
# Chapter 4: Water Resources &
# Chapter 5: Ecosystem Services

Government of Canada / Gouvernement du Canada

Canada

# Outline

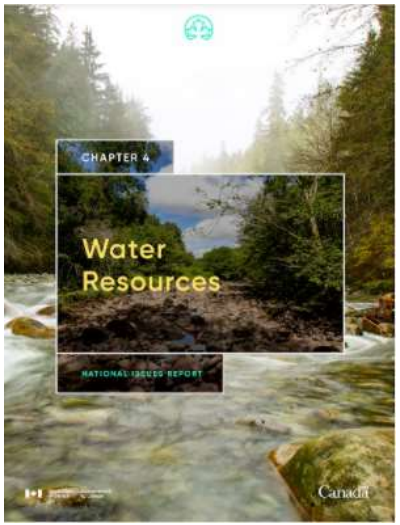
## Water Resources Chapter

1. Introduction to the chapter
2. Key messages
3. Emerging issues and knowledge gaps
4. Q&A

## Ecosystem Services Chapter

5. Introduction to the chapter
6. Key messages
7. Emerging issues and knowledge gaps
8. Q&A

9. What's next in the National Issues Report Winter Webinar Series




# Introduction to the Water Resources chapter

- What and how we are doing on climate change adaptation in the water resources sector in Canada.
- Reviewed material from hundreds of pieces of peer-reviewed and grey literature.
- Some original research based on interviews with water practitioners and a document analysis focused on the prairie provinces.

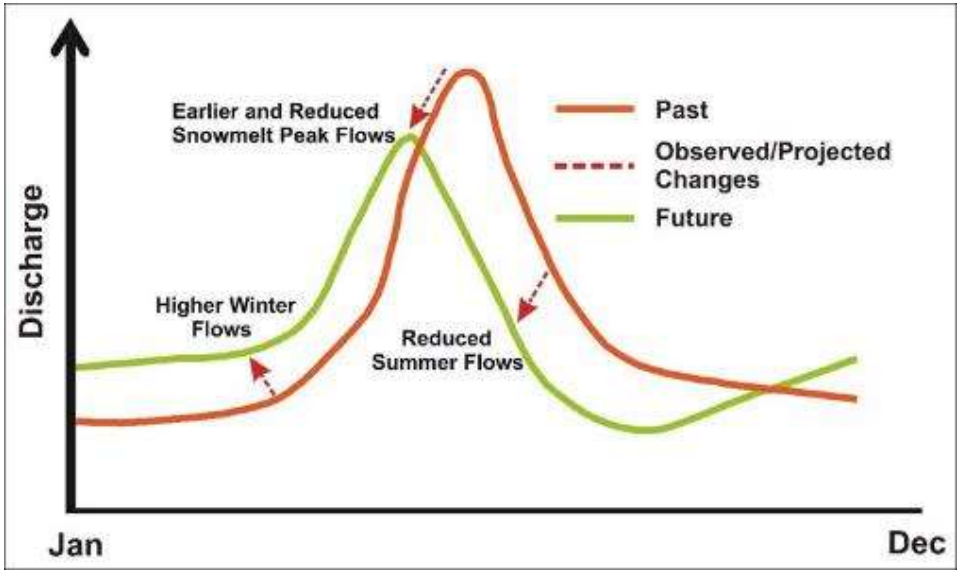
## Key Message #1

# Climate change creates risks for water resources

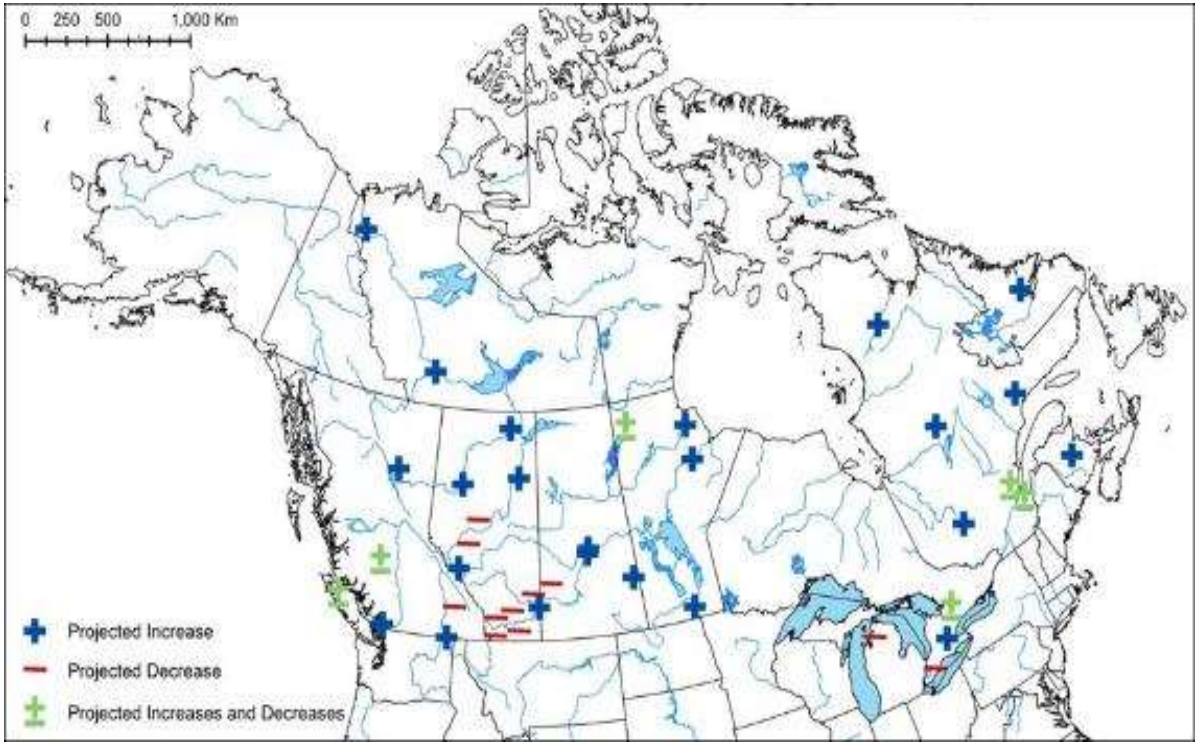
- The seasonal timing of peak streamflow has shifted, driven by **warming temperatures,** occurring earlier, with higher winter and early spring flows (***high confidence***).

- 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***).



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***).



# Streamflow Related Flooding

- Streamflow-related floods result from many factors, and in Canada these mainly include excess precipitation, rapid 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***).

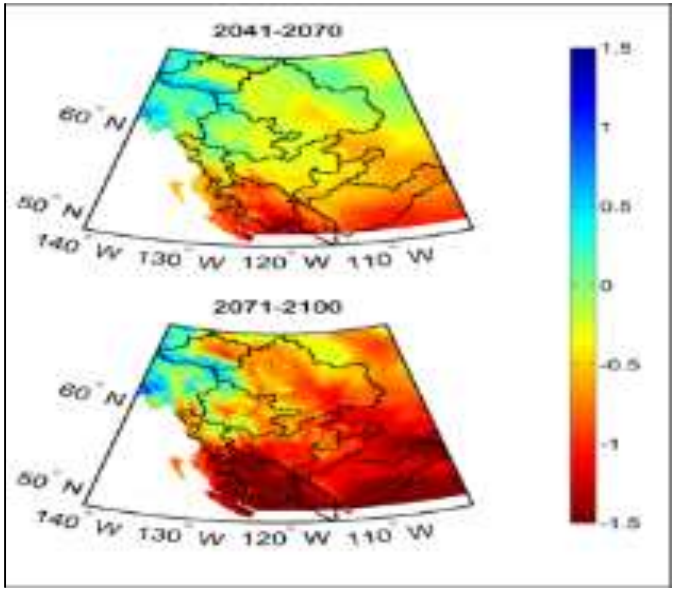
- Projected **higher temperatures** will result in a shift toward earlier floods associated with spring snowmelt, ice jams, and rain-on-snow events (***medium confidence***).

# Soil Moisture and Drought

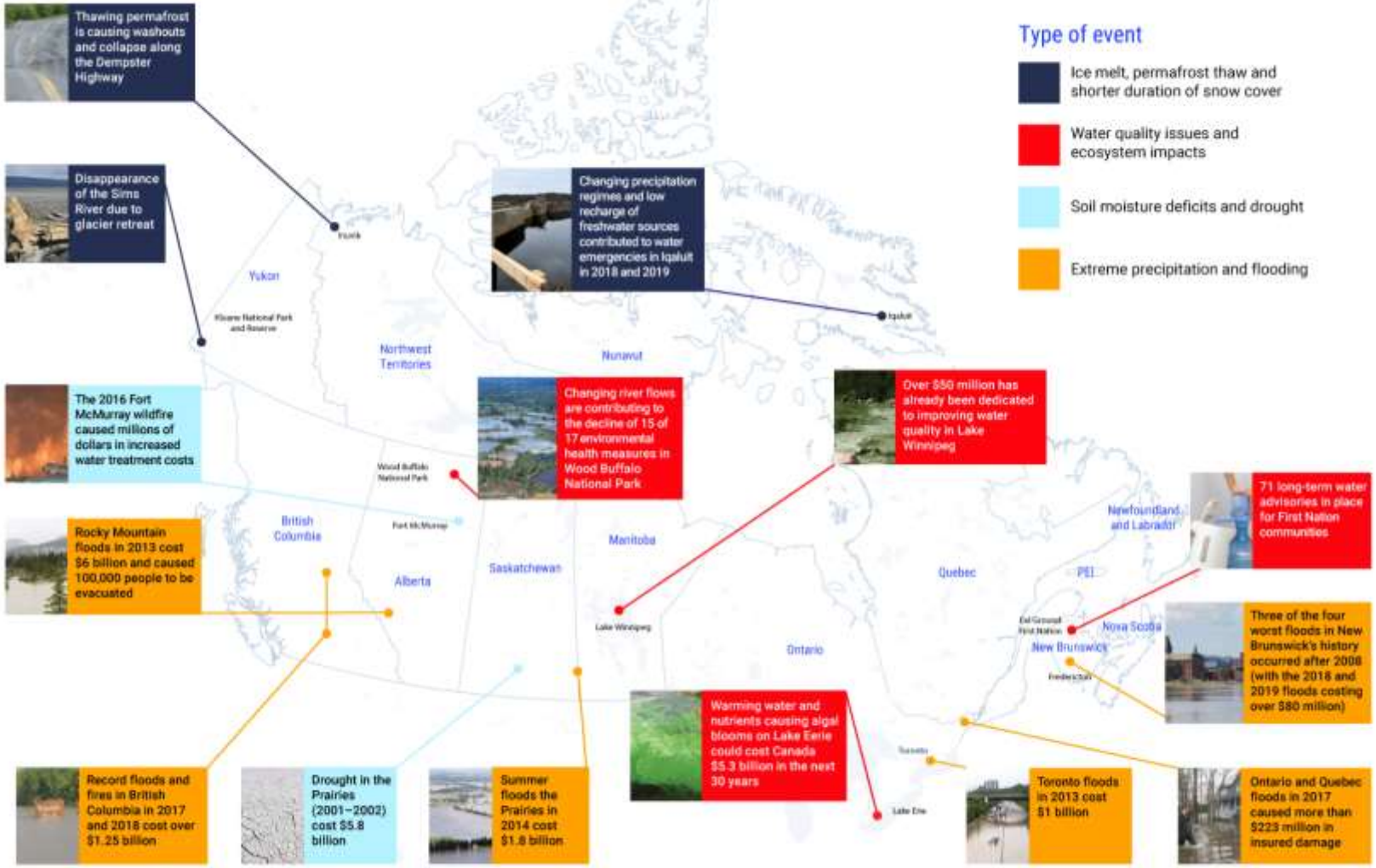
- Periodic droughts have occurred across much of Canada, but no long-term changes are evident.

- 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***).

**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.
No long-term trend; multi-year cycles.

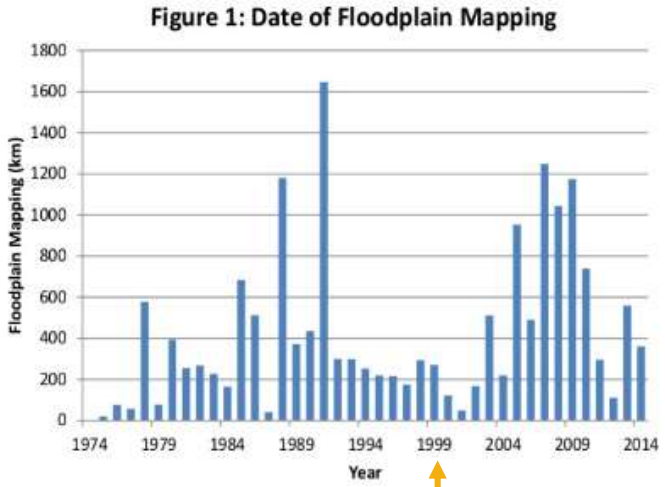

Type of event
Ice melt, permafrost thaw and shorter duration of snow cover
Water quality issues and ecosystem impacts
Soil moisture deficits and drought
Extreme precipitation and flooding
Thawing permafrost is causing washouts and collapse along the Dempster Highway
Disappearance of the Sims River due to glacier retreat
Changing precipitation regimes and low recharge of freshwater sources contributed to water emergencies in Iqaluit in 2018 and 2019
Yukon
Northwest Territories
Nunavut
Manitoba
Saskatchewan
Alberta
British Columbia
Ontario
Quebec
Newfoundland and Labrador
PEI
Nova Scotia
New Brunswick
The 2016 Fort McMurray wildfire caused millions of dollars in increased water treatment costs
Changing river flows are contributing to the decline of 15 of 17 environmental health measures in Wood Buffalo National Park
Over $50 million has already been dedicated to improving water quality in Lake Winnipeg
71 long-term water advisories in place for First Nation communities
Rocky Mountain floods in 2013 cost $6 billion and caused 100,000 people to be evacuated
Three of the four worst floods in New Brunswick's history occurred after 2008 (with the 2018 and 2019 floods costing over $80 million)
Warming water and nutrients causing algal blooms on Lake Erie could cost Canada $5.3 billion in the next 30 years
Record floods and fires in British Columbia in 2017 and 2018 cost over $1.25 billion
Drought in the Prairies (2001–2002) cost $5.8 billion
Summer floods the Prairies in 2014 cost $1.8 billion
Toronto floods in 2013 cost $1 billion
Ontario and Quebec floods in 2017 caused more than $223 million in insured damage

# Key Message #2

## Effective coordination across complex water systems enhances adaptation

### Flood Management and Fragmentation in Canada

- Since the discontinuation of *Flood Damage Reduction Program* in 1999, flood management highlight fragmented and reflects uneven adaptive capacity.
- Recently Federal Government has released Flood Mapping Guidelines Series.
- Still no institutional guidance on how to account for climate change impacts in floodplain mapping.




The National Floodplain Mapping Assessment (2014) found half of existing flood mapping was completed post-FDRP.

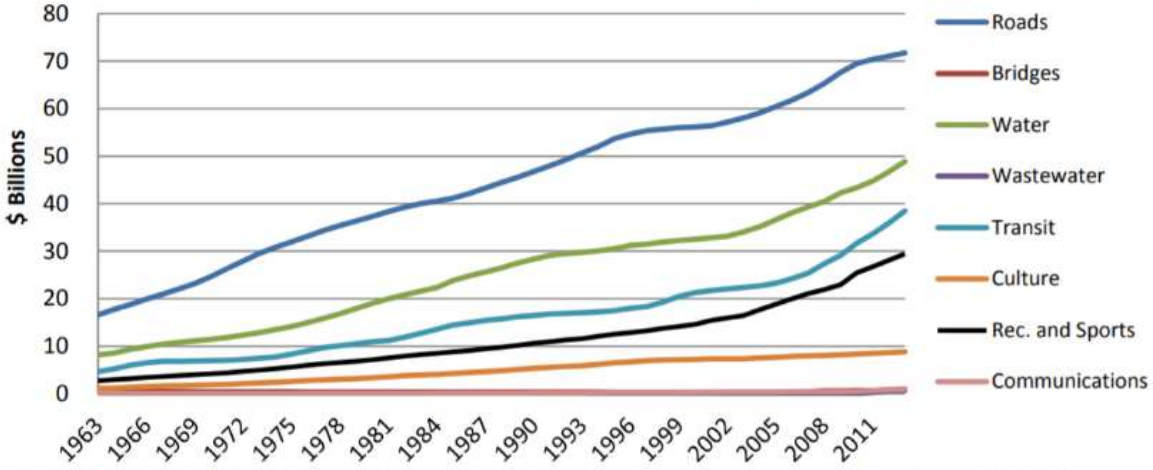
## Uneven Adaptive Capacity

- Perceptions of declining technical skills and resources, employee turnover and burnout, and a lack of stable funding.
- Capacity challenges concentrated in rural, northern and Indigenous communities and non-governmental organizations and municipalities.

IPCC defines adaptive capacity as “the ability of a system to adjust to climate change to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.”

Municipalities are responsible for 60% of public infrastructure across Canada, but <20% have formally introduced adaptation strategies.

**Figure 4: Municipally Owned Core Public Infrastructure Net Stock (Billions, constant $)**




Notes: Net stock using a hyperbolic function for depreciation from general government. Core public infrastructure includes roads, bridges, transit, water, wastewater, culture, and sports and recreation. Communication Infrastructure includes connectivity, broadband, and telecommunications infrastructure. Data for 2013 based on forecast.
Source: Statistics Canada, National Economic Accounts Division.

According to the 2016 Canadian Infrastructure Report Card:

- About 50% of municipalities have undertaken a risk assessment of their water-related assets;
- < 20% have formally introduced adaptation strategies

## Potable Water, Wastewater and Stormwater

- Of our linear assets (e.g., watermains, sewers), 30% are in fair or worse condition.
- Climate change puts an additional strain on these infrastructure systems.

| Asset Category | Subcategory | # And % in Poor/Very Poor Condition | # And % in Fair Condition |
|---|---|---|---|
| Potable Water | Linear Infrastructure | 17,788 km (9.6%) | 32,641 km (17.7%) |
| | Non-linear Infrastructure | 573 Facilities (6.4%) | 1,333 Facilities (15%) |
| Wastewater | Linear Infrastructure | 16,350 km (10.8%) | 26,211 km (17.3%) |
| | Non-linear Infrastructure | 1,386 Facilities (10%) | 2,896 Facilities (20.6%) |
| Stormwater | Linear Infrastructure | 50,251 km (11.3%) | 84,614 km (19%) |
| | Non-linear Infrastructure | 700 Facilities (4.4%) | 1,866 Facilities (11.8%) |

## Adaptive Strategies

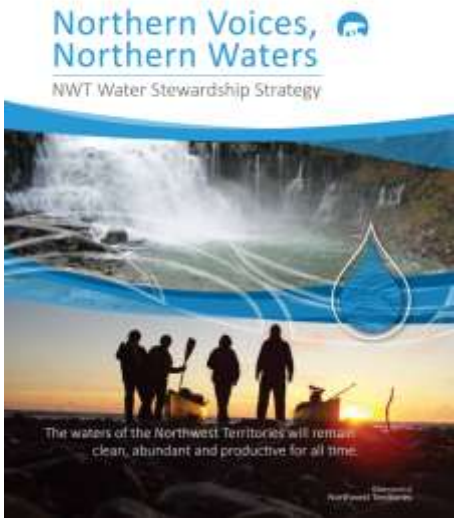
- Partnerships.
- Risk-sharing tools.
- Larger institutions and governments providing support for local adaptation efforts.
- Incorporation of diverse sources of knowledge

Hazard-based (historical event used to estimate probability) v. Risk-based (incorporates exposure and vulnerability)

Thistlethwaite and Henstra (2017) find cities do not always take advantage of all risk-sharing tools available.

e.g. Edmonton, Mississauga, Kitchener and Waterloo charge user fees for storm water management roughly based on the property's contribution to runoff, but Calgary and Toronto do not.

ICLEI Local Governments for Sustainability




Traditional knowledge is "…knowledge and values, which have been acquired through experience, observation, from the land or from spiritual teachings, and handed down from one generation to another" (Government of Northwest Territories Traditional Knowledge Policy: Implementation Framework, p. 1).

# Transboundary and Watershed Organizations


Case 2 explores Lake Simcoe Conservation Authority's role in the climate change adaptation strategy for Lake Simcoe:

- Partners identified vulnerabilities such as the drying of wetlands and spread of aquatic invasive species, using future scenarios of climate and non-climate stressors.
- Now building resilience by promoting natural infrastructure and a new Phosphorous Offsetting Policy.

Case 3 explores notable accomplishment of the International Joint Commission in the Great Lakes:

- Large transboundary integrated assessments such as the Lake Ontario–St. Lawrence River Study (1990–2005) and the International Upper Great Lakes Study (2007–2012).
- The Great Lakes Water Quality Agreement & the Great Lakes Water Quality Protocol of 2012
- A Climate Change Framework (2018).

# Key Message #3

## Adaptation is advancing through innovation and adaptive management

- Adaptive management provides a structured, iterative process of robust decision making in the face of uncertainty, with an aim to reduce uncertainty over time via system monitoring.

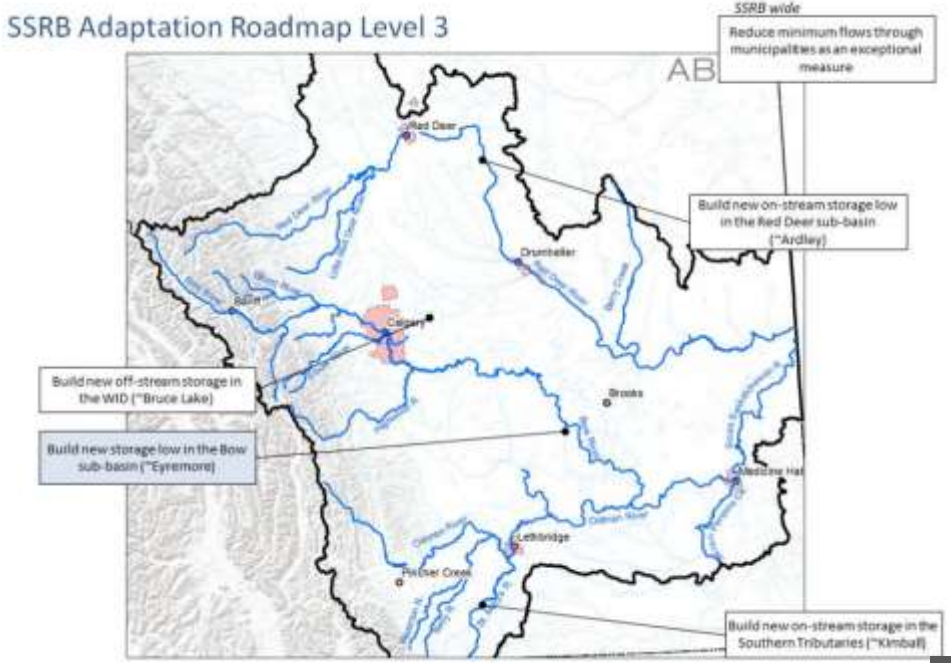

**How are we doing? Variable.**

- Bizikova et al. (2013) find water-related policies in BC, SK, MB, NS don't always include explicit monitoring and review processes, and don't always feed back into policy reviews or adjustments.

- IJC a leader (e.g. The 2012 Great Lakes Water Quality Agreement, Great Lakes – St. Lawrence River Adaptive Management (GLAM) Committee).

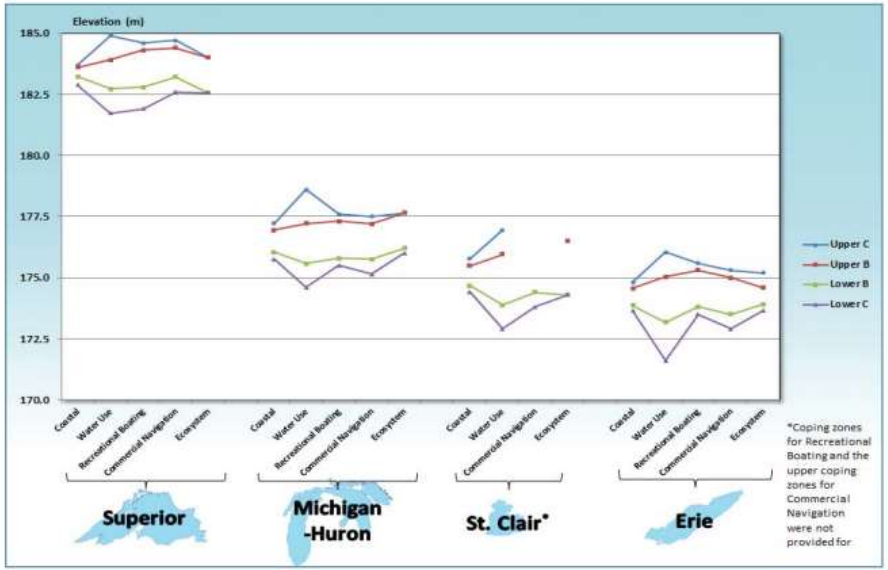
# Scenarios to explore plausible futures and develop robust or “low regret” solutions.

Climate Vulnerability and Sustainable Water Management in the South Saskatchewan River Basin Project (2016)




Shows the adaptation options considered most resilient in the SSRB, with the most promising in blue.

International Upper Great Lakes Study (2007–2012)

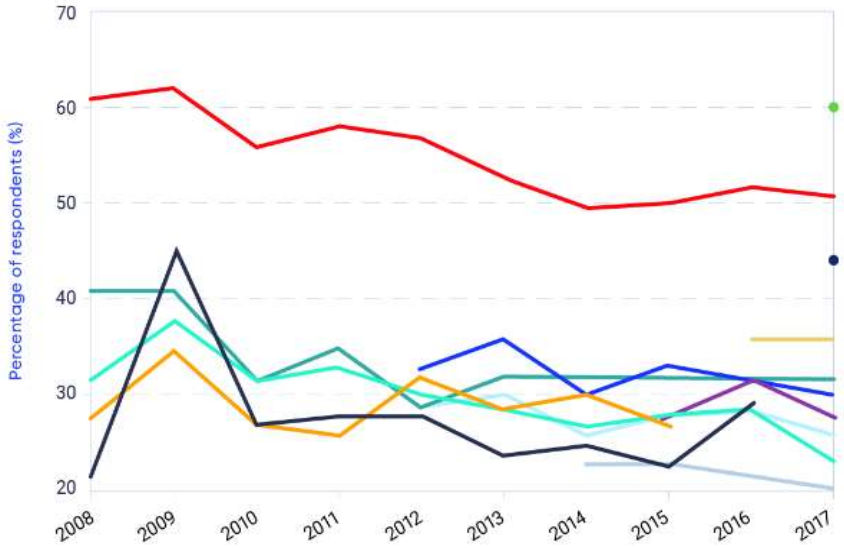



Shows “coping zones” for different water use sectors in the Great Lakes region (Coastal, Water use, Commercial navigation, Recreational boating and Ecosystems)

# Key Message #4

## It is vital to engage the public and build awareness about adaptation opportunities

- Climate change = more extreme storms, flooding and droughts
- Low level of preparedness for extreme events like floods
- Disconnect between practitioner and public perspectives

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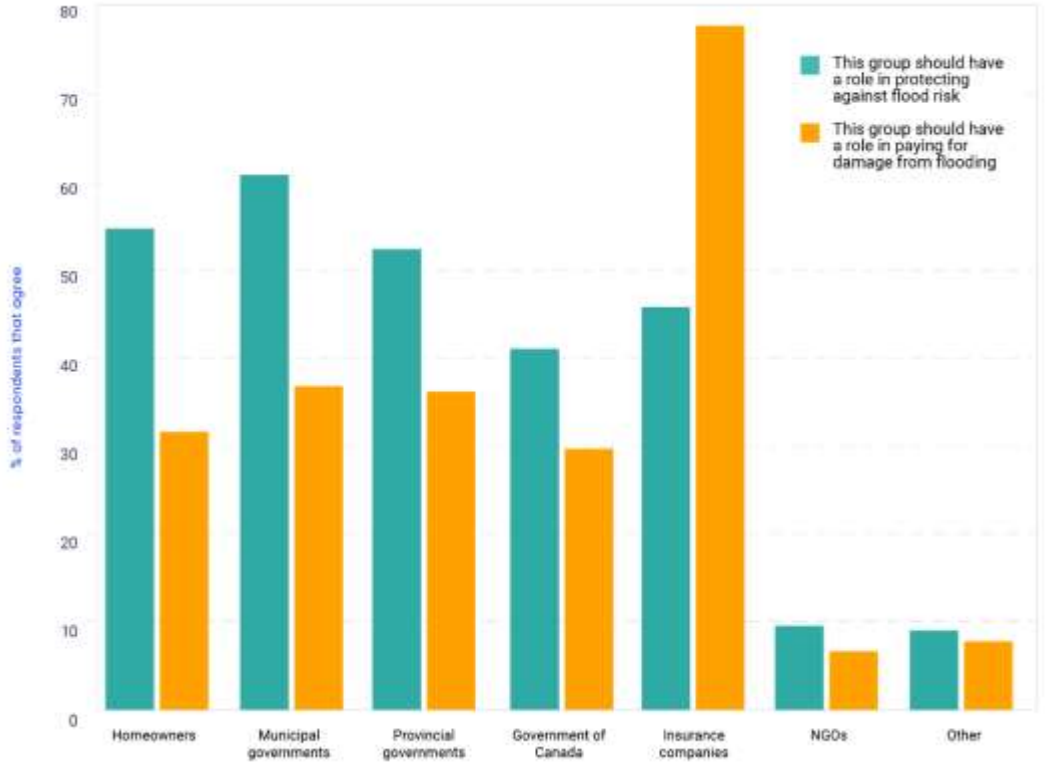
# Overall, Canadians Want Action

- Surveys show strong support overall for action on water-related impacts of climate change.
- Canadians want strong government role, to enforce stricter regulations and require commercial/industrial users to pay the full cost of water supply.
- Support for action can diminish from issue fatigue and politicization of the issues.




The percentage of 2,300 surveyed Canadians who indicated to what extent they believe each group should play a role in protecting against flood risk (green) and paying for flood damages (orange) from Thistlethwaite et al., (2017)

# Building Public Support

- Canadians want info to be relevant and able to be applied.
- Emphasizing co-benefits of action - new framing of problems (e.g. “lower incidence of disease”).
- Early engagement of stakeholders.
- Mainstreaming “water/climate” issues within other policy issues such as urban development.
- Reducing barriers such as time or financial constraints.

Thistlethwaite et al. (2017) found that 92% of survey respondents want publicly available flood risk maps with flood mitigation information, and want access to this information when they are considering home ownership.

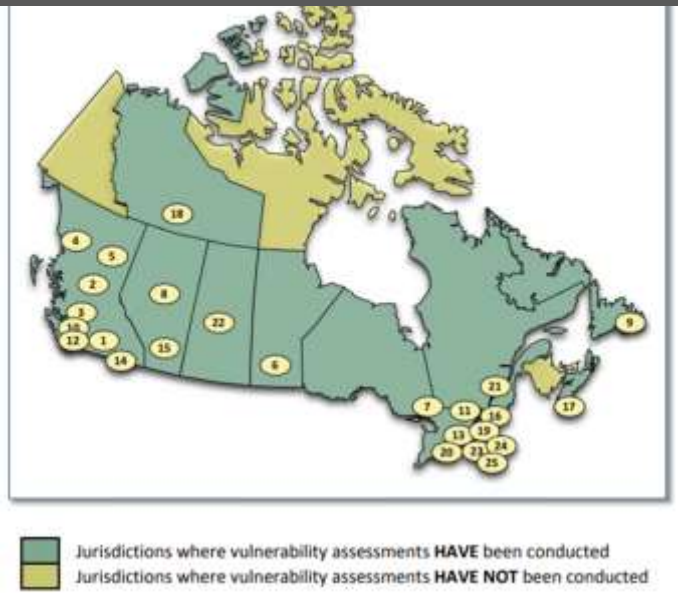
Sherren and Verstraten (2013) found water quality improvements matter more to farmers restoring wetlands in Manitoba, as opposed to climate change.

# Key Message #5

## Water system vulnerability can be reduced through quality data and resilient design

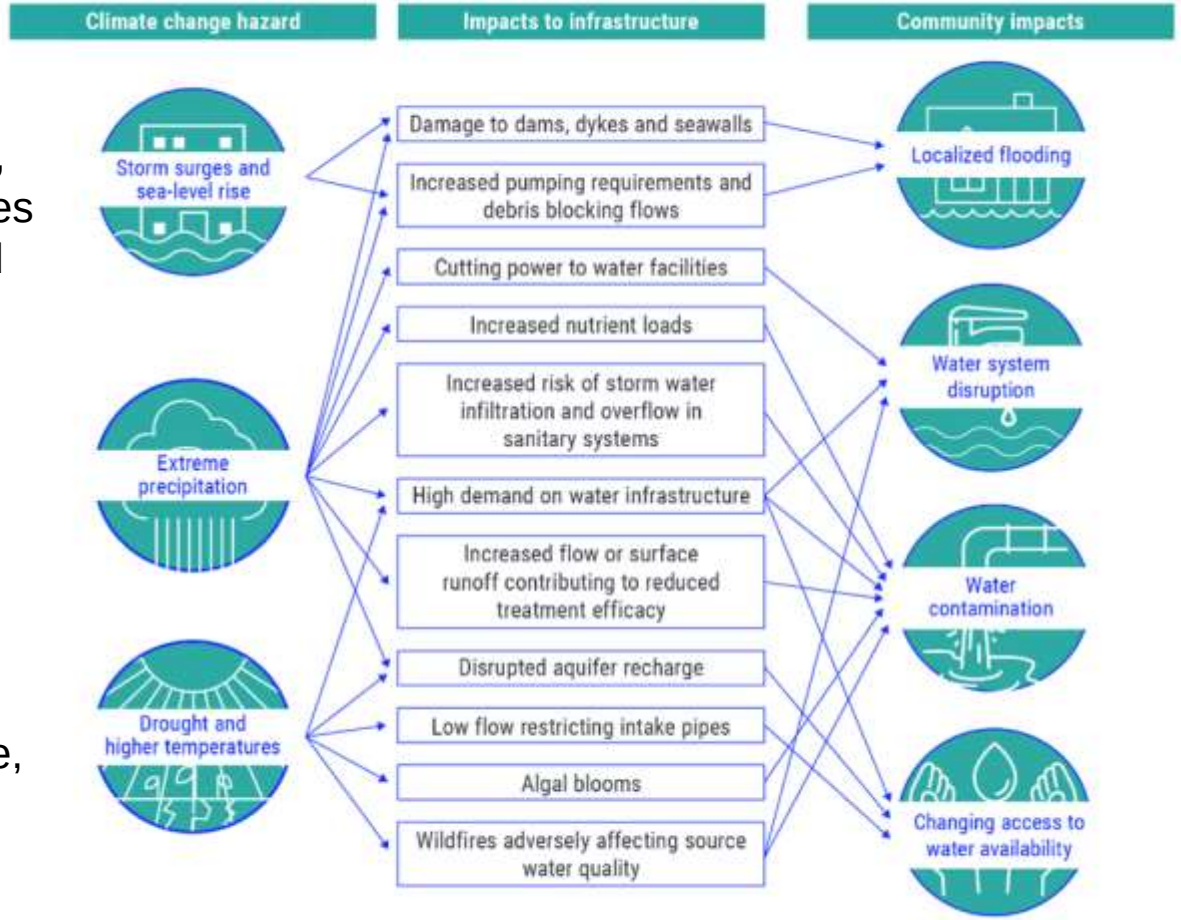
- Technical challenges in identifying a range of climate change impacts.
- High quality, systematic, regularized data collection is not the norm in many parts of Canada.
- Range of info available across organizations – but uneven capacity to provide & data varies significantly in its quality, and temporal and spatial resolution.

Nodelcorp Consulting (2014) synthesized 25 vulnerability assessments across Canada.



# Infrastructure

- Generally, more resilient infrastructure is well-maintained, with reliable and up-to-date codes and standards, and/or may build in redundancies.
- 3 major vulnerabilities:
  1. Assumed stationarity in design and operation;
  2. A tendency to not account for low probability/high impact events;
  3. Costly to maintain, upgrade, and adhere to increasingly stringent regulations.



# Knowledge gaps and research needs

**Information & Knowledge Exchange Gaps**

- Variable data and confusion about what exists and how it can be applied.
- Translating science into practical guidance for decision-making.
- Stakeholder engagement to build shared understanding.
- Increased knowledge mobilization between knowledge producers and users.

**Research Gaps**

- Enhanced monitoring and data collection capacity
- Improved modelling, forecasting and prediction
- Understanding of institutional barriers to adaptation.
- Systematic documentation of successes and failures.

# Question & Answer Period

Climate change creates risks for water resources

Effective coordination across complex water systems enhances adaptation

Adaptation is advancing through innovation and adaptive management

It is vital to engage the public and build awareness about adaptation opportunities

Water system vulnerability can be reduced through quality data and resilient design

# Introduction to the Ecosystem Services chapter

This chapter explores the risks and complex impacts that climate change poses for Canada's ecosystems and the services they provide, as well as opportunities for adapting to climate change.

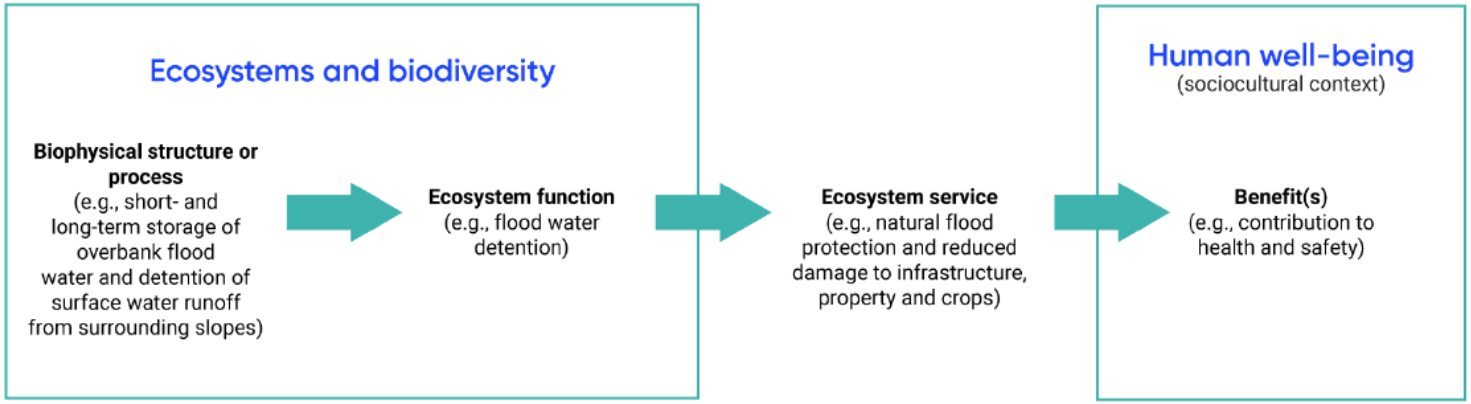



Figure 5.4: The interdependencies of ecosystems, biodiversity, biophysical process, ecosystem function and service, and human well-being. Source: Adapted from de Groot et al., 2010b.

# Ecosystem Services

*First chapter within Canada's national knowledge assessment process to examine ecosystem services and nature-based approaches to adaptation*

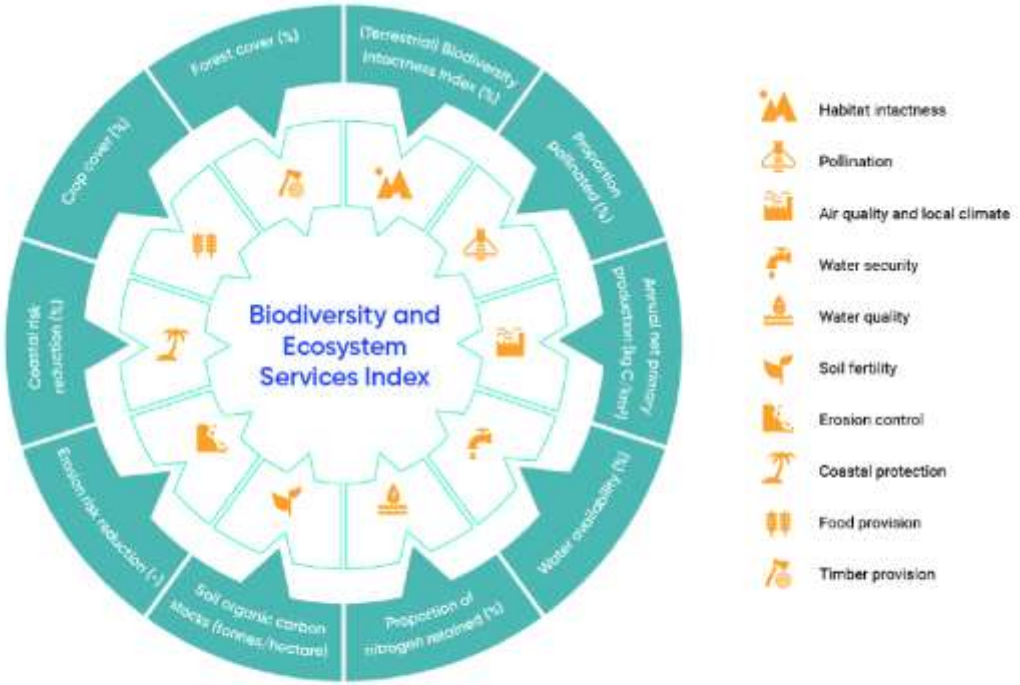



Figure 5.2: Ten categories that are considered within the new Biodiversity and Ecosystem Services Index developed by Swiss Re, which allows for country-wide or regional assessments of the state of biodiversity and ecosystem services. Source: Adapted from Gray, 2020.

# Complexity

- Feedback loops
- Thresholds
- Tipping points

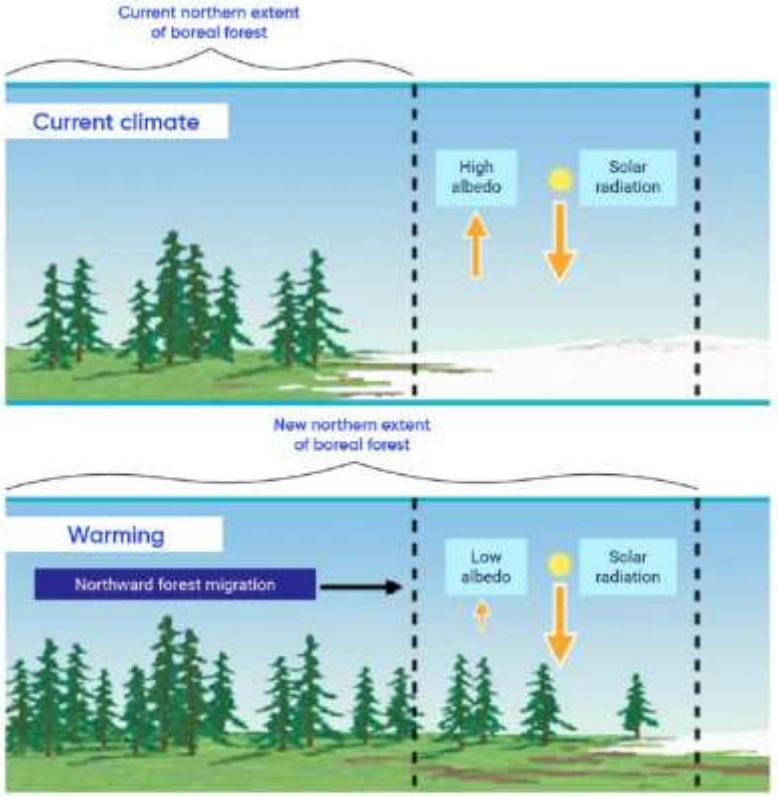



Figure 5.7: Example of a positive feedback loop, whereby the northward advance of forest vegetation due to climate warming reduces land surface albedo, thereby promoting additional warming (a positive climate-ecosystem feedback). Source: Adapted from Kueppers et al., 2007.

## Key Message #1

# Climate change is threatening Canada's ecosystems and the services they provide

- Extreme weather events are increasing
- Shifts in seasonal climate patterns
- Interactions with other pressures

# Changes in Phenology and Ecosystem Services

- Phenology: the cyclic and seasonal patterns of natural phenomena
- Climate change triggers changes in migration, breeding, hibernation, leaf out, and flowering
- Key example: disruptions of plant-pollinator or plant-pest interactions

# Changing Distributions and Ecosystem Services

- Shifts in tree species distributions will impact timber, carbon storage, and wild food
- Poleward migration of freshwater fish changing fishing opportunities
- Range shifts of forest/agricultural pests and disease vectors
- Shrubification of the Arctic and loss of berry production

# Key Message #2

## Impacts will vary across Canada's ecosystems and regions

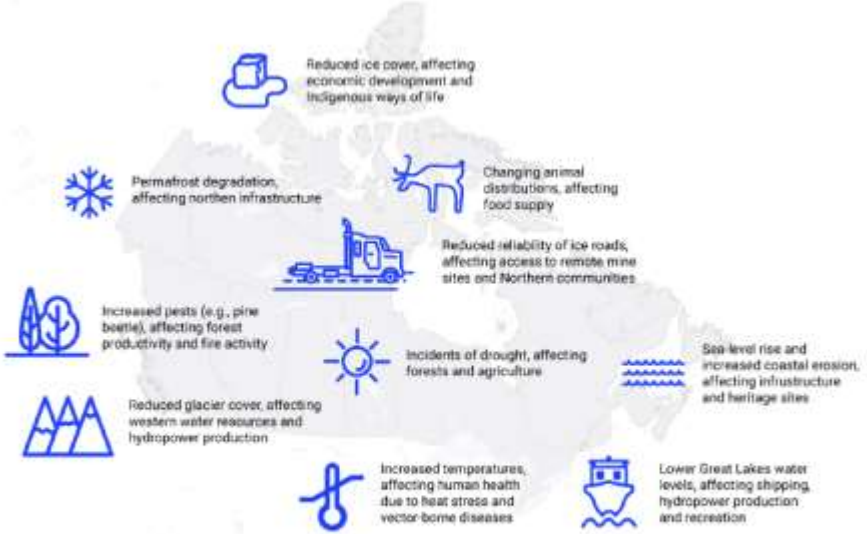
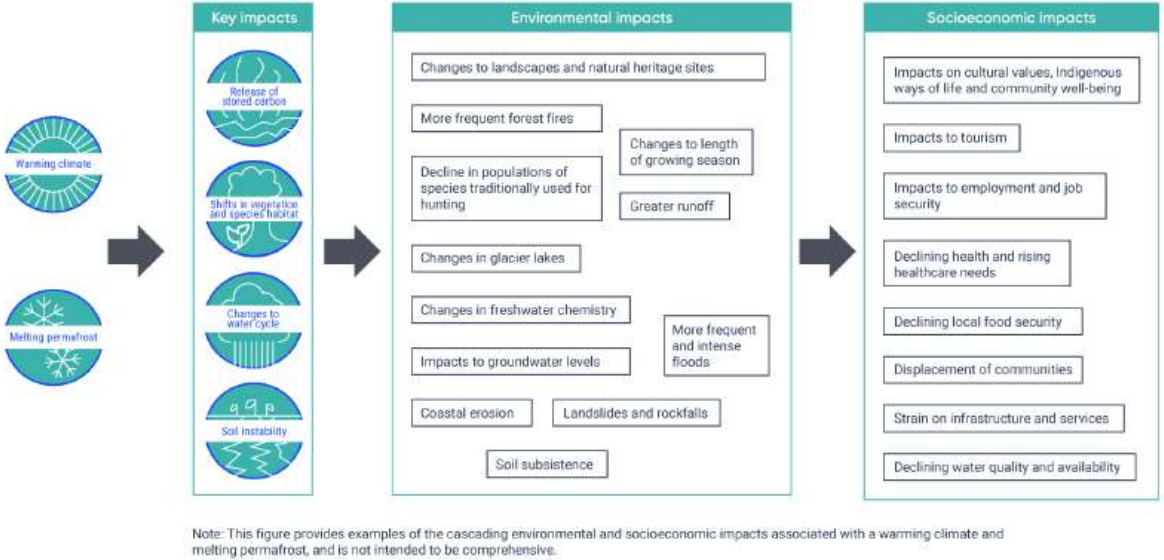



Figure 5.8: Climate change impacts in different regions across Canada, many of which have implications for ecosystems and their services. Source: Adapted from Government of Canada, 2014.

# Impacts to Northern Regions




Note: This figure provides examples of the cascading environmental and socioeconomic impacts associated with a warming climate and melting permafrost, and is not intended to be comprehensive.

Figure 5.9: The effects of climate change on permafrost and their cascading impacts throughout society and environment. Data source: IPCC, 2019b.

# Impacts to Mountain Regions

- Loss of glaciers and snow cover increasing risk of rock falls and mudslides
- Alpine plants especially vulnerable to climate change
- Changes to mountain forests could impact flood control, and water runoff/quality
- Complex impacts on recreation

# Impacts to Forested Regions

- Increased risk of wildfires and droughts with impacts on water quality
- Potential of mega-fires to alter forests, carbon storage, timber supply and recreation
- Increased impacts of forest pests on forest ecosystem services

# Impacts to Coastal Regions

- Loss of coastal ecosystems from sea-level rise
- Changes to ocean-water properties and impacts on fisheries
- Sea ice loss affecting travel and food provision

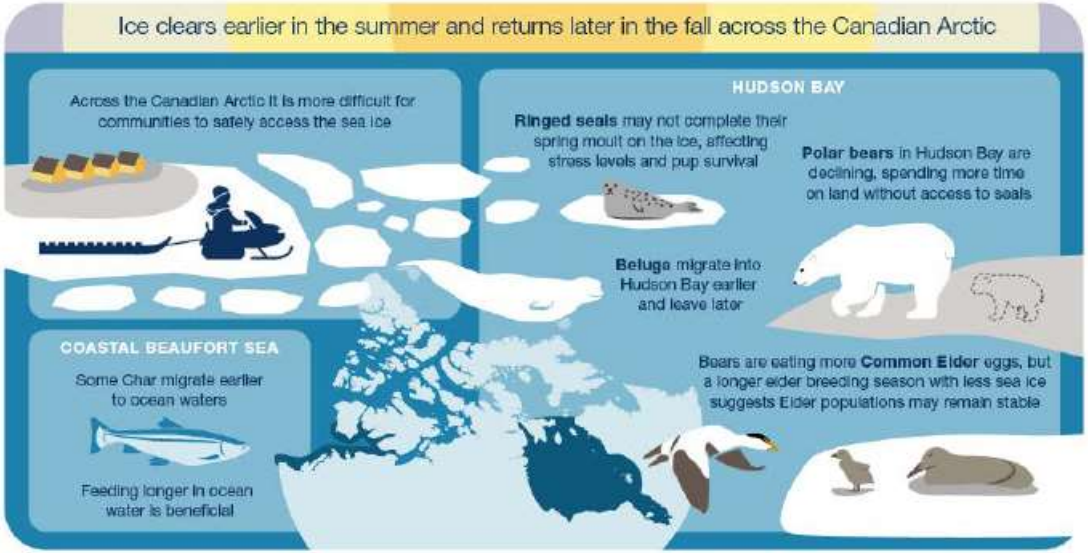



Figure 5.11: Impacts of changes in sea ice on species used for food or other purposes (subsistence species). Source: Department of Fisheries and Oceans Canada, 2019.

# Enhancing Adaptive Capacity

- Diversifying sources of livelihood and economic support
- Increased capacity to sustainably manage key ecosystems
- Assessing vulnerability to ecosystem service change
- Learning from Indigenous Knowledge

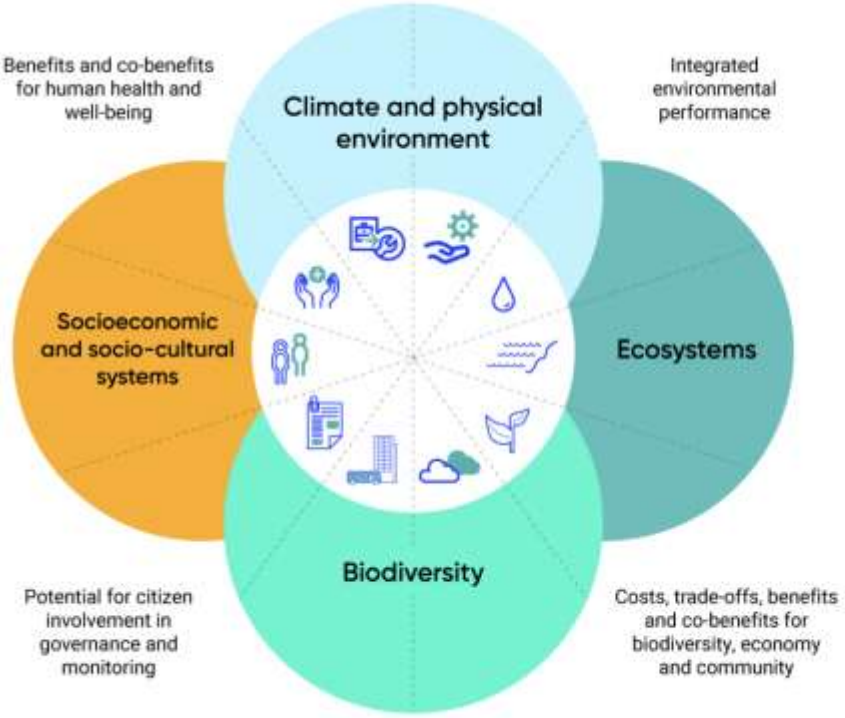
## Key Message #3

# Indigenous Knowledge is vital to maintaining ecosystems

Figure 5.12: An Elder from Wekweètì teaches a younger member of the community to scrape and tan Caribou hides. Hides are soaked and stretched over a board before being scraped with a k'edze, a tool made from a Caribou's lower leg bone. Photo courtesy of Vanita Zoe.

# Key Message #4

## Nature-based approaches to adaptation maximize benefits




Legend

- Water management
- Air quality
- GHG emissions reduction and climate change adaptation
- Coastal resilience
- Green space management
- Urban regeneration
- Participatory planning and governance
- Social justice and social cohesion
- Public health and well-being
- Economic opportunities and green jobs

# Co-benefits: Urban Forests

- Air and Water quality
- Social and Economic benefits
- Physical and Mental Health
- Urban Heat Island Effect

Photo by Enrique Amaya on Unsplash

# Natural vs. Engineered Infrastructure

**Table 5.3:** Examples of water-related municipal services that can be provided by natural assets and ecosystem services

| MUNICIPAL WATER SERVICES | ECOSYSTEM SERVICE | NATURAL ASSET | ENGINEERED REPLACEMENT |
|---|---|---|---|
| Drinking water supply | Aquifer recharge | Aquifer and source water area | Pipes for bringing in water supply, water treatment plant |
| | Lake recharge | Lake watershed | |
| | River headwaters | Headwater lands | |
| Drinking water treatment | Water purification | Wetlands, forests, vegetation | Water treatment plant |
| | Water filtration | | |
| Stormwater Management | Rainwater absorption | Wetlands, forests, vegetation | Stormwater pipes, culverts, storm drains, stormwater ponds |
| | Rainwater filtration | | Water treatment plant |
| Flood Mitigation | Rainwater absorption | Wetlands, forests, vegetation | Dams, retaining walls, embankments |

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# Natural Infrastructure: Greenshores

Figure 5.17: Photographs of the New Brighton Park Shoreline Habitat Restoration Project in Vancouver, B.C. prior to the project starting and in 2018, when the project was completed. Photos courtesy of the Vancouver Fraser Port Authority.

- Reduces impact of storm surges, erosion, sea level rise
- 2.5:1 social return on investment
- Recommended growth via:
  - Community incentives
  - Targeted outreach to engineers/contractors
  - Strengthening links to tools and leading organizations

# Nature-based approaches

- **Funding criteria** to be inclusive of nature and associated co-benefits
- Training support to build capacity, financial support for **collaboration across sectors**
- Inclusion of natural assets in **formal accounting systems**
- Nature-based approaches as part of Canada's forthcoming **National Adaptation Strategy**

# Emerging issues and knowledge gaps

## Knowledge gaps

- Climate change impacts to ecosystems and their services
- Data and support structures

## Emerging Issues

- Valuation of nature-based approaches
- Improved integration of Indigenous Knowledge
- Broadening collaboration

# Question & Answer Period

Climate change is threatening Canada's ecosystems and the services they provide

Impacts will vary across Canada's ecosystems and regions

Indigenous Knowledge is vital to maintaining ecosystems

Nature-based approaches to adaptation maximize benefits

# Upcoming National Issues Report Webinars

## Costs and Benefits of Climate Change Impacts and Adaptation

Friday, February 18, 2022
12:00 – 1:00 pm (EST)

# Thank-you

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