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Measuring erosion rates of contaminated cohesive sediments using laboratory and in-situ devices in combination: experiences of investigations in River Elbe and Saale

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Deposition of contaminated sediments in areas of no or low flow velocity such as groyne fields or impounded river stretches represent a significant thread to water quality if long-deposited sediments are remobilized during flood and storm events. In contrast to non-cohesive sediments the dynamics of cohesive sediments is not fully understood mainly because of multiple physico-chemical factors and variable biological influence. Hence, site-specific investigations are required to develop water management strategies as well as modelling approaches to predict the dynamic behavior of cohesive material.
The Institute for Modelling Hydraulic and Environmental Systems (IWS, University of Stuttgart) has a strong experience in developing measuring strategies and techniques to deal with the complex interactions between biological and sedimentary characteristics regarding erosion and remobilization of cohesive material. Specifically, the detection of critical shear stresses for incipient motion of cohesive particles has been realized for both one laboratory device (SETEG) and an in-situ device. For site-specific investigations ideally both methods should be combined. The first method (SETEG) includes the on-site extraction of sediment cores allowing for depth-dependent analysis under controlled laboratory conditions, while the second one measures the surface only but reduces possible artifacts due to sediment withdrawal and transport.
Both methods were applied at groyne fields and deposition areas of the River Elbe and River Saale, which are both heavily affected by pollution of anthropogenic contaminants mainly originating from the release of chemical industry before 1990. Next to the detection of critical shear stresses and erosion rates, further sedimentary attributes are analyzed such as particle size distribution, water content and density as well as biological attributes such as TOC and microbial mass. The analyses of the sediment cores result in vertical profiles for all sedimentary and biological parameters giving highly complementary insights into the rather complex erosion and resuspension properties of cohesive fine sediments. Further, the detected critical shear stress between the in-situ and laboratory device are compared and especially in case of deviations the biological parameters can be highly beneficial to explain the measured critical shear stress and variances between in situ and laboratory devices. The investigations in both study sites have shown that the joint application of the measuring devices gives comprehensive information which is required to determine the risk of remobilization properly.

Keywords: cohesive sediments, critical shear stress, contaminated sediments, incipient motion, biostabilization