EGU22-9984, updated on 18 Aug 2022
https://doi.org/10.5194/egusphere-egu22-9984
EGU General Assembly 2022

The effect of sediment qualities on the resistance of deltas to anthropogenic pressures

Joshua Johnson[1], Daniel Parsons[1], Christopher Hackney[2], Thomas Coulthard[1], James Best[3], and Douglas Edmonds[4]

[1]Energy and Environment Institute, University of Hull, Hull, UK (J.E.Johnson@hull.ac.uk)
[2]School of Geography, Politics & Sociology, Newcastle University, Newcastle-upon-Tyne, UK
[3]Departments of Geology, Geography and Geographic Information Science, Mechanical Science and Engineering and Ven Te Chow Hydrosystems Laboratory, University of Illinois Urbana-Champaign, Illinois USA
[4]Department of Earth and Atmospheric Sciences, Indiana University Bloomington, Indiana, USA

Many global deltas are heavily populated and ecologically important landforms that exist due to a balance between basin sediment supply, relative sea-level rise and coastal erosion. This balance is being increasingly disrupted by anthropogenic activities, through sediment impoundment behind dams, riverine sediment mining, accelerating eustatic sea-level rise and enhanced delta subsidence through groundwater and oil and gas extraction.

This study utilizes a morphodynamic model, Delft3D, to examine how a range of sedimentological boundary conditions can influence the response of deltas to combined pressures of sediment supply reductions and differing rates of relative sea-level rise. A group of baseline scenarios were created by running the model with a range of different fluvial sediment cohesivities, where the proportions of incoming river sediment defined in the model as cohesive was varied systematically . In addition, a second suite of baseline models were developed where the receiving basin substrate type, over which the deltas evolved and prograded, was varied in terms of its cohesive sediment content and threshold bed shear stress required for erosion. Across these two baseline series of simulations, the prograding deltas were then exposed to a suite of relative sea-level rise scenarios and a set of runs with reductions in fluvial sediment supply. A baseline control scenario was also run in which sediment supply and relative sea-level were kept constant.

The resulting deltas were analysed using channel identification algorithms that quantified the channel geometries and morphodynamics through time. The resultant morphologies and rates of morphological evolution were quantified for each run and scenario. In all cases, sediment starvation was found to be a more significant driver of morphodynamic change than sea-level rise, with reduced deltaic land area and channel mobility resulting from reductions in sediment supply. Deltas forming over more resistant receiving basin substrates, analogous to consolidated clays or glacial till, were found to be more vulnerable to changes in sediment supply than those forming over less resistant substrates. The implications of these findings for both managing deltas and understanding delta deposits in the rock record will be outlined and discussed.