

Mass flux studies of polar organic micropollutants in water

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Two projects will be presented within this talk. First, a national wide model will be discussed for the prediction of mass flows of pharmaceuticals within the river system of Switzerland. Second, a mass flux study of organic micropollutants performed in rivers downstream of the Megacity Beijing will be presented.

1. Swiss national model for predicting concentrations of pharmaceuticals in the river system (Ort et al. 2009; Kuroda et al. 2012).

For the strategic reduction of pharmaceuticals in the environment, modeling of pharmaceutical loads and concentrations using minimum dataset is useful to assess the water quality across catchments. In this study, a model was developed in order to predict the loads and environmental concentrations of pharmaceuticals which are used domestically and in hospitals in a large proportion. In the domestic model, pharmaceutical consumption was distributed according to the number of inhabitants per catchment, and excretion rates as well as elimination in sewage treatment is taken into account (Ort et al. 2009). Additionally to that, hospitals were treated as point sources and the fraction of pharmaceuticals discharged from hospitals were implemented into this model (Kuroda et al. 2012). Model results for commonly used pharmaceuticals (e.g. Diclofenac, Carbamazepine) agree well with measured loads in river water samples. The sum of diclofenac and its metabolites is expected to exceed the corresponding water quality criterion of $0.1 \mu\text{g L}^{-1}$ in 224 river sections (see Figure 1). If diclofenac cannot be eliminated at the source, the model suggests a directed upgrade of 173 WWTPs to meet the condition that concentrations are never to exceed this water quality criterion. For pharmaceuticals which were discharged substantially from hospitals (e.g. X-ray contrast media, Gadolinium), the additional input from hospitals needs to be taken into account.

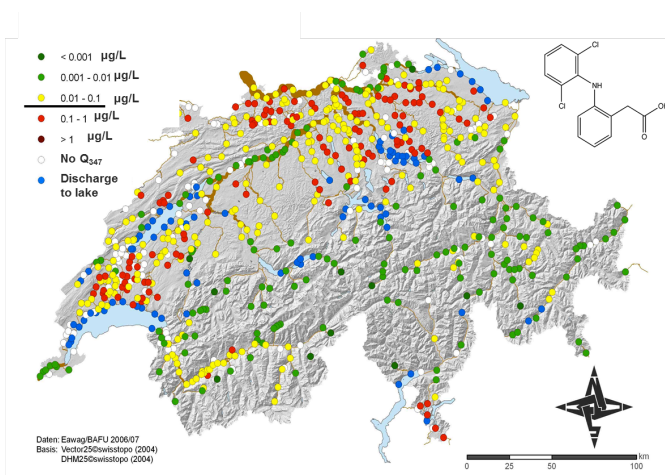


Figure 1. Predicted environmental concentrations (PEC) for diclofenac at base flow conditions (Q_{347}). From Ort et al. (2009).

2. Mass flux study of polar organic micropollutants in the Haihe River system near Beijing (Heeb et al. 2012).

The Haihe River System between the Megacities Beijing and Tianjin in China forms a large-scale wastewater irrigation system. Its discharge is completely dominated by wastewater from Beijing, which is used almost completely for irrigation in agricultural areas downstream. The mass fluxes of 62 polar organic micropollutants in the Haihe River System were studied over 14 months. The scrutinized micropollutants were selected based on an extensive screening as well as on Chinese consumption statistics. The micropollutants were analyzed with an online LC-MS/MS system. Total concentrations added up to 8.8 µg/L on average (0.6–18.0 µg/L). Concentrations of carbendazim, clarithromycin, diclofenac and diuron exceed Environmental Quality Standards (EQS). Mass flow models for six lead compounds (carbamazepine, climbazole, atrazine, carbendazim, DEET and 5-methyl-benzotriazole) revealed a variety of possible combinations of sources and pathways. All lead compounds except atrazine originated from urban sources. 95% of the loads ended up in the downstream irrigation water. Pharmaceuticals (5930 kg/year) and household chemicals (5660 kg/year) were responsible for the main contributions to the loads downstream of Beijing, and pesticides added 1550 kg/year (see Figure 2). As irrigation water is integral for groundwater recharge in this water scarce area, the large loads of polar organic micropollutants therein pose a serious threat to drinking water resources.

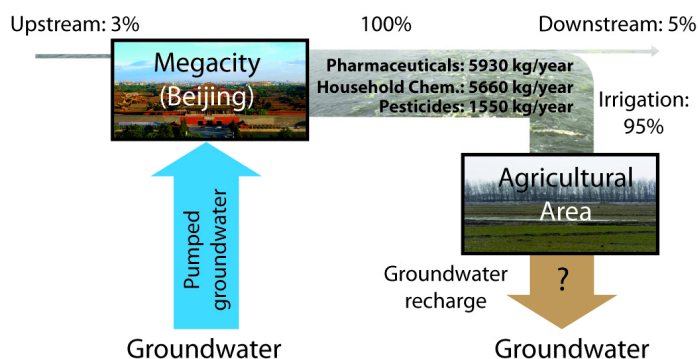


Figure 2. Mass-fluxes of pharmaceuticals, household chemicals and pesticides in Beijing urban wastewaters and downstream rivers. From Heeb et al. (2012).

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