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The Multi-Decadal Simulation of Marsh Topography Under Sea Level Rise and Episodic Sediment Loads

M. W. Brand[1], K. Buffington[2], J. B. Rogers[3], K. Thorne[2], E. D. Stein[3], and B. F. Sanders[1,4]

[1]*Department of Civil and Environmental Engineering, University of California, Irvine, Irvine, CA*
[2]*U.S. Geological Survey, Western Ecological Research Center, Davis, CA*
[3]*Southern California Coastal Water Research Project, Costa Mesa, CA*
[4]*Department of Urban Planning and Public Policy, University of California, Irvine, Irvine, CA*

ABSTRACT

Coastal marsh within Mediterranean climate zones is exposed to episodic watershed runoff and sediment loads that occur during storm events. Simulating future marsh accretion under sea level rise calls for attention to: (a) physical processes acting over the time scale of storm events and (b) biophysical processes acting over time scales longer than storm events. Using the upper Newport Bay in Southern California as a case study, we examine the influence of event-scale processes on simulated change in marsh topography by comparing: (a) a biophysical model that integrates with an annual time step and neglects event-scale processes (BP-Annual), (b) a physical model that resolves event-scale processes but neglects biophysical interactions (P-Event), and (c) a biophysical model that resolves event-scale physical processes and biophysical processes at annual and longer time scales (BP-Event). A calibrated BP-Event model shows that large (>20-year return period) episodic storm events are major drivers of marsh accretion, depositing up to 30 cm of sediment in one event. Greater deposition is predicted near fluvial sources and tidal channels and less on marshes further from fluvial sources and tidal channels. In contrast, the BP-Annual model poorly resolves spatial structure in marsh accretion as a consequence of neglecting event-scale processes. Furthermore, the P-Event model significantly overestimates marsh accretion as a consequence of neglecting marsh surface compaction driven by annual scale biophysical processes. Differences between BP-Event and BP-Annual models translate up to 20 cm per century in marsh surface elevation.