
Sea Level Scare in South Carolina

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Problem

Hilton Head Island in South Carolina attracts 2.5 million tourists every year. This popular locale features endangered species and a sizeable population of about 39,000 residents. The threats of climate change would drastically impact the sensitive community, particularly through sea level rise. Given the current situation of greenhouse gas pollution and other forms of global change, ocean levels are expected to increase by 1 meter in the next 315 years, 5 meters in the next 1,500 years, and 10 meters in the next 3,000 years.

Goal

Use ArcMap to determine the area at risk of destruction due to increasing sea levels in Beaufort County, South Carolina, where Hilton Head Island is located.

Data Acquisition

The data necessary to complete this investigation were a shapefile and digital elevation model (DEM) grid of Beaufort County, which were found through South Carolina's Department of Natural Resources and U.S. Geological Survey, respectively.

South Carolina County Boundaries Shapefile:

<http://www.dnr.sc.gov/GIS/gisdnrdata.html>

Beaufort County DEM Grid:

<https://www.sciencebase.gov/catalog/item/581d2201e4b08da350d53fd2>

Sea Level Rise Data:

https://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?stnid=8670870

Additional County Data:

<http://www.hiltonheadchamber.org/business-resources/press-and-media/fast-facts/>

Methods

On a new, blank document in ArcMap with a NAD1983 UTM Zone 17N projection, I added the shapefile of counties in South Carolina (SC) and changed its symbology to hollow (Figure 1).

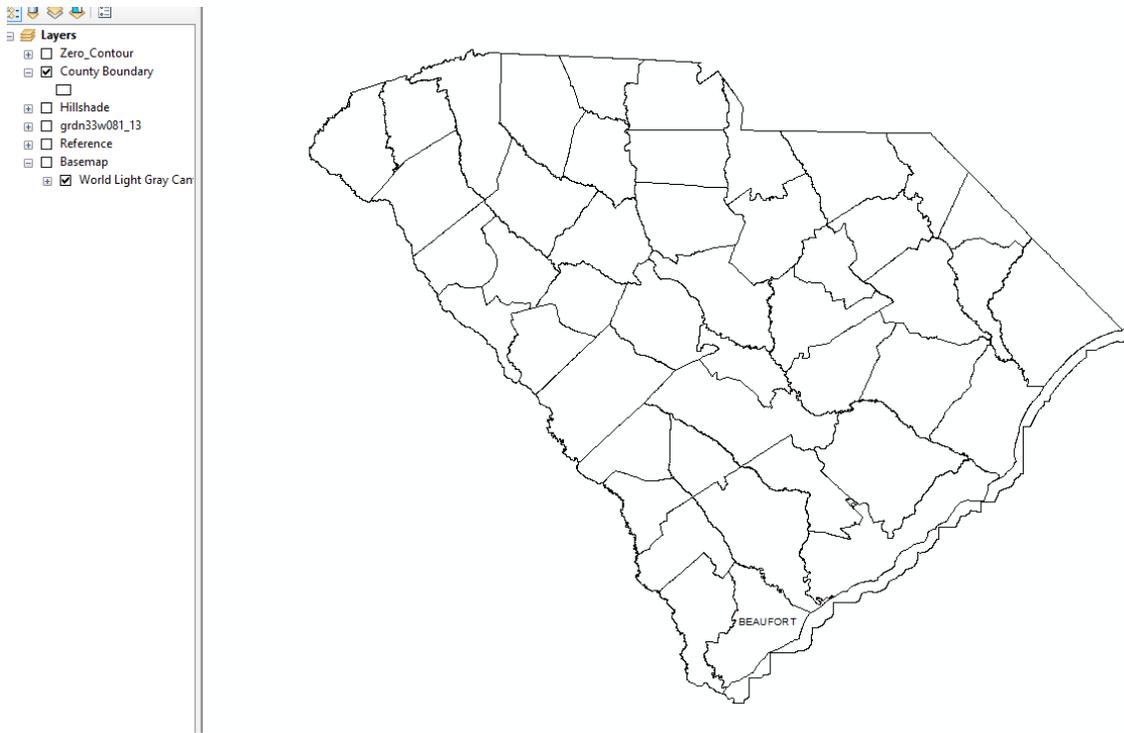


Figure 1. Imported South Carolina county boundaries.

I selected Beaufort County in the SC county attribute table and exported its data to create a new shapefile layer that only included the county of interest (Figure 2). I also labeled Hilton Head Island and the surrounding counties and symbolized the new shapefile to differentiate it from the others, making it 20% transparent in anticipation of creating a hillshade.

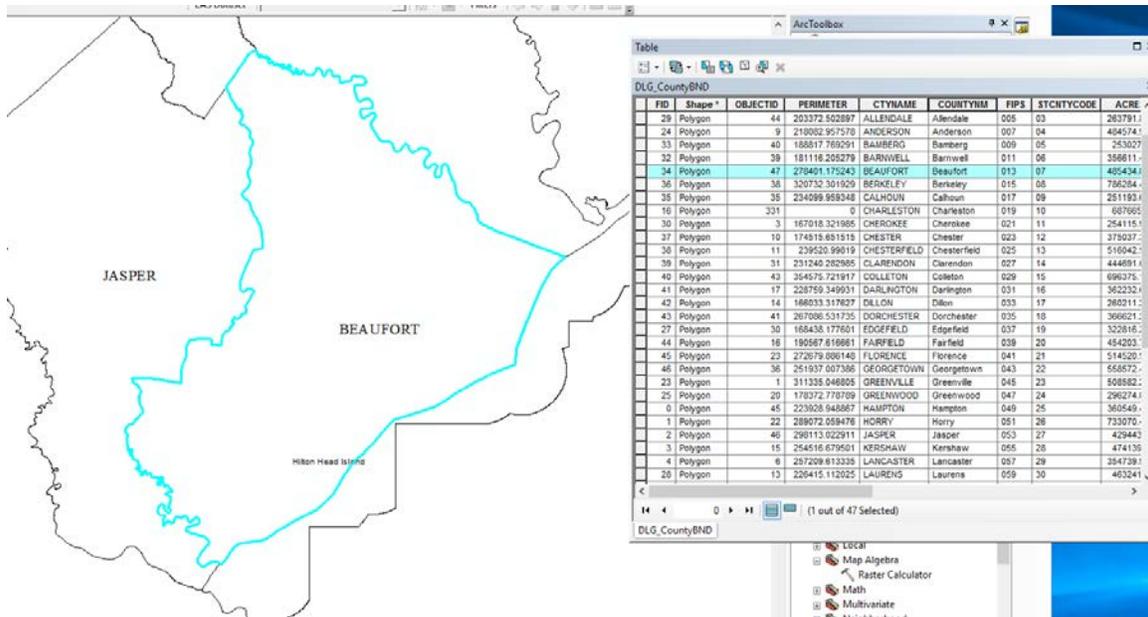


Figure 2. Attribute table with Beaufort County selected.

Next, I went to The National Map's website and exported a DEM of a 1° by 1° ArcGrid area that includes the county of interest before adding it to my map document (Figure 3).

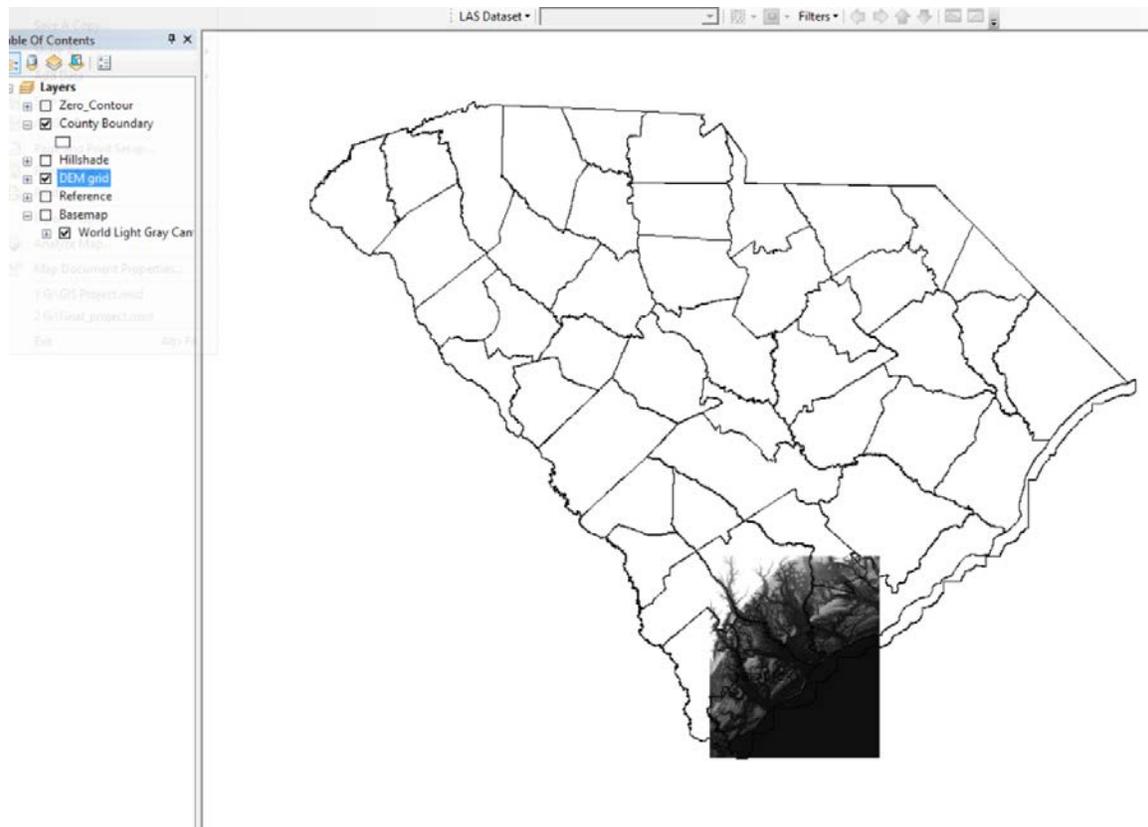


Figure 3. DEM imported from The National Map.

Afterwards, I made a contour on the DEM to outline the areas of 0 meter elevation (Figure 4).

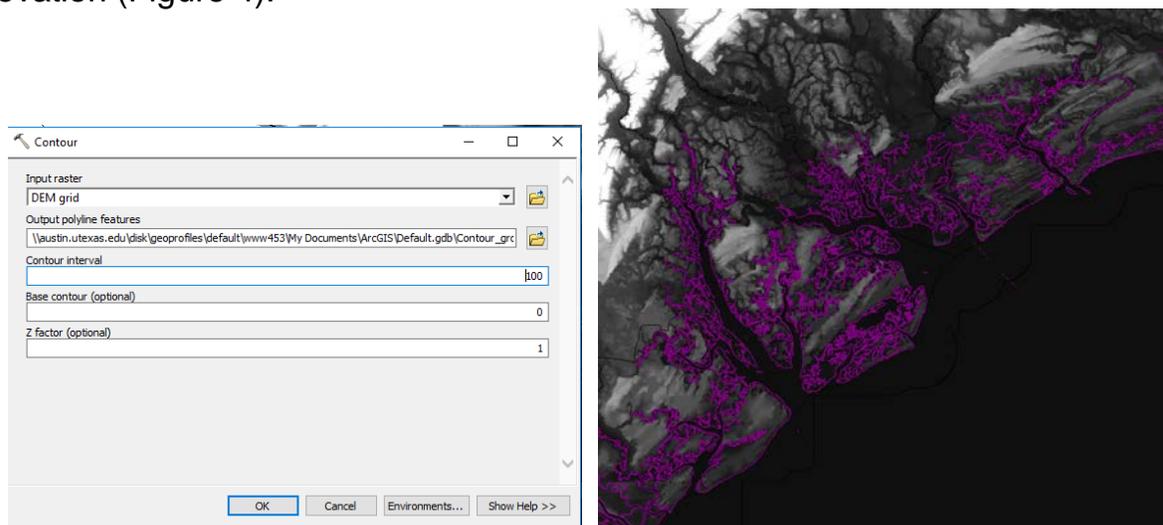


Figure 4. Contour tool settings and output.

I then drew a polygon around Hilton Head Island and used “Convert Graphics to Feature” to use it as a mask for “Extract by Mask” of the DEM (Figure 5).

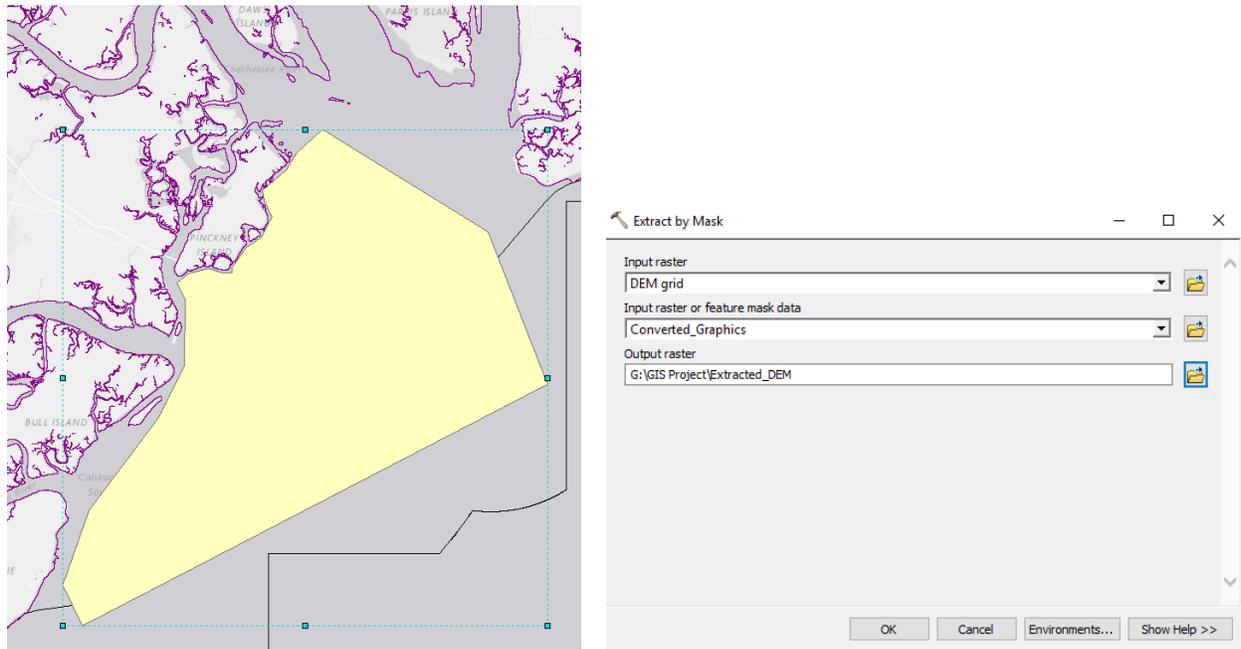


Figure 5. Polygon formed and Extract by Mask tool settings.

Later, I used the newly created DEM to figure out the highest elevation of Hilton Head Island, which is 7.85 meters (Figure 6).

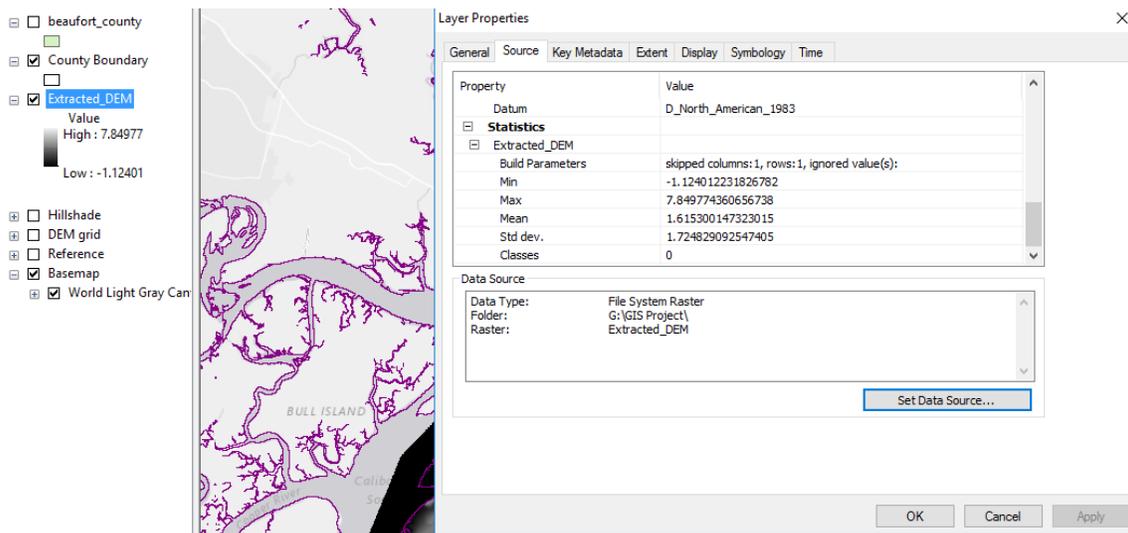


Figure 6. Layer Properties output showing maximum elevation of Hilton Head Island.

To highlight the water coverage of the area, I used a conditional statement in the Raster Calculator, assigning all elevations less than or equal to zero a single value (Figure 7a). In doing this, I was able to symbolize the new raster, which

only included water, on its own. I converted this raster data to a shapefile by using “Raster to Polygon” tool before clipping it to Beaufort County (Figure 7b).

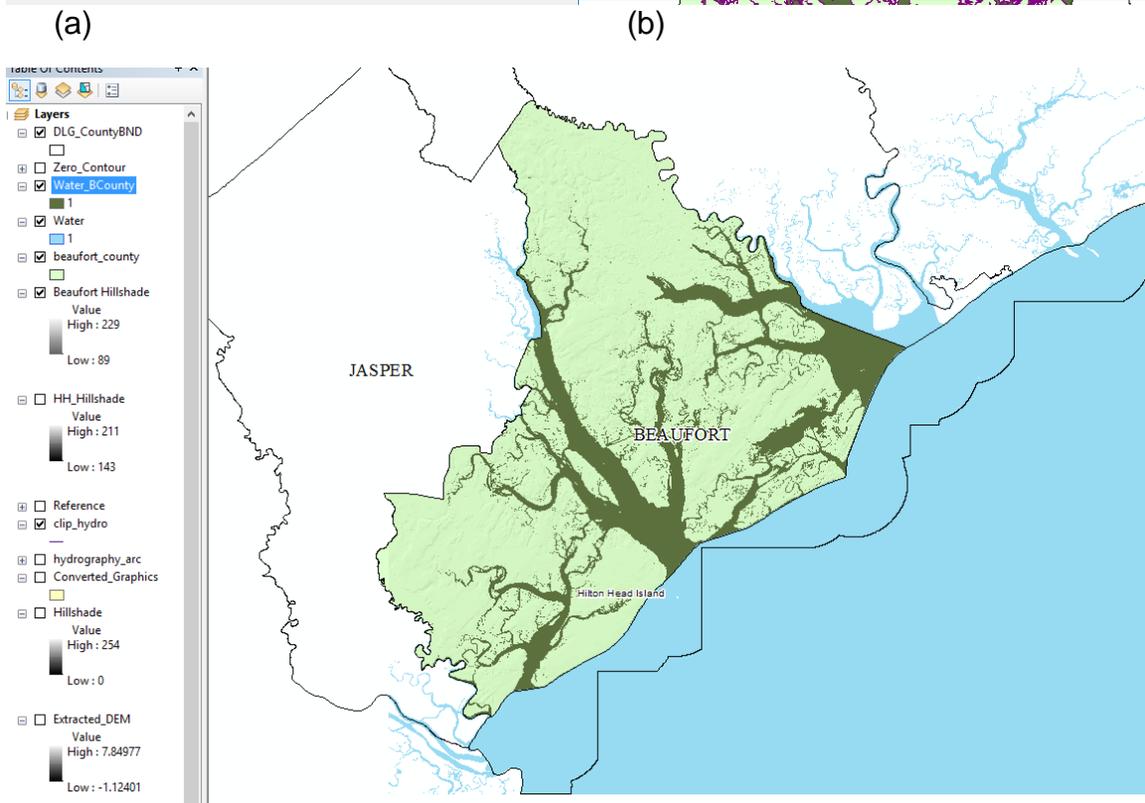
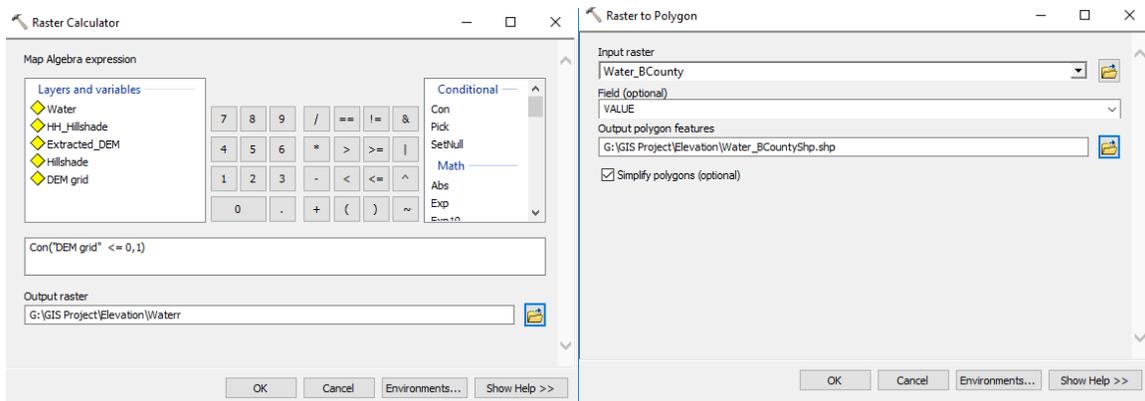


Figure 7. (a) Raster Calculator tool with conditional statement. (b) Raster to Polygon tool settings. (c) Output of conditional statement.

In order to symbolize a 1-meter rise in sea level for the area, I used a similar conditional statement in the Raster Calculator, assigning all elevations less than or equal to 1 a single value. I changed the symbology of the new raster layer to blue to more closely represent water (Figure 8). Then I converted the raster to a shapefile using the aforementioned tool and also clipped it to the county of

interest. I executed a similar process to represent 5- and 10-meter rises, changing the single value to 5 and 10, respectively.

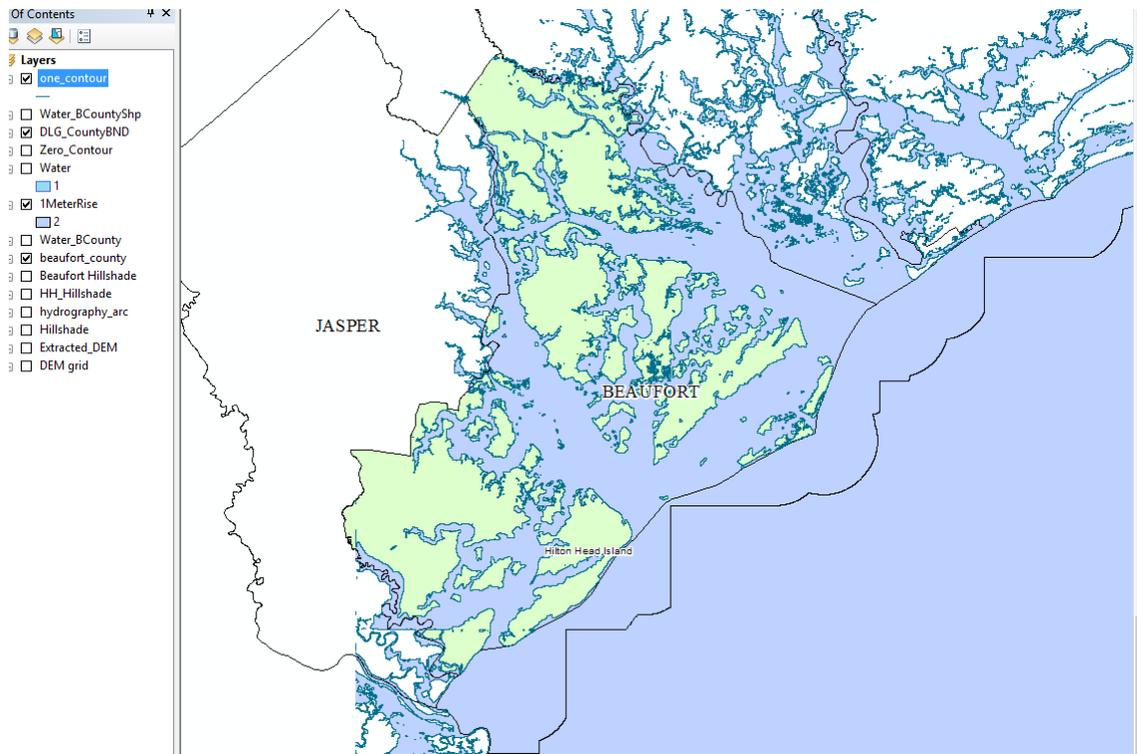
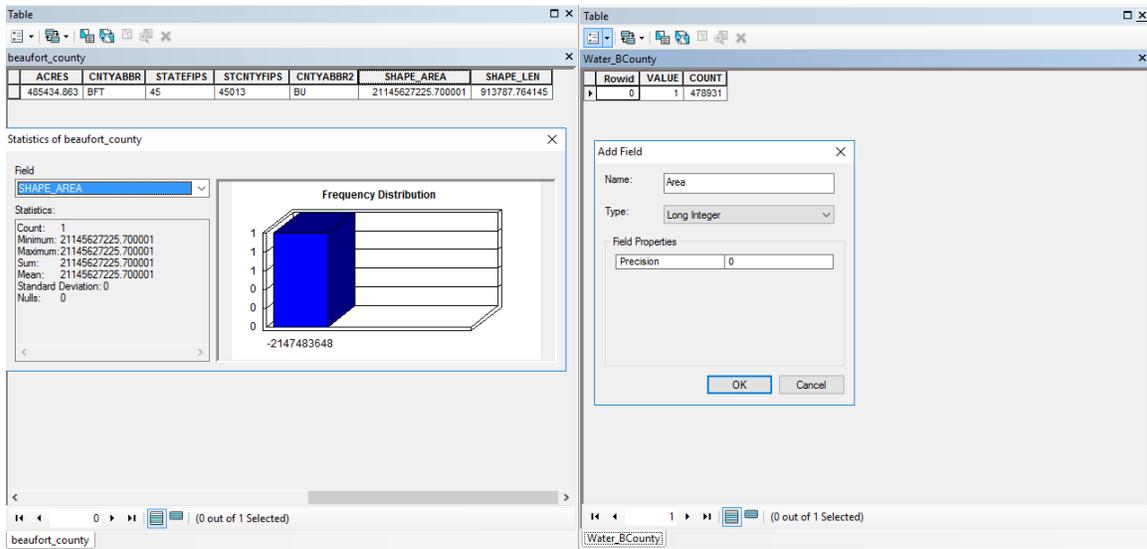


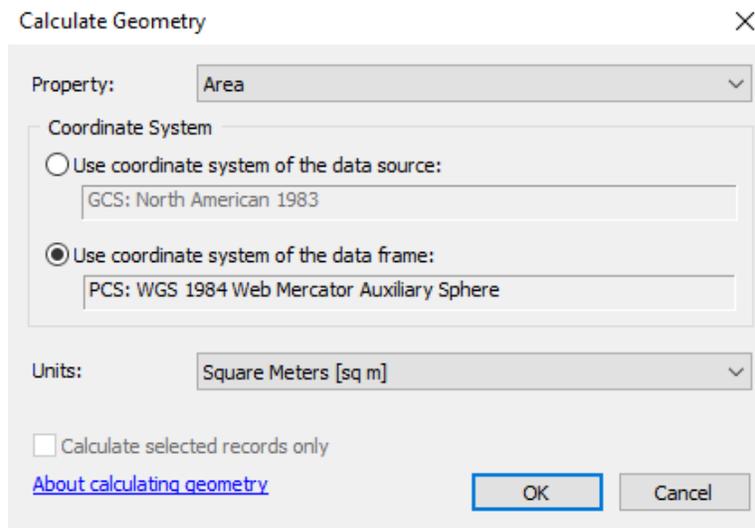
Figure 8. Output of 1-meter rise simulation using conditional statement.

Because I converted the raster data to shapefiles for all the situations, I was able to calculate the percentage of Beaufort County that is at or below sea level (or the adjusted sea level). I converted the "SHAPE_AREA" field of the Beaufort County shapefile to square kilometers (Figure 9a). I then made a new long integer field in each of the attribute tables of the various sea level conditions called "Area" (Figure 9b). Using the "Calculate Geometry" feature, I found the extent of water in square kilometers for each situation (Figure 9c). I calculated the ratios of water and land for the county in percentages (see Calculations).



(a)

(b)



(c)

Figure 9. (a) Output of statistics for “SHAPE_AREA” field. (b) New field tool settings. (c) Calculate Geometry tool settings for area.

Finally, I created a hillshade to emphasize topography and contours surrounding the new sea levels to make them easier to see.

Calculations

The extracted DEM grid around Hilton Head Island told me that the highest point on the island is 7.85 meters above sea level. I divided this by the average yearly rise in sea level near the South Carolina coast (3.17 mm) to determine how long it would take for Hilton Head Island to become completely submerged.

$$7.85 \text{ meters} / (0.00317 \text{ meters/year}) = 2,476 \text{ years}$$

To determine what percent of Beaufort County would be underwater after each period of sea level rise, I found the ratio of the area of water within Beaufort County over the total area of Beaufort County (1963 km²), and multiplied that by 100.

After 1 meter of sea level rise:

$1401 \text{ km}^2 \text{ water} / 1963 \text{ km}^2 * 100 = 71.4\%$ water coverage in Beaufort County

Water Cover in Beaufort County Following a Rise in Sea Level

Rise in Sea Level (m)	Water Cover (km ²)	Water Cover Percent
0 (Present Day)	587	29.9%
1	1401	71.4%
5	1642	83.6%
10	1931	98.4%

Conclusion

Hilton Head Island, and Beaufort County as a whole, have cause for concern when it comes to climate change. Given its unique features and a number of National Wildlife Refuges, this area would lose a devastating amount of homes and habitats if climate change progresses and sea level rises by the increments outlined in this investigation. At its current rates, a rise of 1 meter is predicted in 315 years. This 1-meter rise in sea level showed a loss of 41.5% of land cover within Beaufort County. Given that the highest elevation of Hilton Head Island is 7.85 meters, any ocean increase is problematic, but an absolutely destructive 10-meter rise must be prevented for the sake of this county and many others along coastlines. The sea level is anticipated to rise to 7.85 meters in 2,476 years, and our society must be proactive in these years to slow or stop such a threat.

CURRENT SEA LEVEL IN BEAUFORT COUNTY, SOUTH CAROLINA



Legend

- Sea Level Elevation
- Water in Beaufort County
- Beaufort County

NAD 1983 UTM Zone 17N
1:500,000

BEAUFORT COUNTY, SOUTH CAROLINA AFTER A ONE METER RISE IN SEA LEVEL

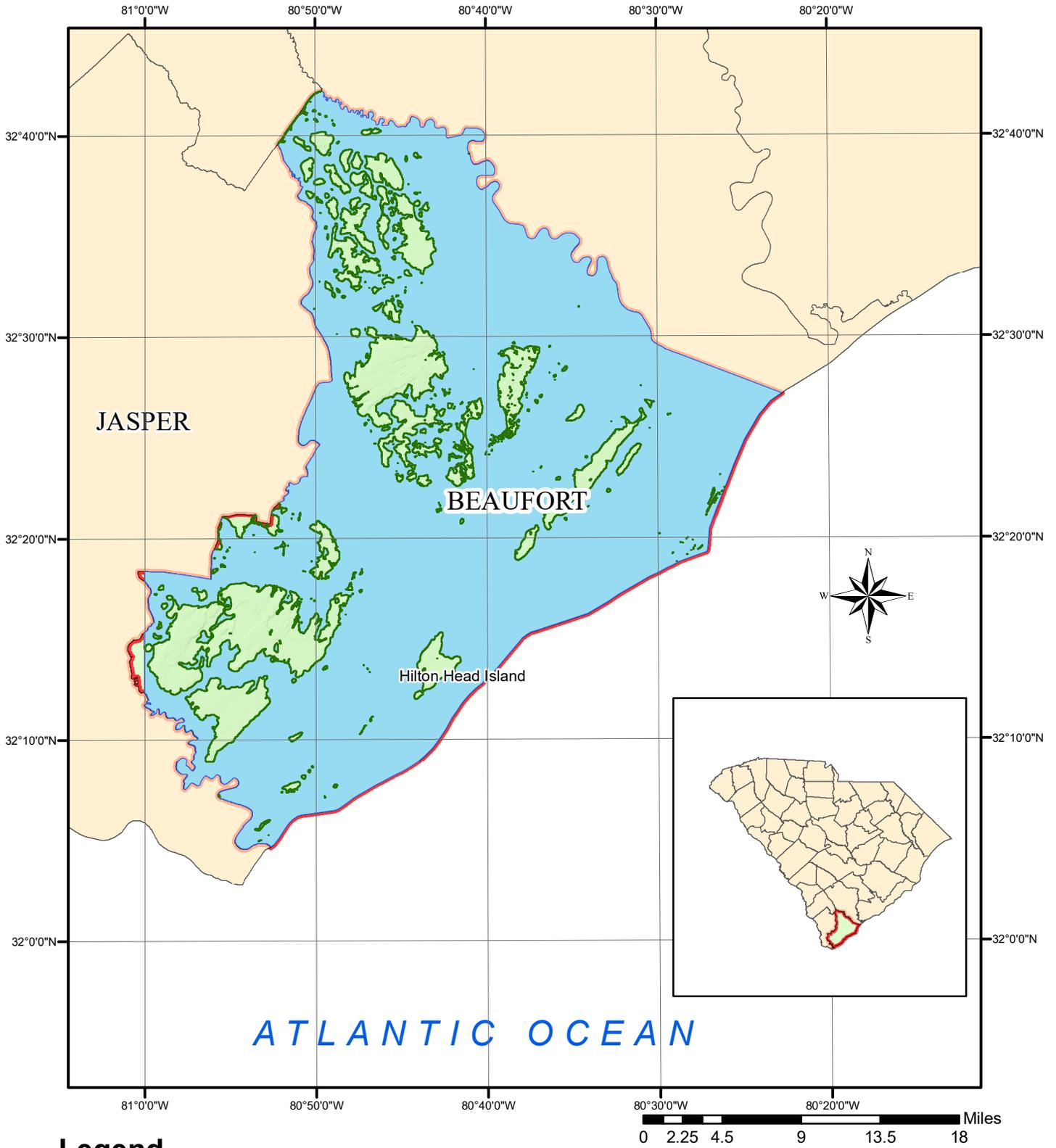


Legend

- Adjusted Sea Level
- Water in Beaufort County
- Beaufort County

NAD 1983 UTM Zone 17N
1:500,000

BEAUFORT COUNTY, SOUTH CAROLINA AFTER A FIVE METER RISE IN SEA LEVEL



Legend

- Adjusted Sea Level
- Water in Beaufort County
- Beaufort County

NAD 1983 UTM Zone 17N
1:500,000

BEAUFORT COUNTY, SOUTH CAROLINA AFTER A 10 METER RISE IN SEA LEVEL



Legend

- Adjusted Sea Level
- Water in Beaufort County
- Beaufort County

NAD 1983 UTM Zone 17N
1:500,000