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▶ **To cite this version:**

Elke Fries, Olfa Mahjoub, Borhane Mahjoub, Jörg Klasmeier, Müfit Bahadir. Emerging contaminants in wastewater and river water: Risks for human water security and aquatic ecosystem sustainability?. 3ème Colloque International sur Matériaux, Pollution et Environnement, Feb 2014, Tanger, Morocco. hal-00934679

HAL Id: hal-00934679

https://brgm.hal.science/hal-00934679

Submitted on 22 Jan 2014

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Emerging contaminants in wastewater and river water: Risks for human water security and aquatic ecosystem sustainability?

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In recent years, there has been increasing concern about the environmental risks of the so called "emerging contaminants (ECs) "in conventional and non conventional water resources. According to the EU NORMAN network ECs are "substances that have been detected in the environment, but which are currently not included in routine monitoring programs at EU level and whose fate, behavior and (eco)toxicological effects are not well understood." ECs originate from a variety of products including human and veterinary pharmaceuticals, industrial chemicals, and personal care products and are continuously discharged into sewer systems. Since degradation rates in conventional sewage treatment plants (STP) are rather low, ECs enter receiving waters through wastewater effluents. During bank filtration, ECs may be transported from river water to groundwater. In addition, if wastewater is used for irrigation of arable land or for artificial aquifer recharge, ECs are transferred into soil and groundwater.

Two case studies on the occurrence of ECs in wastewater and river water are presented. The first study demonstrates the occurrence of 1,3-benzothiazole (BT) in river water within the Schwarzbach watershed (Germany) as well as in wastewater influents and effluents from three municipal STPs in Germany. BT mainly originates from sunlight induced direct photolysis of 2-mercaptobenzothiazole which is added as a vulcanization accelerator to rubber compositions in the manufacturing process of the tire industry. Measured BT concentrations in river water were between 58 and 856 ng/L. Concerning the sources, rather similar BT concentrations over a wide range of river discharge indicated that dilution along the mainstream is negligible and, thus, supports the hypothesis that paved surface runoff during rain events is an important BT source, not only for wastewater influent but also for river water. This was supported by detecting the highest BT concentrations at sampling locations close to the dense highway network around the city of Frankfurt. Since BT was also detected in river water collected from locations that were clearly unaffected by wastewater effluent discharge, surface runoff should be considered as a diffuse source of BT in river water.

In the second study, treated wastewaters that are used for agricultural irrigation at Oued Souhil area (Tunisia) and artificial aquifer recharge at Korba (Tunisia) as well as river water from the River Meliane (Tunisia) were analyzed for the presence of selected pharmaceuticals. Ibuprofene and its metabolite 2-OH-ibuprofene, diclofenac, oxazepam, atenolol, sulphamethoxazole and carbamazepine were detected in wastewaters. Rather similar concentrations were observed in effluents collected at the STPs outlets and in treated wastewater reused on-site either for irrigation (in Oued souhil) or for aquifer recharge (in Korba) indicated their likely persistence. At Oued Souhil, naproxene, trimethoprim, fenofibric acid, ketoprofene and 1-OH-ibuprofene occurred in effluents and irrigation water with lower concentrations in the latter. All pharmaceuticals, except oxazepam were detected also in river water samples at concentrations between 12 ng/L (trimethoprim) and 1024 ng/L (ibuprofene).

From ecotoxicological point of view, the BT concentrations in river water were far below its EC_{50} value of 4.32 mg/L (*Vibrio fischeri*). However, BT was reported to inhibit respiratory and nitrification processes on sediment columns while the effect of pharmaceuticals on ecosystems is still an open question. Concerning the occurrence of thousands of ECs, without precise knowledge of their mixture toxicity and the fact that such polar compounds can easily reach groundwater resources after discharge into the aquatic environment, the release of such chemicals has to be reduced in the future. Since belated removal of such compounds from wastewater by additional treatment such as ozonation, UV treatment or activated carbon is expensive, over-application of such ECs and an improper disposal should be avoided.