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Reducing Vulnerability to Climate Change in the Arctic: The Case of Nunavut, Canada

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ABSTRACT. Research conducted with the communities of Arctic Bay and Igloolik in Nunavut identified key areas where policy can help Inuit reduce their vulnerability to climate change, focusing on the renewable resource harvesting sector. The policy responses are based on an understanding of policy development and decision making and on an understanding of the processes that shape vulnerability, which in Nunavut comprise the erosion of traditional Inuit knowledge and land-based skills, the weakening of social networks, and a reduction in harvesting flexibility. Policies relating to cultural preservation, wildlife co-management, and harvester support can serve as entry points for influencing these processes. Our recommendations fall within the mandates of the Government of Nunavut and the institutions created under the Nunavut Land Claims Agreement, and they have been identified as policy priorities by communities and Inuit organizations.

Key words: climate change, adaptation, policy, vulnerability, Inuit, resource harvesting, Nunavut, policy mainstreaming

RÉSUMÉ. Grâce à des recherches effectuées auprès des collectivités de la baie de l'Arctique et d'Igloolik au Nunavut, on a réussi à déterminer comment la politique peut rendre les Inuits moins vulnérables au changement climatique en se concentrant sur le secteur de l'exploitation des ressources renouvelables. La compréhension de l'élaboration des politiques, de la prise de décisions et des processus qui engendrent la vulnérabilité permet d'aboutir à des réponses en vue de l'établissement de politiques. Au Nunavut, cette vulnérabilité se traduit par l'érosion des connaissances traditionnelles inuites et des habiletés d'utilisation de la terre, l'affaiblissement des réseaux sociaux et l'atténuation de la souplesse caractérisant l'exploitation. Les politiques en matière de conservation culturelle, de cogestion de la faune et de soutien à l'exploitation servent de point d'entrée pour influencer ces processus. Nos recommandations cadrent avec les mandats du gouvernement du Nunavut et des établissements créés en vertu de l'Entente de revendication territoriale du Nunavut. Les collectivités et organismes inuits les considèrent comme des priorités en matière de politique.

Mots clés : changement climatique, adaptation, politique, vulnérabilité, Inuit, exploitation des ressources, Nunavut, intégration des politiques

Traduit pour la revue *Arctic* par Nicole Giguère.

INTRODUCTION

Climate change is considered to be a significant challenge for Inuit (ACIA, 2005). Communities, governments, and regional and national Inuit organizations have expressed concern over climate-related risks and highlighted the urgency of taking appropriate action (GNWT, 2001; NTI, 2001; GN, 2003a; Shirley, 2005; Watt-Cloutier et al., 2005). Existing policy responses to climate change have largely focused on reducing greenhouse gas emissions (mitigation). Even under the most aggressive emission control measures, however, current greenhouse gas emissions commit the earth to continued climate change (Wigley, 2005). The likelihood of adverse impacts has created a growing push for measures to reduce or moderate the expected negative effects of climate change (adaptation). To develop adaptation policy, we need to know the nature of community vulnerability (in terms of who and what are vulnerable, to what stresses, in what way, and why) and what capacity exists to cope with change (Smit and Wandel, 2006).

Although the problems posed by climate change are widely recognized and the need for action well established, research on adaptation policy for the Arctic is only nascent. The policy deficit is evident in the Arctic Climate Impact Assessment (ACIA, 2005), which highlights our limited understanding of the vulnerability of Arctic communities and contains little substantive discussion of adaptation policy. The deficit is also evident in the climate change agenda at federal and regional levels in Canada: despite pronouncements of the importance of adaptation policy, action has been limited (Newton et al., 2005). This paper responds to this deficit by outlining key areas in which policy can reduce vulnerability to climate change,

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and specifically, the vulnerability associated with renewable resource harvesting in small Inuit communities. We draw upon our climate vulnerability work conducted in partnership with the communities of Arctic Bay and Igloolik in the Canadian territory of Nunavut.

CLIMATE CHANGE POLICY

The United Nations Framework Convention on Climate Change (UNFCCC) (UN, 1992) and national governments have focused on the same two broad policy areas: mitigation and adaptation. Mitigation relates to efforts to reduce or stabilize greenhouse gas emissions in order to moderate changes in the climate. Adaptation refers to consciously planned adjustments in a system to reduce, moderate, or take advantage of the expected negative impacts of climate change (Smit et al., 2000).

Mitigation has been the primary focus of academic and political attention as a response to climate change (Huq and Reid, 2004). It has attracted most international attention and forms the basis of the UNFCCC and the Kyoto Protocol (UN, 1998). In Canada too, mitigation is the focus of climate change policy; under Canada's Kyoto commitments, greenhouse gas emissions have to be reduced by 6% compared to 1990 levels by 2008 – 12. Federal, territorial, and provincial plans have proposed a mix of approaches to achieve these reductions, which include investing in green technologies, developing and promoting public transportation, and implementing fixed emission limits for high polluters (GNWT, 2003; GN, 2003a; Government of Canada, 2005; Government of Yukon, 2006).

Adaptation is also recognized in the UNFCCC as an important component of climate change response policies (Smit et al., 1999). Article 4.1b, for example, commits parties to "formulate, implement…national and where appropriate, regional programmes containing measures to…. facilitate adequate adaptation to climate change" (UN, 1992:10). Article 11 of the Kyoto Protocol also commits parties to promote and facilitate adaptation to address climate change. The UNFCCC has established several programs to support adaptation, including the National Adaptation Programme of Action, the Kyoto Protocol Adaptation Fund, the Least Developed Countries Fund, the Strategic Priority on Adaptation, and the Special Climate Change Fund (Huq, 2006). The United Nations Development Program has prepared an Adaptation Policy Framework to provide guidance for developing adaptation initiatives, and adaptation figures prominently in work by bilateral and multilateral development aid agencies (Lim et al., 2005).

In Canada, adaptation has been recognized at both national and regional levels. The federal government has supported research on adaptation, including the Canadian Climate Impacts and Adaptation Research Network, and the Canadian International Development Agency has several climate change adaptation projects in developing countries. Federal, provincial, and territorial governments have prepared a National Adaptation Framework. In Arctic Canada, the governments of Nunavut and Yukon have indicated their intention to promote adaptation to climate change with the release of the Nunavut Climate Change Strategy and the Yukon Climate Change Strategy (GN, 2003a; Government of Yukon, 2006). Inuit organizations have also been vocal in stressing the importance of adaptation, which features prominently in the climate change section of the Inuit Action Plan, and Nunavut Tunngavik Incorporated (NTI), which oversees the implementation of the Nunavut Land Claims Agreement on behalf of Inuit beneficiaries, has organized workshops to discuss adaptation to climate change and outline priority areas for action (NTI, 2005).

However, despite discussions about adaptation at federal, provincial, and territorial levels, Canada has made little progress beyond statements of general principles (Newton et al., 2005; Burton, 2006): the climate change debate remains dominated by mitigation, as noted by Canada's Environment Commissioner (Office of the Auditor General, 2006). Canada needs a more balanced approach to climate change policy, in which adaptation figures more prominently alongside mitigation.

Adaptation is important for two main reasons. First, current greenhouse gas emissions commit the earth to continued climate change even under the most aggressive emission control measures (Hare and Meinshausen, 2006). For instance, estimates indicate that if atmospheric concentrations of greenhouse gases were capped at 2000 levels (considered extremely unlikely), temperature would increase by 0.4˚C to 0.6˚C over the next century (Wigley, 2005). Communities, regions, and economic sectors will have to adapt to some degree of climate change. As Nordhaus (1994:189) comments, "mitigate we might; adapt we must," is all the more pertinent in light of these projections. Adaptation should be a priority focus, especially for Canada's Arctic territories (Northwest Territories, Nunavut, and Yukon). With a combined population of only 100 000 and limited industrial activity, there is little their governments and residents can do to slow or stop climate change because they contribute so little to global greenhouse gas emissions.

Second, climate change is already occurring in some regions where populations are vulnerable. This fact is particularly relevant in the Arctic, where evidence already points to the impact of climate change on local weather patterns, wildlife, sea ice, and livelihoods (Krupnik and Jolly, 2002; Nickels et al., 2005; Gearheard et al., 2006). Adaptation policy can bring immediate benefits, and regional organizations and communities have stressed the need and importance of developing adaptive options that address both current and future climate-related vulnerabilities (DSD, 2003; Kusugak, 2005; NTI, 2005; Shirley, 2005; Streicker, 2005).

ADAPTATION POLICY RESEARCH AND DEVELOPMENT

Adaptation policy research seeks to identify what policy measures are required to moderate or reduce the negative

effects of climate change, as well as how best to develop, apply, and fund such policies. This section reviews and evaluates approaches to adaptation research and introduces a model to guide adaptation policy research and development in the Arctic.

"First Generation" Adaptation Policy Research

Climate change adaptation research has traditionally used scenarios of climate change to model biophysical system impacts and identified adaptation options that will reduce exposure to climate change impacts (O'Brien et al., 2004). This approach, termed "first generation" adaptation research (Burton et al., 2002), formed the basis of several research initiatives, including the U.S. Country Studies Program and United Nations Environment Programme (UNEP) Country Studies. Such studies assume that certain adaptations are needed on the basis of climate change projections alone, and these adaptations are primarily technological and engineering measures. They include the construction of sea defences to protect against rising sea levels, irrigation systems in regions where increasing drought is predicted, and enhanced drainage systems in regions where precipitation is expected to increase (Cuculeanu et al., 2002; Nicholls and Tol, 2006). In the Arctic, as well, research on climate change impacts has focused on specifying technical adjustments required to reduce exposure to climate change (Maxwell, 1997; Johnson et al., 2003; Instanes, 2005).

Experience, however, indicates that adaptation policy targeting climate change alone may not be practical, nor can it be incorporated successfully into the decision-making process (O'Brien and Leichenko, 2000; Dowlatabadi, 2002; Lim et al., 2005). For example, Naess et al. (2005) illustrate in their work in Norway that although scenario-based approaches were important in establishing local attention, they had limited impact on, or incorporation into, policy development. Several explanations are offered here.

First, climate change is only one source of stress on human systems. To policy makers, poverty, public health, economic development, infrastructure, and food security often seem more immediate and pressing needs than responding to future changes in average climatic conditions projected by global climate models (GCMs). In Nunavut, for example, established policy priorities largely relate to suicide prevention, nutrition, cultural preservation, education and training, and employment creation (GN, 2003b, c, 2005; Boyle et al., 2004; Shirley, 2005). Indeed, at the time of writing, despite the importance of climate change to Nunavut and the urgency of taking action indicated in the Nunavut Climate Change Strategy (GN, 2003a), the territory had no specific budget for addressing climate change.

Second, "first generation" research is rarely connected to current experience of communities and usually does not relate to actual decision-making processes (Smit and Wandel, 2006). For example, in the Canadian Arctic, a lot is known about how climate change may affect permafrost and coastal erosion (see ACIA, 2005). These are important system attributes, yet researchers have not assessed how communities, businesses, and governments will manage the changes in these physical systems. Furthermore, the conditions that communities are concerned about, and sensitive to, are those that affect hunting (Krupnik and Jolly, 2002; Nickels et al., 2005; Shirley, 2005). Communities have identified system attributes to which they are vulnerable while hunting (such as the time it takes for sea ice to reach a certain thickness, wind strength and predictability, and the relative timing of sea-ice breakup and animal migrations); however, these attributes are usually not captured in "first generation" research (Ford and the Community of Igloolik, 2006; Ford et al., 2006a, b; Pearce, 2006). Furthermore, the adaptive responses suggested by "first generation" research often do not involve consultation with local communities or government institutions. As a result, recommendations that seek to address the physical conditions are often impractical or inconsistent with local priorities or institutions (Newton et al., 2005).

Third, "first generation" research depends on climate change scenarios that, despite improvements over the years, are subject to significant uncertainty. Uncertainty is multiplied as scenarios produced by GCMs are applied to biophysical impact models that have their own inherent uncertainties. Imperfect knowledge of the relationships between climate parameters and other variables further complicates analysis (Adger and Vincent, 2005), and at a local level, the distinctive geography of widely dispersed communities further reduces predictive capacity (Laidler, 2006). Thus policy makers are faced with the prospect of developing adaptive responses to cope with projections that vary widely depending on the scenario and GCM used: for example, projections of sea level rise by 2100 that range from 0.11 m to 0.77 m (IPCC, 2001). Experience shows that policy makers are reluctant to develop policies based on uncertain results (Dovers, 1995). And as Barnett (2001:983) argues, "…committing resources to adapt to uncertain future dangers can actually make the future more dangerous by displacing basic strategies which enhance adaptability…. and by decreasing the size of the future resource base from which the community will need to draw on in times of crisis." Uncertainty in climate projections is unlikely to be reduced in the near future.

"Second Generation" Adaptation Policy Research

There is growing consensus that the key to adaptation policy research is to identify policies and measures for reducing or moderating the risks associated with climate change that can be integrated into existing decision-making processes and policy goals (Burton and Lim, 2005; Patwardhan, 2006). This approach to adaptation policy, known as "mainstreaming," is increasingly common in the climate change literature. Based upon an understanding of the processes that create vulnerability, mainstreaming involves linking climate change policy to policy normally

seen as outside the scope of climate change, including livelihood enhancement, poverty alleviation, education, improved institutional arrangements, and sustainable development. By integrating the management of climate change risks into existing policy, mainstreaming can lead to "win-win" or "no-regrets" adaptation through policy that reduces vulnerability to climatic risks while addressing other priorities. Enhancing capacity to deal with present conditions strengthens community resilience to longer-term climate change (O'Brien et al., 2004; Smit and Wandel, 2006). For adaptation policy to be successful in Nunavut, it should be mainstreamed into existing policy processes.

A Conceptual Approach for Adaptation Policy Research

To identify adaptation needs, inform development of policies to reduce vulnerability to climate change, and identify opportunities for mainstreaming, it is crucial to identify and characterize vulnerability (Smit and Pilifosova, 2003; Burton and Lim, 2005; Schröter et al., 2005). Vulnerability refers to the susceptibility to harm in a system in response to a stimulus or stimuli. The Nunavut case study developed in this paper uses the vulnerability approach of Ford and Smit (2004) and Ford et al. (2006a, b), which conceptualizes vulnerability as a function of exposure and adaptive capacity. Exposure reflects the susceptibility of people and communities to hazardous conditions, and adaptive capacity reflects a community's potential or ability to address, plan for, or adapt to exposure. Vulnerability at a local level is seen as conditioned by social, economic, cultural, political, and biophysical conditions and processes operating on multiple scales over time and space to affect community exposure and adaptive capacity. Adaptation policy must take into account cross-scale linkages that will influence the success of policy and determine policy entry points. This conceptualization is broadly consistent with other approaches to vulnerability, including those of Turner et al. (2003), Keskitalo (2004), ACIA (2005), Lim et al. (2005), and Smit and Wandel (2006).

In this approach to vulnerability analysis, the first step is to characterize *current vulnerability* by examining past and present experiences of variability, change, and extremes of climate, and the human responses to them. Through this analysis, we can 1) identify conditions that represent risks to community members, 2) characterize how communities experience and manage climatic risks, 3) identify the processes and conditions that influence exposure to climatic hazards and determine the efficacy, availability, and success of past and present adaptations, 4) identify opportunities for and constraints on adapting to climate change, and 5) identify entry points for adaptation policy. Then we can assess *future vulnerability* by analyzing how climate change will alter the nature of climate-related risks the community has identified, and whether the community's coping strategies will be capable of dealing with these risks. This analysis sets the context for adaptation policy and helps to assess policy options.

Place-based case studies are central to the vulnerability approach. Vulnerability will vary between nations, regions, communities, and even within communities, on the basis of differential exposure to climate change effects and differential adaptive capacity (Turner et al., 2003). Understanding the dynamic interaction between humans and the environment requires case studies situated in particular places and cultures. Actively involving communities in the research process is central in linking research to policy. Interventions to reduce vulnerability will be more successful if they are identified and developed in co-operation with local actors, as the community will be more likely to trust them and find them consistent with local goals and norms (Newton et al., 2005; Chapin et al., 2006). Working closely with communities also allows identification of key actors and institutions that play an important role in knowledge transfer and policy development (Huq et al., 2005). These points are particularly salient in the context of Arctic Canada, which has a long history of policy initiatives that were inappropriate in the Arctic context because they were based on research by non-local researchers, who defined terms of well-being for indigenous communities in relation to a worldview different from that of local residents (Berman and Kofinas, 2004). In light of this context, and with Inuit values enshrined in the Nunavut Final Agreement, policy recommendations that have not been identified and developed in collaboration with communities are unlikely to have the required legitimacy and integration of Inuit knowledge that are essential to decision making in Nunavut.

VULNERABILITY TO CLIMATE CHANGE IN NUNAVUT: ARCTIC BAY AND IGLOOLIK CASE STUDIES

Vulnerability assessments, especially assessments of the harvesting sector, have been conducted in only a few Nunavut communities (Shirley, 2005). However, climate change vulnerability analyses by the ArcticNet project (Ford, 2006; Ford and the Community of Arctic Bay, 2006; Ford and the Community of Igloolik, 2006; Ford et al., 2006a, b) have identified key trends and causes of vulnerability. The project was carried out in partnership with the communities of Igloolik and Arctic Bay, Nunavut (Fig. 1), which are illustrative of Nunavut's 28 communities. In the absence of more detailed case studies, and given the urgency to develop adaptive strategies in light of rapid ongoing and predicted climate change, the trends emerging from this research can identify key entry points for adaptation policy.

Arctic Bay and Igloolik Case Studies

Igloolik is a coastal Inuit community of around 1538 people located on Igloolik Island in northern Foxe Basin, Nunavut, approximately 320 km north of the Arctic Circle (Fig. 1). The island is located off the east coast of the

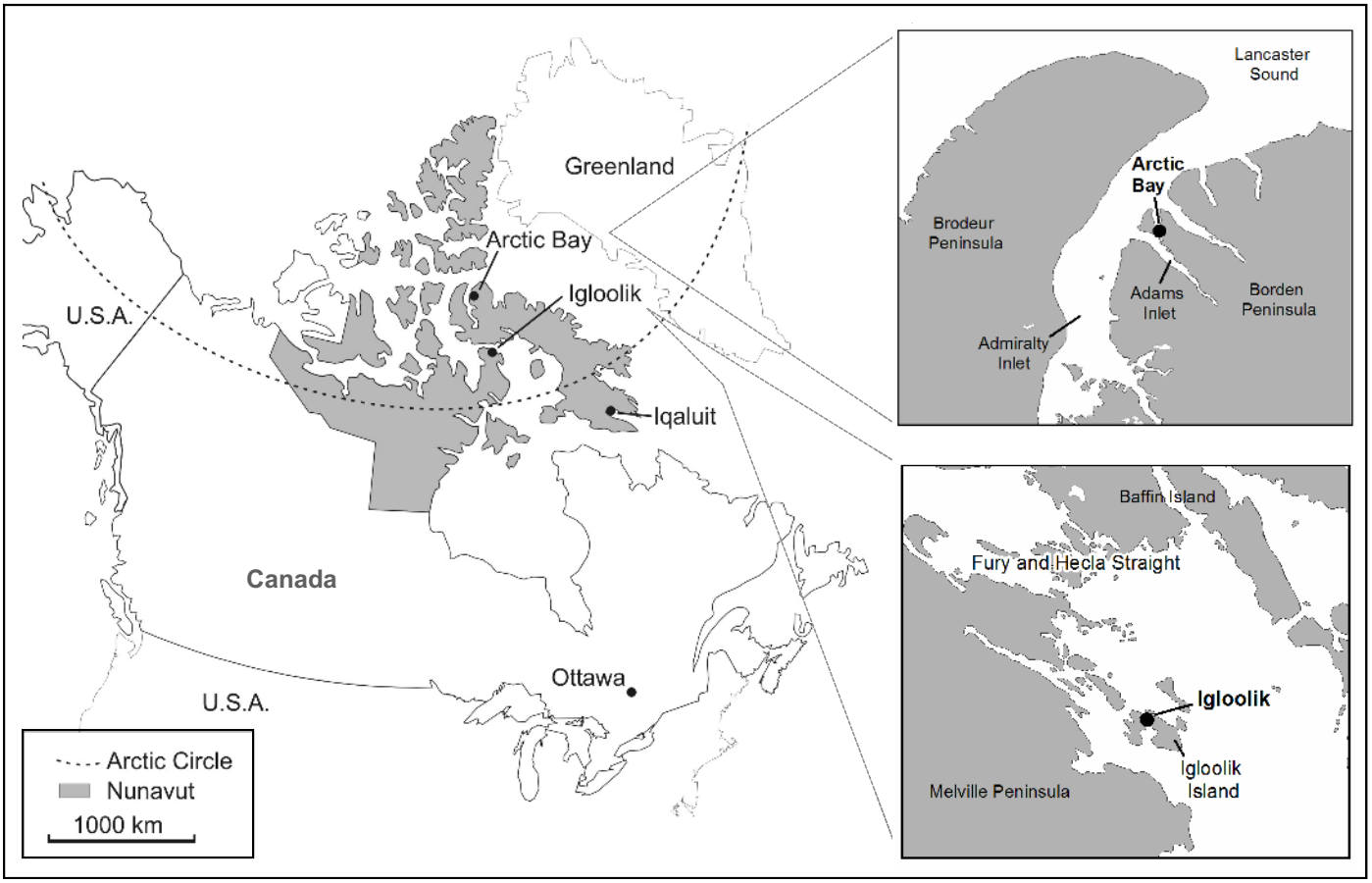

FIG. 1. Vulnerability analyses were conducted in the communities of Arctic Bay and Igloolik, Nunavut.

Melville Peninsula, and like the mainland, it is characterized by a relatively flat topography. Arctic Bay, another coastal Inuit community with around 700 people, is located on the mountainous north Baffin Island, Nunavut, approximately 700 km north of the Arctic Circle (Fig. 1). Harvesting of renewable resources continues to be a valued activity in both communities and contributes significantly to their food supply (Reeves, 1993; Rasing, 1999; NWMB, 2004). Narwhal, ringed seals, walrus, beluga whale, arctic char, caribou, polar bear, and a variety of migratory birds are the mainstays of the wildlife harvest in both communities (NWMB, 2004).

The research involved close collaboration with community members at all stages, from project design to interpretation to dissemination of results (see Ford, 2006). Fieldwork, conducted in 2004–05, included 105 in-depth, semi-structured interviews with a cross section of community members, 65 in Arctic Bay and 40 in Igloolik. The goals were to identify conditions to which each community is currently vulnerable, to characterize the factors that shape vulnerability and how they have changed over time, and to identify entry points for adaptation policy. The data were collected in collaboration with Inuit colleagues. Experiential trips on the land with Inuit and informal meetings with key informants complemented the interviews. Analysis of all available secondary sources, including interviews in the Igloolik Oral History Project, government reports, newspaper articles, books, university theses, accounts of polar explorers, and journal articles, was used to add historical context on how communities manage and experience climatic variability and change.

KEY CHARACTERISTICS OF VULNERABILITY

High Level of Adaptive Capacity

Analysis of past and present experiences of and responses to climate variability, change, and extremes indicates significant adaptive capacity among Inuit. Table 1 shows how community members in Arctic Bay and Igloolik are responding to the climate change they are experiencing today; similar responses have been documented throughout Nunavut (see Fox, 2002; Thorpe et al., 2002; Nickels et al., 2002, 2005; DSD, 2003; Laidler, 2006). Responses are largely behavioural and include avoiding, minimizing, and sharing risk. Many of these are strategies traditionally used by Inuit to manage climatic exposures that affect harvesting, but with climate change, they are becoming increasingly important and are used more often. The ability of Inuit to cope or deal with climate change is indicative of their adaptive capacity. This capacity is facilitated by Inuit knowledge and land-

TABLE 1. Adaptive strategies employed by Inuit in Arctic Bay and Igloolik to deal with climate change and associated costs (adapted from Ford et al., 2006a).

Climate Change Related Risks	Adaptive Strategies	Adaptation Costs
Unpredictability of weather, wind, and ice	• Take extra food, gas, and supplies in anticipation of potential dangers. • Make sure that they travel with others when possible. • Be risk averse, avoiding traveling on the land or water if they expect bad weather. • Use TV and radio weather forecasts to complement traditional forecasts. • Take along new equipment, such as personal location beacons, immersion suits, and satellite phones.	• The cost of purchasing extra supplies is prohibitive for many who have limited income. • Avoiding travel at certain times results in shortages of some traditional foods and the need to purchase more store food. • New equipment is often expensive.
Waves or stormy weather for summer boating	• Wait in the community for adequate conditions. • Identify safe areas where shelter can be found prior to travel.	• Waiting results in reduced harvests and the need to purchase more store food. • Avoiding certain areas can result in higher gas costs and add more time onto hunting trips (a problem for those with full-time jobs).
Snow covered thin ice	• Avoid snow covered areas. • Take extra care while traveling.	• Avoiding certain areas can result in higher gas costs and add more time onto hunting trips (a problem for those with full-time jobs).
Reduced accessibility to hunting areas	• Wait in the community until hunting areas are accessible. • Switch species and location. • Develop new access routes – e.g., overland travel instead of ice travel. • Share country food.	• Waiting results in reduced harvests and the need to purchase more store food. • Not all have the hunting skills to switch species. • New routes can be more time consuming, have higher fuel costs, and be more damaging to equipment.

based skills, strong social networks, flexibility in seasonal hunting cycles, and economic and institutional support.

Inuit knowledge (IK) and land-based skills contribute to the adaptability of hunting and harvesting livelihoods. From knowledge passed down the generations and from repeated personal experience and observations, hunters learn the inherent dangers of hunting, how to evaluate risks, what preparations to make before hunting, and what to do in emergency situations. As a repository of accumulated experience and knowledge of changing conditions and successful adaptations, IK is drawn upon both to maximize hunting opportunities and to minimize the risks. Like other forms of indigenous knowledge, IK is highly experiential, continually expanding and changing in light of observations, trial-and-error experience, and incorporation of non-traditional knowledge alongside the traditional (Berkes, 1999; Huntington et al., 1999; Huntington, 2000; Laidler, 2006). IK has also evolved and changed in response to recent climate changes, through experience with increased exposure and successful adaptations and collective discussion of them. The increasing unpredictability of the weather and sea ice, for example, is now part of the collective social memory that frames individual practice and decision making. Moreover, as a repository of accumulated experience and knowledge of changing conditions and experience of successful adaptations, IK allows "response with experience" to changing exposure (Ford et al., 2006a, b), which confers significant adaptability.

Social networks are a key component of adaptive capacity, increasing security and reducing risk, and have been important in facilitating Inuit survival in the harsh Arctic environment (Damas, 1972; Wenzel, 1991; Robards and Alessa, 2004). While the complex social networks characteristic of traditional Inuit society are not readily evident today, the "economy of sharing," as Wenzel (1991:99) describes it, remains central to Inuit livelihoods across the Canadian Arctic (Oakes and Riewe, 1997; Usher et al., 2003). These networks include a high level of interdependence within the extended family unit and a strong sense of collective community responsibility and mutual aid. These networks facilitate the sharing of food, equipment, and knowledge and ensure rapid response to crisis. The sharing of food in the extended family unit, for instance, underpins the food security of those who do not have the time, money, or knowledge to hunt in light of changing biophysical conditions. Sharing knowledge is also important: elders and experienced hunters act as an "institutional memory," maintaining and transmitting local knowledge and providing adaptation information during periods of change (Ford et al., 2006a).

Flexibility in resource use is a widely recognized strategy for managing risk (Colding et al., 2003). Among Inuit, flexibility in harvesting has traditionally facilitated successful adaptation to, and exploitation of, changing climatic conditions (Balikci, 1968; Bane, 1982; Sabo, 1991; McGhee, 1996). The opportunistic nature of hunting maintains much of this flexibility today: hunters will harvest what is available when it is available and where it is available, making ad hoc changes (where quota systems allow them) to take advantage of game availability and specific local conditions

TABLE 2. Harvester support programs currently offered by Nunavut Tunngavik Incorporated (NTI) and the Department of Environment (DoE), Government of Nunavut, which have potential to reduce climate change vulnerability.

Program	Institution	Details	Relevance to Climate Change
Disaster Compensation	DoE	• Reimburses harvesters for equipment loss due to natural hazards. • Maximum compensation is $4500 per occurrence.	• Provides harvesters with start-up money after a major setback due to hazards. • Is more important as incidence of climate-related hazards increases.
Community Harvesters Assistance	DoE	• Financial support for fuel, harvesting equipment and supplies, radios etc.	• Facilitates purchase of safety equipment needed because of climate change.
DoE – Workers Compensation Board Memorandum of Understanding	DoE	• Those dependant on harvesting for more than 25% of their income are eligible for compensation if injured while harvesting. • DoE is invoiced annually for compensation paid out by the compensation board.	• Provides insurance for those injured in climate-related accidents.
Capital Equipment	NTI	• Provides assistance to harvesting households that cannot afford to invest in the equipment they need to hunt.	• Facilitates purchase of new equipment (e.g., boats, sleds) needed because of climate change.
Small Equipment	NTI	• Provides small equipment (GPS, VHF radios) at subsidized cost.	• Provides small equipment important in managing climate-change risks.
Community Harvest	NTI	• Provides financial aid to local Hunters & Trappers Organizations to organize a community hunt to benefit members of the community. • Maximum of $3000 available for each hunt in each community.	• Helps to provide food for those who cannot hunt because of climate change.

during hunting. In Arctic Bay, for instance, if the caribou hunt in August and September fails, other fall-back species, such as seal will be harvested (Ford et al., 2006a). Substitution allows people to cope with, and take advantage of, variations in animal numbers and also enables them to manage changes in the accessibility of hunting locations. This is particularly important now that recent climate change has affected this accessibility and availability.

Monetary transfers from the federal government, the Government of Nunavut (GN), and institutions formed under the Nunavut Land Claims Agreement, while not designed to address climate change risks, nonetheless play an important role in providing financial support to cover climate change adaptations (see Table 2). For example, the small equipment fund offered by NTI provides subsidized safety equipment such as VHF radios, personal locator beacons, and immersion suits. And the disaster compensation fund offered by the GN Department of the Environment (DoE) provides harvesters with start-up money after a hunting accident in which equipment is lost or damaged. Financial support of this nature is particularly important in the Arctic context, where high levels of unemployment and limited opportunities to earn money limit individual purchasing power.

Emerging Vulnerabilities

Strategies by which Inuit deal with climate variability, change, and extremes are not without their costs, and the ability of people to respond is unequal (Table 1). Technological adaptations, for instance, are available only to those who can afford them, and evidence suggests that technological developments increase inequalities within communities (DSD, 2002; Ford and the Community of Arctic Bay, 2006; Ford and the Community of Igloolik, 2006). Avoiding travel to certain locations at certain times of the year has implications for the availability of country food, and avoiding dangerous areas can be costly if it adds extra distance to trips. Quota systems on certain animal species restrict the flexibility with which hunters can respond to changing accessibility of hunting areas and abundance of animals. The effectiveness of adaptation also varies. Some adaptation technologies, for instance, can increase exposure to climatic hazards by encouraging risk-taking behaviour (Aporta et al., 2005). And other adaptive responses might be maladaptive; for example, opportunistic hunting may backfire if it interferes with the adaptation to climate change of prey species whose numbers and distribution are changing. In other areas, characteristics of Inuit society that traditionally facilitated adaptability were altered during the last half of twentieth century as a result of changing livelihoods. Over time, this has resulted in the emergence of vulnerable groups, specifically younger-generation Inuit and those without access to economic resources.

An erosion of Inuit knowledge and land-based skills—through which hunting risks are managed—has been documented among the younger generation of Inuit throughout Nunavut (Rasing, 1999; Aporta, 2004; Takano, 2004a) and in the Canadian Arctic generally (Condon et al., 1995; Newton, 1995; Collings et al., 1998; Pearce, 2006). While subsistence activities remain important to younger-

generation Inuit, fewer are displaying the same degree of commitment or interest in harvesting. This decline has been attributed to southern educational requirements, which result in decreased time to participate in hunting; increased dependence on wage employment; a general shift in social norms; and segregation of the young and older generations (Kral, 2003; Takano, 2004a). Consequently, certain skills necessary for safe and successful harvesting have been lost, including traditional forms of navigation and the ability to make snow shelters. Other skills have been inadequately developed, including how to dress appropriately, knowledge of what equipment to take along on trips, and the ability to identify precursors to hazardous conditions. Young hunters are therefore more vulnerable when they travel and hunt without experienced hunters.

> It is more dangerous [for the younger generation] because they don't know the conditions, what to avoid.
>
> Kautaq Joseph, Arctic Bay

> I think we have lost the skills so much. I mean, what would have not been dangerous for a man 50 years ago is now dangerous…. because we have lost so many skills.
>
> James Ungalak, Igloolik

> If you don't know the traditional knowledge, you won't last very long: you will freeze to death if you don't know how to survive.
>
> David Kalluk, Arctic Bay

The functioning of social networks has been affected by a decrease in the importance of the extended family, the emergence of inter-generational segregation, a decline in the practice of traditional cultural values, and the concentration of resources in fewer hands (Wenzel, 1995; Kral, 2003; Kishigami, 2004). The increasing importance of money has created division and social tension, and even previously non-monetary sharing practices may now involve money. The sharing of equipment, in particular, is practiced less today, although traditional foods (often referred to as "country foods") are still widely shared. The increasing use of money has also produced economic dependence, making Inuit vulnerable to the volatility of external markets and government support. The recent closure of the Nanisivik mine near Arctic Bay, for example, forced many former employees to sell hunting equipment that they could no longer afford (DSD, 2002). For young Inuit, in particular, the lack of monetary resources limits their opportunities to take part in harvesting activities, further reinforcing the decline in participation and erosion of traditional skills (Collings et al., 1998; Conference Board of Canada, 2002). Weakened social networks compromise the capacity to cope with changing climatic conditions.

New technology and institutional support have, to an extent, emerged to fill the gap left by weakening of social networks and erosion of traditional knowledge. Global Positioning System (GPS) receivers, for instance, mean that traditional navigational knowledge is less necessary for safe travel. Snowmobiles permit hunters to travel long distances fast and without the knowledge required to operate a dog team. However, new technology has also increased risk-taking behaviour and dependency on monetary resources (Aporta et al., 2005).

> We go to areas where we wouldn't normally go because we are assured [by the GPS] we will know where we are…. We [also] take more chances."
>
> Nick Arnatsiaq, Igloolik

> The dog teams know the thin ice and the thicker ice so [people] know that they can walk through thin ice. Snowmobile doesn't say, 'Alert! This is thin ice.' So it's more dangerous [by snowmobile] than by dog team.
>
> Herve Paniaq, Igloolik

Institutional support is also important in buffering risk: people no longer starve in years when there are no animals, as happened occasionally in the past. However, there is also evidence that such institutional support has heightened some inequalities in the community, further weakening social networks (Ford and the Community of Arctic Bay, 2006; Ford and the Community of Igloolik, 2006).

Figure 2 illustrates that these factors affecting vulnerability are interdependent, and that the erosion of adaptive capacity and increased exposure to environmental risks at a community level must be understood in the context of processes operating at different scales. Furthermore, it is evident that the factors producing vulnerability are in many cases mutually reinforcing. For example, Figure 2 demonstrates that the erosion of IK and land-based skills among younger-generation Inuit, largely a consequence of the imposition of western education in the 1970s and 80s, reduced young people's participation in hunting. Elders and experienced hunters perceived that the young were not interested in hunting or traditional Inuit ways, which reduced intergenerational contact. Lack of contact further reduced the land-based skills of the young, creating a situation in which youth are not involved in hunting from an early age; thus, young Inuit are locked into a spiral of traditional knowledge erosion.

LINKING VULNERABILITY ANALYSIS TO ADAPTATION POLICY IN NUNAVUT

This section identifies entry points for adaptation policy in Nunavut that target the factors affecting vulnerability to climate change, identifies agencies responsible for implementing such policies, and highlights ways to facilitate their implementation. It outlines the ways in which three specific entry points—cultural preservation, wildlife management, and harvester support—can reduce vulnerability to climate change and increase overall community well-being. These recommendations target different levels of

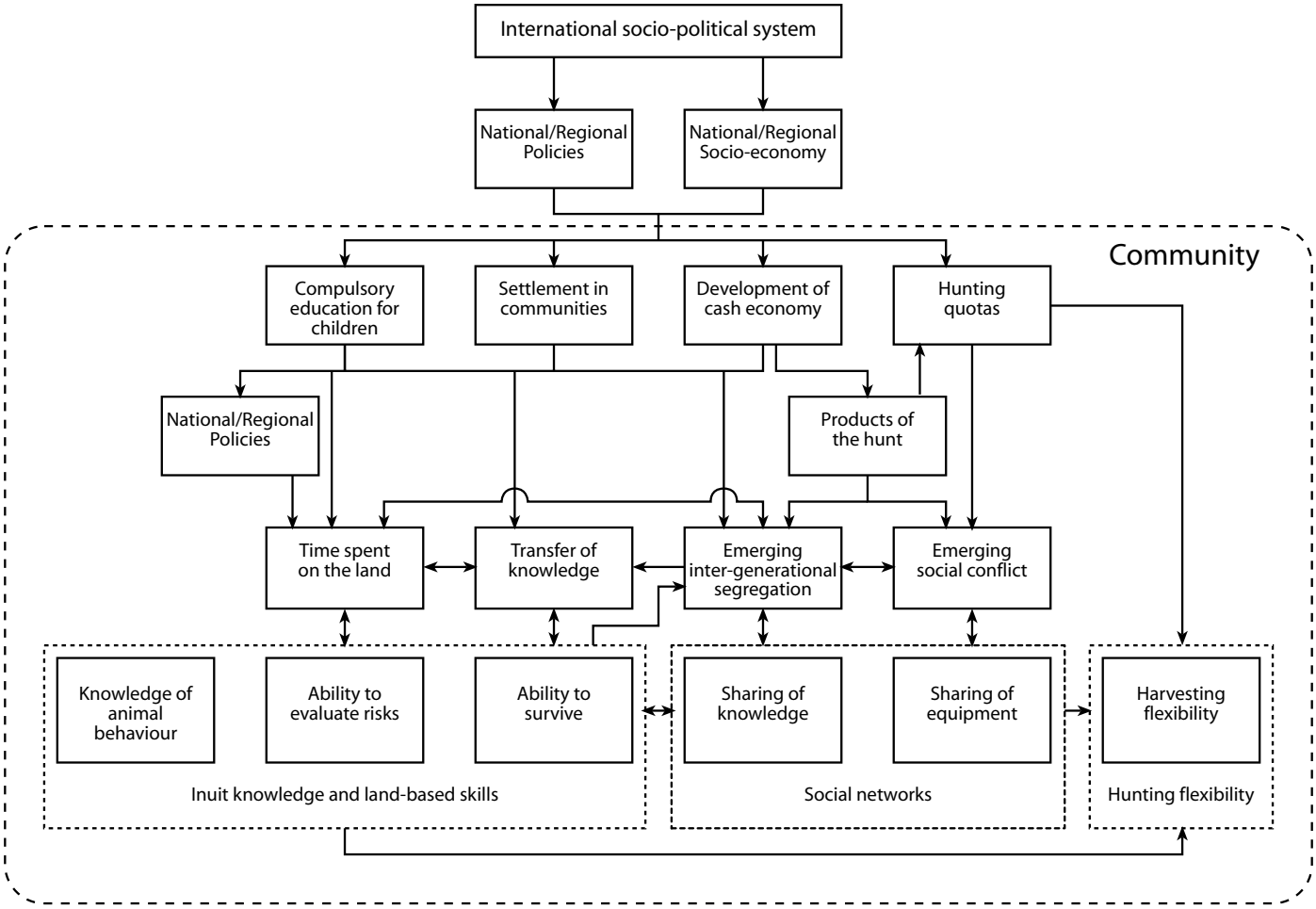

FIG. 2. Factors influencing emerging vulnerability in Arctic Bay and Igloolik.

decision making. The first recommendation, to develop key skills and knowledge among vulnerable groups, targets the individual as the decision-making unit. The other two recommendations, to strengthen and prioritize existing management and support systems, target local, territorial, and federal institutions charged with wildlife management and harvester support. Although these initiatives are explored here in the context of adaptation to climate change, they also concern ongoing policy initiatives in areas of economic, social, and cultural development. Linking climate change policy to these broader policy goals is the essence of adaptation "mainstreaming" (Huq and Reid, 2004; Smit and Wandel, 2006).

Cultural Preservation

Policies that promote and preserve Inuit knowledge, culture, and values have the potential to increase safe hunting practices among vulnerable groups. The erosion of IK and land-based skills strongly affects the vulnerability of young people in Nunavut to climate change. By reducing exposure and increasing young people's capacity to adapt to current climatic stresses, cultural preservation policies can potentially reduce vulnerability to future climate change. And while climate change might make certain aspects of IK obsolete, basic survival and safety skills and knowledge of the land will remain essential to managing and taking advantage of changing conditions (Ford et al., 2006a, b).

Programs offered by Igloolik's Inullariit Society provide a model example of how Inuit culture, heritage, and values can be promoted and preserved at a community level. The society, formed in 1992, offers as one key activity a land skills training program. Elders and experienced hunters take young Inuit "on the land" for weeks at a time to train them in skills such as navigating, recognizing and preparing for various hazards, loading sleds, identifying snow formations, and predicting weather. Training in non-traditional skills, which includes firearm safety and vehicle management, is also important in these programs. Teaching replicates the way in which knowledge and values were traditionally developed: learning by doing, watching, and being on the land. Important safety lessons for hunting and traveling are passed on to younger Inuit in these sessions, along with the values and attitudes essential for survival in the Arctic: patience, persistence, calmness, respect for elders, and respect for the environment (Takano, 2004b). The success of the program in reducing

hunting accidents among youth is debated (Ford et al., 2006b), as accidents are still common. But community interviews generally indicated that those young people who take the course are better situated to manage the risks of hunting than those who do not.

Land skills training programs have value well beyond reducing vulnerability to climatic stresses. IK forms the basis of Inuit cultural identity, spirituality, and values, and preserving and promoting these is important to community well-being. The Government of Nunavut's Youth Identity Development Strategy (GN, 2003b), for example, identifies the learning of traditional skills as an area of major importance to youth and one where support is needed. Workshops and interviews with elders in Nunavut have identified the importance of passing on traditional knowledge (GN, 2000, 2005, 2006). These were also dominant sentiments expressed in interviews with community members in Arctic Bay and Igloolik.

> My main concern is passing on traditional knowledge in terms of the weather, hunting, and so on, the social knowledge, the Inuit traditional knowledge.
>
> Koonark Enoogoo, Arctic Bay

> It is a real concern [to people in the community] that these general skills and ability to read the weather are not being passed on to the young as they should be.
>
> John MacDonald, Igloolik

> What do we expect in our future? To be able to preserve our culture so each individual feels good about [himself or herself].
>
> Anonymous, South Baffin Youth Workshop, Nunavut (from GN, 2003b)

> I would prefer [using] Inuit traditional knowledge in the wellness teaching.
>
> Anonymous, unspecified Nunavut community (from Kral, 2003).

Not only did participants in Igloolik's land skills training program learn important hunting skills, but the program also strengthened their relationships with each other, with their cultural heritage, and with their elders, (Wachowich, 2001; GN, 2003b; Takano, 2004a, 2005). By increasing elder-youth interaction, land skills programs can play a major role in strengthening intergenerational bonds and facilitating improved knowledge transfer.

In addition to the land skills training program, the Inullariit Society of Igloolik offers other programs, including classes that demonstrate how to prepare animal skins, make traditional clothing, and build igloos. Kral (2003) identifies these activities collectively as essential to community well-being, serving to strengthen community social networks and increase individual self-esteem. And Kirmayer et al. (1998, 2000), in their work among small Inuit communities in Nunavik, Northern Quebec, demonstrate links between cultural programs, greater engagement with a community, and reduced suicide risk among youths aged 15 to 25.

Lack of funding has limited the Inullariit Society's programs in Igloolik (Takano, 2004a) and remains a constraint on the development of such initiatives elsewhere in Nunavut (GN, 2000, 2005). Residents in Arctic Bay expressed the need for such a program in their community.

> If they set up a camp here for young people, that could be used to revive the traditional skills.
>
> Leah Kalluk, Arctic Bay

> I think [they] should have more kids going out with older people. They should have more of those kinds of activities in the community.
>
> Martha Attitaq, Arctic Bay

Within the Government of Nunavut, the Department of Culture, Language, Elders and Youth (CLEY) is the department responsible for developing and implementing policies, programs, and services aimed at strengthening the culture, language, and heritage of Nunavummiut (Inuit from Nunavut) (GN, 2006). Nunavut Tunngavik Incorporated is responsible for supporting the traditional harvesting lifestyle of Inuit in Nunavut. The vulnerability assessment supports suggestions made at CLEY and NTI workshops held with Nunavummiut (GN, 2000, 2003b, 2005, 2006). It also supports the plans of both organizations to provide both funding and hands-on support for community projects that will help preserve or promote Nunavut's cultural heritage, and specifically to develop and strengthen land skills training programs. Training should extend to include non-traditional harvesting skills (e.g., GPS use, snowmobile maintenance) and provide a forum for discussing climate change risks, implications for hunting and safety, and adaptation experience.

Cultural preservation programs could form part of Nunavut's climate change adaptation plan. Maintaining and promoting Inuit knowledge and values and integrating them into policy are central to the government's mandate and that of all departments. Successful implementation of the climate change adaptation plan is more likely if climate change policy is linked to these broad objectives, rather than limited to policies designed to address specific projected impacts.

Wildlife Management

Quota systems currently limit the number of animals that can be caught in a given year (narwhal, polar bear) and, in some instances, the timing of the hunt (polar bear). These systems intend to ensure that resources are sustained, but they affect the flexibility with which hunters can respond to climate change. The use of quotas and their allocation at community level have also been linked to conflict between community members, with consequent weakening of social networks.

> [The quota] angers a lot of people …. old and young. They fight amongst each other, they divide families, because [of] disagreement how they should distribute the quotas.
>
> James Ungalak, Igloolik

Climate change will increase pressure on existing quota systems and create increasing demand to develop quotas for currently unregulated species, including seal and caribou. Ringed seals, for instance, are believed to be particularly susceptible to climate change. They depend on the sea ice as a resting platform and for pupping, lactation, haul-out, and moulting, and they require sufficient snow cover in spring to construct their subnivean birth lairs (Ainley et al., 2003; Ferguson, 2005). All these conditions will be affected by climate change (ACIA, 2005; Dumas et al., 2006). Climate change is also likely to increase harvesting pressure on seals; easily accessible year-round near most Nunavut communities, seals become "fallback" prey when hunters cannot access hunting grounds for other species.

Caribou are also believed to be susceptible to climate change. In the High Arctic, Miller and Gunn (2003) documented a 97% decrease in caribou numbers from 1994 to 1995–96 associated with an unusually hard snow pack during early winter and severe ice that created unfavourable foraging conditions. Models indicate that these conditions will be more common in the future, with increased frequency of winter freeze-thaw cycles and freezing rain producing ice conditions unfavourable for caribou (Walsh, 2005).

There is also potential for conflict as species currently regulated by quotas are affected by climate change. The timing of the narwhal migration into Arctic Bay, for instance, could be delayed so that the floe-edge ice hunt is no longer possible. Narwhal numbers could also be negatively affected by climate change (Laidre and Heide-Jorgensen, 2005; Ford and the Community of Arctic Bay, 2006). Polar bears—of significant economic and cultural importance to Inuit communities—are also susceptible (Derocher et al., 2004).

Increasing pressure from the international scientific community to strengthen existing quotas and develop new quota systems has the potential to place federal regulators at odds with communities and Inuit organizations. (For examples of conflicts over polar bear quota allocation that offer a portent for conflict over wildlife management in light of climate change, see Wenzel, 2005 and Diduck et al., 2005.) Developing and altering quotas in response to these outside pressures, which do not take into account local hunting needs, the ecology of harvesting, or community concerns, will almost certainly increase community vulnerability to climate change, undermining social networks and limiting the flexibility of hunting that has traditionally facilitated adaptive capacity.

Creative approaches that integrate IK, scientific understanding of stock vulnerability to climate change, and community concerns are required to build wildlife management strategies that maintain community resilience in light of predicted climate change. Emerging co-management agreements over the allocation of narwhal quotas in Nunavut offer an example of how this can be achieved. Since 1999, narwhal quotas have been determined in a co-management body composed of the local Hunters and Trappers Organization (HTO), the Nunavut Wildlife Management Board, Nunavut Tunngavik Incorporated, and the federal Department of Fisheries and Oceans (DFO). Although the fixed level of the quota is set federally by the DFO, there is flexibility: the community has the opportunity to carry over the total allowable harvest from the previous year or borrow from the limit for the following year (Armitage, 2005). This flexibility is particularly important in light of predictions that narwhal migration patterns and accessibility to the species will alter with climate change (Laidre and Heide-Jørgensen, 2005; Ford and the Community of Arctic Bay, 2006). For example, if ice conditions and migration timing limit harvest in one year, then it is important for the next year's harvest to make up for lost income and food derived from the hunt. And if climate change and harvesting pressure necessitate a complete ban on narwhal hunting, the community is more likely to support the decision if agreement is reached in a co-management body. Evidence in non-Arctic contexts further reinforces the idea that diverse, flexible institutions that are close to the resources and receptive to environmental feedback stand a better chance of successful response to change than top-down, centralized management systems (Kofinas, 2004).

While existing experience of wildlife co-management in Nunavut is encouraging, technical, methodological, and political differences among actors remain. Relationships remain hierarchical, and conflicts exist over the use of scientific and traditional knowledge. In 2000, in the community of Qikiqtarjuaq, Nunavut, the DFO decided to close the narwhal hunt on the basis of scientific stock assessments, creating significant conflict among partners in the co-management arrangement who were not consulted. If current co-management systems are to adapt to climate change, better co-ordination and communication across levels will be required (Armitage, 2005; Diduck et al., 2005). Nonetheless, the narwhal case offers an example of a new cross-scale approach that promises to be more responsive and resilient to change, and it provides a model of how to develop quota systems for new species affected by climate change, while maintaining hunting flexibility and minimizing conflict.

The Nunavut Wildlife Management Board (NWMB), the main agency responsible for wildlife management in Nunavut, is composed of Inuit and government representatives. The NWMB is not a branch of government, but its decisions are carried out by the territorial government, and the ultimate responsibility for wildlife management rests with the federal and territorial governments. The NWMB has an important role in responding to climate change: its mandate includes establishing and modifying quotas and protecting wildlife for the long-term benefit of Inuit and non-Inuit. Continued development of wildlife co-management arrangements, along the lines of the narwhal example

described above, is important in addressing community concerns and building resilience to climate change. Flexible, multi-level governance helps management systems to deal with change by promoting the sharing of information between actors at different scales, linking scientific and traditional management systems, permitting greater opportunity to address conflicts over competing vision or goals, and providing an arena to solve conflict (Kofinas, 2004; Armitage, 2005; Chapin et al., 2004, 2006). It is also important for the federal government, which has ultimate authority in wildlife management, to recognize the importance of wildlife co-management. Increasing international pressure to reduce or even ban harvesting in light of climate change projections will severely test its ability to leave wildlife management to co-management bodies.

Harvester Support

Both Nunavut Tunngavik Incorporated and the Nunavut Department of the Environment currently offer harvester support programs. These funds do not explicitly aim to reduce vulnerability to climatic conditions—they aim to maintain a strong and thriving traditional resource use sector—but they are important in helping hunters recover from climate-related losses and provide financing for climate adaptations. Table 2 identifies support programs that are already moderating vulnerability to climatic stress and can potentially reduce future vulnerability through financing that facilitates adaptive mechanisms.

Climate change is making new demands on harvester support programs and is exacerbating shortcomings in funding allocation. The disaster compensation fund offered by DoE, in particular, is under increasing strain as claims increase with climate change. Interviews in Arctic Bay and Igloolik indicated the inadequate nature of compensation: the $4500 offered is far below the cost of most major capital equipment, such as a new snowmobile. Additionally, very few applications to the fund are successful, because most fail to meet the program criterion of loss arising from a "natural disaster." NTI's small equipment program is also increasingly popular. The increasing use of safety equipment (GPS, VHF radios, flotation devices, etc.) in light of climate change and erosion of land-based skills has greatly increased the demand for funds. It is widely recognized that present support for small equipment is insufficient (GN, 2006).

Future climate change could exacerbate the dangers of hunting and increase the incidence of hunting accidents (Ford et al., 2006a, b). In combination with rising fuel and equipment costs, climate change will further increase pressure on harvester support programs as hunters draw upon these funds to cover their losses and finance adaptations. For those without access to other sources of income, harvester support could determine the sustainability of hunting. Existing harvester support programs can be strengthened in several ways to increase their effectiveness in light of current and predicted climate change.

First, the gap most frequently cited by interviewees in Arctic Bay and Igloolik and in workshops on harvester support programs (GN, 2006) is the difference between the level of funding available and the actual needs of harvesters. The rising cost of fuel and equipment has made this gap particularly broad in recent years, and it is expected to continue to widen as the climate changes. Harvester support programs need more financial resources, and increasing their funding could be a goal of the Nunavut climate change adaptation plan. However, there are challenges to increasing funding. At current rates of usage, the Nunavut Hunters Income Support Trust, which provides financing for NTI's harvester support programs, could run out as early as 2010–11. The GN also faces budget constraints. Strategic prioritization of funding may be needed to place the focus on the programs that communities value most and those that provide protection against climate change. Any such prioritization will require active community consultation.

Second, there is potential to strengthen the effectiveness of existing programs. A subsidized insurance program for hunting equipment could be developed to replace the current disaster compensation fund and would better address hunters' needs. The scheme could be subsidized and offered through NTI or DoE. Major limitations to hunters' using existing commercially available insurance programs are the price and complexity of the application process, along with the necessity of a bank account, which many hunters do not have. Better advertising and promotion to educate community members about harvester programs and promote their use could also increase program effectiveness. The complexity and lack of knowledge of existing programs hampers uptake. Community-based Hunters and Trappers Organizations have a crucial role in this regard, as they are directly involved in promoting hunter support programs and helping hunters to prepare and submit their applications. Most respondents in focus groups conducted by GN (2006) agreed that HTOs should play a crucial role in promoting programs through public meetings and community radio. Yet institutional capacity at HTOs is limited by a lack of training and rapid turnover of personnel, an area that NTI and the DoE will have to address in order to make these support mechanisms more effective and available to all community members.

DISCUSSION

Newton et al. (2005) argue that climate change adaptation policy in Arctic Canada has been limited by the severe nature of projected climate change impacts and apparently limited options for adaptation. Competing policy priorities, a myopic focus on mitigation, and lack of funds for addressing climate change have also limited action on adaptation. However, this paper has demonstrated that there are opportunities to target factors affecting vulnerability in existing policy programs. Entry points exist in policy relating to cultural preservation, wildlife management, and harvester

support. Through expansion and modification of these programs, there is potential to stem the erosion of Inuit knowledge and land-based skills among younger-generation Inuit, maintain social networks and harvesting flexibility, and provide funding to facilitate adaptive mechanisms. Enhancing capacity to deal with present conditions strengthens community resilience to longer-term climate change. Moreover, there is potential for "win-win" adaptation policy in Nunavut, which will reduce vulnerability to climatic risks and strengthen community well-being. In particular, the proposed strategies can help address rising inequalities associated with social change and climate change by providing financial and knowledge-based resources that enable hunters to maintain their livelihoods in the face of externally imposed stress and enable youth to participate in the resource harvesting sector by strengthening intergenerational and intercommunity links. These policies make sense regardless of the nature of climate change. And while the recommendations in this paper do not represent an exhaustive list of entry points—see Ford (2006) for additional recommendations—they represent the most pertinent and pressing needs identified in community consultation.

Active involvement of communities in the research process is required to identify adaptation needs and opportunities for adaptation policy. Interventions to reduce vulnerability will be more successful if they are identified and developed in co-operation with local people. This statement is particularly relevant to decision making in the Government of Nunavut, which strongly emphasizes integrating Inuit cultural values into policy and consulting communities in policy development (GN, 2005). Moreover, lobbying by community actors plays a major role in policy advancement and development in Nunavut. With this in mind, the present researchers worked actively with the communities of Arctic Bay and Igloolik to characterize climate change vulnerability. The adaptation policy options recommended were not only developed in collaboration with the two communities, but also reviewed at the end of the research, both with individual interviewees and decision makers and with each community as a whole via radio, leaflet, and "town hall" presentations. Thus a major contribution of the work, beyond the identification of adaptive options to territorial policy makers, is the empowerment of community actors to lobby government by identifying and structuring information on community vulnerability and the potential for reducing that vulnerability.

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