Geophysical Research Abstracts
Vol. 15, EGU2013-2305, 2013
EGU General Assembly 2013

Analytical solution of tidal dynamics in convergent estuaries: A review

Huayang Cai (1), Hubert H. G. Savenije (1), and Marco Toffolon (2)

(1) Delft University of Technology, Department of Water Management, Delft, Netherlands (h.cai@tudelft.nl), (2) University of Trento, Department of Civil, Environmental and Mechanical Engineering, Trento, Italy

In this contribution we focus on the tidal wave propagation in convergent estuaries, where the cross-sectional area varies approximately as an exponential function along the estuary axis. This kind of estuarine geometry, which is observed in coastal plain estuaries all over the world, including widely studied tidal estuaries such as the Scheldt in the Netherlands, Thames in the UK, Delaware in the USA, can produce amplification or damping of the tidal wave: if the effect of convergence is stronger than the effect of friction, the wave is amplified; if friction is stronger than convergence, the wave is damped. Since real estuaries can experience amplification and damping in different regions, depending primarily on local depth and convergence, a multiple-reach approach is typically required.

It has been recently shown that a fully analytical solution for the one-dimensional tidal hydrodynamics can be obtained by solving a set of four implicit analytical equations, i.e. the damping, the phase lag, the scaling and the celerity equations (Toffolon et al., 2006; Savenije et al., 2008; Cai et al., 2012). Such a solution can be applied locally and represents a valuable tool to describe the tidal dynamics in an affordable yet reliable way. Moreover, it provides a theoretical framework that can be used to compare the different assumptions, like for instance the linearization of the friction term, which are exploited in previously derived analytical solutions. It is found that the main differences between the different approaches lie in: 1) the account of local variability (e.g., the depth), 2) the different approximations of the friction term, 3) the account of asymptotic behaviour.

The purpose of this review is hence to summarize common features and main differences among the various analytical solutions and finally enhance our understanding of tidal wave propagation in estuaries.

References

Cai, H., H. H. G. Savenije, and M. Toffolon (2012), A new analytical framework for assessing the effect of sea-level rise and dredging on tidal damping in estuaries, Journal of Geophysical Research, 117, C09023, doi:10.1029/2012JC008000.

Savenije, H. H. G., M. Toffolon, J. Haas, and E. J. M. Veling (2008), Analytical description of tidal dynamics in convergent estuaries, Journal of Geophysical Research, 113(C10), doi:10.1029/2007JC004408.

Toffolon, M., G. Vignoli, and M. Tubino (2006), Relevant parameters and finite amplitude effects in estuarine hydrodynamics, Journal of Geophysical Research, 111(C10), doi:10.1029/2005JC003104.