Sea-Level Rise Inundation of Habitats on Masonboro Island

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Abstract

Barrier islands are one of the most dynamic natural environments on Earth, and have been thoroughly studied for patterns of erosion, deposition, migration, and other geomorphic change. As sea level continues to rise, management and preservation of coastal resources have become increasingly important for many local, regional, state, and government agencies, and the need for higher resolution analysis of coasts to determine where change is occurring has grown accordingly. This study was conducted to determine how much area of the southern end of Masonboro Island would be lost to sea level rise of 1 foot, 2 feet, and 3 feet. This region was also classified into three habitat classes to assess the damage to specific surface covers.

Background

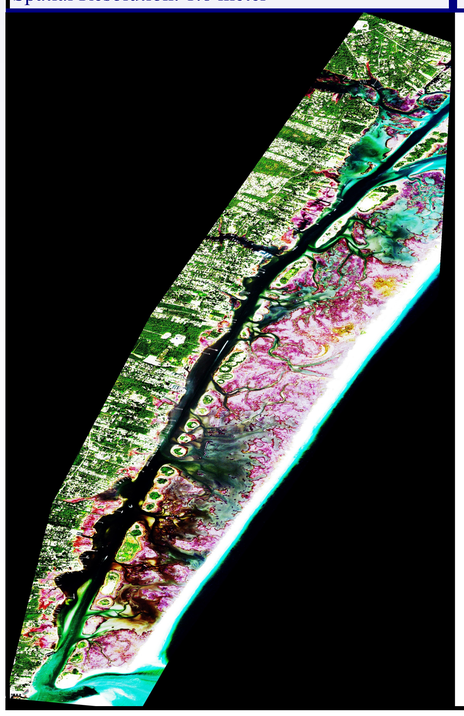
Masonboro Island is an 8-mile long barrier island in southeastern North Carolina that has been studied for many years. These studies have concluded that the island is slowly retreating landward, as occurs naturally with eustatic sea level rise, but increased sea level rise due to anthropogenic climate change, combined with the continual maintenance of the Intracoastal Waterway through dredging, is causing the island to slowly disappear. The island consists of many interconnected habitats including supratidal beach, dune ridge system, tidal marsh, and dredge spoil islands.

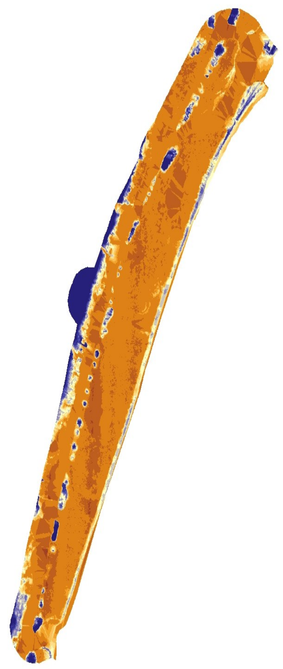
FitzGerald, et al. (2008) and Kemp, et al. (2009) predict a rise in sea level for the North Carolina coast of around 1 inch every 7.75 years. This project analyzed land lost under 1 foot, 2 feet, and 3 feet of rise. These milestones are expected in 93, 186, and 279 years, respectively.

The southern end of the island has been eroding faster than the rest of the island (Doughty, 2006), and features several dredge spoil islands of significant elevation. This project determined the amount of land lost in this area to predicted sea level rise for three habitat classes: sand (including supratidal beach, and sediment in the marsh and spoil islands), marsh, and upland vegetation. With this information policy makers and management officials may be able to better preserve the habitats that are most vulnerable to sea level rise.

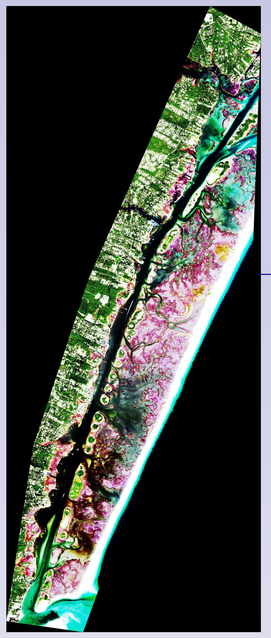
Data

WorldView-2 Satellite Imagery	Lidar 2007
Date: September 10, 2010 Spectral Resolution: 8 MS bands + Panchromatic Spatial Resolution: 1.8 meter	Date: 2007 Vertical Resolution: 1 foot



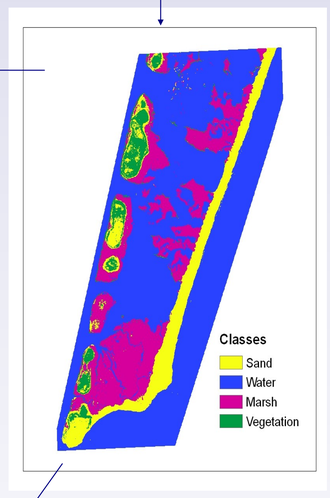


Methods

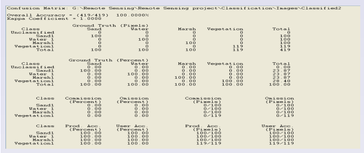


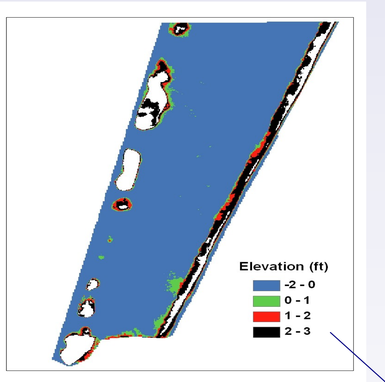
Clip

Classify

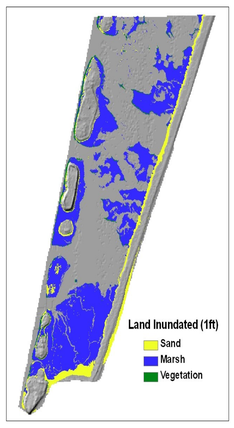


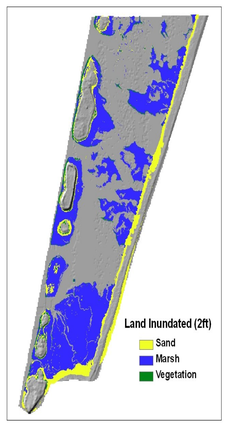
Accuracy Assessment: 100%

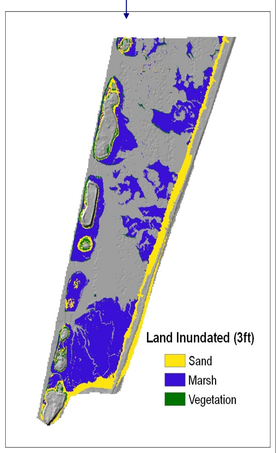




Raster Calculator







Results

The images and statistical results from this project clearly demonstrate that Masonboro Island is vulnerable to rising sea level. Coastal land and barrier islands are most vulnerable to inundation and submergence, but how much land will be lost depends primarily on its elevation, as well as on a number of other dynamic factors. As shown in the table below, three feet of sea level rise is predicted to inundate more than three-quarters of this region. If Masonboro Island did not experience any geomorphic change over time, rising sea level would submerge a total of 1,425,744 m^2 (68%), 1,514,512 m^2 (72%), and 1,620,000 m^2 (76%) by 2100, 2193, and 2286 respectively.

Of this land lost, marshes would be most affected as they occur at the low elevations, often in the intertidal zone of the backbasin of the island. Just one foot of sea level rise could inundate more than 99% of marsh habitat, although a more thorough analysis of marsh species resilience, and recruitment to adjacent substrate would have to be incorporated to determine the specific response of this vegetation to a changing environment.

Inundation of upland vegetation and sand classes showed similar percent loss, but vegetation covered significantly less area to begin with.

Classes	Area (m^2)	SLR 1ft Loss (m^2) [% of class total]	SLR 2ft Loss (m^2) [% of class total]	SLR 3ft Loss (m^2) [% of class total]
Vegetation	253,076	69,304 [27%]	80,172 [32%]	103,524 [41%]
Marsh	1,171,349	1,162,196 [99.2%]	1,165,672 [99.5%]	1,166,000 [99.6%]
Sand	666,274	194,244 [29%]	268,688 [40%]	351,176 [53%]
Total	2,090,699	1,425,744 [68%]	1,514,512 [72%]	1,620,700 [76%]

Conclusions

These results indicate that Masonboro Island's marsh habitats are most vulnerable to loss from sea level rise under static conditions, but it is important to consider that the island will continue to respond to the usual dynamic processes that dominate barrier islands. Erosion, deposition, and migration tend to affect the beach and dune regions more than the marshes, so management officials would need to incorporate studies on areas prone to geomorphic change into their preservation policies.

This have been numerous studies done on barrier islands, and Masonboro Island in particular, focusing on patterns of erosion and deposition of the supratidal beach and dune systems. According to Doughty (2006), the coastline along the southern end of Masonboro Island eroded 35.4 ft between 1998 and 2002. This was largely caused by hurricanes Bonnie (Sept 26, 1998), and Floyd (Sept 16, 1999). From 2002 to 2006 the coastline in the same area remained relatively stable. This stability can be explained, in part, by a lack of near-shore hurricanes off the southern North Carolina coast during these years. This study reflects the significance of storm events alone as island-modifiers, as well as the relatively inconsistent patterns of erosion and deposition that occur continuously under normal wave, wind and tide conditions.

Management of these dynamic environments will not be easy, but data from high resolution spatial analysis projects like this may provide policy makers with indications of the most vulnerable regions, and encourage action to protect these areas.

Sources

Doughty, S.D., 2006. The Influence of Inlet Modifications, Geologic Framework, and Storms on the Recent Evolution of Masonboro Island, NC.

FitzGerald, D.M., Fenster, M.S., Argow, B.A., Buynevich, I.V., 2008. Coastal Impacts Due to Sea-Level Rise. Annual Review of Earth & Planetary Sciences 36, no. 1, p 601-647.

Kemp, A.C., Horton, B.P., Culver, S.J., Corbett, D.R., van de Plassche, O., 2009. Timing and magnitude of recent accelerated sea-level rise (North Carolina, United States). Geology 37, p 1035-1038.

Data

Digital Globe: WorldView-2 satellite image 2010

NC Department of Transportation: Lidar image 2007