

Development of an experimental method for the assessment of contaminated natural sediment

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Introduction: Any event resulting in re-suspension of contaminated sediment needs to be assessed to consider the fate of both the sediment and contaminants with respect to the ecotoxicological impacts on aquatic organisms. Hence, if sediment management is to be effective and sustainable, it needs to adopt an integrated approach and address parameters from different disciplines (e. g. water resources management, ecotoxicology). In order to consider short-term and long-term effects of these events (e. g. dredging operations, extreme events) it is necessary to identify and analyse active parameters and their interactions. The following parameter groups were selected for a first attempt to set up an integrated experimental method to assess contaminated natural sediment: hydrodynamics, sediments, contaminants, ecotoxicology and aquatic environment.

Method: Since analytical descriptions of the interactions of contaminated sediment, aquatic environment and organisms (e. g. fish) during re-suspension are not available at the current state of research, an empirical approach was chosen. The Institutes of Hydraulic Engineering and Water Resources Management (IWW) and Environmental Research (IER) setup an experimental method combining established methods of both disciplines in order to develop an integrated sediment assessment tool. The combination of the existing methods results in the newly established hydrotoxicological method. In order to assess the morphodynamic and ecotoxicological risk followed by re-suspension it is necessary to perform interdisciplinary analyses of sediment transport, bioavailability of present contaminants as well as monitoring the interactions in context of the aquatic system of interest. Therefore, the annular flume (Fig. 1) was utilised to expose fish to contaminated natural sediment, characterize the erosional behaviour, determine the bioavailability of released contaminants and monitor the environmental parameters. For assessing the contaminated sediment and its impact on aquatic organisms the following parameters were measured continuously during experiments: bed shear stress, turbidity, dissolved oxygen, pH value, redox potential, temperature and conductivity.

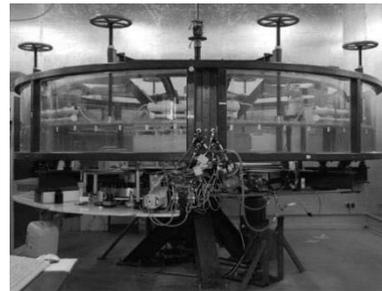


Fig. 1: Annular flume with instrumentation for hydrotoxicological experiments

Results: The hydrotoxicological method was first implemented using sediment from the river Rhine. Copper was added to the sediment as a heavy metal contamination. All experiments concerning the characterization of the erosional behaviour were successfully performed and a characterization of the erosion was made [1]. First results on the biomarker analyses after the fish exposure can be found in [2].

Discussion: The method needs further validating experiments using different freshwater sediments and expand the method for marine environments. Moreover, further single contaminants and their natural mixtures need to be investigated. The current set-up of the method is limited to short-term assessment of freshwater sediment due to the short exposure time (seven-days). Further work is planned and approved to integrate a numerical approach.

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References: [1] Cofalla, C. et al. (2012): A combined hydraulic and toxicological approach to assess re-suspended sediments during simulated flood events-Part II: an interdisciplinary experimental methodology. *Journal of Soils and Sediments*, 12(3), p 429–442; [2] Brinkmann, M. et al. (2010): A combined hydraulic and toxicological approach to assess re-suspended sediments during simulated flood events-Part I: multiple biomarkers in rainbow trout. *Journal of Soils and Sediments*, 10(7), p 1347–1361