Environment and Climate Change Canada | Environnement et Changement climatique Canada

Canada

CHANGES IN FRESHWATER AVAILABILITY ACROSS CANADA

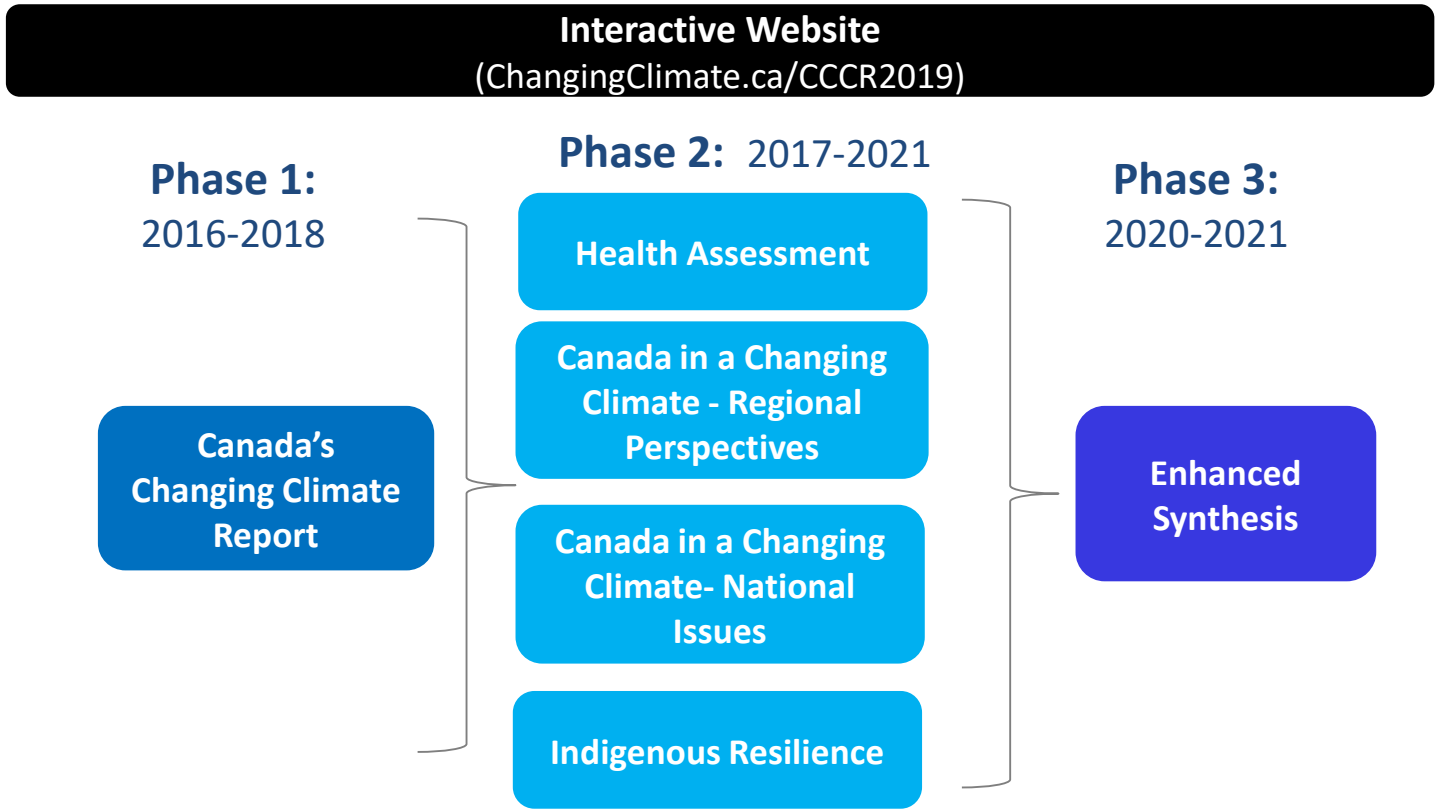


Barrie R. Bonsal, Environment and Climate Change Canada
Daniel L. Peters, Environment and Climate Change Canada
Frank Seglenieks, Environment and Climate Change Canada
Alfonso Rivera, Natural Resources Canada
Aaron Berg, University of Guelph

CANADA'S CHANGING CLIMATE REPORT

- A collaborative effort: Environment and Climate Change Canada; Fisheries and Oceans Canada; Natural Resources Canada; University experts
- Contributions from 43 government and academic authors
- Peer-reviewed science assessment report similar to Intergovernmental Panel on Climate Change and based on published scientific literature
- Released April 2019
- https://changingclimate.ca/

Canada's National Assessment on Climate Change
Canada in a Changing Climate: Advancing our Knowledge for Action



Laying a climate science foundation for the forthcoming reports of the national assessment.

Canada's Changing Climate Report

10 HEADLINE STATEMENTS FOR THE WHOLE REPORT

KEY MESSAGES FOR EACH MAJOR CHAPTER
Assessed confidence in findings and likelihood of results

Chapter 1
About this Report

Chapter 2
Observed Global Climate Change

Chapter 3
Modelling Future Climate Change

Chapter 4
Changes in Temperature and Precipitation

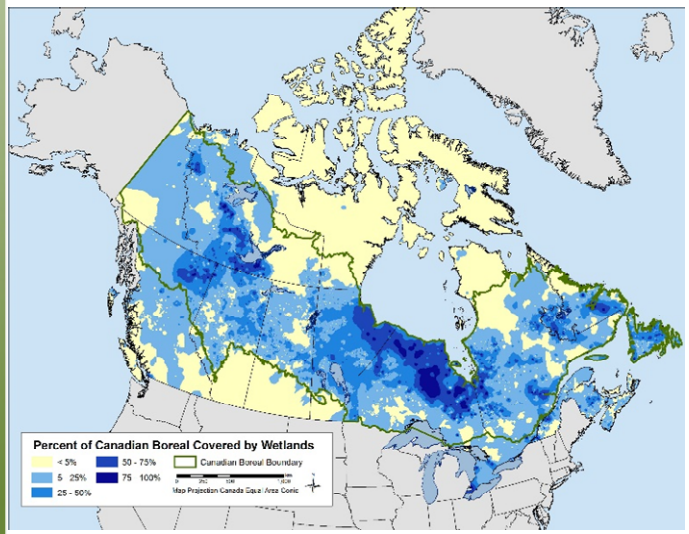
Chapter 5
Changes in Snow, Ice and Permafrost

Chapter 6
Changes in Freshwater Availability

Chapter 7
Changes in Oceans Surrounding Canada

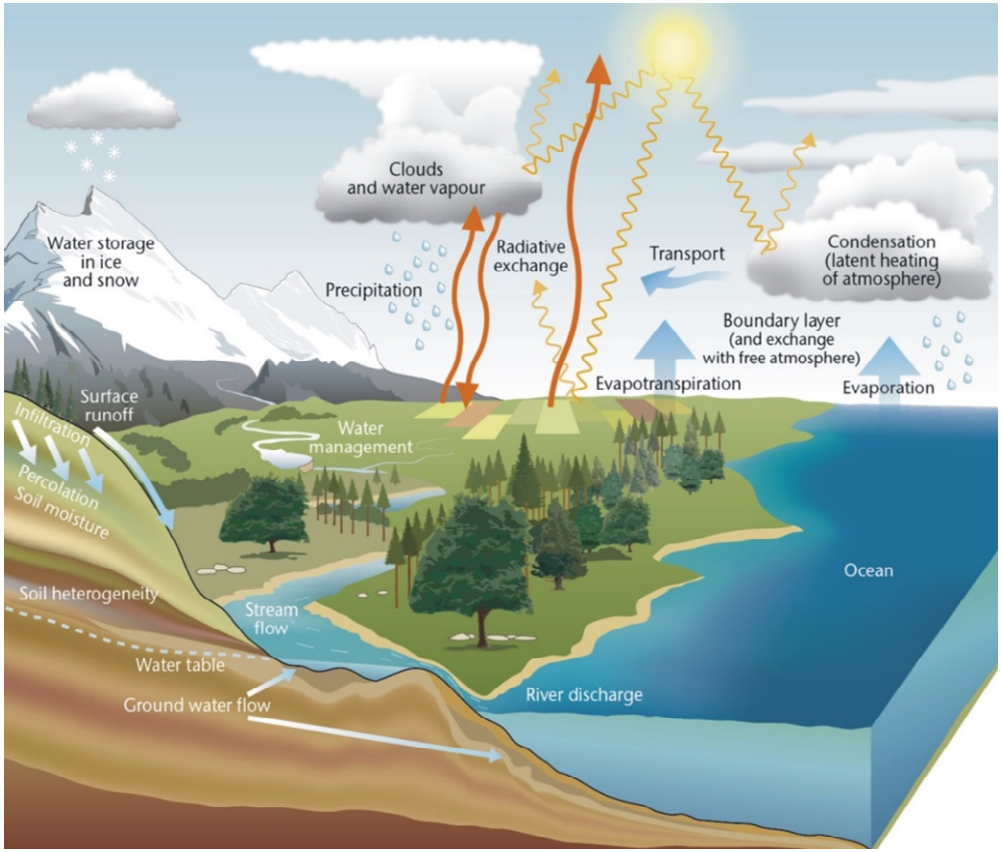
Chapter 8
Changes in Canada's Regions in a National and Global Context

Canada's Freshwater



- Vast amounts of freshwater: Lakes, rivers, wetlands, groundwater, snowpacks, glaciers, & the soil
- Over 8500 rivers and > 2 million lakes - ~9% of Canada
- Wetlands: ~16% of the Canada's landmass
- Fundamental to the environment, social & economic activities: Aquatic ecosystems, agriculture, industry, hydro-electricity, drinking water, recreation

Water Cycle



- Freshwater availability: Processes & interactions within the water cycle
- Closely linked with changes in temperature, precipitation, snow & ice, oceans
- Human management: Dams, reservoirs, withdrawals - an important component of the water cycle

Freshwater Availability Indicators

1. Surface Runoff: Streamflow

- Streamflow magnitude
- Streamflow timing
- Streamflow regime
- Streamflow-related floods

2. Surface Water Levels: Lakes and Wetlands

- Laurentian Great Lakes
- Other lakes
- Wetlands and deltas

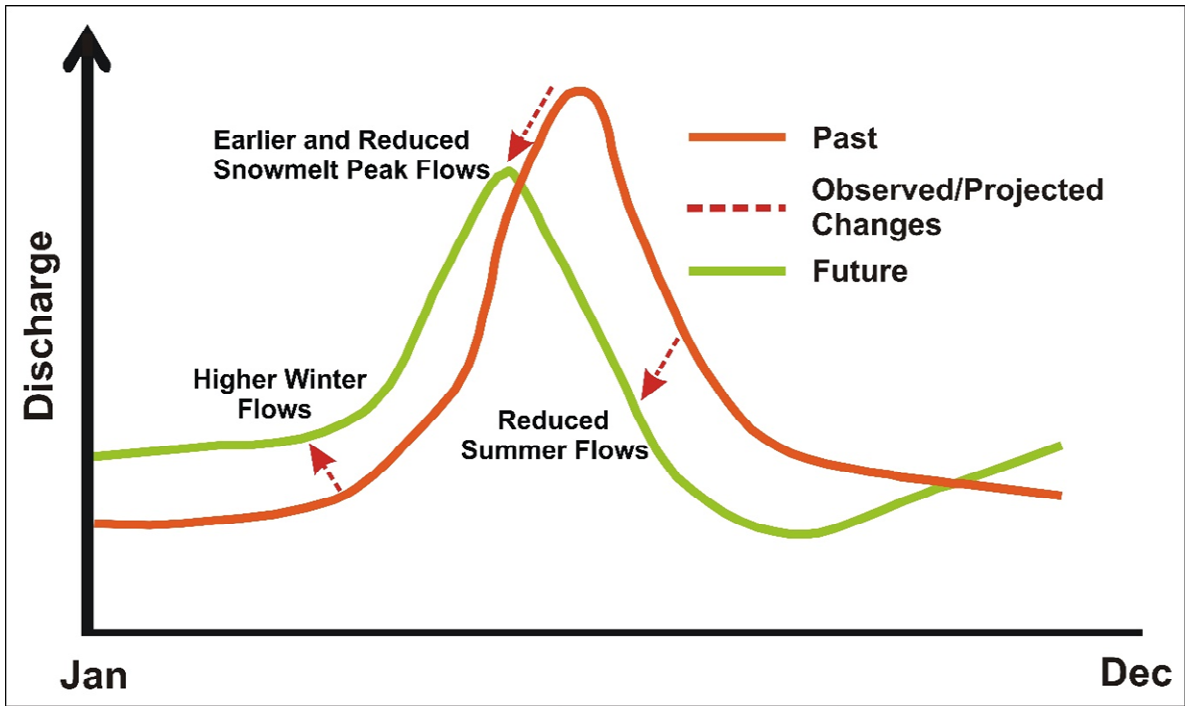
3. Soil Moisture and Drought

4. Groundwater

Surface Runoff: Streamflow

The seasonal timing of peak streamflow has shifted, driven by **warming temperatures**. Over the last several decades, spring peak streamflow following snowmelt has occurred earlier, with higher winter and early spring flows (***high confidence***). In some areas, reduced summer flows have been observed (***medium confidence***).

Seasonal changes projected to continue, with shifts from more snowmelt-dominated regimes toward rainfall-dominated regimes (***high confidence***).

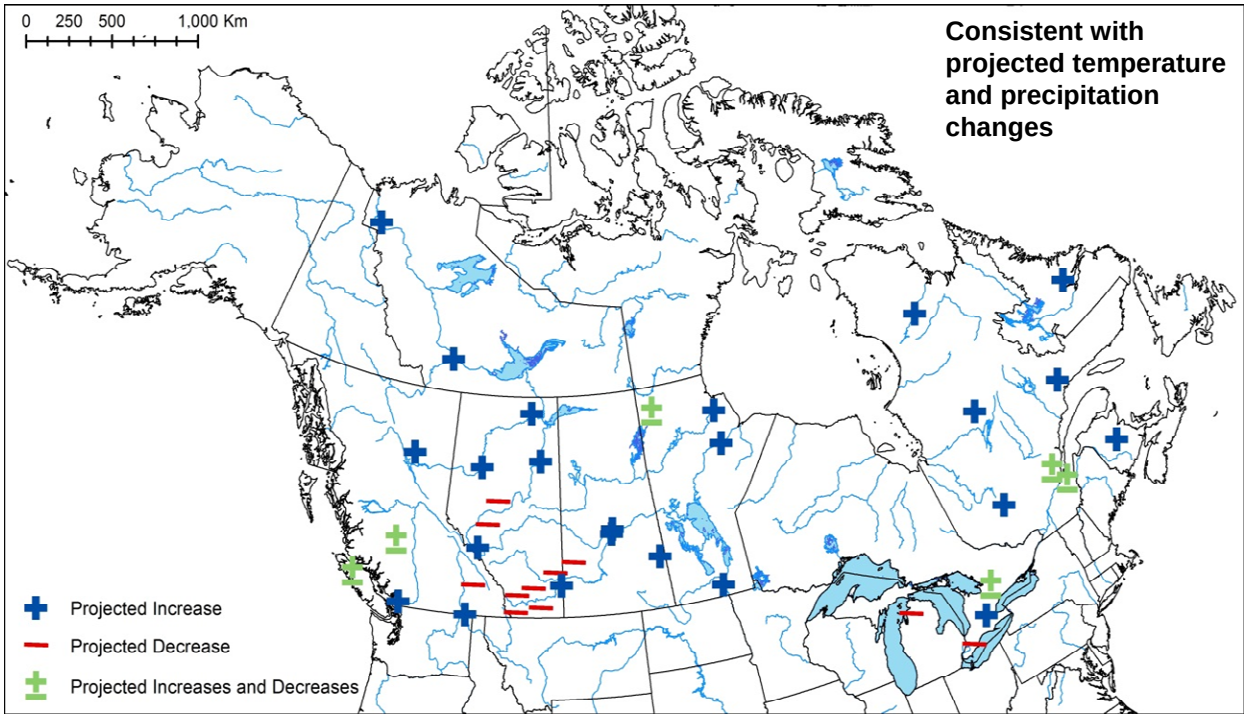


Canada

Surface Runoff: Streamflow

There have been no consistent trends in annual streamflow amounts across Canada as a whole. In the future, annual flows are projected to increase in most northern basins but decrease in southern interior continental regions (***medium confidence***).

Projected Future Changes to Annual Streamflow in Canada



Streamflow Related Flooding

Streamflow-related floods result from many factors, and in Canada these mainly include excess precipitation, snowmelt, ice jams, rain-on-snow, or a combination of these factors. There have been no spatially consistent trends in these flood-causing factors or in flooding events across the country.

Projected increases in **extreme precipitation** are expected to increase the potential for future urban flooding (***high confidence***).

Projected **higher temperatures** will result in a shift toward earlier floods associated with spring snowmelt, ice jams, and rain-on-snow events (***medium confidence***). It is ***uncertain*** how projected higher temperatures and reductions in snow cover will combine to affect the frequency and magnitude of future snowmelt-related flooding.

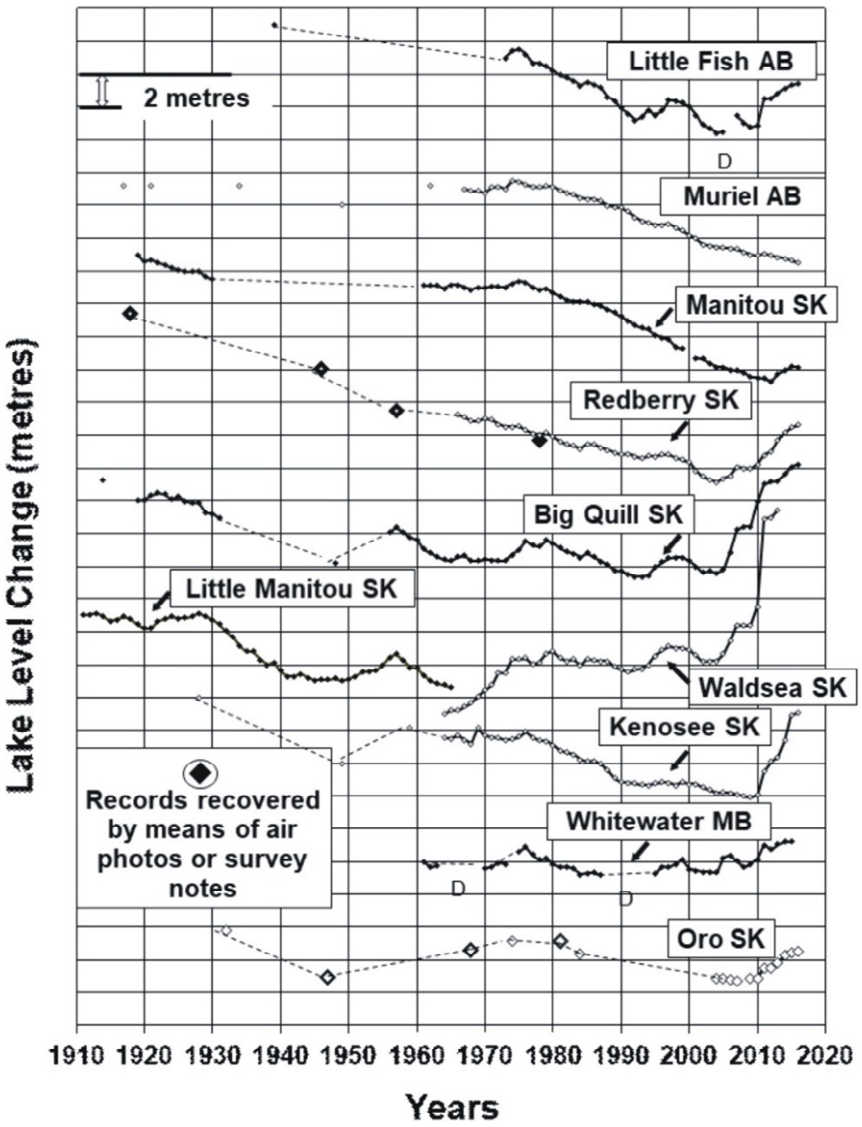
Surface Water Levels

In regions of Canada where there are sufficient data, there is no indication of long-term changes to lake and wetland levels.

Future levels may decline in southern Canada, where **increased evaporation** may exceed increased precipitation (***low confidence***).

Projected warming and **thawing permafrost** has the potential to cause future changes in many northern Canadian lakes, including rapid drainage (***medium confidence***).

Water Levels Across the Southern Prairies

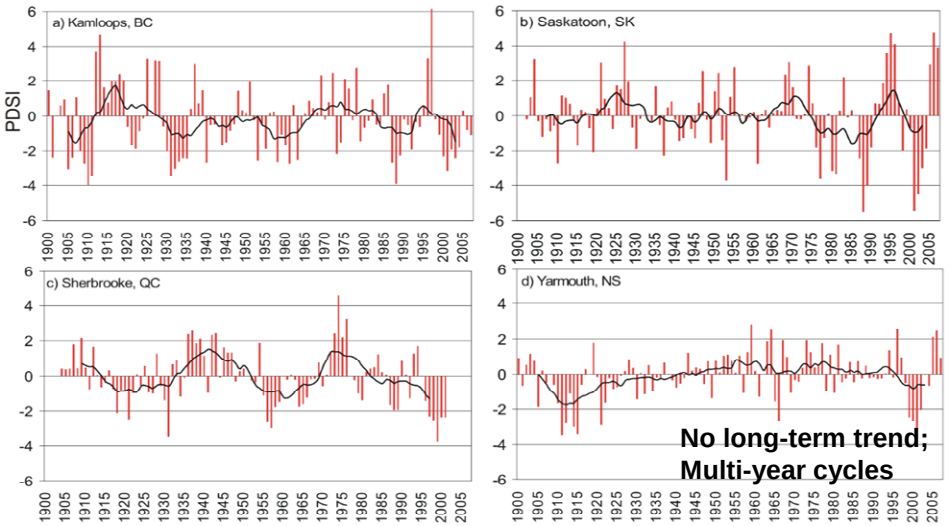


Soil Moisture and Drought

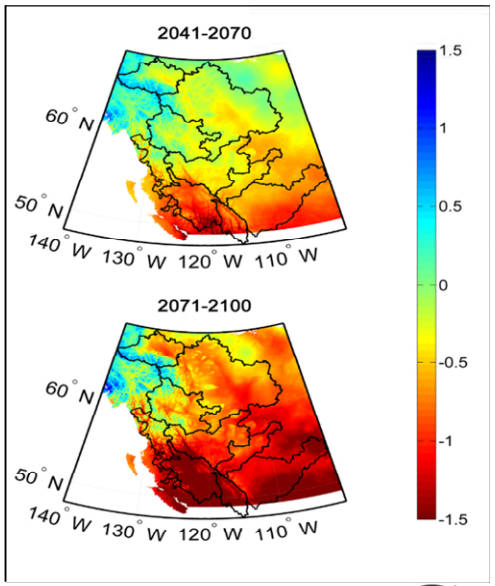
Periodic droughts have occurred across much of Canada, but no long-term changes are evident.

Future droughts and soil moisture deficits are projected to be **more frequent and intense** across the southern Canadian Prairies and interior British Columbia during summer, and to be more prominent at the end of the century under a high emission scenario (***medium confidence***).

Past Changes in Drought



Projected Changes in Summer Drought across Western Canada



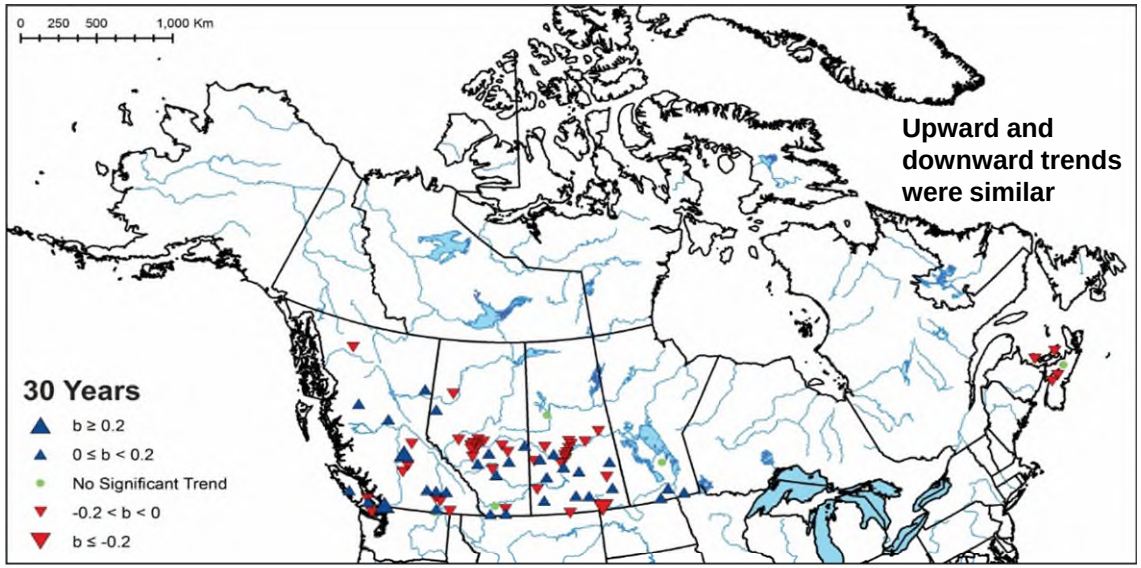
Drier in south from 2041-2070; For 2071–2100, drier almost everywhere and very dry for the south

Groundwater

Complexity of groundwater systems and a lack of information make it difficult to assess whether groundwater levels have changed since records began.

It is expected that projected changes to temperature and precipitation will influence future groundwater levels; however, the magnitude and even direction of change is not clear. Spring recharge of groundwater aquifers over most of the country is anticipated to occur earlier in the future, as a result of **earlier snowmelt** (***medium confidence***).

Past Annual Groundwater Level Trends in Canada

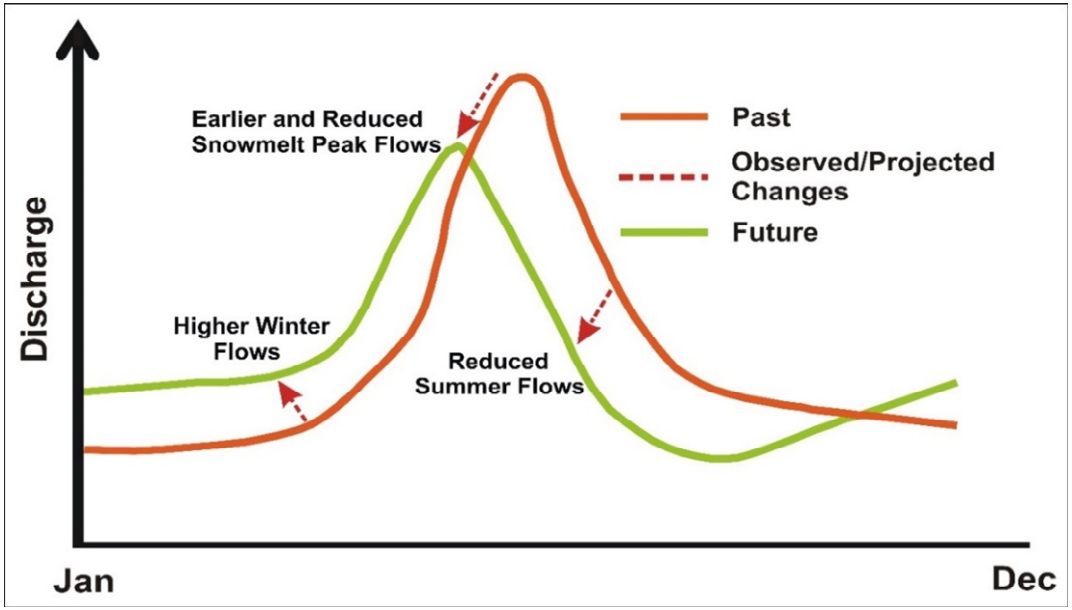


Summary: Past Changes

- National and regional studies, along with information on changes in temperature & precipitation and the cryosphere, were used to assess changes to freshwater availability in Canada.
- The seasonality of streamflow has been characterized by earlier spring freshets due to earlier spring snowmelt, higher winter and early spring flows, and, for many regions, reduced summer flows.
- These changes are consistent with observed warming and related changes to snow and ice.
- During the last 30 to 100 years, annual streamflow magnitudes, surface water levels, soil moisture content and droughts, and shallow groundwater levels have been variable, with no clear increasing or decreasing trends.

Future Impacts: Water Resources

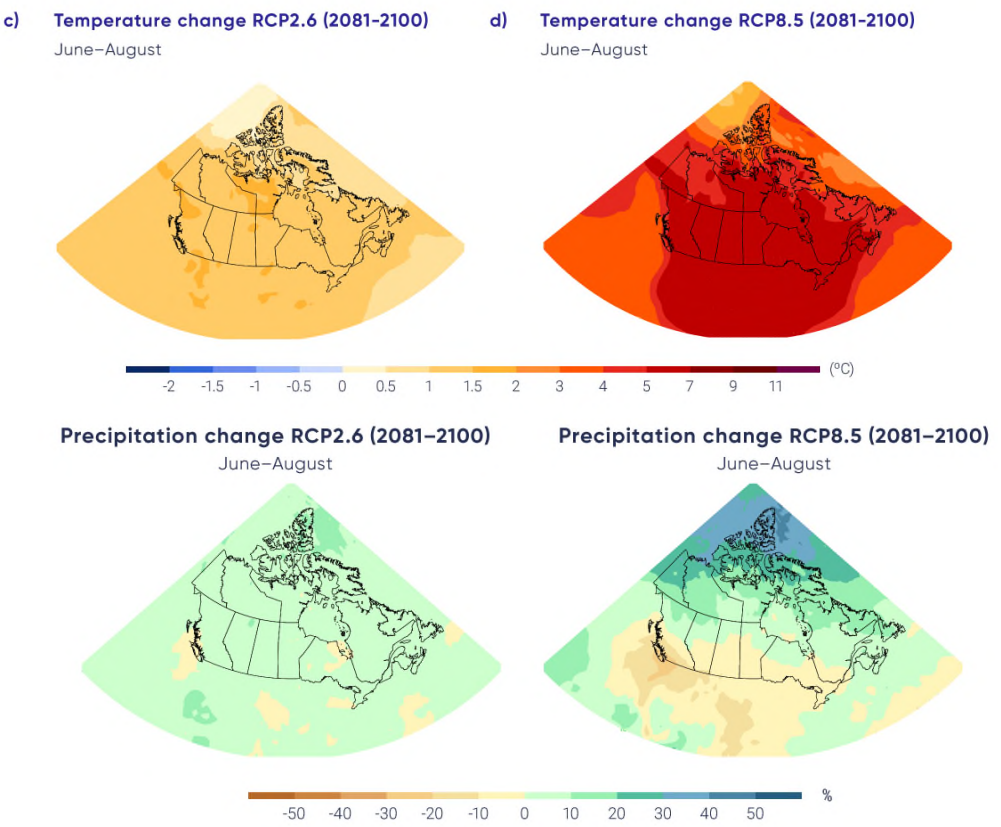
- The seasonal availability of freshwater is changing, with an **increased risk of water supply shortages in summer.**
- Warmer winters and earlier snowmelt will combine to produce higher winter streamflows, while smaller snowpacks and loss of glacier ice during this century will combine to produce lower summer streamflows.
- Warmer summers will increase evaporation and contribute to reduced water availability despite more precipitation in some places.
- Seasonal changes projected to continue, with shifts from more snowmelt-dominated toward rainfall-dominated regimes.



SWE max	1986-2005 Baseline (mm)	2031-2050 (% change) RCP 8.5
North Flowing		
Athabasca	97.0	-11.8
Peace	128.2	-17.8
Liard	181.6	-8.1
Great Slave	106.9	-3.7
Great Bear	129.7	-0.2
Lower Mackenzie	134.7	0.4
Peel	162.8	0.1
Yukon	238.7	-3.0
West Flowing		
Fraser	239.6	-28.9
Upper Columbia	215.9	-23.8
Okanagan	187.2	-33.1
Stikine	459.0	-17.1
Skeena	359.9	-27.4
Vancouver Island	57.0	-55.7
East Flowing		
Saskatchewan	61.2	-21.1
Milk	30.0	-28.3

Future Impacts: Surface Water

- Lower surface lake and wetland levels are expected, especially in southern regions toward the end of this century, under higher emission scenarios, due to higher temperatures and increased evaporation.
- However, the magnitude of these decreases will depend on how much future precipitation increases offset increased evaporation.



- Future increases in drought and decreases in surface soil moisture are anticipated during summer in the southern Canadian prairies Columbia, where increased evapotranspiration are projected to be greater than precipitation increases.

Future Prairie Spring Flooding

- Projected increases in winter and spring precipitation – **increased flood risk.**
- Warmer winters and springs: More precipitation falling as rain; more periodic snowmelt events – smaller spring snowpacks and **decreased flood risk.**
- Therefore **uncertain** how projected increases in winter/spring precipitation, higher temperatures and reductions in snow cover will combine to affect the frequency and magnitude of snowmelt-related flooding.
- Projected **higher temperatures** will result in a shift toward **earlier floods** associated with spring snowmelt.
- Projected increases in **extreme precipitation** are expected to increase the potential for future **urban flooding.**

Take Away Messages

- Anticipated changes from anthropogenic climate warming will directly affect the timing and amount of future freshwater supplies, and these may be exacerbated by human management alterations to freshwater systems.
- The impacts are expected to be more prominent toward the end of this century under higher emission scenarios, given the larger associated climate changes.
- Of particular concern are impacts in regions that currently rely on snow and ice melt as freshwater sources, as well as continental interior areas, where increased evapotranspiration from warmer temperatures could reduce future water supplies.
- However, freshwater supplies in all regions of Canada are expected to be affected in one way or another. It is also anticipated that water-related extremes, such as droughts and floods, will intensify these impacts.

Next Steps

- First comprehensive national assessment of changes to freshwater availability.
- Identified past and projected future changes, but mostly directional change with limited information on the magnitude of change.
- There is a need to reduce the uncertainty with respect to future freshwater availability across Canada; including extremes such as floods and droughts.
- In addition, we need to get a better handle on freshwater demand to better understand future freshwater resources.
- Can we identify future “hot spots”; regions that may be particularly vulnerable to future change?
- Need this information to guide potential future adaptation strategies.

Thank You