Toxic metals in urban watersheds – environmental and sanitary problems?

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Introduction: Toxic metals (TM) belong to the priority substances. While in the last decades a lot of actions were taken to minimize TM pollution related to mining activities and industrial waste water, urban areas become the most significant source of TM pollution. Surface runoff from impermeable surfaces becomes one of the most serious sources of TM.
The ecotoxicological behavior of TM is still not well understood especially in the case when they occur in mix of metals or in an environment, where conditions change often rapidly. This type of the environment is present in small urban creeks impacted by urban drainage. The conditions in the creeks rapidly change during rain events, due to entering water from surface runoff and waste water from combined sewer overflows. The quality of water is deteriorated and affects quality of sediment as well as quality and contamination of the aquatic biota.

Methods: Drawing on data from five Prague creeks, the paper illustrates changes in TM bioavailability resulting from different environmental conditions and related differences in urban drainage types (storm sewer drains-SWD, combined sewer overflows-CSO and waste water treatment plants-WWTP).
To identify the ecotoxicological risk related to TM in the environment of small urban creeks, samples of water, sediment and aquatic organisms were collected. Concentrations of selected TM (Cd, Cr, Cu, Ni, Pb, Zn) were analysed in all types of samples. The occurrence of TM in different fractions of sediment was identified by sequential extraction.

Results and discussions: The results show, that biological availability of TM from sediment is influenced not only by environmental conditions, but also by type of urban drainage. While the amount of TM in sediment of creeks impacted by SWD is lower, than in creeks impacted by CSO, their amount in aquatic biota shows, that TM in sediment from creeks impacted by SWD only are more bioavailable and cumulate in organisms to higher concentrations than in organisms from creeks affected by CSO. Increase of bioavailability of TM was also observed on sites affected by WWTP. The bioavailability of TM is affected by number of factors. In creeks impacted by CSO, the bioavailability can be decreased by AVS (acid volatile sulfides). The bioavailability increases with distance from CSO as the concentration of AVS, entering creek from CSO, decreases. The lower bioavailability in creeks impacted by CSO is confirmed by higher values of distribution coefficients and also results of sequential extraction show that in creeks impacted by CSO higher amount of metals in sediment is bound in less bioavailable fractions. In the cases of creeks impacted by SWD, the bioavailability can be affected by lower pH, during first minutes of rain (the size of creeks is very small and the amount of water entering these creeks during rain events is often bigger than amount of water in the creeks).
Biomagnification in food chain was observed only in the case of zinc on all studied streams. In the case of other metals, biomagnification was not observed, but for Cd and Pb it was not possible to prove or disprove if they are able to biomagnify.
The concentrations of cadmium and lead in fish from monitored creeks were compared with directive EC 466/2001. The concentrations of lead in fish biomass from these creeks many times exceed acceptable concentrations for human consumptions. The consumption of fishes from these creeks can cause hygienic and health risks for human population.

Conclusions: Pollution of rivers by TM is one of the most serious global issues. A good understanding of ecological effects of TM on aquatic ecosystems is an important pre-requisite to decisions on sustainable use and management of water resources in urban and industrial areas, and in the identification of environmental quality standards. From the technical view, the results show high necessity to improve separation efficiency of the objects of drainage system, especially a bigger separation of fine particles is crucial, because they are the main source of pollution in the water bodies. The goal of increasing separation efficiency of drainage system is to minimize entrance of cumulative pollutants into the aquatic environments and minimize a potential health risk.

Acknowledgement: This works was supported by the project SGS12/131/OHK1/2T/11 and 4200/1312/3166.