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Hydrology and Earth System Sciences Discussions

Interactive comment on "Hydroperiod and hydraulic loading for treatment potential in urban tidal wetlands" *by* T. T. Eaton and C. Yi

T. T. Eaton and C. Yi

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We thank the two reviewers for their detailed comments on our discussion paper. Indeed, we appreciate their noting that our work bridges overlapping subdisciplines in the hydrology of coastal wetlands treatment assessment. The challenge is to communicate our results to hydrologists specialized in inland wetland hydrology as well as others who may be more familiar with open-water coastal dynamics. The physical constraints in vegetated wetland systems justify the assumptions made for our mathematically rigorous analysis, and we will make additional efforts to clarify this in our forthcoming revisions, as we address the details of the reviews.

The reviewers comment on our mention of the Manning equation, which is well established as an empirical way of characterizing flows in vegetated channels, not unlike other empirically-developed steady-state equations such as Darcy's Law. In fact,

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Interactive Discussion

Discussion Paper

the Manning equation has recently been derived on the basis of the phenomenological theory of turbulence (Gioia and Bombardelli 2002 Physical Review Letters 88(1)). However, we do not use the Manning equation per se (a point overlooked by both reviewers), but a similar generalized friction equation (eq.6) that has been found to be more applicable to wetlands hydraulics. Detailed discussion of this basic equation and two others we used (eq.16,17) has already been given in two editions of the principal text in engineered wetlands hydrology (Kadlec and Knight 1996 and Kadlec and Wallace 2008) to which we refer interested readers.

The more central theme of the reviewers: that the Mannings and friction equations do not account for acceleration and inertia, is correct, and this is not a limitation of our analysis because of the nature of flow through tidal wetlands. In these shallow, vegetated systems, flow is of such low velocity that Froude and Reynolds numbers are low and laminar conditions prevail, so that acceleration terms are not needed. But our analysis takes into account the nontrivial horizontal component of flow in such settings, unlike the even simpler procedures suggested by both reviewers, which relate hydraulic loading q only to water level change dh/dt. Horizontal flow, accounting for transport of water and associated contaminants, is critical to the water quality improvements addressed in this paper. Moreover, the other suggestion of a "2-D depth-averaged model" misses our important point that wetted area and depth at any point are constantly changing (making the concept of "average depth" meaningless) as the tide advances and recedes. Hence our use of the integral in time and space to incorporate these areally-related dynamics that are critical to treatment processes.

The reviewers also comment on our use of "positive" water depths in deriving the hydroperiod, and the mathematical methods for doing so. Only water depths greater than zero are relevant to inundation-based treatment assessment at any specific location, not the entire period of the tidal cycle, but the limits of integration we used are more appropriate than a mathematical operator like max(f(t),0), which is most applicable to functions f(t) that can be analytically integrated. This is because, as we point out, actual

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hydroperiods are unlikely to be describable using a function, but it is straightforward to assess when h(t) is zero at any location from field observations. We prefer conceptual robustness related to field-observable processes over abstract mathematical elegance. We use only 4 terraces in our model but also demonstrate clearly that the approach would be valid with any number of terraces. Since this is a very generic conceptual model, we prefer to emphasize the need for field-based validation of our results rather than a mathematically precise description of the trend in hydroperiod and hydraulic loading from the shoreline inland (Figure 4).

In summary, we have apparently not quite been able to present our analysis in a way that all scientists unfamiliar with principles of wetland hydrology would be comfortable with, but hope that our goal of advancing research on this important topic has been met. In our revisions, we will clarify where possible in keeping with space limitations.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 6, 589, 2009.

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Interactive Comment