Sandy: A Wake-up Call For Hurricane-exposed Communities

Karthik Ramanathan, Ph.D.

Hurricane Sandy by the Numbers

500 million gallons of water flooded Hoboken, NJ – the equivalent of over 750 Olympic sized pools

Around **8.5 million** customers across 15 states lost power at the peak of the storm

About **600 miles** of New York City's subway tracks were inspected – equivalent to the distance between NYC to Detroit

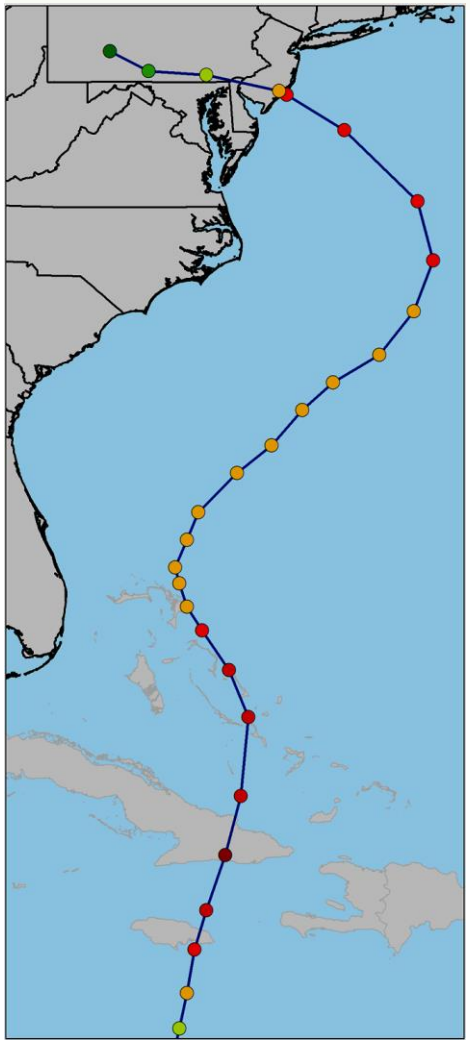
945 miles was the diameter of tropical storm force winds at the time of landfall

Total economic loss: **USD ~50 billion** (as of Feb 2013)

Total insured loss
USD 35 billion Swiss Re (March 2013)
USD 30 billion Munich Re (April 2013)
USD 18.75 billion PCS** (March 2013)

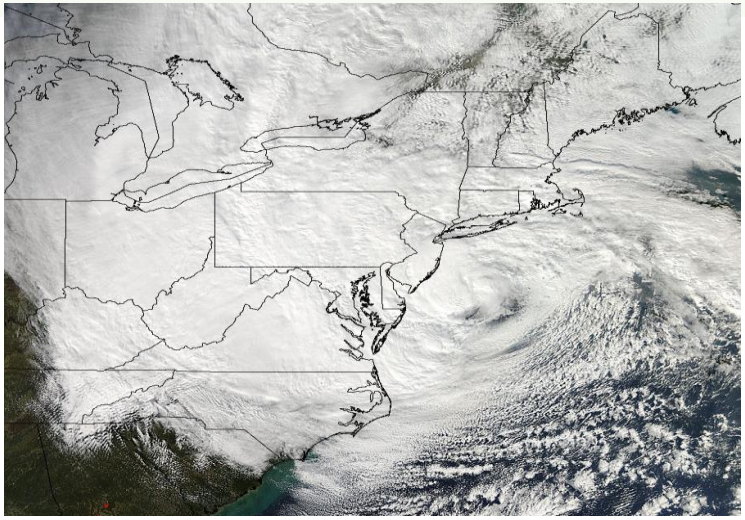
**PCS estimate does not include loss involving uninsured property, including uninsured publicly owned property and utilities, agricultural, aircraft, ocean marine, including oil drilling platforms and property insured under the NFIP or the Write-Your-Own Flood Insurance Program

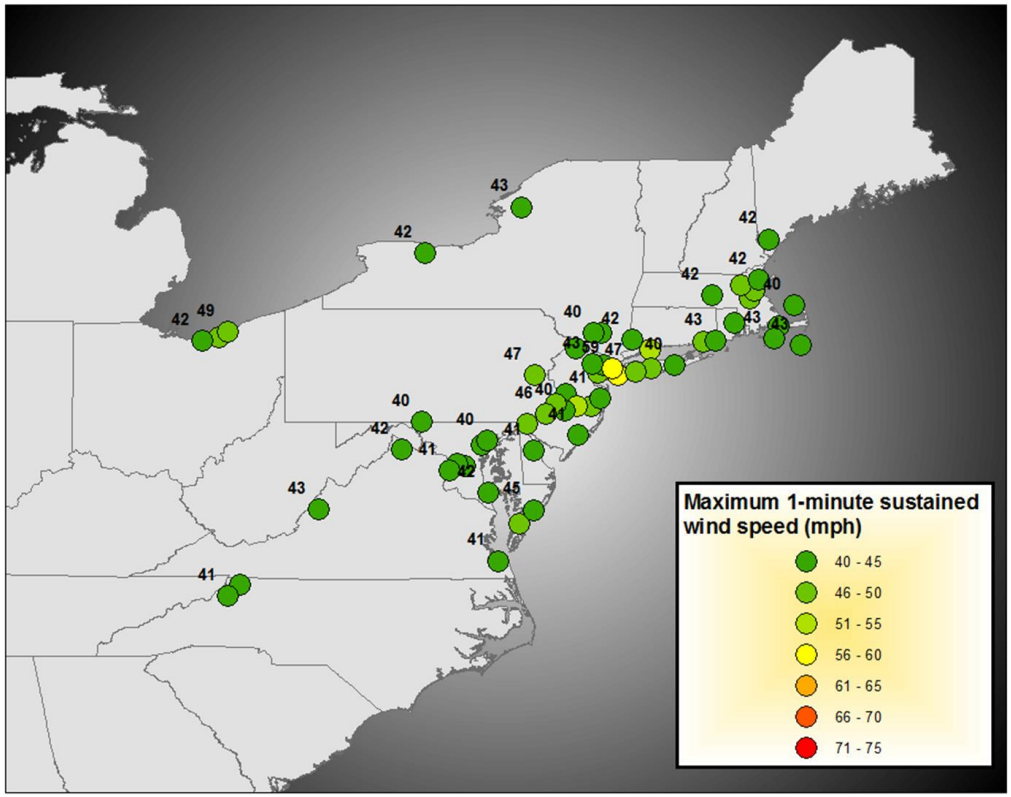
Sandy Impacted Both the Caribbean and Mid-Atlantic Coastline During It's Nine Day Duration



- Sandy's peak intensity occurred off the coast of Cuba on October 25
- The lowest central pressure (940 mb) was observed just prior to landfall, making this the lowest for a northeast hurricane (6 mb lower than the 1938 "Long Island Express")
- Sandy's diameter made it the largest Atlantic hurricane on record. This large size actually helped to lessen the maximum wind speeds, as the pressure difference driving the winds was spread over a larger distance
- Strong winds offshore, coupled with astronomical high tides and westerly track, increased the storm surge risk

Observations from Sandy Indicate the Overland Wind Field Was Broad But Moderate

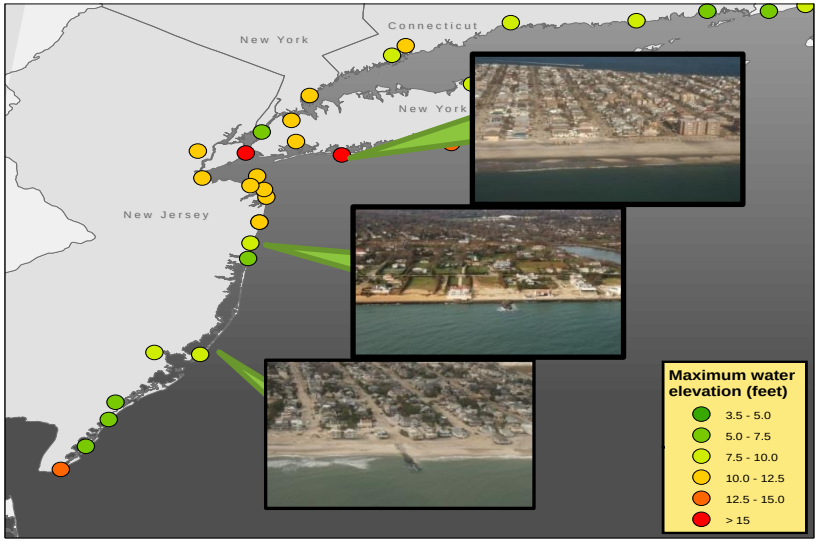




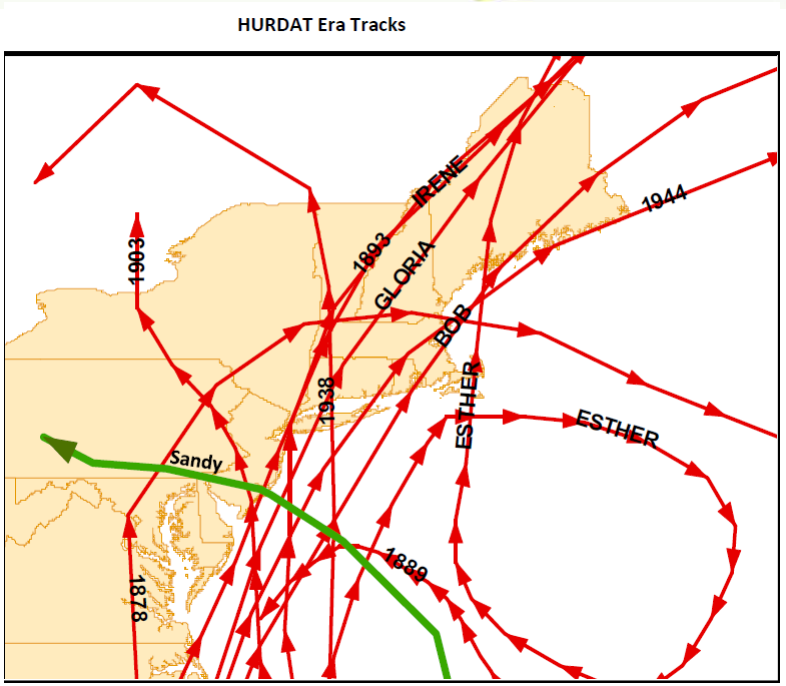
Source: NOAA-NWS 2-minute METAR observations adjusted to 1-minute averaging time

Sandy's Intense Storm Surge Was Influenced By Many Factors

- Westerly track propagation
- Low central pressure
- Large wind field
- Strong intensity of offshore winds prior to landfall
- Astronomically high tides

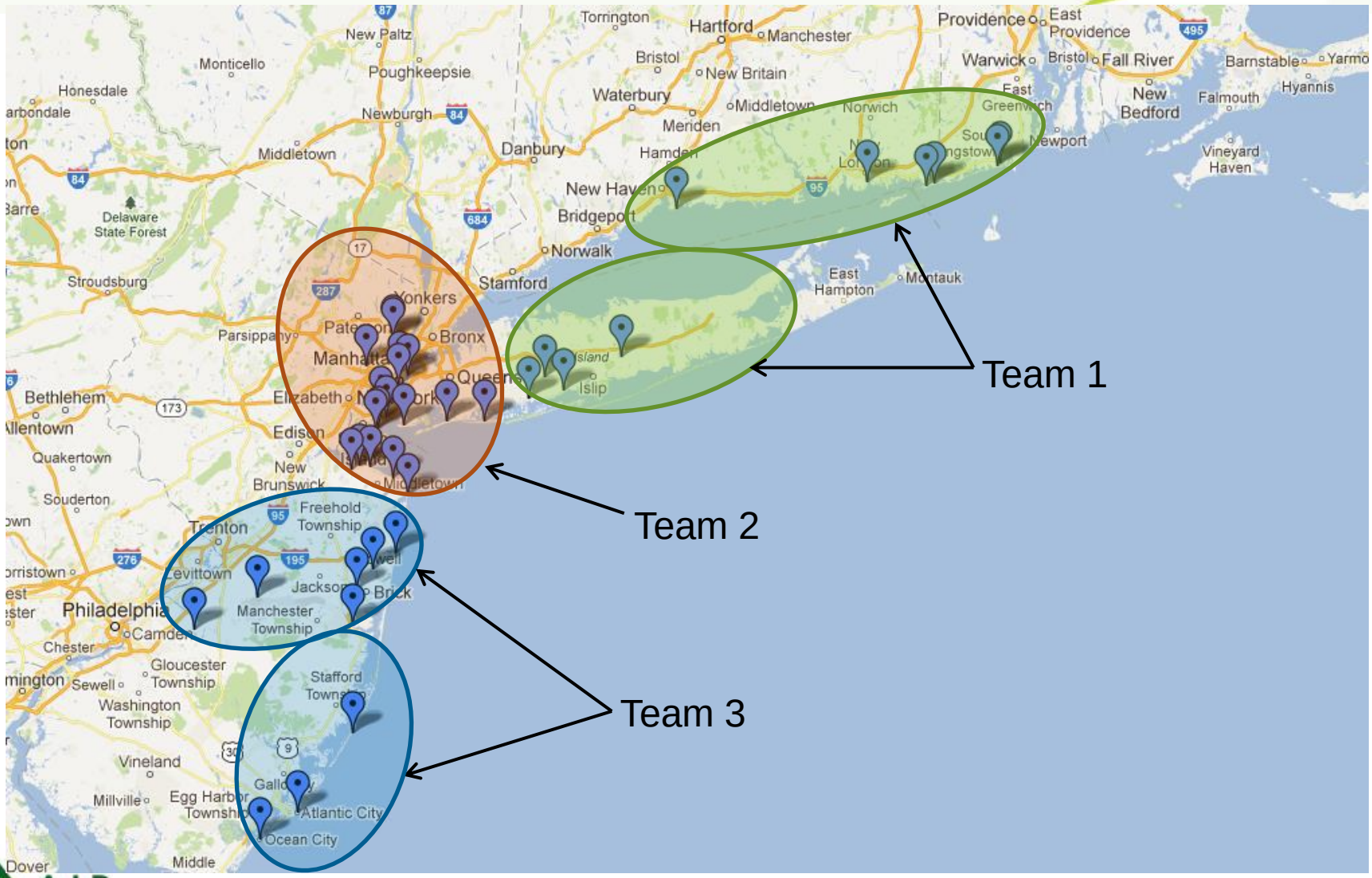


Source: USGS/FEMA water height observations and http://coastal.er.usgs.gov/hurricanes/sandy/post-storm-photos/obliquephotos.html



- Damaging surge occurred from Southern New Jersey to Eastern Long Island

AIR Sent Teams on Damage Surveys Following Sandy to Assess Affected Areas



Wind Damage to Residential Structures Was Generally Minor, Except in Cases of Downed Trees

- Minor damage seen in majority of cases
- Parts of New Jersey and New York observed moderate wind damage, mainly to older structures
- Significant damage was typically due to trees falling

Long Island, NY

Westerly, RI

Rockaway, NY

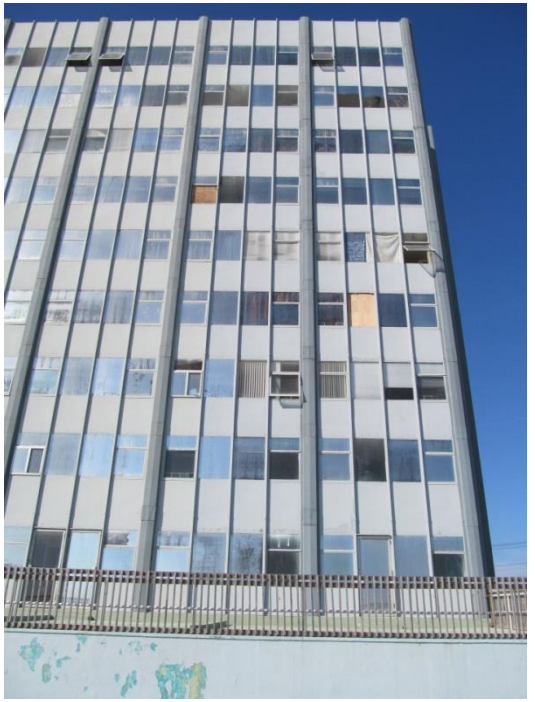
Ocean City, NJ

New London, CT

Wind Damage to Engineered Structures Was Less Pronounced

- Wind damage to engineered structures was occasional
- High-rise commercial structures in Atlantic City, NJ experienced some signage and cladding damage
- Few apartment buildings suffered roof damage due to rooftop equipment and damage to soffits

Long Island, NY



Rockaway, NY

Cosey Beach, CT

Atlantic City, NJ

Surge Damage to Residential Structures Was Significant in Many Coastal Counties

- Significant surge damage all along the coastline of NJ, NY, and parts of CT and RI
- First floor elevation, foundation type, and presence of basement were major factors of damage

Seaside Bright, NJ

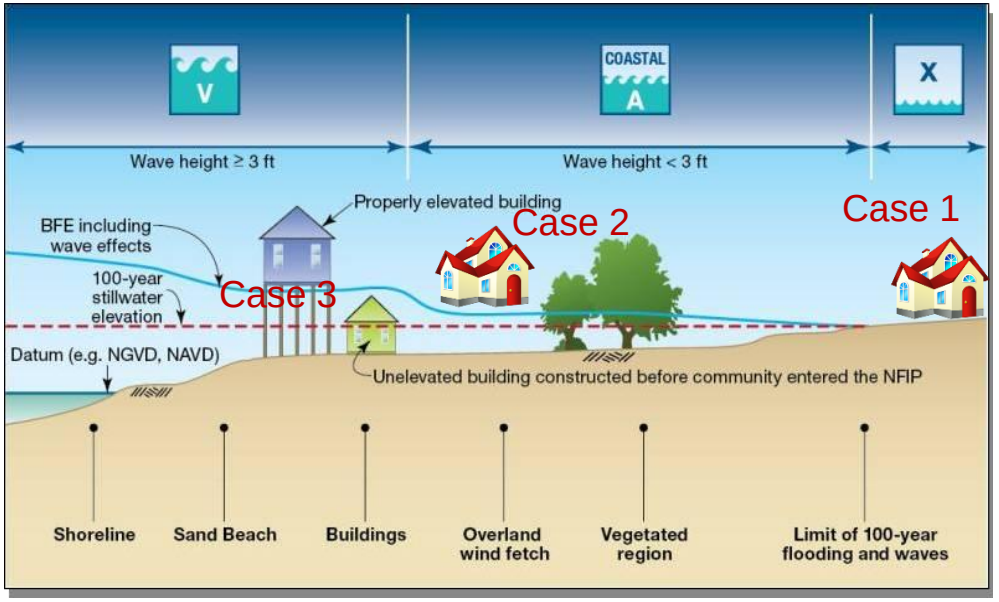
Long Beach Island, NJ

Westerly, RI

Long Island, NY

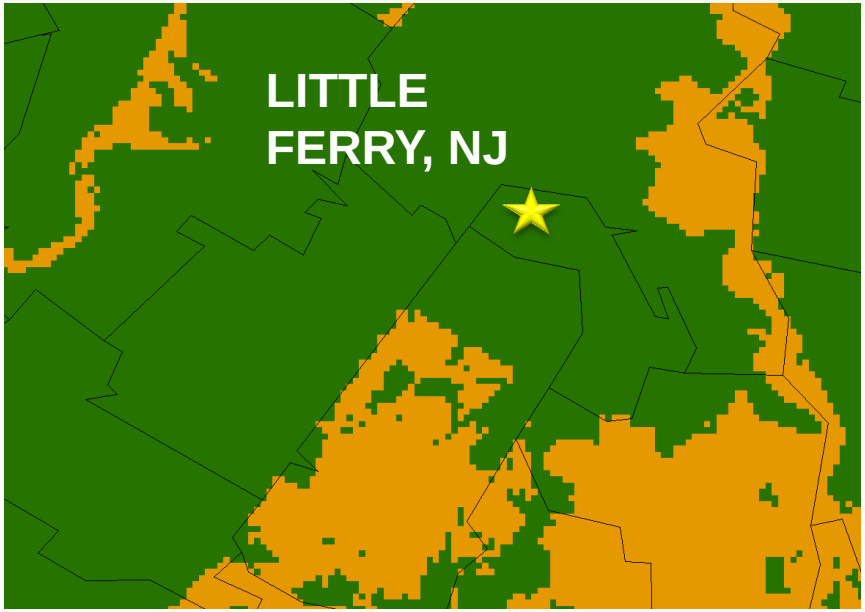
Significant Surge Damage in Residential Properties Can Be Attributed to Several Factors

- In some areas Sandy's surge extended beyond FEMA's 100-year flood zones (A and V)
- Within A and V zones, Sandy's surge heights exceeded recommended design levels (i.e., Base Flood Elevation or BFE)
- There were many residential properties that did not meet recommended design levels, both Pre- and Post-FIRM



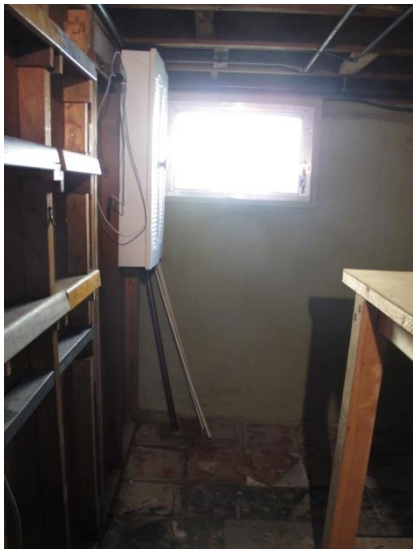
Source: FEMA P-55 Coastal Construction Manual

In Some Areas Sandy's Surge Extended Beyond FEMA's 100-year Flood Zones (A and V)



- Damage occurred primarily to basements, garages and first floors in residential neighborhoods
- Significant contents damage

Significant damage to the basement



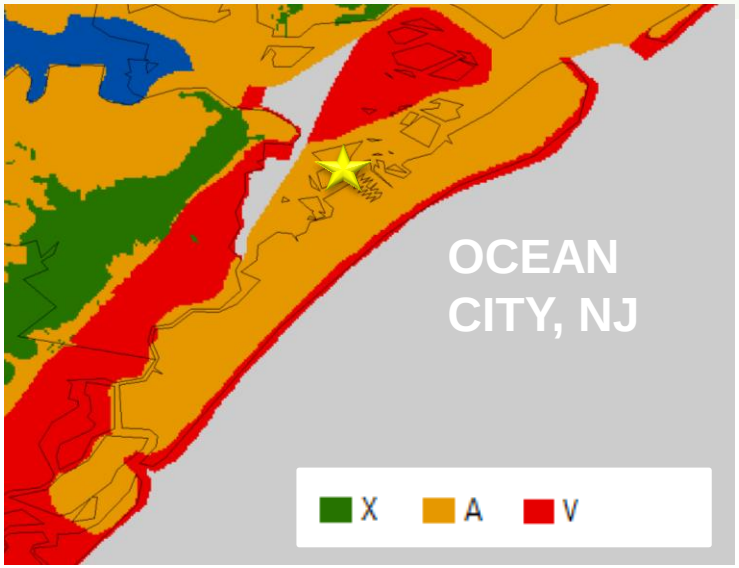
Damaged contents in garage

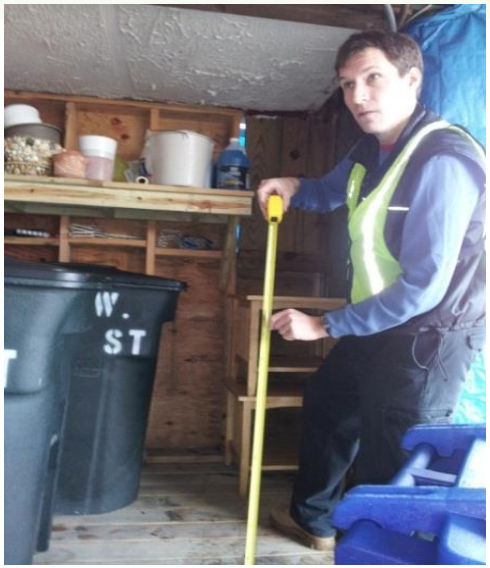
There Were Many Residential Properties That Did Not Meet Recommended Design Levels, Both Pre- And Post-FIRM

Midland Beach

New Dorp Beach

Houses Built According to FEMA Recommendations Generally Fared Much Better



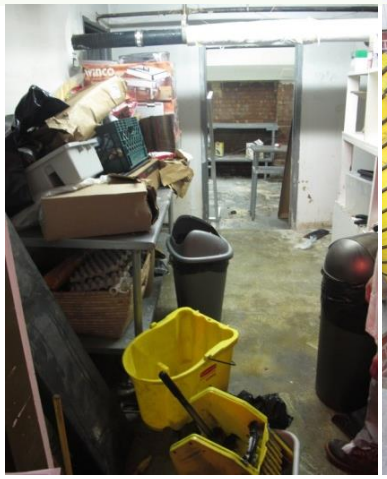


Keyport, NJ

Measured surge height of 4ft in the center building

Surge Damage to Commercial Structures Was Significant But the Level of Insurance Coverage Varies Widely

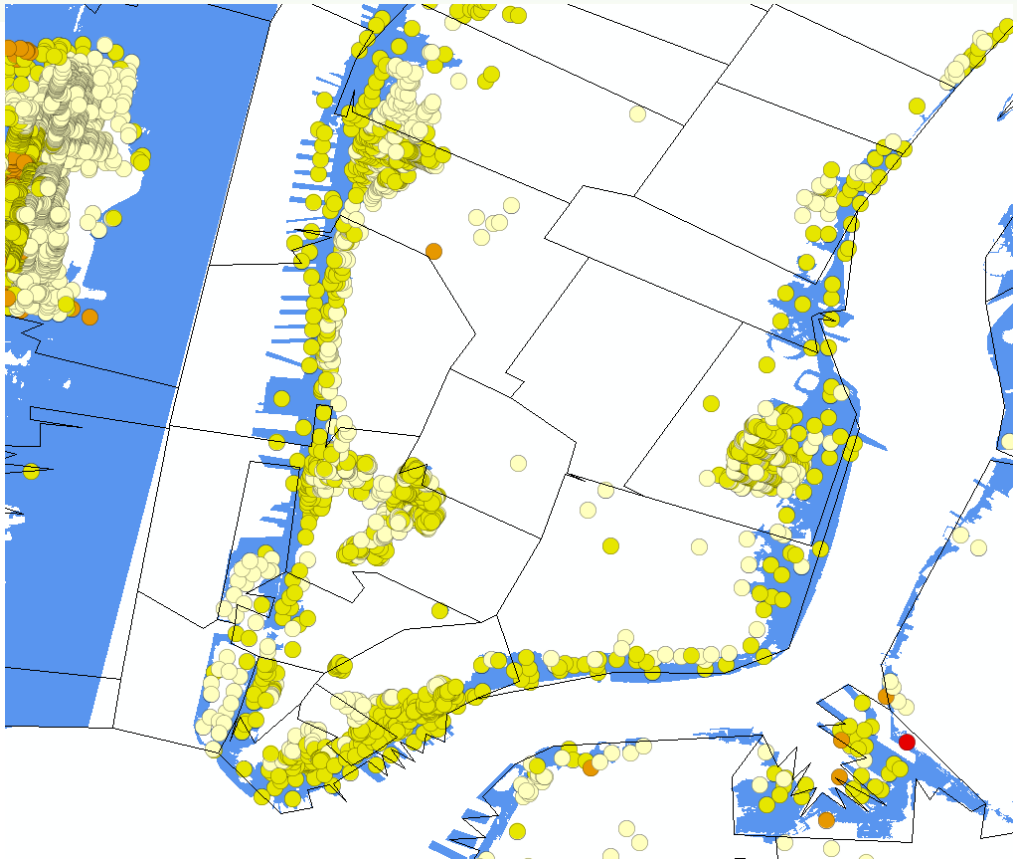
- Wide spread flooding was prevalent in all the areas visited in Manhattan, NY and Atlantic City, NJ
- Presence of underground spaces used for storage, as a basement, or as a garage was widespread
- Widespread contents damage
- Power and gas were still to be restored to many facilities
- Small commercial businesses (restaurants, grocery stores) may not possess any type of flood coverage


Lower Manhattan, NY


Coney Island, NY

Many High-rise Commercial Buildings Were Closed Due to Damage to Critical Equipment and Utility Failure



Source for damage data points:

http://fema-services2.esri.com/arcgis/rest/services/2012_Sandy

Lower Manhattan, NY

Key Drivers Of Downtime and Business Interruption Losses in Commercial Exposures

- Concentration of critical components in “floodable” parts of the building
- Utility failures
- Restoration of functionality (repair crews and spare parts)
- Level of flood and BI coverage
- Policy conditions – deductibles, sub-limits




How Can Flood Damage Caused by Sandy Be Explained in the Context of NY and NJ Building Codes?

- Residential construction – community flood management program instituted by NFIP
- ASCE 24 addresses elevation for commercial buildings
- NFIP specified BFEs are relatively new when compared to the age of buildings located along the NY and NJ waterfronts
- Early BFEs did not account for wave action – BFEs accounting for wave action were inducted in the 1980s
- Older properties grandfathered into the NFIP could have habitable spaces below the BFE

Significant Auto Damage Occurred in Metropolitan Areas

- No evacuation
- Underground parking
- High population density

Lower Manhattan, NY

Long Island, NY

Damage to Other Lines of Business Was Also Significant, Particularly in Areas Exposed to Storm Surge

- Pleasure boats
- Builder's risk
- Infrastructure

New London, CT

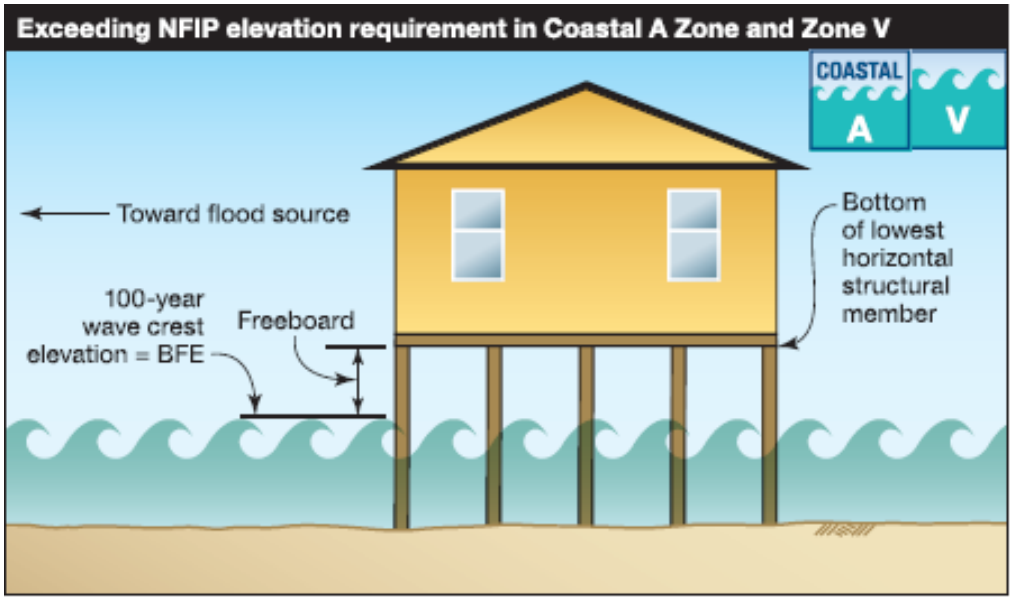
Lower Manhattan, NY

Ocean Breeze, NY

Long Island, NY

Summary

- Sandy exposed the vulnerability of urban Manhattan and coastal communities along the Jersey shore
- Several critical facilities are located in the FEMA flood zones
- Need to revisit and re-evaluate the FEMA flood maps and associated BFEs



Source: FEMA P-55 Coastal Construction Manual

Additional Reading: AIR Currents

AIRCURRENTS: INSIGHTS INTO DAMAGE AND VULNERABILITY FROM AIR'S SANDY SURVEY TEAMS

DECEMBER 2012

BY KARTHIK RAMANATHAN, MATT MADDALO, AND ADITYA KISTEMASETTY
EDITED BY SARA GAMBRILL

EDITOR'S NOTE: *AIR dispatched three teams to survey damage in Rhode Island, Connecticut, New York, and New Jersey caused by Sandy. Team members included structural engineers Dr. Karthik Ramanathan, Matt Maddalo, and Aditya Kistemasetty; Matthew Holland and Nihal Joag from Consulting and Client Services; and Jared Seaquist from Business Development. In this article, Ramanathan, Maddalo, and Kistemasetty discuss the survey findings and how they inform AIR's understanding of damage and vulnerability in the areas impacted by Sandy.*

Sandy was a post-tropical cyclone when it made landfall around 8:00 p.m. EDT on October 29, 2012, five miles southwest of Atlantic City, New Jersey. (For more on Sandy's meteorological evolution and insured loss estimates, please read the AIRCurrents article The 2012 Hurricane Season in Perspective.) On November 6, AIR deployed our first damage survey team to South Kingstown and Westerly, Rhode Island, and New London, East Haven, and Niantic, Connecticut. The same team also surveyed damage the following day in Islip, Little East Neck, Massapequa, Long Beach, and Farmingdale, Long Island, New York.

On November 11, AIR deployed two more teams to Manhattan, Coney Island, Queens, and Staten Island, New York; and Atlantic City, Ocean City, Long Beach Island, Toms River, Point Pleasant Beach, Sea Bright, Keyport, Union Beach, Belmar, Kearsburg, Secaucus, Moonachie, and Little Ferry, New Jersey.

The primary reason for AIR's reconnaissance was to study the effect of storm surge on engineered and non-engineered structures. In areas visited by AIR's survey teams, storm surge damage resulting from Sandy was much more severe than wind damage. In the Connecticut and Rhode Island areas surveyed, only structures on the immediate coast were severely damaged by surge. In Long Island where surge heights were higher, some entire neighborhoods were inundated with surge waters. In these areas, a significant number of properties even several blocks from the coast showed signs of building and contents damage. Cars, pleasure boats, and other heavy objects were displaced.

In coastal areas of New York and New Jersey, the majority of the damage was due to storm surge; in inland areas, there was damage caused by riverine flooding, wind, and tree fall. The coastal communities of New Jersey surveyed experienced extensive to—in some cases—virtually complete damage due to storm surge.

What follows is a detailed look into the type of damage caused by Sandy and the vulnerability of residential, commercial, and industrial exposures the storm revealed in areas surveyed by the AIR teams.

WIND DAMAGE CONSISTENT ACROSS A BROAD FOOTPRINT

Not surprisingly, AIR survey teams found that wind damage was generally higher along the coast where stronger winds were observed. AIR also surveyed inland locations where wind measurements were available. AIR's damage surveys yielded fairly consistent results across the area affected by the storm. The mechanisms of damage observed were in line with AIR engineer expectations for an event of Sandy's sustained wind speeds, which ranged between 40 and 50 mph over the wide event footprint.

In general, wind damage was typically limited to the building envelope: roof covering, flashing, and wall siding (see Figure 1). At inland locations where sustained winds of weak tropical storm strength were recorded, an estimated 2% to 5% of homes experienced wind damage. It was unclear how many windows had been protected during the storm, but winds were probably not strong enough to make debris a significant source of opening damage. Damage to garage doors, typically one of the weaker components in a residential structure, was driven by surge rather than wind.

Figure 1. (Left) Wind damage to siding, Westerly, RI; (right) wind damage to roof, Queens, NY (Source: AIR)

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