What's Next for Plum Island Marshes?

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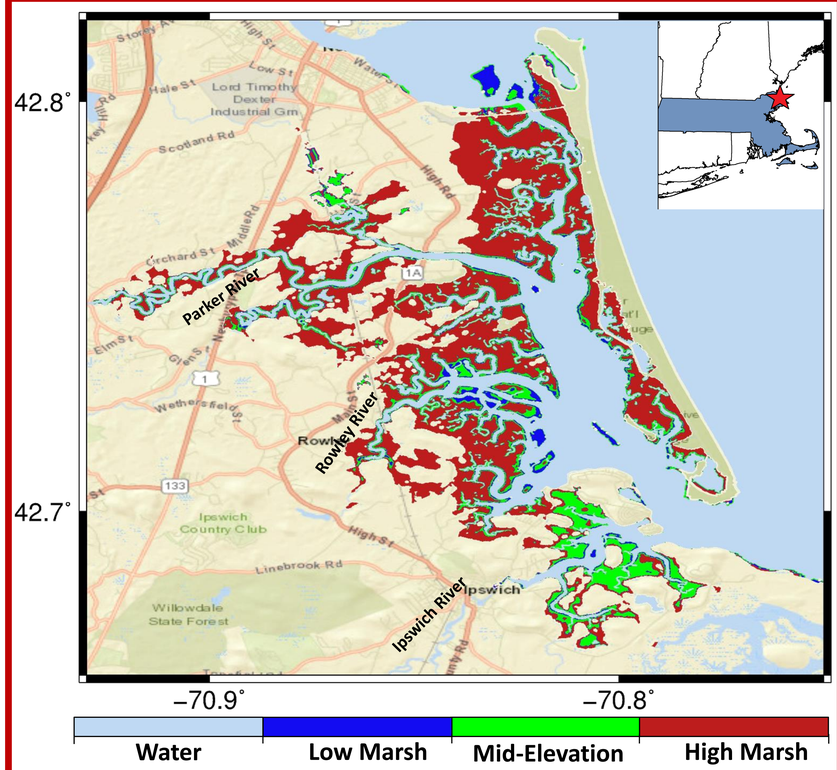
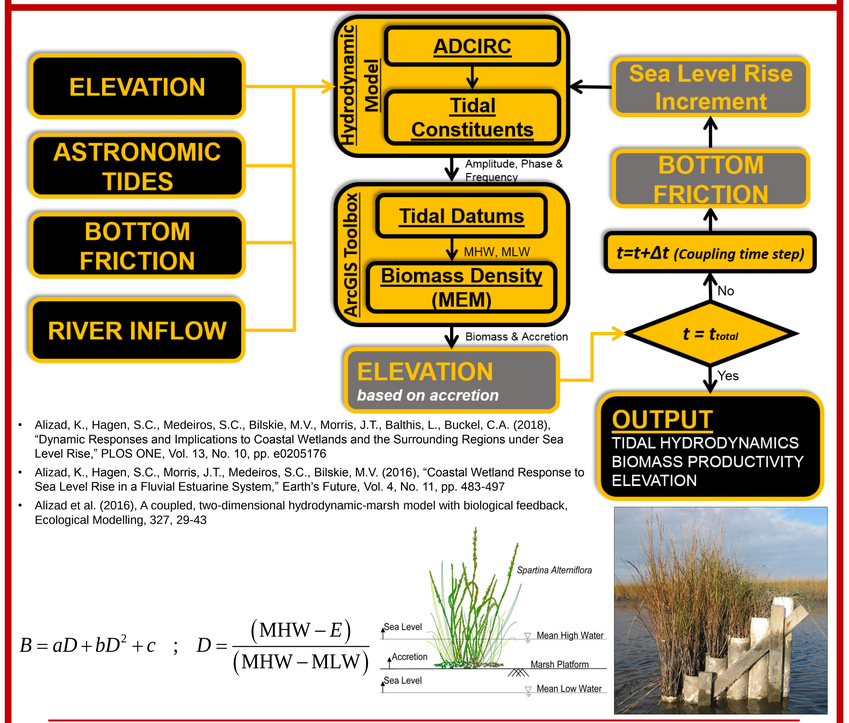
Project Overview

Coastal marsh systems are vulnerable to increased flooding and consequently losing productivity due to increasing rates of sea level rise (SLR). Their responses to sea-level rise vary based on the tide range, topography, shoreline and creeks geometry, nutrient and sediment sources. In this study, Plum Island Estuary (PIE) in Massachusetts was selected to study its marsh system response to three NOAA projected SLR scenarios for the year 2100 (Sweet et al., 2017) : intermediate-low (0.5 m), intermediate (1 m), and intermediate-high (1.5 m). Hydrodynamic changes, as well as marsh productivity, were simulated using the Hydro-MEM model (Alizad et al., 2016). The integrated Hydro-MEM model couples ADvanced CIRCulation model (Luettich and Westerink, 2006) with Marsh Equilibrium Model (MEM) (Morris et al., 2002) and includes feedback between the main physical and biological processes in the marsh system. The model captures topographical changes using accretion rate in the marsh system and updates bottom roughness using marsh productivity variations due to SLR. The Hydro-MEM results in the form of marsh elevation and marsh migration are presented in this research.

Study Area



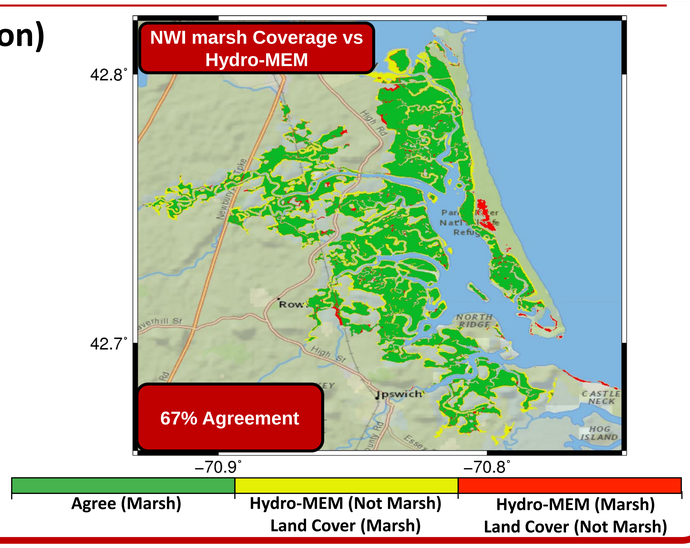
Methodology



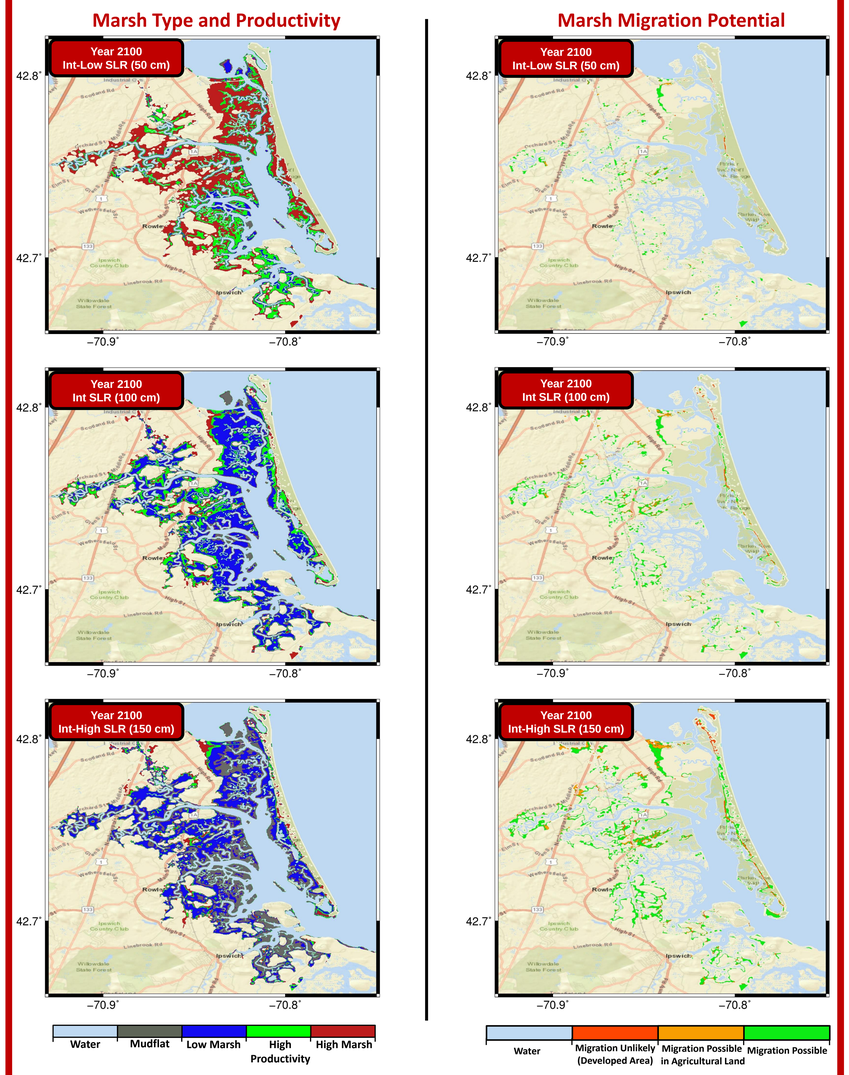
- Alizad, K., Hagen, S.C., Medeiros, S.C., Bilskie, M.V., Morris, J.T., Balthis, L., Buckel, C.A. (2018), "Dynamic Responses and Implications to Coastal Wetlands and the Surrounding Regions under Sea Level Rise," PLOS ONE, Vol. 13, No. 10, pp. e0205176
- Alizad, K., Hagen, S.C., Morris, J.T., Medeiros, S.C., Bilskie, M.V. (2016), "Coastal Wetland Response to Sea Level Rise in a Fluvial Estuarine System," Earth's Future, Vol. 4, No. 11, pp. 483-497
- Alizad et al. (2016), A coupled, two-dimensional hydrodynamic-marsh model with biological feedback, Ecological Modelling, 327, 29-43

$$B = aD + bD^2 + c \quad ; \quad D = \frac{(\mathrm{MHW} - E)}{(\mathrm{MHW} - \mathrm{MLW})}$$

Validation)



Results



- Under intermediate-low SLR scenario, high marsh transitions to mid-elevation, high productivity marsh (above) compared to the current condition (left), whereas creation of mudflats, creak expansion, and changes from high to low marsh (*Spartina patens to Spartina alterniflora*) is projected under intermediate and intermediate-high SLR scenarios.
- Marsh migration maps indicate more migration under intermediate-high SLR scenario. The orange color in the north of estuary shows migration possibility of marsh to agricultural lands.

Future work / References / Acknowledgement

- The Hydro-MEM model results were validated in the Plum Island Estuary (PIE) using National Wetland Inventory (NWI) data with a Cohen's Kappa value of 0.73 and 67% agreement.
- Results for the year 2100 show an increase in marsh productivity under the low SLR scenario. However, the marsh is projected to lose its productivity and change from high marsh to low marsh under higher SLR scenarios; mudflats will be created and more migration upland was shown in projection maps.

- Sweet W, Kopp R, Weaver C, Obeysekera J, Horton RM, Thieler ER, et al. Global and regional sea level rise scenarios for the United States. NOAA, 2017 CO-OPS 083.
- Luettich R, Westerink J. ADCIRC: A parallel advanced circulation model for oceanic, coastal and estuarine waters; users manual for version 45.08. 2006.
- Morris JT, Sundareshwar PV, Nietch CT, Kjerfve B, Cahoon DR. Responses of Coastal Wetlands to Rising Sea Level. Ecology. 2002;83(10):2869-77. doi: 10.1890/0012-9658(2002)083[2869:rocwtr]2.0.co;2.

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