C-CIARN NORTH - NUNAVUT COMMUNITY RESEARCH NEEDS SURVEY

Summary Report

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C-CIARN North

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Introduction

In 2003, the Nunavut office of C-CIARN North initiated a survey of Nunavut community residents' perspectives on the role that scientific research should play in building adaptive capacity in the territory to deal with climate change impacts. The survey sought to identify specific research topics and questions of importance to Nunavut residents, and to solicit local perspectives on the impacts and benefits of research activity and how research projects in Nunavut should be designed, conducted, and communicated to best serve the public interest. Our hope is that this survey will help guide the efforts of researchers and research funding bodies to promote and undertake studies that are responsive and relevant to Nunavut community needs and concerns, and that produce information that local decision makers need and can use.

The Nunavut Research Needs Survey is part of a larger ongoing research needs survey undertaken by C-CIARN North, which involves community based surveys in each of the three northern territories, a literature review of existing expressions of research needs, and various other methods such as topics focused in online workshops. The C-CIARN North survey builds upon results of on the Northern Climate Exchange's Gap Analysis Project (2002) which reviewed the current states of knowledge regarding climate change impacts in a defined suite of biophysical systems (marine, boreal, terrestrial, coastal, freshwater), socioeconomic activities (mining, tourism, forestry, agriculture, fisheries, mining) and other determinants of community well being (health, waste management, infrastructure, transportation).

The community surveys in each territory were developed somewhat differently in response to territorial circumstances and need. The Yukon survey for example utilized a mail in questionnaire, while the NWT survey, which should be available in the coming year, is employing community workshops to gather research needs. To allow for comparison of research need across regions and the identification of cross cutting themes, the territorial community surveys all addresses the same suite of systems invested by the NCE gap analysis.

Methodology

The Nunavut survey relies on a suite of methods to obtain a broad "snapshot" of community research needs across the territory[1]

[1] Nunavut covers one-fifth of the Canadian Land mass. Roughly 85% of Nunavut's 30,000 inhabitants are Inuit who live in 25 small and very isolated communities in three administrative regions, largest of which is the Baffin or Qikiqtani region. Communities range in size from 150 to 6000 people. Nunavut has a mixed

Interviews

The survey data are derived primarily from a series of 36 semi-directed telephone interviews with a purposive sample of elders and hunters in 20 Nunavut communities during 2004. Respondents were identified by the hunters and trappers organizations and municipal councils in each community, and interviews were conducted by a C-CIARN contractor in Inuktitut. Two respondents from each of the 13 communities in the Baffin Region were interviewed however interviews were completed with only four Kivalliq communities and two Kitikmeot communities (see appendix one for a map of Nunavut's regions). Interviews were conducted in Inuktitut and lasted between 45 minutes and one hour. A standard interview template was to elicit information in a consistent manner for the relevant systems of interest in Nunavut. Interviews were transcribed by the interviewer and reviewed with C-CIARN Nunavut manager. When necessary, the transcriptions were verified with respondents to clarify inconsistent or uncertain information.

Respondents were asked to select from a list of categories to describe their occupation(s), interests and role(s) in the community. 48% of respondents self-identified as hunters while 23% self- identified as elders. 18% listed themselves as employees or representatives of the municipal government (the mayors of 5 communities were interviewed). 5% of respondents identified themselves as private business persons (e.g. artisans), 3% were affiliated or employed with Inuit agencies, and 3% described themselves as individuals. Many respondents identified multiple categories to reflect their roles and interest, which creates duplication in the totals shown in Table 1 (below).

Table 1: Identify / Background of Nunavut survey respondents (N= 36)

CATEGORY	#
Elder	14
Hunter	30
Private Sector (e.g. artisan)	3
Municipal government employee	11
Aboriginal government employee	2
Individual	2

Respondent Interests by System

The survey respondents addressed 13 of the systems of interest. The natural systems (tundra, freshwater, marine, coast), harvesting, human health were of most interest to the majority of respondents. Waste management, infrastructure, transportation, tourism, and

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economy, in which households derive cash income from various sources with income "in kind" from traditional land based harvesting activities (Hicks and White 2000). The territory's growth rate is three times the national average and 60% of the territory is under the age of 25 (Hicks and White 2000).

mining also elicited valuable feedback. Systems receiving the lowest response rates were the fisheries and energy systems. The response bias towards community and natural systems is perhaps not surprising considering the majority of survey respondents identified themselves primarily as hunters and elders with an intimate knowledge of climate impacts in the environment and wildlife, particularly in the context of Inuit subsistence harvesting lifestyle. Differentiating among systems with respect to impacts is made difficult by the significant overlap that exists between systems. For example climate change impacts on fisheries and transportation could easily classified as impacts on harvesting.

Table 2: Respondent interest by System

SYSETM	**# of responses**
Fresh Water	35
Coast	33
Tundra	35
Marine	33
Harvesting (Hunting and Trapping)	35
Community Health	35
Infrastructure	32
Waste Management	34
Tourism	22
Transportation	31
Energy	2
Fisheries	7
Mining	16

Other information Sources

To supplement the interviews, and ensure a more balanced regional representation, research needs were obtained opportunistically at a series of local, regional, and national meetings attended by C-CIARN Nunavut staff that addressed issues related to climate change impacts, community vulnerability and adaptation in Nunavut. Expressions of research needs and other relevant comments by community participants were recorded at these events, the major of which included:

- Community climate change workshops, coordinated by Inuit Tapiriit Kanatami (Kugaaruk and Repulse Bay, Feb. 2005)
- Inuit Elders' conference on Adaptation to Climate hosted by Nunavut Tungavik Incorporated (Iqaluit, Feb. 2005)
- ICC Inuit Leaders Briefing on the Arctic Climate Impact Assessment (Iqaluit, May, 2004)
- INAC Nunavut water management workshop (Iqaluit, Nov 2003)

- INAC Northern Contaminants Symposium (Vancouver, Oct. 2004)
- C-CIARN Nunavut advisory group meetings (various, Iqaluit 2003-05)
- Inuit Tapiriit Kanatami Inuit Specific Session on the Environment (Ottawa, 2004)
- C-CIARN North online workshop: "Managing Northern wildlife in a Changing Climate" (2004)
- Nunavut Fisheries Strategy Consultation (Iqaluit, 2004)

Previously documented Nunavut research needs were also derived from existing publications, grey literature and internal documents (e.g. workshop proceedings, consultant reports, meeting minutes).

The research needs and perspectives documented in the survey are primarily those of Inuit elders and hunters. Although elders and hunters comprise a minority of the Nunavut population, they are widely recognized in their home communities as the authorities on most maters pertaining to the evidence and impacts of local environmental change. Elders and hunters are the community members most frequently engaged in climate change research, workshops and meetings, and as such their perspectives on community vulnerability and adaptive capacity are most well documented and have come to serve as the standard. This survey is grounded in elders and hunters perspectives, but also draws on insights of public officials responsible for design and delivery of community based services (e.g. health protection and prevention, municipal infrastructure, wildlife management environmental assessment, land use planning) considered vulnerable to climate change impacts.

Results and Discussion

The survey documents a wide array of specific research needs related to climate impacts and adaptation. Research needs range from "curiosity driven" studies (to help better understand unfamiliar environmental phenomena and/or changes that are not necessarily a cause for concern), to "applied" research aimed at helping individuals and agencies measure, assess and respond to specific problems caused by environmental change. Some community members expressed interest in research that will help them better understand changes and impacts at the regional and national scale, however the majority of expressed a need for investigation, monitoring and assessment of specific local problems or phenomena e.g. "how are sea run char near Chesterfield Inlet being affected by lower water levels in rivers?" Community research interests relate primarily to current ongoing ore recurring phenomena, retrospective analysis of past events, and better modeling and forecasting of future changes were also identified as important. Research results should be returned quickly, and in an appropriate format, to community residents and agencies to allow them to assess perceived problems and plan appropriate responses.

The survey results suggest that Nunavut community members recognize considerable overlap among climate change impacts (e.g. changes in one system affect changes in another system), and that they do not generally view climate change adaptation

challenges in isolation of other social and environmental pressures. Local climate change research needs reflect this holistic perspective, and focus largely on understanding the interactions and cumulative effects of climate change and a host of other factors such as resource development, rapid social change, population growth, health decline, long range contaminant transport, and other factors. The magnitude of climate change impacts is often outweighed by the socio-economic stressors that Inuit communities face. Still, community residents largely agree on the urgency of climate change research and emphasize the need for accurate and reliable assessment of climate change impact. Especially important is the need for more frequent field monitoring to ground truth climate change scenarios and explain perceived discrepancies between the conditions and changes community members are observing and those forecasted by climate models.

Examples of specific questions and topics identified for further research in several key systems are reviewed below.

Marine Ecosystems

A majority of survey respondents commented on the marine system, which reflects the integral importance of the marine environment and resources for Inuit harvesting activities. Community expressed a need for research to define key marine ecosystem thresholds and climate change sensitivities, to monitor and assess changes at various ecological scales, and to investigate specific abnormalities. Questions about the combined role of climate change and other factors in explaining observed changes in marine wildlife behavior, health, migration patterns, and mortality are a particularly important area of interest for Nunavut communities. Other specific research topics and questions identified for the marine system include:

- What is causing specific physical and behavioral abnormalities in marine animals (e.g. what is causing changes in the texture of the skin of narwhal from Repulse Bay)? Are observed changes in marine mammal health determined primarily by changing climate conditions (e.g. water temperature, currents, salinity, sea ice) or by exposure to environmental contaminants?
- What is causing unexplained mortality events in local marine shellfish populations, e.g. sea cucumbers near Sanikiluaq? Studies of current events (real time studies) and past events (retrospective assessment) are needed.
- Need to document the current status, trends, and health conditions of marine mammal populations (e.g. small whales near Arctic Bay) that are unaffected by climate change as benchmarks and thresholds against which climate change impacts can be measured and assessed. Community members expressed concern that information be collected now, before species are affected by change.
- Assessments of how climate change will affect organisms (plankton) at the base of the marine food web are needed to assess “bottom up” implications for higher order consumers.
- Studies are needed to explain the causes of changes in sea water colour/quality. Elders requested a study to explain the appearance of reddish sea water plumes

near Pond Inlet. Kugaaruk residents expressed an interest in research to diagnose a strange oily slick on the ocean near Kugaaruk.

- The nature, origins and toxicity of strange reddish-yellow deposits and stains observed on sea ice and over land (e.g. at Kugaaruk, Hall Beach) should be determined. Similar deposits were discovered on ice near Repulse Bay in the 1990s and were determined to consist of Quebec tree pollen deposited by a rare low low–level atmospheric transport event. Are the deposits near Kugaaruk and Hall Beach examples of the same process? Do the stains constitute a health risk for animals or people?

Coastal Ecosystems

We have to ensure that all communities have a safe boat harbour. Without protection, a lot of boats have been lost in our community. We have to build better wharves. If we aren't prepared, we could get into a lot of trouble, especially if the summers are going to become longer.

(Ashevak: Participant at the Nunavut Tunnavik Incorporated Inuit Elders Conference on Climate Change, Cambridge Bay, 2001)

Nunavut residents from across the territory are reporting widespread and unprecedented changes in prevailing conditions and in the frequency and magnitude of extreme weather events affecting coastal areas. An increase in wave energy and storminess, changes in relative sea level, and changes in tidal dynamics are of particular concern to Nunavut communities, which, save one (Baker Lake), are all located on the sea coast and vulnerable to changes in the coastal environment.

Tides and Sea Level

Local observation of sea level change in Nunavut paints a complex picture. Evidence of sea level rise (higher mean high-tide mark, increased erosion) was reported by respondents from 7 communities, while representatives from 6 other communities reported sea level decline (evidenced by islands becoming larger, seaward expansion of terrestrial vegetation). Sea level rise was reported primarily in Eastern Baffin Island and the High Arctic communities, while sea level decline was reported in Western Baffin Island, Western Hudson Bay, Belcher Islands, and Foxe Basin). Rising tides have flooded hunting shacks and equipment, inundated archeological sites, and graves. Higher tides have prevented expansion of the Iqaluit cemetery and caused flooding of existing graves. Hunters in various communities have been forced to relocate shacks and equipment in several communities to higher ground to avoid tides. Sea level decline has made it more difficult for hunters in certain communities (e.g. Repulse Bay) to launch and land their boats from existing docking areas. Boat engines are more subject to fouling and obstruction due to an increased abundance of seaweed in the tidal zone near some communities.

Survey respondents from three Baffin communities also reported an increase in the tidal range (distance between high and low tide marks). Two survey respondents reported that tides no longer follow lunar cycles as closely as in the past. Accurately anticipating the timing and magnitude of tidal cycles (and Spring tide events) is critical for deciding when to launch and land boats, for planning when to conduct certain harvesting activities (e.g. shellfish gathering). Elders from Qikiqtarjuaq specifically identified the need for basic scientific research to explain the mechanisms driving the observed changes in tidal dynamics in Nunavut communities.

Wave Energy and Storminess

Respondents from four communities reported increased wave energy, both offshore and in the intertidal zone. Survey respondents from three communities reported that shellfish and plankton are being dislodged more frequently from tidal zone substrate due to the impact of stronger waves. Higher wave energy is attributed to an increase in the frequency and severity of high winds coupled with a reduction in the duration of seasonal sea ice coverage.

Winds are also reportedly less predictable, which has made open-water travel by small boats much more dangerous for many Nunavut hunters and their families. Several respondents stated that increasingly stormy, unpredictable weather is causing more boating accidents, and necessitates more planning and preparation. Higher winds and stronger waves are apparently causing more frequent and costly damage to boats anchored at community beaches. Community stakeholders have made urgent requests in recent years for the construction of breakwater structures and secure docking facilities to protect boats and equipment from increasingly rough waters, and to ensure the safety of hunters. In response to calls for safer marine facilities throughout Nunavut, the Government of Nunavut initiated a program in 2004 to build and/or upgrade small craft harbors in 7 Nunavut communities. Local consultations were undertaken in each of the 7 communities in 2004 to document local marine infrastructure needs and vulnerability, and engage local stakeholders in design process to ensure the facilities are most suited to local needs and conditions.

Community members have expressed support for applied research that will develop local adaptive capacity to anticipate and respond to major storm events, erosion and other coastal climate impacts.

In 2003, strong wave action brought on by high wind in Hall Beach damaged the recently built erosion control structure. Emergency repairs to the structure were necessary to protect nearby houses. Hall Beach is a community of 609 people located on Melville Peninsula, west of Baffin Island. Locals report that sea ice in the Hall Beach area forms much later than in the past, making the coast more vulnerable to storm surges caused by strong onshore winds.

Hall Beach residents examine damage to their local shoreline erosion control structure

Photo: Alan Johnson, Nunavut Government, Aug 2004

Freshwater Ecosystems

Changes in Nunavut's freshwater systems were addressed by all 36 survey respondents and emerged as an important theme from the workshops and meetings. Community members have expressed an interest in research that will help answer specific questions about new unfamiliar phenomena (e.g. new insects), and studies that will explain the nature and consequences of interaction between physical-biological changes in the freshwater system. Respondents from 9 communities identified new species of aquatic plants and insects as an important source of concern or curiosity; respondents from 10 communities expressed concern about the affects of declining water levels in rivers and lakes. Respondents from 4 communities reported that char occasionally suffer physical stress and injury (and increased predation mortality) due to low flow conditions in rivers during the fall when char return to their over-wintering habitat. In rare cases, low river levels are believed to have prevented the char sea run altogether, forcing formerly anadromous populations to become landlocked. Residents of several Nunavut communities have requested research to determine the causes for observed abnormalities and health impairment in local char populations.

A meeting convened in 2003 hosted by INAC to discuss water management needs in Nunavut, representatives from government and Nunavut Tunngavik Incorporated (NTI) - the agency tasked with implementing the Nunavut Land Claims agreement - identified the need for a range of research efforts to facilitate sound management of Nunavut's

freshwater resources in the face of climate change and other stressors. Participants stressed that climate change is already altering Nunavut's water systems, but baseline data on the extent (volume, location) and quality of freshwater resources in Nunavut is insufficient to detect and monitor climate change impacts. Additional research needs identified for Nunavut's freshwater systems include:

- Document and describe new, previously unknown species of aquatic insect and plants in ponds and rivers (e.g. near Arviat).
- Monitor water level decline in specific lakes (e.g. near Kugaaruk) and rivers and assess change in water availability and quality.
- Determine the uses and socio-economic value of water resources in Nunavut (on a community and regional scale) and assess the socio-economic consequences of changes in water resource quality and availability due to climate change.
- Help community residents determine why the colour and texture of sea run char populations near Arviat and Rankin Inlet are changing.
- Help community residents assess how Arctic char body condition and health are affected by lower water conditions in rivers during fall return migration to spawning areas (This was identified as a priority for the community of Whale Cove).

Fisheries

Nunavut fishers and fisheries managers recognize that climate change presents a significant challenge for the development of Nunavut's fisheries sector.

A recent strategic evaluation of options for the development of Nunavut fisheries underscores the importance of incorporating climate change considerations in long term planning for Nunavut fisheries development:

> Climate change is expected to lead to dramatic changes in Arctic water flows, leading to major [fisheries] management challenges, *particularly if fundamental ecological research has not been undertaken* [emphasis added]. This involves species interactions, habitat characteristics, and interactions between fishing practices and habitat/species balance (Brubacher Development Strategies Inc., 2004: 13)

Fisheries research needs identified through

- Assess the future sustainability of community water supplies in light of projected changes in precipitation regimes, and user demand (population growth).
- Expand the density and geographic coverage of precipitation and weather monitoring stations in Nunavut to help ground truth and refine climate models.

- Monitor and assess changes in marine fish abundance, productivity and distribution related to changing climate, and evaluate implications for marine fisheries development (e.g. for turbot, shrimp, char and clams)
- Develop realistic management options for fish populations that take into account future productivity and sustainable yield under climate change scenarios over the next 50-100 years

Terrestrial Ecosystems

Climate change impacts in the terrestrial environment are an important area of concern for Nunavumiut. Evidence of permafrost loss (e.g. more muddy conditions along trails) and changes in the quality and amount of snow cover have been widely reported across Nunavut. Changes observed in tundra biota include new and/or more abundant species of insects and plants; changes in plant diversity, productivity and phenology; and changes in the abundance, distribution, movements and health of caribou and other terrestrial birds and mammals. Respondents also provided very insightful hypotheses about the manner in which observed climate changes (e.g. reduced rainfall) are affecting tundra biota. For example, hot and dry summer weather is believed to have reduced the amount and quality of caribou forage available near some communities which in turn has affected caribou health, distributions, and ultimately, caribou availability to local residents. As in the marine system, survey respondents expressed an interest in specific research that will explain anomalies in the tundra environment that may be a source of harm. For example, Grise Fiord and Kugaaruk have requested scientists' help in explaining the nature and origin of strange yellowish greasy/sooty deposits that occur on tundra in spring-time. Community members have also called upon researchers to help explain unfamiliar phenomena (especially new unknown insect species). Other research topics include:

- Monitor and assess change in tundra vegetation cover (e.g. species composition change, tree line advance, caribou forage quality).

- Track rain-on-snow icing events and assess implications for caribou and Arctic hare animals.
- Monitor the rates and magnitude of glacier melt, and evaluate whether glacier melt water is a source of environmental contaminants.
- Determine the importance of glaciers as summer refuge for caribou and assess implications of glacier decline for caribou.
- Document and investigate local geothermal groundwater springs near Clyde River.

In 2003 an Arctic Bay resident contacted the Nunavut Research Institute for assistance in identifying a strange wasp which he photographed near his home community. The insect (above) was identified as a male of *Vespula intermedia*, a continental wasp previously undocumented on Baffin Island. Photo credit: Noire Iqalukjuaq, Arctic Bay, NU

Weather and Atmospheric Phenomena

Changes in weather and atmospheric phenomena are an important topic of local research interest. Elders from various communities have reported observing haze on the horizon and would like to know from researchers what causes this phenomenon. Kugaaruk residents requested a better explanation from researchers to explain why some years are still very cold despite scenarios of global warming. Elders from several Nunavut communities report a change in the timing of polar sunrise, and the position of the sun in the sky, prompting speculation that the Earth's axis has shifted. Several elders would like

researchers' insights on what might be causing this change, and what its broader implications might be. Hunters and elders from several communities reported that researchers should conduct more field studies of environmental conditions and variability during the winter – many community residents believe that climate change research field activities are confined primarily to the spring-summer season, and as a result scientific knowledge of winter conditions, and ground truthing of winter scenarios is insufficient. Community residents have also identified the need for better information on the micro scale spatial variability of wind conditions and snow drifting patterns to enable better community planning (e.g. help minimize the exposure of roads and houses to adverse snow drifting).

Climatologist Nikolaj Nwari assists students from the Nunavut Arctic College Environmental Technology Program to install a mobile automated weather station at the site of a new subdivision in Iqaluit, Nunavut. Photo: J. Shirley, Iqaluit, 2004

Human Health

Residents of several Nunavut communities have requested research to document, assess, and monitor potential negative health consequences associated with environmental change. Examples of specific questions and topics identified for further study include:

- How vulnerable are community residents to increased exposure to road dust during summer? Summers are reportedly warmer and drier in several communities, resulting increased road dust which is viewed as a potential respiratory health risk to residents.

- How serious is the problem of elevated UV exposure for Nunavut residents, especially those who spend considerable time outdoors? Community residents from across Nunavut report that the sun is stronger and more intense resulting in increased incidences of sunburn, rashes, snow-blindness and sores. Residents called for research to monitor and assess the exposure risk of Nunavut residents and the link between UV exposure and incidences of cornea damage, skin disorders, immune suppression, etc. There is also a need to identify and promote options for minimizing UVB exposure (e.g. making available high SPF sun block).
- The impacts of changing environmental conditions on drinking water quality (e.g. thermal changes, introduction of new aquatic insects and plants) is an important concern in several communities (e.g. Arviat).
- Elders from several Nunavut communities called for research to assess the link between environmental changes (climate change and environmental contaminants) and cancer rates among Nunavut residents.

"They should test the water, where we get our drinking water from"
(Research needs survey respondent, Arviat NU

Community Infrastructure and Public Safety

Houses on Piles, Iqaluit NU (J. Shirley, 2004)

"I think that there has to be more research into better pilings and research into the environmental realities of each community so that our houses can be better adapted to our disparate local climates" (Baker Lake elder N. Atunngalak, in Nunavut Tunngavik Incorporated 2001: 32).

There is a strong perception among many residents that the territory's built environment (houses, roads, airstrips, and commercial/institutional buildings) is being impacted by changing environmental conditions (permafrost melt) and an increase in the frequency and magnitude of hazardous weather events (high rains, heavy snow loads, wind storms). Old age and poor construction make Nunavut's infrastructure more vulnerable to environmental change.

Community members consulted as part of this survey reported a variety of extreme weather events impacts on community infrastructure and services. For example, an unprecedented wind storm in the fall of 2004 in the community Igloolik downed power lines and caused extensive damage to shoreline property. Several communities experienced unusually heavy winter snow fall events during 2005 resulting in massive snow loading on houses, and accumulation on roads. In Coral Harbour, the snow accumulation restricted road access to the community airport resulting in delays for emergency medical evacuations. Coral Harbour exceeded its annual budget for snow removal in 2005 and was forced to request additional snow removal funding from the Nunavut Government. Increased damage caused by increased snow loading on houses, and evidence of buildings shifting and/or sinking due to permafrost loss have also been reported from several communities. A deep hole in the paved surface of the Iqaluit airfield was discovered in 2003, raising questions about the conditions and dynamics of underlying permafrost, and the future sensitivity of the airstrip to thaw induced subsidence and settlement.

Infrastructure planners and managers in Nunavut are already revising design standards to accommodate changing environmental conditions. For example, the Nunavut Housing Association is now designing community dwellings to accommodate the heavier snow loading that is becoming the norm in some communities. The Nunavut Association of Municipalities passed a motion in 2005 calling on the Nunavut Government to support research to define and assess current infrastructure vulnerability in Nunavut, and to develop measures to reduce this vulnerability. Better means to improve community capacity to prepare for respond to weather related emergencies disasters have also been identified as a research need. Additional research needs related to community infrastructure might include:

- Community case studies to determine the environmental conditions and hazards that pose the most significant concern for community infrastructure and public health and safety.

- Assess current conditions and evaluate the potential for "failure" of existing roads, buildings, buildings, water-sewer lines, and especially airfields due to the combined affects of changing environmental hazards and aging.
- Conduct soil sampling and analysis to develop maps of community permafrost conditions and to model terrain thaw sensitivity/stability in support of land use planning and development.
- Update Nunavut construction standards and building codes (develop new climate design values) to reflect projected changes in the intensity, frequency and duration of extreme weather events.
- Develop or update community disaster and emergency planning to reflect current and future changes in the incidence of extreme events. For example, certain communities may need additional funding to deal with increasing snow accumulation that blocks road and runway access.
- Investigate and develop construction materials and methods that will make houses more sturdy and resilient to current and future environmental changes (esp. stronger winds and terrain subsidence/shifting).
- Elders from three communities report that higher frequency of windy days, more unpredictable winds make air travel more uncomfortable and potentially dangerous. Improved wind condition forecasting and vertical wind shear analysis for local pilots may help plan less turbulent travel.

Wildlife Harvesting

The impacts of environmental change on Inuit subsistence harvesting activities, and the means by which Inuit are dealing with these impacts are the subject of a growing body of academic research (e.g. Berkes and Jolly, 2001; Fox, 2002). Research has employed a participatory community case study approach (featuring semi-structured interviews and focus groups) to define and model the vulnerability and adaptive capacity of specific community harvesting activities, and more recently, to identify and prescribe policy options and strategic investments that can help make Inuit harvesting activities less vulnerable to climate change (Ford, Smit & Wandel, 2005). However, harvesting vulnerability assessments have only been completed in a small sample of communities, and there is a need for further research in more communities to understand how and to what extent Inuit subsistence practices are affected by changing conditions, and how local vulnerability can best be managed. Potential research needs directly related to harvesting include:

- Community case studies to define the specific conditions and changes that cause problems for local harvesting activities, to assess how and to what extent these conditions are being managed locally, and to the specific identify information, support, and resources community need to better manage their vulnerability
- Evaluate the responsiveness of wildlife management regimes to changes in seasonal abundance and distribution of quota species due to environmental change

- Assess the implications of climate change impacts (e.g. changes in local wildlife availability and access) for harvesting rights guaranteed under the Nunavut Land Claims Agreement
- Identify and develop new risk reduction technologies for hunters (e.g. floating snowmobiles, portable emergency shelters)
- Provide more detailed and geographically extensive satellite imagery of community sea ice conditions and the position of the ice edge conditions for Nunavut communities
- Develop community based projects to monitor and assess the safety of major sea ice travel routes (based on the Nunavik model)

Waste Management

Respondents from several communities identified concern about the combined impacts of warming and community population growth on local waste management and sanitation. One particular concern is that the prevailing trend toward warmer temperatures and stronger winds, coupled with deceasing capacity of municipal landfill due to population growth, will create conditions whereby local landfill sites will contaminate surrounding land, water and wildlife. Residents of several communities have reported that odors from local landfill sites have become stronger, possibly as a result of warmer summer temperatures. Climate change also raises questions about the long term effectiveness of containing contaminated soils *in situ* by buying them in permafrost. Engineers are incorporating temperature change scenarios in reclamation planning, and are considering measures such as placing larger "caps" on soil disposal facilities to ensure freeze back of contaminated materials and minimal the potential impacts of ground temperature warming.

Mining

Research needs related to mining identified through community consultation include:

- Evaluation of mining reclamation techniques that rely on permafrost encapsulation for tailings containment
- More intensive monitoring of mine reclamation efforts and tailings contaminants systems to assess their performance under changing environmental conditions (e.g. stronger winds and permafrost loss) and detect problems.
- Downscaling of climate models to improve the spatial and temporal resolution of ground temperature change scenarios used in mining impact assessment and reclamation planning
- Identification of soapstone deposits currently below the permafrost table that may become available as the active layer depth increases.

Local Perceptions of Research

The Value of Research

Nunavut residents have varied and often conflicting perspectives on the role and importance of scientific research in reducing their vulnerability to environmental change. The majority of Nunavut residents consulted over the course of this survey regarded climate change researchers as experts with specialized knowledge who can assist community members to understand and assess changes in the environment that cannot be explained by local knowledge alone. Research projects are viewed as a source of income from direct employment, sub-contracts, and purchase revenues, and as opportunities for young Inuit to receive valuable hands on experience and technical training. Research is also perceived as a tool that community members can apply to validate local hypotheses and assessments and thus add credibility to community perspectives in the national and international arenas.

Research Design

Several community representatives expressed frustration that their insights and knowledge are not sought and used more meaningfully by scientists when defining impacts and adaptation research questions, and in designing research field studies. Community members often feel they understand local environmental realities better than researchers and believe they can advise researchers on the optimal times and locations to conduct field sampling activities (especially for wildlife). Concern was raised that projects designed without sufficient local input often employ flawed sampling designs, increase the researcher's risks, and produce invalid results. Community members also feel that field researchers should consult local residents about the conditions, hazards (e.g. dangerous ice), archeological sites, and seasonal uses of areas proposed for research. By incorporating local knowledge, researchers can better prepare for field conditions, minimize damage to archeological resources, and avoid disrupting harvesting and land use activities. For example, local knowledge can help researchers identify and avoid areas of high polar bear concentrations (and thus reduce the likelihood of a defense kill). When consulting with communities, researchers should speak with a broad group of active hunters and elders; it is insufficient simply to speak with one or two elders.

Enabling Community-Researcher Partnerships

Although many researchers sincerely want to solicit local feedback at the conceptual stage of their projects, they often have difficulty identifying funding to undertake local consultation solely for the purpose of issue scoping or study design. Obtaining research funding requires the development of a proposal, which in many cases, precludes community involvement in project design (Nunavut Research Institute 1996). Community representatives consulted during the survey stressed the need for the bodies

that fund Arctic climate impacts and adaptation research to identify resources (e.g. "formulation grants") that can be used for pre-project consultation, partnership building, and collaborative research design.

Supporting Community Driven research

Beyond supporting the efforts of scientific researchers, a growing number of Nunavut residents also want to design, conduct and manage their own studies on climate impacts and adaptation questions/themes that they consider important and/or perceive that scientists are ignoring. Scientific researchers are viewed as "technical consultants" who can (and should) assist community groups in developing proposals, identifying and obtaining funding, collecting and analyzing data, and writing reports. There was a strong sentiment that researchers should do more to provide hands-on training and experience to young Inuit to help enable them to design and conduct climate change research. Holding training workshops for community youth was identified as one option. The need to record elders' knowledge about climate related changes, sensitivities, and thresholds in all the natural systems before the current generation elders pass away was identified as urgent. Representatives from several Nunavut communities requested that research funding be made available to community members to support local oral history collection and other special events (local elders and youth conferences) focused on facilitating the transfer of elders knowledge.

Community representatives also emphasized the difficulty they often face in identifying and obtaining funding to undertake their own research. Indeed, much of the funding for impacts and adaptation research in Canada (e.g. funds allocated by Canada's three granting councils) is accessible only by Universities, making it difficult for community groups without academic partners to obtain.

Community representatives need timely, updated information (in Inuktitut and English) on climate change research funding opportunities open to communities, and for an updated directory of impact and adaptation researchers who they can contact to assist in developing proposals.

Assessing Research Impact

The volume of climate change research projects in Nunavut and their intensity is thought to be increasing rapidly. Local respondents identified a variety of potential negative impacts from the increased research intensity including, local respondent fatigue (in cases of research duplication), disruption of seasonal harvesting and camping activities, increased administrative burdens on local regulatory agencies, increased search and rescue costs, increased disturbance of wildlife (and more bear defense kills), and environmental degradation. Positive impacts associated with research include more

opportunities for local training and employment, educational outreach opportunities, purchases of local goods and services, and access to scientific expertise and equipment that would otherwise not be available. Project specific and cumulative impact assessments are needed to better understand how climate change research itself (like any development activity) is affecting environmental and socioeconomic conditions in Nunavut, and to help weigh the benefits and risks of research activity.

Communicating and using research results

Many Inuit believe that researchers should be doing more to share their knowledge of climate change with Inuit communities. Inuit still frequently complain that they still do not receive the results from climate change studies conducted near their communities in a timely fashion. There is a need to assess why this perception exists, and to review and improve methods and structures currently in place to communicate climate change research findings to communities. In the case of projects that rely on samples or data provided by community members, for example, community members want results returned directly to the individual contributors, and not simply to the local HTO (hunters and trappers organization) or hamlet office.

Results from research relating to topics of immediate local concern that community members want to act upon, need to be returned quickly enough to the appropriate decision makers (and in the appropriate format) to enable a local assessment and response. Final study results are often made available too late for local action. It is acknowledged that access to raw data is a difficult issue requiring negotiation at the project outset - in some cases, researchers may be reluctant to share preliminary findings with local communities, especially if the data are unpublished and haven't been peer reviewed. However ensuring that the data can be used for local decision making may require releasing raw data.

There is a pressing need to document the extent to which adaptation research results are (and are not) currently used in local decision making, and barriers to the applicability and usefulness of research results, are also needed to help determine how impacts and adaptation research can and should be directed to benefit local needs.

Limitations

The Nunavut research needs survey reflects the views of only a handful of residents in each community. The variation of research needs and interests among various social groups within a community (e.g. elders vs. youth), among members of a single group, or between regions and communities are not addressed in the survey. Most conspicuously absent are the perspectives and research needs of Inuit youth (under age 25), who comprise 60% of the Nunavut population.

Conclusions

The Nunavut research needs survey provides is a useful point of departure for researchers endeavoring to develop projects that are sensitive and responsive to local needs. The survey provides a glimpse into the specific research questions of Nunavut residents, their perspectives of the value and utility of research and specific ideas about how research should be designed, conducted, and communicated. However, community perspectives and needs change over time, and the specific research needs and questions documented in this report need be verified and updated continually in consultation with community representatives. Frank Duerden (2004) notes that even communities within the same region may experience different impacts from the identical climate events due to their unique economies, demographics, and history (Duerden 2004). Detailed case studies are needed to develop a deeper understanding of the particular climate conditions and changes that matter to individual communities, and to identify the specific research products that local stakeholders can use to adapt to these changes. The importance of taking the time to learn about the unique needs and perspectives of individual communities, and of building local trust and rapport cannot be understated.

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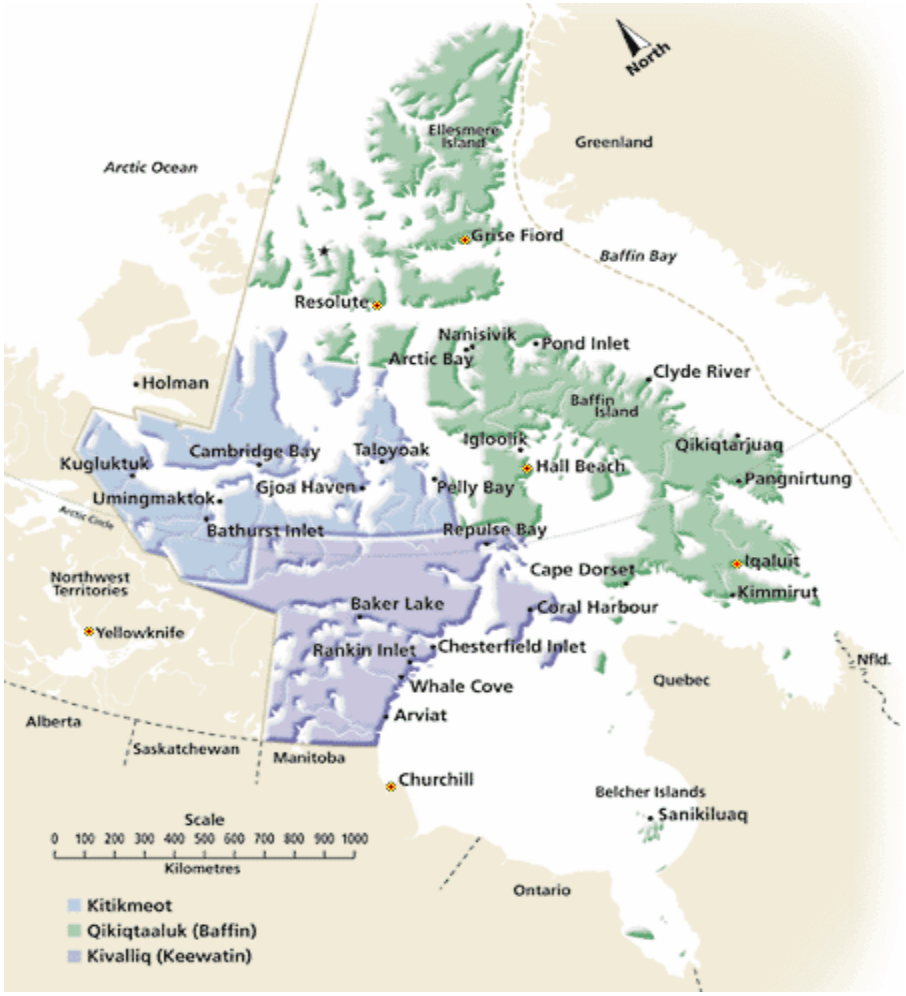
APPENDIX 1



Map of Nunavut's three administrative regions and 27 communities