Episodes of rapid coastal change on the eastern shore of Nova Scotia: are they related to the North Atlantic oscillation?

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Research along Nova Scotia's Eastern Shore has shown that decadal-scale coastal evolution is affected by varying relative sea-level rise, storminess, storm-surge frequency, and sediment supply. Some combination of these factors may cause a sudden shift in shoreline response from relative stability to rapid change. Two episodes of rapid coastal retreat are interpreted from historical charts and airphotos of McNab's Island at the entrance to Halifax Harbour. The first occurred sometime between about 1750 and 1850 and the second between 1954 and 1964. Other sites along the Eastern Shore show accelerated retreat after 1954, although the most rapid retreat in some places occurred in the late 1960s or 1970s as well as in the mid 1990s.

Relative sea level measured at Halifax has been rising since 1920 at a mean rate of 3.0 mm/a. The record shows significant decadal and multi-decadal variability. From 1920 to 1970, the mean rate of rise was 4.0 mm/a, declining to 0.8 mm/a after 1970 and increasing again in the 1990s. Winds measured at CFB Shearwater since 1953 show an anomalous period of storminess between 1954 and 1964. This period was characterized by increased frequency of storms with a southeasterly modal storm wind direction, in contrast to less frequent storms with a southwesterly mode from the 1970s to the early 1990s.

The North Atlantic Oscillation Index (NAOI), defined as the difference between mean normalized winter sea-level air pressures in the Azores and Iceland, has been correlated to a number of meteorological and oceanographic phenomena, including decadal-scale sea-level variability across the North Atlantic. Rapid sea-level rise at Halifax appears to occur during downward trends in the NAOI. The 1954-1964 stormy period occurred during the lowest point in the NAOI since 1864. Earlier episodes of storminess reflected in the sedimentological record of Halifax Harbour appear to correspond to minima in an extended NAOI constructed from a Greenland ice core.

It is important to recognize that geological factors, particularly sediment supply, also influence the shoreline response to varying environmental forcing. Coastal change occurs through non-linear interaction between storm waves, storm surge, sea level, and shore-zone morphology and sediments. Limitation of supply or a vulnerable self-organized morphology may render shorelines more susceptible to exceeding the threshold and change forced by storms and sea-level rise. Global climate change may affect the NAOI, thus storminess and sea-level rise, with a potential impact on rates of shoreline recession.

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