Communities and Ice: Bringing Together Traditional and Scientific Knowledge

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Abstract
Traditional and scientific knowledge are used together to find solutions to adapt to climate variability in Northern Quebec communities within the framework of the project titled "Climate change in Nunavik: Access to territory and resources". This research project is based on interviews with elders and experienced hunters, ice and snow monitoring by local Inuit and Naskapi researchers and supporting analysis of local climate data. Through the combination of this information, the project is beginning to identify the most appropriate indicators to characterize ice conditions and determine when the ice trails - critical for accessing harvesting areas and maintaining a more traditional way of life - are safe for travel by the local populations.

Introduction
While climate warming has already come to affect several regions of the planet, including the Arctic (Anisimov *et al.* 2001) and northern Quebec, Canada was until recently influenced by a cooling trend (Allard *et al.* 1995). Only during the last ten years has this northern region been experiencing the warming reported in other regions of the circumpolar North (Figure 1).

Notes: This text comes from the book: “Climate Change: Linking Traditionnal and Scientific Knowledge” edited by Rick Riewe and Jill Oakes. Aboriginal Issues Press. University of Manitoba. 2006. 289 p.

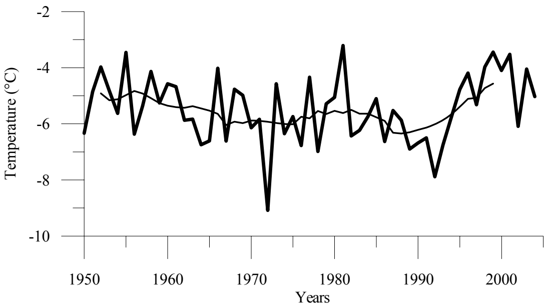

Figure 1 : Annual mean temperature for Kuujjuaq with corresponding 11 years moving average. Until the year 1992, the North of Quebec was cooling. During the last 10 years (1995-2004), only the year 2002 was below the mean annual temperature (1950-2004). Source: http://www.climate.weatheroffice.ec.gc.ca/Welcome_f.html.

Future climate change in the Arctic is difficult to predict but several sources and models agree that it will become, on average, a warmer and wetter region (Anisimov et al. 2001, Kattsov & Kallen, 2005). Such changes are of great interest to scientists working in these regions and of great concern to residents living in northern communities. In addition to representing significant impacts to ecosystems via shifts in fire system dynamics, increased risk of insect outbreaks, introduction of new animal and plant species and changing permafrost dynamics (Cohen *et al.* 2001), climate change in the Arctic may impact the way subsistence-based northern communities access their land and resources (Furgal *et al.* 2002, Figure 2). For example, these new conditions may reduce by several weeks the period when it is safe to use ice trails, both inland and in coastal marine areas. These trails are in fact critical for hunting and traveling outside the local communities and can only be used during the cold season. This situation has already been experienced to some extent by northern communities in the Northwest Territories, Nunavut and Alaska (Fox 2002, Kofinas *et al.* 2002, Nickels *et al.* 2002, Norton 2002). Also, there have been some recent reports of climate change impacts on access to territory in Nunavik and Labrador, where unpredictable weather patterns and ice instability were shown to negatively affect traveling conditions (Furgal *et al.* 2002, Furgal & Communities of Labrador 2003, Furgal & Communities of Nunavik 2003, Lafortune *et al.* 2004).

These changes threaten to reduce contact between communities, decrease access to - and quality of - traditional food resources, indirectly contribute

Figure 2 : Winter trails in Nunavik (Credit: J. Drouin)**.**

to a deterioration of the cultural and social fabric in communities, prevent the generation and transfer of traditional knowledge and reduce the level of physical activity associated with land based activities during winter months. All of these changes have potential impacts on the health and well-being of northern peoples. Both traditional knowledge and local observations as well as scientific knowledge, can be useful in understanding how changes, such as alterations in the safety of ice conditions, affect individuals' access to land and resources and can be used to develop strategies to cope and ultimately adapt to environmental change. Traditional knowledge refers here to the "…cumulative body of knowledge, practice and belief, evolving by adaptive processes handed down through generations by the cultural transmission" (Berkes 1999). Although Inuit have always adapted to change and such capacity has historically been an integral part of the social organization of northern peoples (Nelson 1969), fast, dramatic and unexpected climate change could make current efforts for adaptation much more difficult. Moreover, northern communities and peoples have changed significantly since coming into permanent settlements and experiencing various forms of social, cultural, political and economic change. The development of tools which support adaptation to environmental change could help to protect and preserve aspects of a more traditional lifestyle, increasing population resilience to climate change in the future (Chapin *et al.* 2004).

Northern Québec: The Region and Participating Communities

The region of Nunavik is made up of fourteen (14) communities, the majority of which are located along the coasts of the Hudson Bay, the Hudson Strait and the Ungava Bay. They are accessible only by plane (year-round) or boat (during the summer months). The Inuit communities of this region involved in the project are the coastal villages of Umiujaq, Kangiqsujuaq and Kangiqsualujjuaq. The Naskapi community of Kawawachikamach, located inland from the coast, just south of the Nunavik border (south of the 55^{o}N), is linked by road to the community of Schefferville which in turn is accessible by train from a community on the Lower North Shore of the St-Lawrence (Figure 3 and Table 1). None of the communities in this region are linked to each other or to the rest of the province via a road network as is the case in some other northern regions of the country. Winter trail networks throughout the region, comprised of land and sea ice trails that have been used for generations, are particularly significant as they connect the communities and allow residents to travel between villages in addition to providing access to traditional harvesting grounds. Apart from connections to the south via air, these regional trails are the life lines for many communities throughout the year.

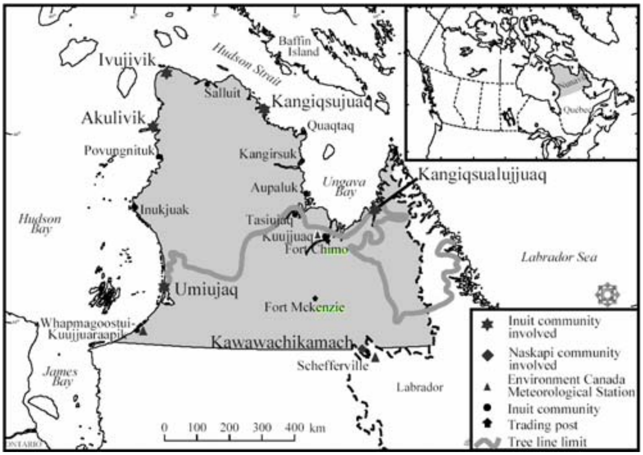

Figure 3 : Map of Nunavik showing participating communities

Traditional knowledge of northern community residents and scientific knowledge were brought together in this project to help understand the consequences of climate related changes on access to resources and use of trail systems in the North. Ultimately this work was aimed at helping develop community tools for coping and adaptation. The four participating communities (Umiujaq, Kangiqsujuaq, Kangiqsualujjuaq and Kawawachikamach) were selected to participate in the project to represent different bioclimatic areas of Northern Quebec. This project is the first of its kind in the region and since its inception, has garnered great support and interest among the participating communities and regional organizations. The project is one of the rare projects where the autochthon populations are entirely involved. The objectives of the project were defined with the communities. The data are collected (interviews and measurement of ice) by a local researcher in each community.

Table 1: Community characteristics

Communities	**Establishment, Biome, & Population (Statistics Canada, 2001)**
Kangiqsujuaq	1910, trading post established with continuous occupation since then (Corporation 2004). Located far above the treeline in the tundra. 535 inhabitants
Umiujaq	1985-86, village established by some Inuit from Kuujjuaraapik to preserve traditional lifestyles (Corporation 2004). Located where the tundra and the forest-tundra meet. 350 inhabitants.
Kangiqsualujjuaq	1962, Inuit established the first co-operative of Northern Québec with continuous occupation since then. Located south of treeline in the forest-tundra, (Makivik Corporation, 2004). 710 inhabitants
Kawawachikamach	1915, Naskapis moved from Fort Chimo (now Kuujjuaq) to Fort McKenzie, back to Fort Chimo in 1948, and to Schefferville in 1956 (Naskapi Nation of Kawawachikamach, 2004). In 1980 the Naskapis voted for the relocation to the present site. Fort McKenzie area is still considered traditional hunting grounds by the Naskapi Elders. Located inland in the forest-tundra. 540 inhabitants

Interviews with Local Experts

The preliminary stages of the project involved bringing together researchers on climate change science, human geography and impact assessment with local researchers from the participating northern communities. At this time, key project objectives most important to both the scientific and local communities were identified. The team then developed interview grids and other data collection tools (e.g. ice and snow monitoring protocols) and the researchers provided training to the local researchers on interview methods, data recording, and analysis. The intent of training within the project was so that local researchers would progressively take direction of the project in their own community; this has been the experience to date. Participatory research methods have been employed throughout the project.

The project has been conducted in several stages and is still ongoing. Initially, during the winter of 2003-04, semi-structured interviews by local researchers with Elders and locally recognized expert harvesters were conducted to document current use of trail networks in the vicinity of each participating community. A cartographic semi-directed interview process was developed with local researchers to first identify trails surrounding the community, specify their current use as well as the typical mode of transportation used on them by participants. Interview questions also included the identification of any observed changes in the use of each trail in the last 20-30 years (Table 2). The second phase of data collection (winter of 2004-05) involved conducting semi-structured in-depth interviews with Elders and experienced hunters in each community to document knowledge on the processes of ice formation and melting around each community and to identify qualitative cues used by local experts to determine when the ice is safe for travel (Table 3). Over the course of the same period (winter 2004-05), an ice monitoring pilot project was initiated in each of the participating communities to collect both qualitative and quantitative data on changes in ice conditions at locations along key trails. This information is being used with meteorological data to identify key indicators (qualitative and quantitative) of ice conditions at the community level.

Table 2: Interview guide for cartographic interviews on use and changes in the trail network in Northern Quebec.

Questions

- ❑ We are going to talk about all the routes in the area that you use. Can you please mark the routes / trails that you use on the map? Starting with the skidoo routes, go through each other form of transportation and give the participant the colour marker for that form of transportation

Snowmobile → Blue	Dogteam → Purple
ATV → Orange	Truck → Green (Naskapis)
Kayak → Green (Inuit)	Walking → Black
Canoe → Red	Speedboat → Red
Peterhead → Brown	Trap line → Pink

While the person is marking the trails on the map, please ask what the trail / route was used for and mark this at the end of the trail with the right code (create new code when needed):

Caribou → C	Polar Bear → PB
Fish → F	Beaver → Be
Black Bear → BB	Seal → S
Canada Goose → G	Muskrats → M
Beluga → B	Fox → FX
Mussels → M	Ptarmigan → P
Snow Geese → GE	Berries → BE
Walrus → W	Wooding → WD

- ❑ Please identify on the map which routes you use most often during a single year (Interviewer: please highlight these with a yellow pen and if it seems to cover more than one type of trail, ask interviewee if this is for skidoo, honda, etc.)
- ❑ Has these routes always been the ones you use most often each year?
- ❑ Are there any important areas you can no longer get to or that you can't get to when you normally could before ? *Probe: Why is this area difficult to get to or no longer accessible ?*
- ❑ Are any of the traditional routes abandoned (not used any more)? (Interviewer: please have the participant draw them on the map and put some x's along the line). *Probe: When was it abandoned? Probe: Why is it no longer used? Probe: What was it used for before?*

Qualitative content analysis (Creswell 2003) of the interviews was conducted whereby common groups or categories of information were developed iteratively for responses to each question among all participants, as described by Tesch (1990). The groups or categories were then re-examined or subdivided in smaller categories if needed. Community researchers and other team members were involved in this process conducting some components of the analysis individually to control for inter-coder variability. A validation phase with the participants was included and maps are now being validated in all communities. An analytical table organizing information from all interviews for each stage was produced as a result of the coding exercise. The coded and summarized interview data was transcribed into the analytical table and reviewed by team members.

Traditional and Scientific Knowledge: Current Trail Use and New Hazards

During the first phase of the project, the interviews conducted with expert hunters and Elders focused on the identification of the network of trails used throughout the year (Table 2) while specifying which type of transportation was used for each one of the trails as well as the usual use of the route (e.g. snowmobile trail to go fishing in Bay X; Table 2). Areas and trails representing increasing risks to humans (based on descriptions provided by the participants) were identified. This information allowed for the production of preliminary trail maps with potentially risky areas for each community. The maps revealed that, although climate change seems to have had little impact so far on the trail network around the Naskapi village of Kawawachikamach, increased travel risks linked to ice instability and weather unpredictability have already become important issues for the communities of Umiujaq, Kangiqsujuaq and Kangiqsualujjuaq. Most climate related hazards associated with trail use were located on ice trails near these coastal communities and were identified as being more “risky”, particularly during the freeze-up and break-up of river, lake and sea ice (Lafortune *et al.* 2004). Specific sectors of trails were identified as key locations in terms of new or increasingly risky areas for travelers’ safety at these periods of time (e.g. see Figure 4).

Table 3: Ice knowledge interviews

Introduction to participants: Last winter, we visited your community to discuss changes people were noticing in the use of trails around the community. We learned that there are areas that are getting more dangerous at certain times of the year out on the ice at river mouths and in shallow coastal areas. Starting this year we would like to start an ice-monitoring program with you in your community. We are talking with people like yourself, who know a lot about the ice, the land and the routes in the area to get a better understanding of the ice dynamics (how it is changing, when is it safe to travel on, things like that) for the lakes and sea ice areas. Sharing your knowledge about ice with us will also guide the work of the local researcher who will make weekly measurements of ice conditions in specific locations. We will be preparing maps to show where there are dangerous areas appearing each year and fact sheets on this issue for KRG and the communities. By the end of March, these will be translated and brought back to the community through the local researchers and we will make sure that you and other people you think should know about this information will be provided a copy. We are doing these interviews in Kangiqsujuaq, Umiujaq, Kangiqsualujjuaq and Kawawachikamach over the next month. The discussion should take about 1-2 hours. **Please have them review and sign the consent form before starting. Use your risk assessment map as an example.** **First ask these questions for <u>sea ice</u>, then repeat the process for <u>lake ice</u>.** ▪ Can you tell me how you know when the ice is safe to travel on? ▪ Can you describe to me how ice usually forms? ▪ When does the ice usually form and become safe to travel on? ▪ What are the best weather conditions to form solid ice that is safe to travel on? ▪ What are the factors that slow down ice becoming solid? ▪ We are trying to educate scientists and people now from the community knowledge about Ice and the different "types" of Ice you can have. Can you tell me what are the different types of ice? Can you tell me the Inuktitut names for the different kinds? Can you describe each of these types of ice to me? Can you tell me under which conditions each type of ice exists?

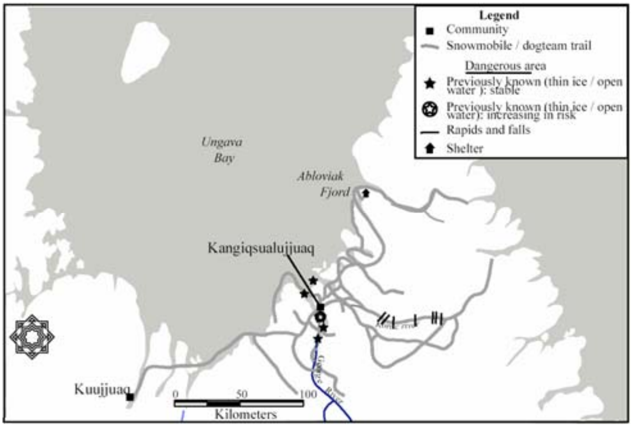

Figure 4 : Trails identifying areas of increasing risk, Kangiqsualujjuaq

Understanding Ice from the Community Perspective

During the second phase of the project, interviews were led by local researchers with Elders and expert hunters known to have a rich knowledge of ice conditions in their local area. The results of these interviews served to document ice dynamics as viewed from a community perspective (Table 3). The interview questions related to the characteristics of sea and fresh water ice during the various stages of the winter season. Traditional knowledge and local observations revealed that ice formation is taking place later in Northern Quebec than ever before, as reported by the interview participants. This observation is shared among experts from Kangiqsujuaq, Kangiqsuluajjuaq and Umiujaq. To know at which time the ice becomes safe to travel on, community experts reported that physical observations of both ice and weather conditions are required. Several days with low temperatures allow the thickening of both sea and lake ice. On the other hand, the presence of wind or snow can delay ice formation. In addition to confirming that lake and sea ice break-up is also influenced by climatic and environmental conditions (such as high temperatures, increased solar radiation, snow accumulation, degree of salinity and presence of currents), the community experts provided information on the different phases the ice undergoes before it becomes safe/unsafe to travel (Figure 5). The information is important for the scientific community as it not only confirms the best climatic indicators related to ice freeze up and break up processes but also provides some perspective as to how the hunters analyze environmental conditions and sets the ground for monitoring and other research initiatives within the community.

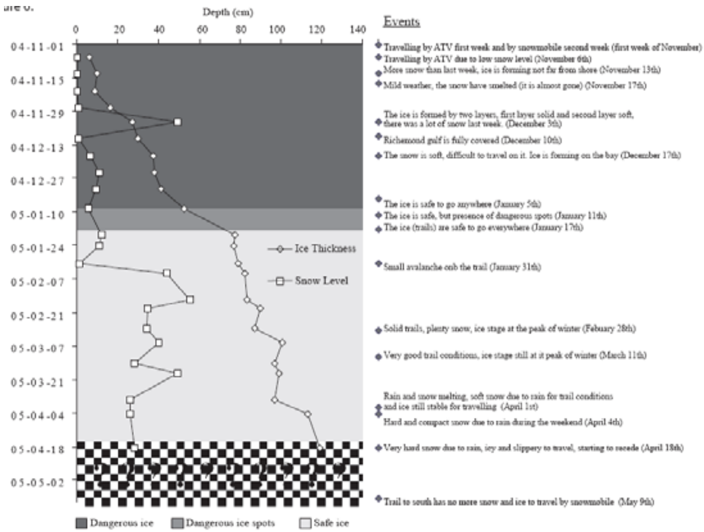

Figure 5: Ice and snow monitoring in relation with expert information, Umiujaq (2004-2005). Expert information allowed for the defining of ice as dangerous, safe with dangerous spots or safe. The ensemble of information presented here is being used to develop indicators of ice safety.

Monitoring Ice: Information from Scientists and Local Experts

As a result of identifying some areas that were becoming increasingly risky or dangerous for travel around communities during the first stage of the project, the need was identified for a focused study or ice monitoring program. The strategy for local ice monitoring in the communities, an activity that will continue until the end of the research project, was based on the collection of two types of data. First, in each community short interviews were conducted weekly with a small number (two or three per community) of experts frequently traveling in the area. These interviews aimed to gather local qualitative descriptions of current ice trail conditions, focusing mainly on but not limited to, two specific areas (one freshwater ice, brackish water ice and/or one sea ice location) along key trails used by community residents. Each area was chosen by the community researchers. The sites selected are important nodes in the trail networks to access harvesting grounds at particular times of the year (e.g. a crossroads of many trails in a local Bay, very important for accessing an important hunting location in the winter). The second set of data collected included a series of field measurements at these sites including snow depth and ice thickness. This data was also collected on a weekly basis. At each location, an ice hole was dug and snow and ice depth were measured. The timing and characteristics of freeze-up and break-up were reported in all cases.

Instrumental data are used to determine quantitative indicators of safe ice. Through the analysis of qualitative interview data from local experts, the project is trying to determine the most appropriate quantitative indicators, or suite of indicators, that are representative of the cues used by local experts to characterize the ice and determine "safe" ice conditions as well as critical determinants of ice formation and break-up. In reviewing both qualitative and quantitative data together, the research team is identifying quantitative indicators to add to the suite of regular instrument measurements taken at specific sites each week and to determine more feasible ways to gather this data through the local monitoring process. This aspect of the work constitutes indicator development in some cases for local ice monitoring. Instrumental data (daily temperature, precipitation, and wind) from Environment Canada (past 50 years; 3 stations throughout the region) and the Centre d'études nordiques meteorological stations (past 15 years, but with many stations closer to many communities) were used to test the relationship between meteorological indicators and ice variables.

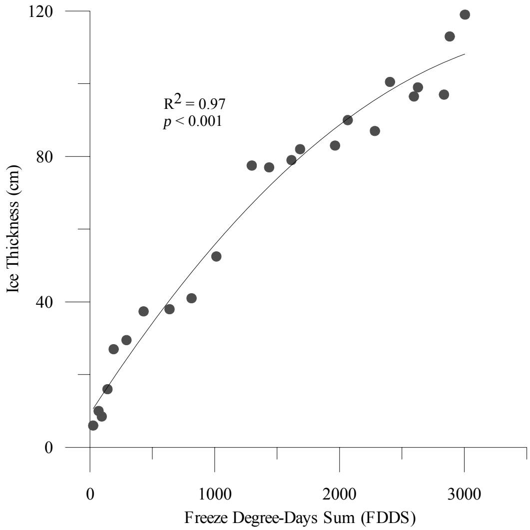

Figure 6 : Relationship between ice formation and Freeze Degrees Day Sum (FDDS) for Guillaume Delisle Lake, Nunavik**.**

The preliminary results show a strong relationship between ice development and the Freeze degree-days Sum (FDDS) (Figure 6). The analysis of this data could prove to be effective in developing an indicator for the time at which the ice becomes safe in specific locations. For example, the ice on Guillaume Delisle Lake was considered safe by community experts as of January 17, 2005 (Figure 5). At this time, the ice at the measurement location had a thickness between 52.5 cm (measured on January 8) and 77.5 cm (measured on January 19) and that area had experienced a total FDDS of 1250 days. The relationship between the minimum thickness of ice considered safe (in a standard location) and FDDS from the moment when the minimal thickness is reached will make it possible to establish a critical point of FDDS at which the ice can be considered safe for travel. This information is important in a climate-warming context. However, other measurements of ice must be carried out to validate the reliability of this threshold. Moreover, other data must be included in the establishment of this threshold, as the presence of currents and the salinity of water have not yet been included in the analysis and are identified by community experts as critical variables in this equation. Similarly, the role that snow plays on ice formation will have to be better documented in coming years. Moreover, increased efforts will also be required to collect data regarding the sea ice melting period to increase data coverage of this time of the year.

Additionally, the information collected each week during the winter season, both quantitative measurements and qualitative descriptions, is posted on the Kativik Regional Government website (http://climatechange.krg.ca/) for the public to view. This website is one of the tools being developed under this project for community dissemination of this information and to support communities in adapting, in this case via sharing of up to date information related to changing environmental conditions, to climate and environmental change taking place in this region. The web site is an addition to the already existing communication network of CB radios and local FM and contributes to linking scientific and traditional knowledge under this project. Future use of this website in school classrooms is being investigated.

Conclusion

Northern Quebec has been warming since 1993 (Allard *et al.* 2002). Climate models predict warmer and wetter conditions and more numerous extreme events in the future in many Arctic regions (Anisimov *et al.* 2001). Some environmental changes have already been observed and experienced by northern community residents and some of these changes may have implications on the lifestyles and livelihoods of people living in this region. In particular, climate warming may impact access to territory and resources by northern Aboriginal peoples. To help support and enhance local community capacity and resilience to respond to various forms of environmental change, traditional and scientific knowledge on this subject must be accessed. Workshops held with community members, interviews conducted with experienced hunters and Elders, ice and snow monitoring activities carried out by local researchers and data analysis performed in cooperation with outside researchers can help to understand the situation and develop tools to support communities in coping with the negative effects of climate change in the North. Through the use of both qualitative and quantitative data, and the involvement of local knowledge and expertise, the most appropriate and relevant indicators for monitoring activities can be determined. Such monitoring can, as in this project, work towards providing practical information on such things as "safe" ice conditions as well as the critical determinants of ice formation and break-up which are of interest to both scientific and northern communities alike.

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