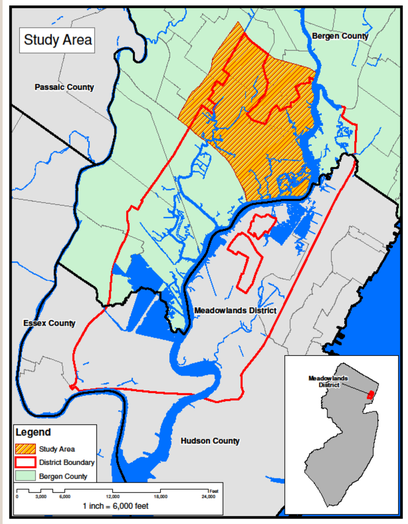
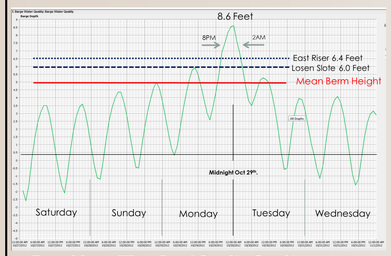
Flood Vulnerability Study for Carlstadt, Little Ferry, and Moonachie: A Post-Sandy Analysis

ABSTRACT



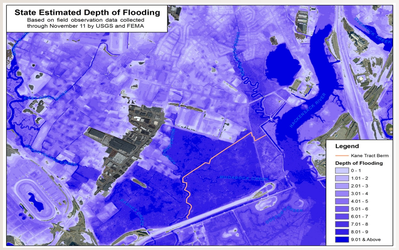
Flooding during extreme storms is a fact of life in the low-lying areas of Carlstadt, Moonachie, Little Ferry and South Hackensack (Bergen County, New Jersey). City planning and emergency response management call for models that can reliably predict flooding in urbanized areas. Measuring surge risk in an urban area requires an understanding of both the natural and artificial features. This study attempts to identify areas most vulnerable to flooding within 5,600 acres of urban area in Northern New Jersey. Two different approaches were used- cost distance analysis and overlay analysis. Topography, storm water infrastructure, ditch networks, and land use were evaluated against recorded high water marks and an NJDEP model of water depths during Sandy. The result is a flood vulnerability index map showing areas in need of fortification to prevent future flooding due to sea surge events and a methodology that may be used to assess vulnerability to sea surge flooding in other areas with similar characteristics.

SUPER STORM-SANDY

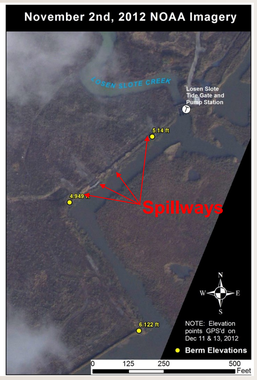


Barge Marina Water Level Oct. 27– Oct. 31

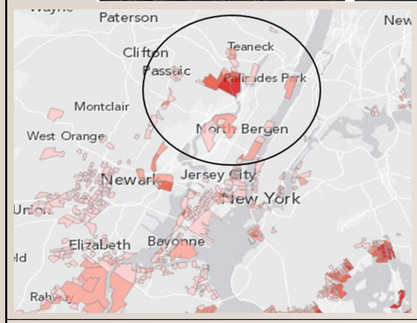
The highest confirmed water marks at the River Barge Park, Carlstadt, NJ was 8.6 feet. There were three tidal cycles which exceeded the mean berm of 5 feet. One of those cycles lasted about 7 hours.



Streams and ditches carried water throughout the area, leading to flooding. Most of the berms failed creating spillways as seen on the right.

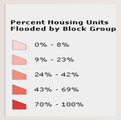


These aerials shows where water overtopped the berm and increased the amount of water flowing in the area.



Hurricane Sandy Damage Estimates by Block Group

http://www.huduser.org/maps/map_sandy_blockgroup.html



New Jersey Meadowlands Commission

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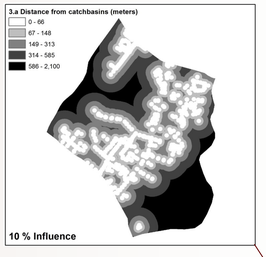
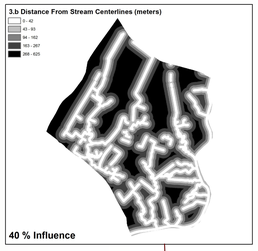
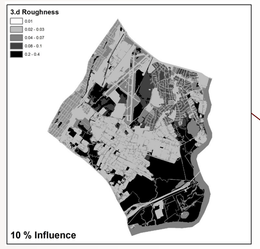
METHODOLOGY

Weighted Overlay Approach

The first approach was a weighted overlay of five input raster. Because the flood hazard index was being created for a storm surge event, it was determined that distance from streams along with elevation and slope were the driving factors in rating an area's vulnerability while roughness and distance from catch basins were secondary in the amount of influence they would have.



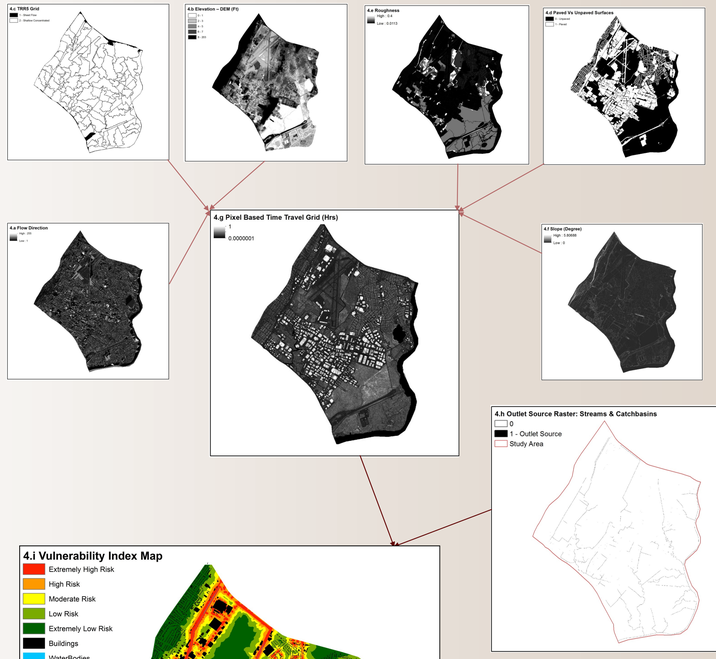


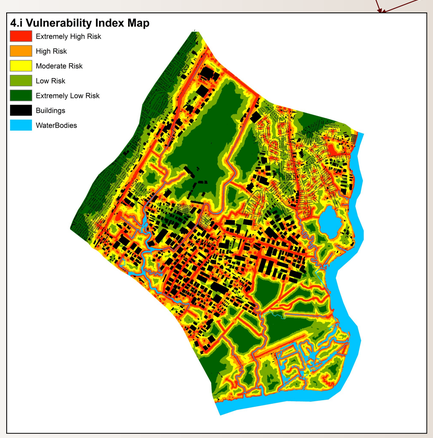


The vulnerability map for the weighted overlay approach shows that there is a high risk of flooding near the streams. Elevation and slope place a large influence on the model. The cost distance method places an emphasis on the streams and catch basins, so those areas have an extremely high risk of flooding. These outlet sources were too influential, while elevation was not as significant.

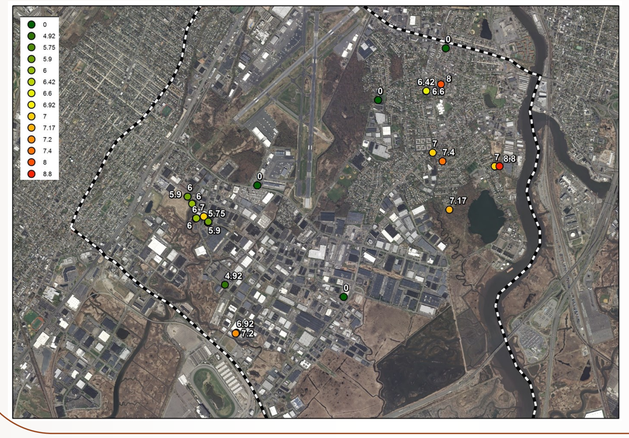
Cost Distance Analysis

A cost distance analysis uses a pixel based time travel grid as the input cost surface with waterways and catch basins as outlet sources. The pixel based time travel grid contained values for a specified amount of water to move across each pixel. This model calculated the cost for the water to drain to the closest outlet source. The inverse of this model was applied to understand how water would move in the event of a tidal surge.





HURRICANE SANDY HIGH-WATER MARKS



Regression Analysis

The Vulnerability Index Maps were compared to the Hurricane Sandy High-Water Marks (left). The correlation of each when compared to the post-Sandy field elevation and USGS water elevation are shown below. It was determined that the Weighted Overlay Approach has a higher correlation, so it is more effective in modeling the flood vulnerability in the study area.

	Weighted Overlay	Cost Distance
Post-Sandy Field Elevation	0.82	0.45
USGS Water Elevation	0.79	0.35

RESULTS

The Weighted Overlay approach produced the model that closest resembles the Hurricane Sandy High-Water Marks. This model can be easily replicated using prominent features of other locations.

In the event of a storm surge, we are able to provide towns with an accurate flood model. We can also use this model to give engineers a better understanding of the area for flood prevention initiatives.