

Response of estuary flow and sediment transport according to different estuarine dam locations and freshwater discharge intervals

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Abstract

Estuarine dams are a recent and global phenomenon. While estuarine dams can provide the benefit of improved freshwater resources, they can also alter estuarine processes. Due to the wide range of estuarine types and estuarine dam configurations, the effect of estuarine dams on estuaries is not well understood in general. To develop a systematic understanding of the effect of estuarine dam location and freshwater discharge interval on a range of estuarine types (strongly stratified, partially mixed, periodically stratified, and well-mixed), this study used a coupled hydrodynamic-sediment dynamic numerical model (COAWST) and compared flow, sediment transport, and morphological conditions in the pre- and post-dam estuaries. For each estuarine type, scenarios with dam locations at 20, 55 and 90 km from the mouth and discharge intervals of a discharge every 0.5, 3, and 7 days were investigated. The results were analyzed in terms of change in tide, river discharge, estuarine classification, and sediment flux mechanism. The estuarine dam location primarily affected the tide-dominated estuaries, and the resonance length was an important length scale affecting the tidal currents and Stokes return flow. When the location was less than the resonance length, the tidal currents and Stokes return flow were most reduced due to the loss of tidal prism, the dead-end channel, and the shift from mixed to standing tides. The discharge interval primarily affected the river-dominated estuaries, and the tidal cycle period was an important time scale. When the interval was greater than the tidal cycle period, notable seaward discharge pulses and freshwater fronts occurred. Dams located near the mouth with large discharge interval differed the most from their pre-dam condition based on the estuarine classification. Greater discharge intervals, associated with large discharge magnitudes, resulted in scour and seaward sediment flux in the river-dominated estuaries, and the dam located near the resonance length resulted in the greatest landward tidal pumping sediment flux and deposition in the tide-dominated estuaries.

Keywords : Estuarine dam, Resonance, Discharge pulse, Estuarine Classification

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