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Arctic Warming and Sea Ice Diminution Herald Changing Glacier and Cryospheric Hazard Regimes

Jeffrey Kargel (1), Andrew Bush (2), and Gregory Leonard (3)

(1) Department of Hydrology & Water Resources, University of Arizona, Tucson, AZ, USA (jeffreyskargel@hotmail.com), (2) Earth Sciences, University of Alberta, Edmonton, Alberta, Canada (abush@ualberta.ca), (3) Department of Hydrology & Water Resources, University of Arizona, Tucson, AZ, USA (gleonard@email.arizona.edu)

The recent expansion of summertime melt zones in both Greenland and some Arctic ice caps, and the clearing of perennial sea ice from much of the Arctic, may presage more rapid shifts in mass balances of land ice than glaciologists had generally expected. The summer openings of vast stretches of open water in the Arctic, particularly in straits and the Arctic Ocean shores of the Queen Elizabeth Islands and along some Greenland coastal zones, must have a large impact on summer and early autumn temperatures and precipitation now that the surface boundary condition is no longer limited by the triple-point temperature and water-vapor pressure of H_2O. This state change in the Arctic probably is part of the explanation for the expanded melt zones high in the Greenland ice sheet.

However, Greenland and the Canadian Arctic are vast regions subject to climatic influences of multiple marine bodies, and the situation with sea ice and climate change remains heterogeneous, and so the local climate feedbacks from sea ice diminution remain patchy. Projected forward just a few decades, it is likely that sea ice will play a significant role in the Queen Elizabeth Islands and around Greenland only in the winter months. The region is in the midst of a dramatic climate change that is affecting the mass balances of the Arctic's ice bodies; some polar-type glaciers must be transforming to polythermal, and polythermal ones to maritime-temperate types. Attendant with these shifts, glacier response times will shorten, the distribution and sizes of glacier lakes will change, unconsolidated debris will be debuttressed, and hazards-related dynamics will shift. Besides changes to outburst flood, debris flow, and rock avalanche occurrences, the tsunami hazard (with ice and debris landslide/avalanche triggers) in glacierized fjords and the surge behaviors of many glaciers is apt to increase or shift locations.

For any given location, the past is no longer the key to the present, and the present is not the key to future behavior of ice in this region.

Hence, as major infrastructural development and population increases, careful consideration must be given to changing dynamics of the cryospheric landscape system. Glacier lake outburst floods never have been important considerations in most of the Canadian Arctic/Greenland region due both to sparseness of population and infrastructure and low frequency and distribution of occurrence of potentially hazardous glacier dynamics. This may no longer be the case; in particular, many lakes are starting to develop where previously they were small, few, or absent; furthermore, the conditions tending toward reduction in ice flow, thinning glaciers, and debris accumulation that commonly precede lake development are now widely present.

20th century maritime glacierized parts of Alaska may be a model for the 21st century Queen Elizabeth Islands and Greenland. In Alaska, the fury and impact of glacier lake outburst floods felt in other parts of the world have largely been mitigated by wise and limited development patterns. This can hold true for Arctic Canada and Greenland this century if consideration is given to the changing crysophere.