Storm Surges in the Canadian Beaufort Sea

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Northwest winds acting over the extensive shallow shelf of the eastern Beaufort Sea can result in significant storm surges which impact human activities and natural ecosystems. Open-water season surges contribute to rapid erosion of unlithified, frozen coastal bluffs with 10-15 m of erosion occurring during a single storm. In many locations surge-elevated waves directly impact coastal bluffs causing deep thermal notching followed by collapse of large blocks directly onto the beach. Where elevations are lower, extensive flooding occurs causing problems for both permanent and seasonal (subsistence hunting and fishing) communities. Winter-season surges also occur, despite complete ice cover, causing flooding and breakup of ice roads and potential erosion of ice-constrained channel mouths. Ivu, or ice push, associated with winter surges can extend onto land with associated risk to human life and infrastructure. Fatalities due to surges are infrequent, but a severe event in 1970 led to two deaths at a camp in the outer Mackenzie Delta. The same event also resulted in salt contamination of a community water supply. An unusually severe event in 1999 led to the salinization of 200 km2 of highly productive waterfowl habitat in the Mackenzie Delta. Occasional occurrences of negative surges (0.4 m below chart datum) due to strong offshore winds can impact commercial ship traffic transiting the wide, shallow inner shelf.

Storm surge chronologies are challenging to construct due to a lack of observations and the limited time span covered by the instrumental records. An additional complexity is the variability of Arctic sea-ice cover. In the Canadian Beaufort Sea, official coastal meteorological and water level records extend back to the early 1960s, although the records are far from complete with very few reporting stations. We have attempted to supplement these records using a variety of sources including unofficial records from military sites, commercial ventures (e.g. Hudson Bay Company records), missionary and church records and oral histories based on interviews with aboriginal elders. While these approaches yield interesting observations, they are not continuous and therefore difficult to use for quantitative analysis. Based on the analysis of the tide gauge record at Tuktoyaktuk (1962-1997), a total water level (relative to chart datum) of 2.36 m represents the 25 year event. The highest recorded water level during that period was in 1993 (2.2 m). Surveys of loglines suggest that the 1970 event reached 2.7 m, but swash driven water levels reach higher than 3.5 m. Relative sea level in the region is rising due to a combination of subsidence and eustatic sea level rise. Sea ice duration is expected to decrease as the Arctic warms and eustatic sea level rise is predicted to accelerate. Therefore, total water levels associated with storm surges are expected to increase. The potential trajectory for frequency and duration of storms is not well constrained by climate model predictions. Present variability is too large and the record too short to detect trends, but even if storminess remains unchanged the exposure to damaging surges is likely to increase due to changing sea ice conditions.