

What multi-beam bathymetric data can tell about morphodynamics and sediment transport in an estuarine environment?

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The Elbe River Estuary is one of the most important waterways for commercial shipping in Europe. It connects the North Sea with the Port of Hamburg located about 100 km inland. To secure navigation, the Federal Waterways and Shipping Administration (WSV) is operating a fleet of survey vessels all equipped with a multi-beam echo sounder controlling the required water depths. Beyond navigational purposes, this monitoring is creating a comprehensive and ever-growing data base, which can be used for a consistent morphodynamical description of the river bed. The history of multi-beam records in the Elbe River Estuary reaches back to 2008. At particular river sections where large amounts of fine grained sediments accumulate surveys are taken biweekly; at other sections there are monthly surveys. Locally, sedimentation rates of up to 12 cm per day have been observed within the fairway.

The time series of multiple multi-beam records have been analyzed with a particular focus on morphodynamics and sedimentation rates. Here we compare the morphodynamical characteristics of two river sections. The first section is located at the downstream end of the estuarine turbidity zone near the city of Cuxhaven; the second section is located 50 km away at the upstream end of the turbidity zone near the city of Hamburg. These two sections have been selected because in both the morphology of the river bed and the sedimentation processes are strongly influenced by the presence of fine grained sediments.

The results show that changing sedimentation rates in both sections are conditioned by different site specific factors, e.g. the dynamic shifting of the turbidity zone along the estuary, which is resulting in a temporarily higher availability of suspended sediments and more intense sedimentation rates in the upper part of the estuary and the respective section. In contrast, in the downstream located river section more intense sedimentation rates could be related to periods of strong north-western wind conditions causing increased water levels and higher wave loads on the adjacent wadden areas of the German Bight. These processes were formerly inferred from theory and numerical studies but could not so far be supported on the basis of direct measurements due to a lack of continuous data records on sedimentation rates with a sufficiently high spatial and temporal resolution.