Collaborative Climate Adaptation Planning for Urban Coastal Flooding

Philip Orton[1], Tanya Marione-Stanton[2], Naomi Hsu[2], Jeffrey Wenger[2], Douglas Greenfeld[2,3], Maryann Bucci-Carter[2], Sergey Vinogradov[1], Alan Blumberg[1], Robert Cotter[2]

1: Davidson Laboratory, Stevens Institute of Technology, 2: Jersey City Department of City Planning, 3: now at North Jersey Transportation Planning Authority

Funding from: NOAA Sea Grant, Together North Jersey

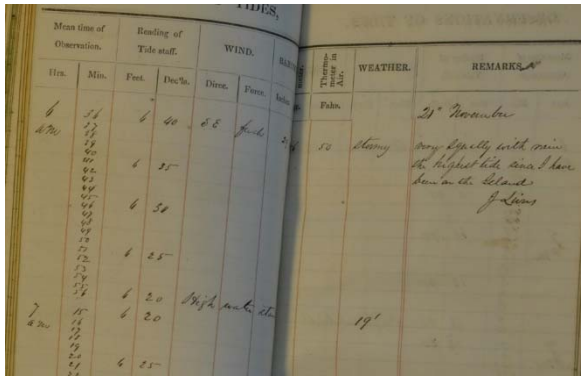
Thanks to: CUNY's High Performance Computing Center at the College of Staten Island

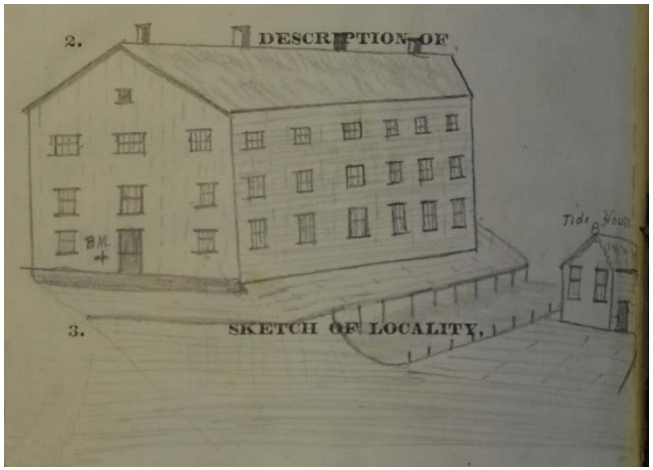
Outline

- Introduction:
  - Historical coastal flooding
  - The region's flood hazard
  - Sea level rise impacts
- Sea Grant project objectives, tasks, limitations
- Results: Hurricane Sandy simulation/validation
- Results: Coastal adaptation impacts on flooding
- Next steps, timeline

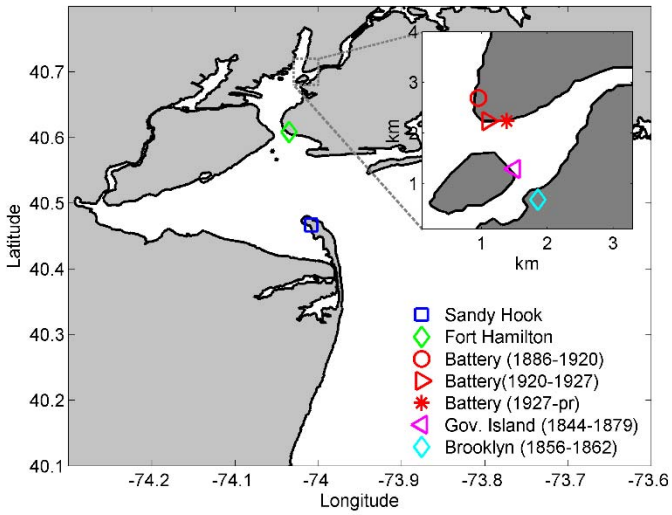
Historical Changes in Storm Tides

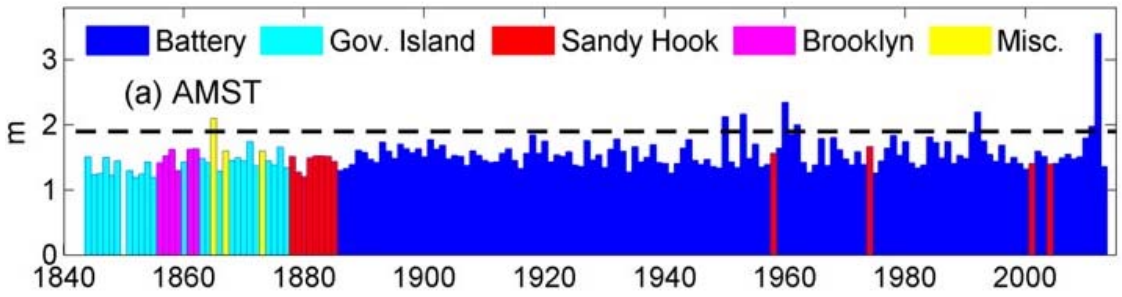
Talke, Orton, Jay – in press, *Geophysical Research Letters*





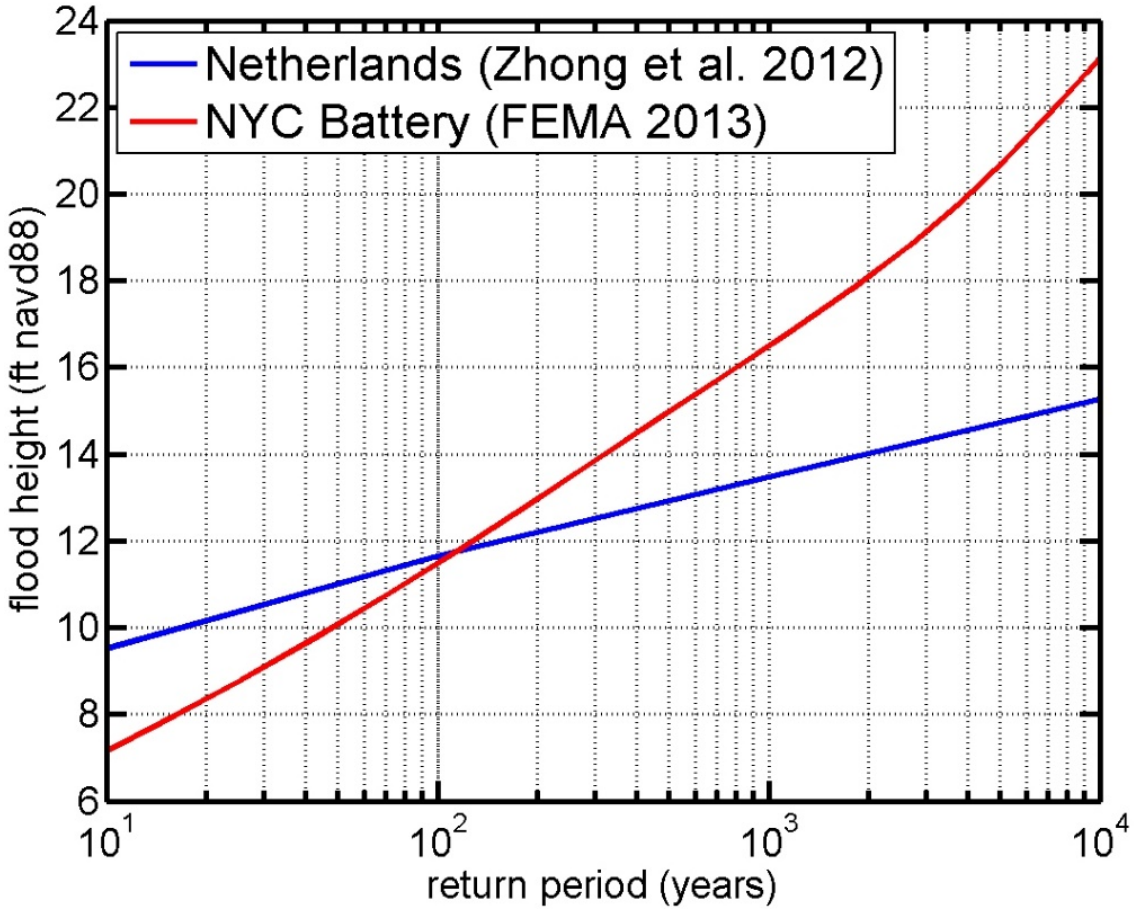
The Brooklyn Tide Gauge House and Benchmark at the Hamilton Ferry Dock in 1861. The 'Tide House' is the small building at right. Photograph by P. Lau at the US National Archives in College Park, MD.





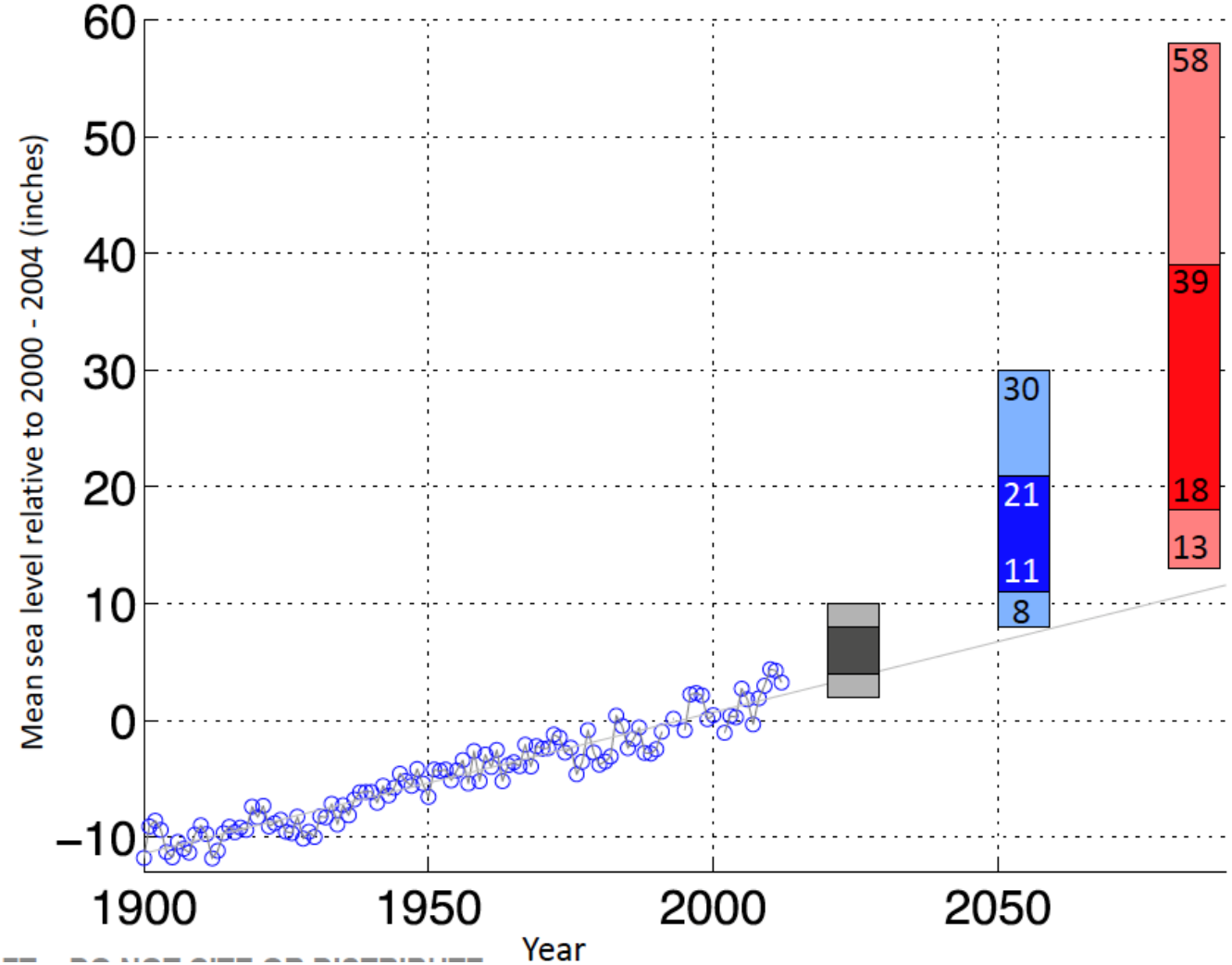
Annual Maximum Storm Tide (above MSL) from gauges around the New York Harbor area (map at left)

Defining the Hazard – Can Help Plan Adaptation
Flood Hazard Curves: NY/NJ vs Netherlands

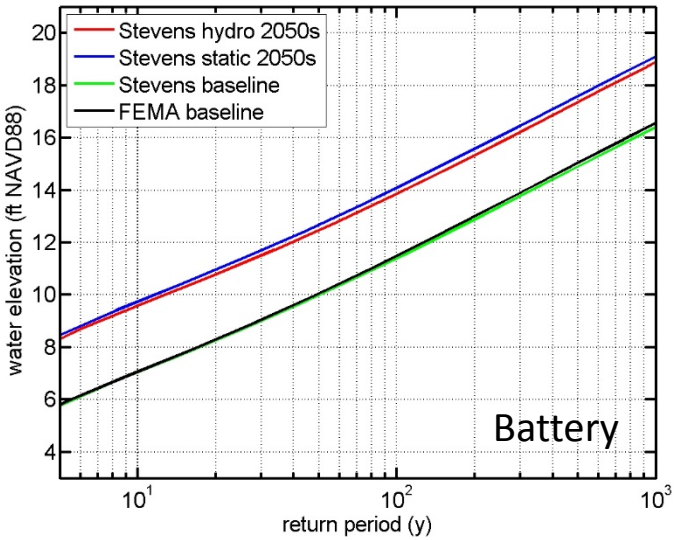


- There is no such thing as **total** coastal protection at NY/NJ Harbor
- Can raise barriers, but will **still** need to evacuate
- Must elevate systems, not only build barriers

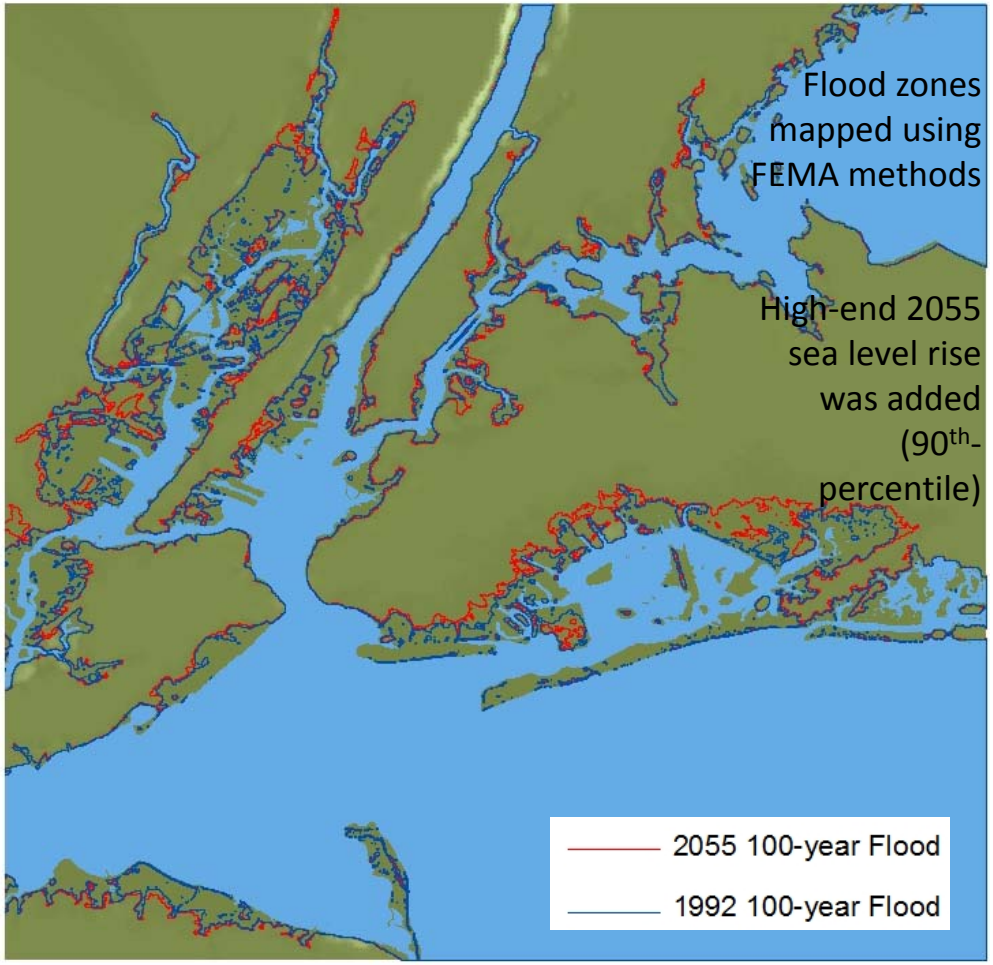
2014 NPCC Sea Level Rise Projections



Hydrodynamic Modeling of Sea Level Rise



Hydrodynamically-modeled 100y flood zone map



Sea Grant / Jersey City: Stevens Project Goals

- To provide basic information on flooding for JC planners
  - flood zone maps for the 2050s decade with climate change
  - map animations showing flood water pathways
- Help collaboratively develop a set of realistic coastal adaptation options
- Utilize storm surge modeling to evaluate each coastal adaptation, as well as how sea level rise and climate change will affect performance
- Transfer our knowledge more broadly around our region
  - write a report
  - publish the research in a peer-reviewed journal
  - have a final regional stakeholder meeting

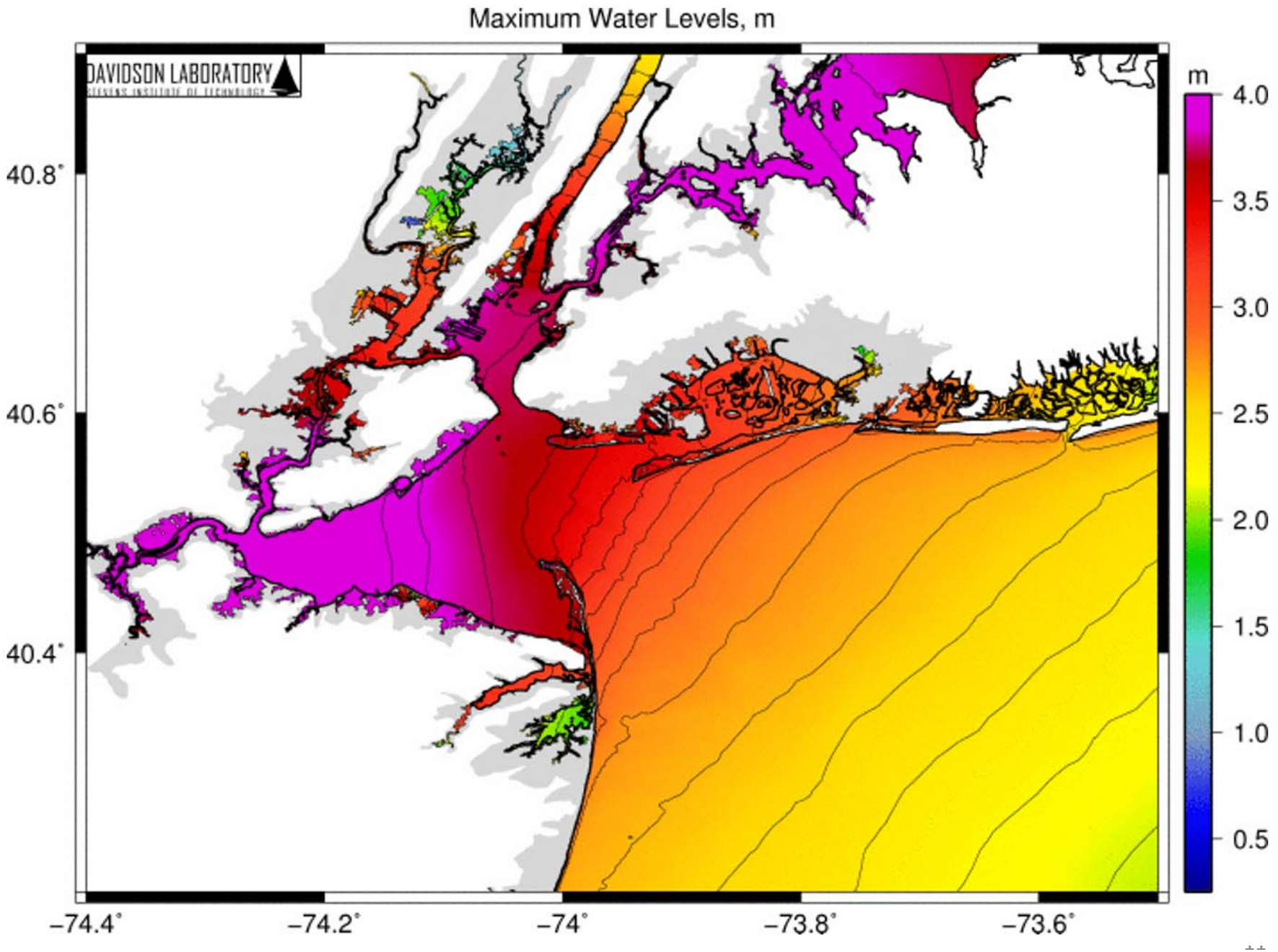
Sea Grant Project Phases/Tasks

- Phase 1: Data Collection
- Phase 2: Protection Development
  - Developed 22 measures
  - Designed for Sandy + 2050s 90th-percentile sea level rise
  - Testing on Hurricane Sandy
- Phase 3: Adaptation evaluation
  - Test/demonstrate effects of protections with five additional storms: Sandy plus sea level rise, Donna (1960), 1992 Nor'easter, category 3 hurricane, category-3 hurricane plus sea level rise
  - Show case study of how conditions (e.g. water velocity; ponding) are affected by a flood that is above the design height
- Phase 4: Final outreach

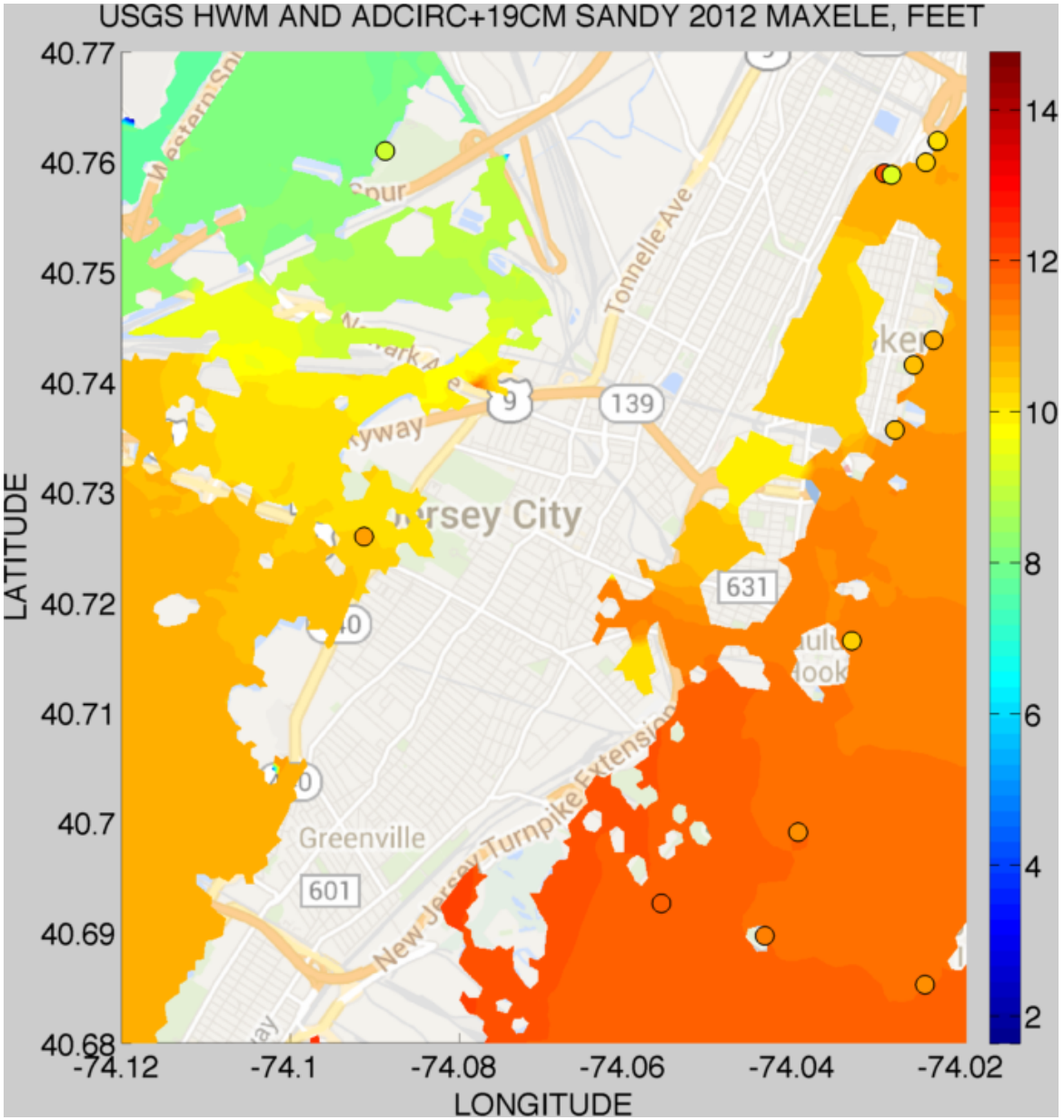
Project Limitations

- Storm tide modeling only
  - There is no quantification of rainfall, sewer system, land porosity (for rainfall flooding), pumps, sewer blockage
  - None of the adaptation measures relate to rainwater storage
  - There is no quantification of how rainfall drainage will increasingly be blocked by rising sea levels
- This is essentially a pilot study
  - Little (if any) cost-benefit considerations, no quantification; Baker will produce a white-paper on what should be done
  - The consideration of socio-political aspects, engineering aspects, etc. are somewhat limited
- Integration with Hoboken's plans is difficult but will eventually be useful

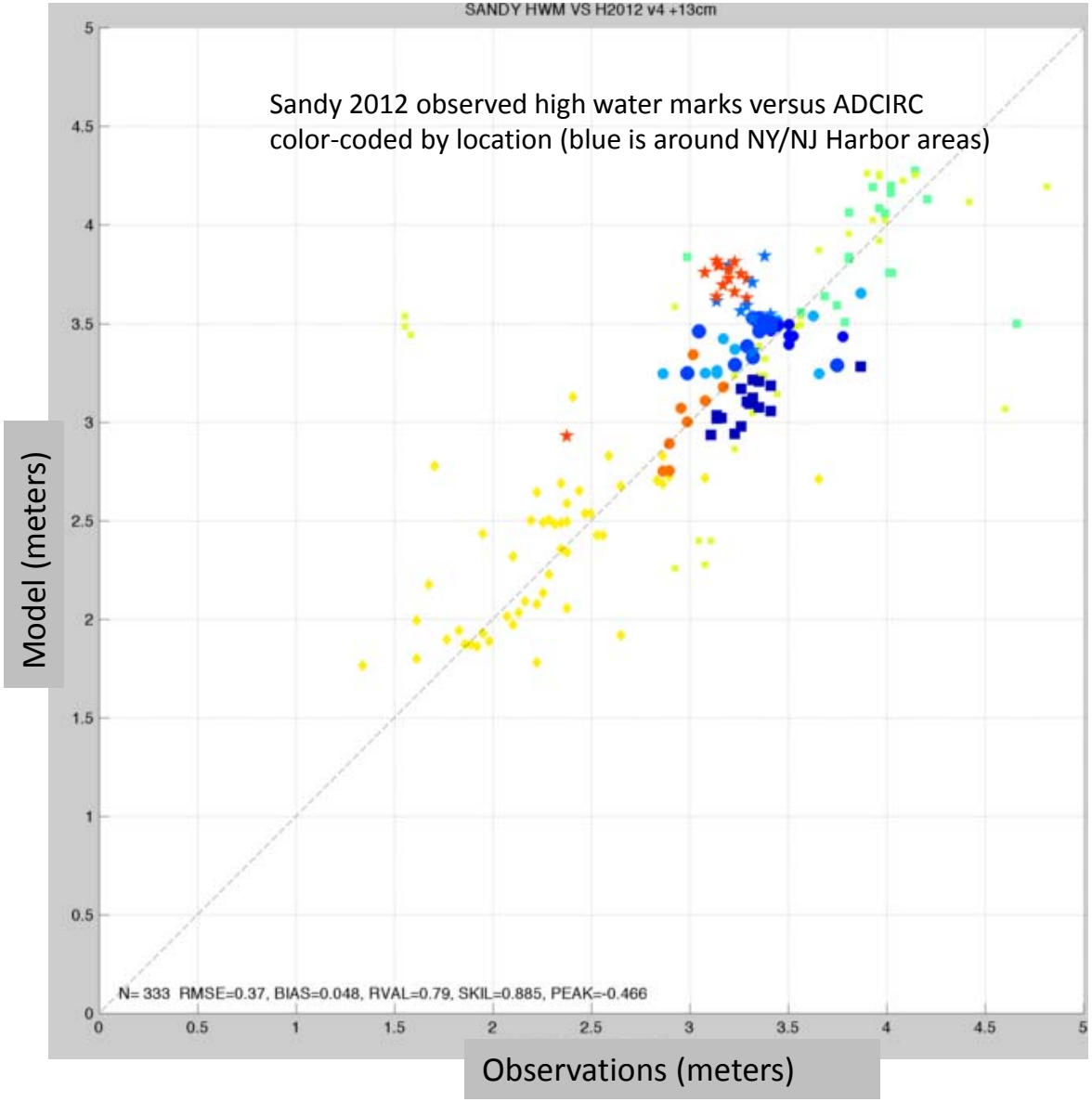
Hurricane Sandy:
Simulation and Validation


Maximum Water Levels, m
DAVIDSON LABORATORY
STEVENS INSTITUTE OF TECHNOLOGY
m
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
40.8°
40.6°
40.4°
−74.4°
−74.2°
−74°
−73.8°
−73.6°

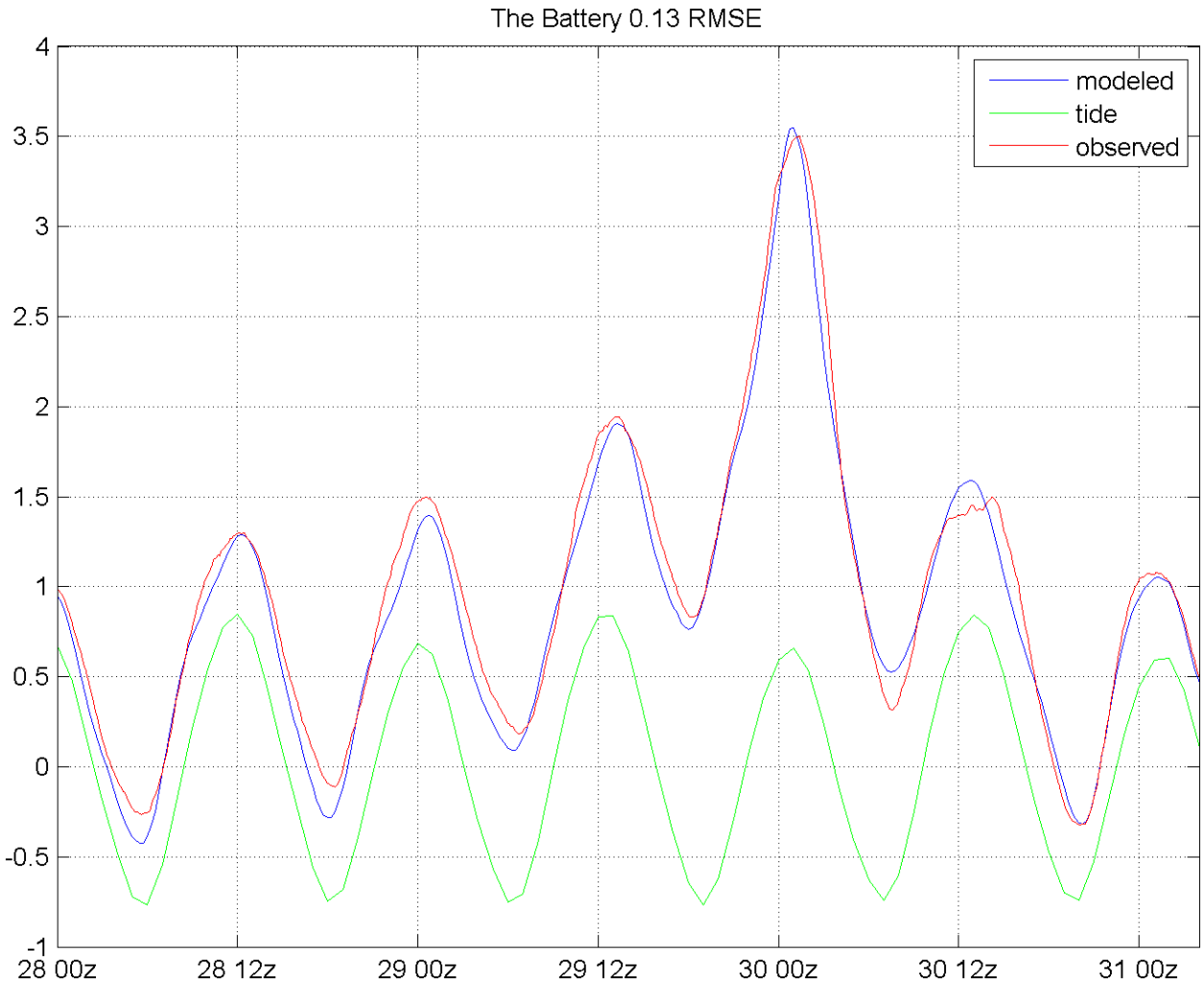
Modeled Flooded Area and Observations (circles)



Model Validation Across Region



Time-Series Validation in the Harbor




STEVENS
INSTITUTE of TECHNOLOGY
THE INNOVATION UNIVERSITY
DAVIDSON LABORATORY
CENTER FOR MARITIME SYSTEMS
2012-10-29 18:45 EDT
N
DOWNTOWN JERSEY CITY
Water Depth
Extreme > 9 ft
High 6~9 ft
Moderate 3~6 ft
Low 0~3 ft
Ground
Hudson River Water Elevation above Mean Sea Level
12 ft
6 ft
0 ft
28/18H
29/00H
29/06H
29/12H
29/18H
30/00H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2012-10-29 21:55 EDT
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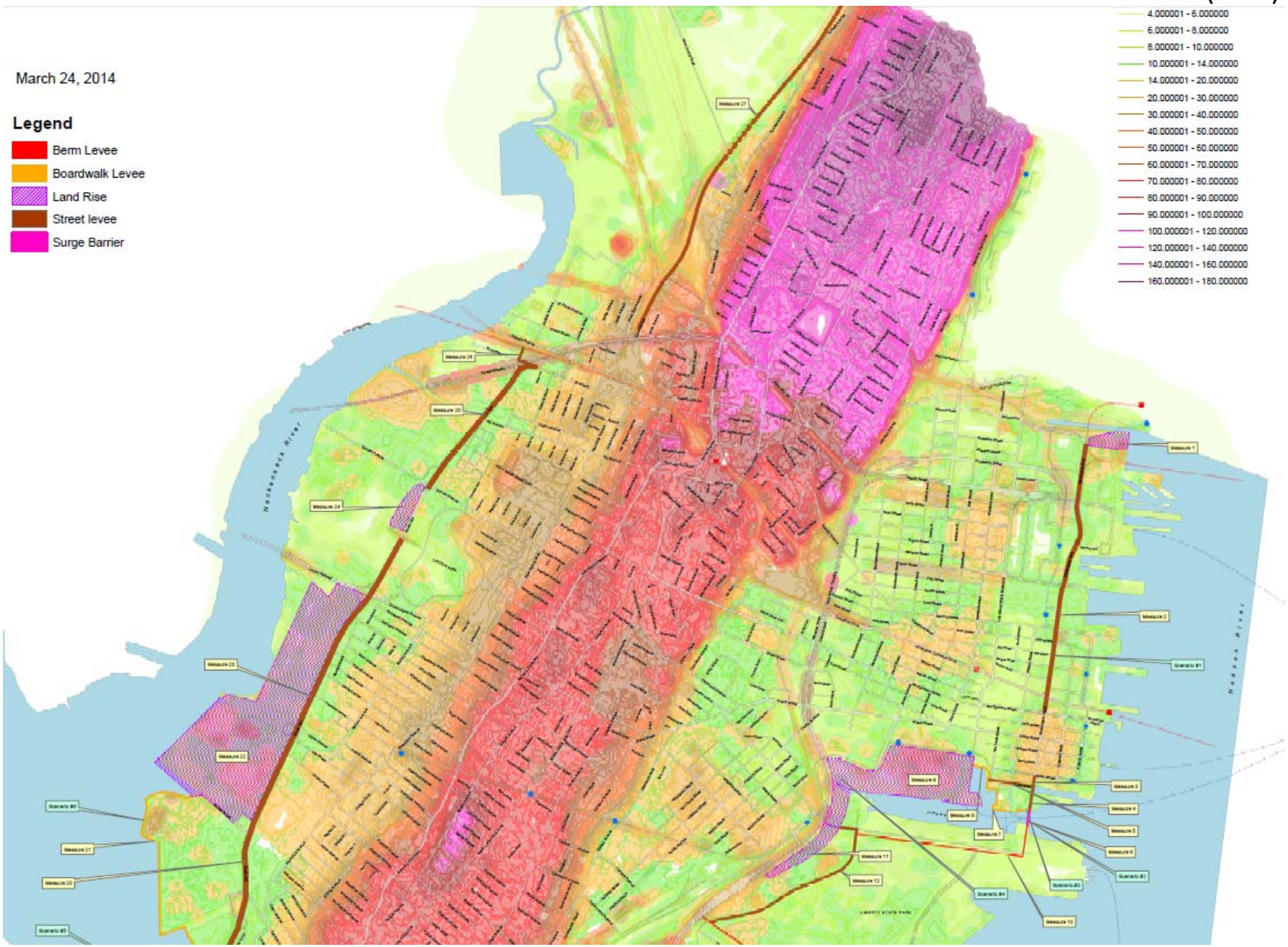
Ground
Hudson River Water Elevation above Mean Sea Level
12 ft
6 ft
0 ft
28/18H
29/00H
29/06H
29/12H
29/18H
30/00H

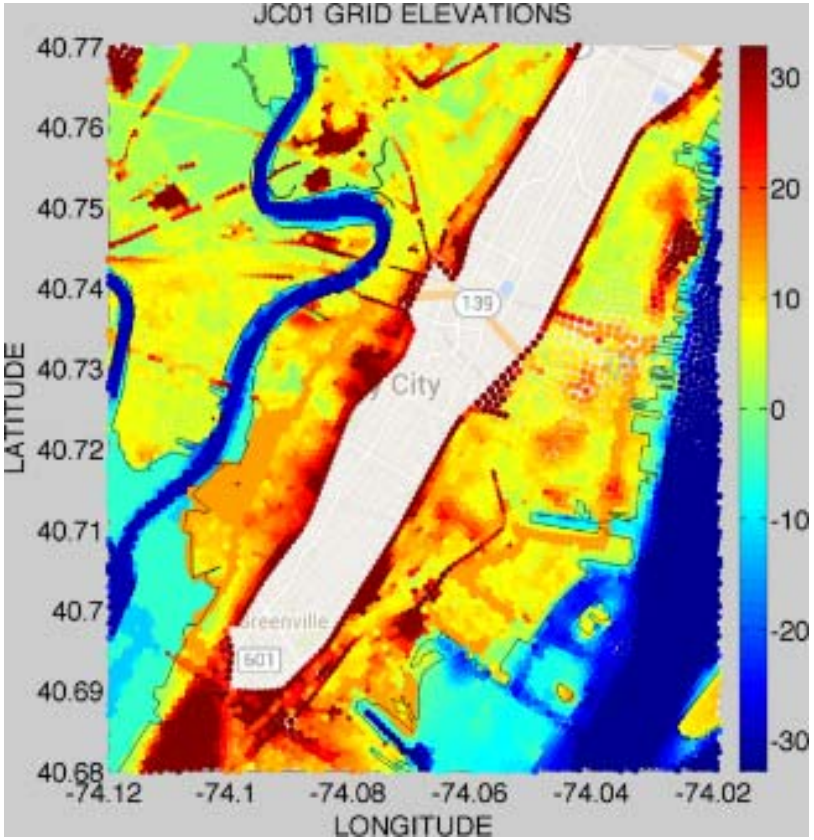
Quantitative Analysis of Coastal Adaptation


elevation(feet)
4.000001 - 6.000000
6.000001 - 8.000000
8.000001 - 10.000000
10.000001 - 14.000000
14.000001 - 20.000000
20.000001 - 30.000000
30.000001 - 40.000000
40.000001 - 50.000000
50.000001 - 60.000000
60.000001 - 70.000000
70.000001 - 80.000000
80.000001 - 90.000000
90.000001 - 100.000000
100.000001 - 120.000000
120.000001 - 140.000000
140.000001 - 160.000000
160.000001 - 180.000000
March 24, 2014
Legend
Berm Levee
Boardwalk Levee
Land Rise
Street levee
Surge Barrier

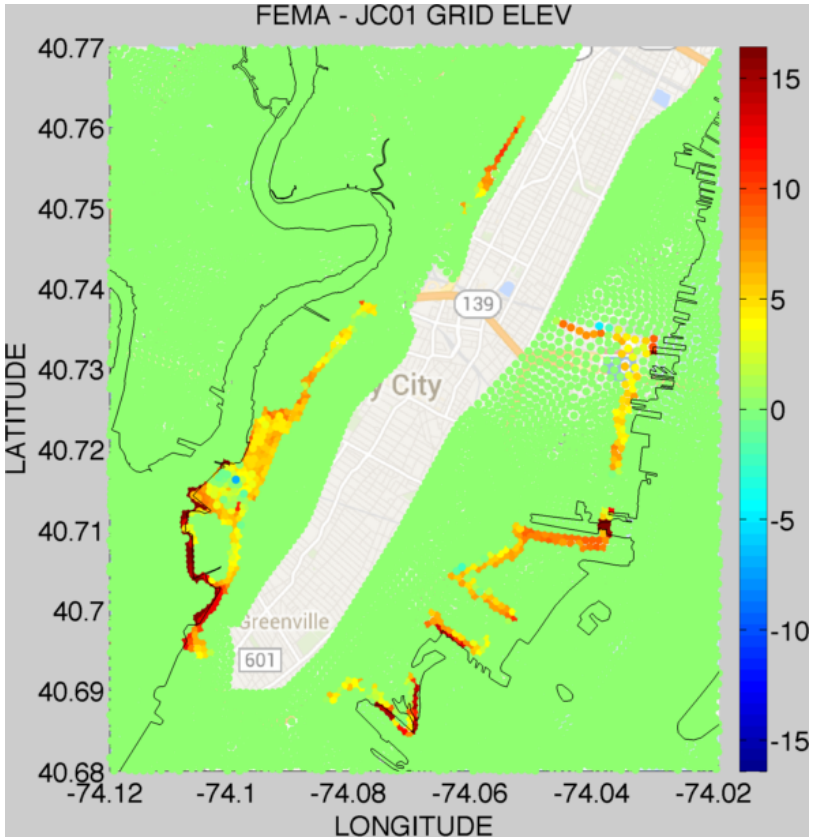
Simulated View: Surge Barrier at Tidewater Basin

Adaptation Plan #1: Landscape Elevations

Adaptation plan #1 land elevations



land elevation change



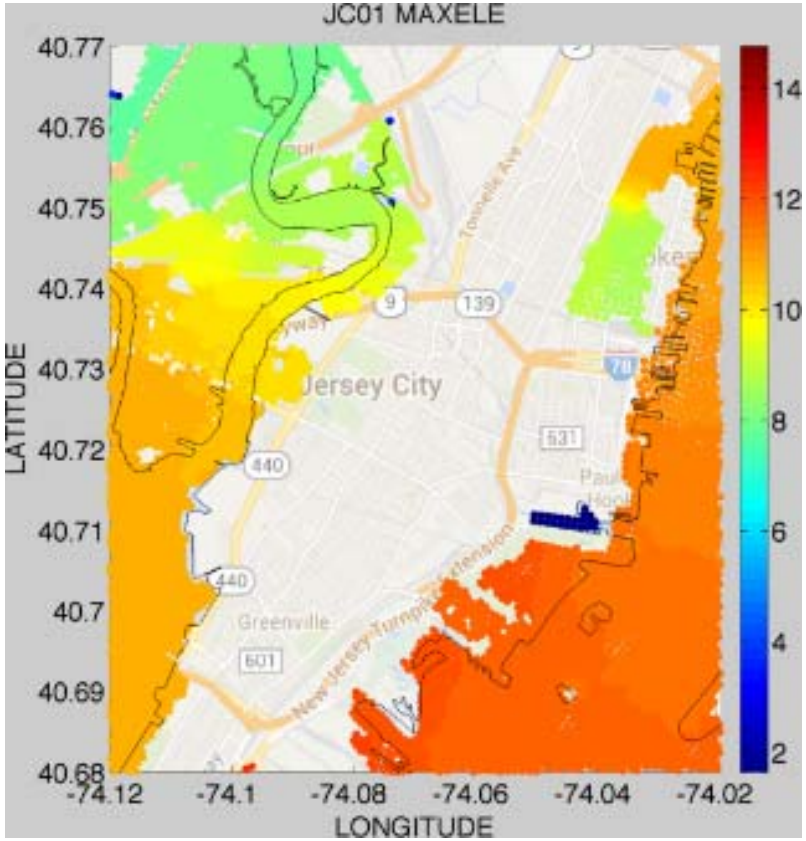
Plan #1 major components:

Washington Street levee, Surge barrier at Tidewater Basin, Levees in Liberty State Park

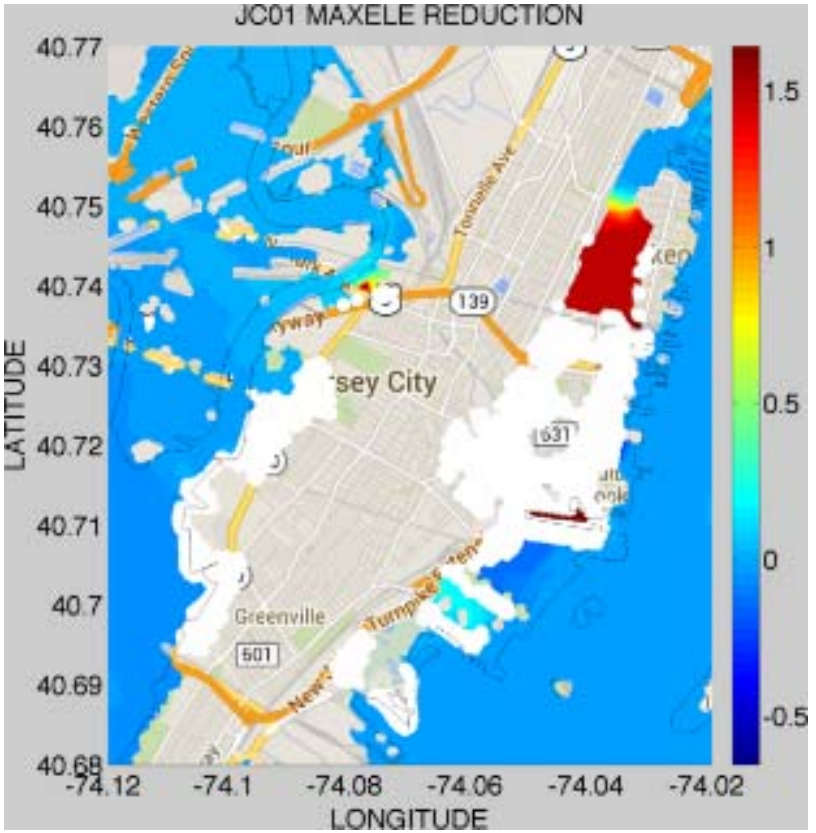
Hoboken /Jersey City surge barrier and levee, Route 440 road levee, Planned land rise for developments

Experimental Results: Adaptation Plan #1

Peak flood elevations (ft)



Flood elevation reduction* (ft)



* White areas were flooded before, now are no longer flooded

Broader View: Adaptation Options

- There are many adaptation options for reducing flooding
- Here we have focused only on local **vertical** solutions (e.g. berms, levees) at +14ft NAVD88 elevation
- Additional options should also be studied and even used in unison for a layered approach, including:
  - (1) policies and zoning law promoting retreat, consolidation or structure/infrastructure elevation
  - (2) regional solutions (e.g. harbor-wide barriers)
  - (3) green infrastructure for reducing rainfall flooding

Updated Project Milestone Timing

September – repeat experiments for other storms, sea level rise scenarios

October – finalize report on coastal adaptation options and their performance with sea level rise

December – publish results in a peer-reviewed journal, for broader outreach

Also, will have sustainability conference presentation and outreach workshops

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Co-PIs Philip Orton, Alan Blumberg
Davidson Laboratory, Stevens Institute of Technology

Funding from: NOAA Sea Grant

Thanks to: FEMA's RAMPP (Risk Assessment, Mapping and Planning Partners), particularly FEMA, URS Corp and Dewberry
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