Transverse variability of flow and sediment transport in estuaries with an estuarine dam

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Abstract

Estuarine dams are dams constructed in estuaries for reasons such as securing freshwater resources, controlling water levels, and hydroelectric power generation. These estuarine dams alter the flow of freshwater to the coastal ocean and the tidal properties of the estuaries which has implications for the estuaries' circulation and sediment transport. A previous study has analyzed the effect of estuarine dams on 1D (along-channel) circulation and sediment transport. However, the effect of estuarine dams on the transverse variability of along-channel and across-channel circulation and sediment transport has not been studied and is not known. In this study, a coupled hydrodynamic-sediment dynamic numerical model (COAWST) was used to analyze the transverse variability of along-channel and across-channel flow and sediment transport in estuaries with estuarine dams. The estuarine dam was found to change the 3D structure of circulation and sediment transport, and the result was found to depend on the estuarine type (i.e., strongly stratified (SS) or well-mixed (WM) estuary). The SS estuary had inflow in the channel and outflow over the shoals, consistent with estuarine circulation. Longer discharge interval reduced the estuarine circulation. The WM estuary had inflow over the shoals and outflow in the channel, consistent with tide-induced circulation. As the estuarine dam was located nearer to the estuary mouth, the tide-induced circulation was reduced and replaced with estuarine circulation. The lateral circualtion was the greatest in the tide-dominated estuaries. It was reduced and changed direction due to differential advection change as the dam was located nearer the mouth. Overall, the WM estuary transverse flow structure changed the most. Lateral sediment flux was important in all estuaries, particularly for transporting sediments to the tidal flats.

Keywords : Estuarine dam, Channel-flat morphology, Residual circulation, Sediment flux

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