Quantifying the Value and Communicating the Protective Services of Green Shorelines using Flood Risk Assessment: Jamaica Bay, New York City, NY

COASTAL GeoTools Conference 2015
Kytt MacManus GIS Programmer
kmacmanu@ciesin.columbia.edu
Columbia University, CIESIN

Primary Project Objectives

1. Map the extent of Jamaica Bay wetlands, beaches, mud flats, other ecosystem features; and the bathymetric depth profile for historic and present-day periods

2. Quantify the flood extent and intensity in historical and present-day coastal zones using model runs of the Stevens Estuarine and Coastal Ocean Model (sECOM)

3. Work with decision-makers and natural resource managers to develop three realistic future green shoreline scenarios which could potentially reduce storm surge flood elevations

Primary Project Objectives

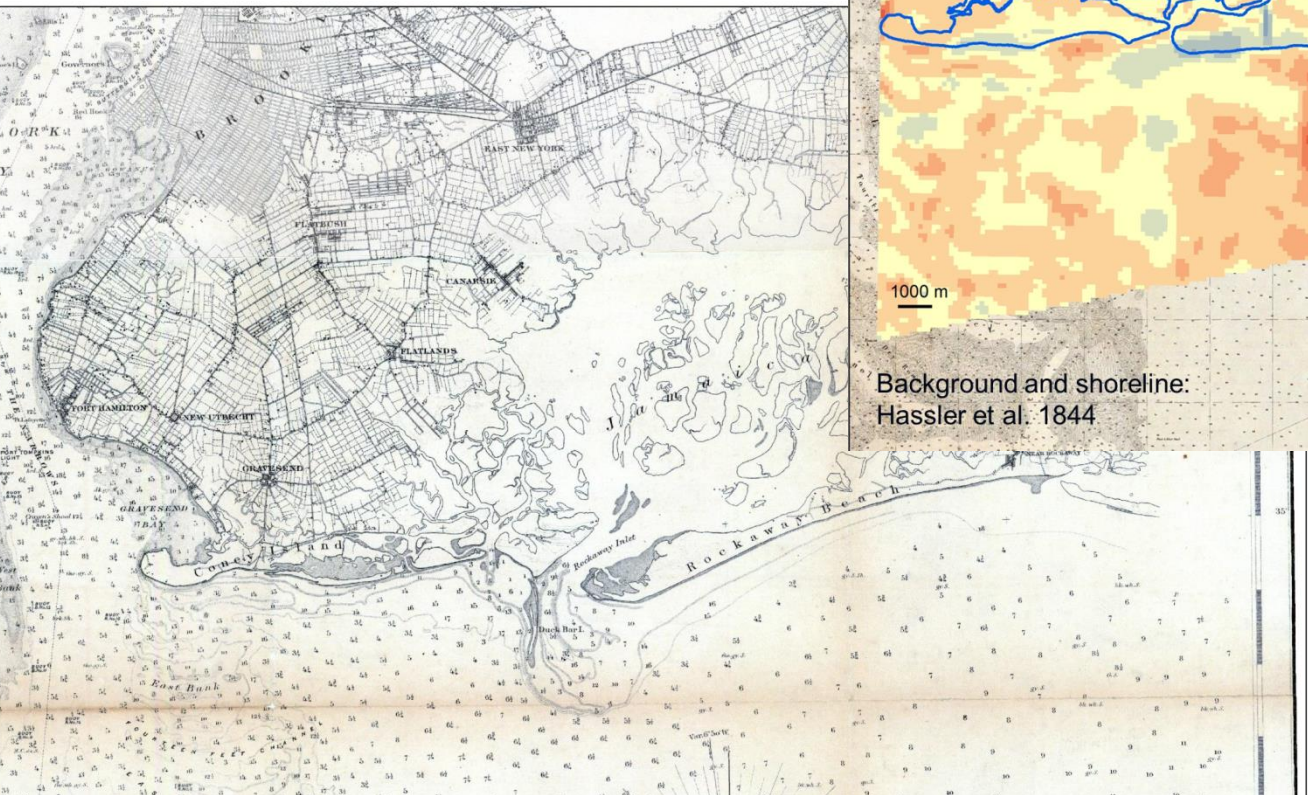
4. Perform a cost-benefit analysis of future living shoreline landscape scenarios based on construction cost analyses and a full risk assessment for storm-driven flooding

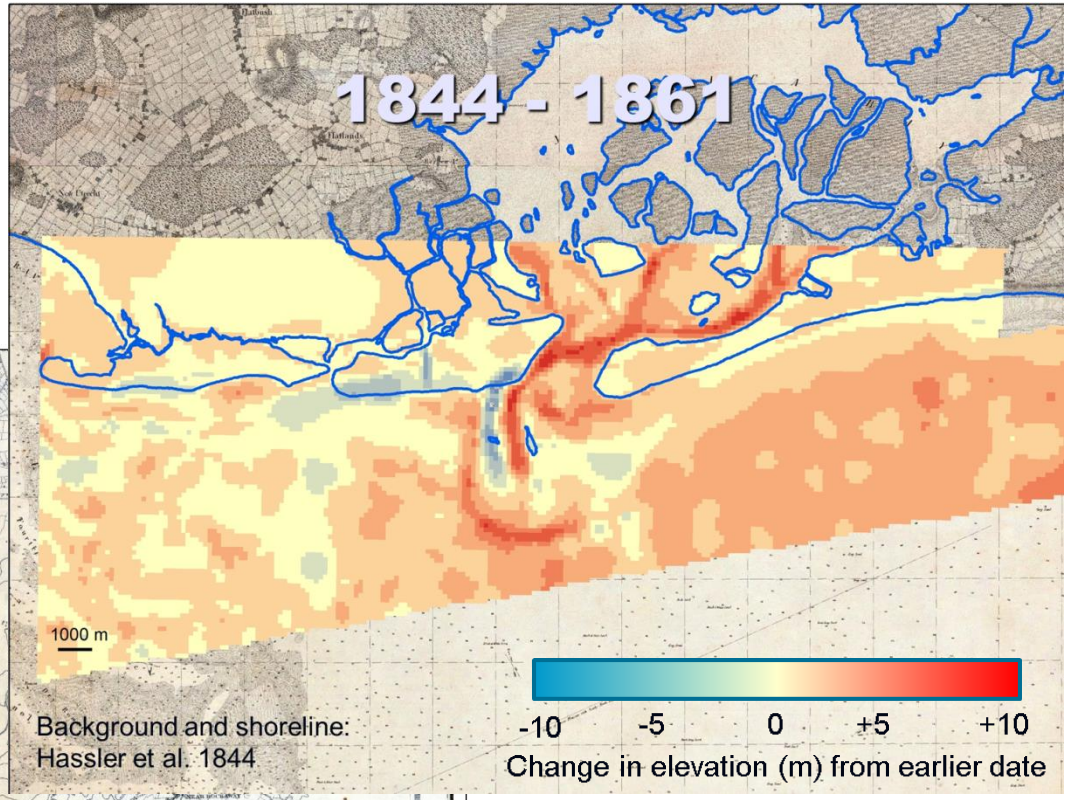
5 . Develop an online interactive mapping tool for decision makers and the general public which:

- helps them obtain an improved quantitative understanding of the role that green shoreline features like wetlands and shellfish reefs can have on coastal flooding
- enables them to explore future flood zones, and to select future living shoreline adaptation scenarios to view their influence on these flood zones

1. **Map the extent of Jamaica Bay wetlands, beaches, mud flats, other ecosystem features; and the bathymetric depth profile for historic and present-day periods**

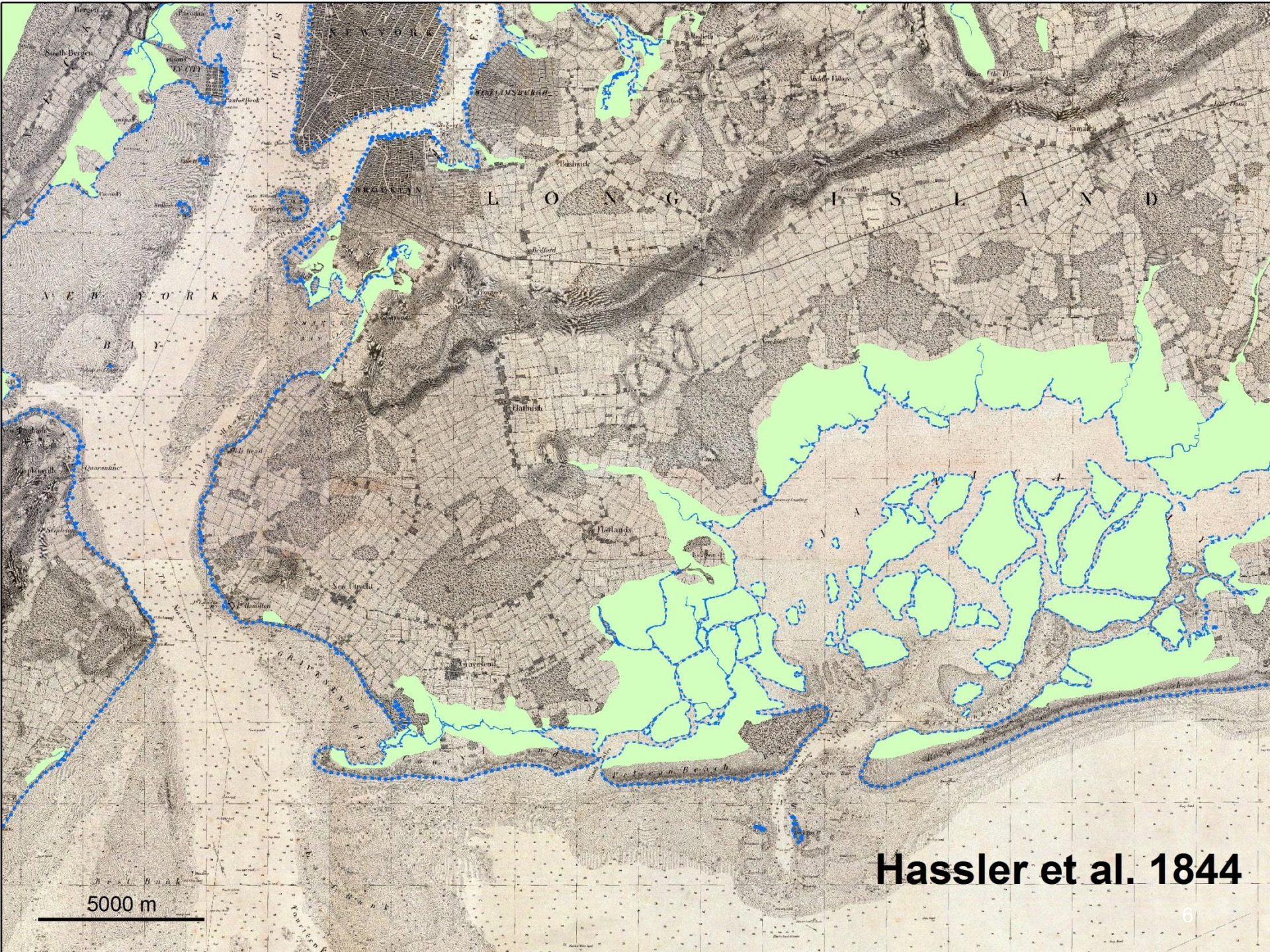
Digitized Historical Maps





DEM's and volumetric change analyses derived from historical maps

L O N G I S L A N D
N E W Y O R K
B A Y
Flatbush
Flatlands
Gravesend
Bedford
Flushing
Jamaica
Quarantine
5000 m
Hassler et al. 1844


NEW YORK
BROOKLYN
LONG ISLAND
NEW YORK BAY
Flatbush
Flatlands
Jamaica
Quarantine
5000 m
Hassler et al. 1844

Hassler et al. 1844
5000 m

Hassler et al. 1844
5000 m

2. Quantify the flood extent and intensity in historical and present-day coastal zones using model runs of the Stevens Estuarine and Coastal Ocean Model (sECOM)

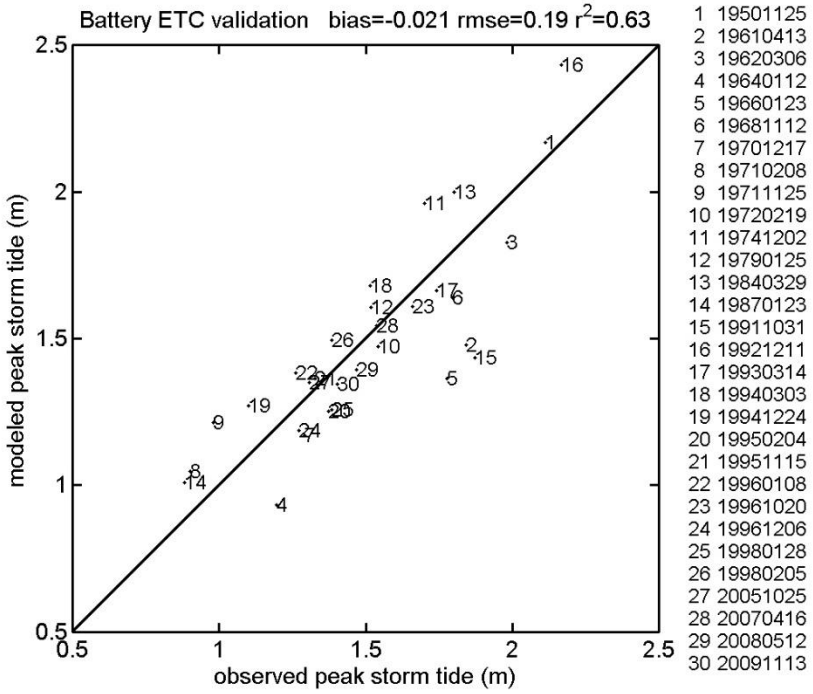
- Database with two primary outputs:
  a) Modeled maximum inundation elevation maps for a diverse set of storms, each reproduced with multiple sea level and landscape scenarios, and

  b) Flood exceedance curves for each model grid point over Jamaica Bay's watershed, for historic, present-day, and three future sea levels across three future landscape scenarios (nine future scenarios)

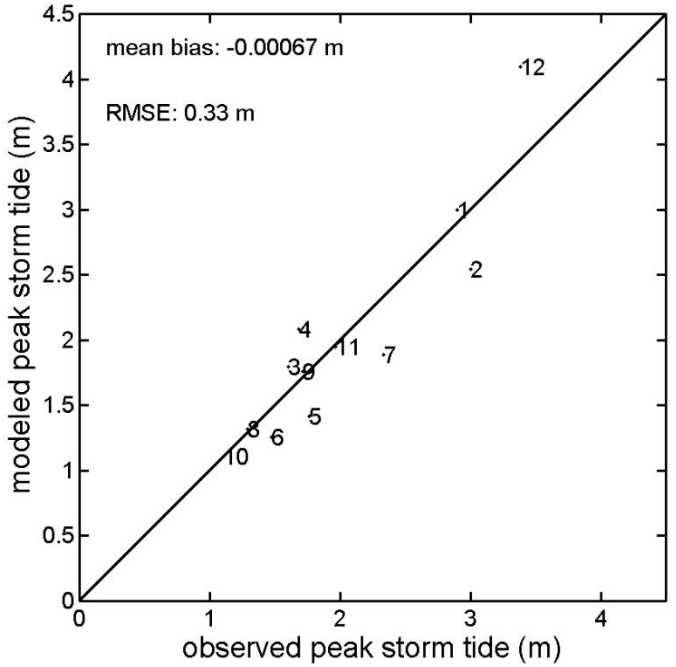
Flood Assessment - Strong Multi-Level Validation

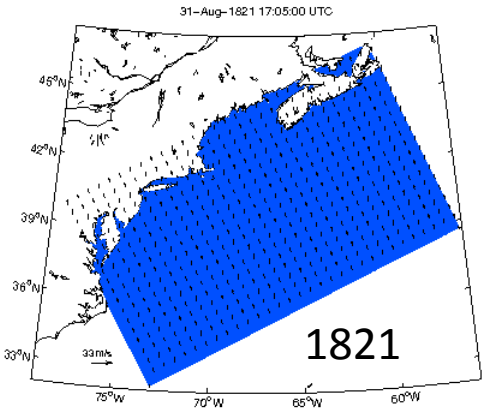
- Flood modeling validation (shown below) – observations versus model results
- Hurricane modeling validation – are modeled landfall rates consistent with historical landfalls, within uncertainty?
- Results validation – e.g. is the model-based flood exceedance curve consistent with an observation-based curve, within uncertainty?

Extratropicals (e.g. nor'easters)



Tropical Cyclones (parametric modeling)

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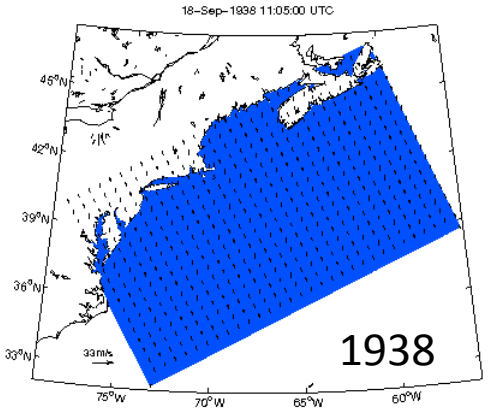
42°N
39°N
36°N
33°N
33m/s
75°W
70°W
65°W
60°W
1821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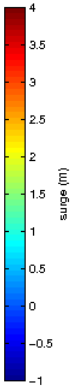
33m/s
75°W
70°W
65°W
60°W
1938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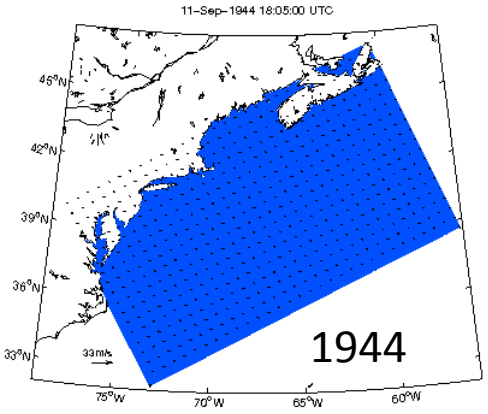
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
-1
surge (m)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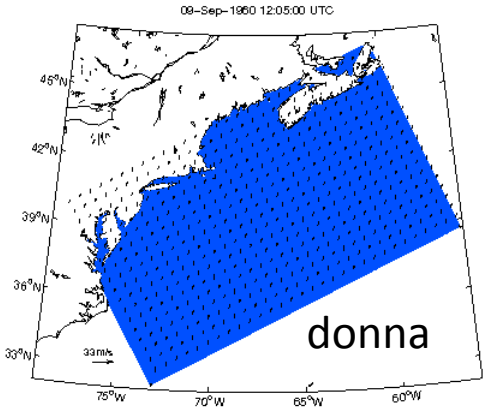
1944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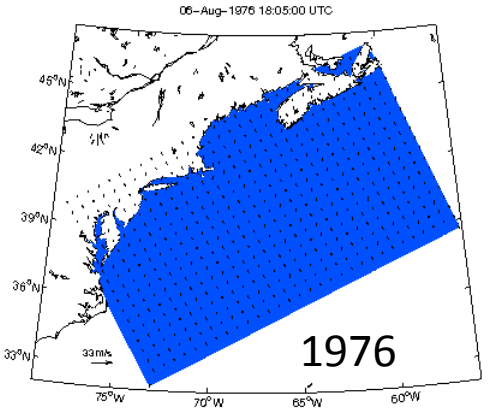
donna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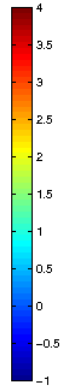
1976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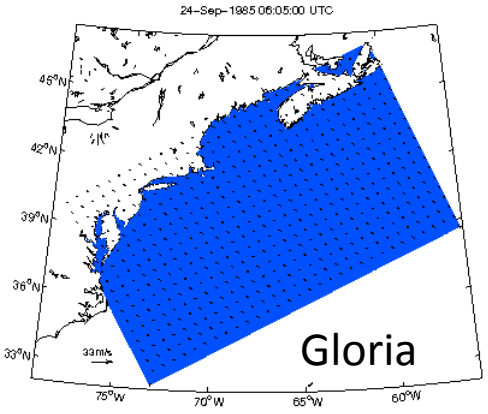
surge (m)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33m/s
75°W
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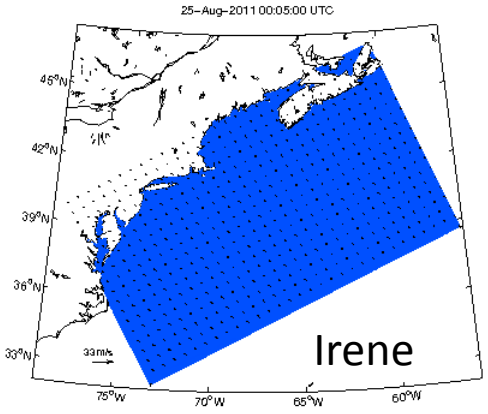
65°W
60°W
Gloria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75°W
70°W
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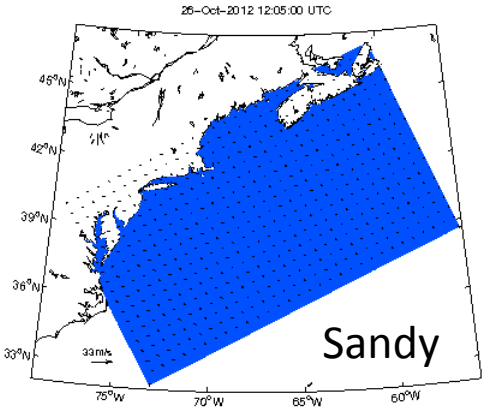
Irene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33m/s
75°W
70°W
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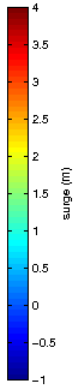
60°W
Sandy


4
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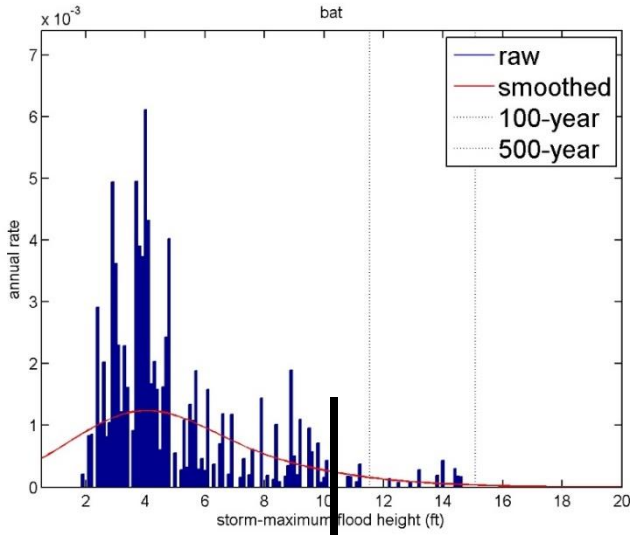
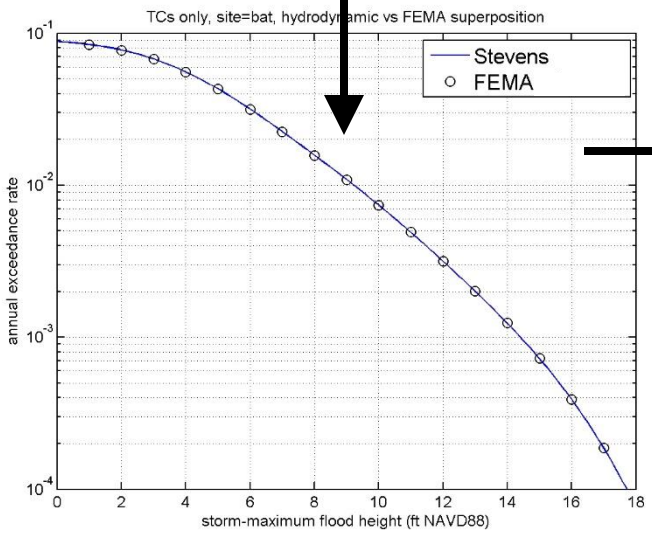
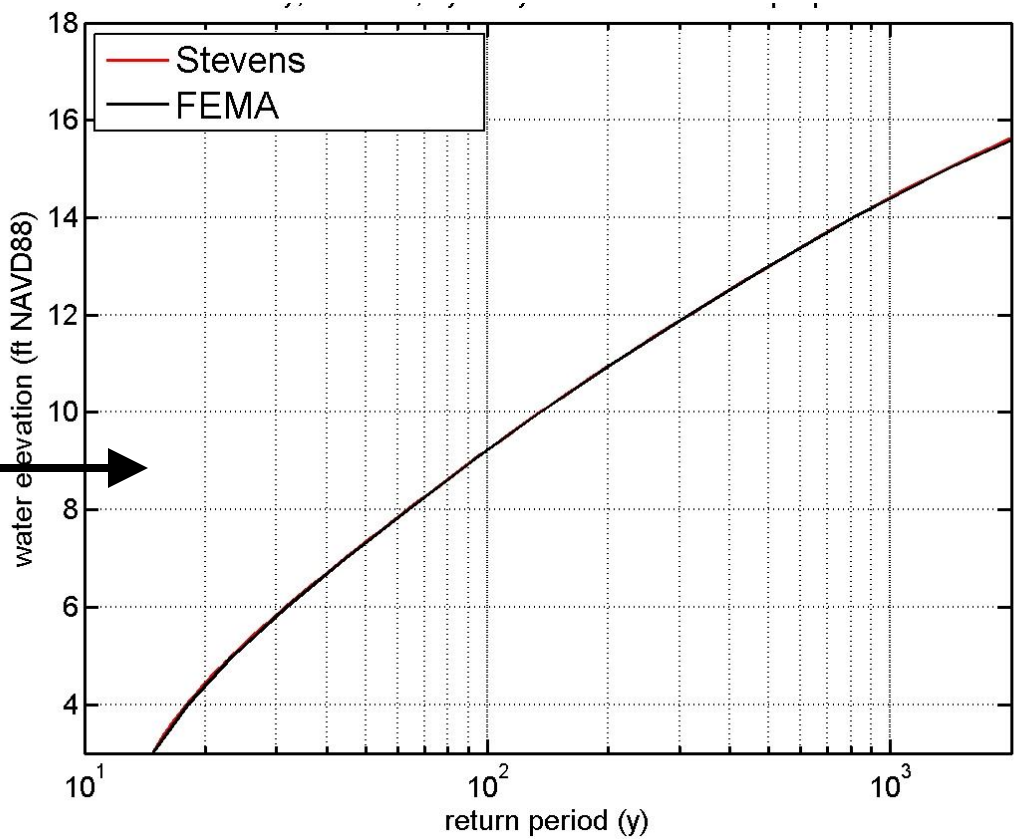
-0.5
-1
surge (m)

Flood Exceedance (Stage-Frequency) Curves







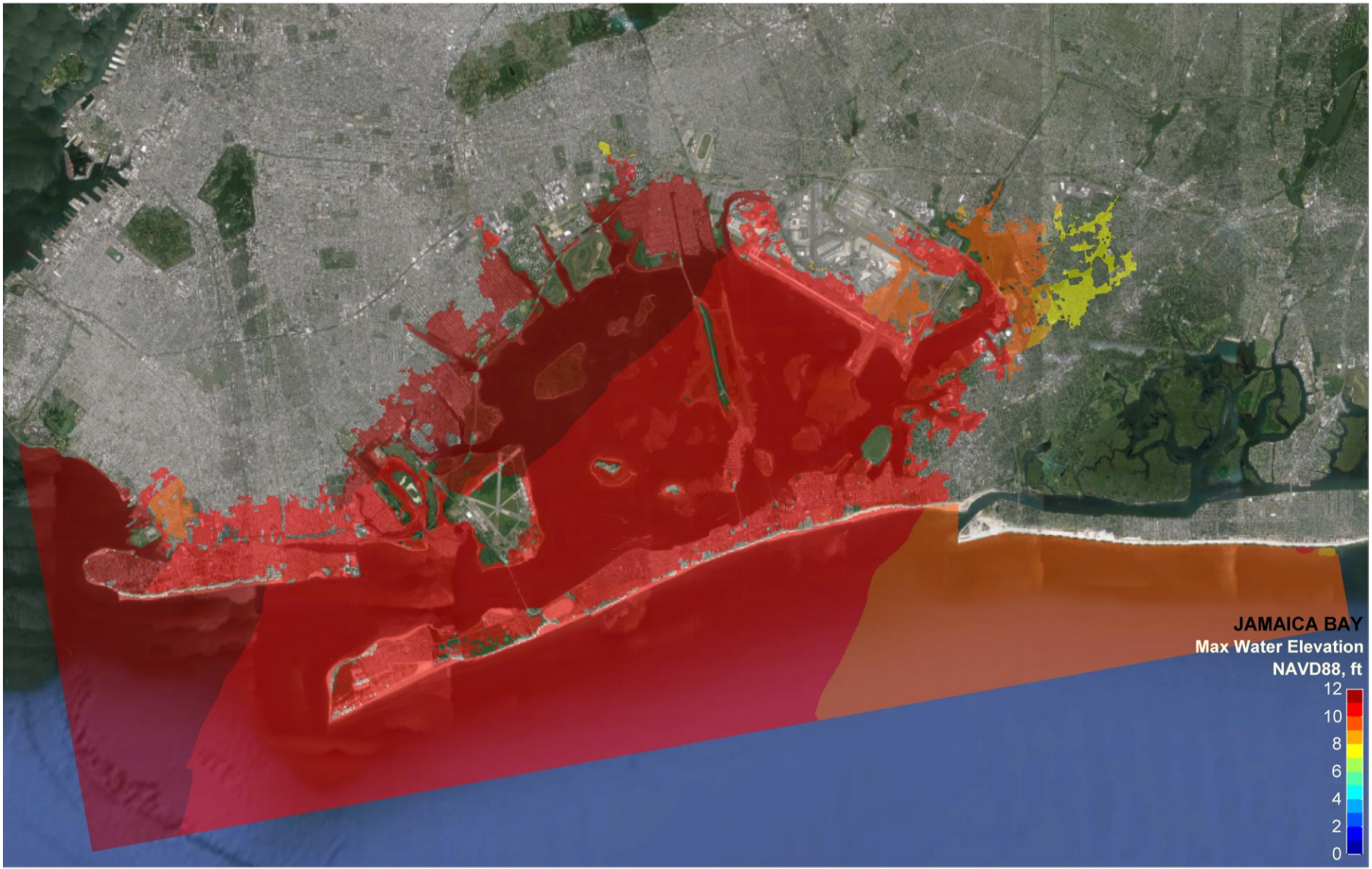
3. Work with decision-makers and natural resource managers to develop three realistic future green shoreline scenarios which could potentially reduce storm surge flood elevations

Experimental Plan (We will develop final scenarios in consultation with expert groups at workshop)

- Control run – full extent of Sandy flooding
- Scenario 3 – wetlands on 1879 footprint
- Scenario 4 – shallowing deep channels
- Scenario 5 – wetlands and shallowing

Wetland elevation = +0.5m; Shallowing = -2m, NAVD88 datum
Wetland Manning's n = 0.045

Control Run Result – Water Elevation



Scenario 5: Full Historical Buildout and Full Shallowing

Conclusions and Next Steps on Green Shoreline Adaptation

- We have explored green adaptations to gain a qualitative knowledge of their efficacy against Sandy's flooding
  - Wetlands do not always reduce flooding - adjacent deep channels can reduce their efficacy
  - Shallowing of deep-dredged channels should be explored for long-term flood adaptation
- Next up: We are looking at 800+ storms, not just 1
- Also: Meeting with stakeholders to develop three realistic future green shoreline scenarios

4. Perform a cost-benefit analysis of future living shoreline landscape scenarios based on construction cost analyses and a full risk assessment for storm-driven flooding

   - Assemble cost estimates at the Year-1 workshop on future adaptive response scenarios.
   - Follow the FEMA Benefit-Cost Analysis Process

EQUATION B-3: BENEFIT-COST RATIO

$$BCR = \frac{Project\ Benefits}{Project\ Costs}$$

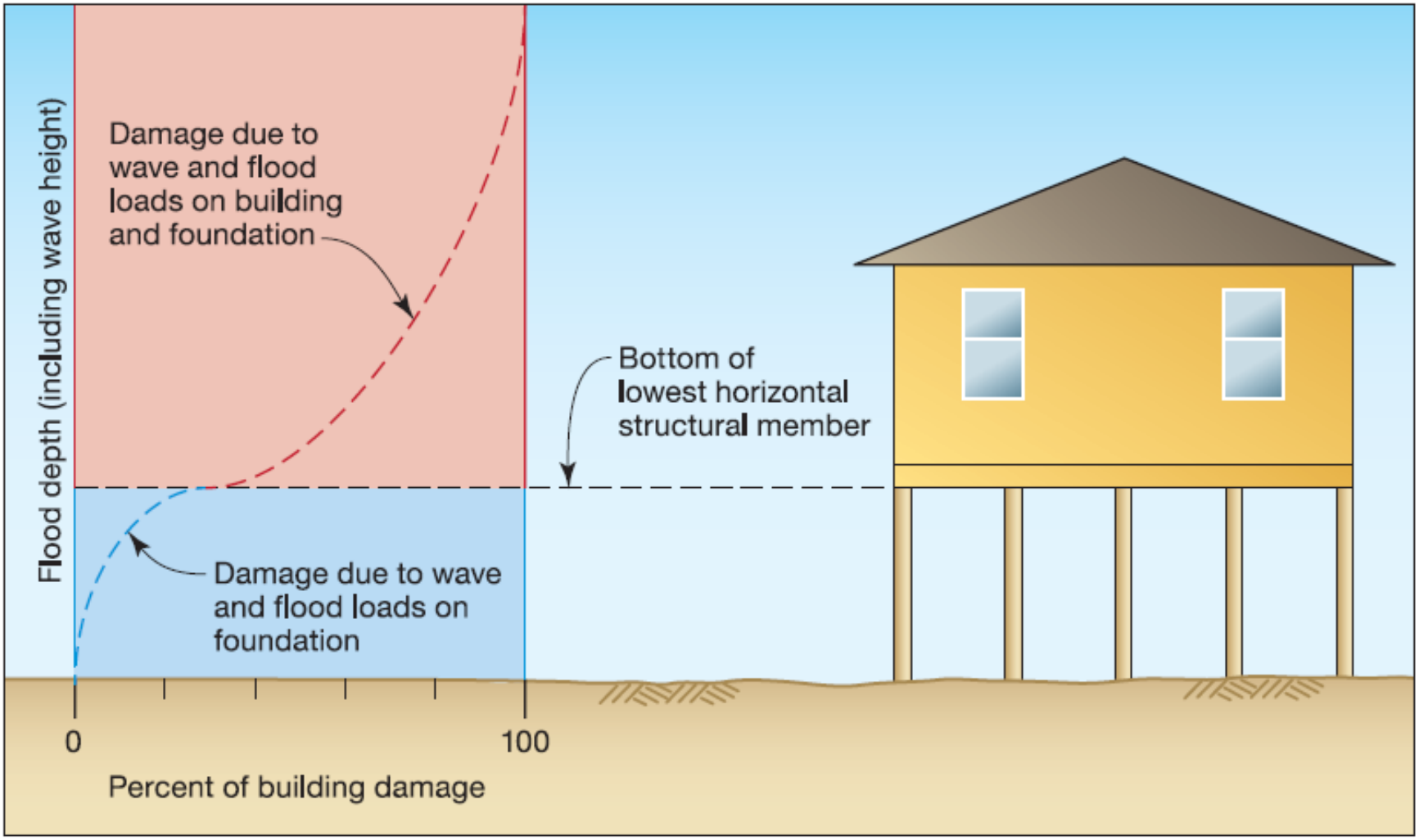
where:

BCR = benefit-cost ratio

$Project\ Benefits$ = total project net benefits

$Project\ Costs$ = total project cost

Compute damage estimates from all storm scenarios, using elements from HAZUS-MH Flood, supplemented by improved data where possible



HAZUS-MH Flood Model

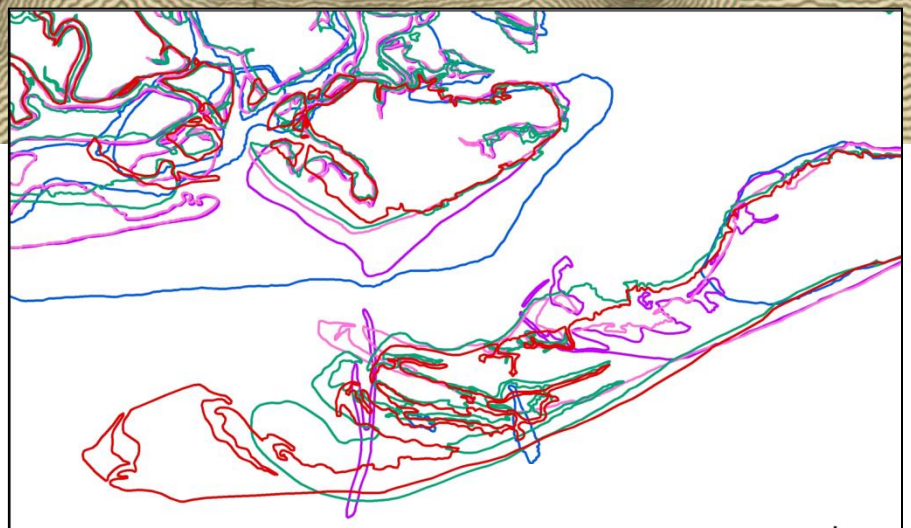
- Version 2.2 Updates include:
  - 2010 Census blocks and demographics
  - Residential square footage data updated using 2010 Census information
- Received User-Defined Facility data for buildings in NYC and Nassau County prepped for HAZUS:
  - Converted over 200 Building Classes to 33 HAZUS Occupancy Types and assigned Foundation Type, First Floor Height, Basement info, Building and Contents Value

Mapping Application Architecture

- The application should be data driven
  - Preference for backend solutions

- Technologies utilized:
  - POSTGIS
  - Geoserver
  - OpenLayers 3
  - Custom REST Services
    - SQL Queries to POSTGIS
    - WFS type Geoserver interaction

Display Historic Data and Derived Data

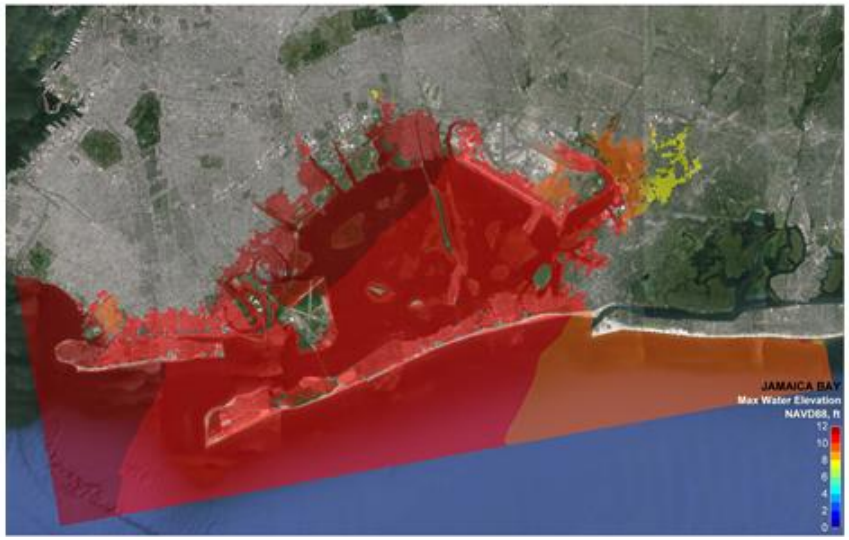


De Witt 1802

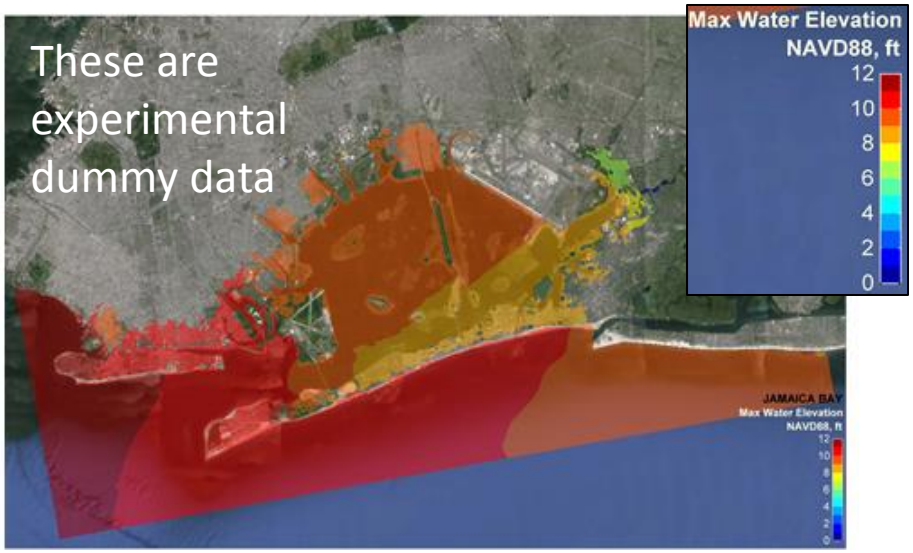
- **Tittman 1907 shoreline**
- **Bien 1891 shoreline**
- **Bache 1882 shoreline**
- **Bache 1861 shoreline**
- **Hassler 1844 shoreline**

Display Adaptation Scenario Impacts

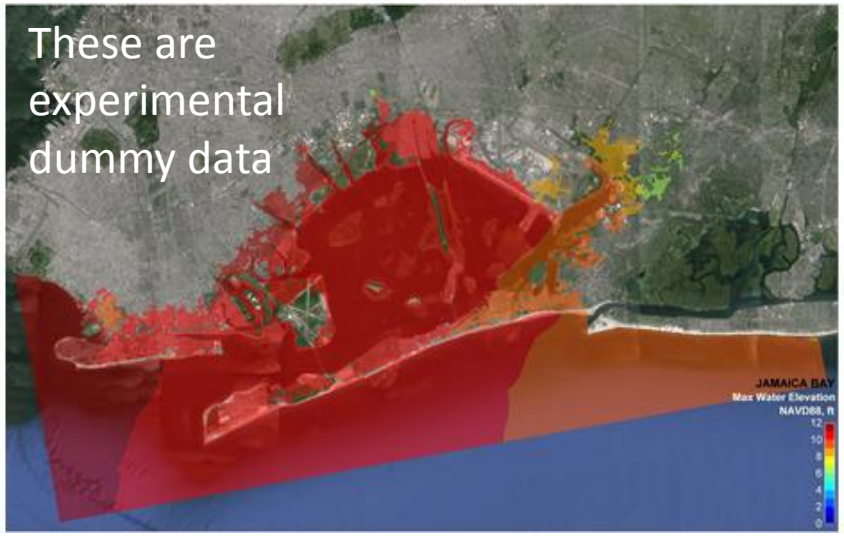
Control Run Result – Water Elevation



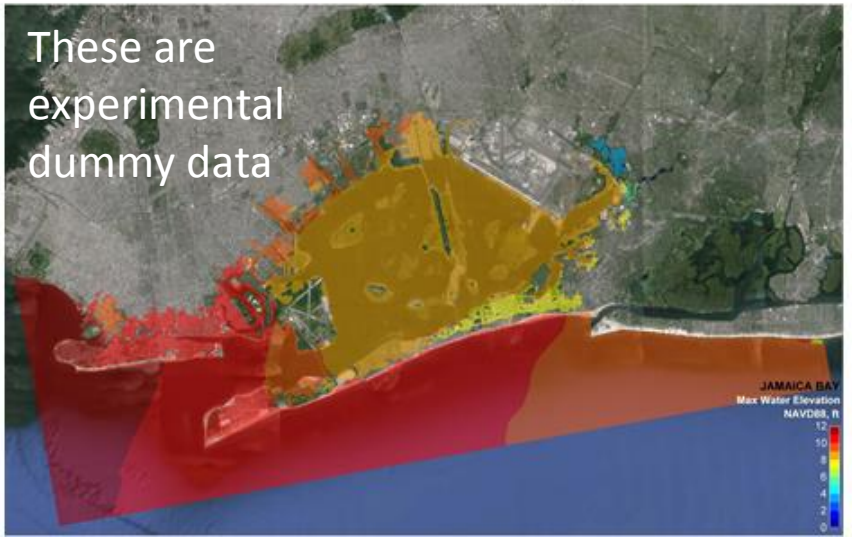
Scenario 4: Full Shallowing



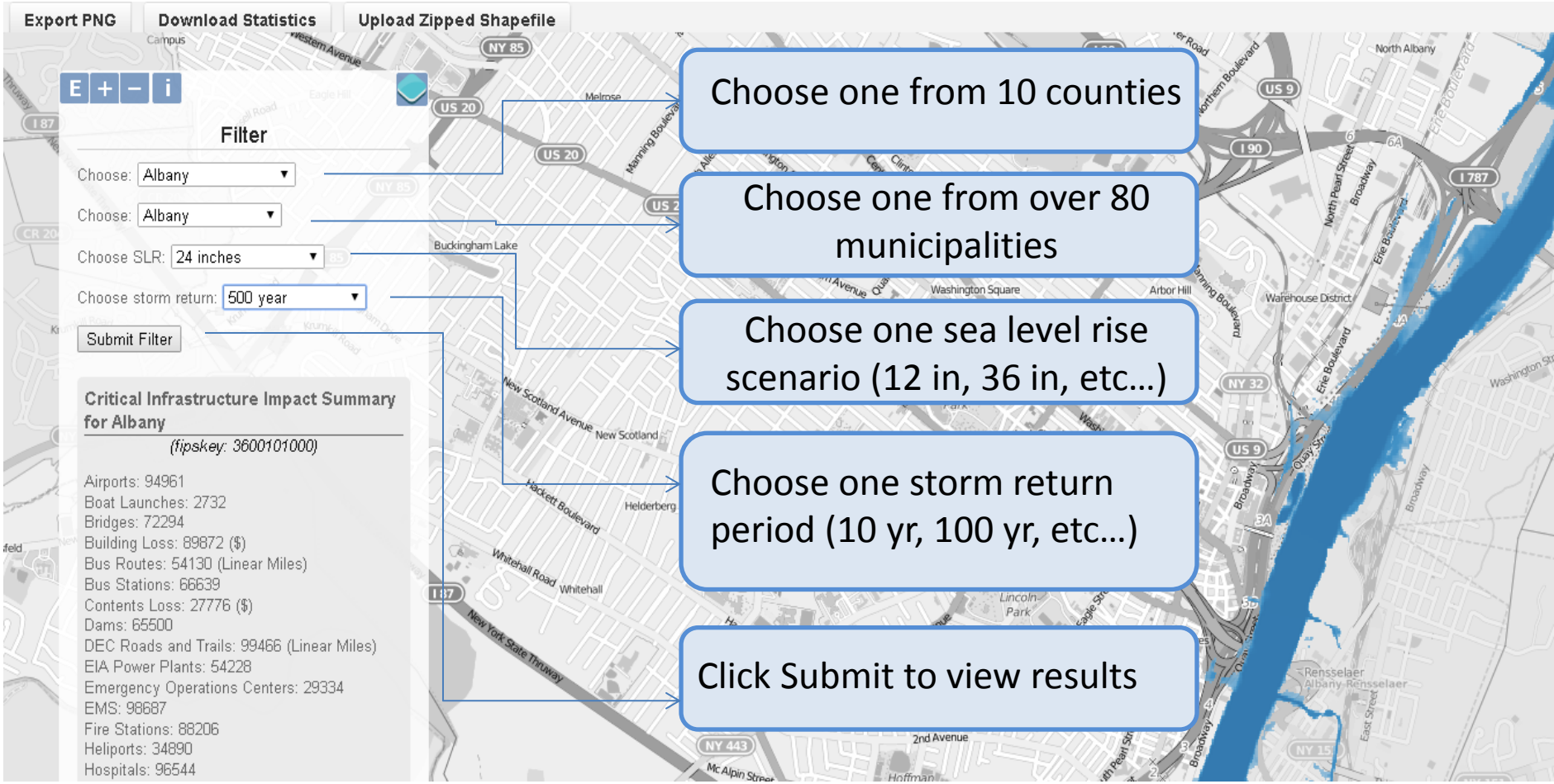
Scenario 3: Full Historical Buildout, Referencing Maps from 1877



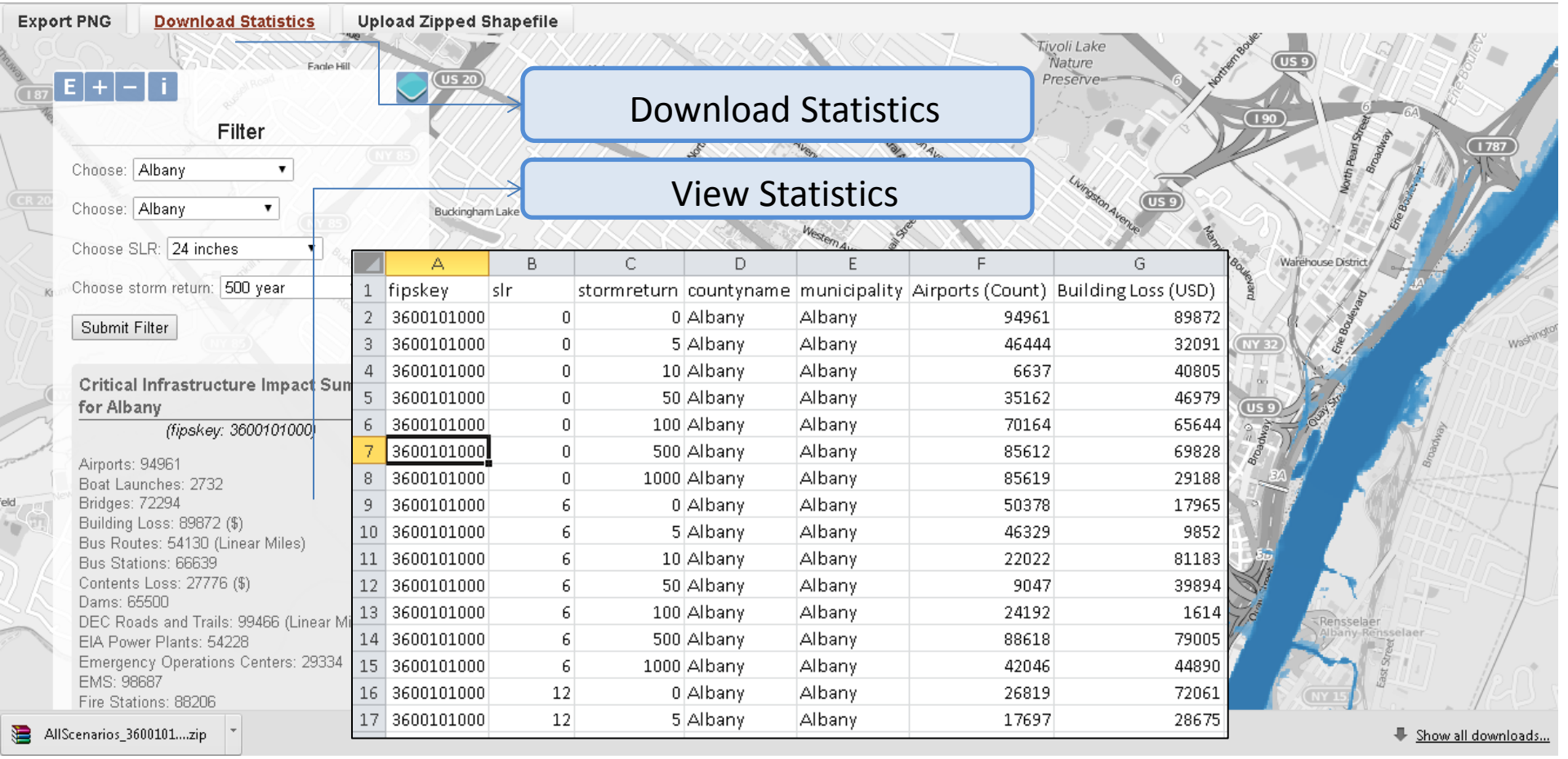
Scenario 5: Full Historical Buildout and Full Shallowing



Visualize flood scenarios for an array of SLR and Storm Return Period Options



Display and make available for download impact assessment estimates, and Cost-Benefit Analysis results by scenario



	A	B	C	D	E	F	G
1	fipskey	slr	stormreturn	countyname	municipality	Airports (Count)	Building Loss (USD)
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3	3600101000	0	5	Albany	Albany	46444	32091
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16	3600101000	12	0	Albany	Albany	26819	72061
17	3600101000	12	5	Albany	Albany	17697	28675

Acknowledgements

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Columbia University CIESIN:

Kytt MacManus Co-PI, & **Erin Doxsey-Whitfield**

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