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Equilibrium bed profiles in an idealized two-inlet embayment

Paulo Salles (1), Corine Meerman (2), and Henk Schuttelaars (3)

(1) UNAM - Mexico (psallesa@iingen.unam.mx), (2) Leiden University - The Netherlands (cmeerman@math.leidenuniv.nl), (3) TU Delft - The Netherlands (tudl0705@xs4all.nl)

Multiple inlet systems are present at many coasts worldwide, often in coastal areas with high ecological and/or economical value (e.g., Wadden Sea, Venice Lagoon, Terminos Lagoon, etc). These coastal systems are highly dynamic, and their equilibrium is fragile. The stability depends mainly on the sediment dynamics at the inlet and inside the embayment, as well as numerous other factors and processes, such as inlet and embayment geometries, sediment properties, sediment availability, tidal and wave forcing, wind, fresh water input, and human interventions. It also depends on the presence of watersheds inside the system that can generate subembayments during some periods of the tidal cycle or longer timescales (e.g., dry season), and consequently modify the residual circulation and transport, which in turn can affect the long-term stability.

This study focuses particularly on the equilibrium bed profile in a two-inlet system, as a function of varying conditions (inlet depth, basin length, tidal amplitude and nonlinearity). In order to address this, an idealized cross-sectionally averaged semi-analytical model was developed, in which only the essential physical processes are taken into account. The basin is assumed to be short (compared to the wavelength) and shallow, and the width may vary in the along-channel direction. The water motion is described by the depth averaged shallow water equations. The model is forced at each inlet with a mean surface elevation, a prescribed semidiurnal signal (M2) and its first overtide (M4), and the depths at the entrances are prescribed. The sediment transport is described by a depth integrated advection-diffusion equation, and the bed evolves due to the divergence of tidally-averaged bedload and suspended load fluxes.

Model results of equilibrium bottom profiles suggest that morphodynamic equilibria can be found in such two-inlet systems. The observed equilibrium profiles show the formation of watersheds, with its location and height depending on the parameters used. The sensitivity of this equilibrium to various parameters, such as tidal amplitude of the M2 and M4 components will be discussed, and results will be compared with the Marsdiep-Vlie system in the Wadden Sea.