Geophysical Research Abstracts
Vol. 16, EGU2014-7391, 2014
EGU General Assembly 2014

Tide-driven fluid mud transport in the Ems estuary

Marius Becker (1), Christian Maushake (2), and Christian Winter (1)

(1) MARUM, Coastal Dynamics, Germany, (2) BAW, Federal Waterway Engineering and Research Institute, Hamburg, Germany

The Ems estuary, located at the border between The Netherlands and Germany, experienced a significant change of the hydrodynamic regime during the past decades, as a result of extensive river engineering. With the net sediment transport now being flood-oriented, suspended sediment concentrations have increased dramatically, inducing siltation and formation of fluid mud layers, which, in turn, influence hydraulic flow properties, such as turbulence and the apparent bed roughness. Here, the process-based understanding of fluid mud is essential to model and predict mud accumulation, not only regarding the anthropogenic impact, but also in view of the expected changes of environmental boundary conditions, i.e. sea level rise. In the recent past, substantial progress has been made concerning the understanding of estuarine circulation and influence of tidal asymmetry on upstream sediment accumulation. While associated sediment transport formulations have been implemented in the framework of numerical modelling systems, in-situ data of fluid mud are scarce. This study presents results on tide-driven fluid mud dynamics, measured during four tidal cycles aside the navigation channel in the Ems estuary. Lutoclines, i.e. strong vertical density gradients, were detected by sediment echo sounder (SES). Acoustic Doppler current profiles (ADCP) of different acoustic frequencies were used to determine hydrodynamic parameters and the vertical distribution of suspended sediment concentrations in the upper part of the water column. These continuous profiling measurements were complemented by CTD, ADV, and OBS casts. SES and ADCP profiles show cycles of fluid mud entrainment during accelerating flow, and subsequent settling, and the reformation of a lutocline during decelerating flow and slack water. Significant differences are revealed between flood and ebb phase. Highest entrainment rates are measured at the beginning of the flood phase, associated with strong current shear and rapid vertical mixing, inducing the highest instantaneous suspended sediment flux measured during the tidal cycle. During decelerating flood currents a lutocline is again established at a certain distance above the consolidated river bed. During slack water after the flood phase the concentration gradient increases and the thickness of the fluid mud layer below is constant, also during a significant part of the ebb phase. As water depth decreases during ebb, entrainment occurs only at the upper part of the fluid mud layer. The suspended sediment flux is low compared to the flood phase. These observations are further elaborated using turbulence parameters obtained from ADV and ADCP, explaining the difference between ebb and flood concerning the vertical location of the maximum concentration gradient. This study is funded through DFG-Research Center / Excellence Cluster „The Ocean in the Earth System“. The Senckenberg Institute and the Federal Waterways Engineering and Research Institute are acknowledged for technical support.