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Discharge conditions control the retention of pesticides and hydrologic tracers in wetland buffer systems

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This study investigates the efficiency of wetland buffer zones to retain pesticides and their transformation products (TP). Two fungicides (boscalid and penconazole) and two herbicides (metazachlor and flufenacet) were selected as target compounds due to their application in the study catchment as well as known soil metabolites of chosen herbicides. The studied buffer system consisted of a sequence of three successive wetlands types: a straight vegetated stream (a), a constructed wetland (b) and a retention pond (c). In multi-tracer experiments the salt tracer bromide was applied to characterize conservative transport while the fluorescent dyes uranine (UR) and resazurin (Raz) were used to assess photolytic and microbial decay, respectively. Tracer breakthroughs were simulated by the transient storage model OTIS, including Monte Carlo based parameter estimation. Simultaneously, sampling for pesticides and TP was performed up- and downstream of the wetland buffer system during different discharge conditions. At base flow, retention of tracers in the in the straight stream (a) and the constructed wetland (b) were low, while the pond (c) was characterized by higher tracer losses, especially in summer. The monitoring of pesticides and TP resulted in concentrations in the range of several ng/l. At these concentrations, no retention was detected in the entire wetland system, neither for pesticides nor for TP. During rain events, maximum concentrations of all pesticides were about one order of magnitude higher. Pesticide retention could be observed as expressed by both peak concentration attenuation (8 out of 11 events) and load reduction (6 out of 11 events) for all target compounds and during another 3 (4, respectively) events for a single compound. Also mass losses of the tracers ranged between 25 and 49 percent. However, remobilization of pesticides and transformation products was also observed. Thus, wetland retention was weak during base flow. This was attributed to a low but constant pesticide and TP exposure. During discharge events, pollutants were retained more efficiently. Total residence times in the wetland system ranged in the order of only a few hours. Therefore, our findings are not comparable to traditional treatment wetlands designed for nutrient removal but may rather be transferred to natural systems like floodplains including permanently and periodically flooded areas. This study was performed within the research project MUTReWa (www.mutrewa.de).