Regional Storm Hydrology and Implementation of the USGS SWaTH Network

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Presentation Overview

- Basic storm hydrology.
- Hurricane Sandy data.
- USGS Surge, Wave, and Tide Hydrologic (SWaTH) Network.
- Integration of Piermont Marsh into SWaTH.
- Questions.
Causes of Major Coastal-Flooding Events in the Southeastern New York Region

- **Hurricanes/Tropical Storms:**
  - Most likely during July to October,
  - Usually quick moving, lasting only one or two tide cycles,
  - Greatest winds and tidal flooding near storm center.

- **Nor’easters:**
  - Most likely during November to March,
  - Can be slow moving, lasting many tide cycles,
  - Greatest winds and tidal flooding generally away from storm center.

- **Hybrid Storms:**
  - Most likely near end of Hurricane season / beginning of Nor’easter season,
  - Have characteristics of both types of storm.
  - Hurricane Sandy was such a hybrid.
Components of Coastal Flooding

Storm Surge vs. Storm Tide

**Storm Surge:** Abnormal water-level rise from a storm, over and above the predicted astronomical tides.

**Storm Tide:** The water level rise due to the combination of storm surge and the astronomical tide.
**Wave Runup:** Occurs when a wave breaks and the water is propelled onto the beach.

**Wave Setup:** Occurs when waves continually break onshore and water from the wave runup piles up along the coast.
Major Flooding from Recent Coastal Storms

Storm of Dec. 11-13, 1992:

- Slow moving Nor’easter type storm.
- Produced widespread major coastal flooding over multiple tidal cycles.
- Remains storm of record in some areas.
Major Flooding from Recent Coastal Storms

Hurricane Irene (August 2011):
- Weakened to a tropical storm.
- Relatively fast moving.
- Caused localized major coastal flooding over a single tidal cycle.
Major Flooding from Recent Coastal Storms

Hurricane Sandy (October 2012):

- Hybrid extra-tropical cyclone.
- Anomalous track and large fetch caused major coastal flooding over multiple tidal cycles.
- Magnitude of local flooding dictated by phasing with astronomical tide.
Storm-Tide Flooding from Hurricane Sandy

Why was Sandy flooding so bad?

- Transition to hybrid storm forces wind field out from center.
- Large wind field (fetch) piles water towards the coast north of center.
- Anomalous track funnels water into New York / Raritan Bay.
- As storm makes landfall south of region, winds switch to south to southeast direction, further enhancing surge.
- Maximum surge along Atlantic Coast coincides with astronomical high tide.
## Storm-Tide Flooding from Hurricane Sandy

<table>
<thead>
<tr>
<th>Location</th>
<th>Approximate peak storm surge, ft</th>
<th>Recorded Peak storm tide, ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Southern Suffolk</td>
<td>6</td>
<td>4.1 - 6.8</td>
</tr>
<tr>
<td>New York City</td>
<td>9</td>
<td>9.5 - 13.2</td>
</tr>
<tr>
<td>Peconic Bay</td>
<td>7</td>
<td>6.3 - 7.9</td>
</tr>
<tr>
<td>Northern Nassau</td>
<td>12</td>
<td>9.9 - 10.3</td>
</tr>
</tbody>
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Peak Storm-Tide Elevations, NAVD 88
Network of long-term gages and storm-deployed temporary sensors.

Developed for Northeast Coast from North Carolina to Maine.

Expanded to include deployment for major Nor’easters, in addition to tropical systems.

Collaborative effort with Federal, State and local partners, emergency managers, coastal researchers, and modelers.

Includes both long-term and temporary stations operated by the USGS and other partners.
Entire proposed network consists of about 900 sites:

- 75 non-USGS stations,
- 115 coastal stations/tidal streams,
- 530 storm-tide/wave sensors,
- 85 rapid-deployment gages,
- 30 tidal crest-stage gages,
- 65 temporary barometric-pressure sensors.

Not all stations will be fitted with sensors for any one storm.

Data distributed through an online mapper in near-real time or as data is collected.
Combination of NOAA and USGS long-term coastal-monitoring stations, and USGS storm-deployed rapid-deployment gages and temporary tide and wave sensors.

Data collected at 6-min. averages at coastal stations and RDGs; transmitted by GOES satellite every 15-min or more frequently as needed.

Some sites have meteorological and/or water-quality monitors.
USGS Storm-Tide Monitoring (SWaTH)

- Temporary tide-sensor data collected at 1-Hz intervals (once per second) or greater, and wave sensors at 4-Hz intervals (4 times per second) and downloaded and processed.
- Sites are pre-determined and pre-surveyed, many with installed fixed-place brackets for easy storm deployment.
- Deployed in location and at height so most complete tidal cycle is recorded.
USGS Storm-Tide Monitoring (SWaTH)

- Verify sensor data.
- Use as indicators of peak storm tide.
- Can reveal effects of waves.

Types of HWMs
- Seed lines
- Mud lines
- Debris lines
Distributed (blue points): stations spaced geographically to facilitate monitoring on a regional scale or for high-priority sites.

Transect (orange points): stations included as part of a wetlands or urban transect (e.g. from open coast to back bays to inland).
USGS Storm-Tide Monitoring (SWaTH) Piermont Region

- Leverage the SWaTH Network and install brackets for up to 6 storm-deployed tide/wave sensors.
- Storm-tide sensors north and south of pier.
- Wave sensor collocated with real-time gage at end of pier.
- Transect of sensors through Piermont marsh.
- Find partners to fund long-term O&M at real-time gage.
USGS Storm-Tide Monitoring (SWaTH) Piermont Region

- Sensors would be deployed during severe nor’easters or tropical cyclones expected to produce widespread major coastal flooding.

- Sensors surrounding pier should provide information on tidal and wave characteristics, timing and extent of inundation, and interactions with local landforms.

- Additionally, wetlands transect should provide information on vegetative wave-setup dissipation to help with marsh resiliency and restoration efforts.
For More Information:

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