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Process-based, long-term morphodynamic modeling to investigate conditions for equilibrium estuarine geometry

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Literature review suggests that alluvial estuaries all over the world have a shape that exponentially widens towards the mouth. In strongly tapering estuaries, the tidal characteristics mimic a standing wave in the sense that the phase difference between maximum water level and maximum velocity is $^1/_2 \quad \pi$, whereas the tidal wave still propagates along the estuary [Friedrichs and Aubrey (1994), Jay (1991), Prandle (2003), Savenije (2001)]. Furthermore, it has been suggested that, for equilibrium conditions, the tidal water level amplitude and the velocity amplitude remain fairly constant along the estuary. This latter condition also implies that sediment transport along the estuary is constant [Friedrichs (1995)].

The aim of the current research is to investigate the development of these assumed equilibrium conditions with a morphodynamic, process-based numerical model (Delft3D).

Model results cover an evolution of a time span of about 6400 years in a 300 km long tidal embayment under constant tidal forcing conditions. This is an extended version of an 80 km basin described in earlier research [Van der Wegen et al. (2008)]. The model starts from a highly schematised rectangular cross-section which is uniform along the embayment. The model allows for bank erosion, bed slope effects and drying and flooding of intertidal area, whereas short waves are not considered. Grid resolution is 100 m by 200 m which covers the length scale of the major patterns. Because of this detailed grid and the long timescale calculations took months on a decent PC.

Model results show considerable widening at the mouth (roughly along an exponentially narrowing profile) and a slower development more landward. The $^1/_2 \quad \pi$ time lag between maximum water level and maximum velocity, the constant water level amplitude and the constant velocity amplitude develop within centuries and are most pronounced in the widened part of the embayment. More landward, the tidal wave characteristics still reflect a (damped) classical progressive wave. After 6400 years the model shows these two tidal wave characteristics, both present in about 40 % of the tidal embayment with a 20% transient interval in between. The results suggest that alluvial estuaries evolve towards an exponentially shaped geometry although the evolution timescale is long and allows for different tidal wave characteristics more landward.

Friedrichs, C.T. and D.G. Aubrey (1994), Tidal propagation in strongly convergent channels, *Journal of Geophysical Research, 99*(C2), 3321-3336.

Friedrichs, C.T., (1995), Stability Shear Stress and Equilibrium Cross-Sectional Geometry of Sheltered Tidal Channels, Journal of Coastal Research, 11, 4, 1062-1074.

Jay, D.A., (1991). Green's law revisited: Tidal long wave propagation in channels with strong topography, *Journal of Geophysical Research*, Vol. 96, no C11, 20,585-20,598

Prandle, D., (2003), Relationship between tidal dynamics and bathymetry in strongly convergent estuaries, *Journal of Physical Oceanography, 33*, 2738-2750.

Savenije, H.H.G., (2001), A simple analytical expression to describe tidal damping or amplification, *Journal of Hydrology, 243*, 205-215.

Van der Wegen, M., Wang, Z.B., Savenije, H.H.G., Roelvink, J.A., 2008. Long-term morphodynamic evolution and energy dissipation in a coastal plain, tidal embayment, J. Geophys. Res., Vol. 113, F03001, doi:10.1029/2007JF000898