Lessons Learned from Superstorm Sandy: Disaster Risk Management, Recovery, and Resilience

New York City Case Study

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NASA GEOS-5

New York Case Study Outline

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7. Arguments & Subpoints

New York Case Study Outline

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Main Messages/ Preliminary Findings

- New York City is vulnerable to sea level rise and an increasing number and strength of hurricanes in the North Atlantic Ocean

- Superstorm Sandy was a rare, high-magnitude event that hit at high tide on the city's southern coast. Disaster preparedness, evacuation plan, and policies at the time of the event were in place but were limited

- **In Superstorm Sandy's recovery, NYC has embedded climate change projections into rebuilding efforts and policies.** NYC has learned from Superstorm Sandy and is better prepared for future, extreme coastal storms

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1. Introduction to New York City

- 520 miles (837 km) of coastline bordering an ocean, rivers, bays, tidal straits, inlets, and a harbor
  - Because of the complexity of the New York City coastline, there can be a large spatial variation in the extent and timing of flooding associated with any particular storm
- 8.4 million residents + commuters and tourists
- NYC occupies only 305 square miles (790 square km)
- NYC is embedded in a metro region with a population of roughly 22 million people and is heavily dependent on complex, interdependent critical systems – energy, telecommunications, transportation, and water and wastewater
  - Aging infrastructure requires continued and extensive maintenance

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1. Introduction to New York City (Continued)

- There has been an increase in the overall strength of hurricanes and in the number of strong (Category 4 and 5) hurricanes in the North Atlantic since the early 1980s
- Leading up to Hurricane Sandy (2012), evacuation zones, emergency protocols, and a sustainability plan existed but were outdated and incomplete
- Factors such as age, disability, chronic health conditions, poverty, and language barriers can increase vulnerability to certain hazards
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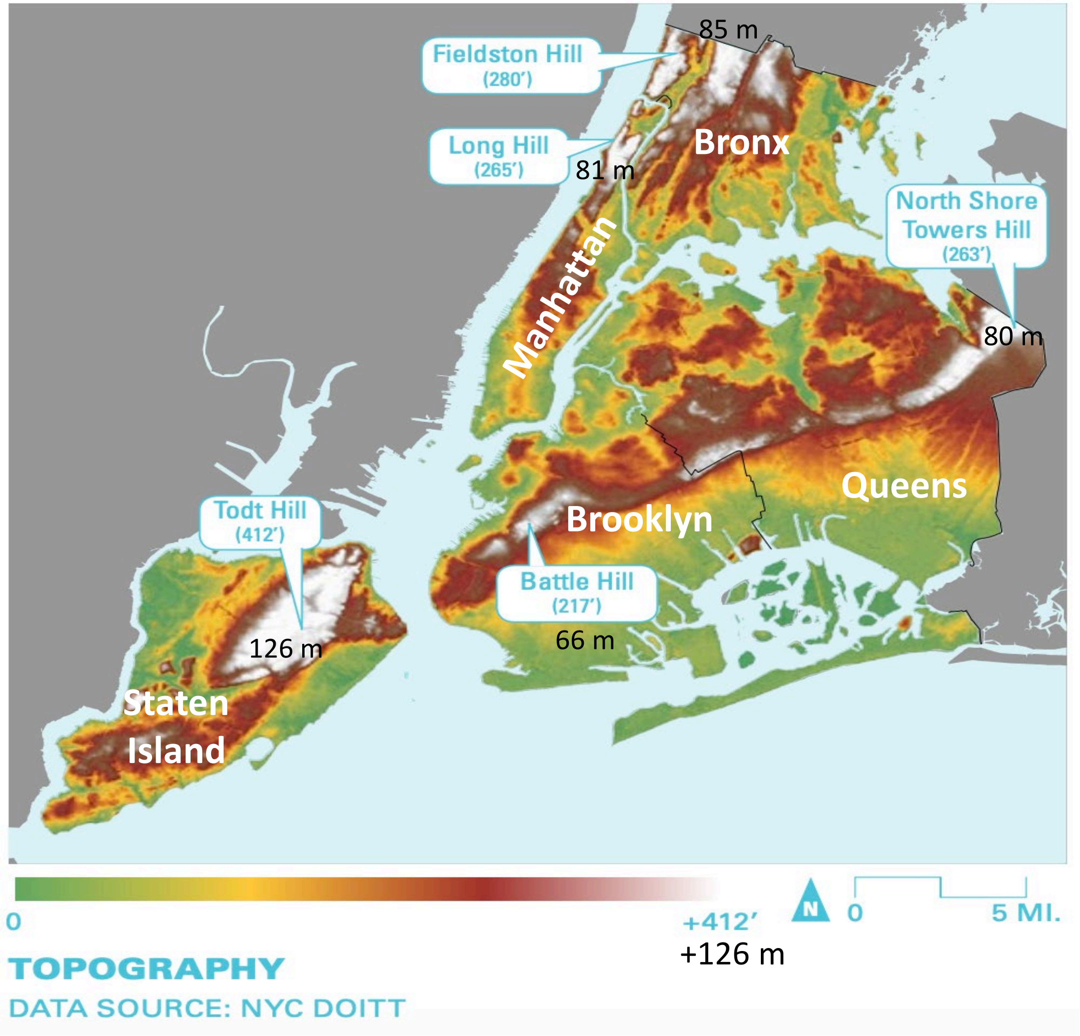
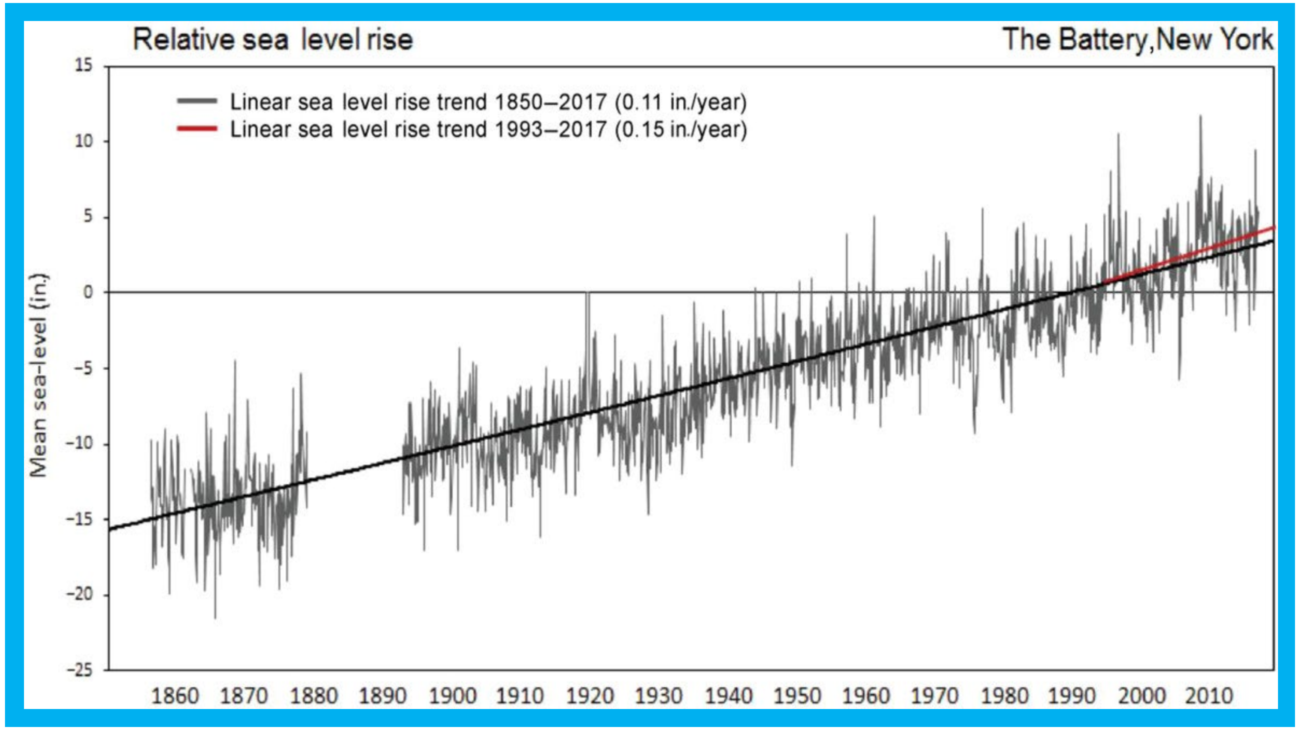


1.1 New York City is a Regional Sea Level Acceleration Hotspot



- NYC experiences higher than global, average sea level rise
- Accelerated sea level rise is due to enhanced thermal expansion, significant losses from land-based ice sheets, and glacial isostatic adjustment
- Since 2012, ice losses from Antarctica have tripled, which has increased sea level by 0.12 inches (0.3 cm)

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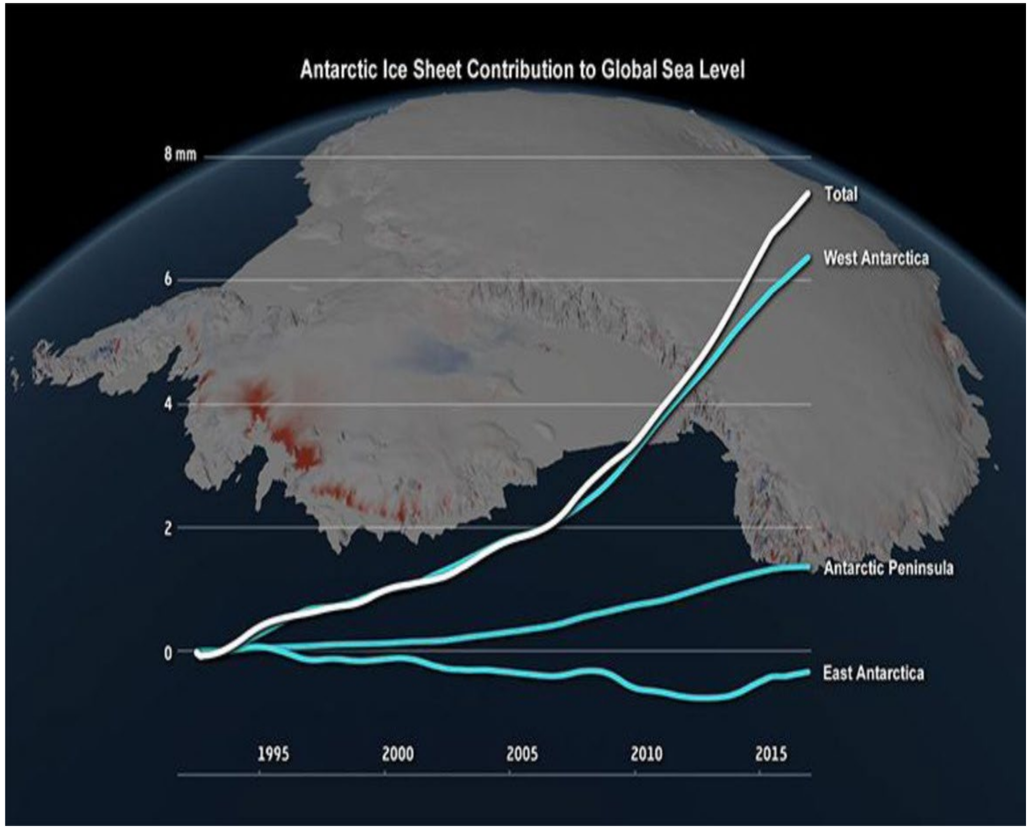
Source: Gornitz, V. et al. NPCC3 (2019);
Orton, P. NPCC3 (2019);

1.2 New York Panel on Climate Change & Future Sea Level Rise Projections

Table 3.2. New York City sea level rise projections, including the new Antarctic Rapid Ice Melt (ARIM) scenario, relative to 2000–2004 (in feet)

	NPCC2 2015 sea level rise projections[a] Projections of record for planning			NPCC3 ARIM scenario[b] Growing awareness of long-term risk
Baseline (2000–2004) 0"[c]	Low estimate (10th percentile)	Middle range (25–75th percentile)	High estimate (90th percentile)	ARIM scenario[d]
2020s	0.17 ft	0.33–0.67 ft	0.83 ft	–
2050s	0.67 ft	0.92–1.75 ft	2.5 ft	–
2080s	1.08 ft	1.50–3.25 ft	4.83 ft	6.75 ft
2100	1.25 ft	1.83–4.17 ft	6.25 ft	9.5 ft



- Projections indicate up to 2.5 feet (76.2 cm) of sea level rise by 2050 and 4.83 feet (147.2 cm) by 2080
- If the West Antarctic ice sheet were to detach (low probability, high consequence), sea level rise would be even higher
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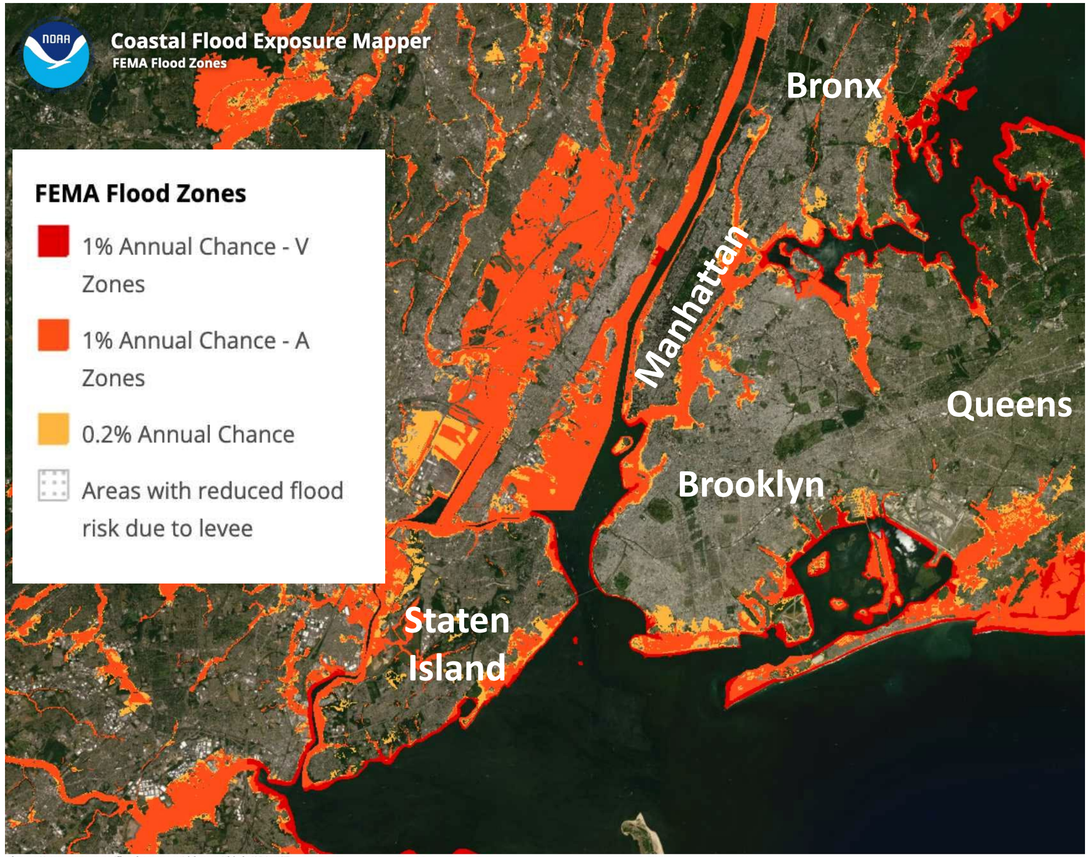
Gornitz, V. et al. NPCC3 (2019);
Shepherd et al., and NASA Planetary Visions

1.3 NOAA Flood Mapper with FEMA Flood Zones



https://coast.noaa.gov/floodexposure/ | https://bit.ly/3DJnyST

- FEMA studies statistical data for river flow and storm tides, hydrologic and hydraulic analyses, rainfall and topographic surveys, and storm frequency and intensity models to designate the zones and determine insurance premiums
- Some regions of the New York flood zone experience frequent flooding while other areas are only affected by severe storms
- Some areas in NYC flood during high tide without the presence of a storm (“nuisance flooding”). Nuisance flooding occurs at The Battery, Rockaway Peninsula, and Hamilton Beach

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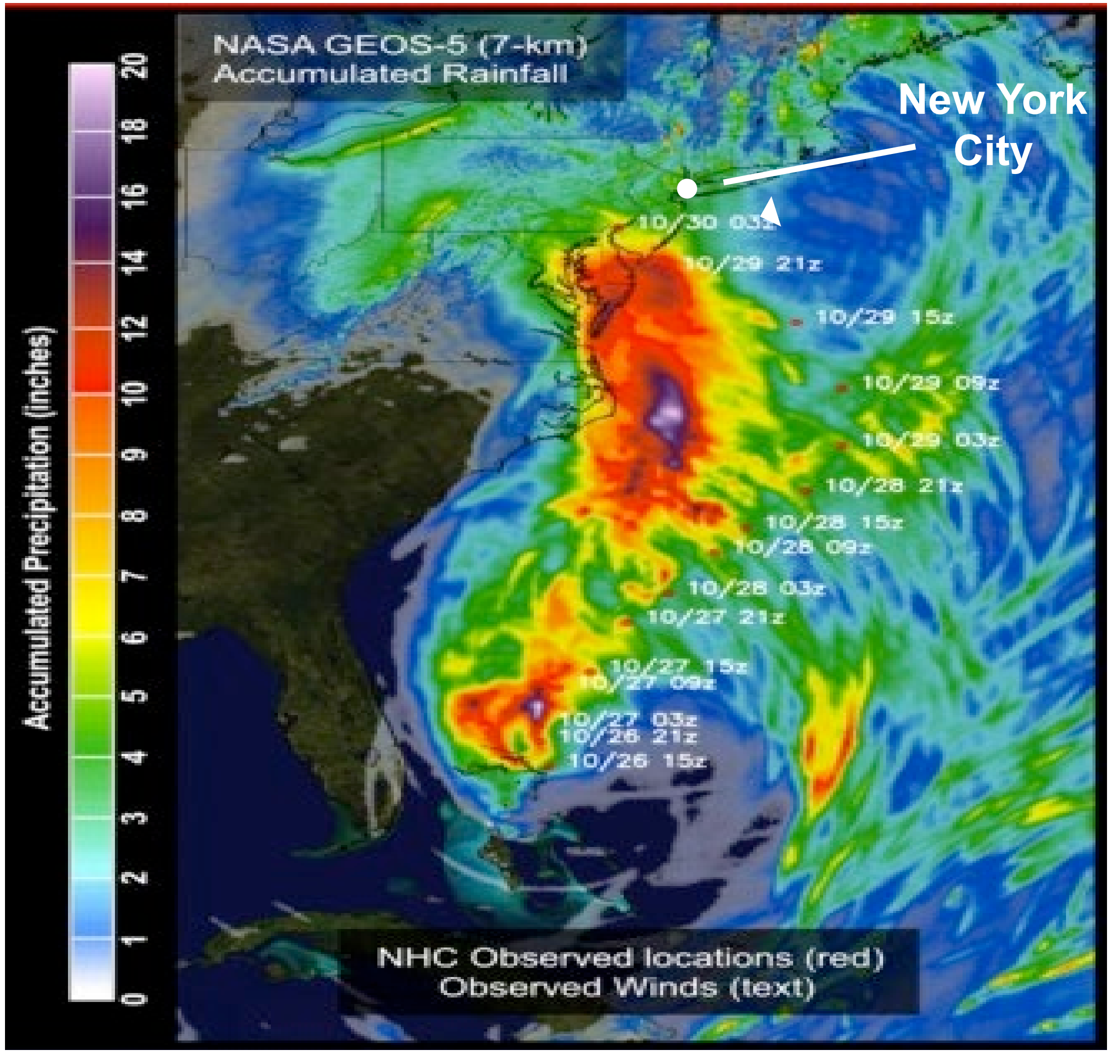
2. Understanding Superstorm Sandy



NOAA National Hurricane Center

- On **October 29, 2012**, Hurricane Sandy made landfall near Atlantic City, New Jersey
- Estimated New York Total Cost: 23 Billion
- The storm surge in The Battery (lower Manhattan) was 9.4 feet (2.87 m) high
- New York regions saw 5.4 to 6.5 feet (1.6 to 2.0 m) of inundation
- 43 New York fatalities with widespread building damages, power outages, interruptions to utility services, and large-scale flooding

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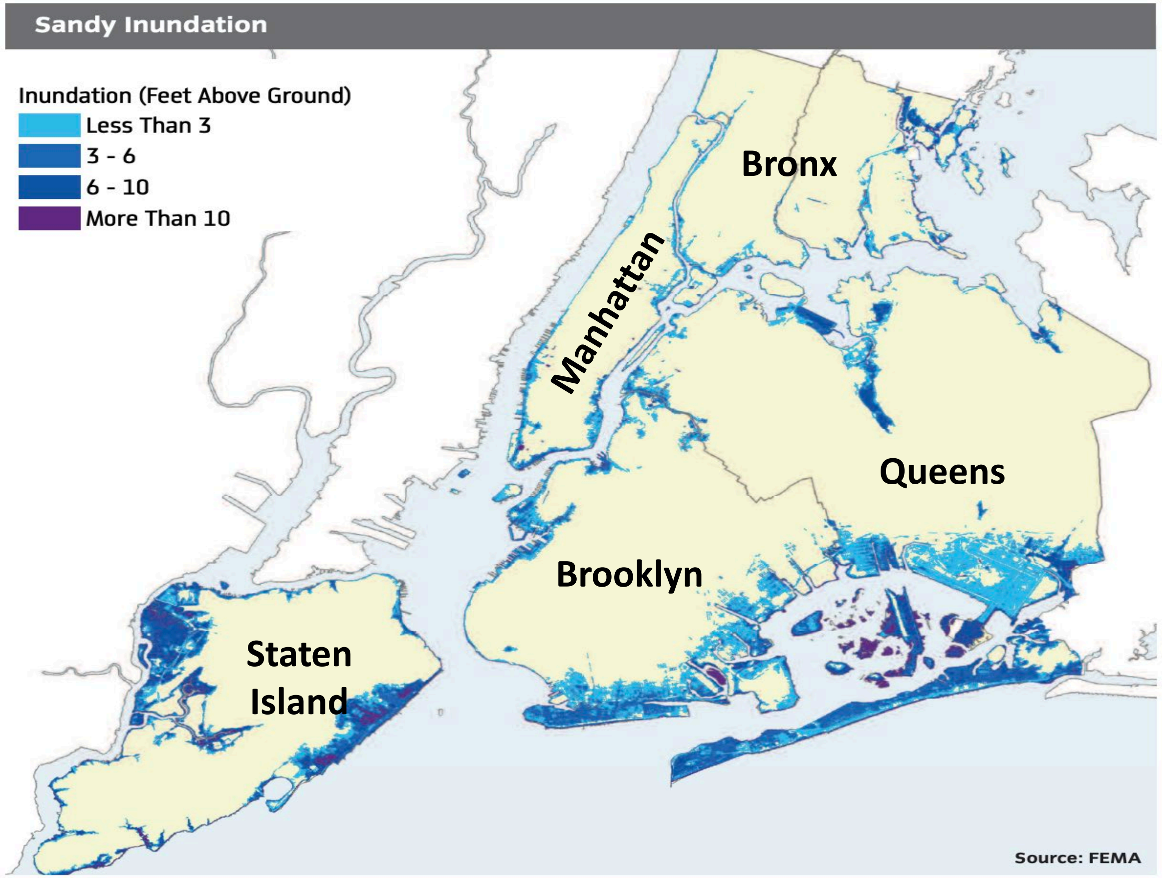
2. Understanding Superstorm Sandy (Cont.)

- Interdependent, critical infrastructure, such as electricity, underground transportation, and telecommunications were the hardest hit sectors

- The Brooklyn-Queens Waterfront, west and east shores of Staten Island, southern Queens, southern Brooklyn, and southern Manhattan were most impacted

Climate Central



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2.1 Scale of Sandy in Comparison to Other Recent NYC Hurricanes

	Customers without Electricity in Lower New York
Hurricane Irene August 28, 2011	204,000
Superstorm Sandy October 29, 2012	1,100,000
Storm Isaias August 4, 2020	257,000

- Hurricane Irene occurred a year before Superstorm Sandy but was not as devastating for New York City
- Superstorm Sandy caused multi-week electricity outages (in some places such as lower Manhattan) and petroleum shortages
  - Miles of underground rail inundated and ruptured natural gas lines
- Tropical Storm Isaias caused electric outages and railway disruptions due to wind but caused very little flooding

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ConEd, "Storm Isaias Outage is Second Largest in Con-Edison's Long History"

3. Post-Disaster Emergency Services & Short-Term and Mid-Term Recovery

- FEMA Response
  - President Obama directed FEMA to create the National Power Restoration Taskforce, which increased coordination among government agencies at all levels and the private sector to rapidly restore fuel and power
  - Coordinated federal, state, and local response sent 17,000 federal responders
  - Provided grants for temporary housing and home repairs & low-cost loans to cover uninsured property losses
  - NY shelter system housed 6,800 evacuees in 73 shelters with medical professional volunteers

- Disaster Relief Appropriations Act (2013)
  - $50.7 billion package for disaster relief agencies

- Sandy Recovery Improvement Act of 2013
  - Allowed FEMA -- and the state, tribal, local and territorial governments it supports -- greater flexibility in administering assistance programs

- The Resiliency Innovations for a Stronger Economy (RISENYC)
  - Helps Sandy-impacted small businesses to prepare their buildings, energy systems, and telecommunication networks for extreme weather and climate change

- Economic short recovery was the highest priority while communities turned to local volunteer efforts

3. Post-Disaster Emergency Services & Short-Term and Mid-Term Recovery

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4. Long-Term Recovery and Resilience Decision-Making in NYC

- Immediately following Hurricane Sandy, NYC responded with a sense of urgency to address the most pressing economic, critical infrastructure, and community damages. Keeping New York economically competitive was amongst the highest priorities

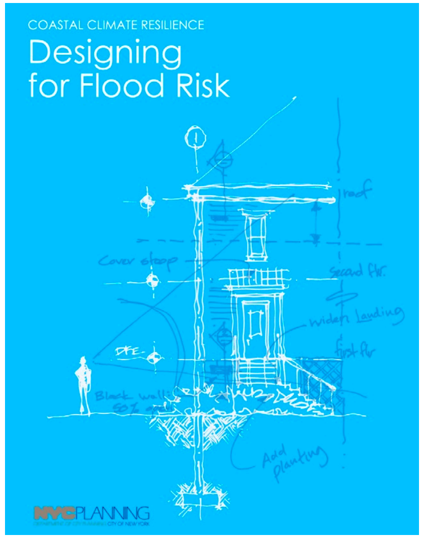
- Understanding, using, and improving the climate science became imbedded into decision-making and policy. This includes temperature, precipitation, sea level rise, and other extreme events

- After taking stock of the damages, there was a reactionary focus on coastal resilience. Main objectives included minimizing upland wave zones (which causes inundation), increasing coastal elevation, integrating community flood protection systems, improving coastal design and governance, and repairing damaged coastal infrastructure

- Less than 20% of inundated residential buildings had flood insurance at the time of Sandy – meaning that thousands of homeowners did not receive money to rebuild. New York State now requires homeowners in the 100-year floodplain to build using FEMA "freeboard" standards, which reduces flood insurance rates

- *Designing For Flood Risk* (June 2013) is a written design guide that addresses the challenges of building reconstruction and focuses on preparing buildings to withstand coastal flooding. This guide uses FEMA flood zones and includes the modifications to the National Flood Insurance Program

- Billions of dollars (federal, state, and local emergency funding) flowed into NYC. The largest FEMA grants (over 1 Billion) were allocated to the New York City Housing Authority, Health and Hospitals Corporation, Department of Environmental Protection, and Department of Parks and Recreation



4. Long-Term Recovery and Resilience Decision-Making in NYC

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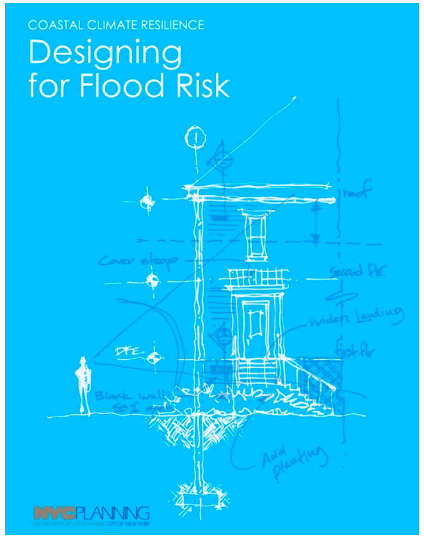

4.1 Long-Term Recovery and Resilience Planning

***Stronger, More Resilient New York* (SIRR)** is New York City's comprehensive plan to rebuild the most impacted communities, increase resiliency of infrastructure systems, and integrate/improve sea level rise climate models

SIRR was spearheaded by the NYC Mayor's Office during the Michael Bloomberg Administration (Published June 2013)

Calls on the State and Federal governments to coordinate with the City on local climate change projections

- Works with FEMA to improve the flood-mapping process, future flood risks, and enhance the communication of current flood risks
- Continues to refine NY-based climate change projections and sea level rise to inform decision-making
- Creates coastal protection strategies with green infrastructure
- Details how U.S. federal funds will be used for rebuilding efforts
- Launched a pilot program to identify and test strategies for protecting vulnerable neighborhoods from extreme heat health impacts

Salt Marsh Restoration at Jamaica Bay

Related Publications & Tools: *New York Panel on Climate Change (NPCC), Designing for Flood Risk, Zoning for Coastal Flood Resiliency: Planning Resilient Neighborhoods, Financial District and Seaport Climate Resilience Master Plan*, NYC Flood Hazard Mapper

4. Long-Term Recovery and Resilience Decision-Making in NYC

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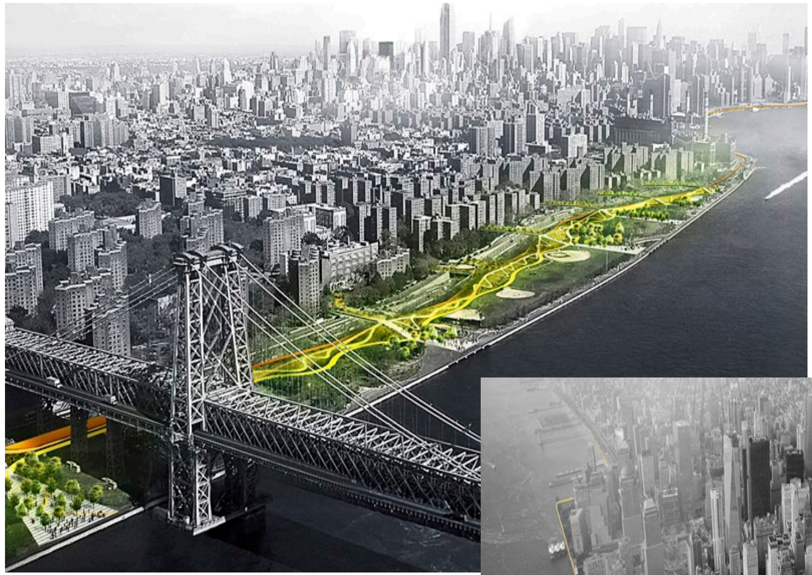
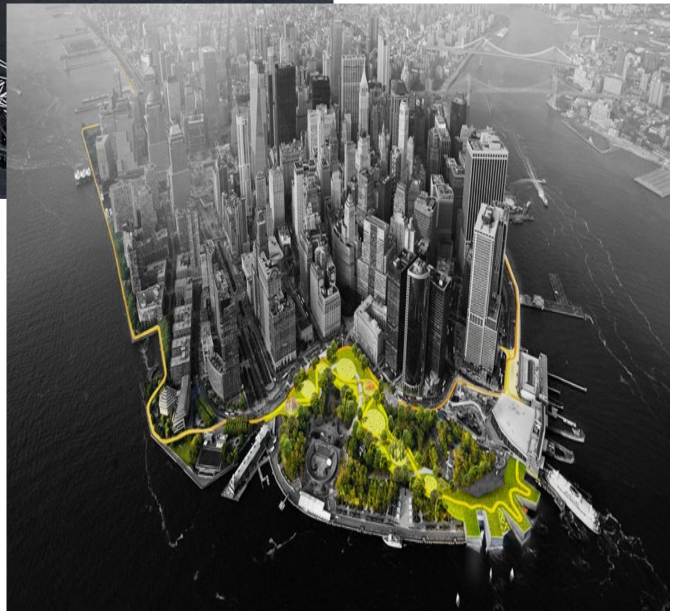
Salt Marsh Restoration at Jamaica Bay

4.2 Coastal Resilience Measures as a Result of SIRR

- Strengthen bulkheads; raise seawalls; build tidal barriers
- Broaden shorelines, construct berms, create multi-use public spaces
- Elevate frequently flooded streets and street edges
- Restore saltmarshes; replant native vegetation; “soften” land-sea slope edges (nature-based solutions)
- Flood-proof buildings; elevate new buildings above 1% annual floodplain
- Buyout and restore land to natural state (e.g., East Shore, Staten Island)
- Manage relocation (unfavorable option)



Planned Berm and Park, Lower East Side, Manhattan



The Big U (2026) Manhattan’s Southern Tip

4.2 Coastal Resilience Measures as a Result of SIRR

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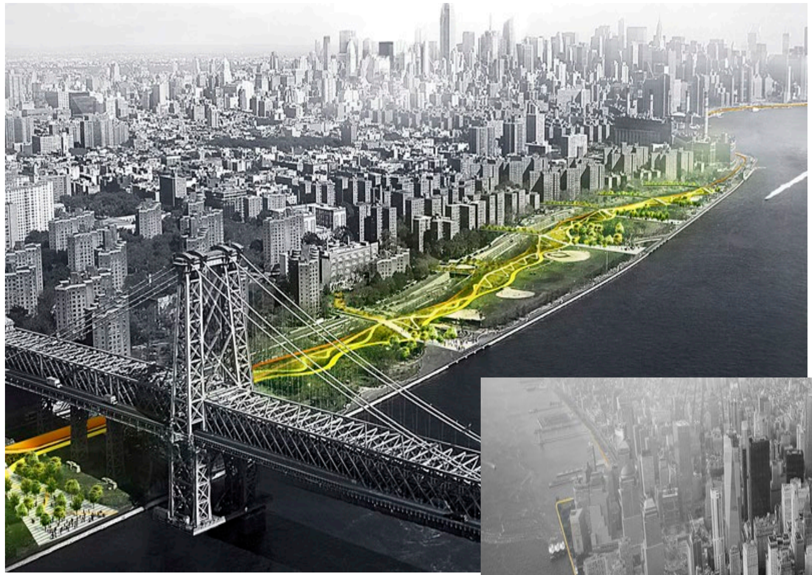
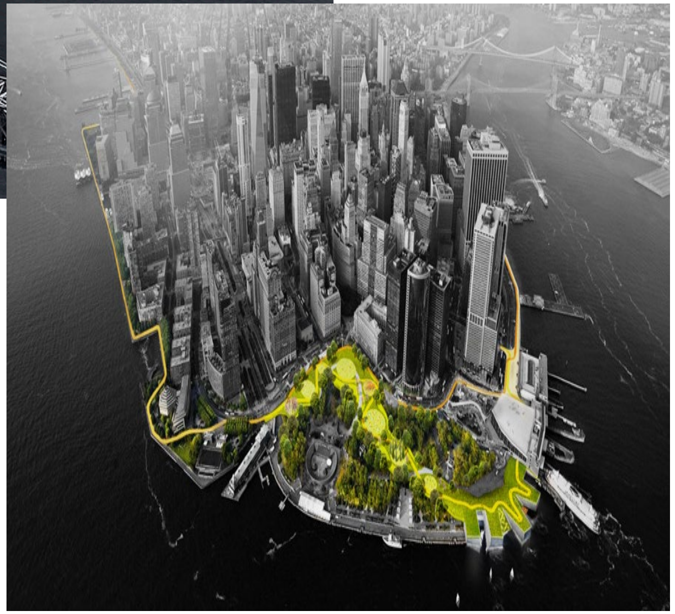


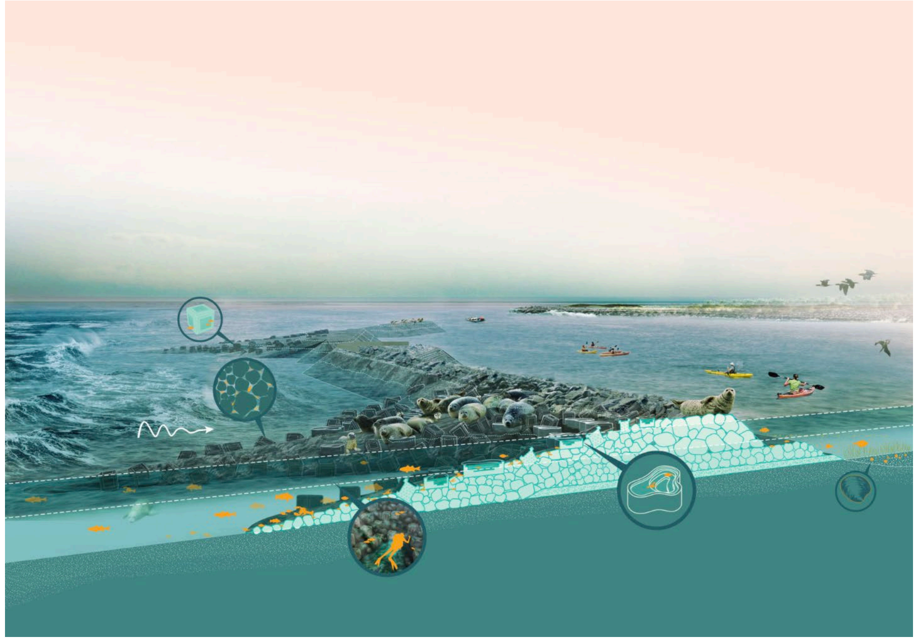


4.2 Coastal Resilience Measures as a Result of SIRR

Living Breakwaters (Staten Island, NY)

Composed of rock or other robust materials, living breakwaters reduce the forces of the waves before they reach the coast and adjacent neighborhoods. By calming nearby waters, these structures also can provide new habitat for sea organisms and reduce erosion

DESIGN



IMPLEMENTATION

View NYC's Sandy Funding Tracker for thousands of other ongoing recovery projects

4.2 Coastal Resilience Measures as a Result of SIRR

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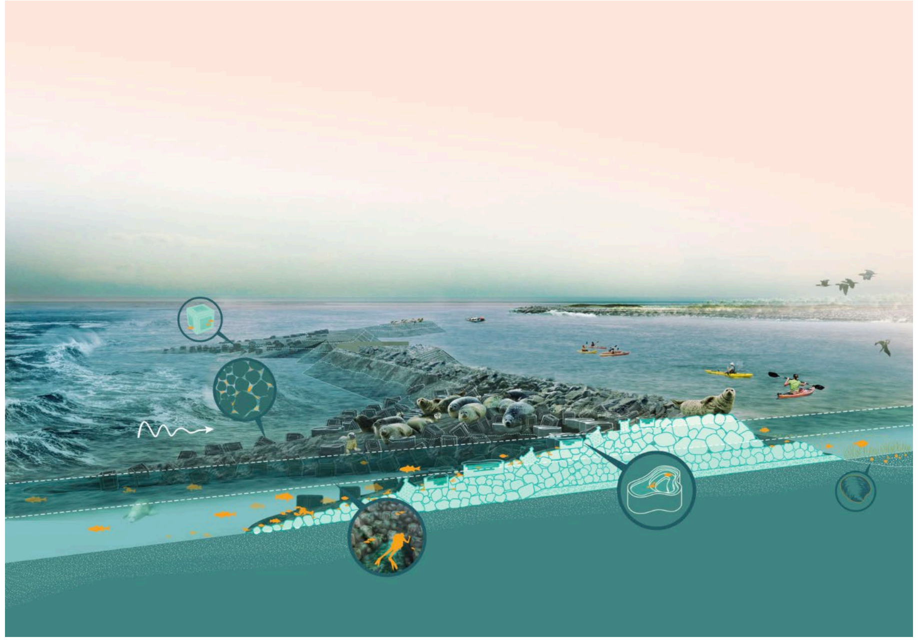

5. Lessons Learned at the 10-Year Mark
Superstorm Sandy Was a Tipping Point for Resilience Planning

Superstorm Sandy was a rare, high-magnitude event that hit at high tide on the city's southern coast

Exposure
- 5,700 structures, comprised of 162,700 residences, were situated in high-risk flood areas
- 80% of these were built prior to 1983
- Only 55% of the residences had federal flood insurance before Sandy

Adaptive Capacity
- Adaptive measures taken before the storm included beach nourishment in Coney Island and Brighton Beach, dune restoration at Rockaway Peninsula, elevated structures at Battery Park City, and some constructed wetlands with elevated edges
- Bulkheads were largely washed over by the storm surge but did diminish wave energy in Bay Ridge and Lower Manhattan
- In all not sufficient

Risk
- City and the Metropolitan Transit Authority has not fully incorporated climate risks into major infrastructure projects, built new South Ferry station in flood zone with no protection

Communication Lacking
- Non-English speakers at risk
- Inhabitants of high-rise buildings not accessed

Low risk aversion and low levels of coastal risk management contributed to the magnitude of the damages
- Low flood insurance protection

Unforeseen hazards
- Fuel shortages in the City and metropolitan region
- Breezy Point Fire, 100 homes destroyed

5. Lessons Learned at the 10-Year Mark
Superstorm Sandy Was a Tipping Point for Resilience Planning

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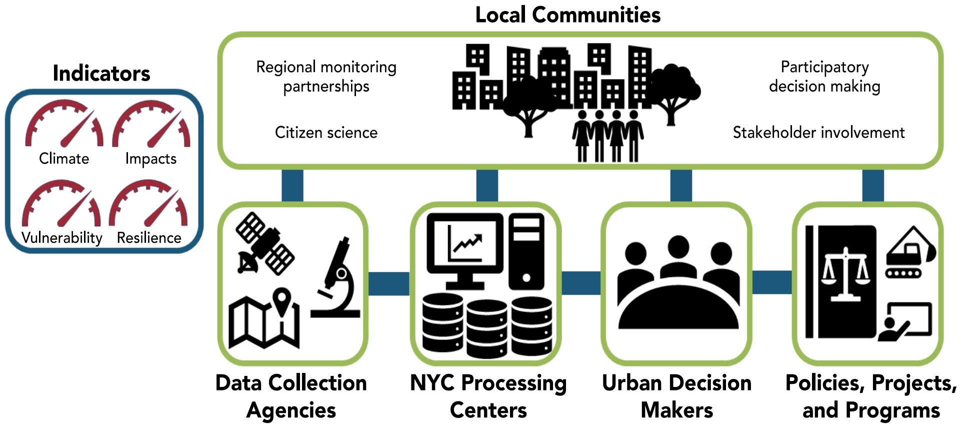
6. Recommendations

- Utilize indicators and monitoring, co-generated by stakeholders and scientists, to track data related to climate risks, hazards, and impacts to better inform climate change-related decision-making and evaluation of adaptation metrics
- Develop enhanced methods for estimating probabilities of changes in an expanded range of climate hazards and improve computational and statistical modeling of the climate system to better understand changes in future coastal flooding
- Apply dynamic flood inundation (storm surge) modeling and flood hazard mapping techniques in decision-making and disaster planning
- Improve understanding and mapping of neighborhood vulnerability to the range of current and future climate stresses, such as river flooding, heat waves, and the urban heat island effect
- During Sandy, disaster communication was insufficient and storm surge emergency messages should have been sent sooner. Risk perception is central to residents' safety and evacuation
- Prohibit rebuilding in excessively vulnerable areas



6. Recommendations

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7. Arguments & Subpoints

Arguments

- In Superstorm Sandy's recovery, NYC has embedded climate change projections into rebuilding efforts and policies
- Cities around the world, such as New York, have a critical responsibility to scale up climate change adaptation action, bringing together short-term, medium-term, and long-term disaster risk reduction

Subpoints

- The presence of compounding and cascading risks of extreme events must be accounted for in planning
- Fields of psychology, trauma-informed care, and public health should be interweaved in emergency management and preparedness

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