Geophysical Research Abstracts,
Vol. 11, EGU2009-11564, 2009
EGU General Assembly 2009

Simulating Suspended Silt Concentrations in the Ems Estuary, The Netherlands

B.T. Grasmeijer
(grasmeijer@alkyon.nl)

1 Introduction

The Ems Estuary is situated in the North-east Netherlands on the border with Germany. Its area, including the tidal river and excluding the outer delta, is $\pm$ 500 km^2. The area of the outer delta is $\pm$ 100 km^2. The length of the estuary from the inlet to the town of Leer in Germany is approximately 75 km. The mean tidal range varies over years (de Jonge, 1992), but is approximately 2.3 m near the island of Borkum (tidal inlet) and approximately 3.2 m near the town of Emden in Germany. The estuary receives water from the rain-fed River Ems (approximately 115 m^3/s on average). A second much smaller freshwater input emanates from the small canalized river Westerwoldsche Aa (12.5 m^3/s on average). These discharges vary strongly within and between years. The result of the interaction between freshwater discharge and seawater brought in by the tide is a salinity gradient, the length and position of which is strongly dependent on the water discharge by the rivers.

The present morphology of the estuary is the result of natural processes such as tidal currents, wind and wave driven currents and river discharge, resulting in sediment trans-port and sedimentation and erosion patterns. These natural processes are affected by human interferences like maintenance dredging of the navigation channels, land reclamation, building of dikes, etc. The greatest changes in the last 50 years in the physical functioning of the Ems estuary have been the increased sea level and tidal range, the increased amplitude and frequency of storm surge, and greatly increased turbidity and sediment concentrations (particularly near the estuarine turbidity maximum). Much of the changes can be traced directly or indirectly to anthropogenic influence.

2 Aim and approach

We studied the hydrodynamics and morphodynamics of the Ems estuary. One of the aims was to gain more insight in the behaviour of the suspended silt concentrations in the estuary and the anthropogenic influence thereon. We applied a beta release of the state-of-the-art Delft3D numerical model for this purpose. The model includes a new sediment transport module published by Van Rijn (2007, 2007a). The vertical distribution of the suspended sediment concentration in the transport module depends on the effective settling velocity of the sediment, the bed shear velocity and the turbulence. The silt transport is simulated every time step together with the flow (online), which means that the impact of the calculated concentration is accounted for in the hydrodynamics. Major challenge was to accurately simulate the relatively high suspended silt concentrations observed near the estuarine turbidity maximum.

3 Results

The paper will compare observed and predicted water levels, salinity distributions and suspended silt concentrations. Figure 1 shows an example of predicted depth-averaged suspended silt concentrations during spring high

tide without waves. Under these conditions the depth-averaged concentrations decrease from about 2 kg/m^3 in the Unterems (upstream of Emden) to almost zero seaward of Borkum.

Figure 1: Figure 2 Observed and predicted salinities in the upper part of the water column along the estuary

The presence of waves will increase the concentrations on the shoals but have a limited effect on the concentrations in the channels. Figure 2 presents observed and predicted salinities along the estuary. The model results encouragingly agree with the observations.

4 References

De Jonge, V.N., 1992. Tidal flow and residual flow in the Ems estuary. Estuarine, Coastal and Shelf Science, 34: 1-22.

Van Rijn, L.C., 2007. Unified View of Sediment Transport by Currents and Waves. I: Initiation of Motion, Bed Roughness, and Bed-Load Transport. Journal of Hydraulic Engineering, 133(6): 649-667.

Van Rijn, L.C., 2007a. Unified View of Sediment Transport by Currents and Waves. II: Suspended Transport. Journal of Hydraulic Engineering, 133(6): 668-689.