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Convergence of estuarine channels

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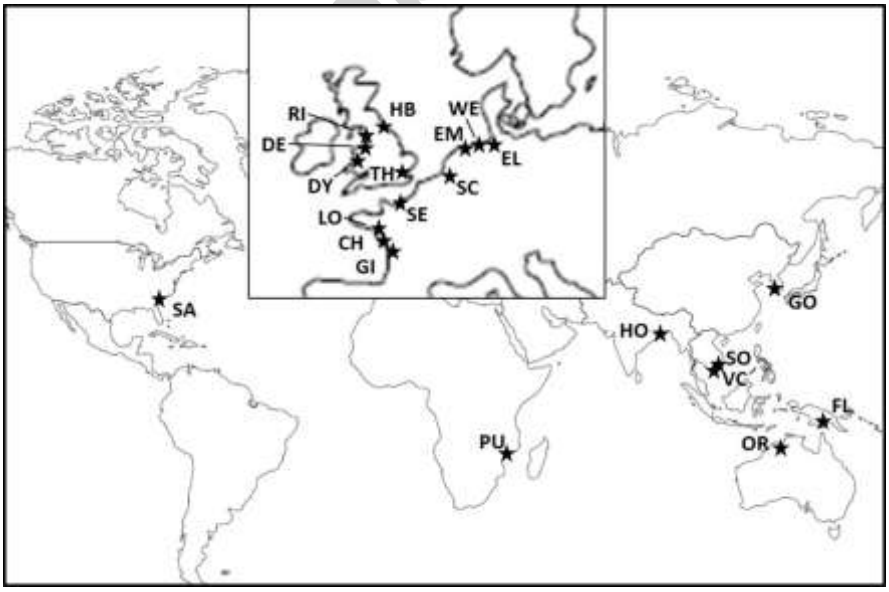
Abstract
Tide-dominated coastal plain estuaries have typically up-estuary convergent tidal channels. Analysis of estuarine characteristics indicates a dependence of the convergence length on relative tidal amplitude, relative intertidal area and river flow velocity. In order to explain these relationships we investigate a condition for continuity of net sediment transport throughout the estuary, corresponding to morphodynamic equilibrium. We show, by using an analytical solution of the tidal equations, that this condition is equivalent to a condition on the convergence length. This condition is evaluated for 21 estuaries in different regions of the world. It appears that the convergence length determined in this way can explain observed convergence lengths for the considered set of estuaries. The dependence of the convergence length on different estuarine characteristics is analysed by solving the fully coupled hydro-morphodynamic equations. We show that this dependence limits the range of variation of the tidal velocity amplitude. The analysis provides insight in the morphological response of estuaries to human interventions. The condition can easily be evaluated to yield an estimate of this response.

Keywords:
Estuary, Morphodynamics, Morphology, Equilibrium

1. Introduction

Estuaries which have developed in wide coastal plains are shaped by morphodynamic feedback: the mutual interaction of accretion/erosion and hydrodynamic forcing. This is less true for estuaries which are constrained by geology, such as rias and fjords; such estuaries are not considered In our analysis. We focus on estuaries with strong tides and substantial river inflow. However, we exclude estuaries where river flow velocities become comparable to tidal velocities under high runoff conditions. The estuaries considered in this paper for illustration of the theoretical analysis are indicated in figure 1.



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