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# Modelling herbicide transfers from land to water in the Upper Cherwell catchment UK

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Pesticide losses from land to water can present problems for environmental management, particularly in catchments where surface waters are abstracted for drinking water. Here, we describe a model to predict chemical transfers from land to water at the catchment scale. The model was used to describe the behaviour of two herbicides, propyzamide and carbetamide, in the 199 km2 Upper Cherwell catchment, UK, which is used as a municipal water supply. The model operates at two spatial scales: (1) the hillslope scale and (2) the catchment scale. At the hillslope scale pesticide is assumed to diffuse into the majority of the water filled pore volume in a shallow soil layer after application, where it partitions between the dissolved and sorbed phases. A fraction of the dissolved phase pesticide mass in a "mobile" pore water fraction is then displaced by rainfall and is transported to field drains, if present. The hillslope-scale model was tested in a 15.5 ha headwater sub-catchment of the Cherwell, dominated by under-drained heavy clay soil. Significant transfers of both herbicides to the drain network occurred soon after application. Peak concentration coincided with peak drain flow and concentrations then decreased gradually in a quasi-exponential fashion, mirroring the receding hydrograph. Observed carbetamide concentrations were about an order of magnitude higher that those observed for propyzamide due to a combination of a higher application rate and lower KOC. For propyzamide, total observed loss over the study period was estimated to be 1.1% of the applied mass and for carbetamide the loss was estimated to be 8.6%. At the catchment scale, hillslope contributions are integrated using a convolution of the network width function (link frequency distribution), assuming a constant kinematic wave celerity and allowing for the spatial distribution of hillslope contributions from different soil types throughout the network. Two soil types dominate: heavy soils which are under-drained and lighter soils which are not, but which generate some groundwater flow. Baseflow contributions were modelled using a one-dimensional time-variant groundwater model. Hydrograph and chemograph behaviours were reasonably well predicted at the hillslope scale. At the catchment scale, model hydrographs were also reasonable, although model performance was more variable for pesticide concentrations. Overall, the work underpins the utility of relatively simple models for explaining processes operating in the catchment. The results confirm that drainflow is probably the dominant pathway for the transfer of these herbicides to the catchment outlet. This imposes considerable constraints on the management options available to reduce problematic herbicide exposure in abstracted water.