A multiple biomarker approach to assess the toxicity of re-suspended sediments during simulated flood events – a feasibility study

S. Hudjetz[1], M. Brinkmann[1], C. Cofalla[2], S. Roger[2], U. Kammann[3], A. Schäffer[1], M. Hecker[4], B. Schmidt[1], H. Schüttrumpf[2], J. Wölz[1], H. Hollert[1]

[1]Institute for Environmental Research, RWTH Aachen University, Aachen, Germany
[2]Institute of Hydraulic Engineering and Water Resources Management, RWTH Aachen University, Aachen, Germany
[3]Johann Heinrich von Thünen-Institut (vTI), Hamburg, Germany
[4]Toxicology Centre, University of Saskatchewan, Saskatoon, Canada

Phone: +0049-(0)-241-80-26686

E-mail: hudjetz@bio5.rwth-aachen.de

Introduction: In response to increasing concerns about the potential toxicological impacts of (extreme) flood events in streams, scientists from several disciplines have joined technologies of hydraulic engineering and ecotoxicology in an interdisciplinary project named FLOODSEARCH that was supported by the German Excellence Initiative [1]. This new approach is intended to assist assessing the risks associated with the re-mobilization of particle-bound contaminants resulting from increasingly frequent and intense flood events. In a first feasibility study, rainbow trout (*Oncorhynchus mykiss*) were exposed under simulated flood conditions in an annular flume (**Fig. 1**) to artificial sediment that was spiked with a mixture of polycyclic aromatic hydrocarbons (PAH) at environmentally relevant concentrations. A set of different molecular, biochemical and histological markers was used to experimentally verify the hypothesis that re-suspension of sediments can lead to effects in aquatic organisms [2].

Methods: The exposure experiment was conducted with sediment (OECD 218) that was spiked with a mixture of the PAHs pyrene, phenanthrene, chrysene, and benzo[*a*]pyrene. A second experiment with unspiked sediment served as a reference. An additional control group was exposed to a 5 d simulated flood event in the absence of sediment. Hepatic activities of the enzymes 7-ethoxyresorufin *O*-deethylase (EROD), glutathione-*S*-transferase (GST) and catalase (CAT), lipid peroxidation (LPO), CYP1A protein content, PAH metabolites in bile fluid, micronucleus formation in blood cells, and the expression of a number of genes related to the AhR gene battery were assessed.

Results: The micronucleus frequency was significantly 4.3-fold elevated after exposure. There was no indication of significant AhR-signalling (no EROD induction or increased CYP1A protein content, only slight induction of CYP1A gene expression). Biliary metabolite concentrations were shown to be the most sensitive markers on PAH exposure, clearly indicating uptake and metabolism.

Fig. 1: Annular flume at the Institute of Hydraulic Engineering and Water Resources Management, RWTH Aachen University.

Discussion: In combination with chemical analyses of SPM, the presented approach will be used to improve our understanding of the re-mobilization of pollutants from sediments in support of environmental risk assessment. Artificial sediment (OECD 218) is principally erodible in the flume but the constituents separate during the experiments. Artificial sediments are good standardized substrates only on a small scale but do not reflect on the morphodynamic situation in field. Furthermore, preparation, spiking, conditioning and storage of 120 kg artificial sediment per experiment is time consuming and bear risk for mistakes. Elevated micronucleus frequency indicates potentially high ecological impact of short flood events.

Acknowledgements: This study was generously supported by the German Excellence Initiative, the RWTH Aachen University Undergraduate Research Opportunities Programme (UROP), the Canada Research Chairs program and a discovery grant from NSERC.

References:

[1] Wölz et al. (2009) *J Soils Sediments* **9**:1-5;
[2] Brinkmann et al. (2010) *J Soils Sediments:* DOI 10.1007/s11368-010-0271-x