Task 1

Project activity: Tidal marsh frame movement under sea level rise

Objective: Tidal marshes are important ecological components of the coastal system that are currently responding to sea level rise-driven changes in tidal regimes. These changes will affect future tidal marsh distribution, connectivity and role in estuarine systems. Concurrently, human development along the coastline is creating barriers to marsh migration that will also be an important moderator of future tidal marsh distributions. Sea level rise is creating pressures for coastal areas to defend their infrastructure, leading to conflict between human and natural landscapes as tidal marshes attempt to migrate inland.

The goal of this project was to examine the movement of the tidal marsh frame across the landscape under projected sea level rise for the Chesapeake Bay, VA. This allows examination of changes in marsh extent by location, the conflict with developed lands, and targeting of critical areas for preservation and retreat management action.

Methods: Modeling of the tidal marsh extent was based on elevation in a high-resolution lidar data set of the Chesapeake Bay, VA localities using ArcGIS software. The vegetated tidal marsh frame in the Chesapeake Bay falls in an approximately 0.61m elevation range between Mean Sea Level (MSL) and the Highest Astronomical Tide (HAT). In this vulnerability matrix, the vegetated tidal marsh frame (as described above) was moved across a lidar-based digital elevation model (DEM) land surface in overlapping 0.15 m (the vertical resolution of the lidar data) elevational increments. To set a timeframe for shifts in elevation in the tidal frame, a sea level rise projection curve based on data from Sewell's Point, VA tide gauge was used. To examine the importance of developed areas on future marsh persistence, current impervious surfaces that are in the migration pathway were identified at each time step. This gives a "best case scenario", assuming no future development into coastal areas. Impervious surface projections for 2050 and 2100 within the migration pathway were also identified for the appropriate time steps. This gives a "projected scenario" which assumes continued patterns of development into the coastal zone.

Progress to date: This project has been completed. A draft paper "Evolution of tidal marsh distribution under accelerating sea level rise" is being prepared for publication.

Task 1

Project activity: Changes in marsh vegetation in response to sea level rise

Objective: Tidal marshes are important ecological components of the coastal system that are currently responding to sea level rise-driven changes in tidal regimes and their long term sustainability is a critical variable to understand. Sea level is rising at an unusually high rate in the Chesapeake Bay relative to most of the Atlantic coastline, putting Bay marshes at high risk from drowning and erosion. Understanding the patterns of change and the importance of different drivers of change is critical to planning for coastal resilience. Tidal marshes plant communities are highly reflective of their environment and can be an indicator of marsh resilience or response to sea level rise and may help improve predictions about future conditions. Specifically, marsh vegetation can help identify marshes which are not keeping pace with sea level rise (therefore likely to drown and disappear) and marshes which are undergoing salinization, resulting in ecosystem shifts. Changing marsh vegetation is a flexible measure of ecosystem alternation; understanding the patterns of vegetative change should enhance our understanding of future marsh changes and the ecosystem consequences of those shifts.

Methods: We used tidal marsh vegetation surveys from approximately 40 years apart to examine changes in plant communities indicative of stress from salinity and inundation. The Tidal Marsh Inventory is a geospatial survey of all tidal marshes in Virginia, including their location, extent and plant community which has been done twice, approximately 30-40 years apart. The surveys involved digitization of marsh extents and locations from maps and aerial imagery. Marshes were geospatially linked between the two time periods through superposition and cross-walking identification numbers. Field surveys of tidal marsh vegetation (henceforth referred to a TMIs or Tidal Marsh Inventories) were conducted in the Chesapeake Bay, Virginia, with a particular emphasis on the York River sub-estuary. Species matrices (York River) and community types (Chesapeake Bay, VA) were georeferenced for analysis and examined for inundation or salinization signals.

Progress to date: This project has been completed. A draft paper “Marsh vegetation as an indicator of ecosystem response to sea level rise” is being prepared for publication.

Task 1

Project activity: Changes in marsh extent in response to sea level rise

Objective: Tidal marshes are important ecological components of the coastal system that are currently responding to sea level rise-driven changes in tidal regimes and their long term sustainability is a critical variable to understand. Sea level is rising at an unusually high rate in the Chesapeake Bay relative to most of the Atlantic coastline, putting Bay marshes at high risk from drowning and erosion. Understanding the patterns of change and the importance of different drivers of change is critical to planning for coastal resilience. Concurrent with sea-level rise, marshes are eroding and appear to be disappearing through ponding in their interior; in addition, in many places they are being replaced with shoreline stabilization structures. We examined the changes in marsh extent and community over the past 40 years within a Chesapeake Bay subestuary, to better understand the effects of sea-level rise and human pressure on marsh extent.

Methods: We used digital tidal marsh extents from approximately 40 years apart to examine shifts in marsh distribution. The Tidal Marsh Inventory is a geospatial survey of all tidal marshes in Virginia, including their location, extent and plant community which has been done twice, approximately 30-40 years apart. The surveys involved digitization of marsh extents and locations from maps and aerial imagery. Marshes were geospatially linked between the two time periods through superposition and cross-walking identification numbers. Marsh change was calculated on a subwatershed scale for the entire York River. Development, shoreline stabilization, wave energy, and migration potential were used in a recursive partition analysis to classify percent marsh change according to sub-watershed characteristics.

Progress to date: This project has been completed. Results have been published in:

Mitchell, M., Herman, J., Bilkovic, D.M. and Hershner, C., 2017. Marsh persistence under sea-level rise is controlled by multiple, geologically variable stressors. Ecosystem Health and Sustainability, 3(10), DOI: 10.1080/20964129.2017.1396009.