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Transfer of tracers and pesticides in lab scale wetland systems: the role of vegetation

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Surface wetlands can collect contaminated runoff from urban or agricultural catchments and have intrinsic physical, chemical and biological retention and removal processes useful for mitigating contaminants, including pesticides, and thus limiting the contamination of aquatic ecosystems. Yet little is known about the transfer of pesticides between wetlands collecting pesticides runoff and groundwater, and the subsequent threat of groundwater contamination. In particular, the influence of wetland vegetation and related processes during pesticide transfer is largely unknown. Here we evaluate the transfer of the widely used herbicide Isoproturon (IPU) and the fungicide Metalaxyl (MTX) with that of Uranine (UR) and Sulphorhodamine (SRB) in a vegetated and a non-vegetated lab-scale wetland. UR and SRB had successfully served as a reference for pesticides in surface wetlands. We filled two 65 cm long and 15 cm diameter borosilicate columns with sediment cores from a wetland, one without and one with vegetation (Phragmites australis, Cav.). When a constant flow-through rate of 0.33 ml min-1 was reached, tracers and pesticides were injected simultaneously and continuously. The hydrological mass balance and tracer concentrations were measured daily at the outlet of the lab-scale wetland. Samples for pesticides and hydrochemical analyses were collected biweekly. The lab-scale wetlands were covered to limit evaporation and light decay of injected compounds. The reactive transfer of compounds in the vegetated and non-vegetated lab-scale wetland was compared based on breakthrough curves (BTC's) and model parameters of the lumped parameter model CXTFIT.

The hydrologic balance revealed that the intensity of transpiration and hence plant activity in the lab-scale wetlands progressively decreased and then apparently ceased after about eight days following continuous pesticide injection. In this first phase, no significant difference in the hydrologic balances could be observed between the vegetated and the non-vegetated column. In a second phase, vegetation transpiration progressively increased, as inferred from lower volumes of effluent water in the vegetated system. Overall, the behavior of pesticides and tracers, as inferred from the BTC's, were similar. This suggests that fluorescent tracers may be used as a reference for pesticides when studying the surface-groundwater interface. Both pesticides and tracers showed larger recovery rates (UR: 81.7 to 78.6%; SRB: 65.6 to 55.9%; IPU: 76.6 to 79.7%; MTX: 39.5 to 37.5%) and lower retention in the vegetated system. We attribute this finding to preferential flow paths along plant roots. Overall, our study suggests that wetland vegetation and rhizosheric processes may have a dual role in wetland pollutant transfer: while wetland vegetation may enhance retention and bio-degradation of contaminants in surface water, it may also generate preferential flow paths and hence facilitate pollutant transfer to groundwater.

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