Geophysical Research Abstracts
Vol. 16, EGU2014-6333, 2014
EGU General Assembly 2014

Mitigation of micropollutants inside wetland systems: Impacts of season and flow conditions

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The important role of wetlands for retention and mitigation of micropollutants has been documented by numerous studies. Natural wetlands in stream eco-systems comprise different elements, e.g. open water bodies, densely vegetated areas and riparian zones with fluctuating water tables, where different biogeochemical conditions prevail. However, our main knowledge on the mitigation potential of these wetlands stems from input-output balances established for constructed systems and from controlled lab-scale experiments. Less is known about internal processes occurring in natural wetlands. The ability of hydrological tracers to serve as a reference for the transport of aquatic pollutants has been shown for a variety of micropollutants. In this study we used a set of hydrological tracers with different physico-chemical properties to assess the retention potential of a recently restored wetland that comprises a variety of internal flowpaths and wetland elements. We conducted our experiments during summer and winter to document the impacts of different seasons and flow conditions. As such we aimed to shed light on real-world retention capabilities of different wetland elements as a guideline for wetland (re-) construction. On a clear winter day (0°C, runoff 21 l/s) we injected 1kg of sodium bromide (NaBr), 1g of uranine (UR) and 1g of sulphorhodamine (SRB). Tracers were measured continuously by field fluorometers and conductivity meters complemented by manual and automatic sampling for laboratory analysis. In accordance with the constructional setup the Multi-Flow Dispersion Model (MDM) enabled us to numerically separate the existing three main flowpaths (FPs). Approximately 25% of the injected tracers traveled through FP1, which only comprised straight channel sections and narrow riparian zones. Approximately 65% of the tracers followed FP2, which contained one small open water body. The remaining tracers (approximately 10%) made their way through a large water body with a diffuse outlet through a densely vegetated zone. A comparison between conservative (NaBr) and non-conservative tracers (UR, SRB) yielded different retention capabilities for the three different FPs and hence wetland elements. During summer (20°C, runoff 0.8 l/s) we repeated the tracer injections using the same protocol. Then the entire wetland was densely vegetated and we expected higher tracer retention due to enhanced biological activity and longer residence times at low flow conditions. However, we observed the opposite, since only one flowpath (FP1) was active and all open water bodies were disconnected due to wetland succession. Regarding retention of micropollutants in our restored wetland we conclude that (a) retention in deep water bodies is decisive, (b) straight sections show relative small retention capabilities, (c) vegetation activity (summer/winter) seems less important for treatment than for flow path development, and (d) in our case photolysis is overall more effective than sorption. These findings highlight the importance of open water bodies for wetland restoration.

This study was financed by the PhytoRet-Project (C.21) of the European INTERREG IV program Upper Rhine.