INFLUENCE OF EBB-DELTA DYNAMICS ON EVOLUTION OF INLET-INTERRUPTED COASTS

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INTRODUCTION

Shoreline variation along inlet-interrupted coasts in macro-time scales can be addressed as a sediment budget-related process, and it was first presented by Ranasinghe et al. (2013) as the Scale-aggregated Model for Inlet-interrupted Coasts (i.e., SMIC). This was further developed as the Generalised Scale-aggregated Model for Inlet-interrupted Coasts (i.e., G-SMIC) by Bamunawala et al. (2020a, 2020b, 2021). The G-SMIC is a fully probabilistic, generically applicable model that simulates the evolution of inlet-interrupted coasts under climate-change impacts and anthropogenic activities. However, G-SMIC does not consider any ebb-deltas in the vicinity of inlet-estuary systems. Thus, this study aims to include the ebb-delta dynamics into the G-SMIC so that its generic applicability would further increase.

THE MODEL AND RESULTS

Three main sediment volume components contribute to the long-term evolution of inlet-interrupted coasts: (1) sediment volume demand/supply by the inlet-estuary system, (2) sediment dynamics of the ebb-delta system, and (3) longshore sediment transport capacity. Probabilistic assessment of estuarine sediment volume is fully described by Bamunawala et al. (2020a, 2020b, 2021). The sediment reservoir concept for inlet sediment storage and the transfer was first introduced by Kraus (2000), and it was adopted in the CASCADE model (Larson et al., 2003), which simulates longshore sediment transport and coastal evolution at the regional and local scale.

Since the estuarine sediment demand (or supply) would dominate the overall evolution of its adjacent inlet-interrupted coastline, the modelling framework is separated into three main categories: (1) systems where the inlet-estuary system exports sediment to its adjacent coast (i.e., prograding shoreline), (2) systems where inlet-estuary system imports sediment from its adjacent coast with its magnitude (V_T) smaller than the annual longshore sediment transport (LST) capacity (i.e., eroding shoreline – type 1), and (3) systems where inlet-estuary system imports sediment from its adjacent coast with its magnitude (V_T) more prominent than the annual longshore sediment transport (LST) capacity (i.e., eroding shoreline – type 2).

The improved version of G-SMIC (G-SMIC+) was applied at the three case study sites considered in the G-SMIC development (i.e., Alsea estuary, Oregon, USA, Dyfi estuary, Walse, UK, and Kalutara estuary, Sri Lanka). Here, it was assumed that an ebb-delta system exists at each inlet-estuary system and the results presented for the Alsea estuary system, which is projected as Erosion Type 1 (i.e.,$LST > V_T$).

The eroding sediment volume projections shown in Figure 1 illustrate that the presence of an ebb-delta system may significantly reduce the down-drift coast erosion volume under RCP 8.5 (~0.9 MCM) by the end of the 21st century. The same reduction under RCP 2.6 and 6.0 are projected to be ~0.2 MCM by 2100. Results also indicate that ebb-delta may further enhance coastline progradation and has trivial impacts on eroding volumes at the Erosion Type 2 systems ($LST > V_T$).

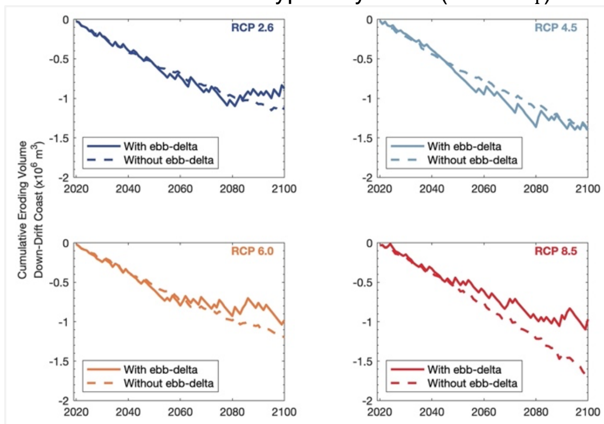

Figure 1 – Projected median (50th percentile) sediment volume that may erode from the down-drift shoreline at the Alsea estuary system, Oregon, USA.

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