Improving risk assessment of dredging activities by passive sampling

Sabine Schäfer[1], Julia Bachtin[1], Christel Möhlenkamp[1], Anna-Jorina Wicht[1,2], Annette Kramer[3], Maja Karrasch[3], Georg Reifferscheid[1], Benjamin Becker[1]

[1]Federal Institute of Hydrology, Koblenz, Germany
[2]Bavarian Environment Agency, Augsburg, Germany (current address)
[3]Hamburg Port Authority, Hamburg, Germany

Phone: +49(0)261-1306-5375
E-mail: sabine.schaefer@bafg.de

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Introduction: One of the main environmental risks of dredging activities in waterways is the remobilization of contaminants associated with the sediments at the operation site itself [1]. If the sediment is disposed in aquatic environments, sediment-associated chemicals may also result in negative impacts by increased contaminant bioavailability at the disposal sites [2]. A measure of bioavailability are freely dissolved concentrations that can directly be quantified by passive sampling [3]. During the last years, we have applied silicone-based passive samplers for monitoring hydrophobic organic contaminants (HOCs) during dredging activities at operation sites and at a sediment disposal site in German waterways.

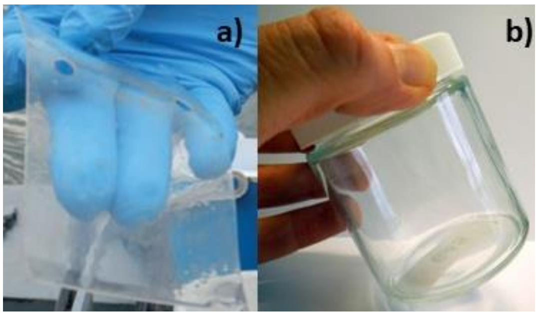

Fig. 1: Silicone-based passive samplers for a) the water phase *in situ* b) for sediment *ex situ*

Methods: Silicone-based passive samplers were applied for quantifying HOCs either in the water phase or in sediments (Fig. 1). For monitoring remobilization of contaminants at the operation site, we used silicone rubber (SR) sheets [4] that were exposed before, during and after the dredging activities directly in the water phase. Fixed by deployment devices to e.g. boys SR sheets were exposed for four weeks in the water.
For assessing bioavailability of contaminants at a disposal site, we used silicone-based equilibrium samplers that are applied *ex situ* [5]. In the laboratory, sediment is incubated in glass jars that are coated with µm thin silicone coatings for several weeks.
After exposure or incubation, both types of samplers were extracted by solvents and HOCs (PCBs, PAHs, DDT and their metabolites) were analyzed in extracts by GC-MS/MS. Silicone-based passive sampling in water yielded freely dissolved concentrations of HOCs that were averaged over the exposure time of the samplers. In contrast, freely dissolved equilibrium concentrations in sediment pore waters were obtained when applying coated glass jars.

Results: With both approaches very low quantification limits up to the low pg L^{-1} range were obtained. At a coastal site, dredging of sediment with low contamination resulted in no or only minor changes in freely dissolved concentrations of HOCs measured by SR sheets in the water phase. In the German North Sea, equilibrium sampling in sediments indicates that freely dissolved concentrations of DDT metabolites were increased by a factor 2 in sediment porewaters in close vicinity to a disposal site. Levels of all analytes were, however, distinctively elevated at sampling sites influenced by the river Elbe.

Discussion: This presentation gives insights in the practical application of passive samplers for monitoring bioavailability of HOCs in water and sediment. Chances to combine passive sampling with biomonitoring are demonstrated. Furthermore, we present the pros and cons of this approach for improving risk assessment of dredging activities and their implementation in sediment management.

References: [1] Martins et al. 2012 DOI 10.1016/j.ecoenv.2012.08.008 [2] Cornelissen et al. 2008 doi:10.1016/j.chemosphere.2008.04.041 [3] Mayer et al. 2014 DOI 10.1002/ieam.1508 [4] Smedes & Booij 2012. ICES Techniques No. 52. 20 pp. [5] Witt et al. 2020 DOI 10.1007/7653_2019_39.

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