Change Detection at Long Point Peninsula, Massachusetts

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GEOG 788G Final Project

Abstract

How does Long Point peninsula change over the course of 8 months and the winter months?

Background

For this project I decided to look at the extent at which long point peninsula located in Provincetown, Massachusetts has changed over a short short period of time. Due to it being a peninsula at the extreme tip of cape cod, and even curling back in on itself to create the Provincetown Harbor, as well has having a salt marsh it is a great study area to look into. The reason behind Long Point peninsula being an interesting area to look into is due to its location and make up. By being surrounded by the salty ocean waters it, unlike most areas, curls back onto itself which helps protects itself from heavy ocean currents and any severe storms. This gives us a perfect opportunity to look at how a salt marsh environment can fluctuate from year to year. Is there a great change over the course of the year or does this type of environment sustain itself fairly well.

Not a whole lot has been done on this area of interest, which also makes this such a interesting study area. Tidal salt marshes habitats as a whole have decreased in number by nearly 50% due largely to human interactions and a trend of global warming which is effecting coastal water levels (Journal of Coastal Research, yr. 2001, p731). This is of huge concern since they are among the most abundant, fertile, and accessible coastal habitats on earth, and provide more ecosystem services to coastal populations than any other environment (Annual Review of Marine Science, yr. 2009, p117). With this in mind, we need to better understand this particular ecosystem in order to help combat its reduction in size.

Objectives:

- Study area
- Find/Download data
- Use Lasmerge to obtain one las file per year
- Use Las Dataset to Raster on each lasd dataset
- Use Raster Calculator to normalize data
- Use Minus tool to find difference between years
- Use Raster Calculator to find areas that lost elevation, and lost 0.5 meters or more in elevation
- Use Zonal Statistic to find area of lost elevation
- Use Surface Volume tool to find total loss or gained volume between years.

Study Area: Long Point Peninsula

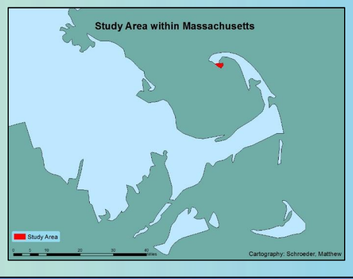
For this project I decided to look at the extent at which long point peninsula located in Provincetown, Massachusetts has changed over the course of short period of time . Due to it being a peninsula at the extreme tip of cape cod, and even curling back in on itself to create the Provincetown Harbor it has several currents at play on it. The peninsula has had a long history of human interactions, and even holding a small town for a short time, but with increased fears of a growing ocean due to a general increase in the earths temperatures it is even more crustal to understand how a shore line interacts with its surrounding environment.

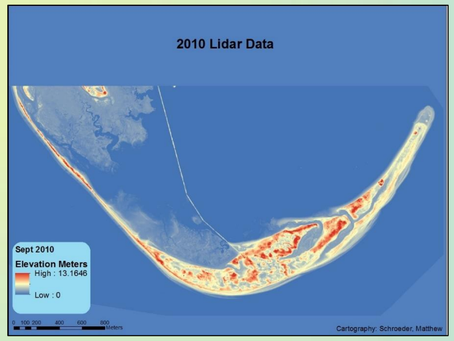
Data & Methodology

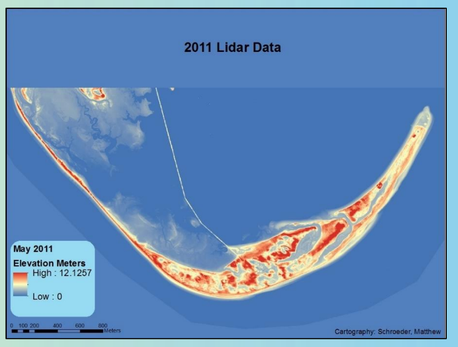
To accomplish the tasks laid out above I used two different Lidar data obtained from various websites. The 2011 data was obtained from EarthExplorer, which was in turn produced by Photo Science INC between April 22, 2011 and May 27, 2011. The second dataset was obtained from NSF open Topography, which was acquisitioned on July 20, 2010 and then processed by the National Center for Airborne Laser Mapping (NCALM).

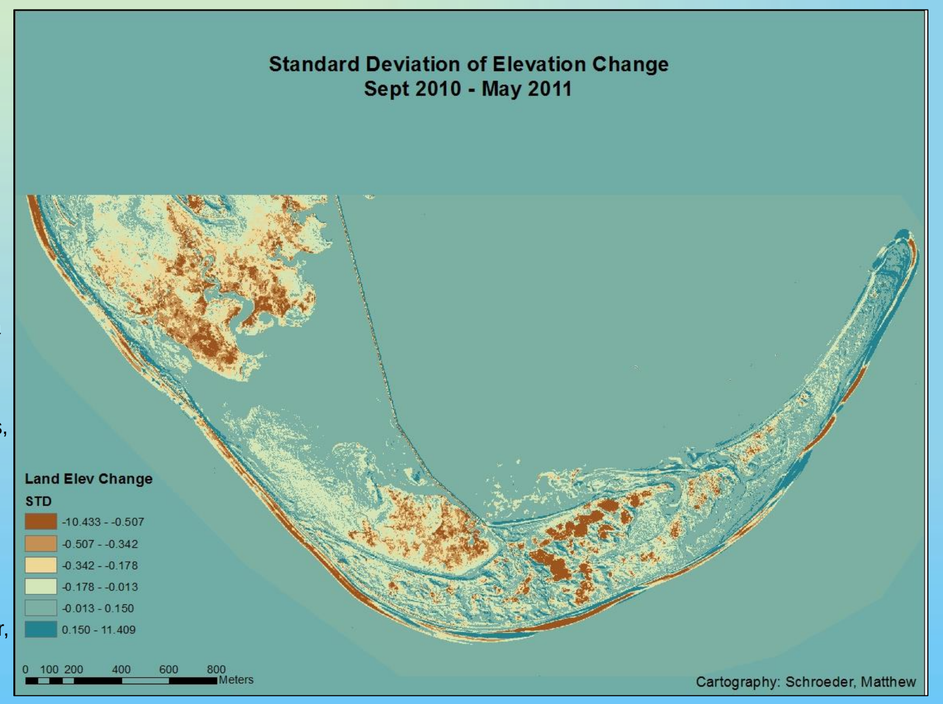
This data, for each year, was merged together using lasmerge (one merge for the 2010 data, and another for the 2011 data). These where then loaded in to there own lasd files for processing within ArcGIS. From there they were run through the Las Dataset to Raster tool which outputted two separate raster files depicting the Lidar datasets for each year. Raster calculator was then used to normalize the data so that there elevations would not be lower than Zero and no higher than 14m. From here the data was ready to be run through various tools such as Surface Volume, Zonal Statistics, and Raster Calculator in order to obtain valid results for this project.

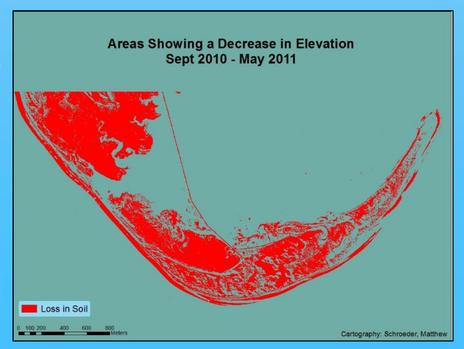
Date	Number of Points	Point Spacing	Point Density	Website Source	Producer
10 July 2010	24048835	0.52m	3.63 pts/m^2	NSF open Topography	Photo Science INC
22 May 2011	15087791	0.67m	2.24 pts/m^2	EarthExplorer.com	NCALM

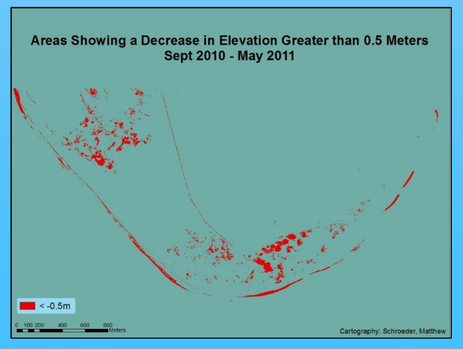












Results

The first step in this project was obtaining a raster dataset for each year which would depict the elevation throughout the study area of Long Point, Mass. This was done by importing the merged las files for each year into ArcGis as lasd files then running each dataset through Arcs “Las dataset to Raster tool”. You can see these outputs to your right at the center of the poster just under the study area maps. First off you will notice that they both have different highest elevation levels (2011 max is 12.13, and 2010 max is 13.17). You will also notice that the 2011 has a higher concentration of higher elevations than in 2010. But due to the symbology not being exactly the same this could be off.

The next step was to use the minus tool to minus tool within Arc to see where there was soil loos and gain throughout the study region. The output from this process can be seen in the image below the two raster's discussed above. The dark brown areas indicate a decrease in elevation while the lighter blue indicate a gain in elevation over the year time span. Below is a table showing the various statistics for that map. This map will also be further discussed below in the next section.

Change Between years	
MIN	-10.433
MAX	11.410
RANGE	21.843
MEAN	-0.036
STD	0.167

The third step was to use Raster Calculator to find the areas that lost elevation overall, as well as lost only 0.5 meters or more in elevation. The mapped outputs for this can be seen at the bottom center of the poster. You can see that most areas saw a decrease in elevation, but a much smaller group saw a decrease of 0.5m or more. The final step after this was to see how much total volume was lost between the two years. This was done by using the Surface Volume tool on both the 2011 and 2010 raster's then simply minus the two values. These values can be seen below in the chart.

	Volume m3
2010	3,668,884.76
2011	3,454,996.54
Volume Loss	-213888.224

Discussion

From looking at the results it can be seen that the Long Point Peninsula saw a decrees in elevation and volume over the one year time period. From looking at map to your left you can see that there was a decrease in elevation over nearly the entire peninsula. Areas that saw little to now loss were areas closer to the peninsula tip, which sees lees ocean current as well as small areas in and around the inside of the peninsula. This is also supported by the two maps depicted at the bottom which show area that had any loos or loss of -0.5m or greater. Nearly the entire peninsula saw a decrease in elevation, with the outside shore line and various spot within the harbor side seeing the most soil loss. Over all the Long Point Peninsula saw a decrease in volume of -213,888.224m3 (which is a 5.83% loss of total volume from 2010).

Conclusion

Although this study focuses only over a very short time period of one year it was able to show a strong trend over that one year. Not only was the loss in soil over most of the peninsula but the areas that saw the most loss were areas adjacent to the stronger ocean currents as well as a few hot spots from within the Salt Marshes. It was also found that there was a overall decrease in volume of -213,888.224m3 from 2010 to 2011, which is a 5.83% loss in volume. This may not seem like a lot but it is a substantial amount for such a small study area over such a short time period. Due to the limitation of data availability I was only able to test the change over the one year period of 2010 and 2011. Further study into the trend of soil erosion at this location needs to be done in order to determine if this particular time period was outside of the areas norm or if this is a greater trend in the slowly eroding Salt marshes of Long Point, Massachusetts.

References

1. Gedan, K. Bromberg, B.r. Silliman, and M.d. Bertness. "Centuries of Human-Driven Change in Salt Marsh Ecosystems." *Annual Review of Marine Science* 1.1 (2009): 117-41. Web. 18 Feb. 2015. <http://www.annualreviews.org/doi/full/10.1146/annurev.marine.010908.163930>.

2. Kennish, Michael J. "Coastal Salt Marsh Systems in the U.S.: A Review of Anthropogenic Impacts." *Journal of Coastal Research* 17.3 (2001): 731-48. Web. 18 Feb. 2015. <http://www.jstor.org/discover/10.2307/4300224?sid=21105897718593&uid=2&uid=4&uid=3739704&uid=3739256>.