Modelling the long-term impact of catchment and coastal management on estuarine morphology

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Climate change puts estuaries at higher risk of flooding from the land, river, and coast by increasing sea levels and extreme weather events such as heavy rainfall. Meanwhile, sediment delivery from catchments and the seas is expected to play a crucial role in estuarine to keep up with sea-level rise (SLR), which will consequently affect estuarine hydrodynamics and flood risks in the future. Nevertheless, the actual impact of fluvial inputs, and specifically, the role of catchment management for the long-term estuarine development, is less known due to a lack of integrated catchment and coastal modelling works. Therefore, this study built a modelling framework that combined catchment hydrological and estuary hydro-morphological processes to understand the impact of catchment management, particularly natural flood management, on long-term estuarine evolution. A cellular automata model (Bentley, 2016) and HEC-HMS were applied for estuary and catchment modelling, respectively. The reforestation scenario with and without SLR (3 mm/year) for 100 years on a hypothetical catchment and estuary were tested. The reforestation effect was captured as the proportionally reduced catchment discharge and sediment delivery at the rainfall events compared to the baseline (non-reforestation) scenario. Preliminary results, however, showed the estuarine morphology is less sensitive to reforestation cases. In both management scenarios, SLR cases resulted in a 50 % increase in sedimentation in the estuary compared to non-SLR. Though due to rapid SLR, that sedimentation was not sufficient to keep tidal prism constant, and it was increased by 13% in 100 years as a result. The above results/sensitivities are based on simulation runs, with no tidal pumping, incorporating this may change these results. Further work such as introducing tidal asymmetry to the estuary model will provide a more comprehensive view of the fluvial impact on estuaries' long-term evolution.

Bentley, I. (2016) A novel cellular automata based estuarine morphodynamic model. PhD. University of Glasgow. Available at: http://theses.gla.ac.uk/6821/.