Forecasting Coastal Marsh Responses to Sea Level Rise using Models with Satellite Data

A NASA-funded feasibility study to project regional changes in coastal marsh habitats and dependent species for conservation and coastal planning in the NOAA National Estuarine Research Reserves and adjacent coastal communities

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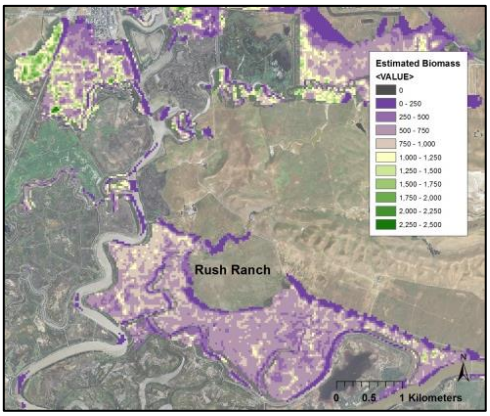
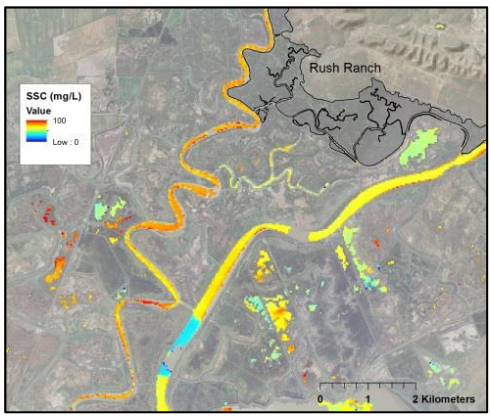
Project Summary

The NASA Applied Sciences Ecological Forecasting program has funded USGS and NOAA National Estuarine Research Reserve System (NERRS) scientists to integrate remote sensing and *in situ* data to the Marsh Equilibrium Model (MEM), a model of tidal marsh elevation, to project how coastal marsh habitat and dependent species respond to sea level rise. With remote sensing inputs to MEM, scientists will be able to generate regional maps of coastal vulnerability and habitat suitability for a set of sea level rise scenarios. The objective of these maps and model outputs is to assist the NERRS and coastal managers with climate change adaptation planning, conservation and restoration decisions. This one-year feasibility study focuses research on a highly diverse brackish marsh, Rush Ranch in Suisun Bay, one of two sites in the San Francisco Bay NERR. Working at Rush Ranch, the research team found that Landsat 8 can be feasibly used to map two important MEM parameters – peak biomass and suspended sediment concentration. The benefits of using this satellite data include 1) the ability to apply MEM regionally, using the NERR as a reference marsh, 2) reduction of field data collection, and 3) reducing uncertainty in estimating these parameters.

The NERRS is national network of 28 reserves that share system-wide monitoring programs and initiatives to assess habitat responses to sea level rise. The NERRS System-Wide Monitoring Program, the Sentinel Sites Program and other NOAA products will provide much of the data needed to run the MEM model and produce coastal habitat change maps. These include: tide gauge data, vegetation surveys, elevation ranges for various plant communities, accurate LiDAR digital elevation models (DEMs) and high-resolution vegetation maps.

Three additional years of NASA funding may be available to further develop this application into a decision tool and transfer it to the partner, the NERRS. Researchers plan to expand the use of this tool to other NERRS sites around the country. Benefits of this tool can include: increased use of NERRS monitoring data, development of data products for NERRS outreach, and increased support for habitat suitability assessments, land conservation and restoration decisions.

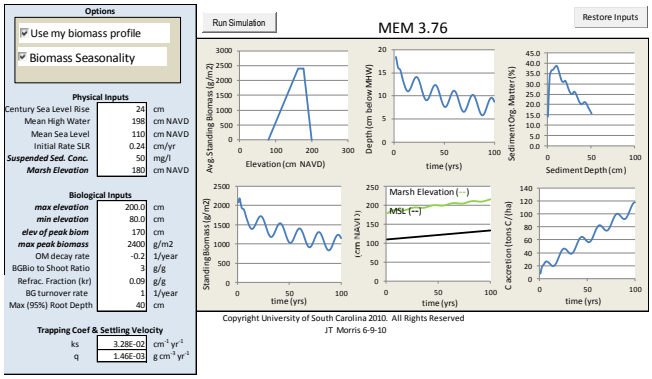




Maps of plant biomass (left) and suspended sediment concentration (right), important parameters for the Marsh Equilibrium Model. Maps are based on Landsat 8 satellite data.

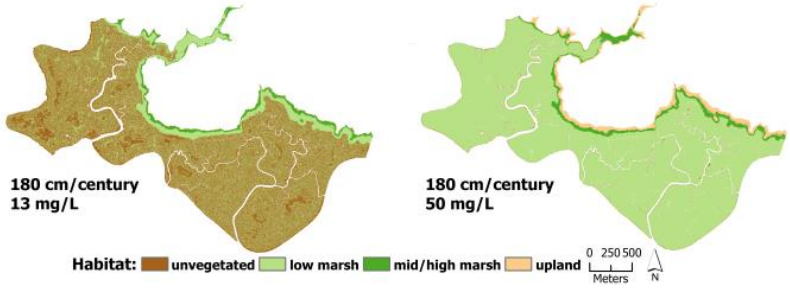
Diagram of the Coastal Habitat Forecasting Tool

The application will produce regional maps of habitat change with sea level rise for communicating climate change impacts, improving coastal resilience and conservation planning.



Marsh Equilibrium Model (MEM3):

Multiple important variables can be **remotely-sensed:**
Peak biomass
Vegetation distribution
Suspended sediment concentration



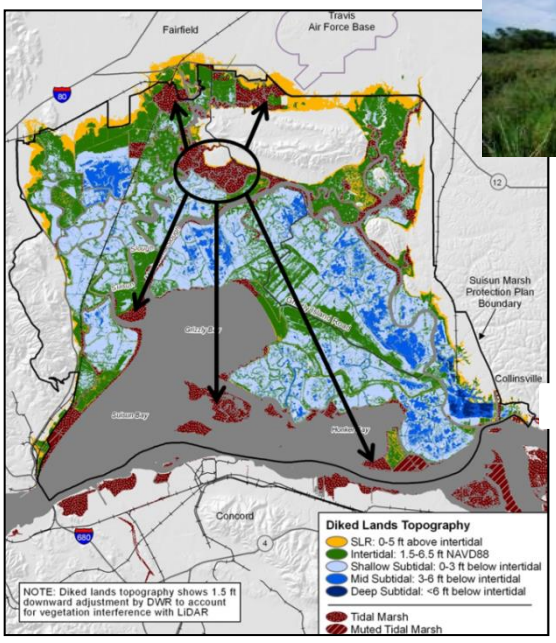
Habitat Distribution Model:

100-yr habitat projections
MEM elevation projections + LiDAR DEM = centimeter-level projection across landscape
Good for acreage, patch distribution
(Schile et al. 2014, PLoS ONE 9(2): e88760)
doi:10.1371/journal.pone.0088760

	Evaluation criteria	Explanation
Vegetation	% area where $z^* > 0.3$	Pickleweed (S. pacifica) habitat
	% area where $0 < z^* < 0.3$	Cordgrass (S. foliosa) habitat
Salt marsh harvest mouse (R. raviventris)	% area where $z^* > 1$	Nesting habitat and refuge during extreme events
California clapper rail (R. longirostris obsoletus)	% area where $z^* > 1$	Nesting habitat and refuge during extreme events
	% area where vegetation heights are >20 cm above MAT	Refuge from predation

Species Distribution Model:

Objective, quantifiable, regional-scale projections of current and future habitat quality for endangered species (Swanson et al. 2014, Estuaries and Coasts 37:476–492)
doi 10.1007/s12237-013-9694-0



Regional Forecasting Model:

For landscape level coastal vulnerability and habitat suitability assessments, with NERRS as reference sites