Chemical Monitoring in the Context of Sediment Management in Estuaries

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Introduction: For the environmental assessment of dredged material as well as of sediments at disposal sites, results of chemical monitoring in sediments and suspended particulate matter (SPM) in the German North Sea estuaries are used. In addition, contaminants which are predominantly adsorbed to fine-grained material are also used as tracers for the transport of fine particulate matter in estuaries. Wadden areas and branches of estuaries are of special interest in contaminant transport, as potentially contaminated SPM tend to accumulate in these areas. They may represent secondary sources of contamination, which may be remobilised by e.g. extreme hydrological events, changes in hydraulic conditions or direct interventions. Taking into consideration natural hydrological variations, investigations on contaminants support the assessment of the impact of sediment management and dredging activities on sediment transport in estuarine waterways.

Methods: Long-term monitoring of contaminants in recently deposited sediments and SPM is carried out at several sampling stations along the German North Sea estuaries. Samples were frequently collected at monthly or quarterly intervals. Since the contaminants of interest predominantly accumulate in the fine fraction (i.e <20 µm), concentrations are normalised to 100 % of this fraction. The consideration of river discharge and contaminant input from rivers allows for the transport of fine particulate matter to be derived from variations in trace metal concentrations [1]. In addition, contaminants in sediment cores and surface samples of the flat zones of estuaries are investigated. Comparison of these concentrations with those detected in SPM or recently deposited sediments provide information on deposition or erosion tendencies.

Results: It is well known that there is a decrease of contaminant concentrations in particulate matter from the tidal weir to the outer estuaries [2, 3]. The concentrations at most monitoring sites vary considerably, and are mainly controlled by river discharge. These results allow for an estimation of the mixing ratios of marine to fluvial particulate matter under varying river discharges. After 1999, these ratios increased. For example, at a sampling site situated upstream of Hamburg harbour the ratio increased from 0 % to 20–40 % at high river discharge.

Sediment cores, sampled in 1998 in flat zones of the Elbe estuary showed an increase in contaminant concentrations with depth and with maximum concentrations at 2 to 3 m depth. In these areas, high contaminant loads originnating from past years, are accumulated. Concentrations in the upper layers are often similar to those found in freshly deposited sediments. In addition, contaminant concentrations in most surface samples and upper layers of sediment cores, taken from 2005 to 2008, corresponded well to the current contamination level of SPM. These results indicate that sedimentation still occurs. Only at individual sites concentrations close to background concentrations or elevated concentrations were found. Both indicate erosion or no deposition.

Discussion: The concentration patterns of contaminants in particulate matter in the Elbe estuary indicate an increase in upstream transport of fine marine sediments. Furthermore, marine solids are transported further upstream to the upper estuary, probably due to the deepening of the Elbe estuary in 1999. These observations support the results of a computer simulation on solid material transport [4]. In several flat zones along the Elbe estuary, deposition still prevails. Respective investigations at nearby disposal sites might give indications on the short- to medium-term transport of fine contaminated sediments from the relocation of dredged material. Therefore, knowledge on transport of potentially contaminated fine-grained material should be taken into consideration in the sustainable planning of dredged material and sediment management decisions.

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References: [1] Ackermann et al. (2007) in: *U. Förstner und B. Westrich (ed.): Sediment Dynamics and Pollutant Mobility in Rivers, 296-304. Springer-Verlag*, [2] ARGE Elbe (1980) *Bericht über die Ergebnisse der Schwermetalluntersuchungen 1979/ 1980*, [3] Ackermann 1998, *BFG-Bericht BfG-118, Koblenz*, BAW (2005) *Untersuchung des Sedimenttransportregimes in der Unterelbe als Grundlage für die Optimierung der Baggerstrategie für den Hamburger Hafen, Hamburg*