Methods for Analysis of Redevelopments in Estuaries

Florian Ladage, Oliver Stoschek, Monika Donner & Christian Pohl

DHI-WASY GmbH, Office Syke, cpo@dhi-wasy.de

ABSTRACT

Estuaries play an important role for ecological interdigitation of aquatic habitats as well as for water management and channel shipping issues. All these interests are degraded if anthropological changes, like straightening or deepening of watercourses, result in an increase of turbidity in estuaries. One of the largest estuaries in Germany, the Ems estuary, suffered a dramatic turbidity increase over the last 15 years: The annual averaged suspended sediment concentration rose from 1 g/l in 1992/93 (Schuttelaars & De Jonge, 2009) up to 10 g/l in 2008/09 (NLWKN Aurich, 2009) accompanied by an extreme shift of the estuarine turbidity maximum (ETM) to upstream locations. This development resulted in a classification as “heavily polluted” water quality and a “heavily modified” water body by EU-WFWD. As a consequence oxygen supply is reduced during summer periods down to zero with disastrous effects for the aquatic fauna.

In the joint research project “Perspective Revitalized Lower Ems” ecologists and water management authorities analysed different concepts to impel a sustainable development for the Lower Ems region and to assess effects and chances of implementation. The project was sponsored by the DBU (Deutsche Bundesstiftung Umwelt) and BINGO (Umweltstiftung Niedersachsen) and collaborative processed by WWF Germany, BUND, NABU and University of Technology in Berlin. The project aimed at finding solutions by analysing different restoration measures to reduce suspended sediment concentrations and to increase oxygen supply.

Hydrodynamics, salinity and suspended sediment transport processes for the Outer and Lower Ems were simulated and analysed by DHI-WASY using a high resolution, three dimensional numerical model (software MIKE 3 FM). The finite-volume method was applied for the model which was based on a horizontally unstructured mesh and a sigma-layered water column (10 layers). The numerical model was calibrated and validated against existing measurements for water levels, currents, salinity and suspended sediment concentrations. NWLKN Aurich, BAW Hamburg and WSA Emden provided measured time-series for appr. eight monitoring stations to support validation of model quality. The empirical parameters for erosion and sedimentation processes were estimated by additional data for grain size distribution of the channel bed.

The following redevelopment measures were analysed for the Ems estuary and assessed with different analysis tools:

- The flattening of the river bed in some parts of the estuary (including an alternative Ems channel)
- The extension of the estuary by decommissioning of the upstream weir
- The arrangement of different tidal reservoirs along the Lower Ems
- The connecting of shallow water areas
- The reactivation of old river cut-offs and braided channels in the form of tributaries

Based on current deficits in the Lower Ems and the historical development of tidal range and suspended sediment concentration, parameters were derived which were subsequently used for

assessing the restoration potential. This analysis of the effects of the various measures included not only the changes in the suspended sediment balance (reduction in suspended sediment concentration, downstream shift of turbidity maximum, and reversal of net estuarine sediment import), but also the modification of hydrodynamic parameters with respect to tidal asymmetry (Dronkers, 1986). The main focus was on parameters that are significant for the dynamics of cohesive sediments, such as the relationship of high and low tide to maximum current gradients and currents. Additionally an analysis of 2D-longitudinal sections was conducted to locate and compare the different restoration measures.

All scenarios were classified and compared with the aid of a matrix and graduated in terms of the importance of these parameters for restoration potential. In particular, priority was given to reversing net estuarine sediment import and reducing suspended matter concentrations.

The poster illustrates the results of the analysis with respect to estuarine dynamic and compares the effect of different restoration measures.

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