Storm Surges Congress, Hamburg, Germany
13–17 September 2010
SSC2010-170

Storm surges and extreme water levels in southeastern Canada: observed events, community impacts, and planning scenarios (2000-2100)

D. L. Forbes (1), G. K. Manson (1), G. S. Parkes (2), K. Thompson (3), and R. B. Taylor (1)

(1) Geological Survey of Canada, Bedford Institute of Oceanography, Dartmouth, NS, B2Y 4A2, Canada, (2) Meteorological Service of Canada, Environment Canada, Dartmouth, NS, B2Y 2N6, Canada, (3) Oceanography & Mathematics and Statistics, Dalhousie University, Halifax, NS, B3H 3J5, Canada

The Maritime Provinces of Nova Scotia (NS), New Brunswick (NB), and Prince Edward Island (PEI) in southeastern Canada have experienced a number of exceptional high-water events over the past decade. Record water levels have been exceeded in long tide-gauge records at Charlottetown (PEI) and Halifax (NS). These events were variously associated with tropical, post-tropical, and extra-tropical storm systems. They occurred against a background of rising relative sea level (3.2 mm·a^{-1} at both Charlottetown and Halifax). Accelerated sea-level rise and possible increases in storm severity are expected to produce further increases in extreme water levels over coming decades, with increased frequency of flooding, while reduced sea ice in the Gulf of St. Lawrence may result in more storms over open water, with resulting increases in coastal damage.

Even under ice-covered conditions, exceptional winter storms can be very damaging. Extra¬ordinary flooding of coastal communities in the southeastern Gulf of St. Lawrence occurred during a deep winter storm on 21 January 2000, when most of the southern Gulf was ice-covered. There was little wave action, but extensive damage to shorefront properties and infrastructure from ice motion onshore. The low-lying community of Pointe-du-Chêne (NB) was inundated with a 2.00 m storm surge, the largest recorded in Atlantic Canada, and a record total water level (tide plus surge). At Charlottetown (PEI), the previous water level record, set exactly 39 years earlier, was exceeded by 0.39 m on 21 January 2000.

The record high water-level event at Halifax (NS) was Hurricane Juan in September 2003. Warm sea-surface temperatures over the Scotian Shelf allowed this storm to maintain hurricane strength through landfall just west of Halifax. The eastern eyewall moved up Halifax Harbour, generating a record storm surge, a record total water level, and large waves within the harbour, leading to overtopping and severe damage to port, rail, residential, commercial, municipal and other waterfront properties and infrastructure. Had this surge of 1.63 m coincided with higher high water at large tides, the water level would have been 0.8 m higher.

Projections of extreme water levels for Halifax over the 21st century have been developed by combining various scenarios and projections of relative sea-level rise with statistics for high water levels. The latter were derived from a generalized extreme values distribution for annual maximum water levels in the 1920-2007 Halifax tide-gauge record. This provided a set of scenarios for the year 2100 for maximum water levels during storm events of varying severity, superimposed on higher mean sea level. Combining these scenarios with a LiDAR-derived digital elevation model, flood extents and depths for selected scenarios could be demonstrated in relation to existing topography and infrastructure, paving the way for a vulnerability analysis and the development of adaptation policies by the municipality and major stakeholders. A similar approach to scientific support of adaptation planning is currently underway in Charlottetown.