A Comparison of the USGS N.E.D. and LiDAR Data in Long Beach, New York in Flood Simulations

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Abstract

Flooding has become a major issue in both across the country and around the world, as sea level rises rapidly. Among many advanced global mapping technologies, LiDAR *(*Light Detection and Ranging) and NED (the National Elevation Dataset) are publicly available and help us immensely in determining various flood zones due to their capabilities of DEM (Digital Elevation Model) construction. In this research, we run multiple flood simulations using both LiDAR and NED to compare the two data sets' results and related interpretations for flood rate evaluation. The region we selected for this comparison is Long Beach island, which is one of the barrier islands on the southern coast of Long Island, in New York. This island is relatively flat and prone to flooding making it an interesting study area to determine regions of high or low flood rate. LiDAR and N.E.D data were utilized in Global Mapper to run various flood simulations with the intention of viewing which data system provides a more accurate model of flood simulation. The results of our simulation have shown a large gap in the rate of flooding between the datasets because they have registered elevations differently on Long Beach Island. LiDAR dataset provides more precise and accurate measurements than the N.E.D. data. Overall, flood rate simulations are very important for coastal natural disaster mitigation, as they may identify which flood zones can be improved against such hazards. Flood rate data may lower insurance premiums, and it can also guide first responders to efficiently evaluate which areas are at a higher risk during a flood.

1. Introduction

Long Beach Island in New York is one of the many barrier islands on the south shore of Long Island, and it is relatively flat and as a result prone to flooding. The previous methodology has been used to construct a high-resolution Light Detection and Ranging (LiDAR) Digital Elevation Model (DEM) in the region for use to predict flooding in the area (Weinstein and Marsellos, 2018). One of the newest technologies known as LiDAR uses a laser beam to scan the landscape and create a Digital Elevation Model (DEM). Also, LiDAR provides the capability of excluding surface structures and reconstructing the ground surface which is called the Digital Terrain Model (DTM). This study compares lidar-derived surface elevation on Long Beach Island to 10-meter elevation data previously incorporated in the National Elevation Dataset (N.E.D.) Previous work has been done comparing the two elevation systems however most are in relation to hydrography (Popenga, 2009). One study however has done a comparison and preliminarily indicated that any disparities between the systems comes about as a result of the different methods of collecting data (Chirico, 2004). While this study did attempt to make a comparison of the systems they did not study a very flat region like Long Beach, New York.

2. Methodology

The data were projected in Global Mapper for our study area (Figure 1). A map of the island showing the LiDAR elevation measurements were obtained, and a high-resolution DEM was constructed. A mosaic of all required LiDAR data in tiles was assembled and Long Beach island was cropped in Global Mapper. We created a DEM utilizing all the LiDAR points with tight constraints including only the ground points to create a Digital Terrain Model (DTM) with a minimum elevation to avoid structures such as trees showing up as a higher elevation from the ground.

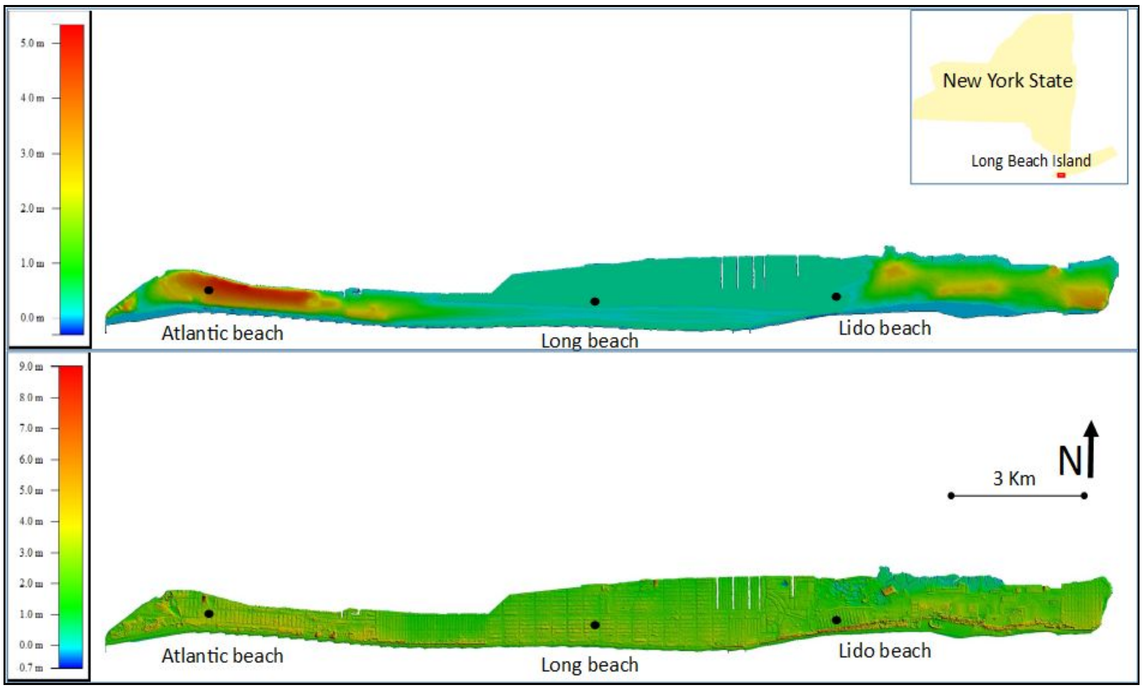

Figure 1: The Digital Elevation Models (DEMs) of the study area of Long Beach Island, New York were constructed in Global Mapper. The top map shows the island's elevation using the former N.E.D. data (with a spatial resolution of 10 meters). The bottom map was derived using LiDAR (with a spatial resolution of less than 1 meter) elevation data of the same region.

LiDAR and N.E.D data were then used in order to run various flood simulations with the intention of viewing which data system provides a more accurate model for flood simulation purposes. To ensure that the entire island was flooded in the simulator, for each system, we decided to set a maximum elevation at 10 meters above sea level and increments of 0.1 meter to detect any flood rate differences upon flood progress. Using the volumetric and surface calculations produced by the flood simulations we plotted the area that was submerged in relation to the height of the simulated water surface.

3. Results

The simulations determined the area covered by the water at each incremental height as well as the volume of the water covering the area. In less than a meter below sea level, both the N.E.D data and the LiDAR data showed the water beginning to encroach on the shoreline. By 0.3 meters BSL the N.E.D data stated that the water would begin encroaching on the land.

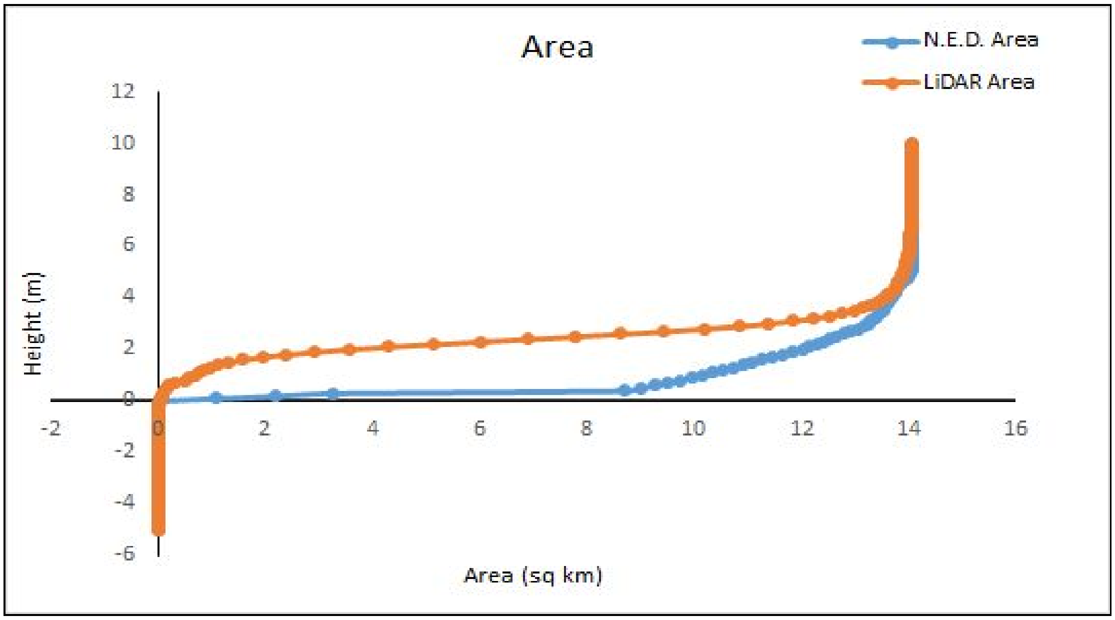

Figure 2: Comparison of the area filled in using N.E.D. and LiDAR mapping for Long Beach Island, NY during a flood simulator.

The N.E.D. data showed that at -0.3 meters of elevation 0.00067 square kilometers on Long beach was covered. While the LiDAR measured that at -0.6 meters 0.0001563 square kilometers would be flooded (Figure 2). At 2.0 meters the LiDAR flood simulations show that 3.565 square kilometers were covered. While at the same elevation of 2.0 meters the N.E.D data show 12.029 square kilometers of Long Beach would be underwater. Finally, the LiDAR measurements showed that at 8.6 meters an area of 14.058 square kilometers was covered, totally submerging the island. The N.E.D. data shows the island being entirely submerged at a lower elevation, which is at 5.4 meters with 14.061 square kilometers underwater. Based upon the maps there is a prominent difference on the N.E.D. map with a large contrast in the elevation between the western, eastern, and the central parts of the island. The LiDAR map meanwhile displays less contrast between the large areas of the island and a wider range of elevations in localized regions such as from house to house.

4. Discussion

LiDAR data show a superior spatial resolution to NED, but perhaps, the vertical resolution of a laser scanning application is not as good as it is with the horizontal resolution. LiDAR dataset shows the first stages of flooding at a relatively lower elevation and below sea level, while NED indicates at higher elevation but still below the sea surface. This may raise some concerns about the flood rate calculations in increments less than 0.1 meters.

According to the data displayed on the graph, the N.E.D data indicate a steep increase in the rate of the area being flooded between 0.0 and 1.0 meters. Opposingly, the LiDAR dataset shows a more gradual increase suggesting a sharper differentiation between elevations. It is interesting that N.E.D maximum elevations at various places on the island are smaller than the LiDAR data even though both datasets correspond to DTM. LiDAR data are ground points, and they should do much with N.E.D. This study is focused on a relatively flat island off of Long Island that is not only highly populated but prone to flooding. While our results do show a disparity between the two systems we have to wonder if the difference would become larger or smaller at higher topographic relief regions with a larger contrast between elevation points.

5. Conclusion

According to our results, the N.E.D data tended to overestimate the rate at which the area would begin flooding within some cases twice the amount of area underwater. The LiDAR data, on the other hand, displayed a much slower rate of the island being submerged. These differences can provide the basis for more accurately calculated insurance rates affecting any development in the area. Additionally, in times of severe flooding and storms, reformed flood zones when re-evaluated with LiDAR will help first responders to efficiently decide which areas need to be a priority.

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