

# Climate Change Impacts in Northern Canada: Assessing Our Current Knowledge

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## *Summary*

A “state of knowledge” assessment was prepared by the Northern Climate ExChange and partners to determine our current understanding of climate change and its impacts in northern Canada. Information and key references were brought together into one document for reference by northern communities, interested Canadian public, researchers, and policy makers. This assessment will help facilitate the identification of priorities for climate change research, monitoring, technological development, and policy development in Canada’s North. Deliverables from this project also include a database of climate change information sources and a database of northern climate change contacts.

To carry out this assessment, Northern Canada was divided into seventeen natural and human systems (e.g., boreal forest, community health, mining, etc.). A review of scientific, local, and Traditional Knowledge sources relating to climate change was conducted for all systems. The information was then synthesised into a table for each system, with projected environmental changes (i.e., temperature changes) crossed in matrix format with system components. Each cross-relationship (cell) was given a ranking and supporting information included, based on the current state of knowledge of that relationship.

Broad patterns in our state of knowledge were found, and included

- Inequalities in the amount of existing information across systems (i.e., most information on climate change impacts concern physical processes, with less information concerning biological systems, and even less concerning socio-economic systems);
- Greater knowledge and confidence concerning baseline information and predicted changes to temperature than for other climate components (i.e., rain, snow, extreme events);
- Strong regional trends for compiled information (i.e., climate change impacts on physical systems well studied in the Mackenzie Basin and in Alaska; less studied elsewhere);
- Although much local and traditional knowledge exists regarding climate change impacts, relatively little has been documented. Most

documented knowledge has occurred in regions where scientific research has been focussed;

- Greater information for climate change impacts on biological systems with an economic component (i.e., harvested fish species), than for those without.

The results of the assessment are being distributed widely and posted on the Northern Climate ExChange website at [www.taiga.net/nce](http://www.taiga.net/nce). This project was supported by Canada's Climate Change Action Fund.

### *Introduction*

Awareness and concern about climate change and its impacts have grown steadily over the past fifteen years. With climate change considered to be impacting extreme latitudes first and most severely, the need to understand climate change and its impacts in the North has become a growing focus. In response, many climate change research and monitoring projects have been initiated in Canada and elsewhere involving a large number of people from government agencies, universities and non-governmental organisations.

Information already exists regarding climate, climate change and its potential impacts in northern Canada. Much of this knowledge lies with the inhabitants of small and remote communities of northern Canada; the same communities that will likely be the most affected by climate change.

At present, there are limited communication pathways and little coordination amongst and between researchers, communities, First Nations and Inuit. This has limited the exchange of both local and scientific knowledge and has likely caused some overlap in efforts to understand and predict climate change impacts. Moreover, currently there exists a lack of clear direction and consensus about what is already known about climate change and its impacts and where efforts and resources are best focussed. Improved communication, coordination and research focus is needed to predict and respond effectively to climate change in northern Canada.

Together, researchers from the Northern Climate ExChange, Environment Canada, University of Alberta, Ryerson University, GeoNorth Limited and Legend Seekers Anthropological Research worked collaboratively to conduct an assessment of our current understanding of climate change and its impacts in Northern Canada. The objectives of this project were to: 1) determine what is currently known about climate change and its impacts in Northern Canada; 2) use this information to facilitate the identification for research, monitoring, technological and policy priorities; and 3) improve collaboration and coordination amongst and between researchers, communities, First Nations and Inuit.

## *Methods*

We conducted a gap analysis to determine the current state of knowledge of climate change and its impacts in Northern Canada. A gap analysis is a systematic method for identifying the degree to which information exists for a given topic. This involved identifying, accessing, synthesising and organising existing information related to climate and climate change in Northern Canada. Information sources included journal articles, conference proceedings, researcher/expert surveys, research license compendia, the Internet, and experts from governments, universities and communities. Compiled information involved documented scientific, local and Traditional Knowledge, although methods yielded a bias in finding scientifically derived information. Local knowledge regarding climate change and its impacts was collected, organised and analysed in two separate, but related projects.

The information gathered was organised into seventeen natural, economic and community systems represented in Northern Canada. The natural systems were baseline climate data, boreal, freshwater, tundra, coastal, and marine ecosystems. The economic systems were agriculture, fisheries, forestry, mining, tourism and recreation, and hunting and trapping. The community systems were community health, energy development, infrastructure, transportation, and waste management.

For each system, a matrix (table) was designed with components of the system listed as the matrix rows. For example, the "Boreal" matrix included components such as vegetation, distribution, mammals, and carbon and nutrient cycling.

Crossed with the system components, as columns, were general climate change projections. These projections were classified as "Temperature Changes" (i.e., warmer summers), "Precipitation Changes" (i.e., increased or decreased snow or rainfall), and "Other Climate and Indirect Impacts" (i.e., increased cloudiness, increased storm frequency). Also crossed with the system components was a category classified as "Baseline Knowledge."

Information supporting the assessment of the current state of knowledge for each cross-relationship (i.e., the impact of temperature changes on boreal forest distribution; current baseline knowledge of water quality) was entered into the cells of the matrix. Each cell was assigned a ranking of "good," "fair," or "poor" to denote the current state of knowledge of the specific topic/relationship. The ranking was based on the following sets of questions:

1. For baseline information: Does the existing knowledge allow for a solid understanding of this system component?
2. For predicted climate changes: Does the existing knowledge and capacity provide the ability to detect a change in this climate variable and to confidently predict future changes to this climate variable? and

3. For climate change impacts: Both of the above questions were asked and Is the mechanism by which the climate parameter influences the system component understood?

To assist us in answering each of these questions, we asked ourselves a number of more specific questions for each cell, when appropriate:

- Overall, is the existing knowledge applicable across northern Canada?
- Is the existing knowledge mostly current?
- For the most part, does the existing knowledge represent a sufficient period of time to allow for the detection of a trend? And
- Does most of the existing knowledge originate from and agree with a number of sources (i.e., community experts, scientific community, etc.)?

The original question(s) could only be answered “yes” if at least three of the specific questions were answered “yes.” Conversely, the original question(s) could still be answered “no,” even if all of the specific questions were answered “yes.”

The answers to these questions were based upon expert opinions (i.e. personal communications), summary articles (i.e., Canada Country Study), and compiled information (i.e. ,books, journal articles, etc.).

The rankings did not imply judgement about whether a topic area needed further research. These ratings were solely based on the amount and quality of existing information. The rankings also did not indicate whether the predicted impacts of climate change on a system component are likely to be positive or negative.

In some cases, we were unsuccessful in locating any information regarding a system component and/or how it may be impacted by climate change. As a result, it was impossible to determine a ranking on the current state of knowledge for that topic. In such a case, the statement, “No information compiled for this relationship,” was inserted into the cell.

### *Results and Discussion*

Generally speaking, current information concerning northern systems, predicted climate changes and the impacts of those changes on northern systems is poor. However, much information currently exists and the gap analysis revealed a number of general patterns relating to this information. For predicted climate changes, more extensive and accurate baseline information and a more complete understanding of temperatures allows for greater confidence in predicting temperature changes than in predicting changes in other climate variables such precipitation, wind, or extreme events. This, in turn, influences our ability to predict the impacts of these climate changes on northern systems. The impacts of climate change on physical systems, such as

permafrost, are much better understood than the impacts of climate change on biological systems or socio-economic systems. This relates to the complexity of the system, with more complex systems (those influenced by many variables) being more poorly understood (i.e., more uncertainty surrounding wildlife species versus plant species). Furthermore, existing knowledge tends to be more concentrated in economic rather than uneconomic system components (i.e., commercial fishery information versus general fish ecology; little information on invertebrate species). Finally, terrestrial ecosystems have received more research focus than marine or aquatic ecosystems.

This analysis also revealed important spatial dimensions of climate change information and research coverage. For instance, the impact of climate change on physical systems (i.e., permafrost) has received more study in the western Arctic (Alaska, Yukon and Mackenzie Basin) than in the eastern Arctic (Nunavut). Furthermore, climate monitoring and research coverage in northern Canada is sparse and unevenly distributed. Often, to assist in understanding systems and to make impact predictions, information from studies conducted elsewhere, such as in temperate areas, is extrapolated into a northern context. As well, climate information is commonly extrapolated between regional climate stations to assist in making regional climate change predictions.

Local and Traditional Knowledge provides local scale (site specific), detailed, and holistic information and gives a long-term perspective of change, thereby complementing scientific information on climate change, which is often at a broader (regional) scale (i.e., climate data), less integrated (i.e., single species versus ecosystems), and short-term in perspective. Although much local and Traditional Knowledge exists regarding climate change and its impacts on northern systems, relatively little of it has been documented. Most of the documented knowledge has been collected in regions where scientific research has been focussed.

Both long-term and regionally focussed studies on climate change and its impacts on northern systems are lacking. Regionally focussed studies, such as the Mackenzie Basin Impact Study, which use various knowledge sources and integrate systems, are of great value in adding to our understanding of climate change and its impacts in northern Canada. This one study alone provided a disproportionate amount of information for our gap analysis.

The results of this analysis point to the need for more regionally focussed studies that incorporate Traditional, scientific and local knowledge and include focus on socio-economic and biological systems in addition to physical systems. In many instances, uneconomic components of systems need greater focus and more information is needed concerning marine and aquatic ecosystems. Long-term studies are needed to provide better perspectives of directional climate change against the backdrop of natural climate variability and

to provide greater understanding of the long-term effects of climate change on northern systems. More research is required throughout northern Canada, but, in particular, in the eastern Arctic, to provide a greater understanding of the implications of climate changes across the North. Efforts to further document Traditional and local knowledge concerning climate change are needed. Monitoring networks for such physical parameters as climate and hydrology need to be expanded to provide more accurate and site-specific baseline information regarding climate and physical conditions in northern Canada. This will aid in the development of finer-scale, regional circulation models resulting in better predictive capacity of climate change and its impacts in northern areas.

### *Products*

This project has yielded a number of useful products. These products will assist northern communities, the interested Canadian public, researchers, and policy makers in finding both general and specific information regarding climate change in northern Canada, in establishing priorities for further research, and in developing partnerships to improve collaboration and coordination.

Products are in hard copy, CD-ROM, and in searchable Internet format (at [www.taiga.net/nce](http://www.taiga.net/nce)) and include

- An executive report that includes summaries of our current state of climate change knowledge across northern systems and regions;
- A complete set of matrices outlining the current state of knowledge of climate change and its impacts across the 17 northern systems;
- A searchable database containing climate change information sources for Northern Canada; and
- A searchable directory of contacts for climate change information in the Canadian North.

This project was supported by Canada's Climate Change Action Fund.

### *Notes*

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