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Tidal asymmetry and residual sediment transport in a short tidal basin under sea level rise

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ABSTRACT

Tidal asymmetry in estuaries and lagoons (tidal basins) controls residual sediment transport, and quantifying tidal asymmetry is important for understanding the factors contributing to long-term morphological changes. Asymmetry in peak flood and ebb currents (Peak Current Asymmetry –PCA) controls residual transport of coarse sediment, and asymmetry in slack water duration preceding flood and ebb currents (Slack Water Asymmetry –SWA) controls residual transport of fine sediment. PCA and SWA are analyzed herein for Newport Bay, a tidal embayment in southern California, based on the skewness of tidal currents predicted for several stations by a hydrodynamic model. Use of skewness for tidal asymmetry is relatively new and offers several advantages over a traditional harmonic method including the ability to resolve variability over a wide range of time scales. Newport Bay is externally forced by mixed oceanic tides that are shown to be ebb dominant because of shorter falling tide than rising tide. Both PCA and SWA indicate ebb dominance that favors export of coarse and fine sediments, respectively, to the coastal ocean. However, we show that the ebb dominance of SWA is derived from the basin geometry and not the external forcing, while ebb dominance of PCA is linked to the external forcing and the basin geometry. We also show that tidal flats in Newport Bay play an important role in maintaining ebb dominated transport of both coarse and fine sediments. Loss of tidal flats could weaken PCA and reverse SWA to become flood dominant. Specifically, we show that sea level rise > 0.8 m that inundates tidal flats will begin to weaken ebb dominant PCA and SWA and that sea level rise > 1.0 m will reverse SWA to become flood dominant. This feedback mechanism is likely to be important for predicting long-term evolution of tidal basins under accelerating sea level rise.

Full Text

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