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URP6238 Lidar & 3D Applications of GIS

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## Lab 2

Pinckney Island is a barrier island off the southern coast of South Carolina, located between the mainland and neighboring Hilton Head Island. The island is a designated National Wildlife Refuge, serving as part of the Atlantic Flyway for migratory birds and nesting site for local species (FWS, n.d.). Pinckney Island's refuge designation would spare it from major anthropological change, but meteorological events still have the potential to impact the island.

On October 8<sup>th</sup>, 2016, Hurricane Matthew made landfall as a category one system in South Carolina. Having formed less than two weeks in the Caribbean Ocean, Matthew traveled through Haiti and Cuba and up to the south-east coast of the United States, creating \$10.3 billion worth of damages for the United States alone and a total of twenty-nine deaths between the states of North Carolina and South Carolina (Armstrong, 2021). In addition to the economic impacts, coastal communities also experienced impacts on the environment. Neighboring Hilton Head Island suffered over 100,000 tree fellings, 6 feet of storm surge, and the movement of more than 700,000 cubic yards of sand on the island because of the hurricane (Island Club of Hilton Head, n.d.). While the impact on communities and the environment was devastating, reporting of these impacts centered on places populated by people. Media attention to ecological areas like Pinckney Island may not get equal representation in the media, so impacts from the hurricane may go unnoticed.

LasD	Point Count	Point Spacing (ft)	Source
2013	152475471	1.4805	South Carolina Department of Natural Resources (2013)
2020	276919355	1.098	United States Geological Survey (2020)
Difference	124443884	-0.3825	

Figure 1: 2013 and 2020 LasD Statistics

This report looks at changes to Pinckney Island between years before and after hurricane Matthew. To see where Pinckney Island has changed, I compared LiDAR data from 2013 and 2020 (fig. 1) to see where accretion and erosion have occurred on the island. LasD statistics for both datasets (fig. 2; fig. 3) detail the percentage and elevation ranges of each point cloud. Analysis of these point clouds included creating digital elevation maps (DEM) at a 5-foot resolution, with spatial statistics calculated using ArcGIS Pro's surface volume tool. Using the cell statistics tool with the DEMs, I created maps to help locate areas with elevation change on the island. Both analyses will only incorporate areas of the island with an elevation above 0.25 feet to limit the influence of tide level change on island shape and area.

Category	Count	Percent	Z Min (ft)	Z Max (ft)	Range (ft)
1_Unclassified	91192841	59.81	-5.22	80.11	85.33
2_Ground	27224926	17.86	-5.17	37.58	42.75
8_Model_Key_Point	17729032	11.63	-5.79	37.62	43.41
9_Water	16122487	10.57	-6.52	11.48	18
10_Rail	72406	0.05	-5.52	10.2	15.72
13_Wire_Guard	133779	0.09	5.69	78.34	72.65
Total	152475471		-6.52	80.11	86.63

Figure 2: 2013 LasD Statistics

Category	Count	Percent	Z Min (ft)	Z Max (ft)	Range (ft)
1 Unassigned	154211292	55.69	-94.59	243.83	338.42
2 Ground	89141225	32.19	-95.01	37.3	132.31
9 Water	33236251	12	-4.49	16.54	21.03
17 Bridge Deck	127616	0.05	12.93	77.26	64.33
20 Ignored Ground	202971	0.07	-4.4	14.24	18.64
Total	276919355		-95.01	243.83	338.84

Figure 3: 2020 LasD Statistics

With the creation of the DEMs from the two years of LiDAR data, surface volume calculations can help to reveal landmass changes. Focusing on Pinckney Island itself, surface volume calculations show decreases in all calculations from 2013 to 2020 (figure 4). However, in comparison to the larger effects felt by Hilton Head Island during Hurricane Matthew, there does not appear to be as significant changes for Pinckney Island. While there appears to be shrinking of the island (fig. 5), it is not certain if these changes are due to hurricane impacts. The following maps lend to the lack of visible change by hurricane, as the island's shape remains mostly intact between the 7-year difference, with much of the elevation change occurring within 1.5 feet of accretion or erosion. These results are hindered by limited data availability, as LiDAR data created during years closer to the hurricane are not available. Having data created more closely to the time of the hurricane could provide a more accurate view of the impacts, as the four-year difference between landfall and the 2020 dataset might have provide enough time for the island to reform any damages.

Raster	2D Area (ft <sup>2</sup> )	3D Area (ft <sup>2</sup> )	Volume (ft <sup>3</sup> )
2013	82,103,325	82,337,820.67	479,426,251.40
2020	81,008,900	81,183,165.48	469,511,871.16
Difference	-1,094,425 (-1.35%)	-1,154,655.19 (-1.42%)	-9,914,380.24 (-2.11%)

Figure 4: Surface Volume Calculations

<b>Class</b>	<b>2D Area (ft<sup>2</sup>)</b>
<b>Accretion (elevation gain greater than 0.1 ft)</b>	8635125
<b>Erosion (elevation loss greater than 0.1 ft)</b>	27441125
<b>Difference</b>	18806000

Figure 5: Accretion and Erosion Area

With potentially minor impact from Hurricane Matthew, future research should incorporate other factors to find any effects. The next steps should look at surface changes to see how wind might have shaped the island, either through removing topsoil and sand from the beaches, and for impact to roosting locations of the island's birds. Additionally, identifying change between land cover types could reveal unequal change from the hurricane. Having more specificity to the island's geography may provide more patterns than the generalized ground elevation used in this report. Lastly, understanding Pinckney Island's location between Hilton Head Island and the mainland could provide explanation for the lack of apparent change to the Island's area and volume. Finding additional explanations to Pinckney Island's changes from Hurricane Matthew will assist in any action needed to support the island's local species and status as a refuge.

## References

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