



# **Review of Climate Change Adaptation in the Canadian North**

Identifying common themes, actions, and opportunities to  
improve access to adaptation knowledge

## Impressum

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# Review of Climate Change Adaptation

## in the Canadian North

Canada's North is changing rapidly. It is unique in terms of its relatively strong representation of indigenous people and variety of landscapes. This creates a unique context for climate change adaptation, both in terms of urgency (change is happening now!) and interconnectedness with other socio-economic factors. To help understand common themes, gaps, and climate change adaptation needs, Northern Climate ExChange conducted a review of academic and non-academic papers, presentations, websites, and reports. This review was funded by Crown-Indigenous Relations and Northern Affairs Canada.

We searched for documents that speak to climate change adaptation either in specific northern regions of Canada, or more general in a significant part to the North. Over 300 records were compiled in a database and analyzed for common themes, adaptation enablers and barriers, project types, and geographical distribution. In addition, online knowledge brokering platforms were reviewed and analyzed for their effectiveness.

Our search for adaptation literature spanned the three territories as well as the northern parts of

provinces. We found a relatively equal distribution of adaptation projects across the three territories while the representation of the northern parts of the provinces is more variable.

Important topics across northern Canada are changes to ecology, primarily in response to permafrost thaw, sea ice loss, and climate related disturbances such as insect infestation and wildfire. Climate change impacts game, fish, and berries that are hunted and harvested as part of traditional cultural practices. Safety while travelling on the land is another dominant pan-northern theme. Both are important components of food security to people in the North, where there is a strong reliance on land-based food.

Web-based knowledge platforms are an increasingly important tool in climate change adaptation. To deliver a successful product, developers must understand users and their needs are, build relationships, and organize the platform intuitively. This ensures the presented information is relevant, easy to navigate, and understandable to the end user.





# Common Themes

## across Northern Canada

Climate change adaptation in northern Canada is based in its culturally specific context. Indigenous livelihood and lifestyles are threatened by a changing environment. In the past, Indigenous Knowledge (IK) has served indigenous people well in adapting to a dynamic environment. As some IK is lost and environmental changes occur more rapidly and beyond past extend, communities struggle to apply IK successfully. For example, sea ice is becoming increasingly unstable and is exists for shorter time periods than what is known from IK. Today, people find it difficult to evaluate ice conditions based on learning from IK. This poses a hazard for people crossing it to hunt or travel to other communities. New approaches combining IK and other knowledge systems provide a means to reestablish resilience, but are not yet equitably available across the North.

Many species inhabiting the North are adapted to very specific climatic conditions. With climate changing, these species may or may not be able to adapt effectively<sup>i</sup>. This results in a decrease in a variety of key species, which has been observed by researchers as well as local hunters and gatherers<sup>ii</sup>. As a result, some game, fish, and berries, which are important traditional food sources, are now threatened to diminish. Difficulties obtaining traditional food and general concern over witnessing a changing landscape affects the mental and physical health of Canada's indigenous people.

25% of records discuss food security as an issue. It is defined as the time “when all people at all times have enough access to affordable, nutritious, safe, and culturally appropriate foods”<sup>iii</sup>.

Traditional food plays an important role in providing adequate nutrition, as well as in the execution of traditional activities such as hunting and harvesting. Therefore, food security ties in with the mental and physical health of people. Communities tackle the problem by creating community greenhouses and food storage, sustainable management of their lands, and monitoring ice conditions to improve safety during hunting<sup>iv</sup>. These proactive measures focus directly on solving northern problems. Governance was

covered by 32% of records and is an important piece in adaptation work, as measures are most successful with local communities in charge. Additionally, technology, such as online tools that are specifically catered to the needs of northerners, has been found to be a successful enabler to adaptation. To improve the safety of sea ice travel, the SIKU tool was created. It provides information about the current conditions of sea ice and presents information that is directly applicable to the life of Inuit people<sup>v</sup>.

# Yukon

## Common Themes

Yukon has recognized that it will be affected by climate change through increased air temperatures, changes in precipitation, more extreme events such as storms, flooding, and fires, changes in species distribution, melting of glaciers and sea ice, thawing permafrost, and altered water quality. Impacts on Yukoners are a decreased access to country food and ability for traditional activities, compromised infrastructure, air pollution due to wildland fires, and decreased water quality<sup>vi</sup>. The Yukon Territory is represented by a total of 59 records. The five most common topics are traditional practices (26 records), ecology (17 records), food security (16 records), and governance and hunting and harvesting, each with 10 records. The data base shows gaps in the topics air pollution, conservation, infrastructure, fires, flooding, and water quality.

The fly-in community of Old Crow in Northern Yukon has the strongest representation with 9 records. This is the main community of the Vuntut Gwitchin First Nation (VGFN). Here, there are historical effect from flooding of the Porcupine River and erosion along its banks, as well as from permafrost thaw. Permafrost thaw in Crow Flats is impacting game and fish populations and is making access to traditional hunting grounds more difficult<sup>vii</sup>. To discuss possibilities for food security, youth were conducting interviews with elders. Options such as a community freezer, traditional ways to store food, as well as gardening and farming as a community, and healthy ways to include market foods were evaluated. To prepare for risks arising from mass wasting, flooding, and permafrost, hazard maps were created.



Haines Junction in Yukon's South has the second highest representation with 8 records. There is a long legacy of research in this location due to the proximity to Kluane National Park and Reserve, and the presence of longstanding research stations nearby. Studies in the area have documented a need to expand monitoring to enhance the understanding of ecosystem changes. This can help to improve planning for forest, wildlife, and water management. Whitehorse, as Yukon's capital contains most of the territory's population. However, the city is only represented by four records. Smaller hubs such as Faro, and Tagish are not covered at all.



# Northwest Territories

## Common Themes

A total of 74 records were identified for NWT. Across the NWT, traditional practices (40 records), governance (30 records), food security (26 records), policy (24 records), and hunting and harvesting (22 records) have received the most attention. Records found in the Northwest Territories are strongly focused on the community of Ulukhaktok (16 records), followed by Aklavik (14 records). Residents of Ulukhaktok are exposed to increasing risk during subsistence hunting due to more variable and less predictable weather. A higher frequency of strong winds and storms make travel on the land more dangerous<sup>viii</sup>. The risk of being out on the land further increases through the erosion of traditional knowledge and land skills among youth<sup>ix</sup>. The availability of wildlife has been affected as well. A decline in the populations of ringed seals and caribou have been observed<sup>viii</sup>. The community of Aklavik is facing similar climate change impacts. Both communities issued action plans that relate adaptation strategies to each identified issue arising from

climate change. To increase safety on the land, the communities plan to organize camps to teach traditional land-based skills, as well as offer training on skills such as reading weather forecast, GPS, sea ice map reading, and emergency communication devices. Search and rescue training and capacity is planned to be expanded. To adapt to the decline in hunted species, the communities want to improve the tracking of species, expand to new hunting grounds, consider hunting other species, and consider a community freezer to store meat for longer periods of time. Ulukhaktok and Aklavik have populations of a view hundred people. Population centres with larger populations (several thousands) such as Yellowknife (5 records), Hay River (4 records), Fort Smith (4 records), and Fort Simpson (2 records) each have five records or less. However, each community has at least one mention. There appears to be a stronger focus on smaller communities in NWTs far North.

According to the literature, fires are an important issue. However, this topic was only the focus of one record<sup>x</sup>. A climate change induced increase in lightning activity is projected, leading to an increase in fires. Another important issue is water quality, which was only covered in two records for the NWT. Increased precipitation, water temperature, and permafrost melt lead to an increase in turbidity, algae growth, and contaminants. This can cause issues with the filtration of wastewater, require larger amounts of chlorine to clean water, increase leachate of solid waste, and alter water quality<sup>xi</sup>.



# Nunavut

## Common Themes

Out of 59 records related to climate change adaptation in Nunavut, traditional practices is the top theme with 27 records, followed by food security (19 records), hunting and harvesting (17 records), governance (16 records), and sea ice (14 records). Nunavut shows a strong focus on the communities Iqaluit and Igloolik; each was the focus of 14 records. Conditions of sea ice and the resulting ability to hunt and conduct traditional activities are important topics in these two communities, as well as in Nunavut in general. Climate change is causing decreased spatial and temporal extent of sea ice cover, as well as ice thickness. Igloolik residents report a delay in the seal hunting period, altered travel routes, unstable floe edge

and hampered access to some hunting grounds. Increased ice floe break-off events can leave people stranded. Inuit Qaujimajatuqangit (IQ; Inuit traditional knowledge) is seen as an enabler to climate change adaptation and can help with risk management, risk sharing, and resource use flexibility<sup>xii</sup>. IQ is transferred between generations of Inuit by experiencing time on the land and observing elders and experienced hunters. However, school, employment in the wage sector and limited financial resources restrict the amount of time available to spend on the land. Furthermore, as IQ and skills are lost, intergenerational transfer of these skills is reduced.



# Ontario

## Common Themes

Northern Ontario is represented by a total of 15 records. Ecology, foods security, hunting and harvesting, and traditional activities were each mentioned five times, while cumulative effects were mentioned four times. Most projects were conducted on a provincial or regional scale, so community-specific numbers do not apply. Many residents practice hunting for subsistence purposes<sup>xiii</sup>. However, changes in both the

abundance and distribution of plant and animal species have led to reduced access to important traditional food sources<sup>xiv</sup> and ice conditions have changed, reducing access to traditional foods and increasing costs associated with access. Additionally, hunters are exposed to greater risk<sup>xv</sup>. The number of ice related search and rescue incidents in northern Ontario is increasing as the climate warms<sup>xiv</sup>.



# Québec

## Common Themes

Northern Québec is represented by a total of 15 records, with the top five themes being food security and hunting and harvesting with 7 records each, traditional practices with 6 records, and sea ice and wildlife 3 records each. The largest number of records can be found in Kuujuaq and Kangisualujuaq, which each have 4 records. Due to the generally low number of records, many communities are not specifically covered. Most records look at Northern Québec on a larger scale and don't focus as much on particular communities. Communities in Northern Québec are observing shorter and warmer winters<sup>xvi</sup>. On the coastline of Québec, permafrost degradation leads to erosion and formation of new wetlands. Slumping, erosion and landslides present

challenges to existing infrastructure<sup>xvii</sup>. Permafrost degradation further results in changes in the ecosystem, affecting animals and plants traditionally hunted and gathered<sup>xviii</sup>. Nunavik and northern Québec contain important trail networks which connect communities and serve to support traditional practices such as hunting, fishing and trapping<sup>xvi</sup>. Thinning of sea ice due to climate change is affecting the safety of people travelling on it<sup>ii</sup>. While indigenous people have used traditional knowledge to adapt to changing climatic conditions, the intensity of current changes present challenges to this system<sup>xvi</sup>. Reduced opportunities for safe travel make it difficult for indigenous people to visit other communities, access the land, and hunt<sup>xix</sup>.





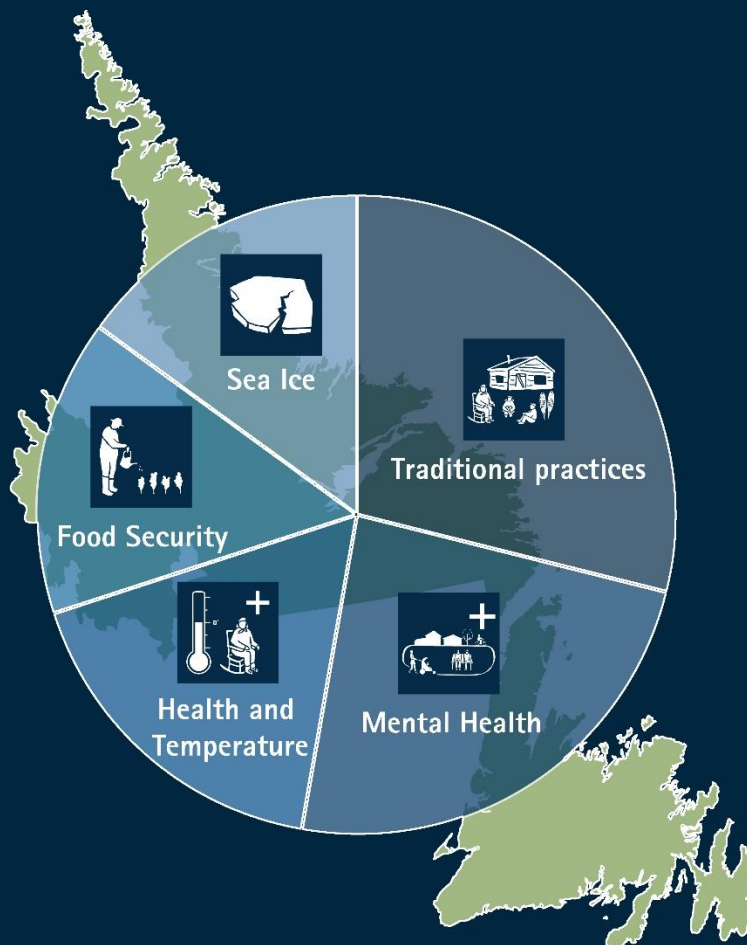
# Newfoundland and Labrador

## Common Themes

Out of 24 records, 12 speak about traditional practices, ten about mental health, seven about health and temperature, and six about each food security and sea ice. Traditional practices like hunting, fishing, trapping, foraging and living on the land are important to the culture of the people of Labrador, identity, and spirituality. However, the ability to execute traditional practices is highly dependent on snow and ice cover for large portions of the year<sup>xx</sup>. Climate change is reducing the time period and amount of snow cover, reducing the ability to access the land. Rapid weather changes and unpredictable environmental variation can hinder land-based activities like hunting, fishing, foraging, trapping and traveling to field camps<sup>xxi</sup>. For the people of Labrador, traditional practices and skills are strongly linked to mental and physical health, and well-being of community members. Food and water security are issues faced by many households and communities in Labrador. Changes to wildlife patterns and abundance can reduce

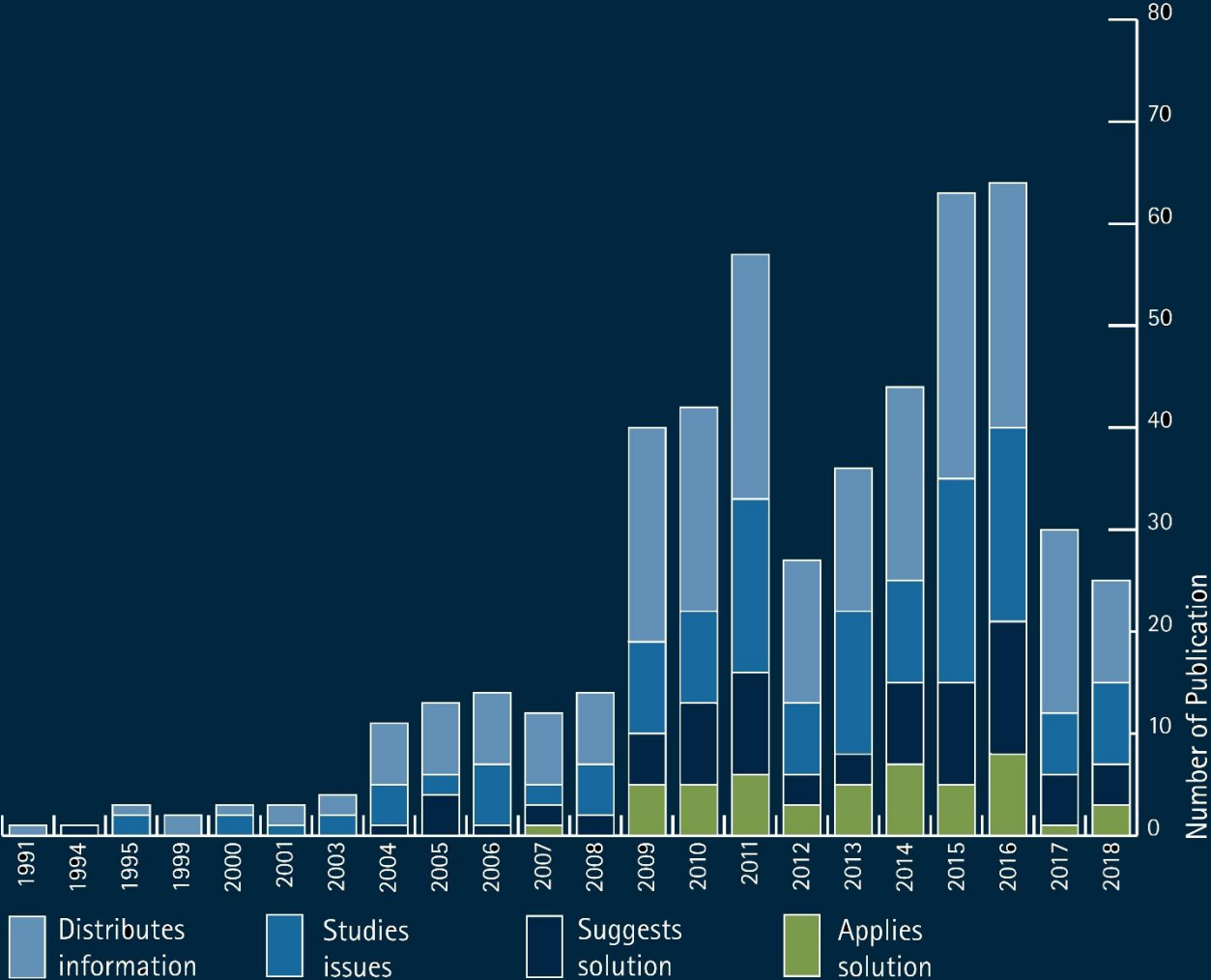
community member's food security if they are unable to obtain enough country food. There is a big focus on the town of Rigolet, consisting of 305 inhabitants<sup>xxii</sup>. The community is covered by 16 records and followed by Nain, consisting of 1,125 residents<sup>xxiii</sup>, with 11 records. The connection between climate change and mental and physical health appear to be an important topic in the community of Rigolet. Environmental changes impede land-based activities, leading to a disconnect from cultural identity, higher risk of land-based activities and increased food insecurity. Inhabitants of Rigolet report increasing mental health issues, such as anxiety, depression, family stress, drug abuse, amplified previous trauma, and suicidal thoughts<sup>xxv</sup>. Youth suggest scoping for new places to conduct traditional activities that are more safely accessible and adjust the timing to more stable sea ice conditions. It is further suggested to create programs in the community to make the land accessible to youth and teach proper execution of land-based activities<sup>xxiv</sup>.

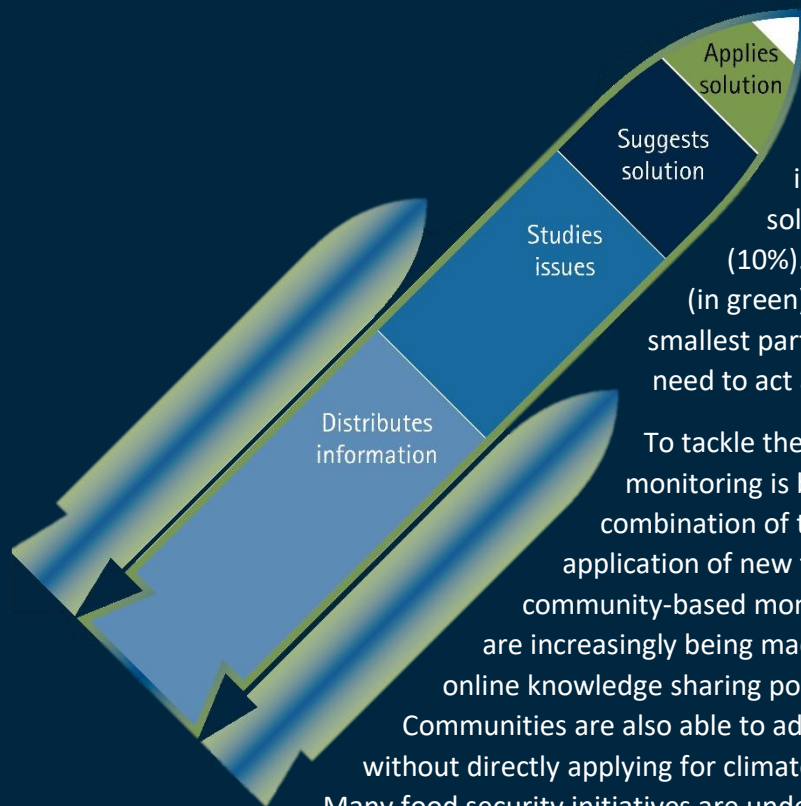
Both Rigolet and Nain have restricted access to drinking water. Residents prefer water gathered from the land, however decreasing water levels have been observed<sup>xxv</sup>. The communities of Hopedale (8 records), Makkovik (3 records), and Postville (2 records) have received some attention. The larger communities of Happy Valley-Goose Bay and Sheshatshiu have only one record, and Labrador City and Wabush have none. Other smaller communities don't contain any entries in our data base. It appears that the communities of Rigolet and Nain have received repeated interest from a few researchers.



# Project Types

Application matters





The types of projects in publications were categorized into four categories: studies issues (28%), distributes information (46%), suggests solutions (16%), and applies solutions (10%). The project type applies solutions (in green) with a total of 10%, makes up the smallest part. For adaptation to happen, we need to act and apply solutions.

To tackle the problem of sparse baseline data, monitoring is being improved through a combination of training to increase local capacity, application of new technologies, and expansion of community-based monitoring programs. The data gained are increasingly being made accessible to locals both through online knowledge sharing portals, and direct collaborations.

Communities are also able to advance many food security initiatives without directly applying for climate change funding, specifically.

Many food security initiatives are underway that are improving resilience, while not being tied directly to climate change.

# Top 10 Recommendations

## for the development of northern climate knowledge brokering platforms

46% of records have the goal to distribute information. To share information successfully, online climate knowledge brokering platforms are being created. These aim to build a connection between researchers, information, and users.

A well build platform can be a useful for climate change adaptation. Therefore, we listed the top 0 recommendation for the development of northern climate knowledge brokering platforms below.

### Organization

**Streamline efficient access to online Canadian climate knowledge.** Canadian platforms should be connected and reorganized to ensure easy and efficient access and comparison of both raw and interpreted climate change data.

**Bridge specialty sources of information.** There are few concrete examples of the successful implementation of climate change adaption. Climate knowledge brokering platforms should be actively working to bridge concrete examples of climate change adaptation to wider climate change resources.

**Expand learning tools.** Platforms should expand interactive learning tools, including tips on how to effectively navigate platforms, the differences between types of resources, and examples of how climate change knowledge can be applied.

**Avoid the creation of project-based portals.** Climate knowledge brokering platforms that rely on project funding are often insufficiently maintained, updated, monitored and evaluated.

## Understanding users

**Identify users.** Platforms should clearly define intended users and continually identify actual users to address gaps between intended and actual users. Information that is tailored to specific audiences has greater usability.

**Produce user-driven climate information.** Platforms should shift from a supply to a user driven climate knowledge production, which will be enabled by a deeper understanding of user needs and preference.

**Prioritize co-production.** Usable climate knowledge requires a shared understanding of what is usable. Knowledge that is co-produced is more likely to fit user needs and specific decision contexts.

## Building relationships

**Focus on local.** Platforms should encourage collaboration and community participation on climate change issues at both a local and regional scale. Climate information that reflects local conditions is perceived to be more credible and useful.

**Prioritize iterative relationships.** Platforms should prioritize building iterative relationships to combat distrust, misunderstanding, and perceived irrelevance. Collaborative processes encourage decision-makers to understand and to prioritize the value of climate change informed decisions.

**Capitalize on in-person opportunities.** Translating climate change information into action can be challenging. Therefore, platforms should capitalize on opportunities to connect decision makers with each other and climate science producers.

# Enablers and Barriers

## to Climate Change Adaptation

These are the top 10 enablers and barriers to climate change in northern Canada. The size of the symbols reflects how often an enabler or barrier was mentioned in the literature. Traditional knowledge has been key for indigenous people in adapting to a changing environment. Adaptation has been shown to be

most successful when it is done in collaboration with and support of the community. The lack of financial resources, particularly for long term adaptation planning, are a major barrier. It is important to build capacity in the North to increase equity and enable locals to be in charge of adapting to climate change.

Enabler	Count
Traditional knowledge	148
Community support	131
Technology	82
Raising of awareness	73
Collaboration	62
Information sharing	59
Education	55
Shared responsibility	49
Flexibility of resource use	43
Training	38

Barrier	Count
Lack of financial resources	58
Inequity	52
Communication challenges	46
Mainstreaming	46
Lack of baseline data	39
Lack of awareness	36
Climate change sceptism	34
Lack of knowledge	34
Lack of long-term adaptations	33
Lack of clear and consistent policy guidelines	31



## References

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- <sup>i</sup> Terry D. Prowse et al., “Implications of Climate Change for Northern Canada: Freshwater, Marine, and Terrestrial Ecosystems,” *Ambio* 38, no. 5 (2009): 282–89.
- <sup>ii</sup> Thora Martina Herrmann, Marie-Jeanne S. Royer, and Rick Cuciurean, “Understanding Subarctic Wildlife in Eastern James Bay under Changing Climatic and Socio-Environmental Conditions: Bringing Together Cree Hunters’ Ecological Knowledge and Scientific Observations,” *Polar Geography* 35, no. 3–4 (September 1, 2012): 245–70, <https://doi.org/10.1080/1088937X.2011.654356>.
- <sup>iii</sup> Kluane First Nation, “Nourishing Our Future: An Adaptive Food Security Strategy to Ensure the Cultural and Physical Well-Being of the Kluane First Nation Against the Impacts of Climate Change in the Yukon,” 2014.
- <sup>iv</sup> Selkirk First Nation, “Adapting to Climate Change and Keeping Our Traditions” (Health Canada, 2016), [https://static1.squarespace.com/static/56afc7218259b53bd8383cb8/t/57ab923e59cc68307527742f/1470861914849/Selkirk+Climate+Change+Adaptation+Plan\\_CommunityReport\\_final%5B2%5D.compressed.pdf](https://static1.squarespace.com/static/56afc7218259b53bd8383cb8/t/57ab923e59cc68307527742f/1470861914849/Selkirk+Climate+Change+Adaptation+Plan_CommunityReport_final%5B2%5D.compressed.pdf); B. Deer, “Assessing the Feasibility of a Small Scale Hydroponic Rotating Garden as an Adaptation Action with Respect to Community Food Security,” *ClimateTelling*, 2015, <http://www.climate-telling.info/quaqtaq.html>.
- <sup>v</sup> The Arctic Eider Society, “SIKU: The Arctic Eider Society’s Google Impact Challenge Project,” accessed July 3, 2019, <http://votesiku.com>.
- <sup>vi</sup> Government of Yukon, “Climate Change and Yukon,” *Climate Change and Yukon*, June 4, 2018, <http://www.env.gov.yk.ca/air-water-waste/climatechange.php>.
- <sup>vii</sup> Roseanne C. Schuster et al., “Importance of Traditional Foods for the Food Security of Two First Nations Communities in the Yukon, Canada,” *International Journal of Circumpolar Health* 70, no. 3 (February 18, 2011): 286–300, <https://doi.org/10.3402/ijch.v70i3.17833>.

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<sup>viii</sup> Tristan Pearce et al., “Inuit Vulnerability and Adaptive Capacity to Climate Change in Ulukhaktok, Northwest Territories, Canada,” *Polar Record* 46, no. 2 (2010): 157–77, <https://doi.org/10.1017/S0032247409008602>.

<sup>ix</sup> Community of Ulukhaktok, “Climate Change Adaptation Action Plan Community of Ulukhaktok, Northwest Territories,” 2011.

<sup>x</sup> Bob Kochtubajda et al., *Lightning and Fires in the Northwest Territories and Responses to Future Climate Change*, vol. 59, 2006, <https://doi.org/10.14430/arctic343>.

<sup>xi</sup> L. Nesbitt, “Protocol to Assess the Vulnerability of Northern Water and Waste Water Systems to Climate Change Impacts.” (Ecology North, 2010).

<sup>xii</sup> Gita J. Laidler et al., “Travelling and Hunting in a Changing Arctic: Assessing Inuit Vulnerability to Sea Ice Change in Igloodik, Nunavut,” *Climatic Change* 94, no. 3 (June 1, 2009): 363–97, <https://doi.org/10.1007/s10584-008-9512-z>.

<sup>xiii</sup> Allard, Michel, and Nancy Beaulieu. *The Impact of Climate Change on an Emerging Coastline Affected by Discontinuous Permafrost: Manitousuk Strait, Northern Quebec*. Vol. 40, 2003. <https://doi.org/10.1139/e03-056>.

<sup>xiv</sup> Y. Hori, “The Use of Traditional Environmental Knowledge to Assess the Impact of Climate Change on Subsistence Fishing in the James Bay Region, Ontario, Canada” (University of Waterloo, 2010).

<sup>xv</sup> Benita Tam et al., *The Impact of Climate Change on the Well-Being and Lifestyle of a First Nation Community in the Western James Bay Region*, vol. 57, 2013, <https://doi.org/10.1111/j.1541-0064.2013.12033.x>.

<sup>xvi</sup> C. Furgal and Martin Tremblay, “Climate Change in Northern Quebec and Nunavik: Access to Resources,” 2008.

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<sup>xvii</sup> Government of Quebec, “2013-2020 Government Strategy for Climate Change Adaptation” (Government of Quebec, 2012).

<sup>xviii</sup> Michel Allard and Nancy Beaulieu, *The Impact of Climate Change on an Emerging Coastline Affected by Discontinuous Permafrost: Manitousuk Strait, Northern Quebec*, vol. 40, 2003, <https://doi.org/10.1139/e03-056>.

<sup>xix</sup> A. Lewis, “Real-Time Monitoring for Travel Safety and Food Security in Salluit, Nunavik,” *ClimateTelling*, 2011, <http://www.climate telling.info/salluit.html>.

<sup>xx</sup> Ashlee Cunsolo Willox et al., “Climate Change and Mental Health: An Exploratory Case Study from Rigolet, Nunatsiavut, Canada,” *Climatic Change* 121, no. 2 (November 1, 2013): 255–70, <https://doi.org/10.1007/s10584-013-0875-4>.

<sup>xxi</sup> Ashlee Cunsolo et al., *From This Place and of This Place: Climate Change, Sense of Place, and Health in Nunatsiavut, Canada*, vol. 75, 2012, <https://doi.org/10.1016/j.socscimed.2012.03.043>.

<sup>xxiii</sup> Statistics Canada Government of Canada, “Census Profile, 2016 Census - Newfoundland and Labrador,” February 8, 2017, <https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/details/Page.cfm?Lang=E&Geo1=PR&Code1=10&Geo2=&Code2=&Data=Count&SearchText=Newfoundland%20and%20Labrador&SearchType=Begins&SearchPR=01&B1=All&GeoLevel=PR&GeoCode=10>.

<sup>xxiv</sup> Joanna Petrusek MacDonald et al., *Protective Factors For Mental Health And Well-Being In A Changing Climate: Perspectives From Inuit Youth In Nunatsiavut, Labrador*, vol. 141, 2015, <https://doi.org/10.1016/j.socscimed.2015.07.017>.

<sup>xxv</sup> C. Goldhar, T. Bell, and J. Wolf, “Rethinking Existing Approaches to Water Security in Remote Communities: An Analysis of Two Drinking Water Systems in Nunatsiavut, Labrador, Canada,” *Water Alternatives* 6, no. 3 (2013): 462–86.



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