

## THE INFLUENCES OF RAINWATER AND SURFACTANTS ON THE DESORPTION PROCESSES OF HEAVY METALS FROM ROAD-DEPOSITED AND SEWER SEDIMENTS

Jin Zhang, Nora Franzke, Heike Brueckner, Pei Hua, Peter Krebs

*Institute of Urban Water Management, Technische Universität Dresden, 01062 Dresden, Germany*

[jin.zhang@tu-dresden.de](mailto:jin.zhang@tu-dresden.de)

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### Introduction

A considerable literature confirms the importance of road-deposited sediment (RDS) adsorbed pollutants in contribution to the pollution load of stormwater runoff (Zhang *et al.* 2015). The potential risk of RDS adsorbed heavy metals, with respect to the mobility and eco-toxicological significance, is determined by their solid-liquid partitioning rather than the total mass of metals per unit mass of dry solid. The release of metal cations to the liquid phase and thereafter the susceptibility for transport processes, depends on their solution speciation and their affinity for binding the reactive surfaces in the RDS and solution matrixes (Zhang *et al.* 2016). In addition, during a rainfall event or some other cases, the sewer sediment adsorbed heavy metals could be also released and eventually pose a potential risk to receiving waters.

Additionally, surfactants also known as surface active agents are important incorporative organic compounds in various detergents, which are released in high quantities from households and industries into sewer systems, and are thus a major wastewater constituent. More recently, it has been shown that surfactants can be used to enhance metals removal via surfactant-associated complexation and ionic exchange in the research matrix of soil sciences. However, comparably less or no studies were conducted on the function of surfactants on the metal leaching from RDS and sewer sediment. Therefore, to better understand the potential risk of RDS and sewer sediment adsorbed metals on stormwater quality, the influences of rainwater and different surfactants on the desorption dynamic of heavy metals from RDS and sewer sediment were investigated.

### Materials and Methods

#### Study area and sample collection

The sampling campaign was performed in January 2016. The RDS samples were collected from three asphalt traffic roads (Nossener Bruecke, Löbtauer Bruecke and Emrich-Ambros-Ufer Streets, average daily traffic up to 43300 cars, heavy vehicular traffic up to 5%) in the city centre of Dresden (51°02'55" N, 13°44'29" E), located in the state of Saxony, Germany. The sampling sites were selected due to the elevated RDS adsorbed pollutants levels according to the previous study (Zhang *et al.* 2015). Furthermore, in order to find the most reprehensive samples, the homogeneous samples were collected by a municipal street sweeping vehicle cleaning. Sewer sediment was collected from the sewage system in the city centre of Dresden. Bulk RDS and sewer sediment samples were further fractionated into sub-samples and dry-sieved using stainless-steel sieves (Retsch GmbH, Germany). The fractionated samples were labelled, sealed and refrigerated at 4 °C in preparation for analysis.

#### Rainwater and surfactant solutions

To avoid external factors interfering with the desorption process, synthetic rainwater solutions with initial pH of  $4.8 \pm 0.02$  and  $5.2 \pm 0.02$  were prepared. The rainwater formula was adapted from Zhang *et al.* (2016). An anionic surfactant of sodium dodecyl sulfonate (SDS), with the formula  $\text{CH}_3(\text{CH}_2)_{11}\text{OSO}_3\text{Na}$ , and a nonionic surfactant of Hexaethylene glycol monododecyl ether (HGME), with the formula  $\text{C}_{24}\text{H}_{50}\text{O}_7$ , were

selected. SDS and HGME solutions in five concentrations for each were prepared, namely, 10 mg·L<sup>-1</sup>, 26 mg·L<sup>-1</sup>, a critical micelle concentration (CMC, 8.08 mM ± 1.2 nM; 2350.3 mg·L<sup>-1</sup> of SDS, and 0.064 mM; 33 mg·L<sup>-1</sup> of HGME), 1.2·CMC, and 1.5·CMC. CMC is defined as the concentration above which any added surfactant molecules appear with high probability as micellar aggregates. In other words, at concentrations higher than the CMC, a further increase in metals desorption concentration should not be expected.

Rainwater as well as surfactant solutions were mixed with the sediments in a solid liquid ratio of 20 g·L<sup>-1</sup> and stirred with a horizontal universal shaker (SM 30- B) at 60 oscillations/min for 16 h. The collected solutions were filtered through a 0.45 µm cellulose nitrate membrane filter. Cu and Zn dissolved in the filtrates were determined following the German Norm DIN 38406-7 (E7) and DIN 38406-8 (E8) by an atomic absorption spectrophotometer (Varian, SpectraAA 220 Fast Sequential AAS-220 Z).

## Results and discussion

Taking the influence of SDS for example as shown in Figure 1, SDS concentrations of 10 mg·L<sup>-1</sup> (0.03 mM) and 26 mg·L<sup>-1</sup> (0.09 mM), reflecting low and high concentrations in the sewage system only slightly increased the releasing of Cu and Zn in comparison to the rainwater solution. However, at a CMC concentration, the removal rates were considerably increased. Furthermore, the highest leaching effects were monitored for the sewer sediment.

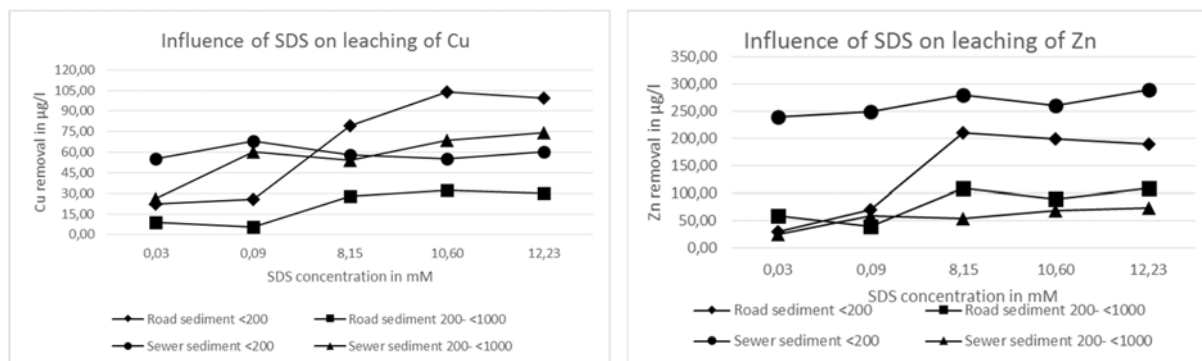


Figure 1. Desorption dynamics of Cu and Zn in SDS solutions

## Conclusion

This study showcases the effects of rainwater and surfactants on the desorption dynamics of heavy metals from road-deposited sediment (RDS) and sewer sediment. Results show sediments in a smaller size fraction intend to release more Cu and Zn contents than a larger size fraction. Increasing surfactant concentrations posed no apparently threat for Cu and Zn mobilization within the sewage system. However, increasing surfactants concentration enhance the leaching of Cu and Zn from RDS.

## References

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