Geophysical Research Abstracts
Vol. 21, EGU2019-3991, 2019
EGU General Assembly 2019

Effect of dredging and disposal on tidal bifurcations and flow asymmetry

Wout M. van Dijk, Jasper R.F.W. Leuven, Pauline S. Martens, Joyce Vlaming, and Maarten G. Kleinhans
Universiteit Utrecht, Geoscience, Physical Geography, Utrecht, Netherlands (W.M.vanDijk@uu.nl)

Estuaries are characterized by intertidal bars, i.e. shoals, that are encompassed by ebb and flood channels. Division of the flow at channel junctions into the ebb and flood channels indicates that the estuary consists of bifurcations that become confluences when flow reverts. While disturbances, such as shoal margin collapses (Van Dijk et al., 2019) only have a near-field effect on erosion and deposition at individual channel scale, the disturbance has a far-field effect on elevation jumps and flow division at the channel junctions. Because tidal asymmetry, produced by the distortion of the propagating tidal wave, is observed, we expect that a disturbance will migrate differently through the flood- and ebb-dominated channels. Our aim is to determine if we can approximate tidal bifurcations as river bifurcations, and quantify how dredging and disposal affect the channel network and bifurcation asymmetry at channel junctions. Therefore, we analysed bathymetry of the Western Scheldt (The Netherlands) since 1955 and used a Delft3D schematization of the Western Scheldt to isolate the effect of dredging and disposal strategies. We applied a novel channel network extraction tool, to determine changes in the bifurcation asymmetry and tidal asymmetry between the main, side and connecting channel scales.

The tidal asymmetry in the Western Scheldt, represented by peak velocity ratio and period of flood-ebb ratio, shows that generally, the duration of the ebb flow is longer, whereas the flow current is stronger. Model results indicate that the bifurcation asymmetry is hardly affected by dredging. Tidal asymmetry changes depending on the disposal locations. The ebb period becomes longer and stronger at bifurcations in case dredged sediment is disposed of in the side channels. Dredging of the main channel leads to an increased elevation jump between the high-order channel and the bifurcating channel. We expected that the bifurcating channels would close off because the increase in elevation jump, however, both channels remains open because the increase in gradient is opposed by an increase in sinuosity, indicated by the bifurcation angle between the ebb and flood channels. Bifurcations become less stable in the case of dredging, which is indicated by the decrease in the number of bifurcations and the decrease in the number of ebb and flood channels in the channel networks.

We conclude that tidal bifurcations, described by a bifurcation angle and elevation jump, can be approximated as river bifurcations. While dredging and disposal affect the stability of bifurcations by increasing the ebb period and decreasing the peak velocity ratio. The stability of bifurcations is important as it determines the number of connecting channels and the continuation of the multi-channel system, which affects the area of tidal flat and biodiversity in the Western Scheldt.

Van Dijk, W.M., Hiatt, M.R. Van der Werf, J.J. and Kleinhans, M.G. (2019), Effects of shoal margin collapses on the morphodynamics of a sandy estuary. Journal of Geophysical Research – Earth Surface.