Sedimentation patterns in Nasuet Marsh, MA

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Sedimentation Patterns in Nauset Marsh, MA

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Abstract

Salt marshes are some of the most productive ecosystems on the planet and provide adjacent coastlines with nutrient filtration and protection from wave and storm damage. Today, salt marshes throughout the world face the threat of drowning under accelerated sea level rise, a threat that is exacerbated by diminished surface area and sediment supply from past and present anthropogenic modifications. New England alone has lost an average of 37% of marsh cover since the 16th century, with urban areas like Boston seeing losses up to 81% from infrastructure and population growth (Bromberg and Bertness, 2005). To ensure the health of salt marshes under sea level rise and coastal armoring, it is essential that we understand the characteristics of sediment delivery to salt marsh systems worldwide. This poster presents the first step in an ongoing project aimed at (i) identifying the sources of sediment to Nauset Marsh in Cape Cod, MA, (ii) identifying sediment flow patterns throughout the marsh system, (iii) assessing the impact of coastal armoring along the bluffs to the west of the Nauset Lagoon and (iv) determining whether the location of the inlet fronting the marsh has an effect on the aforementioned characteristics. The first step presented here includes an analysis of elevation data from 2005 and 2013 to determine whether the difference in inlet location correlates with spatial changes in marsh erosion and accretion.

Methods

Data

The elevation data for this study is USGS Lidar-derived bare earth topography for 2005 and 2011. The 2005 elevation data was obtained from USGS.org and was produced as a collaborative effort between the U.S. Geological Survey (USGS) Coastal and Marine Geology Program, the Northeast Coastal and Barrier Network of the National Park Service (NPS) Inventory and Monitoring Program, the South Florida/Caribbean Network of the NPS Inventory and Monitoring Program, and the National Aeronautics and Space Administration (NASA) Wallops Flight Facility. The product was derived using the NASA Experimental Advanced Airborne Research Lidar (EAARL). The 2011 elevation data was obtained from MassGIS and was produced through a partnership between state and federal agencies as part of the 3D elevation mapping program.

ArcGIS

DEM files of the study site were downloaded from MassGIS and USGS.org and clipped to an outline of marsh patches to isolate vegetated marsh surface and eliminate errors associated with Lidar detection through deep water channels. Marsh elevations are shown in Figure 2 (left). Raster math was used subtract 2005 from 2013 patch elevations to better visualize the spatial distribution of major variations between those two years (Figure 2, right). ArcGIS was also used to isolate contours of the lagoon and inlet location for both years (Figure 1, bottom right), and create a reference for patch analysis performed in MATLAB (Figure 3, bottom right). Each marsh patch was then isolated and converted to an ASCII file of elevation values for MATLAB analysis.

MATLAB

ASCII files of elevation data for each marsh patch (2005 and 2013 datasets) were loaded into MATLAB and converted into grids of numerical values for analysis. For each marsh section, elevation values along all latitude lines were averaged to obtain mean elevation as a function of distance from the most shoreward location of marsh growth (Figure 3).

Nauset Marsh, Cape Cod

Figure 1

Nauset Marsh is located in a back-barrier lagoon on the eastern edge of Outer Cape Cod, MA. It is fronted by two dynamic barrier splits and one inlet that is the only major source of water exchange for the marsh system. Since the 1950's the inlet has exhibited a cycle of northward migration and southern breaching.
(Top) Cape Cod, MA. Blue box outlines Nauset Marsh.
(Bottom Right) Orthophotos of Nauset Marsh taken in 2005 and 2013, downloaded from MassGIS.
(Bottom Left) Outline of the Nauset Lagoon boundary, including the barrier spits and inlet location. Orange outline shows the 2013 lagoon boarder and the blue outline is the 2005 barrier inlet location.

Nauset Marsh Elevations

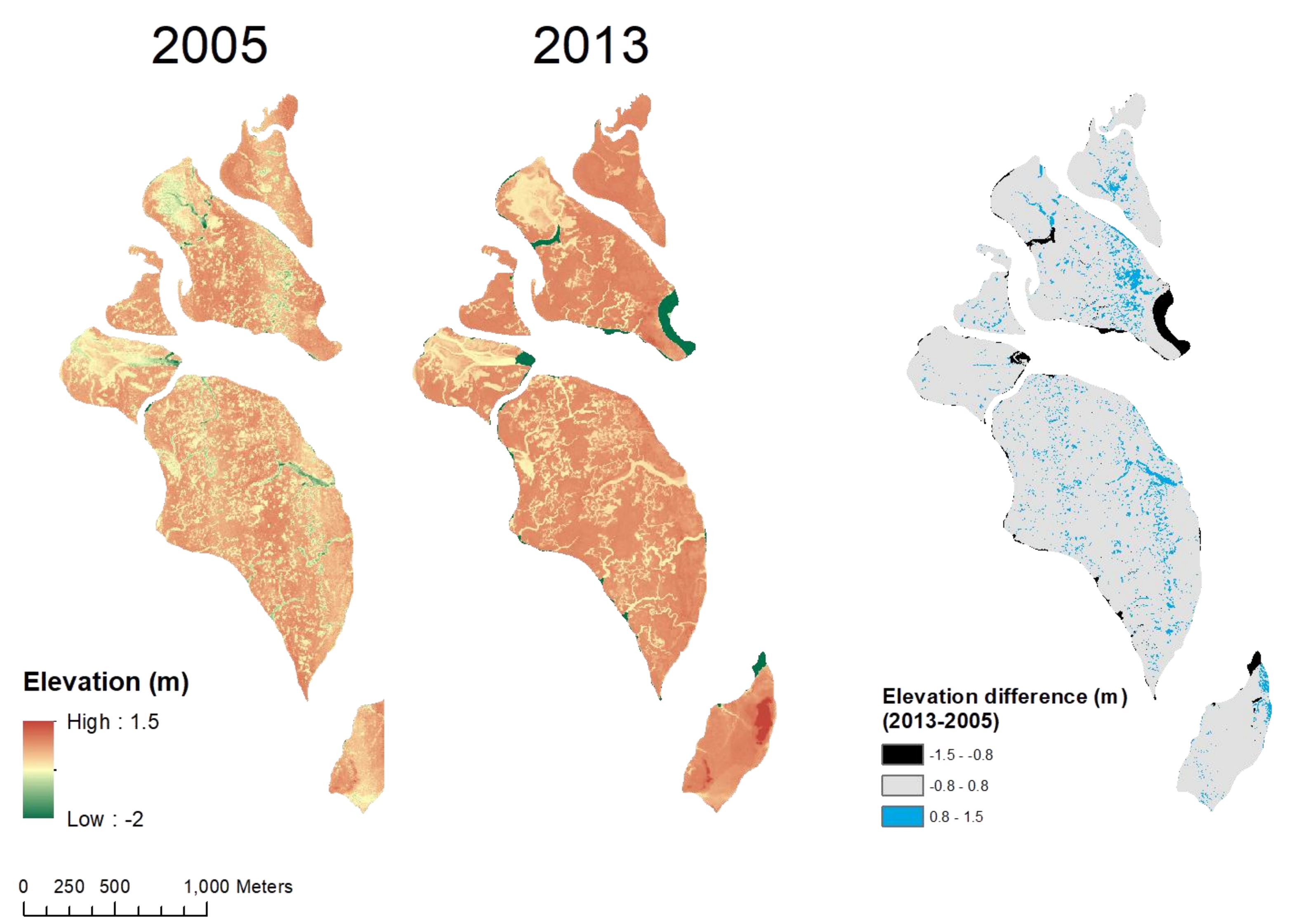

Figure 2

(Left) Elevations of Nauset Marsh patches in 2005 and 2013. Elevations are based on NAVD88 vertical datum with a 1 meter horizontal resolution. Values are shown in meters, with high elevations represented by orange colors and low elevations represented by green colors.
(Right) Elevation differences obtained by subtracting 2005 raster values from 2013 raster values. Blue areas indicate the largest differences representing higher elevations in 2013 than 2005. Black areas indicate the largest differences representing higher elevations in 2005 than 2013. Elevation differences from -0.8 to 0.8 meters have been grouped together to visualize only the most extreme variations.

Elevation vs. Distance

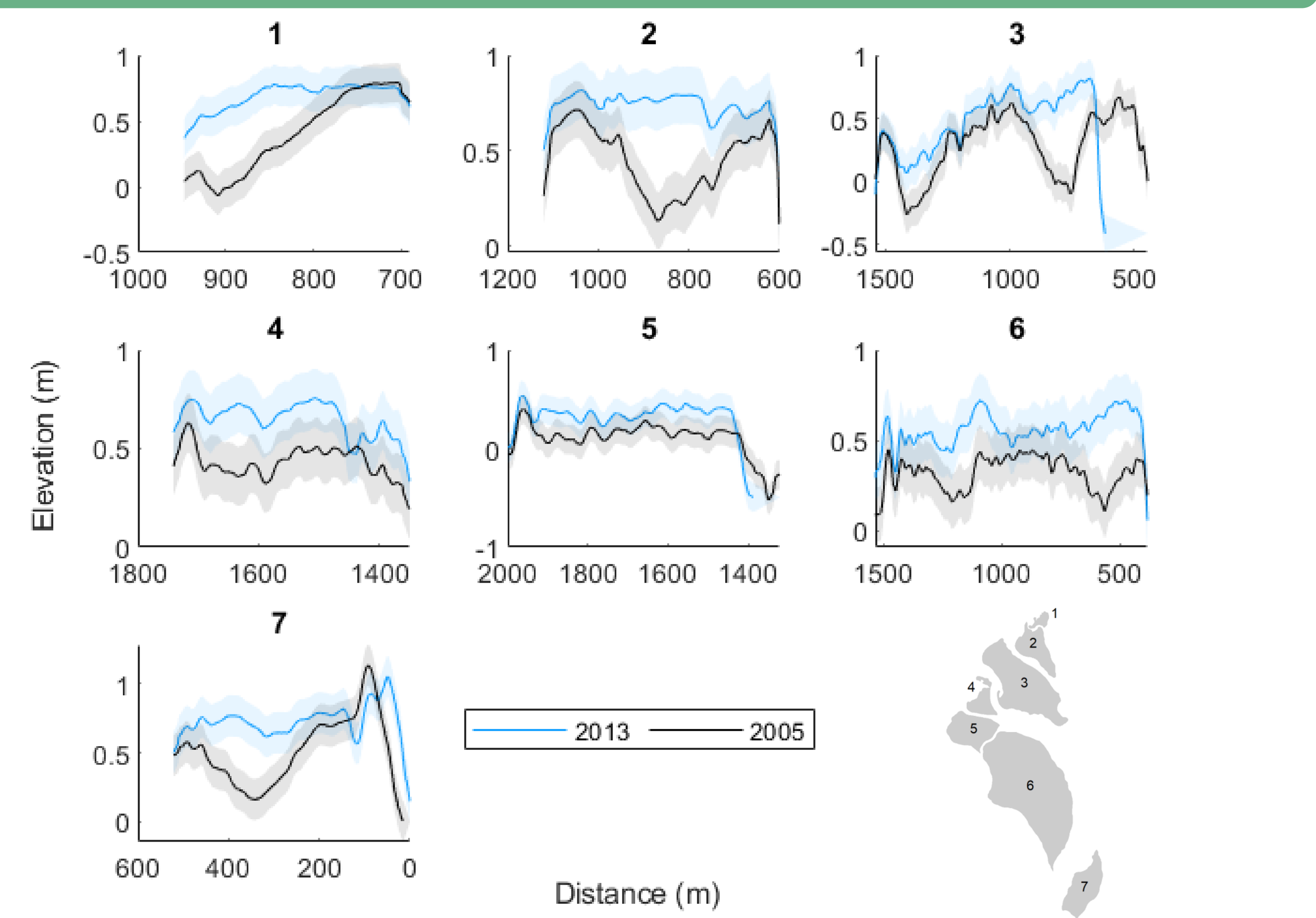

Figure 3

Plots show mean elevation changes with distance landward for each marsh patch (2013 elevations plotted in blue, 2005 elevations plotted in black). References for location of patches 1-7 shown on the bottom right. Y axes show elevations based on vertical datum NAVD88. X axes were converted from UTM zone 19 x coordinates to meters starting at 0 from the most shoreward location of marsh growth and increasing landward. Shaded boundaries show 15 cm Lidar elevation measurement error.

Discussion and Conclusions

Primary analysis of 2005 and 2013 elevation data indicates a more stable marsh configuration and higher sediment accretion in select areas when the inlet is located near the northernmost position. Some of the most notable changes can be seen in elevation analyses of patches 1, 2 and 7. Patch 1 shows a significant decrease in elevation with distance landward in 2005 while patches 2 and 7 show significantly lower interior elevations in 2005 than in 2013. In addition, 2005 elevations show increased patchiness throughout the marsh that could signify sparser vegetation or deeper marsh pools. These patterns may be indicative of variations in flow circulation and sediment delivery to the marsh through time (Fagherazzi et al., 2012). In this case, these variations may result from changes in inlet location.

Further Research

Further research includes similar analysis of 2011 and upcoming 2018 Lidar data of the same area to see if the elevation trends hold true. Contour comparison of Lidar DEMs and visual mapping of aerial imagery going back to the 1930's will be used to look at erosion patterns along the western boundary to determine if the bluffs to the west of the marsh supply a significant amount of sediment to the marsh platform and if erosion patterns change with inlet location. Field work will be done to identify present day sedimentation characteristics with the goal of identifying sediment sources and supply mechanisms and how they change over time. Ultimately, knowledge of past and present sedimentation trends can aid in better management decisions for the area.

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