates highly uncertain. Field data from a drained silt loam (considered 95th percentile worst-case for silt and organic carbon content under Swedish conditions) suggest 35-50% of total monthly water flow during summer (May-September) occurs through surface runoff [2]. Thus, surface runoff may contribute considerably to pesticide transport locally, but is still considered unlikely to be of major importance on a national level; nevertheless, data are lacking to confirm this assumption. Therefore, local adaptation of mitigation measures is deemed a more efficient strategy for Sweden, than general solutions, such as mandatory buffer strips along all water courses. This would also simplify links with other environmental mitigation measures e.g. for nutrients and biodiversity. However, the implementation of local solutions in the regulatory system is not straightforward and the implications for risk assessment for pesticide product registration must be considered.

Currently, the Swedish Chemicals Agency is using the PRZM FOCUS R1 scenario for runoff risk assessment and allows a 10 m buffer strip as a conditional mitigating measure for use of products found to represent a risk. However, in a validation test the R1 scenario greatly overestimated the risks for Sweden, due to more extreme soil and weather conditions than are realistic for Sweden (Figure 1).
Figure 1. Relevance of the FOCUS R1 scenario for Swedish conditions.

Left: Silt (S) and organic carbon content (OC) in Swedish arable soils (dark grey circles) and the R1 soil (blue triangle) show that no soil sample in our database has both a higher S and a lower OC than the R1 soil (from SW Germany), two properties strongly influencing the risk of surface runoff. The red lines represent equal-probabilities, defined as the fraction of samples in our database that both exceed S and do not exceed OC, for each point on the lines. Note that the area above and below the curves does not reflect these probabilities. The green cross represents the soil used in the simulation shown to the right.

Right: PRZM-in-FOCUS simulations of runoff (top) and erosion (bottom) with original R1 data (circles), R1 with Swedish worst-case weather data (diamonds) and R1 with Swedish weather and soil data (the soil represented by the green cross in the figure on the left). Stefan Reichenberger (FOOTWAYS, Orléans, France) is gratefully acknowledged for performing these PRZM simulations.

Conclusions
- There is very limited data on surface runoff in Sweden (none on pesticides)
- Surface runoff is deemed a locally important transport route for pesticides
- The FOCUS R1 scenario over-estimates risks for Sweden (Figure 1)

Alternative solutions for assessing pesticide runoff risks in Sweden are suggested: 1) developing a Swedish scenario for the PRZM model, 2) developing the Swedish groundwater scenario for the MACRO-in-FOCUS model to include runoff estimation, and 3) establishing a system for local runoff mitigation that is reliable enough to justify the assumption that pesticides will rarely enter surface waters through runoff [3]. It is strongly suggested that research and monitoring projects are supported to provide a better database on which to build risk assessment scenarios and risk management strategies.

References