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TITLE: Appropriate complexity for the prediction of coastal and estuarine geomorphic behaviour at decadal to centennial scales

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ABSTRACT:

Coastal and estuarine landforms provide a physical template that not only accommodates diverse ecosystem functions and human activities, but also mediates flood and erosion risks that are expected to increase with climate change. In this paper, we explore some of the issues associated with the conceptualisation and modelling of coastal morphological change at time and space scales relevant to managers and policy makers. Firstly, we revisit the question of how to define the most appropriate scales at which to seek quantitative predictions of landform change within an age defined by human interference with natural sediment systems and by the prospect of significant changes in climate and ocean forcing. Secondly, we consider the theoretical bases and conceptual frameworks for determining which processes are most important at a given scale of interest and the related problem of how to translate this understanding into models that are computationally feasible, retain a sound physical basis and demonstrate useful predictive skill. In particular, we explore the limitations of a primary scale approach and the extent to which these can be resolved with reference to the concept of the coastal tract and application of systems theory. Thirdly, we consider the importance of different styles of landform change and the need to resolve not only incremental evolution of morphology but also changes in the qualitative dynamics of a system and/or its gross morphological configuration. The extreme complexity and spatially distributed nature of landform systems means that quantitative prediction of future changes must necessarily be approached through mechanistic modelling of some form or another. Geomorphology has increasingly embraced so-called 'reduced complexity' models as a means of moving from an essentially reductionist focus on the mechanics of sediment transport towards a more synthesist view of landform evolution. However, there is little consensus on exactly what constitutes a reduced complexity model and the term itself is both misleading and, arguably, unhelpful. Accordingly, we synthesise a set of requirements for what might be termed 'appropriate complexity modelling' of quantitative coastal morphological change at scales commensurate with contemporary management and policy-making requirements: 1) The system being studied must be bounded with reference to the time and space scales at which behaviours of interest emerge and/or scientific or management problems arise; 2) model complexity and comprehensiveness must be appropriate to the problem at hand; 3) modellers should seek a priori insights into what kind of behaviours are likely to be evident at the scale of interest and the extent to which the behavioural validity of a model may be constrained by its underlying assumptions and its comprehensiveness; 4) informed by qualitative insights into likely dynamic behaviour, models should then be formulated with a view to resolving critical state changes; and 5) meso-scale modelling of coastal morphological change should reflect critically on the role of modelling and its relation to the observable world.

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