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Towards a Reduced-Complexity Approach for Forecasting Medium- to Long-term Geomorphic Changes in Estuaries

Christopher Skinner (1) and Tom Coulthard (2)

(1) Energy and Environment Institute, University of Hull, Hull, United Kingdom (c.skinner@hull.ac.uk), (2) School of Environmental Sciences, University of Hull, Hull, United Kingdom

Reduced-complexity geomorphic models, such as Landscape Evolution Models (LEMs), make careful simplifications of physical processes in order to improve computational efficiency and make longer and/or larger model runs feasible. These models have found success and popularity in forecasting the medium-term (10 to 100 years) to long-term (> 100 years) changes in fluvial settings, be it at a reach or a catchment scale. There is the possibility for these models to be applied in a similar way in estuarine settings although these environments are far more complex than their fluvial counterparts.

Recent work has shown that the reduced-complexity hydraulic codes, which underpin some geomorphic models, are able to reproduce water levels in these complex environments successfully. The Lisflood-FP component of the CAESAR-Lisflood model has been extensively tested for the Humber Estuary in the UK - the model showed an error of just 0.12 m versus a set of observations stretching from the mouth to 70 km inland, and showed a similar response in changes of water levels to new defence infrastructure as predicted by the more complex Delft-3D model. The model was able to reproduce the overtopping of defences observed during the December 5th 2013 storm surge. This is despite the model not having any representation of momentum, salinity, temperature, turbulence or waves.

Preliminary work to incorporate the sediment dynamics and geomorphic changes into the modelling (fully utilising and enhancing the capabilities of CAESAR-Lisflood) has shown promise, with a calibration achieved within physically realistic boundaries producing an in-filling rate in line with values suggested in previous studies. When applied with predicted sea level rises, the model suggests an increase of the in-filling rate keeping pace with the sea level rise. With further development, this modelling approach will be able to provide useful information about changes to estuaries at the decadal scale.