From Montauk to Manhattan – Measuring Storm Tide and High-Water Marks caused by Hurricane Sandy in New York

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In response to the forecasted landfall of Hurricane Sandy, personnel from the U.S. Geological Survey (USGS) deployed storm-tide sensors along the eastern seaboard from Virginia to Maine. The New York Water Science Center deployed 38 storm-tide sensors, 4 wave-height sensors, 11 barometric-pressure sensors, and 4 rapid-deployment gages (RDGs) throughout Long Island, New York City, and Westchester County. Storm-tide and wave-height sensors are pressure transducers that are relatively quick and easy to attach to permanent structures, such as docks and piers, and are programmed to measure water levels during a storm event. Sensor locations were selected to supplement 13 existing USGS real-time coastal gages in southeastern New York, and to ensure that sufficient data were collected in areas where National Oceanic and Atmospheric Administration (NOAA) models predicted significant storm-surge and storm-tide flooding. As defined by NOAA, a storm surge is the storm-generated rise in water levels above predicted astronomical tides, whereas a storm tide is the rise in water levels due to storm surge plus astronomical tide. Hurricane Sandy posed a particularly dangerous threat as the landfalling storm was expected to transition into a large and powerful extra-tropical cyclone, take an unprecedented track towards the northeast coast, and hit during a period of astronomical high tide.

During Hurricane Sandy's approach and landfall, local emergency managers and NOAA forecasters were able to observe water levels in real time from the existing USGS network of coastal gages (http://ny.water.usgs.gov/projects/tidal/live_coast.html) and from the temporary RDGs installed in advance of the storm. The timing of storm-tide inundation was extremely important. For example, along the south shores of New York City and western Long Island, the peak storm surge of 8 to 9 ft coincided with the astronomical high tide (Figure 1A), which resulted in record storm-tide inundation in these areas. In the Peconic Estuary and northern Nassau County, however, the maximum surge of 7 to 9 ft and nearly 12 ft (Figure 1B), respectively, occurred near the time of normal low tide, which helped spare the surrounding communities from further coastal flooding.

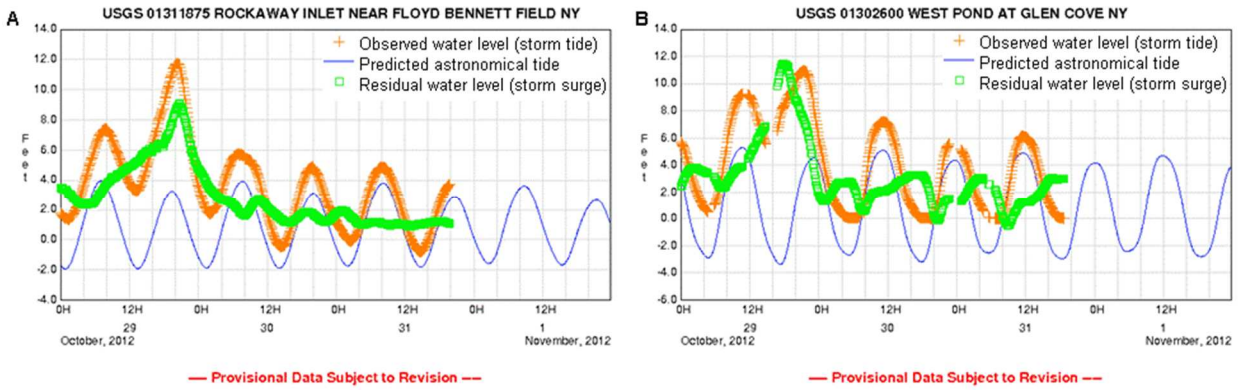

Figure 1. Hydrograph for October 29 to November 1, 2012, at USGS coastal gages 01311875 Rockaway Inlet near Floyd Bennett Field NY and 01302600 West Pond at Glen Cove NY, water elevation record (orange crosses) in feet above NGVD 1929 (National Geodetic Vertical Datum of 1929); astronomical-tide elevation in feet above NGVD 1929 for nearby National Ocean Service (NOS) tidal-prediction stations NOS 1281 Jamaica Bay, Barren Island, Rockaway Inlet and NOS 1165 Glen Cove, Hempstead Harbor (blue line); and residual water level or storm surge (green squares) calculated from difference between observed water elevation and predicted (astronomical) tide elevation; hours are in Eastern Standard Time.

After the storm, USGS scientists and technicians retrieved the temporary storm-tide sensors and RDGs and also surveyed over 350 high-water marks (HWMs) within 10 days after Hurricane Sandy's landfall. The RDGs in Suffolk and Westchester Counties recorded peak storm-tide elevations of 5.2 and 10.2 ft (feet) above NAVD 88 (North American Vertical Datum of 1988), respectively. The existing coastal gages recorded peak storm-tide elevations from a low of 6.4 ft above NAVD 88 in eastern Suffolk County to a high of 10.6 ft in Kings County (more information is available at http://ny.water.usgs.gov/sandyindex.html). The storm-tide and wave-height sensors measured water levels to provide the timing, water depth, and duration of storm-tide flooding. High-water marks, such as debris or seed lines, were documented as an independent verification of the storm-tide sensor data and as indicators of peak storm tide. Because precipitation and clean-up efforts can easily destroy such marks, they must be identified as soon as possible after an event. For comparison to the aforementioned coastal gages, the water levels recorded by the storm-tide sensors and indicated by HWMs ranged from 4 to 10 ft (above NAVD88) in Suffolk County, from 6 to 8 ft in the Peconic Estuary, from 8 to 12 ft in northern Nassau County, and from 9 to 17 ft in New York City (Figure 2).

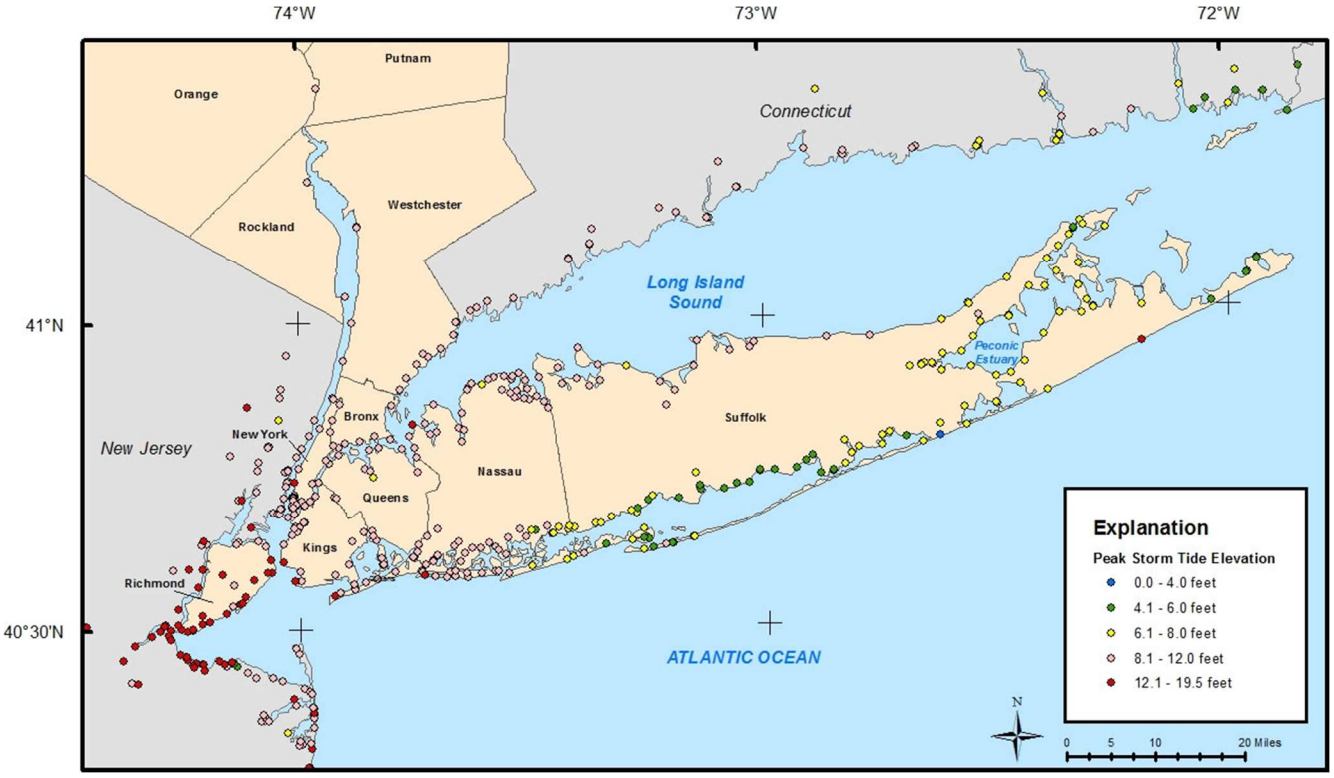

Figure 2. Map of peak storm-tide elevations derived from HWMs and storm-tide sensors. Data from the USGS Hurricane Sandy Mapper http://water.usgs.gov/floods/events/2012/sandy.

All storm-tide data collected by the USGS for Hurricane Sandy are displayed and archived on an online mapper (such as Figure 2) and are summarized in a recently released USGS report (http://pubs.usgs.gov/of/2013/1043). Data from the mapper were conveyed in near-real time to FEMA and NOAA scientists for use in supporting deployment of emergency-response resources, production of inundation maps, and assessment and improvement of storm-surge forecast models, and ultimately will provide the insight required to help minimize loss of life and property during future coastal storms.