Hydrodynamic/GIS Simulation of Storm Surge Flooding in the NY/NJ Harbor System

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Overview

- Hydrodynamic simulations of extreme surge event (Hurricane Donna, September 1960)
- Operations of four storm surge barriers under projected sea level rises
- Assessment of inundation areas using GIS model
ECOMSED Features

- 3D Hydrodynamic Model
  Current
  Temperature
  Salinity
  Water Levels
  Turbulence closure model

- Flexible Grid System: Orthogonal Curvilinear (Horizontal) and Sigma coordinates (vertical)
Input data required:
- Water elevations: Global Tidal Model and NOAA Sandy Hook station
- Wind data from Atlantic City, Newark, LaGuardia, Bridgeport, and Groton

Simulation period: September 1960

Available field data:
- NOAA tide gages
- Maximum storm surge data
Figure 3. Comparisons of Computed and Observed Hourly Water Surface Elevations During Hurricane Donna
### Projection Scenarios

<table>
<thead>
<tr>
<th></th>
<th>Sea Level Rise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Sea Level</td>
<td>-</td>
</tr>
<tr>
<td>2020’s</td>
<td>9.4 cm (3.7 inches)</td>
</tr>
<tr>
<td>2050’s</td>
<td>24.6 cm (9.7 inches)</td>
</tr>
<tr>
<td>2080’s</td>
<td>45.2 cm (17.8 inches)</td>
</tr>
</tbody>
</table>

Source: New York City Panel on Climate Change, 2009, Climate Risk Information
Development of a Digital Elevation Model (DEM)

- Spot Elevations obtained from New York City Department of Information Technology and Telecommunications (NYCDoITT)
- Isolated true terrain elevation points (removed elevated transportation structures, buildings, etc)
Development of a Digital Elevation Model (DEM)

- Generated Triangulated Irregular Network (TIN)
- Developed an ESRI Grid with 100ftx100ft cells
Inundation Mapping

- Storm surge values from model output were assigned at 50 foot intervals along shoreline.
- A series of iterative steps were performed in GIS starting with the lowest surge elevation and flooding all adjacent cells with a terrain elevation less than the surge value.
Inundated Land Area - Approximate Reduction of 25%
Inundated Land Area - Approximate Reduction of 25%

Current Sea Level

- Blue: Inundated Area with Storm Surge Barriers (sq km)
- Yellow: Inundated Area without Storm Surge Barriers (sq km)

<table>
<thead>
<tr>
<th>Location</th>
<th>Inundated Area with Storm Surge Barriers</th>
<th>Inundated Area without Storm Surge Barriers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manhattan</td>
<td>2.3</td>
<td>5.3</td>
</tr>
<tr>
<td>Bronx</td>
<td>5.9</td>
<td>7.1</td>
</tr>
<tr>
<td>Brooklyn</td>
<td>17.8</td>
<td>23.1</td>
</tr>
<tr>
<td>Queens</td>
<td>23.4</td>
<td>32.2</td>
</tr>
<tr>
<td>Staten Island</td>
<td>13.5</td>
<td>18.4</td>
</tr>
<tr>
<td>NYC</td>
<td>63.0</td>
<td>86.1</td>
</tr>
</tbody>
</table>
Affected Population - Approximate Reduction of 20%
Affected Population - Approximate Reduction of 20%
Affected Property Value - Approximate Reduction of 35%
Affected Property Value - Approximate Reduction of 35%
Hazardous Material/Waste Sites Impacted – Approximate Reduction of 50%
Hazardous Material/Waste Sites Impacted – Approximate Reduction of 50%
Summary

- Significant reduction in inundated area, affected population, affected property values, and hazardous waste sites with storm surge barriers in place
- Suggestions for more detailed analysis:
  - detailed data for shoreline features (bulkheads, etc)
  - integrating population projections for future scenarios
  - detailed information on property value and extent of damage
  - critical infrastructure impacted: WPCPs, subway station entrances, power grid, etc.