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Morphogenetic modelling of coastal and estuarine evolution

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Abstract

Environmental pressures from climate change and anthropogenic activities have increased the need for quantitative morphogenetic models of coasts and estuaries. These quantitative models enable geoscientists to explain and forecast coastal and estuarine morphogenetic processes. Reducing model (predictive) uncertainties requires increasing awareness and reconsideration of common fundamental principles upon which existing models have built. Based on a review of most of the existing morphogenetic models applicable on open oceanic coasts and in estuaries, we use Exner equations to clarify the potential of individual models. Fundamental coastal and estuarine behaviours, and cautions required when implementing the models are also discussed on the basis of the Exner equations. Major differences and difficulties among these models are in the derivation and computation of vertical and horizontal sediment fluxes; these can be even more complicated in estuaries than on open coasts because it is more important to consider estuarine systems in three dimensions and to account for a wider range of grain sizes. In addition, estuaries experience interference from ecological processes as well as connections with both hinterland and the open coast. Tackling these difficulties requires more observational data to derive increasingly reliable parameterizations of sediment fluxes. Future model development and application across a range of spatial-temporal scales should be based on the Exner equations, modified to suit local coastal and estuarine settings, and incorporating natural complexities and hierarchical landform features.

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