Geological Survey of Canada | Commission gÉologique du Canada

OPEN FILE 2825

SENSITIVITY OF THE COASTS OF CANADA TO SEA-LEVEL RISE

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Kilometres

0 200 400 600 800 1000

Digital base map from Canadian Hydrographic Service Map M-270,

This map depicts the sensitivity of the coastlines of Canada to an accelerated rise in sea level due to global warming. The increase could amount to 0.65 m by the end of the next century (Houghton et al., 1990). Here, sensitivity means the degree to which a coastline may experience physical changes due to sea-level rise. These could include, for example, erosion, inundation, increased frequency of overtopping and overwashing, beach migration, and coastal dune destabilization. The map depicts spatial variation of a vulnerability index, a modified version of the Coastal Vulnerability Index of Gornitz (1990) which is obtained by manipulating scores of 1 to 5 attributed to each of seven variables - relief, geology, coastal landform, sea-level tendency, shoreline displacement, tidal range, and wave height. Data were obtained for each of 2899 1:50 000 scale NTS sheets.

Vulnerability Index scores range from 0.8 to 56.7, with a modal value of 4.2. They are grouped into three categories, low (0 - 4.9), moderate (5.0 - 14.9), and high vulnerability (>15.0). The map identifies two major regions of high vulnerability: (1) Maritime Canada (parts of the coasts of Nova Scotia, Prince Edward Island, and New Brunswick) and (2) parts of the Beaufort Sea coast. Small areas of high vulnerability occur in Quebec, Newfoundland, and British Columbia. The vulnerability scores are not equated with specific effects; they merely indicate in a relative sense the degree of change to be expected. Furthermore, the map is highly generalized, and there is no accounting for very small areas of vulnerability (cf. photograph D).

The accompanying text describes the potential impacts of sea-level change, using the coastal environments of Owens (1977) as a framework. The emphasis is on the range of processes which occur today on Canadian coasts and which would be intensified if sea-level rise were to occur. Hopefully, this map is a precursor of regional and local scale studies which will use more accurate data to predict changes not only to physical systems, but also to socio-economic and ecological systems.

The map also displays the present rate of sea-level change at selected tide-gauge stations, one of the seven factors used for calculating the vulnerability index. Accelerated sea-level rise would be superimposed upon these existing trends. The photographs A to L illustrate the diversity of Canadian coasts and the wide range of impacts that might be expected.

References

Gornitz, V. 1990. Vulnerability of the East Coast, U.S.A. to future sea level rise. Journal of Coastal Research, Special Issue No. 9, p. 201-237.

Houghton, J.T., Jenkins, G.J., and Ephraums, J.J. (editors). 1990. Climate change, the IPCC scientific assessment. Cambridge University Press, Cambridge, 365 p.

Owens, E.H. 1977. Coastal Environments of Canada: the impact and cleanup of oil spills. Economic and Technical Review Report EPS 3-EC-77-13, Fisheries and Environment Canada, Halifax, 413 p.

To accompany Open File 2825 report "Sensitivity of the Canadian Coast to Sea-Level Rise"

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COASTAL ENVIRONMENTS OF CANADA

E.H. Owens (1977) classified the coasts of Canada into distinct coastal environments on the basis of the physical processes that act on the shoreline and on the geology and relief of the coastal zone. These environments are used as a framework for discussion in the text.

ATLANTIC COAST
1 Labrador: Outer Newfoundland
2 West Newfoundland; Northern Gulf
3 St. Lawrence Estuary
4 Southern Gulf of St. Lawrence
5 Atlantic Nova Scotia
6 Bay of Fundy
7 Sable Island

PACIFIC COAST
1 Fraser River Delta
2 Queen Charlotte Sound - Strait of Georgia
3 Juan de Fuca Strait
4 Outer Coast
5 Queen Charlotte Sound and Hecate Strait
6 East Graham Island

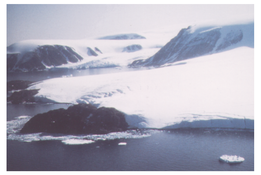
ARCTIC COAST
1 Frobisher Bay; Ungava Bay; Hudson Strait
2a/b Hudson Bay; James Bay
3 Fjord coasts.
4 Jones Sound; Lancaster Sound; Prince Regent Sound
5 W. Ellesmere Island; Axel Heiberg
6 Ice Shelf
7 Coastal Plain
8 Ria Coast
9 S. Archipelago - Mainland
10 Tuktoyaktuk Peninsula; Liverpool Bay.
11 Mackenzie Delta
12 Yukon

* Box outline colours correspond to coastal environments as shown on map

VULNERABILITY INDEX
0 - 4.9 LOW
5 - 14.9 MODERATE
≥15.0 HIGH

A: Prince Patrick Island, N.W.T. This low, ice-congested, sandy coastline is moderately vulnerable to sea-level rise (score 9.6), particularly to inundation and coastal retreat. If the extent and duration of open water increases (due to global warming), additional effects could include overwashing and development of barrier beaches.

B: Bylot Island, N.W.T. This part of Bylot Island has a low vulnerability overall (score 3.6). However, unlike the high, rocky coast in the background, the low barrier beach could migrate landward due to more frequent overwashing, particularly if the duration and extent of ice cover decreased. The backbarrier lowland (right) is vulnerable to inundation.



C: Devon Island, N.W.T. A small percentage of eastern Arctic coasts consist of tidewater glaciers. These are vulnerable not only to sea-level rise, but also to increases in open water extent and duration which could increase calving rates and change coastal configuration. This region has a moderate vulnerability (score 8.0).

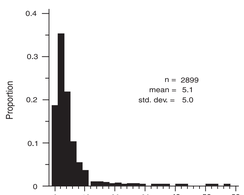
D: Placentia, Nfld. This is an example of a high vulnerability location within a region assessed to be at low risk overall (score 3.2). The low, gravel beach-ridge plain has been inundated several times in recent years during storms. This could occur more frequently in the future.

E: Magdalen Islands, Que. At least three nearshore bars dissipate wave energy on this dune coast (score 33.8). Similar coasts exist throughout the southern Gulf of St. Lawrence. Impacts could include dune instability, changes in configuration of nearshore bars, and erosion of beaches. Photo E.H. Owens.

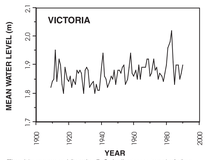
F: Story Head, N.S. This region is highly vulnerable (42.8). The low, curving barrier beach in the photo retreats 8 m annually, and will soon become detached from the eroding drumlin remnant in the foreground, exposing a sheltered inlet to Atlantic storm waves. Accelerated sea-level rise will result in more frequent changes at the outer coast, accompanied by the formation of new barriers, and innundation of coastal marshes.

G: Pointe aux Outardes, Que. Holocene deltas along Quebec's North Shore are pockets of moderate vulnerability in an otherwise low vulnerability region. Future sea-level rise would result in increased coastal erosion and coastal mobility in these areas. Photo J.-C. Dionne.

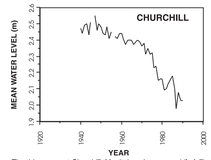
H: North Richibucto Beach, N. B. The Gulf coast of New Brunswick has moderate to high vulnerability levels - this area has a score of 16.0. This low, sandy barrier beach could experience increased rates of overwashing, retreat, and inlet migration. Erosion of peat cliffs and inundation of backbarrier marshes could also be expected. Photo E.A. Bryant.



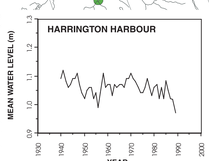
The statistical distribution of vulnerability indices shows that most of the Canadian coastline falls within the low and moderate domains. Only a few regions have high scores and these are mainly in Atlantic Canada and the Beaufort Sea region



The tide gauge at Victoria, B.C. indicates a trend of slow rising sea-level. Gauges elsewhere in British Columbia show both falling and rising trends.

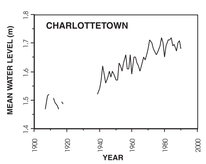


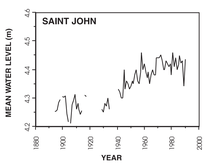
The tide gauge at Churchill, Manitoba, shows a rapidly falling sea-level. This trend is characteristic of much of Hudson Bay and reduces the vulnerability of that region.

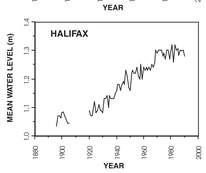


The tide gauge from Harrington Harbour, Que., is typical of the north coast of the Gulf of St. Lawrence, where sea level is stable. To the north, sea level is falling on the inner coast of Labrador but is stable or rising on the outer coast.

These tide gauge records from the Maritime Provinces illustrate the rapid sea-level rise which is presently occurring in that region. This is one of the factors which make this area vulnerable.







I: Northeast Graham Island, B.C. This is one of two regions of high vulnerability in British Columbia - the score is 24.8. The sandy bluffs in this photo are retreating up to 12 m annually, supplying sediment to prograding beaches elsewhere in the region. Photo C.L. Amos.

J: Beaufort Sea coast, Yukon Terr. These 5 m high bluffs at Kay Point are retreating due to thawing of ice wedges, undercutting of polygons, and block slumping. The vulnerability score of this region is 11.7. If open water duration increased, the coast would be exposed to waves much higher than those that exist today.

K: Toba Inlet, B.C. Like much of British Columbia's coast, this fiord, surrounded by mountains rising above 1800 m, is at low risk of modification by a sea-level rise. The vulnerability index here is 1.9. Nevertheless, there could be impacts, including inundation of the numerous bayhead deltas in the region. Photo J.P.M Syvitski.

L: West coast of Hudson Bay, Man. This low coast with sandy beaches, raised beaches, and coastal marshes is moderately vulnerable. The effects of global sea-level rise would be mitigated by ongoing crustal rise here and elsewhere in Hudson Bay. Photo I.P. Martini.

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