

Sediment flux from the Elbe River into the Elbe Estuary – indications from Multibeam Sonar Surveys

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Introduction: In order to advance the understanding of sediment flux through the river Elbe into the Elbe estuary, especially with regard to mobilization and deposition of the sandy bed material, a time series (2004 to 2014 which represents available sonar data base) of DEM's derived from multibeam surveys was analyzed. The considered study area ranges from Elbe-km 575 upstream the weir Geesthacht to approximately km 620, downstream of the weir. The weir Geesthacht is located at km 586 and divides the estuary downstream and the non-tidal river section upstream of the structure.

Methods: The study area was split into segments according to the existing multibeam data structure. Faulty xyz data and overlaps between different multibeam records were cleaned to achieve consistent and congruent coverages within the segments. The initial multibeam records were subtracted from the following records using a GIS to determine differences in bed level height as well as eroded and accumulated volumes of bed material. The evolution of the bed level height and the associated volumetric changes were interpreted, taking discharge data and dredged material statistics into account.

Results: The transport of bed material and the suspended sand fraction is strongly affected by the barrier function of the weir in Geesthacht. Predominantly most of the substrate is detained upstream of the structure. Comparing the volumetric bed change to the dredged volume a net accumulation of sandy sediments is determined within the non-tidal section upstream of the weir. Downstream the weir the morphological evolution of the bed is predominantly characterized by an erosive regime and episodically accumulative, triggered by high discharge events (cf. Fig. 1).

Discussion: The results indicate that upstream of the weir accumulation is overbalancing the erosion. A steady state of the bed level height is achieved only by frequent dredging activities. However, during hydraulic regimes with very high discharge rates, larger amounts of sand are mobilized and transported into the tidal part of the Elbe River, downstream of

the weir. During these events the sand budget of the Elbe section between the weir and the port of Hamburg is being compensated for the deficit during lower runoff-conditions. This effect is clearly visible during the high discharge of about 4000 m³/s in June 2013 (cf. Fig 1).

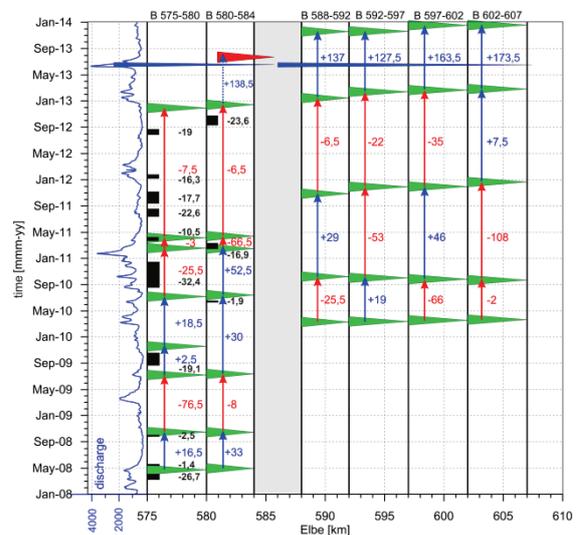


Fig. 1: mean erosion (negative/red vectors) and mean accumulation (positive/blue vectors) [m³/a] from km 575 to km 607, dredging activities (black), blue vertical curve illustrates discharge, weir area illustrated in grey

In this study a maximum of the available multibeam data, which fully covers the fairway was integrated. However, the sonar data usually does not cover the very shallow sides of the river. Therefore the material in- and output of potential sources and sinks as groynefields or the floodplains was not respected. However, the results so far contribute to the understanding in sediment transport and sediment budget of the river Elbe, especially in view of the transition into the tidal part of the Elbe. Upcoming sediment management activities or future designs of sediment management concepts may benefit from this study. Intended bedform tracking studies as well as measurements of the bed load- and suspended sand transport within the study area are mutually beneficial to validate the achieved results.