Effects of an Estuarine Dam on Sediment Flux Mechanisms in a Macrotidal Estuary

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Sediment flux convergence traps sediment in many estuaries of the world coast. This sediment flux can be decomposed into a mean-flow flux and correlation flux to better understand the mechanisms driving the sediment trapping in estuaries. Humans have modified and are modifying many natural estuarine systems, however it isn’ t well understood what affects humans can have on sediment flux mechanisms and flux convergence in altered estuaries. Geum Estuary is a shallow, macrotidal estuary on the eastern Yellow Sea which has experienced tidal amplification and enhanced depositional rates following the operation of an estuarine dam since 1994. Geum Estuary thus serves as a good case for studying decomposed sediment fluxes for a shallow, macrotidal estuary affected by an estuarine dam. To quantify the sediment fluxes, we measured current and acoustic backscatter profiles at 1.5 km and 6.5 km seaward of the estuarine dam in Geum Estuary, over a period of two neap-spring cycles during which six episodic dam discharges occurred. Suspended sediment concentration (SSC) was estimated from acoustic backscatter and sediment flux was computed as the product of current velocity and SSC. The flux was decomposed into a mean-flow flux and correlation flux using 36-hr Lanczos filters. Additionally, ship-borne surveys were conducted at the two stations seaward of the estuarine dam to investigate more closely the role of dam-induced horizontal salinity gradient and vertical stratification on sediment resuspension and flocculation tidal asymmetries. Results indicated landward flux at both moorings with a negative flux gradient indicating deposition. Landward directed correlation flux was the dominant term. Its magnitude was proportional to the tidal range and tidal asymmetry and was found to occur in the bottom boundary layer. Seaward directed mean-flow fluxes were caused by the episodic dam discharges. Their magnitude was proportional to the discharge volume and was greatest in the surface layer of the water column. At the seaward station, periodic stratification occurred following the dam discharge and resulted in tidal asymmetries in resuspension and flocculation providing evidence for landward flux due to tidal straining. Overall the data confirms that the estuarine dam controls the seaward mean-flow fluxes, and these fluxes are smaller when the dam is closed. Furthermore, the proportionality of the correlation flux with tidal range provides supports that the dam enhanced the landward correlation fluxes because of the tidal amplification effect. Finally, the tidal straining effect was confirmed to occur in a macrotidal estuary with an estuarine dam.

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