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

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Overview

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

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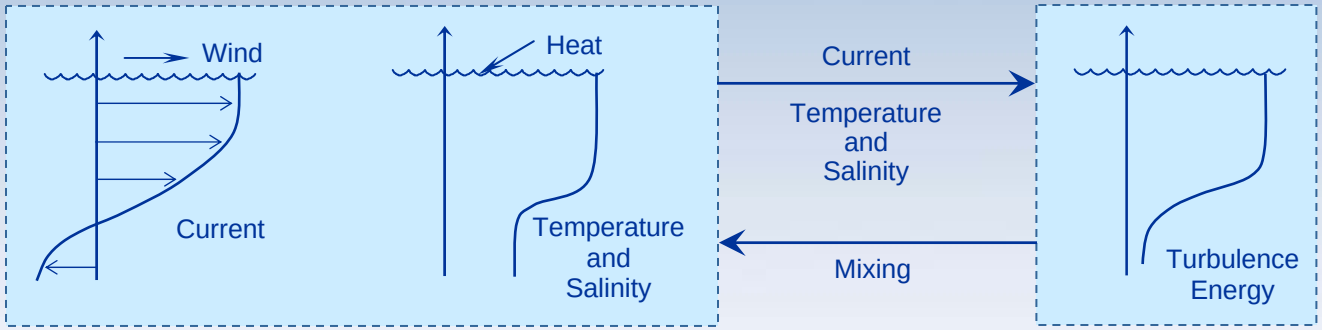
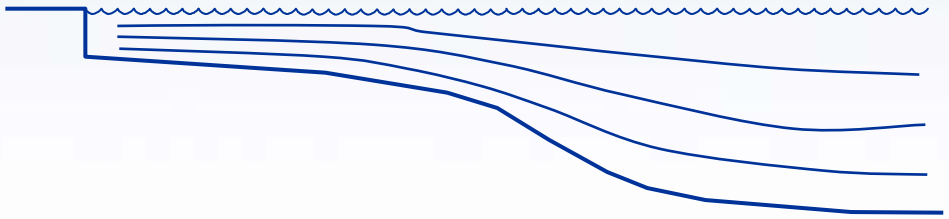
ECOMSED Features

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



- Flexible Grid System: Orthogonal Curvilinear (Horizontal) and Sigma coordinates (vertical)



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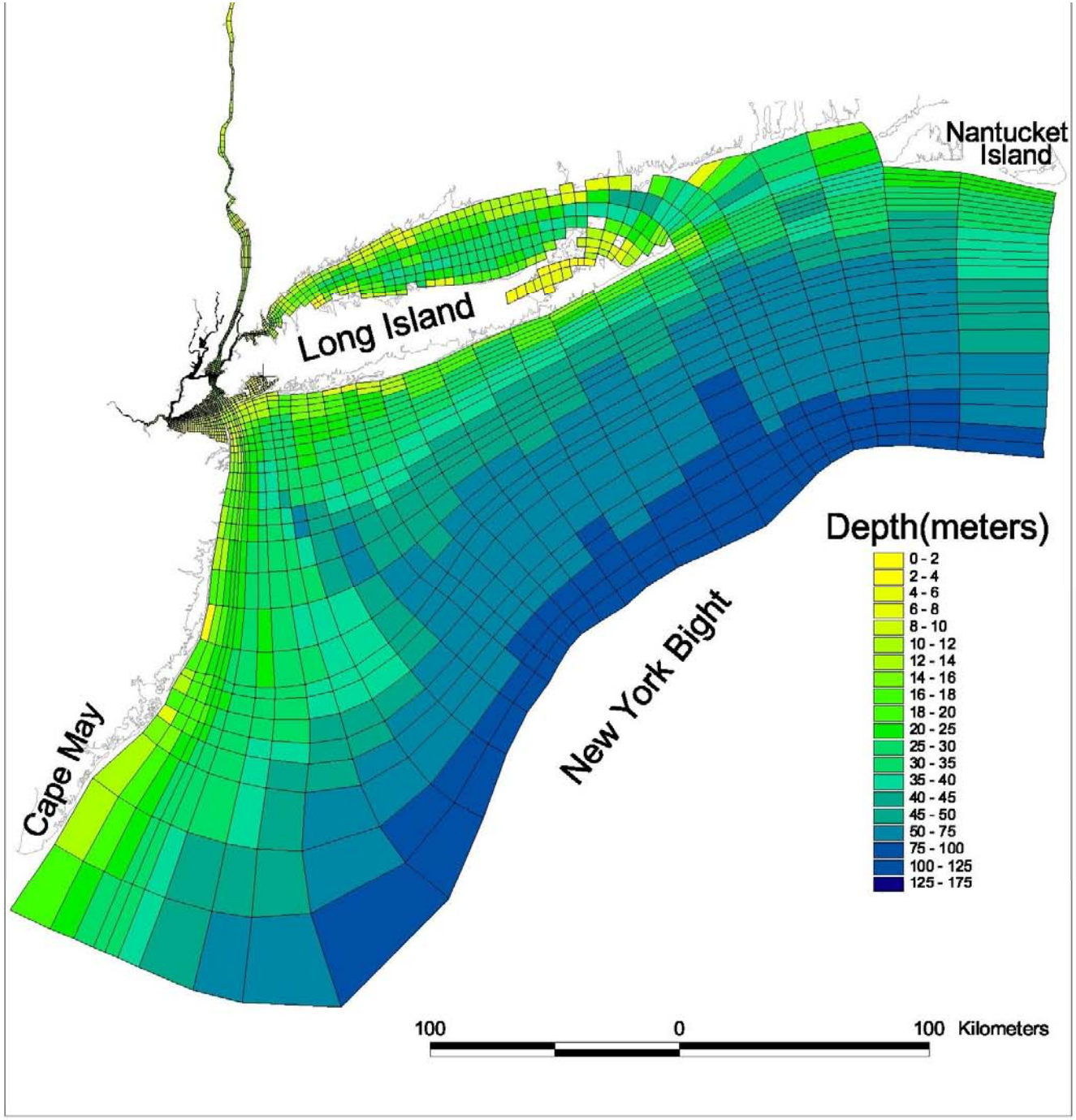
Nantucket Island
Long Island
New York Bight
Cape May
Depth(meters)
0 - 2
2 - 4
4 - 6
6 - 8
8 - 10
10 - 12
12 - 14
14 - 16
16 - 18
18 - 20
20 - 25
25 - 30
30 - 35
35 - 40
40 - 45
45 - 50
50 - 75
75 - 100
100 - 125
125 - 175
100
0
100 Kilometers

CALIBRATION OF MODEL

- 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

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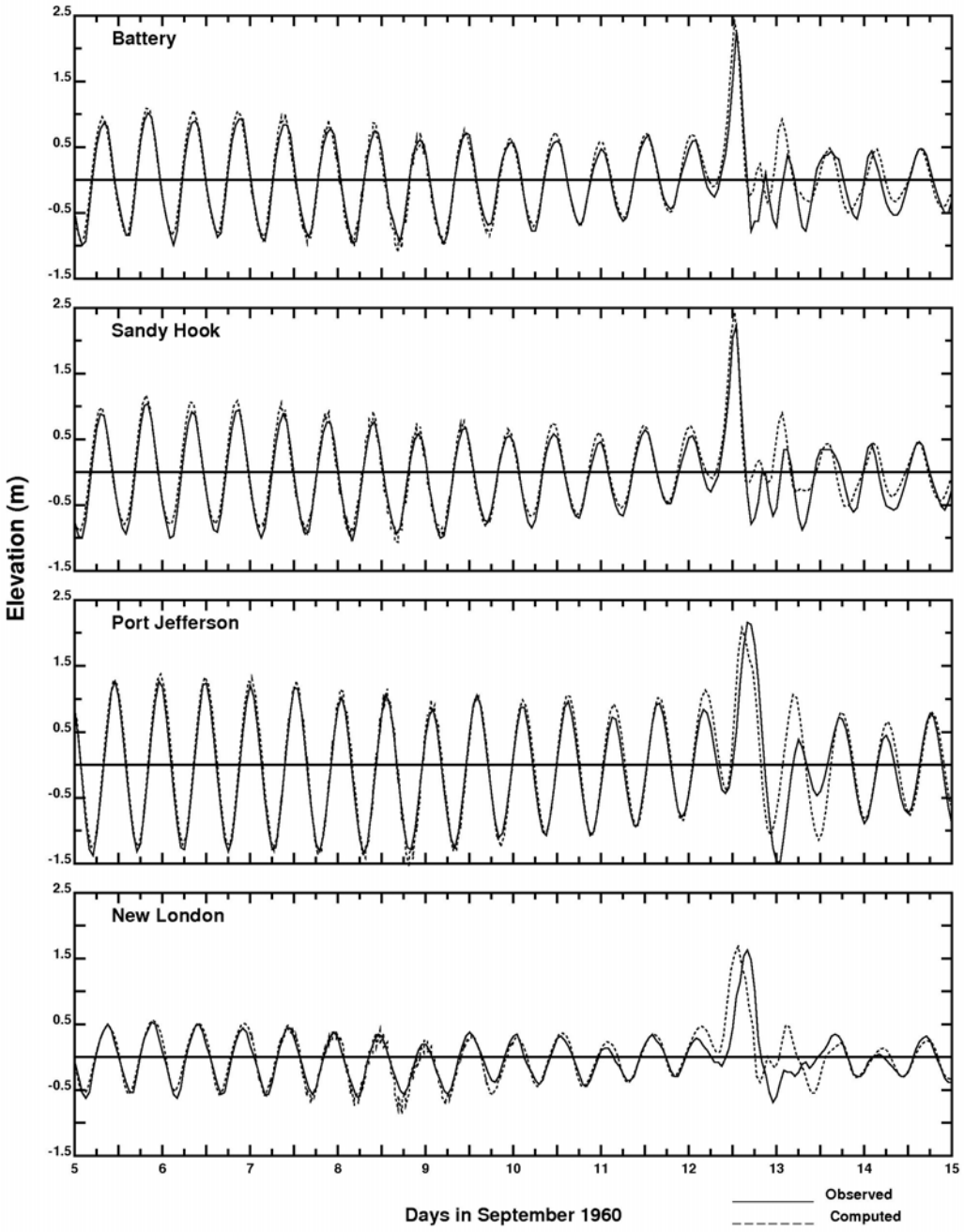
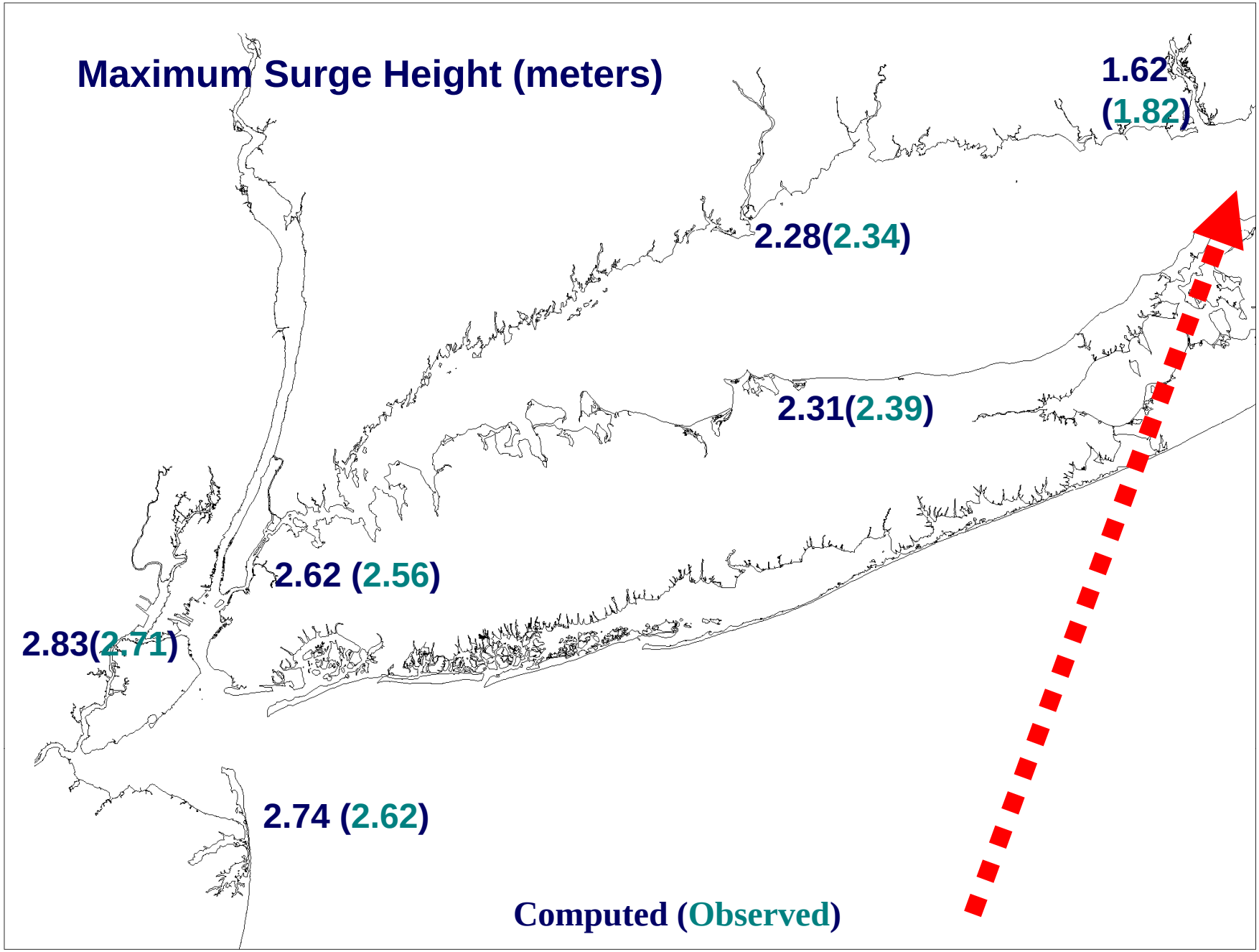


Figure 3. Comparisons of Computed and Observed Hourly Water Surface Elevations During Hurricane Donna


Maximum Surge Height (meters)
1.62
(1.82)
2.28(2.34)
2.31(2.39)
2.62 (2.56)
2.83(2.71)
2.74 (2.62)
Computed (Observed)

Projection Scenarios

	Sea Level Rise
Current Sea Level	-
2020's	9.4 cm (3.7 inches)
2050's	24.6 cm (9.7 inches)
2080's	45.2 cm (17.8 inches)

Source: New York City Panel on Climate Change, 2009, Climate Risk Information

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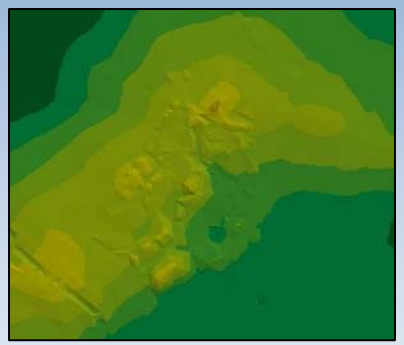
Development of a Digital Elevation Model (DEM)

- 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)

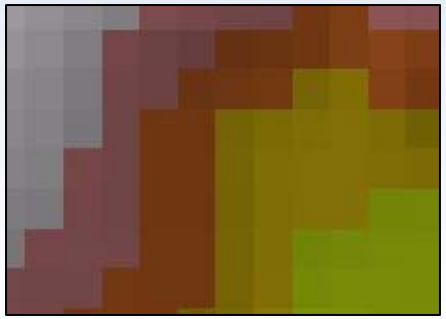
Development of a Digital Elevation Model (DEM)

- Generated Triangulated Irregular Network (TIN)



Elevation Data as TIN

- Developed an ESRI Grid with 100ftx100ft cells



Elevation Data as Grid

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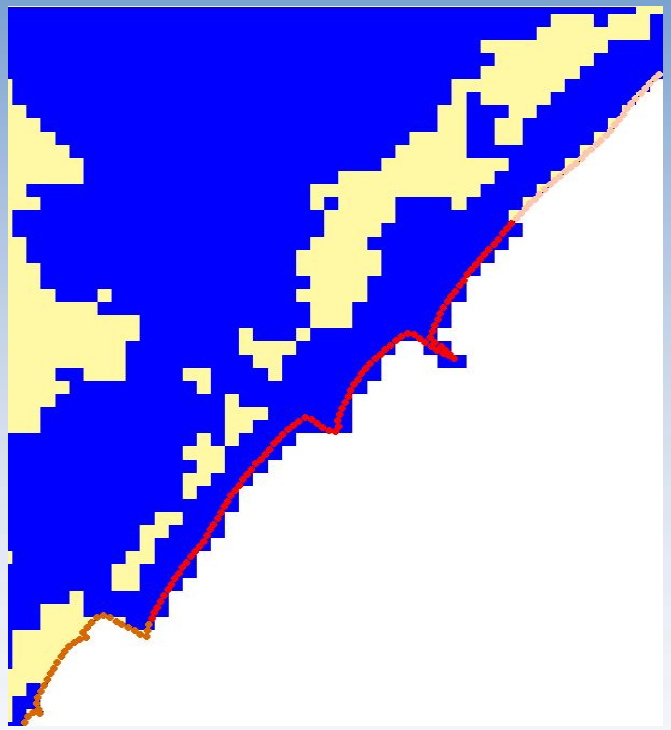
Inundation Mapping

- 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



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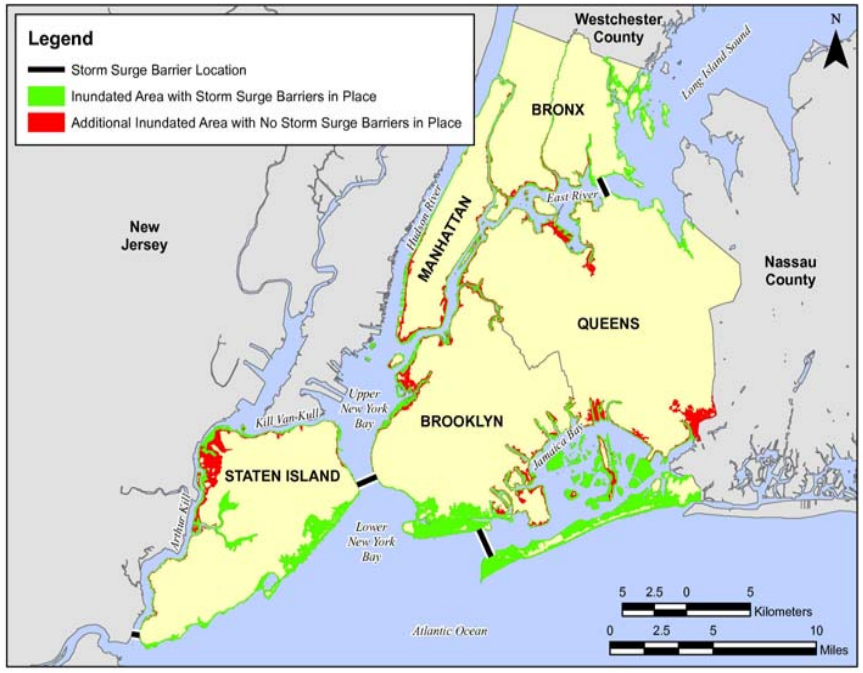
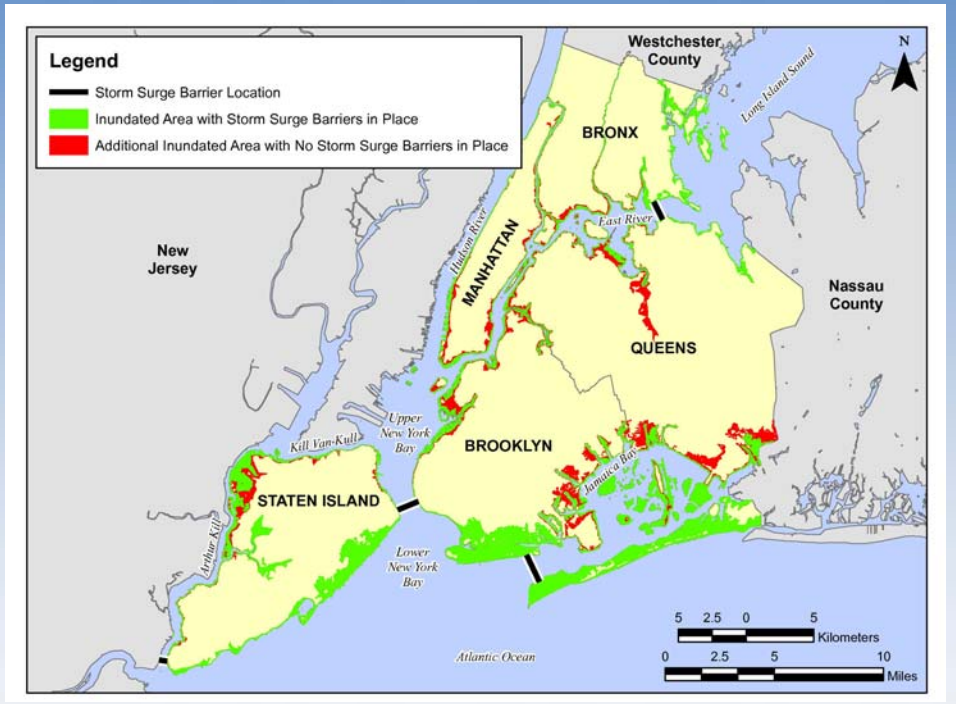
Overview of Inundation Zones

Current Sea Level





2080's Sea Level

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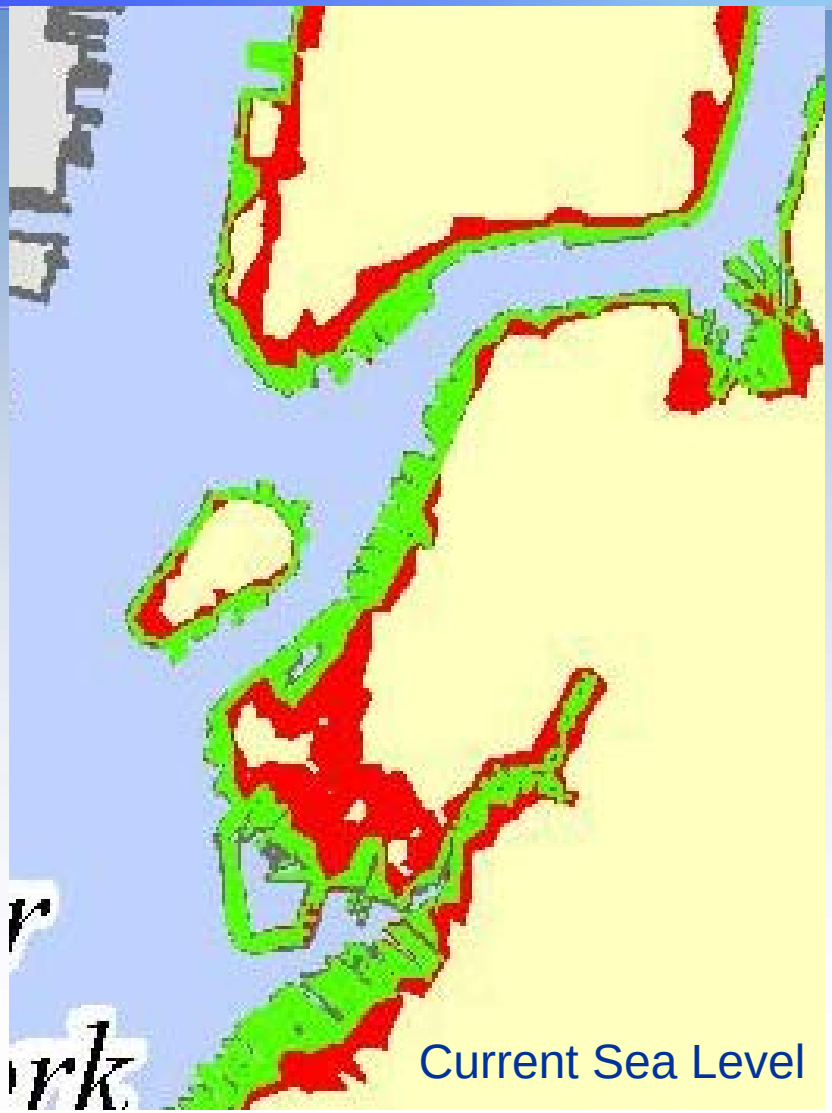
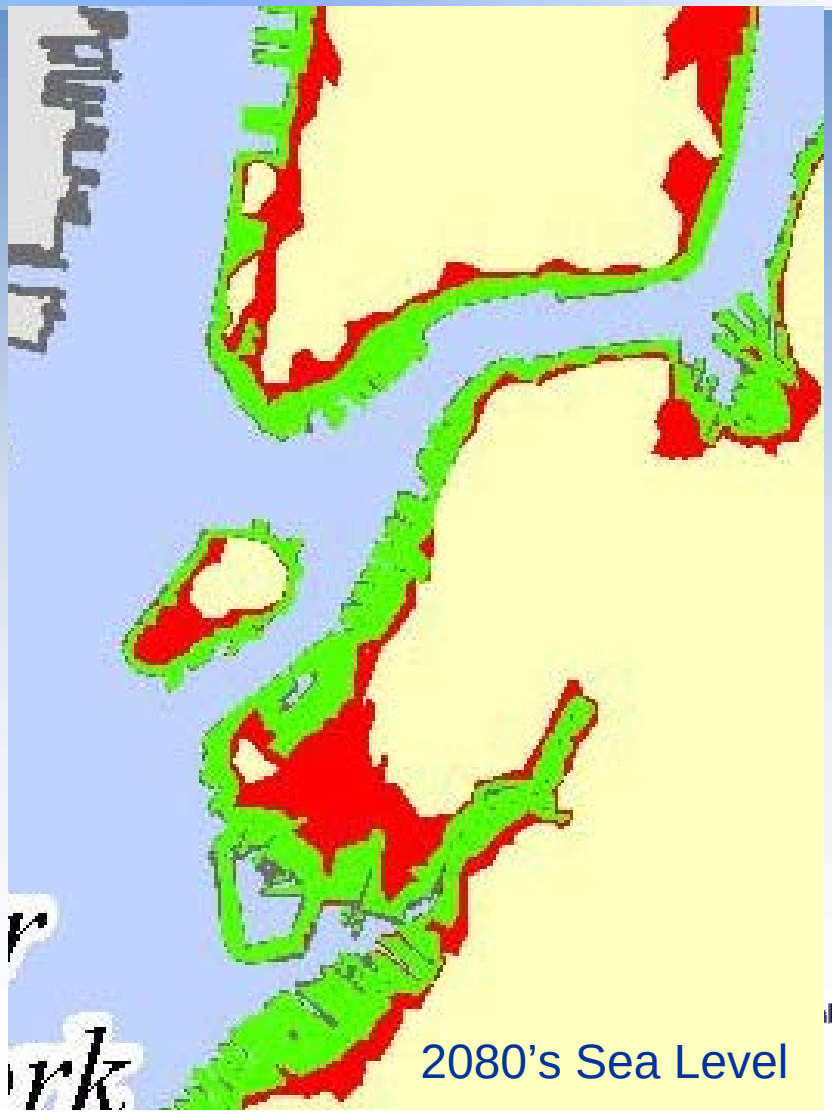
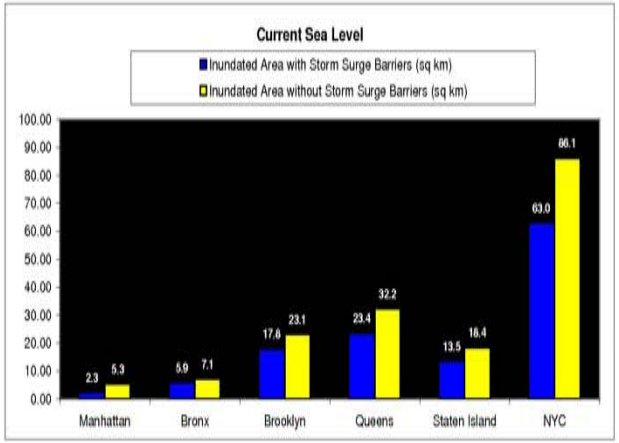
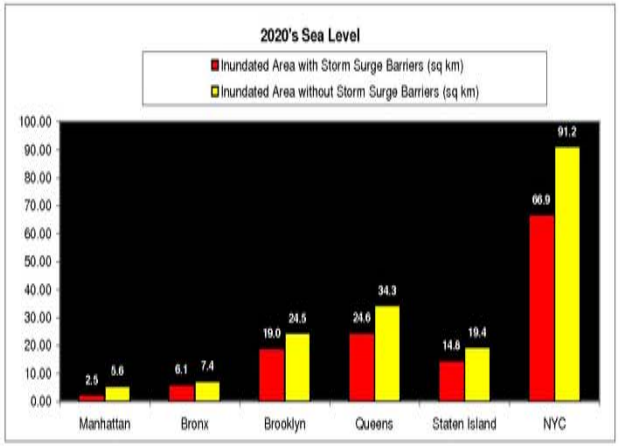
Inundation Zones - Closeup

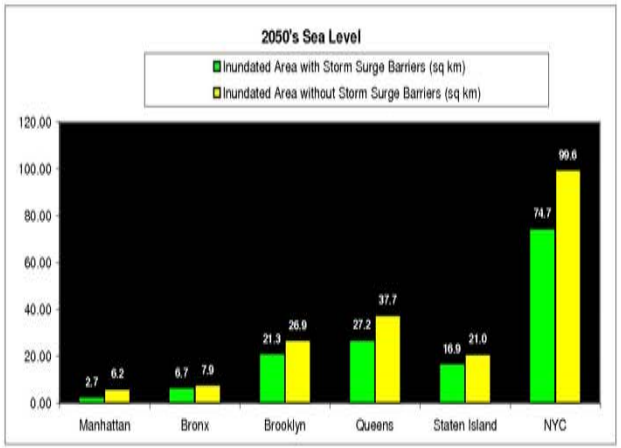


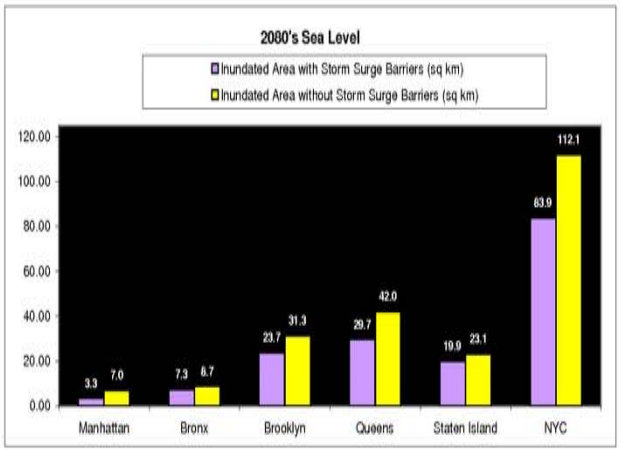


Inundated Land Area - Approximate Reduction of 25%









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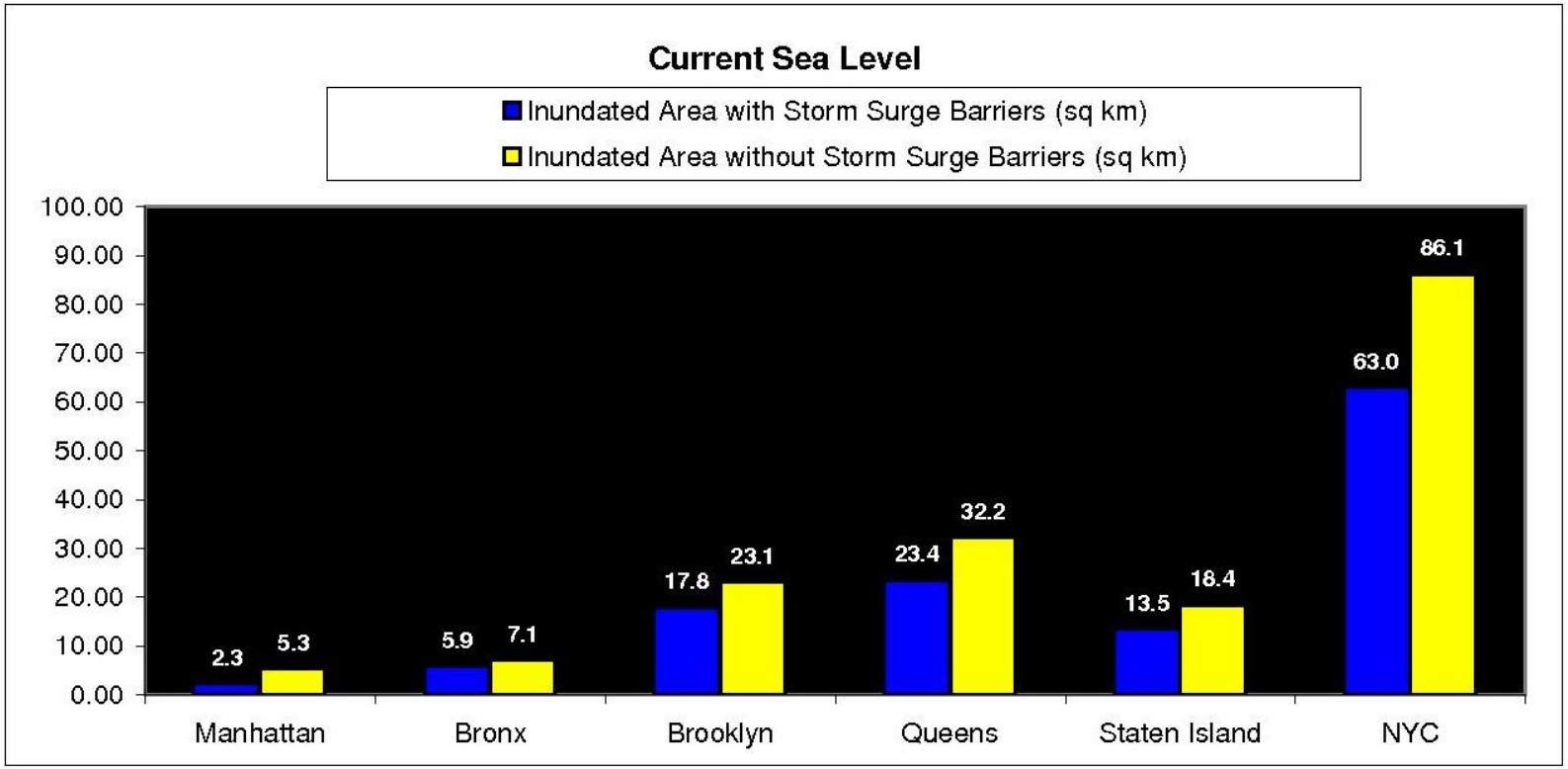

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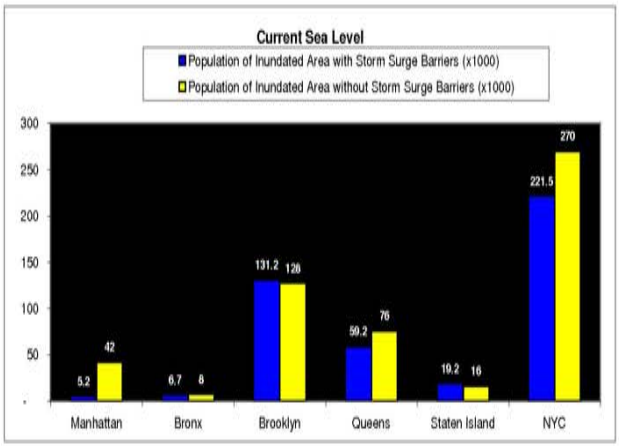
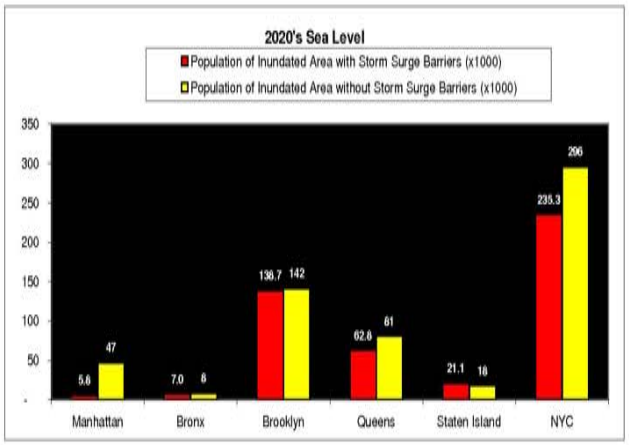
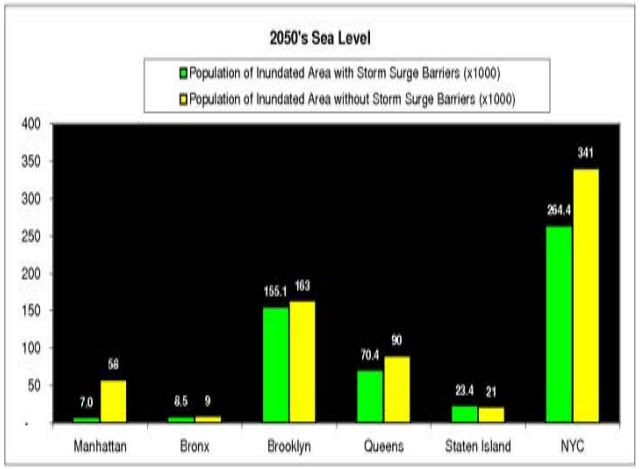
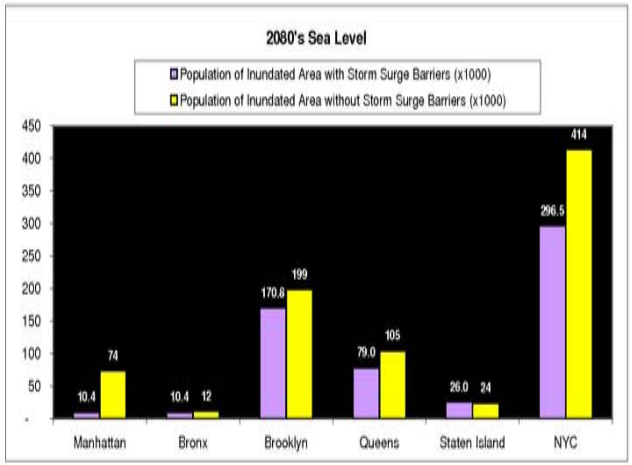
Affected Population - Approximate Reduction of 20%









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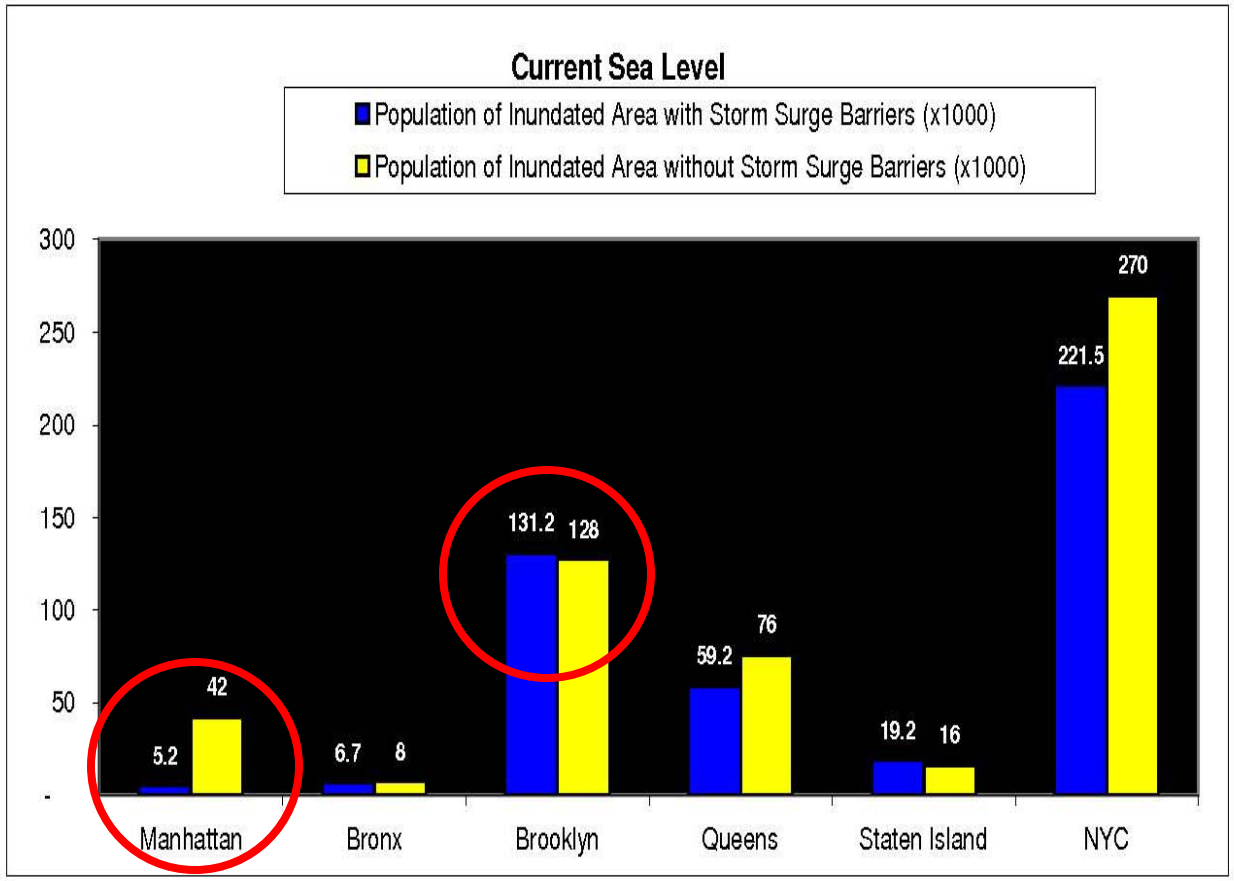

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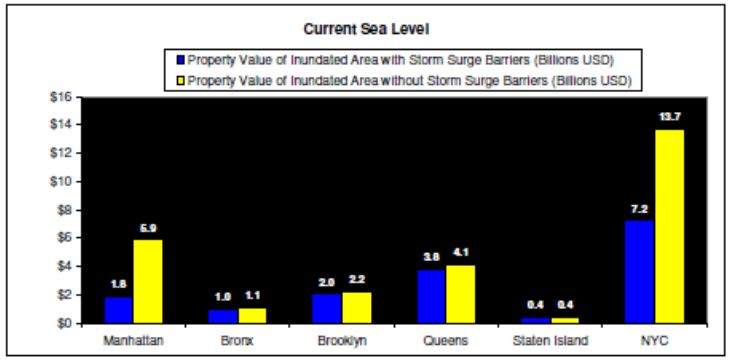
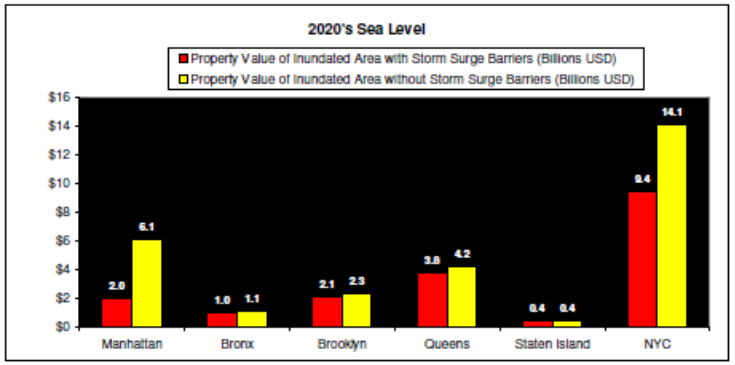
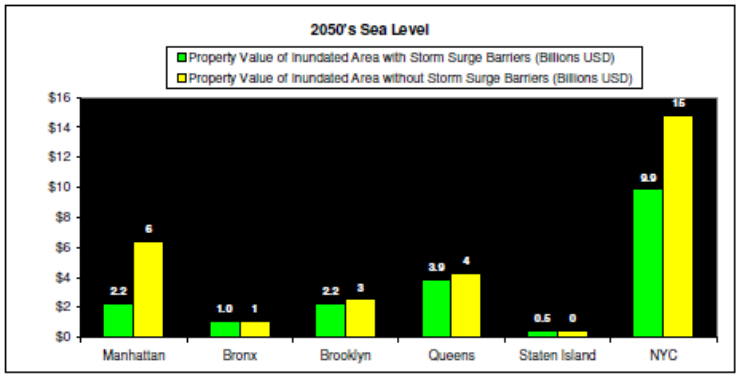
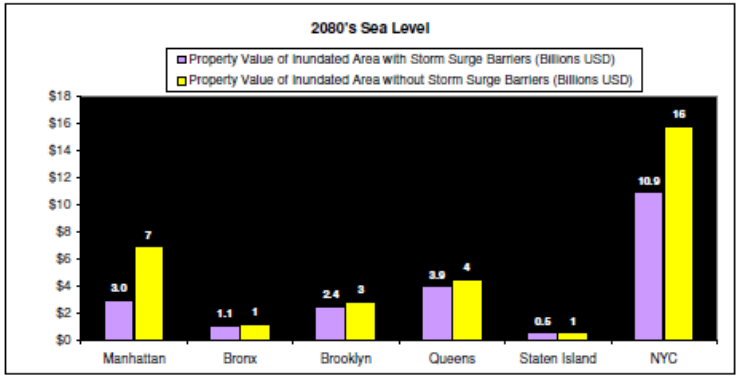
Affected Property Value - Approximate Reduction of 35%









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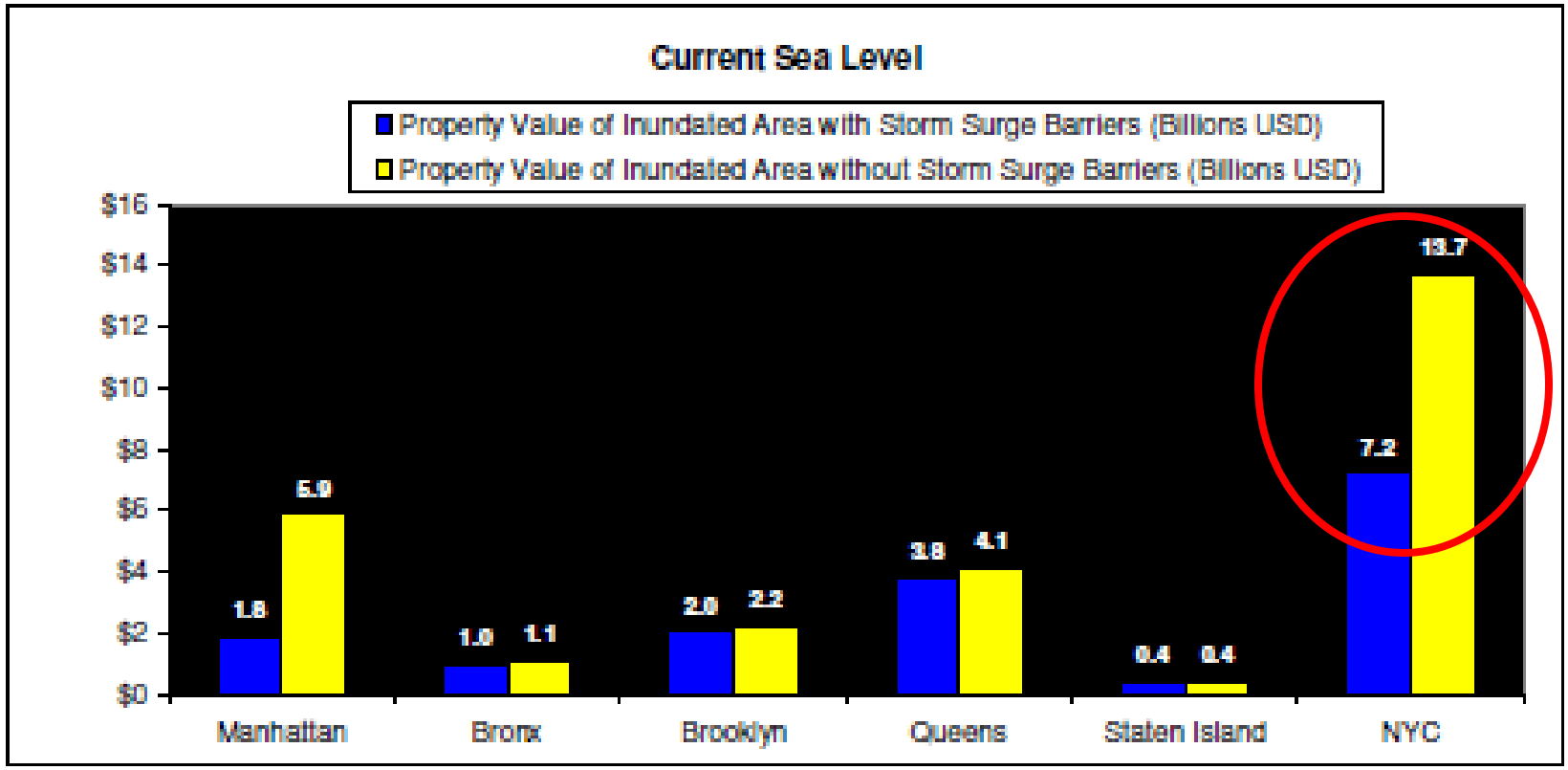
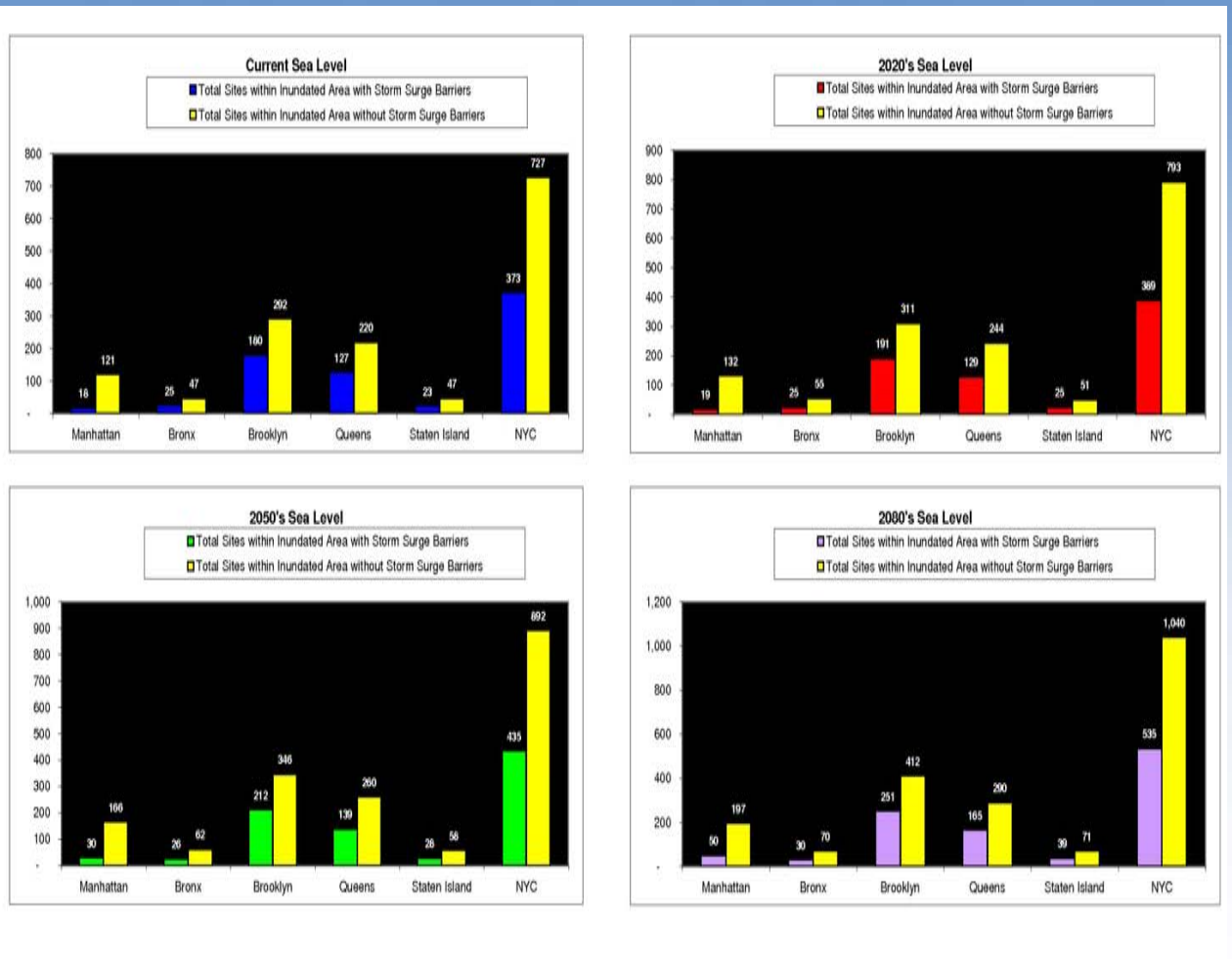


Hazardous Material/Waste Sites Impacted – Approximate Reduction of 50%



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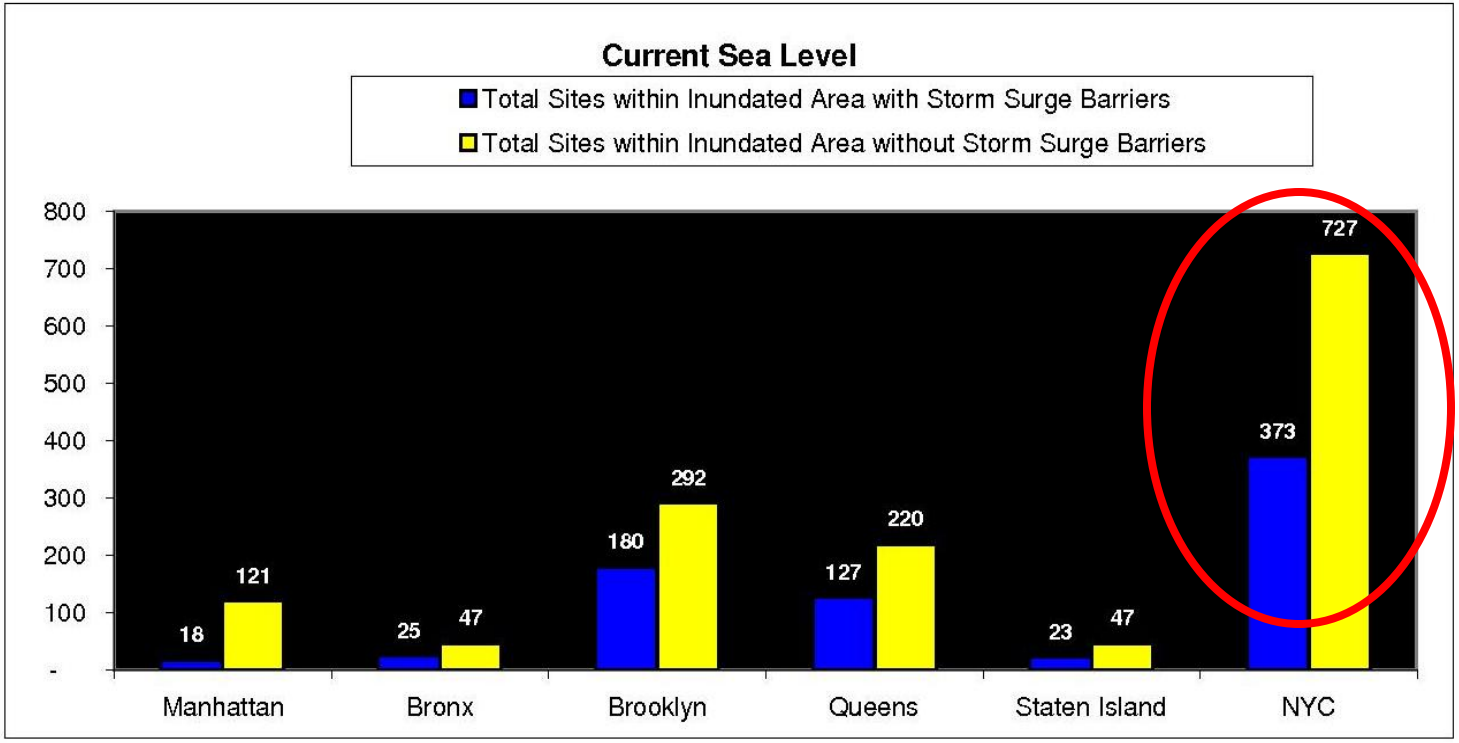

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Summary

- 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.