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Analysis of the near-bed morphological processes in a sediment trap in the Tidal Elbe near Hamburg

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This presentation contributes to the session by means of new insights into near-bed morphological processes in an estuarine environment. In June 2008 the Hamburg Port Authority built a sediment trap in the Tidal River Elbe near Hamburg / Germany (refer to www.tideelbe.de/167-0-Sedimentfang.html). The trap is ∼2 km long, ∼2 m deep in average and spans the whole roughly 300 meter width of the navigation channel. Its main function is to trap sediments before they reach the port area. Until May 2010 ∼4 Mio.m^3 of fine sediments have been removed from the trap in four maintenance campaigns. The operation of the trap includes a monitoring programme tailored to study morphological processes in detail. Among other activities in these activities sediment and suspended samples have been collected.

(1) Every two months grab samples were collected to analyse the grain size distribution of the bed material inside the trap. In the long-term average the bed material contained two grain size domains. The coarser domain was composed of fine and medium sand, whereas - predominantly found on the western side of the trap - the fine domain contained primarily silt. The most eastern part of the sediment trap and the river bed upstream is dominated by dunes.
(2) In order to study the near-bed morphological processes, a special platform - equipped with trap-samplers that collect suspended material ∼0.3 and ∼0.8 m above the bed - was installed directly on the bottom of the sediment trap. The average material was composed of 30 % fine sand and 70 % silt.
(3) In several campaigns water samples were drawn by a lowered pump. The sampling took place simultaneously on two cross-sections up- and downstream of the sediment trap throughout an entire tidal cycle in 3 different water depths. More than 99 % of solid particulate matter (SPM) belonged to the silt fraction. The average SPM concentration was between 450 and 70 mg/l dependent of water depth.

The analysis of the data has identified a strong gradient in particle size distribution close to the river bed which constitutes a near-bed zone of approximately 1 to 2 m thickness. All water samples, even those taken in the lower unit of the water column, contain only a small portion of material larger than 63 μm. The suspended material, however, which has been collected by the trap-samplers 0.8 m (equal to ∼16 m water depth) above the ground within this near-bed zone contains up to 30 % fine sand. Finally, there is a good agreement in grain size distribution between the material collected by the trap-samplers and the grab samples taken on the western side of the sediment trap, where fine sediments prevail.

Considering the results altogether leads to the conclusion that the actual sedimentation rates inside the trap must be significantly influenced by the transportation processes within this near-bed zone of approximately 1 to 2 m thickness. The influence of SPM concentrations in the water column above this near-bed zone on the sedimentation rate is considered rather insignificant. The analysis of all water samples taken ∼2.0 m (equal to ∼14 m water depth) above the bottom even shows an increase in SPM concentrations between both cross-sections along flow direction. Hence, deposition is unlikely to originate from the upper water column.

The detection of this near-bed zone enables a better targeted monitoring to identify those parameters that significantly influence the rate of sedimentation and the grain size distribution within the sediment trap. Henceforward, this supports the Hamburg Port Authority in their effort to improve the management of this trap.