

**A Northern Assessment of the Impacts of Climate Change:**  
*Defining our Knowledge Base and Research Priorities*

**Workshop Report**



September 20-21, 2000



**Yukon  
College**

**Yukon**  
Government of Yukon



**Canada** 

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## **Executive Summary**

The Northern Climate ExChange, with assistance from an interdisciplinary project team, are mid-way through a project to understand the quantity and quality of information that exists on the impacts of climate change in northern Canada. The project is intended for use by communities, researchers and policy-makers to assist them in developing appropriate actions on this issue. The project is also intended to facilitate the development of priorities for research, policy, and data collection in Northern Canada.

To assist us with this project, a workshop was held in September, 2000 entitled *A Northern Assessment of the Impacts of Climate Change: Defining our Knowledge Base and Research Priorities*. The workshop brought together over 60 individuals including federal, territorial and municipal government representatives, community representatives, practitioners and researchers from across the north to assist with assessing the state of knowledge of climate change impacts on various human and natural systems in northern Canada.

The Project will yield a number of products including:

- A *Gap Analysis* of the state of knowledge (scientific and traditional) of climate change impacts in the Canadian north, including a set of one-page matrices, with its cells colour coded to denote the state of knowledge for all cross-relationships; and reviews of the state of knowledge for each matrix that provides an overview of the existing level of knowledge
- A searchable database of all identified literature on climate change impacts in northern Canada
- A searchable database of climate change experts (scientists and community experts) in northern Canada
- A detailed report describing patterns in our state of knowledge of climate change, and its impacts on the Canadian north
- An organized set of recommendations for research priorities including, monitoring, technological development, management structures, education, etc.
- A summary document describing the process and the main outcomes
- A web version of the above.

This workshop was designed to help the project team in developing final products that are of most use to the intended users. Workshop participants made a number of recommendations to the project team on how to make the above-mentioned products from this project more relevant and accessible to the users of the information. These recommendations, including those listed below, will be incorporated into the final report and information system. Prior to releasing the final report and database, draft products will be made available for review and comment.

- Formalize a way in which new records and information can be added to the system (i.e. add a form on to the website)
- Provide regular updates to communities when new relevant information is available, and provide some means for non-electronic distribution of information
- Formalize a system where communities can look for non-documented sources of information and discuss new issues/current events
- Record case studies of what communities in the north are doing to respond to impacts of climate change
- Provide checklists of climate-related considerations for communities i.e. decision support tools or a resource guide for communities to aid in long-range planning exercises
- Keep track of information needs, and formalize a system to document and distribute
- Expand current NCE mailing list to a discussion list to assist those who are looking for non-documented sources of information, to solicit feedback on current events and significant issues
- List community observations on website based on NCE summer community tour to assist in matching community questions to researchers and to assist communities with similar issues to get in touch with each other
- Provide an opportunity to keep track of questions people have related to climate change that they have not been able to find information on
- Include recommendations for policy mechanisms within the final report
- Include case studies or pilot projects that describe how northern communities that are developing or implementing adaptation strategies
- Include guidance on “what we should be doing” re adaptation and prevention
- Describe the state of knowledge by sub-regions (traditional territory) as well as by natural and human systems
- Provide a list of codes, standards and regulatory processes in place in the north where climate change should be considered (i.e. the Development Assessment Process)
- Provide a list of where we need to regain monitoring capacity and on what
- Identify collaborative research opportunities

This project provides an opportunity for Northerners to learn more about climate change, and to contribute their knowledge so that a regional response to minimizing vulnerability to climate change impacts can be developed. With community involvement in the project, we hope that the evolving needs of northern communities, industries and governments in response to this issue will begin to be addressed. Through ongoing consultation, we hope this project will assist in deriving ‘useful’ approaches to addressing community needs in the future. There is tremendous value in prioritizing research and monitoring needs. Partnerships between communities, industry, and governments are essential to ensure that steps are taken to meet information needs

## **1.0 Introduction and Meeting Objectives**

Aynslie Ogden  
Northern Climate ExChange

### **1.1 Introduction**

The Northern Climate ExChange, with assistance from an interdisciplinary project team, are mid-way through a project to understand the quantity and quality of available information on the impacts of climate change in northern Canada. To assist us with this project, a workshop was held in September, 2000 entitled *A Northern Assessment of the Impacts of Climate Change: Defining our Knowledge Base and Research Priorities*.

The workshop brought together government, community representatives, practitioners and researchers from across the north to assist with assessing the state of knowledge of climate change impacts on various human and natural systems in northern Canada.

Not surprisingly, this was a very challenging workshop, especially when we discussed the development of community-based priorities for climate change research in north. Despite these challenges, workshop participants developed encouraging and forward-looking recommendations that will assist the project team in providing a product from this project that are of greater value to its users.

### **1.2 Project Significance**

As many northerners are aware, concern has been growing during the last few decades that increasing concentrations of greenhouse gases in the atmosphere will change our climate in ways that may be detrimental to our environmental, social and economic systems. There is a wealth of information to demonstrate that the global climate has warmed during the past 150 years. Temperature increase has not been constant, but has consisted of warming and cooling cycles at intervals of several decades. The long-term trend is one of net global warming with the ten warmest years since 1880 all having occurred in the 1980s or 1990s. Corresponding with this warming, many environmental changes have been observed across northern Canada - alpine glaciers have been retreating, permafrost has thawed, sea levels have risen, arctic ice has been thinning, and climatic zones have been shifting. However, it is important to note that observations on climate and environmental change differ across the Canadian north.

A changing climate will affect many components of the northern environment. Northern regions are predicted to receive the earliest and most extreme impacts as a result of a changing climate. Scenarios of climate change, based on experimental results of General Circulation Models of the atmosphere for a doubling of atmospheric carbon dioxide, suggest that this region could warm up by 5°C by the middle of the 21st century. These changes will affect the northern economy, wildlife, traditional cultures and recreational activities.

Stakeholders will need to respond to the effects of climate change on water and land resources. These responses will be influenced by the political, lifestyle and economic choices made by government officials, community residents and industry leaders in response to these changes (Stewart Cohen, 1997). The availability and accessibility of information upon which decisions are made will also influence responses.

This project is designed to determine the amount and type of information that exists on climate change impacts. The project is intended for use by communities, researchers and policy-makers to assist them in developing appropriate actions on this issue. The project is also intended to facilitate the development of priorities for research, policy, and data collection in Northern Canada.

Northern communities must be involved in the process of developing research priorities for reasons including those listed below:

- Community participation in research and decision making is essential to long term resource, environmental and cultural sustainability in the North;
- An integrated, community-based, northern approach to addressing the challenges posed by climate change, that complements other climate change initiatives, will make best use of limited resources;
- It is in the best interest of Northerners to be well-prepared to address the possible impacts of climate change and reduce the vulnerability of our environmental, economic and social systems to those impacts; and
- To put in place milestones for action and to monitor progress.

This project provides an opportunity for Northerners to learn more about climate change, and to contribute their knowledge so that a regional response to minimizing vulnerability to climate change impacts can be developed. With community involvement in the project, we hope that the evolving needs of northern communities, industries and governments in response to this issue will begin to be addressed. Through ongoing consultation, we hope this project will assist in deriving 'useful' approaches to addressing community needs in the future.

### **1.3 Project Description**

This workshop focused on a project that is currently underway at the Northern Climate ExChange - *A Northern Assessment of the Impacts of Climate Change*. This project involves a broad analysis of the current state of documented knowledge (both scientific and traditional) of the impacts of climate change in Canada's north. This exercise is designed to provide researchers, communities, and policy-makers with sound baseline information on what is known about climate change and its effects on northern Canada. The assessment is intended to facilitate the establishment of priorities for climate change research, monitoring, technological development, policy development, etc. in Canada's north. This project will also assist those faced with developing strategies to adapt to a changing climate and are in need of information to assist them with this task.

The Project will yield a number of products including:

- A *Gap Analysis* of the state of knowledge (scientific and traditional) of climate change impacts in the Canadian north, including a set of one-page matrices, with its cells colour coded to denote the state of knowledge for all cross-relationships; and reviews of the state of knowledge for each matrix that provides an overview of the existing level of knowledge
- A searchable database of all identified literature on climate change impacts in northern Canada
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- A detailed report describing patterns in our state of knowledge of climate change, and its impacts on the Canadian north
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#### **1.4 Workshop Objectives**

The objectives of the workshop were as follows:

- Review and assess our current state of knowledge of climate change impacts on various components of northern natural and human-oriented systems;
- Develop priorities for action in the north on climate change that may include research, monitoring, technological development, management structures and education.
- Discuss product format and delivery, with the goal of creating a user-friendly, “living” document that is relevant and accessible to researchers, policy-makers, and community representatives.

#### **1.5 Project Partners**

The Northern Climate ExChange would like to extend gratitude to the agencies and individuals whose contributions have made this project possible.

The project team consists of representatives from a number of agencies including:

- Environment Canada
- University of Alberta
- Ryerson Polytechnical University
- Legend Seekers Anthropological Research
- Geonorth Consulting

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This project is funded by:

- Government of Canada (Climate Change Action Fund)
- Environment Canada – Canadian Wildlife Service (regional office)
- Government of Yukon
- Yukon College
- The Northern Research Institute

A special thank you is also given to our workshop facilitator, Doug Urquhart, of Quill Consulting, and to the over 60 participants at the workshop.

## 2.0 Project Terminology

A considerable amount of terminology will be used in this workshop report. To assist readers when reviewing this report, below are definitions of some of the key terms.

**Climate Change** - Climate Change is the change in climate over a time period that ranges from decades to centuries. The term refers to both natural and human-induced changes and includes changes in long-term temperature and precipitation patterns, and changes in return intervals and magnitude of extreme events.

**Greenhouse Effect** – A number of minor gases in the atmosphere, although relatively transparent to sunlight, absorb most of the infrared heat energy transmitted by the Earth towards space. This phenomenon has been called the "greenhouse effect" and the absorbing gases that cause it "greenhouse gases". Important greenhouse gases include water vapour, carbon dioxide, methane, nitrous oxide, ozone, and halocarbons.

**Impacts** - Changes in regional climate patterns may have positive and negative effects on human and natural systems in northern Canada. These effects are termed "impacts".

**Adaptation** – Undertaking efforts to adapt to the adverse impacts of climate change. Reducing vulnerability of natural and human systems to the adverse effects of climate change.

**Gap Analysis** – A systematic evaluation method for identifying the degree to which information exists for a given topic. In simple terms, a way to find out how complete our knowledge is regarding a certain topic to determine what information exists and what doesn't exist.

**Matrices** – A tool used in carrying out a gap analysis, and is essentially a way of organizing information into table format.

**Database** – Also referred to as an information system. A system for storing and retrieving information.

**State of Knowledge** - A summary of the amount and type of information available on a given subject.

## **3.0 Presentation Summaries**

### **3.1 Gap Analysis: An Assessment of Information Documenting the Impacts of Climate Change on Northern Canada**

**Anne Munier, Aynslie Ogden - Northern Climate ExChange**  
**Mike Gill, Joan Eamer – Environment Canada, Canadian Wildlife Service**

#### ***Background***

The concept of human induced climate change was first highlighted in the 1970's. However, this issue did not receive international attention until the late 1980's. Increasing public awareness forced governments to provide greater resources to research and policy initiatives.

In the past decade, the level of research effort towards understanding, preventing and mitigating climate change impacts has greatly increased. An overall vision of where efforts and resources should be allocated has been absent. This is evident by a number of initiatives with overlapping efforts.

Small and remote communities characterize Northern Canada. These communities are expected to face considerable challenges associated with climate and environmental change. A considerable amount of knowledge regarding climate change lies in these communities. However, communication pathways between researchers, communities, First Nations, governments and industry are limited. This has limited the exchange of both local and scientific knowledge.

The objective of the gap analysis is to provide an overall broad-scale analysis of our state of knowledge of climate change impacts on human and natural systems across Northern Canada. By identifying sources of information regarding climate change and its impacts on Northern Canada, the database produced by this project will also improve accessibility of all types of knowledge to communities, researchers, policy makers and governments.

#### ***Methodology***

The project involved the identification, access, synthesis and organization of information sources that deal with the impacts of climate change on Northern Canada. Information sources reviewed included journal articles, conference proceedings, research license compendiums, databases, and consultation with local experts and researchers. Information collected includes documented scientific, local and traditional knowledge. The collection and assessment of the state of local and traditional knowledge was undertaken with assistance of consultants Legend Seekers (Yukon) and Geonorth (Eastern Arctic including Northwest Territories and Nunavut).

Data sources were organized into seventeen matrices:

- Baseline Data (1)
- Physical Systems (5) – Boreal Forest/Taiga, Tundra, Freshwater, Coast and Marine
- Human Systems (11) – Agriculture, Community Health, Energy, Fisheries, Forestry, Hunting, Infrastructure, Mining, Tourism/Recreation, Transportation, and Waste Management

Climate change projections were compiled based on general circulation models:

- Baseline Data Temperature
- Precipitation
- Temperature
- Other (extreme events, wind, atmospheric carbon dioxide concentrations, etc.)

For each of the systems, a table (matrix) was constructed that lists climate change projections on the horizontal axis, and system components on the vertical axis. The state of knowledge (good, fair, poor) was determined for each relationship of system component and climate change projection.

### ***Preliminary Findings***

To date, only a preliminary assessment of the state of knowledge has been completed as members of the project team are preparing objective ranking criteria to assist in our evaluation. However, a number of trends have been observed in our analysis of information that is available on the impacts of climate change in northern Canada. These trends include:

- The state of knowledge of the impacts of climate change has important regional dimensions (i.e. the impacts of climate change on physical systems of the Mackenzie Basin + Alaska are well studied but poorly studied in the rest of the North)
- There is fairly good information on the impacts of climate change on physical processes (such as permafrost); fair information for biological systems (i.e. community ecology) and less information for socio-economic systems (i.e. especially impacts on community health, and traditional pursuits)
- There tends to be much more information for biological systems that have a strong economic component (i.e. commercial fisheries as opposed to general fisheries ecology, commercial forestry as opposed to basic forest ecology)
- The baseline climate data that exists for temperature is generally better than for precipitation or extreme weather events; this trend is reflected in our state of knowledge of the various climate change impacts on a system (i.e. better state of knowledge of the impacts of warmer temperatures on ecosystem distribution than there is for the impacts of precipitation changes to that same ecosystem)

- Baseline climate data provides reasonable regional coverage but very little site specific coverage
- There is great uncertainty about the impacts of climate change on complex systems (i.e. system components that are influenced by many factors other than climate - such as wildlife and water quality)
- There is somewhat of a clearer understanding of the impacts of climate change on simpler systems such as impacts on vegetation (terrestrial not aquatic) and physical processes (i.e. permafrost, forest fires, etc.)
- Uncertainty exists concerning the impacts of climate change on the ranges of species, both plants and animals
- Little is known about invertebrates (both baseline data and impacts of climate change)
- Little is known about the impacts of climate change on tourism in the north, and there is a poor understanding of the mechanisms that influence tourist activity
- The level between good and poor in these matrices is relative. In the big scheme of things, one could say that our information is poor for all of these systems as there is much more that we need to know to be able to achieve certainty concerning the impacts that climate change is having on these systems

### **3.2 A Preliminary Assessment of the State of Documented Traditional and Local Knowledge of Climate Change in North-Eastern Canada**

**Natasha Thorpe, Dyanna Riedlinger, Shari Fox**  
**Geonorth Consultants Ltd.**

Preliminary findings of the availability of documented traditional knowledge on climate change impacts in the Eastern Arctic, including Nunavut, Northwest Territories and the Hudson Bay Region (Northern Manitoba, Ontario, Quebec and Labrador) were presented by Geonorth Consultants.

#### ***Methods***

To locate sources of traditional and local knowledge, internet web searches, libraries, email requests to experts were searched for sources of published and unpublished information on climate change impacts. Sources included journal articles, reports, theses, conference proceedings and video productions. Both academic and community sources of information are included in the traditional knowledge database.

#### ***Preliminary Findings***

To date, 60 document sources of traditional knowledge were found. This relatively low number reflects the following:

- Recent interest in climate change issue (1980's)
- Recent empowerment of community members through the validation of the their knowledge through the land claims process
- Increase in available funds to document local knowledge
- Most sources are community-researcher collaborations
- Difficult and costly to locate sources that are nested or embedded in other works (archives, community offices, etc.)

To date, for levels of analysis were undertaken to identify gaps, strengths and weaknesses in information sources – where (region), how (format), content, and keywords. Information will also be assessed for continuity, duration, regional extent, and type of information.

The greatest number of information sources pertain to the Western Arctic, Mackenzie Basin, Central and Eastern Arctic, and not specific to a region. There was less information found for the northern provinces and Labrador. However, this assessment may be misleading due to disparate geographical scales and populations of the various regions considered by this study.

The format of the information found is strong in books, reports, and journals, and relatively weak in video, maps, raw data, brochures, etc. This raises an interesting finding in that the format of traditional sources of information are more accessible to researchers and academics, and fewer information sources are available in the format more readily accessible by communities.

Keywords were used to describe the information contained in the sources of traditional knowledge that were reviewed in this study. Popular keywords include climate, traditional knowledge, land use, land, human activity, and wildlife. Relatively scientific keywords, such as invertebrates, streams, forests, glaciers, ground ice, ice cores, landslides etc. were not commonly used to describe traditional sources of information. This leads us to the preliminary conclusion that locals can offer detailed knowledge at a small scale. Therefore, local and traditional knowledge on the impacts of climate change are most relevant at this level

In terms of content, local and traditional sources of information reviewed to date are relatively strong in covering weather and seasonal change, and human impacts of climate change. Local and traditional information is relatively weak in historical references (archives) that may be a valuable source of knowledge but difficult and expensive to access.

### ***Preliminary Conclusions***

Based on our analysis and information reviewed to date, we have drawn the following preliminary conclusions:

- The state of *documented* traditional and local knowledge of climate change does not adequately reflect the state of traditional and local knowledge of climate change.
- Western science based research is providing an extensive body of literature on climate change trends and impacts. In contrast, climate change as observed, experienced and explained through traditional and local knowledge has received less attention.
- Many sources of documented traditional and local knowledge of climate change are incidental and are often only components of larger sources.
- There is substantial progress to be made in linking western science based climate change research with local knowledge to move towards a more comprehensive understanding of the impacts of change on the North.

### ***Preliminary Recommendations***

Based on analysis and information reviewed to date, the following recommendations are made:

- Documenting traditional and local knowledge of climate change requires creative methodologies.
- Project structures, funding requirements and timelines must reflect the needs of community-based research.

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- The efforts of the Northern Climate ExChange to develop of a forum for compiling and listing who is doing what kind of research on climate change in the North will be valuable.
- Scientists should be actively encouraged to communicate and collaborate with communities, and include traditional and local knowledge in their research.
- Continued support for documentation and community-based monitoring projects that are initiated by communities.
- Creation of a series of conferences, bioregion meetings, or “on the land summits” should be considered to improve the documentation of local/traditional sources of information
- More effort needs to be made on overall capacity building through funding initiatives and research projects.
- Focus on adaptation strategies
- Support/create opportunities for northern communities to share their experiences and concerns related to environmental and climate change.

### **3.3 Climate Change and the Central Yukon**

**Mark O'Donaghue**  
**Regional Biologist**

The Village of Mayo, the “hottest and coldest spot in the Yukon”, is located at the confluence of two rivers. Over the past few decades, residents have noticed changes in local climate and environmental conditions. A general warming trend, greater extremes in weather systems, and changes in the behaviour and abundance of wildlife are among the many observations that residents have made. These changes have created real issues that the community has no choice but to deal with on a daily basis.

The Village of Mayo is experiencing increases in maintenance requirements for local roads, dykes, and the sewage lagoon -- arising from the trend towards increasing temperatures and melting of permafrost. Construction of a new school has faced several unanticipated challenges that may be attributable to changing environmental conditions. The Nacho N'yak Dun First Nation is coping with the implications of declining fish stocks on subsistence food supplies, and the impacts of prolonged leaf miner infestations on local aspen stands.

Mayo has seen severe flooding and forest fires in the past. Will climate change result in larger and more frequent flooding? Are long periods of drought predicted in this region that will change the frequency and severity of forest fires, or water supply to the local hydro dam? How have climate and environmental conditions in the 1990s differed from the rest of the century?

Information requirements to assist this community in dealing with these issues are continually evolving. Climate and environmental change is straining local budgets and abilities to cope with changing conditions. In terms of information on climate and environmental change, the Village of Mayo and Nacho N'yak Dun require:

- Access to the most current information available on what is happening right now.
- Access to the best in expert opinions on how to respond to climate change that will assist with local decision making.
- Plain language sources of information.
- Agenda-free (unbiased) sources of information.
- Information that responds to the most critical concerns and needs at the community level.

The community acknowledges that there is, and always will be, some level of uncertainty associated with information on climate change. However, at the community level it is useful to fully understand the nature of the information that is available to make appropriate decisions in response to climate change.

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The Village of Mayo and the Nacho N'yak Dun First Nation are engaging in a long-range planning exercise to address the specific consequences of climate change on infrastructure, renewable resources, placer-mining, and energy requirements in the community. The Community Development Fund has provided funds to the Village to compile information to develop a baseline understanding of the impacts of climate change on the environment of central Yukon, specifically to determine how conditions in the 1990s differed from the rest of the century. A graduate student at Carleton University, Vicky McCoy, and her supervisor, Dr. Chris Burn, are assisting the Village with completing this analysis. To review this information, the Northern Climate ExChange is hosting the *Central Yukon Climate Change Workshop* on February 19-20, 2001 to assist the community in developing strategies that are specific to the issues faced by this community.

### **3.4 Options for the NCE Information System**

**David Hik**  
**University of Alberta**

Despite increasing awareness of the problems associated with climate change, governments, non-governmental organizations and other organizations are still responding in an ad hoc manner. As well, given the highly variable and specific problems associated with climate change, decision-making processes will need to be made at local levels where there is less available and accessible information.

Information used in decision-making processes currently flows in one direction, from global to regional to local levels. One consequence is that the relevant information required at the local level is not incorporated into larger scale processes, and as a result, planning for variability and change is difficult. There is a need information at local levels to be more accessible for local decision making processes, and to enhance regional and global predictions. The NCE has a role in facilitating the flow of information, particularly at local levels, which can then be applied to decision-making processes. It will be difficult to undertake appropriate mitigative and adaptive options in the absence of information about climate change impacts.

Mark O'Donoghue made several important points when discussing the situation in Mayo. The information needs of the communities are

1. knowledge about what is happening right now at various scales
2. accurate and agenda-free information and options for mitigation and adaptation, and
3. appropriate responses targeted at the community level.

The NCE Information System could incorporate elements that provide information about scientific, traditional and local knowledge concerning climate change impacts. Although a searchable database is important, the most crucial elements will likely be links to an experts database, summaries of what is known about climate change in a particular region, and the capacity to discuss issues of concern with other communities attempting to manage similar problems. Although portals to the NCE Information System need to exist at different levels, is it essential that the information provided is relevant to concerns that communities may have about climate change related impacts.

### **3.5 The Role of a Climate Change Database for Northern Canada**

**Frank Duerden**  
**Ryerson Polytechnical University**

#### ***Introduction***

The purpose behind asking what we do and don't know about climate change impacts is to identify priorities for future investigation and action. From a pragmatic standpoint the question is important because it is individuals, businesses, agencies and governments that have to react to stresses created by climate change. From the standpoint of agencies two courses of action may be contemplated, one of these is ameliorating or mitigating the changing climate, the other is dealing with consequences of change. Although some measures to ameliorate climate change could be seen as broadly environmentally beneficial, the degree of international cooperation required combined with uncertainty regarding the mechanics of climate change mean that it is not realistic to think that we can reverse the process. We thus have to consider dealing with the problem as it arises.

#### ***Climate Change Is Not New***

The considerable hype about climate change has been counter-productive, creating the notion that suddenly we have to be aware of climate and its impacts; that we suddenly have to adapt. The reality, of course, is that in the north populations have been living with the rhythm of the climate, and adapting to changes for thousands of years. Changes in ocean temperatures impacted on Inuit harvest practices; the Hypsithermal impacted Yukon populations, as did the climatic stresses resulting from the Klutan volcano. The impact of past changes were doubtless brutal---but there is a continuity of adaptation, and the accumulation of knowledge about change, all of which fed (feed) into essential decision making processes regarding sustenance. To populations who have lived on the land in the north and have experienced changing environments for thousands of years the message that the climate changes may not be big news. Conversely to Euro-Americans (notably southerners) who perfected sedentary living and developed all sorts of devices to eliminate the impacts of climate (central heating, underground malls, air conditioning) it perhaps comes as a bit of a shock that way of life can be threatened by climatic events. Notwithstanding these observations it is important that people at all levels become vitally aware of the possible impacts of climate change.

The project that was discussed at the workshop is concerned with identifying our state of knowledge regarding climate change and establishing what we need to know to address the issue. Pragmatically the output should have two roles. First, raising general awareness of the possible impacts of climate change; secondly as a decision support tool. Regardless of location, humans at all scales of organization,---the individual, house-holds, businesses, governments---make decisions incorporating information about climate and information on the impact of climate. They all deal with change at different levels, daily or seasonal. The

annual round of First Nation harvest practices, construction schedules in northern environments and snow clearance strategies in southern cities such as Toronto have their basis in climatic cycles. Here, however, we believe that we are dealing with generally predictable events and people make decisions based on the notion that trends that have taken place last year or for the last several years will continue. But even in this apparently predictable world with seemingly sophisticated approaches to gathering and using information we are dealing with uncertainty. In a study we conducted of attitudes towards snowfall in eight cities in southern Ontario several years ago we noted that while good information feeding into decision making processes generally minimized disruption due to snowfall, major disruptions persisted and strategies developed essentially reflected a sense of uncertainty. Two years ago Toronto had a major snow storm and did not know what to do!

### ***Uncertainty***

The reality is that changes are taking place; we do not know the precise nature of these changes, but observations of people on the land and the observations of scientists tell us that the physical environment is changing; and in some parts of the north are changing rapidly. And while we know that physical changes are taking place we know perhaps even less about the impact of change on infrastructure, community economies (broadly defined) or way of life. The one thing to be said with any certainty is that we are dealing with uncertainty. As resource managers at all levels know (e.g. Mitchell (1995)), although we cannot know the future with certainty, accumulating as much information can go some way towards reducing uncertainty. We see this at many levels, from the manner in which Traditional Knowledge which is, continually updated to provide the detailed environmental and ecological information required to support harvesting over vast regions, through to the assembly of detailed scientific information on hydrology to attempt to predict river-basin impacts (flooding etc). In short, identifying the nature of probable changes and their connection to current land-use practices reduces uncertainty and thus the range of possibilities facing decision makers. We cannot know with certainty how change will take place or what the nature of the response should be to these changes. However, we do know that the more knowledge we have, the more we can reduce uncertainty and identify the most promising approaches to dealing with the consequences of climate change.

### ***Uncertainty and a Data-Base for Northern Canada***

Dealing with climate related events is costly. Very broadly these costs come out in two ways. One of these is in the form of damage, losses, disruption, through failure to respond, the other is because of “option paralysis”, wanting to respond but not knowing what possible options there are or not knowing which options are the most desirable. The persuasive reason for developing an easily accessible database on climate change is that it could save individuals, First Nation Councils, communities and businesses a considerable amount of money through anticipation of possible impacts and providing information on possible courses of action. This can be cast in a “benefit-cost” framework (for example, in some cases it is cheaper to respond than to do nothing). In more appropriate human terms the benefits can be expressed in terms of health, employment, quality of life etc. The geography

of the north (its vastness; small populations; isolation; lack of a driving imperative for collecting detailed information in the past) has resulted in “spotty” information of varying degrees of quality, located in different places, and based on a range of different experiences. A consolidated data-base would be very useful; it would provide “one source shopping” for individuals, businesses and governments seeking information on change. It would also facilitate the sharing of information and experiences.

### **Who Is the Information For?**

Although there is a vast amount of literature on climate change in Canada, and a plethora of initiatives, programs, investigations etc, but few seemed to have paused and asked the question, who is this for? Will the intended “end-user” make use of the information? There seems to be sense that someone will read reports etc. and act on them. Ultimately it is at the community level, where impacts will be felt, where pressures to do something will be felt, where decisions have to be made that prognosis about change and impacts have value. The population of northern Canada numbers less than 100,000 who make their home in some ninety widely scattered communities, and it is in these communities that the impact of climate change will be felt. How will information enter into community decision making? For example, how is information made available to a community regarding change? Who informs? Who acts? Will it be incumbent on governments to act? Will it be an expectation? How well informed are communities in terms of what to expect?

To some extent these questions are answered if we consider a range of possible questions that different players may well ask about the future climate. How will harvesting be affected? What will happen to winter ice formation? Will it impact on the ability to hunt? Will it create problems for winter road construction? What will be the impact of permafrost melting on construction? What technologies do we have to deal with such a question. How will employment be affected? Will the industrial base of some northern communities widen as it becomes easier to access northern oil and gas? Will the subsistence base of some communities collapse because change is so rapid that adaptation lags? (an observation made by residents of Sanakilaqu). In individual terms what will happen to employment? How should we modify traditional housing design in the face of warmer (and perhaps wetter) times? Should we prepare for increased flooding? Will there be increased incidence of forest fire? Transport disruptions because of slope instability and landslides? It is expected that will be manifest in an increased incidence of natural hazards that could threaten individual communities, forest fires, flooding, landslides, and catastrophic storms. Have communities had experience of these in the past? How frequently? What magnitude? How did they cope? Perhaps if there is experience with stresses such as these they would cope quite easily.

To deal with questions such as these (and a host of others) a useful data-base must not just identify possible changes, but more importantly would allow users to seek possible approaches to a given problem by having access to information that would assist them in problem solving. The data base is aimed at assisting in individuals, communities, businesses and agencies in adapting to change. Ideally it will assist in identifying information needs and ultimately serve as a resource that anyone can use to seek information about change. An information system would have two important uses. It would,

- a) **Provide base-line data thus enabling users to build scenarios for local impacts.** If there is detailed information on current population and economy it should be possible to predict how a community economy may respond to environmental changes; or given the prevailing permafrost environment and information on temperature trends a community may get a sense of melting impacts.
- b) **Enable users to investigate impacts, responses, etc. of others in similar circumstances to their own.** This would be both a labour saving and cost saving device, reducing the need for extensive time-consuming primary research and allowing users to focus on the most likely approaches or solutions. Given the pace of change time is an important consideration.

### **Data Tests**

A number of tests can be performed on sources of information to determine their applicability and value to the users of the information:

- Timeliness - How recent are the data?
- Quality – Are the data reliable? Robust? Speculative?
- Scale - Is the data spotty (few observations over large areas) or lumpy (specific small areas where a large number of quality observations are available)?
- Usefulness? Can the data answer questions of direct importance?

### **Sanakilaqu Case Example; Community Level Information Needs**

The knowledge we tend to rely on in making prognosis about climate change is scientific, gathered as a matter of necessity through sampling and painting very broad pictures. We can come up with prognosis regarding the retreat of the continuous permafrost zone or what happens to river basins. But the scale of such analysis or interpolation from one region to another may be inappropriate given the diverse geographies of the north and diverse location and economic structure of individual communities. The real nature of impacts can only be gauged by understanding the economic structure of individual communities. For example, there are a number of studies that speak to changes in wildlife harvests or changes in industrialization that may be brought about by climate change.

Data provided from a classic study of the community of Sanakilaqu in Hudson's Bay in the late 1980's (Quigley and McBride 1987) serves to illustrate the complexity of decisions facing northern communities and a sense of the complex information needed to address them. As has been done in many communities in the north they mapped out the community micro-economy in detail, identifying transactions between the wage and non-wage sectors, and estimated that the replacement value of country food and various bi-products of harvesting was some 56% of total community income. However the distribution of wealth in the community was such that most salaried employment (teaching, government administration) lay in the hands of non-natives, essentially meaning that harvesting constituted 70% of

household income for the Indigenous population. Because of its links to the bio-sphere it is this part of the economy that is most at risk from climate change. Wein (1995) (working with Yukon FN communities amongst others) speculated on the possible impact of global warming on food consumption patterns in the Arctic and sub-Arctic. Effects, she argues will vary from region to region. Overall, she concluded that global warming would probably lead to greater dependency on store purchased food-stuffs as consumption patterns shift to compensate for the loss of country food harvests. Prices in northern communities are high and in communities with a similar profile to Sanakilaqu that portion of society with the lowest income could lose the most (country food all its associated nutritional and cultural attributes) and would have to pay the most in terms of proportion of cash income to compensate for the loss. From the standpoint of physical health shift to increased dependence on store-bought food would, at best, be a mixed blessing. It would perhaps mitigate the adverse impacts that may arise as warming exacerbates the role of contaminants in the country food chain; but give rise to new medical problems as processed foods increasingly replace traditional diet.

The scenario described here is perhaps overly negative given recent events that may bring about marked shifts in the relative roles of the components of dual economies. Settlement of comprehensive land claims across northern Canada and the emergence of Nunavut should result in a broader range of wage employment opportunities for native populations, and this may go some way towards off-setting stresses created in those areas where environmental change will lead to a decrease in food harvests. Additional opportunities may also arise as changing ocean conditions and permafrost melting could make extraction and transport of oil and natural gas from the north a lot cheaper resulting in growth in this sector along with increased wage employment for native populations (how much employment would be created?). The extent to which this would offset losses in the traditional sector would depend on cultural acceptance of new activities (are they accepted?) and the rate of local labor absorption (how much is this?). This case example is rather speculative, but it does illustrate the uncertainties regarding change as well as the need for detailed information on community economies required for dealing with it.

## **4.0 Discussion Session Summaries**

At the workshop, discussion sessions were held on the following topics:

- What do northern communities require in a climate change information system?
- How do northern communities make decisions, and how do these decisions take climate change into account?

The outcomes of these discussion sessions are summarized below.

### **4.1 What do Northern Communities require in an Information System?**

The first discussion session at the workshop considered what northerners need in a database and in an information system to assist them with incorporating climate change into local decision making processes. We asked workshop participants to consider what components of the NCE information system would be most useful. The main recommendations from this discussion session are summarized below.

- The database should include general climate and climate change studies.
- The database should include the best of the broad review articles on climate change, including review articles from different perspectives, and these articles do not need to be specifically northern-focused.
- The database should include the location (i.e. libraries, offices etc.) where each record can be found.
- The database should include a summary of content of each information source, what regions/systems they pertain to, and the type of information source (i.e. conference proceedings, journal article, etc.)
- The database should include figures, graphs or tables for records where this information is relevant to the summary, and would be useful to bring to the attention of the user of the database.
- The database should include a search engine to allow users to search the sources of information and the experts database by geographical location, keyword, etc.
- The database should include criteria to assist users in objectively assessing the applicability or usefulness of each source of information within the database. These ranking criteria should address the level of relevance, accuracy and trust associated with each source of information.
- Efforts should be made to ensure that the database is not biased; the database itself can not include value judgements as to the usefulness of a particular source of information.
- The database should be made available on CD-ROM for communities without internet access
- A format should be developed to allow users of the database can add new information and/or records to the database; all new entries should be filtered through the NCE to ensure quality of the database is maintained.

- The information system should provide information on which communities are experiencing similar climate and climate change conditions
- The information system should include an interactive page to the website where users of the database can document observations and concerns related to climate and environmental change in their community, and document types of information that are not currently available but the users wish they had access to. This addition to the database will help researchers to develop research questions that are relevant to community needs.
- The information system should include information on coming events, conferences.
- New publications and other sources of information should be highlighted when they are added to the database
- The information system should include an email network where people can discuss current issues, share information, and request information.
- The information system should include checklists of questions on important climate change considerations for communities undertaking construction projects, development projects, forest management, wildlife management, and other activities.
- For each region in the database, provide a list of mitigation and adaptation strategies that have been implemented in northern communities, and indicate whether the strategy was successfully or not successful and why.

To conclude this discussion session, it was recommended that the Northern Climate ExChange consider offering training sessions in northern communities to assist individuals with learning how to navigate the new climate change database and information system. The NCE should also be available to assist communities in tracking down sources of information and experts noted within the database. It was also recognized that the database will be an ongoing project, requiring regular updating with new information.

## **4.2 Climate Change and Decision Making in Northern Communities**

The second discussion session within the workshop focused climate change and decision making in northern communities. Participants discussed the following questions:

- What types of decisions are made in your community and surrounding area that may be affected by climate change?
- What type of information does your community need to incorporate climate change into local decision making processes?
- What are community-level priorities for information relating to climate change?

Without a doubt, this discussion session was the most challenging component of the workshop. Despite these challenges, workshop participants developed encouraging and forward-looking recommendations that will assist the project team in providing a product from this project that is of greater value to its users. The main recommendations from this discussion session are summarized below:

- Climate and environmental monitoring capacity needs to be regained in northern regions.
- Climate change predictions at a regional and local scales need to be improved.
- There is a need to identify ecosystems, industries, and locations that are vulnerable to a change in climate.
- There is a need for decision support tools, not just information.
- We need to highlight where we need to fill in the gaps in our knowledge base.
- Checklists are needed to ensure the appropriate questions related to climate change are asked at the appropriate time.
- Additional effort needs to be made to make available community concerns and observations on climate change to researchers.
- Communication pathways between communities with similar climate change related concerns needs to be improved.
- Northern standards, codes and guidelines for infrastructure construction and maintenance (i.e. roads, pipelines, buildings) need to be updated to take climate change considerations into account, especially in 'warm' permafrost regions.
- Hydrometeorological models that are relevant to frozen ground need to be developed/updated.
- Information is needed on long term water flow rates to determine hydroelectric potential, and appropriate flood control measures
- Forestry/Ecosystem Issues:
  - How should forest reforestation programs be altered to prepare for new climate conditions?
  - How should wildlife management programs, including habitat preservation and conservation strategies, take climate change into account?
  - Keystone species, or those that are particularly vulnerable to climate change, need to be identified and monitored.
  - How should forest protection programs respond to increased stresses on forest ecosystems by insects, disease, windthrow, and fire?
  - How will the current forest age class structure change in response to increased forest stresses?
  - Should forest harvesting methods change in response to changing climate conditions? If so, where, and how?
- How will our Emergency Preparedness Programs respond to changes in the magnitude and frequency of extreme climate events?

At the conclusion of this discussion session, a number of participants suggested that there is tremendous value in prioritizing research and monitoring needs. Partnerships between communities, industry, and governments are seen as essential to ensure that steps are taken to meet information needs, and to make best use of limited resources.

## **5.0 What's Next?**

As mentioned earlier in this report, this project (to understand the quantity and quality of available information on the impacts of climate change in northern Canada) is mid-way to completion. This workshop was designed to help the project team in developing final products that are of most use to the intended users.

Information gained from this workshop will be incorporated into the deliverables from this work, which include a report and database. Prior to releasing the final report and database, draft products will be made available for review and comment. The following section outlines dates when various components of the project will be available at the Northern Climate ExChange office and/or on the Northern Climate ExChange website (<http://www.taiga.net/nce>).

### **5.1 Deliverables and Timelines**

The following product deliverables will be available for review at the following times:

#### ***December 2000***

- Draft Gap Analysis Matrices

#### ***January 2001***

- Draft Database of information sources on the impacts of climate change in northern Canada.
- Draft Report including summaries of the state of documented scientific and traditional knowledge available for review
  - by regions in northern Canada
  - by system (human and natural)
- Draft Priorities and future directions for research, policy, adaptation, etc.
- Draft Information System
- Draft Experts Database
- Draft Website
- Draft proposal outlining how the project will develop over the coming years.

**March 2001**

- Final report – refined based on comments on draft
- Final structure of information system/website – structure refined based on feedback
- Defined procedures for how the database/information system will be kept up to date
- Workplan
- CD-ROM version of database

## 6.0 Workshop Summary

The workshop, *A Northern Assessment of the Impacts of Climate Change: Defining our Knowledge Base and Research Priorities*, held September 20-21, 2000, brought together government, community representatives, practitioners and researchers from across the north. The workshop was designed to provide feedback to the project team to assist with reviewing the state of information, and the organization of information, on climate change impacts in northern Canada.

This was a very challenging workshop, especially when we discussed how to incorporate climate change considerations into decision making in northern communities. Despite the challenges, workshop participants developed encouraging and forward-looking recommendations that will assist the project team in providing a product from this project that is of greater value to its users.

Based on comments received at the workshop on “what our information system should do” we will:

- Formalize a way in which new records and information can be added to the system (i.e. add a form on to the website)
- Provide regular updates to let communities know when new relevant information is available, when new info posted on website or added to database, and provide some means for non-electronic distribution of information
- Formalize a system where communities can look for non-documented sources of information and discuss new issues/current events
- Record case studies of what communities in the north are doing to respond to impacts of climate change
- Provide checklists of climate-related considerations for communities i.e. decision support tools or a resource guide for communities to aid in long-range planning exercises
- Keep track of information needs, and formalize a system to document and distribute
- Expand current NCE mailing list to a discussion list to assist those who are looking for non-documented sources of information, to solicit feedback on current events and significant issues
- List community observations on website based on NCE summer community tour to assist in matching community questions to researchers and to assist communities with similar issues to get in touch with each other
- Provide an opportunity to keep track of questions people have related to climate change that they have not been able to find information on
- Include recommendations for policy mechanisms within the final report
- Include case studies or pilot projects that describe how northern communities that are developing or implementing adaptation strategies

Based on comments received at the workshop on “what our report should do” we will

- Include guidance on “what we should be doing” re adaptation and prevention
- Describe the state of knowledge by sub-regions (traditional territory) as well as by natural and human systems
- Provide a list of codes, standards and regulatory processes in place in the north where climate change should be considered (i.e. DAP)
- Provide a list of where we need to regain monitoring capacity and on what
- Identify collaborative research opportunities

**APPENDIX A**  
**WORKSHOP AGENDA**

**A Northern Assessment of the Impacts of Climate Change**  
***Defining Our Knowledge Base and Research Priorities***  
(Yukon Inn, Whitehorse, Yukon; September 20-21, 2000)

This working meeting is hosted by the Northern Climate Exchange Centre, Environment Canada – Canadian Wildlife Service, Yukon Government, Climate Change Action Fund, Yukon College, and Northern Research Institute.

**Objectives:**

- Review and assess our current state of knowledge of climate change impacts on various components of northern natural and human-oriented systems;
- Develop priorities for action in the north on climate change that may include research, monitoring, technological development, management structures, and education.
- Discuss product format and delivery, with the goal of creating a user-friendly, “living” document that is relevant and accessible to researchers, policy-makers, and community representatives.

**Wednesday, September 20<sup>th</sup>**

**I. Plenary: Introduction and Presentations**

(8:30–8:45) Welcome – Aynslie Ogden; Meeting Objectives – Doug Urquhart

**Decision Making and Climate Change**

(8:45–9:45) Keynote Speakers: Professor Frank Duerden, Dr. David Hik, and Mark O’Donoghue and Shannon Cooper

(9:45-10:00) Coffee Break and Sign-In (Pick up your workshop package, name tag and sign-in)

**Cogs in the Machine**

(10:00-11:00) Keynote Speakers: Legend Seekers, GeoNorth, and Anne Munier/Mike Gill

**How Do We Make Decisions?**

(11:00-12:00) Dr. David Hik and Doug Urquhart

(12:00-12:45) Lunch

**II. Break-out Groups: Needs, Priorities, Products and Information**

(12:45-2:15) Session I

(2:15-2:30) Coffee Break

(2:30-4:00) Session II

**Thursday, September 21:**

**II. Plenary: Discussion and Conclusions**

(8:30-9:00) Break-out Group Session Summary

(9:00-10:00) Discussion

(10:00-10:15) Coffee Break

(10:15-11:30) What's Next? Discussion of Deliverables and Timelines: Product Format and Delivery

## **APPENDIX B**

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