PEAK STORM-TIDE ELEVATIONS PRODUCED BY THE DECEMBER 1992 STORM ALONG THE COAST OF LONG ISLAND, NEW YORK, WITH HISTORICAL PEAK STORM-TIDE ELEVATIONS

Christopher E. Schubert and Ronald Busciolano
U.S. Geological Survey
5 Aerial Way
Syosset, NY 11791

Abstract

Peak storm-tide elevations produced by an intense coastal storm were recorded during December 11-12, 1992, at five U.S. Geological Survey (USGS) streamflow-gaging stations on Long Island that were inundated by tidal flooding during the storm, and at six National Ocean Service (NOS) tide-gaging stations. The highest peak storm-tide elevations were in shoreline areas of western Long Island Sound, and the highest storm-surge estimate was along shoreline areas of western Great Peconic Bay. The recorded peak storm-tide elevations approached or exceeded the historical peak water-level elevations at all five USGS stations and four of the six NOS stations. The USGS station on the Peconic River at Riverhead and the NOS station at Sandy Hook, N.J., both recorded peak storm-tide elevations that surpassed the respective historical peak water-level elevations for the periods of record. The coastal settings of the five USGS stations strongly affect the patterns of peak storm-tide elevations recorded during the periods of record.

Introduction

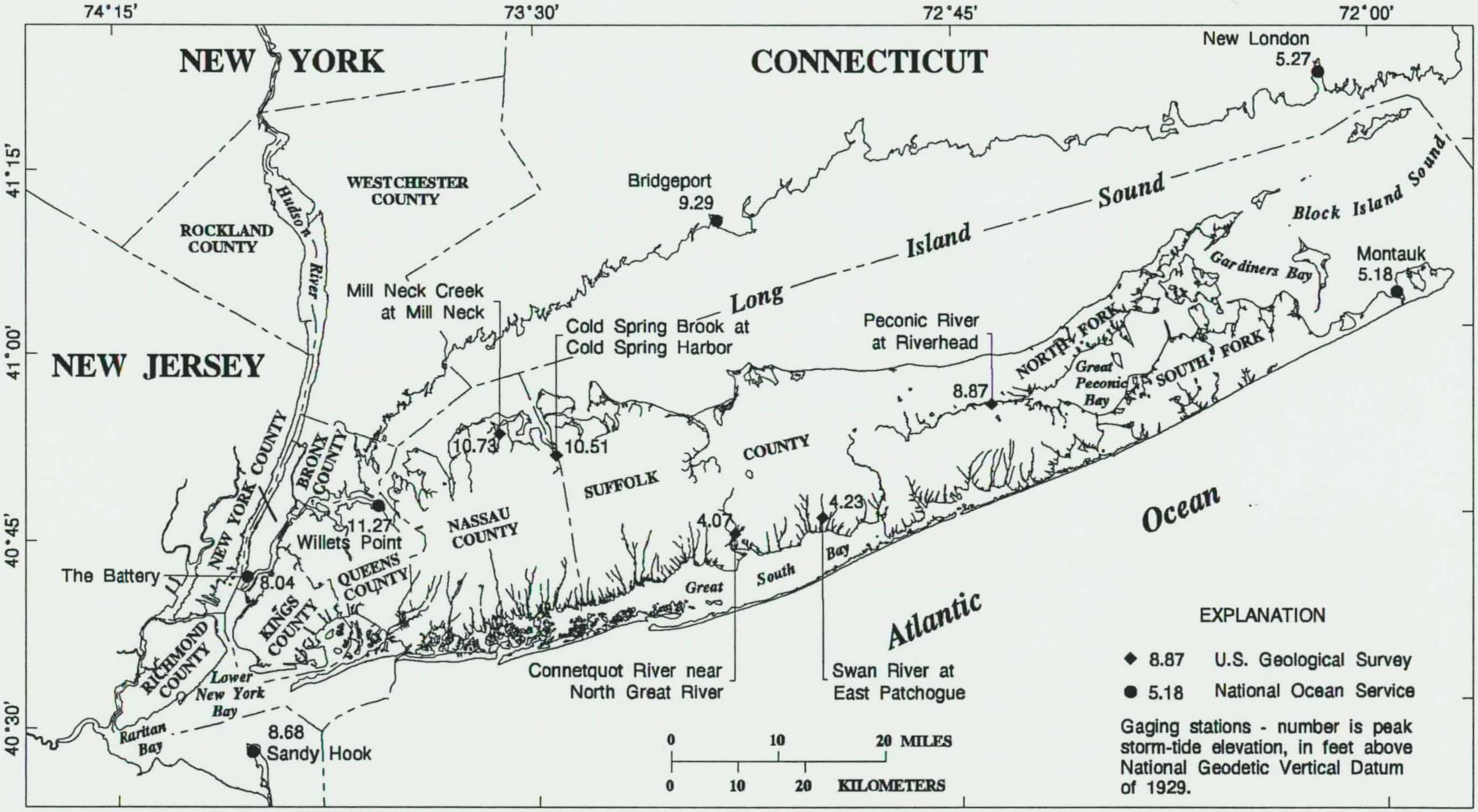
An intense storm affected the mid-Atlantic and northeastern coastline of the United States during December 10-14, 1992, producing east-to-northeast winds of gale-force strength (39 to 54 mi/h) that gusted to above hurricane strength (greater than 73 mi/h) and caused heavy rain, extensive coastal flooding, and severe beach erosion. Severe tidal flooding occurred along coastal areas of southeastern New York, northern New Jersey, and southern Connecticut during the morning of December 11 and continued through the early afternoon of December 12. Although peak storm-tide levels were encountered near the times of normal tidal high water during December 11-12, widespread tidal flooding did not subside in many coastal areas until December 14.

The U.S. Geological Survey (USGS) operates 20 continuous-record streamflow-gaging stations on Long Island. Most stations consist of primary and backup water-stage recorders that measure water-surface elevation in a stilling well that is in hydraulic connection with a stream. A weir (fixed flow-control structure) aligned across the streambed perpendicular to the direction of flow and immediately downstream from the stilling-well intake forms the control for the stream's stage-to-discharge relation at the site. Five of the stations are at elevations sufficiently close to sea level to be inundated by tidal flooding during hurricanes and intense coastal storms known regionally as northeasters (Unpublished water-level elevation records from January 1937 to present are available in files of the Long Island Office of the USGS). Two of the gaged streams, Mill Neck Creek at Mill Neck and Cold Spring Brook at Cold Spring Harbor (fig. 1), are on the north shore of western Long Island and discharge into parts of western Long Island Sound. Another, the Peconic River at Riverhead, is at the junction of the north and south forks of eastern Long Island and discharges into parts of western Great Peconic Bay. The two remaining gaged streams, Swan River at East Patchogue and Connetquot River near North Great River (base gage for station on the Connetqout River at Oakdale), are midway along the south shore of Long Island and discharge into Great South Bay.

This paper summarizes peak storm-tide levels at the five USGS streamflow-gaging stations during December 11-12, 1992, presents peak storm-tide levels for that storm from six National Ocean Service (NOS) tide-gaging stations, and compares trends in the historical record for the five USGS stations.

Peak Storm-Tide Elevations, December 11-12, 1992

Locations of the five USGS and six NOS stations and the peak storm-tide elevations recorded during December 11-12, 1992, are given in figure 1. In this paper, peak storm-tide elevation is presented in units of feet above National Geodetic Vertical Datum of 1929 (NGVD), formerly "Sea Level Datum of 1929," which was derived from a general adjustment of the first-order level nets of the United States and Canada. The highest peak storm-tide elevations were in shoreline areas of western Long Island Sound, as indicated by records of the USGS stations on Mill Neck Creek at Mill Neck and Cold Spring Brook at Cold Spring Harbor, and the NOS station at Willets Point (fig. 1).



Base digitized from U.S. Geological Survey 1:24,000 quadrangles and N.Y.S. Department of Transportation 1:24,000 quadrangles.

Figure 1--Gaging-station locations and peak storm-tide elevations recorded during December 11-12, 1992, along coastal areas of southeastern New York, northern New Jersey, and southern Connecticut. (National Ocean Service peak storm-tide-level data from Ray Smith, Ocean and Lake Levels Division, National Ocean Service, written commun., 1993. NGVD, National Geodetic Vertical Datum of 1929.)

Peak storm-tide elevations were more than 10 ft above NGVD in this area. Peak storm-tide elevations in shoreline areas of western Great Peconic Bay, as recorded by the USGS station on the Peconic River at Riverhead, and shoreline areas of the New York Bay - Raritan Bay waterways, as recorded by the NOS stations at The Battery and at Sandy Hook, N.J., were more than 8 ft above NGVD. Peak storm-tide elevations in shoreline areas of Block Island Sound and eastern Long Island Sound were slightly more than 5 ft above NGVD, as recorded by the NOS stations at Montauk and at New London, Conn. Peak storm-tide elevations along the relatively protected shoreline areas of Great South Bay, landward of the south-shore barrier-island chain, were slightly more than 4 ft above NGVD, as recorded by the USGS stations on Swan River at East Patchogue and Connetquot River near North Great River.

Storm-Surge Estimates, December 11-12, 1992

Storm surge is expressed as the height of the observed peak storm-tide level above the normal or predicted tidal level, which varies with time and location along the coast. Published values of predicted tidal high- and low-water levels are given in units of feet above the local Mean Lower-Low-Water (MLLW) Datum, also called the Chart Datum, established by the NOS at many locations along the coast to minimize the reporting of negative values in predicted tidal levels (U.S. Department of Commerce, 1991). The predicted tidal high-water levels near the time of the observed peak storm-tide level at the approximate locations of the five USGS stations can be determined from local values of the difference between NGVD and MLLW Datum. Adding preliminary values for the difference between the two datum planes determined at nearby NOS tidal benchmarks for the most recent tidal epoch (1960-78) to the gage datum of each of the five USGS stations gives an approximate reference for the stations to local MLLW Datum (table 1) (James R. Hubbard, Datums Section, National Ocean Service, written commun., 1993). Storm-surge estimates at the five USGS stations, taken as the height of the observed peak storm-tide levels above the predicted tidal high-water levels, both referenced to MLLW Datum, are given in figure 2, which includes recorded peak storm-tide levels and predicted tidal high-water levels for the six NOS stations, in feet above MLLW Datum, for December 11-12, 1992. The storm-surge estimates presented in figure 2 likely represent minimum values, however, since the arrival of the maximum storm surge at a given station may not have closely coincided with the occurrence of the observed peak storm-tide and predicted tidal high-water levels.

Table 1.--Relation between National Geodetic Vertical Datum of 1929 and local Mean Lower-Low-Water Datum at the National Ocean Service tidal benchmark indicated, and gage datums at five U.S. Geological Survey stations.

(Station locations are shown in fig. 1. All gage datum values are in feet above stated datum. Tidal datums from James R. Hubbard, Datums Section, National Ocean Service, written commun., 1993. NGVD, National Geodetic Vertical Datum of 1929. MLLW, Mean Lower-Low-Water Datum.)

National Ocean Service tidal benchmark		U.S. Geological Survey streamflow-gaging station		
			Gage datum	
Name	NGVD minus MLLW (ft)	Name	(NGVD)	(MLLW)
Bayville Bridge, Oyster Bay	3.20	Mill Neck Creek at Mill Neck	6.49	9.69
Cold Spring Harbor	3.16	Cold Spring Brook at Cold Spring Harbor	5.38	8.54
South Jamesport	1.35	Peconic River at Riverhead	6.54	7.89
Patchogue	-0.20	Swan River at East Patchogue	2.84	2.64
Great River	-0.36	Connetquot River near North Great River	1.56	1.20

In contrast to the distribution of December 11-12, 1992 peak storm-tide elevations, referenced to NGVD, the highest storm-surge estimate was along shoreline areas of western Great Peconic Bay, about 6.5 ft above the predicted tidal high-water level, as estimated at the USGS station on the Peconic River at Riverhead (fig. 2). Storm-surge estimates in shoreline areas of western Long Island Sound ranged from 4 to 6 ft above the predicted tidal high-water levels, as estimated at the USGS stations on Mill Neck Creek at Mill Neck and Cold Spring Brook at Cold Spring Harbor, and recorded at the NOS stations at Willets Point and at Bridgeport, Conn. Storm-surge estimates in shoreline areas of the New York Bay - Raritan Bay waterways ranged from 4 to 5 ft above the predicted tidal high-water levels, as recorded at the NOS stations at The Battery and at Sandy Hook, N.J. Storm-surge estimates in shoreline areas of Block Island Sound and eastern Long Island Sound were about 3 ft above the predicted tidal high-water levels, as recorded at the NOS stations at Montauk and at New London, Conn. Storm-surge estimates along the relatively protected shoreline areas of Great South Bay, landward of the south-shore barrier-island chain, were about 3 ft above the predicted tidal high-water levels, as estimated at the USGS stations on Swan River at East Patchogue and Connetquot River near North Great River.

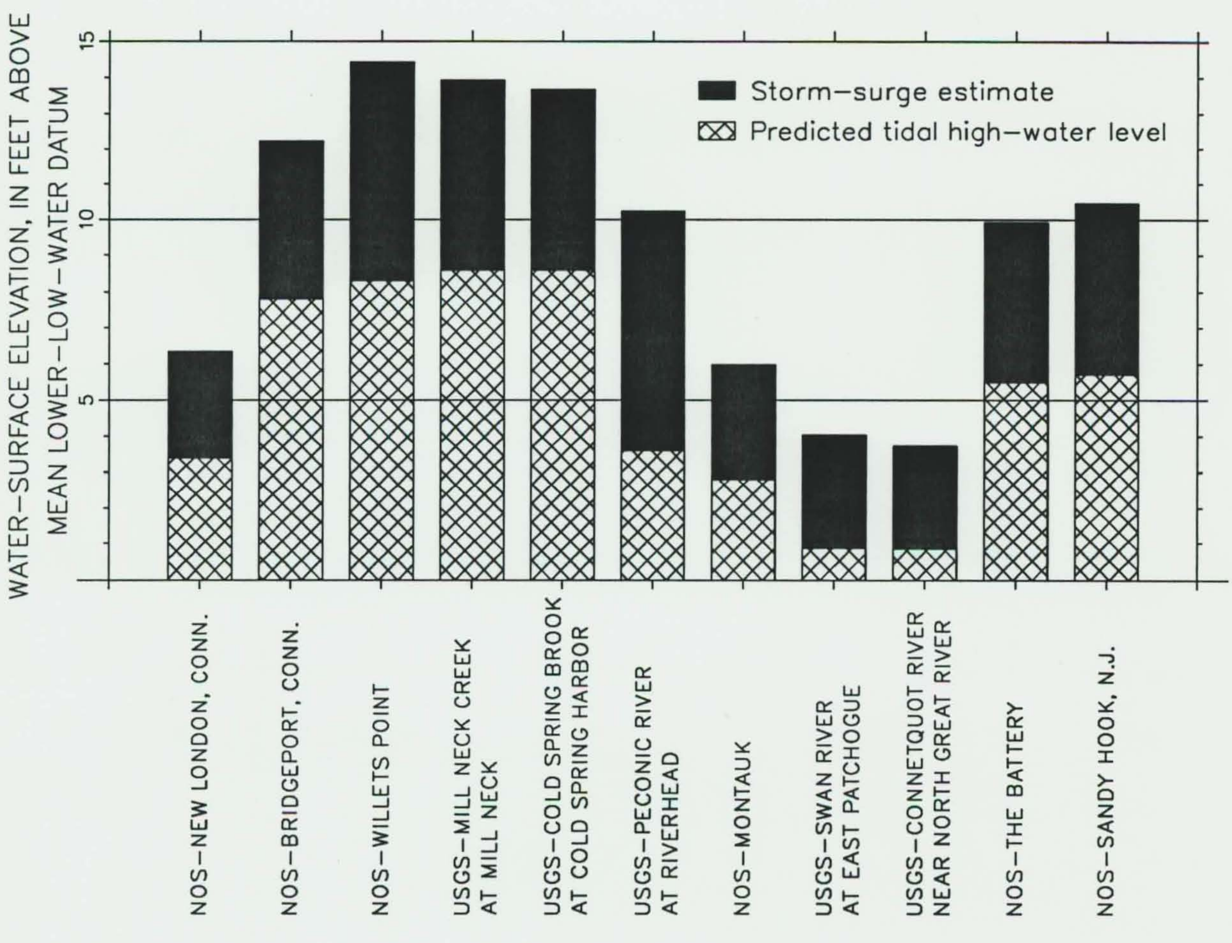


Figure 2--Heights of observed peak storm-tide levels above the predicted tidal high-water levels and the corresponding storm-surge estimates at 11 stations during December 11-12, 1992. (Station locations are shown in fig. 1. National Ocean Service peak storm-tide-level data from Ray Smith, Ocean and Lake Levels Division, National Ocean Service, written commun., 1993. NOS, National Ocean Service. USGS, U.S. Geological Survey.)

Historical Peak Storm-Tide Elevations

Peak storm-tide elevations produced by the December 1992 storm are presented in table 2 with the historical peak water-level elevations at the five USGS and six NOS stations and their dates of occurrence and periods of record. Historical peak water-level elevations at the five USGS stations, except as noted below, represent the peak water-level elevation for the period of record among both tidal-flooding and high-streamflow events. Except for the stations on Swan River at East Patchogue and Connetquot River near North Great River, where high-streamflows dominate the record and are therefore excluded, the historical peak water-level elevations at the three remaining USGS stations analyzed are the result of storm-tides. As indicated in table 2, peak storm-tide elevations of December 11-12, 1992, approached or exceeded the historical peak water-level elevations at all five USGS stations and four of the six NOS stations–Bridgeport, Conn., Willets Point, The Battery, and at Sandy Hook, N.J. The USGS station on the Peconic River at Riverhead and the NOS station at Sandy Hook, N.J., both recorded peak storm-tide elevations that surpassed the respective historical peak water-level elevations for the periods of record.

Table 2.--Peak storm-tide elevations produced by the December 1992 storm and historical peak water-level elevations, dates of occurrence, and periods of record at 11 stations.

(Station locations are shown in fig. 1. All elevations are in feet above National Geodetic Vertical Datum of 1929. National Ocean Service peak storm-tide-level data from Ray Smith, Ocean and Lake Levels Division, National Ocean Service, written commun., 1993. NOS, National Ocean Service. USGS, U.S. Geological Survey.)

	Peak elevation			
Station	Dec. 1992 storm tide	Historical water level	Peak-event date	Period of record
NOS - New London, Conn.	5.27	9.69	9/21/38	5/38 to present
NOS - Bridgeport, Conn.	[1] 9.29	[5] 9.52	9/21/38	9/64 to present
NOS - Willets Point	[1] 11.27	13.74	9/21/38	7/31 to present
USGS - Mill Neck Creek at Mill Neck	[3] 10.73	11.40	9/21/38	1/37 to present
USGS - Cold Spring Brook at Cold Spring Harbor	[3] 10.51	10.72	8/31/54	7/50 to present
USGS - Peconic River at Riverhead	[4] 8.87	8.63	3/29/84	6/42 to present
NOS - Montauk	5.18	8.10	8/31/54	8/54 to present
USGS - Swan River at East Patchogue	4.23	[6] 4.63	10/31/91	10/46 to present
USGS - Connetquot River near North Great River	4.07	[6] 4.7	10/31/91	10/43 to present
NOS - The Battery	[1,2] 8.04	8.35	9/12/60	5/20 to present
NOS - Sandy Hook, N.J.	8.68	8.56	9/12/60	10/32 to present

[1] Primary gage limit was exceeded. Peak storm-tide elevation extrapolated from curve plot of backup gage record.
[2] Possible backup gage malfunction.
[3] Primary and backup gage limits were exceeded. Peak storm-tide elevation obtained from high-water mark on interior wall of gage house.
[4] Peak storm-tide elevation obtained from maximum stage indicator.
[5] From high-water mark obtained near present gage location.
[6] Among historical peak water-level elevations that are the result of storm-tides only.

The severity of tidal flooding at each of the five USGS stations during December 11-12, 1992, in relation to major hurricanes and intense northeasters during the periods of record at the five stations is indicated in figure 3. (Omitted are Hurricane Bob of August 19, 1991, which produced significant tidal flooding only along shoreline areas of extreme eastern Long Island, and Hurricane Donna of September 12, 1960, which produced significant tidal flooding along shoreline areas of southwestern Long Island and brought heavy rain that caused elevated streamflows.) The pattern of peak storm-tide elevations at Mill Neck Creek at Mill Neck is similar to that at Cold Spring Brook at Cold Spring Harbor (fig. 3). At both stations, the peak storm-tide elevations produced by the December 1992 storm were

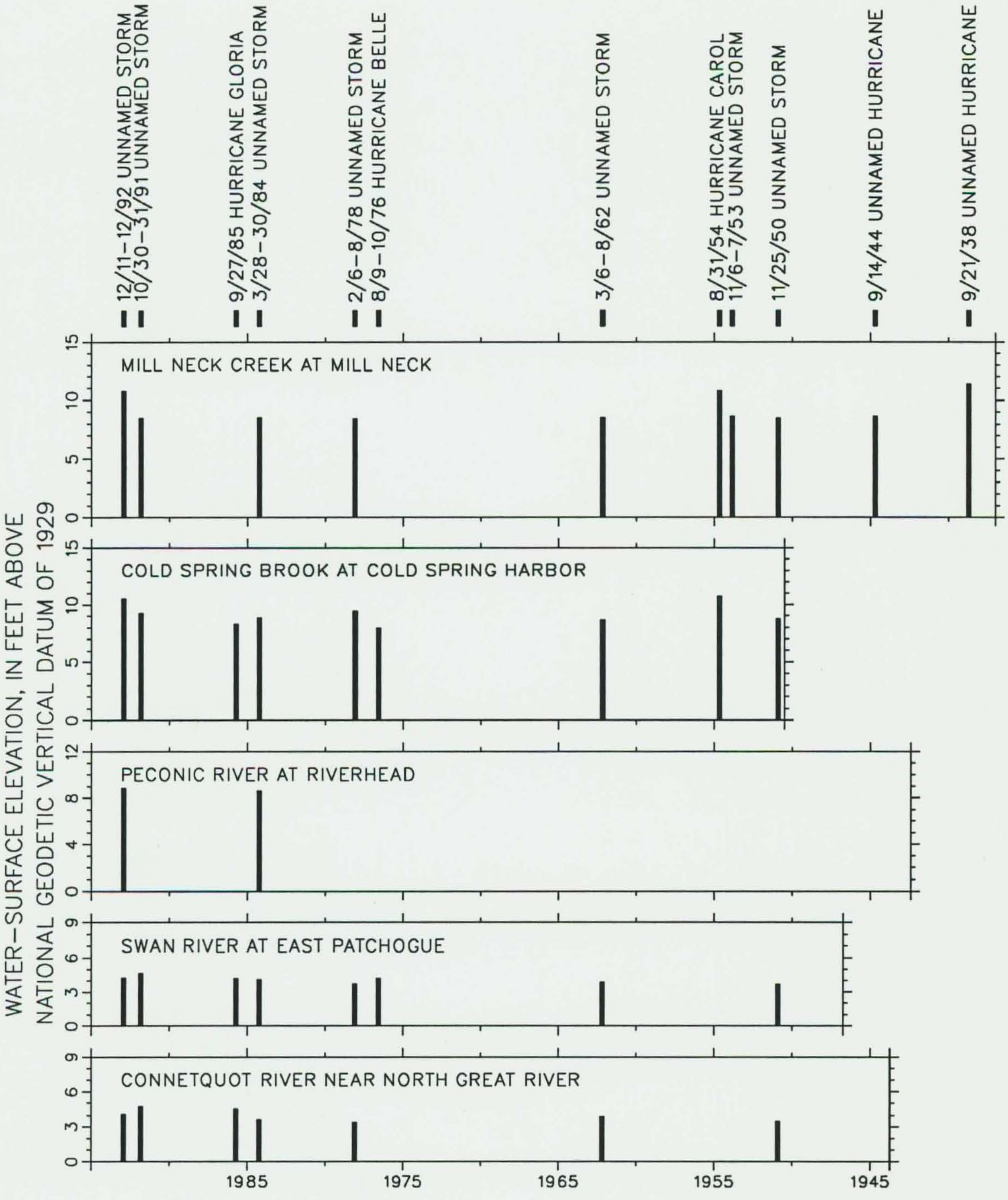


Figure 3--Peak storm-tide elevations produced by five hurricanes and seven intense northeasters on Long Island during the periods of record at five U.S. Geological Survey stations. (Station locations are shown in fig. 1. Unpublished water-level elevation records from January 1937 to present are available in files of the Long Island Office of the U.S. Geological Survey. List of hurricanes and northeasters causing significant damage along the Long Island coast modified from Long Island Regional Planning Board, 1984.)

only 0.1 to 0.2 ft below those of Hurricane Carol on August 31, 1954, and the peak storm-tide elevation at Mill Neck Creek at Mill Neck during December 11-12, 1992, was 0.7 ft lower than during the September 21, 1938 hurricane. If the peak storm-tide-elevation records of both stations are combined to eliminate gaps caused by locally elevated streamflows, five of the twelve recorded storm-tides over the period of record are the result of hurricanes.

In contrast, the peak storm-tide-elevation record from the Peconic River at Riverhead consists of only a few recorded storm-tides. This can be attributed partly to the station's elevation near the upstream limit of historical tidal flooding, as indicated by the estimated gage-datum elevation of 7.89 ft above MLLW Datum (table 1), which is about 5 ft above the mean tidal high-water level (U.S. Department of Commerce, 1991), and partly to the sheltering of Great Peconic Bay on all sides except the east, and the constricted waterways at the east end of Great Peconic Bay through which the storm tide must pass. As a result, the peak storm-tide-elevation record for this station is dominated by unusually intense northeasters that spanned multiple tidal cycles, allowing the storm tides to fully propagate westward to Great Peconic Bay. Not surprisingly, the stations on Swan River at East Patchogue and Connetquot River near North Great River, which are along shoreline areas of Great South Bay that are protected by the south-shore barrier-island chain, have nearly identical peak storm-tide elevation records. If the peak storm-tide-elevation records of both stations are combined to eliminate gaps caused by locally elevated streamflows, two of the eight recorded storm-tides over the period of record are the result of hurricanes. The considerable attenuation of the open-ocean storm tides of hurricanes and northeasters as they propagate through tidal inlets in the barrier-island chain results in only small variations in the magnitude of recorded storm-tides over the period of record.

Summary

Peak storm-tide elevations were recorded during December 11-12, 1992, at five USGS streamflow-gaging stations on Long Island, and at six NOS tide-gaging stations. The highest peak storm-tide elevations were in shoreline areas of western Long Island Sound, more than 10 ft above NGVD. Peak storm-tide elevations in shoreline areas of western Great Peconic Bay and the New York Bay - Raritan Bay waterways were more than 8 ft above NGVD. Peak storm-tide elevations in shoreline areas of Block Island Sound and eastern Long Island Sound were slightly more than 5 ft above NGVD. Peak storm-tide elevations along the relatively protected shoreline areas of Great South Bay were slightly more than 4 ft above NGVD.

Storm-surge estimates were computed for the observed peak storm-tide levels recorded at the five USGS and six NOS stations during December 11-12, 1992. The highest storm-surge estimate was along shoreline areas of western Great Peconic Bay, about 6.5 ft above the predicted tidal high-water level. Storm-surge estimates in shoreline areas of western Long Island Sound ranged from 4 to 6 ft above the predicted tidal high-water levels and, in shoreline areas of the New York Bay - Raritan Bay waterways, ranged from 4 to 5 ft above the predicted tidal high-water levels. Storm-surge estimates in shoreline areas of Block Island Sound and eastern Long Island Sound were about 3 ft above the predicted tidal high-water levels. Storm-surge estimates along the relatively protected shoreline areas of Great South Bay, landward of the south-shore barrier-island chain, were about 3 ft above the predicted tidal high-water levels.

Peak storm-tide elevations recorded during December 11-12, 1992, approached or exceeded the historical peak water-level elevations at all five USGS stations and four of the six NOS stations. The USGS station on the Peconic River at Riverhead and the NOS station at Sandy Hook, N.J., both recorded peak storm-tide elevations that surpassed the respective historical peak water-level elevations for the periods of record. The coastal settings of the five USGS stations strongly affect the patterns of peak storm-tide elevations recorded during the periods of record.

Acknowledgments

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