Preparing for Sea Level Rise in New York City

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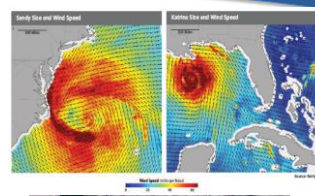
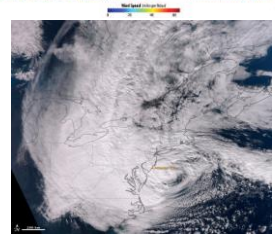
Deltas in Times of Climate Change II
September 25, 2014

1

Hurricane Sandy
October 29, 2012



- **Storm timing** coincided almost exactly with astronomically high, high tide
- **Tropical-storm-force winds extended 1,600 kilometers** from end to end, making it more than three times the size of Hurricane Katrina
- Storm surge combined with high tide created a **"storm tide" of over 4.2 meters** above Mean Lower Low Water at the Battery
- **Unusual storm track,** Sandy turned sharply west just as it was reaching another peak of intensity



SIRR, 2013
CCSR, 2013

Storm Forecast Well In Advance

2

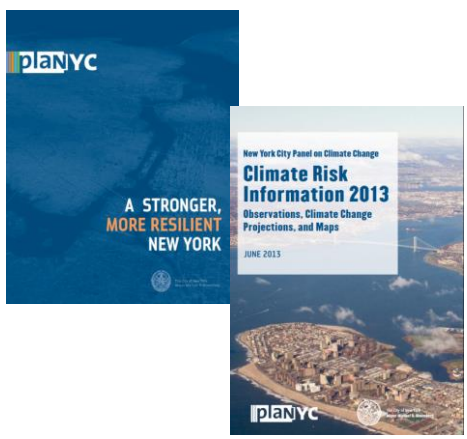
Hurricane Sandy
New York City

- Hurricane Sandy in New York City
  - 44 deaths
  - Highest water level on record at the Battery (4.2 meters above MLLW)
  - 90,000 buildings in the inundation zone
  - ~2 million without power
  - ~$19 billion in damage

South Ferry Subway Station, Manhattan
December 12, 2012
Source: D. Bader

Second New York City Panel on Climate Change

After Hurricane Sandy, Mayor Bloomberg re-convened the NPCC in January to provide updated climate risk information for the Special Initiative for Rebuilding and Resiliency (SIRR)



- The 2013 NPCC Climate Risk Information Report (CRI) provides new climate change projections and future coastal flood risk maps for New York City
- Both "A Stronger, More Resilient New York" and CRI reports released on June 11, 2013

re•sil•ient [ri-zil-yuhnt] adj.

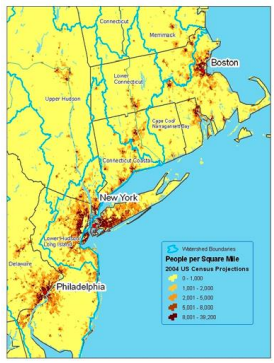
1. Able to bounce back after change or adversity.
2. Capable of preparing for, responding to, and recovering from difficult conditions.

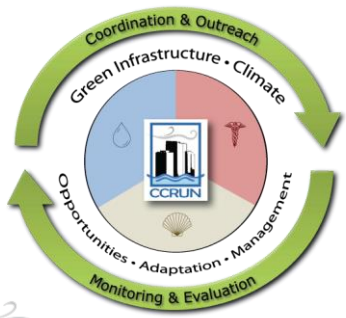
Syn.: TOUGH
See also: New York City

Consortium for Climate Risk in the Urban Northeast

• CCRUN conducts stakeholder-driven research that reduces climate-related vulnerability and advances opportunities for adaptation in the urban Northeast

• CCRUN scientists lead the technical team that developed the projections for the NPCC2 report

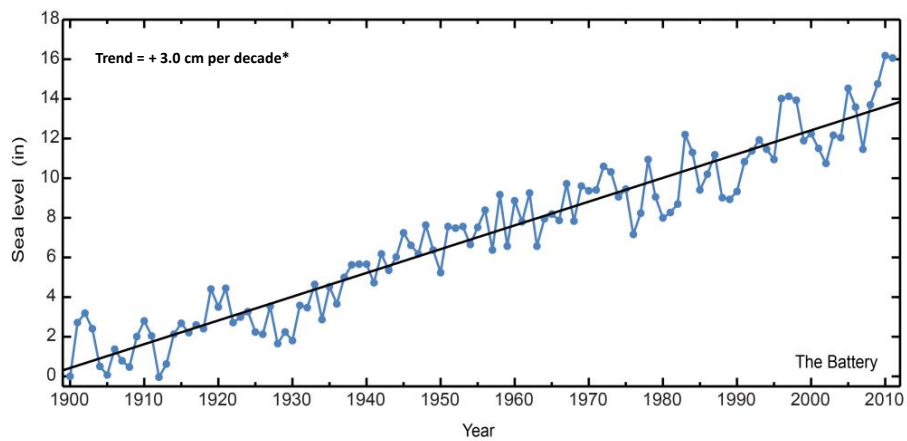




CCRUN

5

Sea Level Rise
New York City Observations

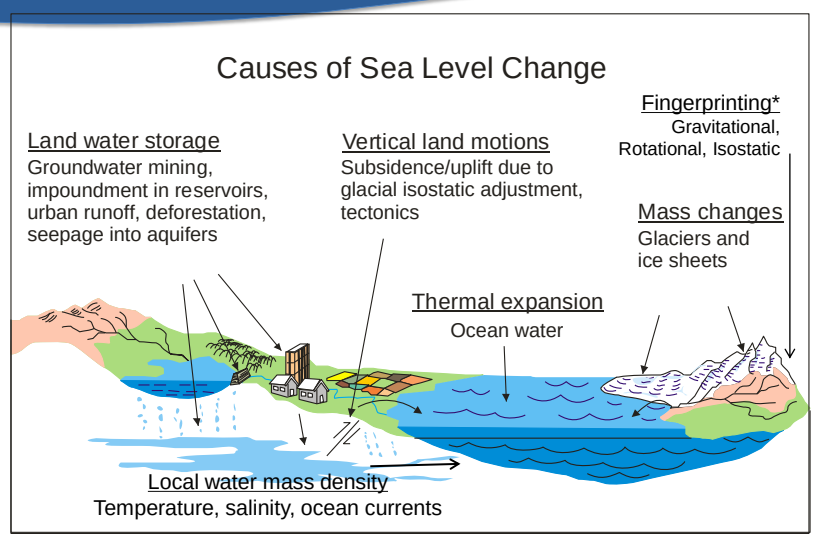


Sea level rise in New York City has averaged 3.0 centimeters per decade since 1900, nearly twice the observed global rate of 1.8 centimeters per decade over a similar time period

NPCC2 Climate Projection Methods
Sea Level Change

- Innovative, 6-component approach used to develop regional sea level rise projections
  - Model-based components based on CMIP5 Data (24 GCMs and 2 RCPs)
    - Thermal expansion (global)
    - Changes in dynamic ocean height (local)
  - Components based on literature review and expert analysis
    - Ice mass loss from ice sheets and glaciers and ice caps (global)
    - Gravitational, rotational, and isostatic "fingerprinting" (local)
    - Vertical land movements (GIA) (local)
    - Land water storage (global)
- Projections are taken as the sum of the 6 sea level components
  - Provided for 2020s, 2050s, 2080s, 2100
    - 10-year average centered around decade
  - Changes are relative to the 2000 to 2004 base period

NPCC2 Climate Projection Methods
Sea Level Change



*Gravitational - Attraction force of the ice (bigger mass, pulls more water towards it)
*Isostatic - Fast response of the underlying land to the removal of ice mass
*Rotational - Changing mass distribution impacts speed and tilt of the earth (sloshing)

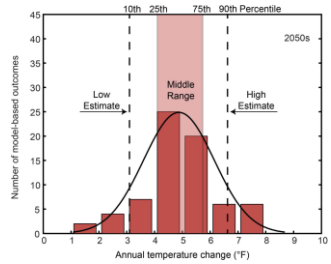
Future Climate Projections
New York City

Sea Level Rise Baseline (2000 – 2004)	Low-estimate (10th percentile)	Middle range (25th to 75th percentile)	High-estimate (90th percentile)
2020s	+ 5 cm	+ 10 cm to 20 cm	+ 25 cm
2050s	+ 20 cm	+ 28 cm to 53 cm	+ 76 cm
2080s	+ 33 cm	+ 46 cm to 99 cm	+ 147 cm
2100	+ 38 cm	+ 56 cm to 127 cm	+ 191 cm

Based on 24 GCMs and two Representative Concentration Pathways. Shown are the low-estimate (10th percentile), middle range (25th percentile to 75th percentile), and high-estimate (90th percentile).

Higher sea levels are extremely likely for New York City

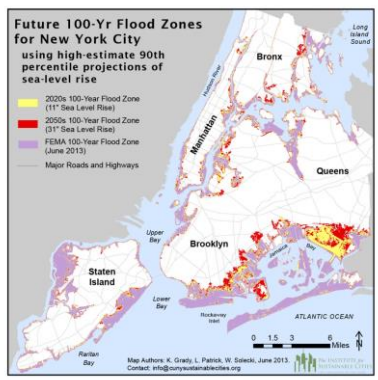
Projections broadly consistent with IPCC AR5 global projections, with the NPCC high end slightly higher



Source: NPCC 2013

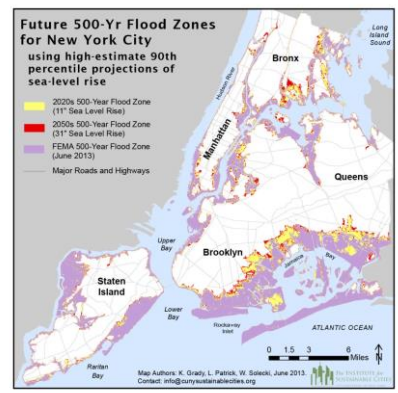
9

Future Coastal Flood Risk Maps



The potential areas that could be impacted by the 100-year flood in the 2020s and 2050s based on projections of the high-estimate 90th percentile sea level rise scenario

Dynamic costal flood modeling also part of NPCC2 work

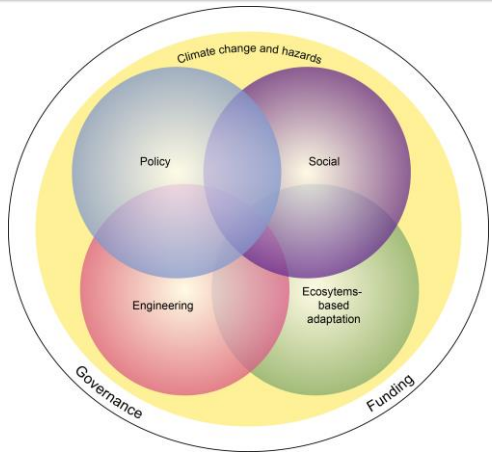


The potential areas that could be impacted by the 500-year flood in the 2020s and 2050s based on projections of the high-estimate 90th percentile sea level rise scenario

Source: NPCC 2013

10

Approaches to Resilience Actions

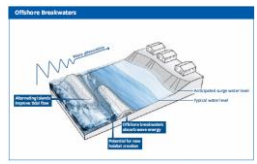


Policy, social, engineering, and ecosystems interact to respond to changing climate and coastal hazards. Overlapping areas illustrate opportunities for adaptation and resilience strategies that combine components of each domain.

UCCRN, 2014

NYC SIRR Key Findings for Coastal Protection

- **Increase coastal edge elevations**
  - The City will **increase the height of vulnerable coastal edges** with **bulkheads**, **beach nourishment** and other measures over time
- **Minimize upland wave zones**
  - The City will work to provide significant attenuation of waves—that is, to knock down waves, or diminish their velocity—both off and onshore, before they reach neighborhoods
- **Protect against storm surge**
  - The City will use **flood protection structures, such as floodwalls, levees, and local storm surge barriers** built, where possible, to the 100-year flood elevation with an additional allowance for future sea level rise
- **Improve coastal design**
  - The City will study **how natural areas and open space can be used to protect adjacent neighborhoods and maintain neighborhood quality of life**, and will work to **manage its own waterfront assets** more effectively
- **Governance**
  - Developing partnerships to improve permitting and study innovative coastal protections.



SIRR, 2013

Coastal Zones
Key Findings from National Climate Assessment

- Coastal zones are increasingly vulnerable to **higher sea levels and storm surges, inland flooding, and other climate-related changes**.
- Climate change **increases exposure of important assets**, such as **ports**, **tourism and fishing sites**, in already-vulnerable coastal locations, threatening to disrupt economic activity beyond the coast and incurring significant costs for protecting or moving them.
- **Socioeconomic disparities create uneven exposures** and sensitivities to coastal risks and limit adaptation options for some coastal communities, resulting in the displacement of the most vulnerable from coastal areas.
- Challenges of multi-jurisdictions

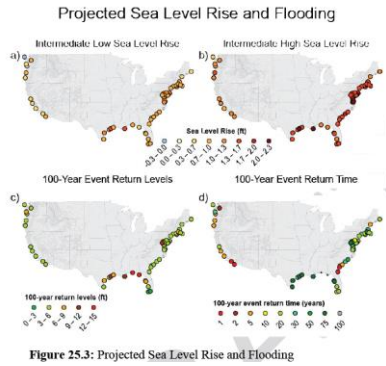


Figure 25.3: Projected Sea Level Rise and Flooding

NCA, 2014

Hurricane Sandy as Tipping Point

- Leadership in responding to climate change
- Climate science in place and in time
- Municipal, state, and federal alignment

Need for federal coordination that recognizes local and state initiatives and public-private partnerships

URBAN CLIMATE CHANGE RESEARCH NETWORK

References and Links

- Consortium for Climate Risk in the Urban Northeast (www.ccrun.org)
- NYSERDA ClimAID (www.nyserda.ny.gov/climaid)
- New York City Panel on Climate Change report available online at (www.nyas.org)
- Urban Climate Change Research Network (www.uccrn.org)

15