



Analytical analysis of resonant behaviour in a semi-closed estuary

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In this study, we study the dynamics of the tidal wave in a semi-closed estuary as dependent on local quantities, such as tidal amplitude, estuary depth, friction, convergence, and as a function of distance to the head of the estuary. To provide insight into the tidal propagation in such a system, simple implicit relationships between these features are derived. A multi-reach approach has been adopted to follow variations of the estuarine sections along the estuary by simple integration of the obtained damping factor over a distance interval, which is repeated for the entire length of the estuary. The proposed analytical model has been subsequently used to investigate the resonant behavior in a semi-closed estuary, taking into account the effects of both width and depth convergence. It is found that friction tends to move the position of the first node seaward while channel convergence moves it landward. We also note the importance of depth convergence since it intensifies the channel convergence but also increases the friction. As expected, tidal resonance at one quarter wave length only occurs in a frictionless prismatic channel with a horizontal bed. We have also compared the analytical solutions with 1D numerical simulations. Finally, the analytical model has been used to investigate the influence of the position of a tidal barrier on the tidal dynamics along an estuary.