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6.8. Storm Surges

One of the many catastrophes said to be caused by global warming is the heaving of the world's seas beyond their normal bounds in more frequent and increasingly violent storm surges. The following section summarizes the findings of a number of pertinent papers.

De Lange and Gibb (2000) analyzed trends in sea-level data obtained from several tide gauges

located within Tauranga Harbor, New Zealand, over the period 1960-1998. In studying seasonal, interannual, and decadal distributions of storm surge data, they discovered a considerable decline in the annual number of storm surge events in the latter half of the nearly four-decade-long record. A similar trend was noted in the magnitude of storm surges. In addition, maximum water levels, including tides, also declined over the past two decades.

Decadal variations in the data were linked to the Inter-decadal Pacific Oscillation (IPO) and the El Niño-Southern Oscillation (ENSO), with La Niña events producing more storm surge days than El Niño events. In addition, wavelet analyses of annual storm surge frequency data indicated that before 1978 the frequency “was enhanced by the IPO, and subsequently it has been attenuated.”

Pirazzoli (2000) analyzed tide-gauge and meteorological (wind and atmospheric pressure) data for the slightly longer period of 1951-1997 along the northern portion of the Atlantic coast of France. This effort revealed that the number of atmospheric depressions (storms) and strong surge winds in this region “are becoming less frequent” and that “ongoing trends of climate variability show a decrease in the frequency and hence the gravity of coastal flooding.” Pirazzoli suggests these findings should be “reassuring,” especially for those concerned about coastal flooding.

Raicich (2003) analyzed 62 years of sea-level data for the period 1 July 1939 to 30 June 2001 at Trieste, in the Northern Adriatic, in an attempt to determine historical trends of positive and negative surge anomalies. This work led to the discovery that weak and moderate positive surges did not exhibit any definite trends, while strong positive surges clearly became less frequent over the period of study, even in the face of a gradually rising sea level, “presumably,” in Raicich's words, “as a consequence of a general weakening of the atmospheric activity,” which was likewise found by Pirazzoli to be the case for Brittany.

Based on data for the somewhat longer period of 1901-1990, Wroblewski (2001) determined there was a linear increase in mean annual sea level at the southern Baltic seaport of Kolobrzeg of 12 ± 2 cm per century. Over this same period, however, there was no trend in annual sea-level maxima. Two high values stood out above the rest in the 1980s, but two similar spikes occurred in the 1940s; there were half-a-dozen comparable high values in the first two decades of the record. In light of the slow upward trend in mean sea

level, therefore, it is extremely surprising that annual maximum sea levels due to storm surges did not likewise rise over the past century. One can only conclude these events must have become less intense over the same time interval.

Utilizing a full century of data, Zhang *et al.* (2000) analyzed 10 very long records of storm surges derived from hourly tide gauge measurements made along the east coast of the United States, in order to calculate indexes of count, duration and integrated intensity of surge-producing storms that provide objective, quantitative, and comprehensive measures of historical storm activities in this region. The end result of their comprehensive undertaking was a demonstrable lack of “any discernible long-term secular trend in storm activity during the twentieth century,” which finding, in their words, “suggests a lack of response of storminess to minor global warming along the U.S. Atlantic coast during the last 100 years.”

Looking considerably further back in time, Woodworth and Blackman (2002) analyzed four discontinuous sets of high-water data from the UK’s Liverpool waterfront that span the period 1768-1999, looking for changes in annual maximum high water (tide plus surge), surge at annual maximum high water (surge component of annual maximum high water), and annual maximum surge-at-high-water. They could detect no significant trends in the first two parameters over the period of study; but they found that the annual maximum surge-at-high-water declined at a rate of 0.11 ± 0.04 meters per century. This finding suggests the winds responsible for producing high storm surges were much stronger and/or more common during the early part of the record (Little Ice Age) than during the latter part (Current Warm Period).

Last, in what is the longest look back in time of the papers treating this subject, Nott and Hayne (2001) produced a 5,000-year record of tropical cyclone frequency and intensity along a 1,500-km stretch of coastline in northeastern Australia located between latitudes 13 and 24°S by (1) geologically dating and topographically surveying landform features left by surges produced by historic hurricanes and (2) running numerical models to estimate storm surge and wave heights necessary to reach the landform locations. This work revealed that several “super-cyclones” with central pressures less than 920 hPa and wind speeds in excess of 182 kilometers per hour had occurred over the past 5,000 years at intervals of roughly 200 to 300 years in all parts of

the region of study. The two researchers also report that the Great Barrier Reef “experienced at least five such storms over the past 200 years, with the area now occupied by Cairns experiencing two super-cyclones between 1800 and 1870.” The twentieth century, however, was totally devoid of such storms, “with only one such event (1899) since European settlement in the mid-nineteenth century.”

It seems safe to conclude that storm surges around the world have not responded to rising temperatures during the twentieth century. In the majority of cases investigated, they have decreased.

Additional information on this topic, including reviews of newer publications as they become available, can be found at <http://www.co2science.org/subject/o/oceanstormsurge.php>.

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6.9. Temperature Variability

One more measure of climatic change is temperature variability. Has the earth experienced more record highs or lows of temperature during the Current Warm Period?