Characterization of particles in urban stormwater runoff

S. Kittlaus, R. Eyckmanns-Wolters, S. Fuchs

Karlsruhe Institute of Technology (KIT), Institute for Water and River Basin Management, Department of Aquatic Environmental Engineering, Gotthard-Franz-Str. 3, Bldg. 50.31, 76131 Karlsruhe, Germany

kittlaus@kit.edu

ABSTRACT

Suspended particles from storm sewers in separate sewer systems play a major role in surface water contamination by heavy metals and PAH. For improvement of stormwater treatment a better understanding of these particles is necessary.

This project characterises particles by physical and chemical properties using SEM-EDX and XRF analysis. The elemental composition of the particles is analysed at different sources in the drainage area and at the end of the sewer system. Thus the load of contamination by heavy metals can be determined.

Finally an attempt for a source was made using ‘fingerprinting’ with composite fingerprints.

INTRODUCTION

In the last decades the pollution of water bodies in Europe were mitigated, nevertheless further improvements are necessary due to legal (European Water Framework Directive) and ecological (e.g. reduction of coastal water contamination) requirements.

In Germany the reduction of emissions from point sources (waste water treatment plants and industrial dischargers) leads to an increasing importance of diffuse sources. Regarding heavy metals, emissions from storm sewers in separate sewer systems are of high relevance (Fuchs et al., 2010).

Important pollutants like heavy metals and PAH, generally show a strong affinity to the solid phase (Allan, 1986). Thus, improvement of the storm water treatment needs a better understanding of particles regarding their properties and their sources.

RESULTS AND DISCUSSION

Results of SEM-EDX analysis show: Most particles are geogenic, typically they appear as agglomerations of minerals with lammelar structure, containing mainly O, Si, Al, Mg, Na, K and Fe thus representing probably clay minerals (cp. fig. 1 B). Organic material appears as fibres, which were cemented in the mineral agglomerations. These agglomerations appear in all sizes (1-200 µm).

Other particles (<10 µm) show a typical crystal shape and can be identified with EDX as e.g. quartz, feldspar, barite or pyrite.

Particles consisting of heavier elements, identified by BSE, mainly consist of Fe and O, sometimes with small amounts of Zn or Cu. Some of them show a spherical shape, the typical shape of fly-ashes (Suzuki et al., 2006). Non spherical Fe-rich particles might be geogenic minerals (e.g. haematite) or abrasion material from technical products e.g. brakes (cp. fig. 1).

Results of the bulk particle analysis will show the load of contaminants in the sediments at the end of the sewer system as well as at the sources. A comparison of the sediment loads from the two storm water tanks might give an indication, how catchments of different size and with different land use influence the sediment composition and contamination.

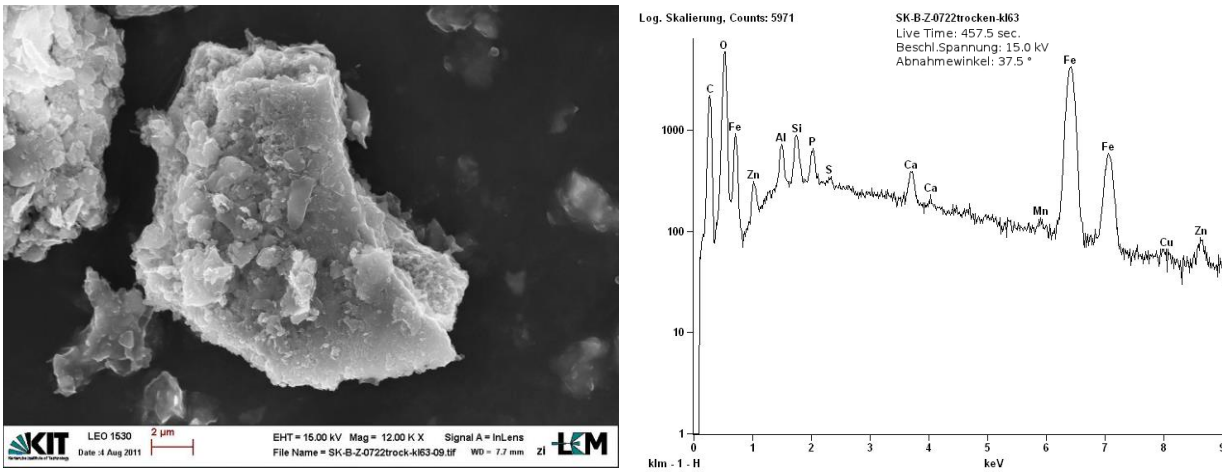

Figure 6 Particle from the inlet of a stormwater tank (Rastatt 22.07.11): Non spherical Fe-rich particle, containig traces of Zn, Cu, and Mn. Possibly of anthropogenic origin.

FINGERPRINTING OF PARTICLE SOURCES

Finally a ‘fingerprintig’ was made with the different properties of the sediments.

Fingerprinting is a method to trace sediment to the main sources. By using composite fingerprints,

made of different properties of a sediment, combined with quantitative mixing models it is possible to quantify the contribution of different sources to a sediment. (Walling, 2005)

The use of the fingerprinting methodology is a new approach for tracing sources in the separate sewer system. While a complete source allocation might not be possible at this stage of the project, we attempted to identify significant parameters for a composite fingerprint and found an apropriate method to handle problems with different particle size distributions and organic fractions.

REFERENCES

Allan, R. J. (1986). The role of particulate matter in the fate of contaminants in aquatic ecosystems. Scientific Series No. 142. Inland Waters Directorate, National Water Research Institute, Canada Centre for Inland Waters, Burlington, Ontario.

Fuchs, S., Scherer, U., Wander, R., Behrendt, H., Venor, M., Opitz, D., Hillenbrand, T., Marscheider-Weidemann, F. and Götz, T. (2010). Calculation of Emissions into Rivers in Germany using the MONERIS Model. Nutrients, heavy metals and polycyclic aromatic hydrocarbons. 46/2010, Environment Agency of Germany, Dessau.

Suzuki, K., Takii, T., Tomiyasu, B., and Nihei, Y. (2006). Characterization of individual complex particles in urban atmospheric environment. Applied Surface Science, 252(19):7022–7025.

Walling, D. (2005). Tracing suspended sediment sources in catchments and river systems. Science of The Total Environment, 344(1-3):159–184.