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Simulation of the fate of Boscalid and its transformation product 4-Chlorobenzoic acid in a vineyard-terraces catchment

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In the viniculture fungicides are commonly applied foliar on the plant surface, resulting in high concentrations in runoff water. The fungicide Boscalid occurred frequently and in high concentrations in runoff water in the Loechernbach catchment, a 180 ha vineyard catchment in south-west Germany, during rainfall-runoff events in 2016. The catchment is characterized by a typical terraces structure and the connection of a dense road network. The washing off from drift-depositions on the streets is expected to be a major pathway for pesticides. The main objective of this study was the provision of a catchment model to simulate the transport and transformation processes of Boscalid. Based on this model, source areas of Boscalid residue pollution and its export pathways will be identified and provide urgently needed information for the development of water pollution control strategies.

The distributed, process-based, reactive transport catchment model ZIN-AgriTra was used for the evaluation of the pesticide mobilization and the export processes. The hydrological model was successfully calibrated for a 6-month high-resolution time series of discharge data. Pesticide modelling was calibrated for single rainfall events after Boscalid application. Additionally, the transformation product 4-Chlorobenzoic acid has been simulated using literature substance parameters, in order to gain information about anticipated environmental concentrations.

The pathways for the discharge of Boscalid were characterized and the streets were confirmed as major pathway for the pesticide discharge in the catchment. The main Boscalid loss occured during the first flush after a storm event containing concentrations up to 10 μg/l. The results show that storage on surfaces without sorption contributes significantly to the export of pesticides through the first flush. Therefore, the mobilization process affects a combination of both sorptive (e.g. at the soil) and non-sorptive (e.g. on the surface) storages at the roads. Furthermore, measurements and simulation results show that there are background pesticide concentrations, an order of magnitude lower than the first flush concentration, for the whole simulation period. Additionally, almost half of the applied Boscalid still remains as residue in the soil at the end of the simulated 6-month period, because of slow degradation rates of Boscalid. The transformation product 4-Chlorobenzoic acid was simulated to have concentrations in the range of 0.1 μg/l. The model assumes that subsurface flow is the major loss pathway for this substance.

Concluding, the introduced catchment model is an applicable tool to simulate the individual processes of the Boscalid fate in the vineyard catchment. It was confirmed that roads receiving pesticide drift are the major loss areas of Boscalid in the Loechernbach catchment.