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Menno Eelkema (1) and Zheng Bing Wang (2)

(1) Department of Civil Engineering & Geosciences, Delft University of Technology, Stevinweg 1, 2628 CN Delft, NL, M.Eelkema@tudelft.nl, (2) Deltares, P.O. Box 177, 2600 MH Delft, NL, Zheng.Wang@deltares.nl

SEDIMENT TRANSPORT DYNAMICS IN RESPONSE TO LARGE-SCALE HUMAN INTERVENTION

M. Eelkema and Z.B. Wang

The Eastern Scheldt basin in the southwestern part of the Netherlands is an elongated tidal basin of approximately 50 km in length with an average tidal range of roughly 3 meters at the inlet. Before 1969 A.D., this basin was also connected to two more tidal basins to the north through several narrow, yet deep channels. These connections were closed off with dams in the nineteen sixties in response to the catastrophic flooding in 1953. In the inlet of the Eastern Scheldt a storm-surge barrier was built in order to safeguard against flooding during storms while retaining a part of the tidal influence inside the basin during normal conditions. This barrier was finalized in 1986. The construction of the back-barrier dams in 1965 and 1969 had a significant impact on the tidal hydrodynamics and sediment transport (Van den Berg, 1986). The effects of these interventions were still ongoing when the hydrodynamic regime was altered again by the construction of the storm-surge barrier between 1983 and 1986.

This research aims to describe the hydrodynamic and morphodynamic evolution of the Eastern Scheldt between 1953 and 1983, before construction of the storm-surge barrier had started. An analysis is made of the manner in which the back-barrier dams changed the tidal flow through the basin, and how these altered hydrodynamics influenced the sediment transport and morphology. This analysis consists first of all of a description of the observed hydrodynamical and bathymetrical changes. Second, these observations are used as input for a process-based hydrodynamic model (Delft3D), which is applied in order to gain more insight into the changes in sediment transport patterns. The model is used to simulate the situations before and after the closures of the connections between the Eastern Scheldt and the basins north of it

In the decades before 1965, the Eastern Scheldt exported large quantities of sediment towards sea through its inlet. This export was estimated to be roughly 2 to 3 million m3 per year, and was observable as deepening channels inside the basin, and a growing ebb-tidal delta. The implementation of the dams caused a significant increase in tidal prism, while at the same time they stopped the residual flow of water from the Eastern Scheldt towards the northern basins. The increase in tidal prism was observable in the response of bathymetry; the rates of channel deepening and ebb-tidal delta growth both increased.

Analysis of tidal flow measurements and model output show a persistent trend for sediment transport towards and out of the Eastern Scheldt's inlet. This export is caused by both the strong ebb-directed asymmetry in the tidal flow as well as higher sediment concentrations during ebb. The construction of the back-barrier dams only amplified this export by cutting off the residual import of flow and by causing the basin to be out of equilibrium even more than it apparently already was.

References

Van den Berg, J.H., 1986. Aspects of Sediment- and Morphodynamics of Subtidal Deposits of the Oosterschelde (the Netherlands). Rijkswaterstaat Communications, no. 43/1986, The Hague.