The Impact of Sea Level Rise on Coastal South Carolina

Alyson Churchill ('17) ES212: Introduction to GIS and Remote Sensing
Colby College, Waterville, ME

Introduction

This project aims to examine the effect of varying levels of sea level rise on the residents of South Carolina, particularly within the coastal communities, and provide rough estimations for the impact of sea level rise for use of classroom analysis. Regions along the coast continue to be popular destinations and living areas, despite the increasing prominence of rising sea levels, flooding events, and strong weather events triggered by climate change.[4] This poses a great risk to those living near or on the coast, as almost 40% of the U.S.'s population live in densely populated areas near the coast despite the associated risks.[1] While there are many different predictions for the severity of sea level rise for the next century and beyond (e.g. NASA 2017 and EPA 2016), it is clear that coastal communities are in danger. Therefore, this project investigates methods of assessing the degree to which South Carolina's residents may be impacted by rising sea levels, given different estimates of global sea level rise for the next century.

Methods

Population Density Model:

- Imported digital elevation model for South Carolina[7] into ArcMap document.
- Transformation of raster from the GSC_Clarke_1866 projection to the NAD 1983 Zone 19N projection.
- Downloaded, merged, and dissolved statewide roads and highways of South Carolina[8] into the ArcMap document.
- Creation of raster line density map using statewide highways and roads.
- Computation of a weighted linear combination for the raster line density map to create standardized index values for population density on a scale of 1-10, where higher values represent greater population densities.

Sea Level Rise Hazard Map:

- Calculation of sea level rise for 0.5 feet, 1, 1.5, 2, 3, 4, 5, 8, 10, and 12 feet using the digital elevation model for South Carolina.
- Reclassification and merge of projected rise values into a single raster layer, where a rise of 0.5 feet was classified as 10, signifying the highest risk of impact from sea level rise, and a rise of 12 was classified as 1, signifying the lowest risk relative to the other values.
- Computation of the sum of the population density model and the sea level rise projections map rasters, creating a population density-dependent hazard map for projected sea level rise for coastal South Carolina.

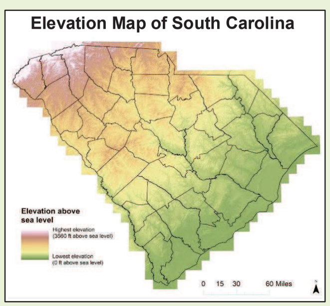

Figure 1: Digital elevation model of South Carolina, from the South Carolina Department of Natural Resources.[7] South Carolina's coast is particularly prone to flooding because of the low elevation gradient that extends relatively far inland.

Results

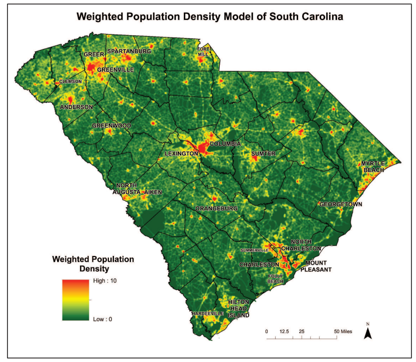

Figure 2: Weighted population density model of South Carolina based on proximity to state highways and roads, with major cities labeled.[7,8]

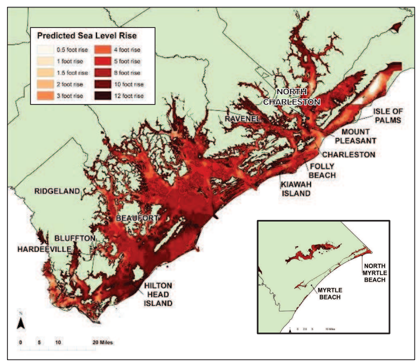

Figure 3: Model of various sea level rise projections for coastal South Carolina, with major coastal cities labeled.[7,8]

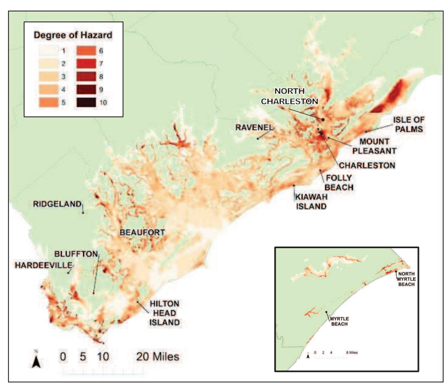

Figure 4: Hazard map model for sea level rise for coastal South Carolina, using population density and sea level rise projections.[7,8]

Coastal City	Population (2011-2015 ACS)[6]	Estimated lowest sea level rise impact	Hazard level range
Charleston	127,694	0.5 feet	1-10
North Charleston	104,146	4 feet	1-6
Mount Pleasant	74,885	1.5 feet	1-8
Hilton Head	39,071	8 feet	1-5
Myrtle Beach	29,198	4 feet	1-6

Table 1: Major coastal cities of South Carolina and their vulnerability to sea level rise, based on the proposed sea level rise projections and hazard map model for the coast (figures 3 and 4). Population data taken from the 2011-2015 American Community Survey.[6]

Discussion

By examining the population density of South Carolina (figure 2), it is clear that many populous cities, including North Charleston, Charleston, Mount Pleasant, Myrtle Beach, and Hilton Head, are located along the coast at lower elevations. It is also clear that the coast of South Carolina will be affected by even moderate levels of sea level rise (4-5 feet), indicating that coastal communities should take rising sea levels very seriously (figure 3). Major cities such as North Charleston, Charleston, Mount Pleasant, and Hilton Head were found to be on the top half of the weighted hazard scale, which encompasses a maximum of over 345,000 people (figure 4, table 1).[6] Furthermore, Charleston and Mount Pleasant exhibit hazard degrees of 7 and above within the city limits, indicating that these cities will almost certainly be affected by even the minimum (less than 3 feet) sea level rise in the next century (figure 4, table 1).[6,3,1]

The hydrosphere is extremely complex, causing changes in global sea level to be governed by numerous parameters, such as localized topography, regional tides, atmospheric volatile content, thermal expansion, and the rate of shelf and glacial melt, to name a few.[4,3] Since the documented rise of modern sea levels is primarily a consequence of anthropogenic climate change, action is necessary from the global community if the rate of sea level rise and climate change is to be slowed.[5] While these models may be **model-dependent estimations** for the level of impact of sea level rise, and were generated for **classroom use only**, the data clearly indicate that coastal populations in South Carolina, and undoubtedly around the world, will be impacted by sea level rise within the next century.

Resources

1. Crossett, K., Ache, B., Pacheco, P., and Haber, K., 2013, National Coastal Population Report: Population Trends from 1970-2020. National Oceanic and Atmospheric Administration, p. 1-19.
2. EPA, 2016, Future of Climate Change. United States Environmental Protection Agency, web. https://www.epa.gov/climate-change-science/future-climate-change
3. NASA, 2017, Climate change: How do we know? Earth Science Communications Team at NASA's Jet Propulsion Laboratory, web. https://climate.nasa.gov/evidence/
4. Nicholls, R.J. and Cazenave, A., 2010, Sea-Level Rise and Its Impact on Coastal Zones. Science Magazine, v. 328, p. 1517-1520.
5. Woodworth, P.L., Menéndez, M. and Gehrels, W.R., 2011, Evidence for Century-Timescale Acceleration in Mean Sea Levels and for Recent Changes in Extreme Sea Levels. Surveys in Geophysics, v. 32, p. 603-618.

Data sources

6. American Community Survey 2011-2015: Population of principal cities in South Carolina. Social Explorer, web. http://www.socialexplorer.com/
7. SC DNR, 2015, Statewide DEM for SC; DLG County Boundary. South Carolina Department of Natural Resources, web. http://www.dnr.sc.gov/GIS/gisdnrdata.html
8. SCDOT, 2017, Shape Files: Statewide Highways; Statewide Other Roads; Municipal Areas. South Carolina Department of Transportation, web. http://info.scdot.org/sites/GIS/SitePages/GISFiles.aspx?MapType=Shape