Tidal Flats in S2S Systematics: Importers and Exporters of Fine Sediment

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Tidal flats sit at the interface between the terrestrial and marine portions of source-to-sink dispersal systems, and as such they play a pivotal role in the transfer of sediment. Recent investigation of two systems in the Pacific Northwest demonstrates the diverse roles of tidal flats. In one case, the Skagit River discharges 3-4 million tons of sediment each year, and much of this is mud (silt- and clay-sized material). However, the tidal flat that forms on the delta at the river mouth contains very little mud, with only thin ephemeral deposits near tidal channels. Consequently, the flat is primarily composed of sand, and finer sediment is exported to subtidal areas, where it is accumulating at rates reaching 1 cm/y. The transport of mud beyond the tidal flat appears to be related to the delivery mechanism associated with large discharge events (river floods) that allow suspended mud to bypass the flat. In addition, the shallow tidal-flat surface experiences strong shear stresses from surface waves, river flows and tidal currents. The net effect of these processes is to leave the intertidal flat dominated by sand and to export the mud to subtidal areas away from the river mouth. In contrast, southern Willapa Bay is an area with orders of magnitude less direct input of sediment, but is accumulating silt and clay at rates that can exceed 1 cm/y and is forming extensive mudflats. Be-7 observations show widely distributed input of sediment soon after winter storms, probably from distant streams. Detailed observations of the flats show much short-term temporal variability (e.g., semi-diurnal, seasonal) in the transport and deposition of sediment. Tidal channels transport more sediment during ebb than flood tides, and transport fluxes are much greater during winter than summer. A mechanism must allow broad flooding of the flats (likely during late stage of flood tides), such that sediment is retained on the flat after high tide. This leads to net import of mud onto the flat. The physiography of the tidal-flat setting and the operative sedimentary processes determine how a particular flat will operate (export, import) and control the fate of muddy sediment. These factors give tidal flats a complex role in dispersal of muddy sediment within a source-to-sink system.