Potential Impacts

Recent research on the potential impacts of climate change in Canada has revealed that a warming climate could have wide-ranging effects on Canada's environment and the human community.

The potential impacts of climate change in Canada can be shown in the following areas:

1. The growing season is expected to be warmer and longer. It is possible that not all agriculture may benefit from this change since the plants may not adapt as quickly to the rate at which changes in the growing season occur (research in biologic engineering of plant seeds has been ongoing and successful).

2. Navigation is likely to improve in seasons with ice-covered waters due to a warmer climate that would cause a later freezing and an earlier break-up date for ice in waterways.

3. A shorter warmer winter would lower space heating costs.

4. Sea level is expected to rise, which will cause flooding and erosion in many coastal regions.

5. The move of the permafrost limit towards the north could potentially extend the forest zone and the habitat for both animal and plant species towards the north, but the extendibility may be constrained by the soil quality and the adaptability of species.

6. Forests (particularly boreal forests) could be at higher risk of fire, pests and drought.

7. While a warmer temperature could be of benefit to commercial agriculture for Ontario, Quebec and the Prairies, increased risks of drought and insect infestations will add stress to crops, and thus may affect the crop yield.

8. Both the Pacific and the Atlantic fisheries are expected to be at risk, as climate change may affect both the population and the range of species which are notably sensitive to changes in water temperature.

9. Primarily in southern Canada, increasing drought may also threaten water resources, causing decreases in water quality and quantity.

10. There could be increased frequency of extreme weather conditions, such as floods, droughts, winter storms, heat waves and tornadoes.

11. The increasing frequency and severity of heat waves may lead to an increase in heat stress and death, especially among the very young, the elderly and the ill. A number of indirect impacts are also expected on human health, including an increasing incidence of respiratory disorders, infectious diseases, and allergy problems.

This Module

The potential impacts of climate change on the environment and the human community for Canada are expected to occur, but with significant regional variations. This module is aimed at representing these regional patterns. The maps currently present in this module represent the module's first phase. Seven maps are included in this phase, addressing the sensitivity of five elements of Canada's environment to climate change. These elements are:

- Coastlines
- River regions
- Soils sensitive to wind erosion
- Peatlands
- Forest fires

Coastal Sensitivity to Sea-Level Rise

Abstract

Sensitivity of the coastlines of Canada to the expected rise in sea level is shown here. Sensitivity here means the degree to which a coastline may experience physical changes such as flooding, erosion, beach migration, and coastal dune destabilization. Climate warming is expected to cause warming of the oceans and the partial melting of glaciers and ice-caps, resulting in a global rise in sea level. Two major regions of high sensitivity are identified: Atlantic Canada and parts of the Beaufort Sea coast.

The Theme

Climate warming is expected to cause warming of the oceans and the partial melting of glaciers and ice-caps, resulting in a global rise in sea level. By the end of this century, the global mean sea-level rise could amount to 0.09 to 0.88 metres (Intergovernmental Panel on Climate Change 2001). In Canada, where the total coastline exceeds 203 000 kilometres, sea level rise is a significant issue.

This map shows the sensitivity of the coastlines of Canada to the expected rise in sea level, due to climate warming. Sensitivity here means the degree to which a coastline may experience physical changes such as flooding, erosion, beach migration, and coastal dune destabilization. It is measured by a sensitivity index, which is a modified version of the coastal vulnerability index of Gornitz (1990). This sensitivity index 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.

Sensitivity Projection

As shown in the map, sensitivity index scores range from 0.8 to 56.7. Two major regions of high sensitivity are identified: 1) Atlantic Canada (much of the coasts of Nova Scotia, Prince Edward Island, and New Brunswick); and 2) parts of the Beaufort Sea coast. Small areas of high sensitivity occur in Quebec, Newfoundland and Labrador, and British Columbia.

As sea level rises, storm surges will inflict greater damage on communities located close to the level of the ocean. A reminder of this was the flooding of Charlottetown, Prince Edward Island by a storm surge in January 2000. Other communities at risk include Placentia in Newfoundland and Labrador, and even downtown Halifax. The lowlands at the head of the Bay of Fundy are also at risk from storm surges. This

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area was devastated in the great storm surge of 1869, the so-called 'Saxby Tide'. With accelerated sea-level rise, the dykes will be breached by some of the high tides by the middle of the century.

The other large area of high sensitivity is the Beaufort Sea, where some of the most rapid coastal erosion rates in Canada are found. The problem is exacerbated by the thawing of permafrost in beach sediments. Storm surges commonly cause flooding in this region. Settlements such as Tuktoyaktuk will undoubtedly experience further difficulties in the coming years. An additional concern in this region is that the extent and duration of sea ice will be reduced as the climate warms, thus allowing storms to flood and erode the coast more frequently. Note that coastal erosion is restricted to summer months, and cannot occur in winter when the ocean is frozen.

A rising sea level will result in more coastal erosion in this century. However, when compared with Europe and Japan, where expenditures on coastal protection are in the many billions of dollars, Canada is fortunate in having low population densities and small amounts of infrastructure at risk. Awareness of the expected sea-level rise and coastal erosion, which have been occurring for many thousands of years, should ensure that future developments are set back from threatened areas.

Photos of Canadian Coasts

Photographs A to L illustrate the diversity of Canadian coasts and the wide range of impacts that might be expected.

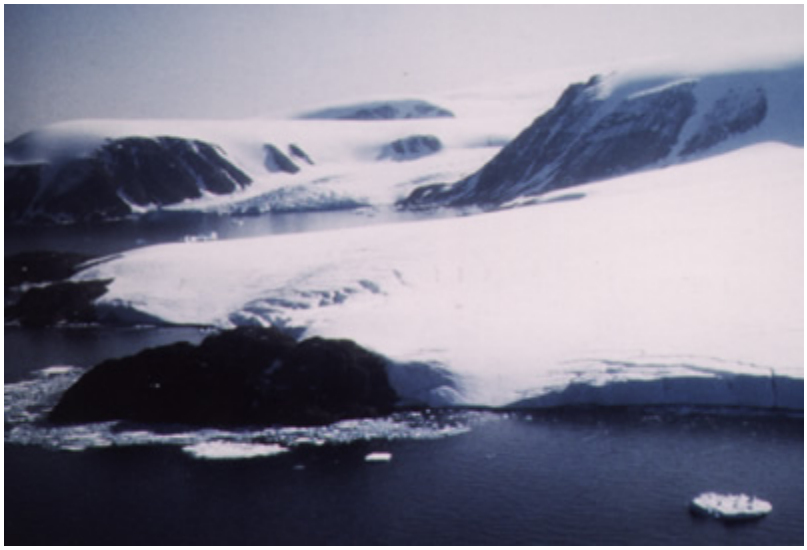
Photograph A: Prince Patrick Island, Northwest Territories. This low, ice-congested, sandy coastline is moderately sensitive to sea-level rise (score 9.6), particularly to inundation and coastal retreat. If the extent and duration of open water increases (due to global warming), additional effects could include overwashing and development of barrier beaches. Photo by R.B. Taylor. GSC 1998-038-A

Photograph A. Prince Patrick Island, Northwest Territories
Source: R.B. Taylor. GSC 1998-038-A

Photograph B: Bylot Island, Nunavut. This part of Bylot Island has a low sensitivity 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. Photo by R.B. Taylor. GSC 1998-038-B

Photograph B. Bylot Island, Nunavut
Source: R.B. Taylor. GSC 1998-038-B

Photograph C: Devon Island, Nunavut. A small percentage of eastern Arctic coasts consist of tidewater glaciers. These are sensitive 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 sensitivity (score 8.0). Photo by R.B. Taylor. GSC 1998-038-C



Photograph C. Devon Island, Nunavut
Source: R.B. Taylor. GSC 1998-038-C

Photograph D: Placentia, Newfoundland and Labrador. This is an example of a high sensitivity 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. Photo by D.L. Forbes. GSC 1998-038-D

Photograph D. Placentia, Newfoundland and Labrador
Source: D.L. Forbes. GSC 1998-038-D

Photograph E: Îles-de-la-Madeleine, Quebec. 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 by E.H. Owens. GSC 1998-038-E

Photograph E. Îles-de-la-Madeleine, Quebec
Source: E.H. Owens. GSC 1998-038-E

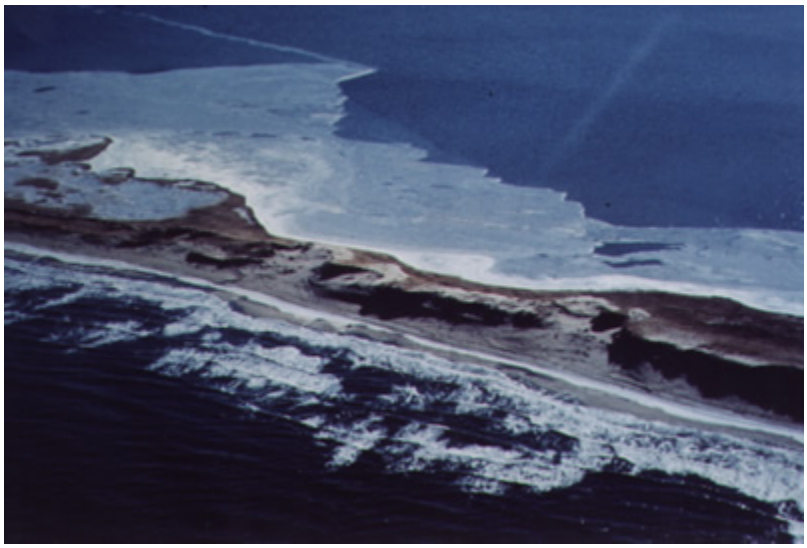
Photograph F: Story Head, Nova Scotia. This region is highly sensitive (42.8). The low, curving barrier beach in the photo retreats 8 metres annually, and will soon become detached from the eroding drumlin remnant in the foreground, exposing a sheltered inlet to Atlantic storm waves. Accelerated sea-level rise will result in more frequent changes at the outer coast, accompanied by the formation of new barriers, and inundation of coastal marshes. Photo by J. Shaw. GSC 1998-038-F

Photograph F. Story Head, Nova Scotia
Source: J. Shaw. GSC 1998-038-F

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

Photograph G. Pointe aux Outardes, Quebec
Source: J.-C. Dionne.

Photograph H: North Richibucto Beach, New Brunswick. The gulf coast of New Brunswick has moderate to high sensitivity 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 courtesy of E.A. Bryant.



Photograph H. North Richibucto Beach, New Brunswick
Source: E.A. Bryant

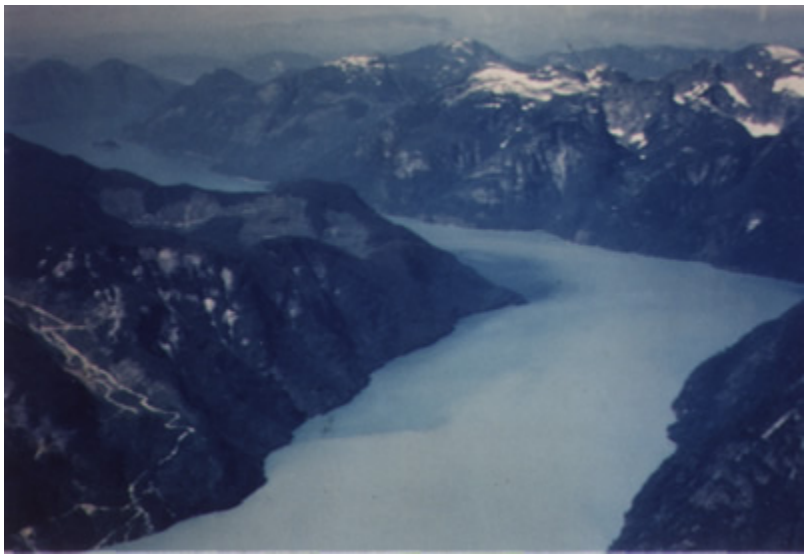
Photograph I: Northeast Graham Island, British Columbia. This is one of two regions of high sensitivity in British Columbia - the score is 24.8. The sandy bluffs in this photo are retreating up to 12 metres annually, supplying sediment to prograding beaches elsewhere in the region. Photo by C.L. Amos. GSC 1998-038-G

Photograph I. Northeast Graham Island, British Columbia
Source: C.L. Amos. GSC 1998-038-G

Photograph J: Beaufort Sea coast, Yukon Territory. These 5 metre-high bluffs at Kay Point are retreating due to thawing of ice wedges, undercutting of polygons, and block slumping. The sensitivity 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. Photo by D.L. Forbes. GSC 1998-038-H

Photograph J. Beaufort Sea Coast, Yukon Territory
Source: D.L. Forbes. GSC 1998-038-H

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



Photograph K. Toba Inlet, British Columbia
Source: J.P.M. Syvitski

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

Photograph L. West Coast of Hudson Bay, Manitoba
Source: I.P. Martini

Data Source

J. Shaw, R.B. Taylor, D.L. Forbes, M.-H. Ruz, and S. Solomon. 1998. Sensitivity of the Coasts of Canada to Sea-level Rise. Geological Survey of Canada Bulletin 505. Ottawa.

Map Sources

Coastal Sensitivity to Sea-level Rise
The sensitivity of the entire coastline of Canada to inundation, erosion and other processes which might result from accelerated sea-level rise is displayed with low, moderate or high sensitivity values. J. Shaw, R.B. Taylor, D.L. Forbes, M.-H. Ruz, and S. Solomon. 1998. Sensitivity of the Coasts of Canada to Sea-level Rise. Geological Survey of Canada Bulletin 505. Ottawa.

Delineation Between Submerging and Emerging Areas
The line delineating present-day submerging coastal areas from emerging coastal areas of Canada. J. Shaw, R.B. Taylor, D.L. Forbes, M.-H. Ruz, and S. Solomon. 1998. Sensitivity of the Coasts of Canada to Sea-level Rise. Geological Survey of Canada Bulletin 505. Ottawa.

Present-day Submerging of Coasts
The approximate areas that are submerging present-day in Canada. J. Shaw, R.B. Taylor, D.L. Forbes, M.-H. Ruz, and S. Solomon. 1998. Sensitivity of the Coasts of Canada to Sea-level Rise. Geological Survey of Canada Bulletin 505. Ottawa.

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United Nations. 1992. United Nations Framework Convention on Climate Change. New York (http://unfccc.int/resource/docs/convkp/conveng.pdf).

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Related Web sites (1999 – 2009)

Federal Government

Environment Canada. Climate Change. The Science of Climate Change
http://www.ec.gc.ca/cc/

Environment Canada. Climate Change Web Site
http://www.ec.gc.ca/cc/

Environment Canada. State of the Environment Infobase
http://www.ec.gc.ca/indicateurs-indicators/default.asp?lang=en&n=32E1E173-1
The State of the Environment (SOE) Infobase was originally developed in 1996 as an interactive and convenient mechanism for presenting a number of environmental reporting products and tools, including The State of Canada's Environment 1996 and Canada's National Environmental Indicators Series 2003.

Government of Canada. Climate Change Impacts and Adaptation Program
http://adaptation.nrcan.gc.ca/
The Government of Canada's Climate Change Impacts and Adaptation Program provides funding for research and activities to improve our knowledge of Canada's vulnerability to climate change.

Government of Canada. National Climate Change Process of Canada. Climate change backgrounder
http://www.ecoaction.gc.ca/index-eng.cfm
This site has been created to inform Canadians about how Canadian governments are responding to the challenge of climate change.

Natural Resources Canada: Climate Change in Canada. Posters
http://adaptation.nrcan.gc.ca/posters/
A series of seven posters depicting the regional impacts of climate change in Canada.

Other

Canadian Institute for Climate Studies. Canadian climate impacts scenarios
http://www.cics.uvic.ca/scenarios/index.cgi
The main role of the Canadian Climate Impacts and Scenarios project is to provide climate scenario information and scenario construction advice to impacts researchers in Canada.

United States Government. Environmental Protection Agency. Global Warming. Impacts
http://yosemite.epa.gov/oar/globalwarming.nsf/content/Impacts.html

International Government

United Nations Environment Network
http://climatechange.unep.net/

United Nations Environment Programme: GRID-Arendal
http://www.grida.no/activities.cfm?pageID=2

Inter-agency

IPCC Working Group II: Climate Change Impacts, Adaptation and Vulnerability
http://www.ipcc-wg2.org/index.html

The Atlas of Canada / L'Atlas du Canada
atlas.gc.ca
Since 1906 / Depuis 1906

Atlas of Canada 6th Edition
(archival version)

Potential Impacts — Coastal Sensitivity to Sea-Level Rise

Sensitivity of the coastlines of Canada to the expected rise in sea level is shown on the map. Sensitivity here means the degree to which a coastline may experience physical changes such as flooding, erosion, beach migration, and coastal dune destabilization. Climate warming is expected to cause warming of the oceans and the partial melting of glaciers and ice-caps, resulting in a global rise in sea level. Two major regions of high sensitivity are identified: Atlantic Canada and parts of the Beaufort Sea coast.

0 150 300 450 600 km

Lambert Conformal Conic Projection. Standard Parallels 49°N and 77°N

Coastal Sensitivity to Sea-level Rise
- Low (0 - 4.9)
- Moderate (5.0 - 14.9)
- High (15 and up)

Present-day Submerging of Coasts
- Present day submerging areas

Capitals (Canada)
- National
- Provincial and Territorial

Populated Places
- 1 - 4999
- 5 000 - 49 999
- 50 000 - 99 999
- 100 000 and greater

International Boundaries
- EEZ (200 mile)
- Canada / Kalaallit Nunaat dividing line
- International

Provincial and Territorial Boundaries
- Provincial / Territorial

Source(s):
Coastal Sensitivity to Sea-level Rise
J. Shaw, R.B. Taylor, D.L. Forbes, M.-H. Ruz, and S. Solomon. 1998. Sensitivity of the Coasts of Canada to Sea-level Rise. Geological Survey of Canada Bulletin 505. Ottawa.

Alert
Resolute
Pond Inlet
Igloolik
Clyde River
Cambridge Bay
Kugluktuk
Old Crow
Inuvik
Dawson
Norman Wells
Faro
Whitehorse
Watson Lake
Fort Simpson
Yellowknife
Hay River
Fort Nelson
Fort Smith
High Level
Prince Rupert
Fort St. John
Grande Prairie
Fort McMurray
Prince George
Williams Lake
Hinton
Edmonton
Lloydminster
Kamloops
Red Deer
Banff
Calgary
Kelowna
Vancouver
Victoria
Cranbrook
Lethbridge
Swift Current
Regina
Saskatoon
Yorkton
Dauphin
Brandon
Winnipeg
Estevan
Kenora
Thunder Bay
Marathon
Sault Ste. Marie
Greater Sudbury
Timmins
Val-d'Or
Ottawa
Montréal
Drummondville
Kingston
Toronto
Hamilton
London
Windsor
Gjoa Haven
Taloyoak
Cape Dorset
Iqaluit
Resolute Inlet
Churchill
Chisasibi
Moosonee
Chibougamau
Sept-Îles
Natashquan
Kuujjuaq
Nain
Happy Valley-Goose Bay
Labrador City
Gander
St. John's
Corner Brook
Channel-Port aux Basques
Gaspé
Cape Breton
Bathurst
Dalhousie
Charlottetown
Moncton
Saint John
Fredericton
Halifax
Yarmouth
Rimouski
Baie-Comeau
Thompson
Flin Flon
La Ronge
Norway House