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Variability of removal rate constants - A compilation from lab experiments on the fate of organic micropollutants within an urban water cycle

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Introduction

Owing to advanced analytical procedures an increasing number of organic micropollutants have been identified within the aquatic environment. Within urban areas, organic micropollutants are mainly introduced into the water cycle via sewage systems, since treated wastewater containing residuals of these pollutants is discharged into surface water and thus resupplied to the water cycle (see Fig. 1).
Results from field investigations evidenced the attenuation of various micropollutants to be impacted by the prevailing hydrochemical conditions [e.g. 1,2] , e.g. the redox environment. In order to investigate the impact of the redox conditions on the attenuation of various organic pollutants within an urban water cycle, we simulated three stages of it by means of different experimental setups.

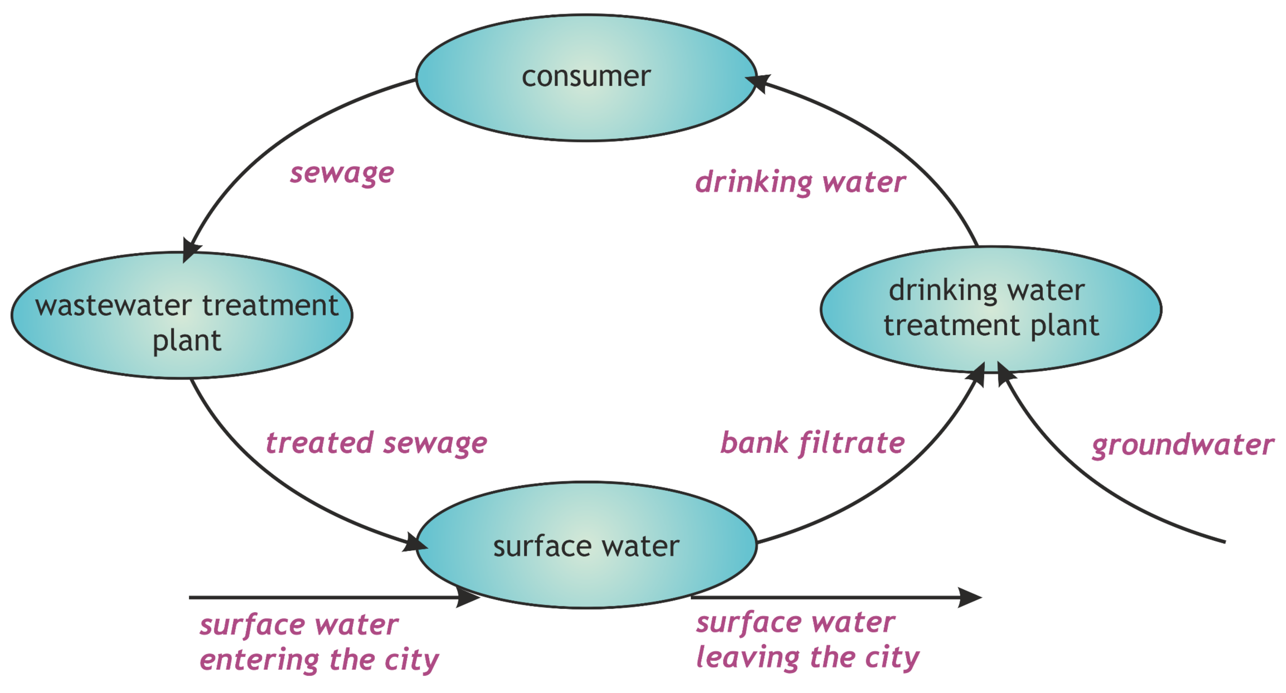
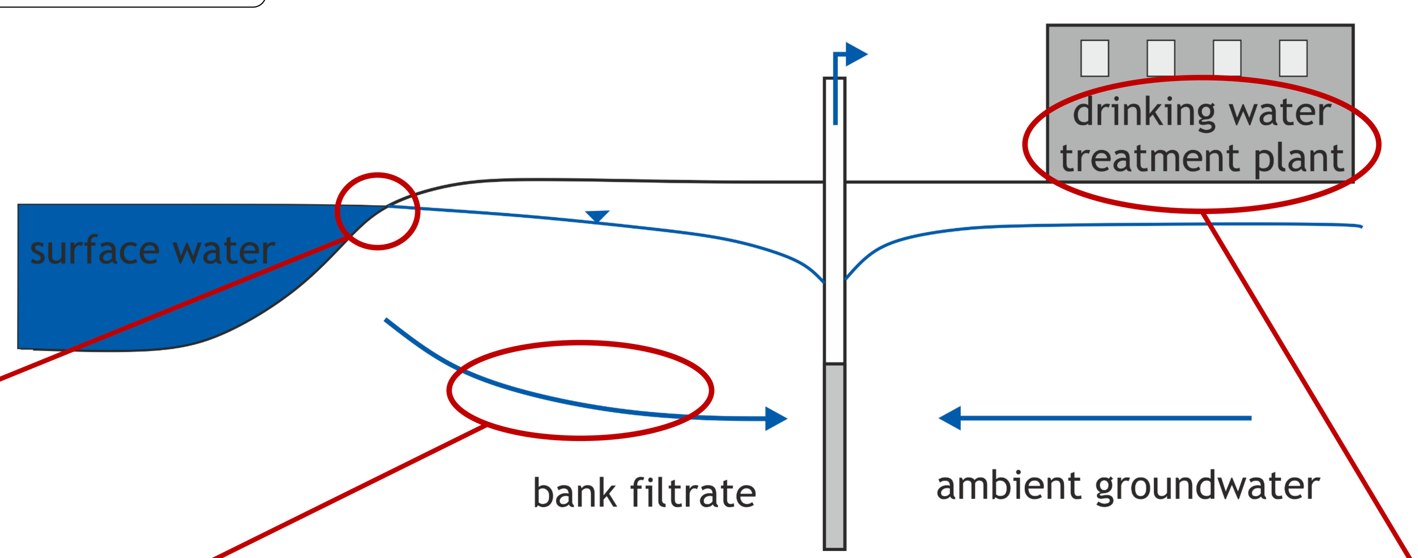


Fig. 1: Urban partly closed water cycle

Methods

1. 'undisturbed core study' in order to simulate the process of infiltration of wastewater loaded surface water into the subsurface (Fig. 2)
2. 'systematic column study' in order to mimic conditions along the groundwater flow path within the aquifer (Fig. 3)
3. 'tank aeration experiments' covering one treatment step within drinking water treatment (Fig. 4)



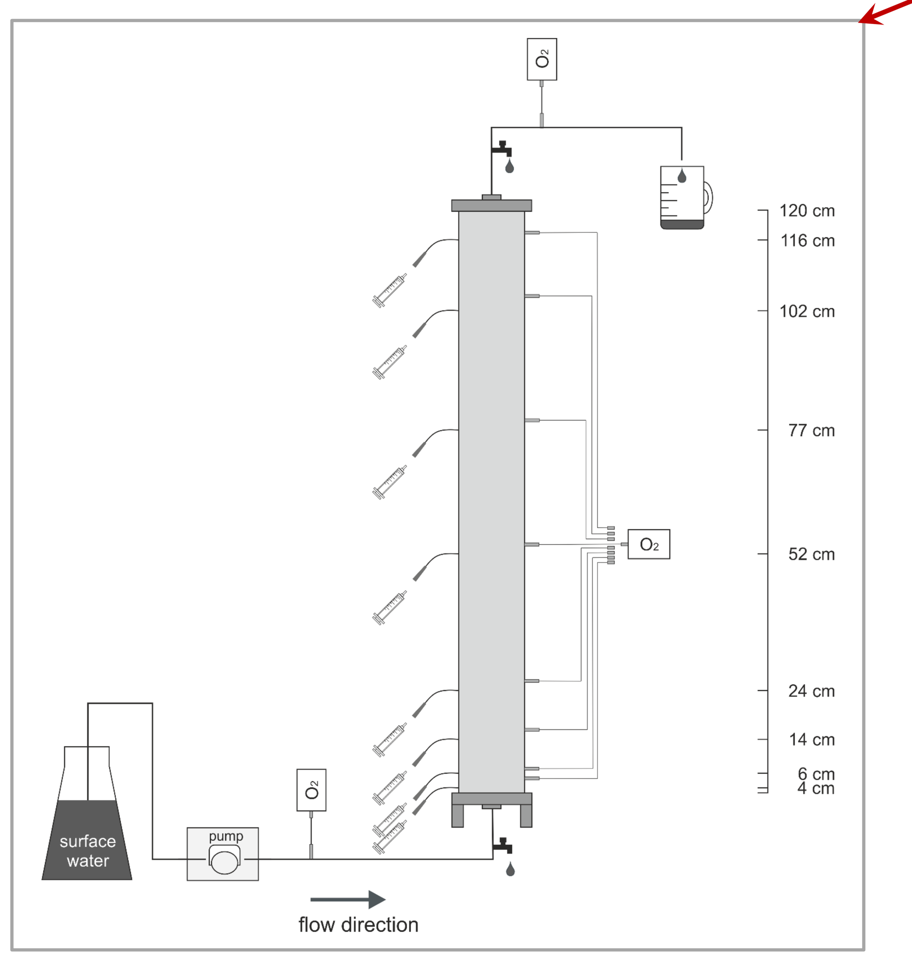


Fig. 2: Setup 'undisturbed core study' [3]

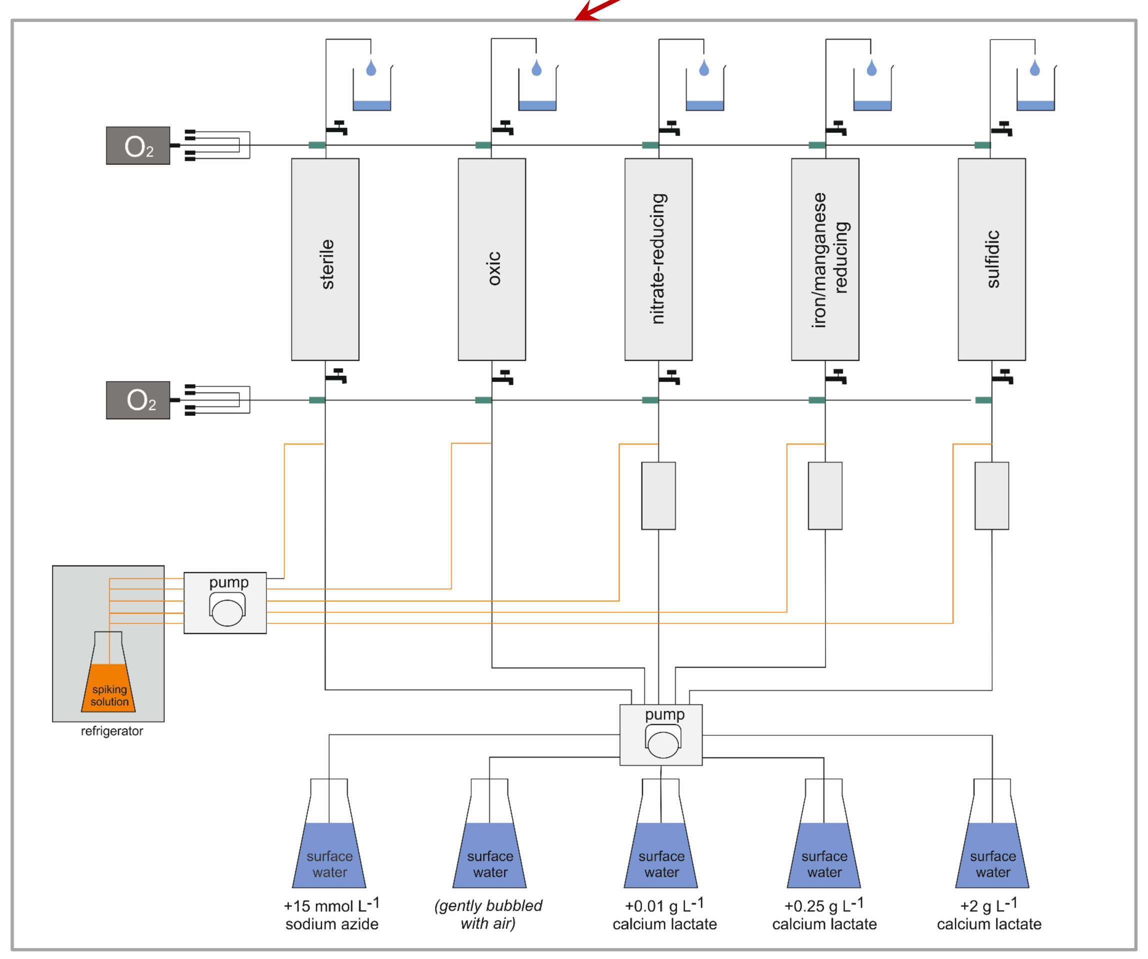


Fig. 3: Setup 'systematic column study'

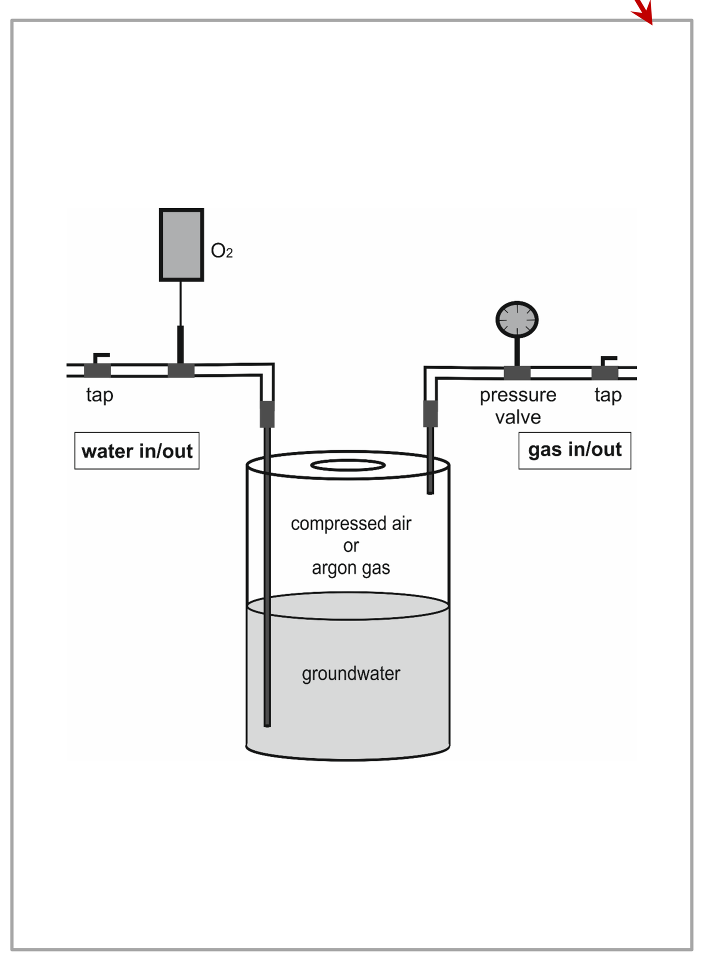


Fig. 4: Setup 'tank aeration experiments'[4]

Results & Conclusions

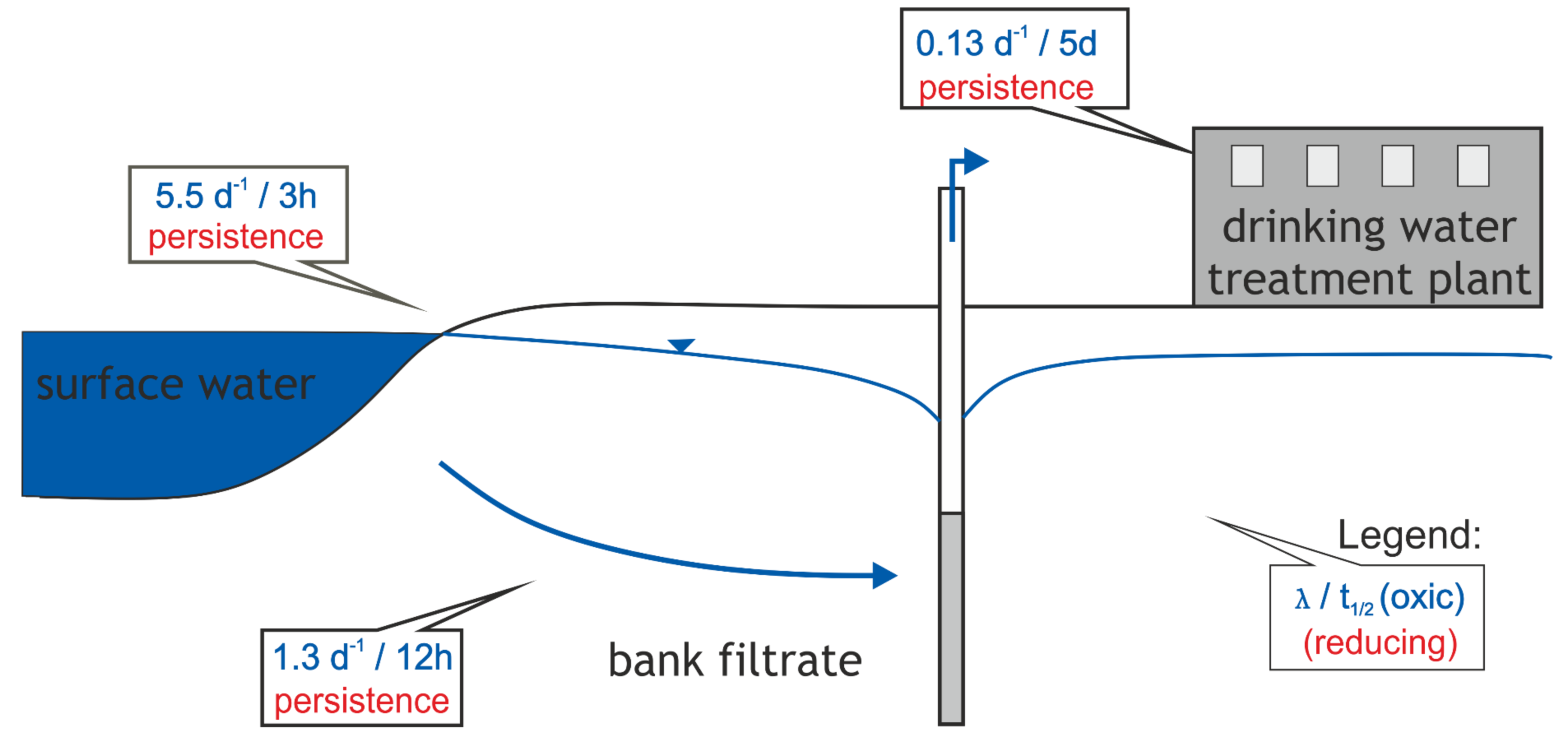


*Fig. 5: Observed removal rate constants and corresponding half-life times **exemplified** illustrated for the analgesic **phenazone***

- no degradation under of anoxic conditions, indicating the strong influence of the redox environment
- the hyporheic zone was proven to be highly reactive, as under oxic conditions a half-life time of 3 hours was observed
- proceeding along the groundwater flow path resulted in decreasing removal rate constants (1.3 d-1 and a corresponding half-life time of 12 hours for phenazone) → still indicating an efficient removal under oxic conditions
- simple aeration of anoxic groundwater within the tank experiments resulted in the removal of numerous micropollutants, but significantly lower removal rate constants compared to the aforementioned studies
- results highlight the enormous attenuation efficiency of the saturated zone compared to technical systems

$$\lambda_{infiltration\ zone} > \lambda_{gw\ flow\ path} > \lambda_{aeration}$$

- similar results were observed for other compounds (e.g. FAA, Metoprolol) while investigating the redox-sensitive degradation behavior of a total of 36 organic micropollutants classified as pharmaceuticals and industrial products

References

[1] Massmann et al., Chemosphere 2008, 71(8), 1476-1485
[2] Hijosa-Valsero et al., Water Research 2010, 44(12), 3669-3678
[3] Burke et al., Science of the Total Environment 2014, 482, 53-61
[4] Burke et al., Water Science and Technology 2013, 67(3), 658-666

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