

Modeling effects of secondary tidal basins on estuarine morphodynamics

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Many estuaries are situated in very densely populated areas with high economic activities that often conflict with their ecological values. For centuries, geometry and bathymetry of estuaries have been drastically modified through engineering works such as embanking, sand extraction, channel deepening, land reclamations, etc. It is generally recognized that these works may increase the tidal range (e.g., Scheldt, Ems, Elbe) and turbidity (e.g., Loire, Ems) in estuaries [cf. Kerner, 2007; Wang et al., 2009; Winterwerp and Wang, 2013; Van Maren et al., 2015b,a].

In recent years, construction of secondary basins (also called retention basins) has gained increasing popularity among coastal managers to reduce tidal range and turbidity [Donner et al., 2012]. Previous studies have shown that location, geometry and number of secondary basins have a significant impact on tidal characteristics and sediment transport [Alebrege and de Swart, 2014; Roos and Schuttelaars, 2015]. However, knowledge on how these secondary basins affect the morphodynamic development of estuaries on long time scales (order decades to centuries) is still lacking.

The specific objectives of this study are twofold. First, to investigate effects of secondary basins on the long-term morphodynamic evolution of estuaries. In particular, effects of the presence of such a basin on the morphodynamic evolution of the main channel in the estuary and the physics underlying channel migration will be examined. For this, the Western Scheldt estuary (situated in the Netherlands) is used as a case study, which used to consist of multiple secondary tidal basins that were located at different positions in the estuary, and which have been gradually closed off between 1800 and 1968. Second, to systematically quantify sensitivity of model results to location, geometry, and to number of secondary basins. To this end, the state-of-the-art numerical model Delft3D is used, which has been successfully applied to morphodynamic modeling of estuaries and other coastal systems [cf. Hibma et al., 2003; Van der Wegen and Roelvink 2008; Dissanayake et al., 2012; Eelkema et al., 2013; Ridderinkhof et al., 2014].

With this contribution it will be shown that the presence of secondary basins causes, among other things, local migration of the main channel in the vicinity of the basin, and it decreases the overall depth of the channel network. These results agree well with findings from an observational study on historical morphological development of the Western Scheldt estuary.

References available upon request