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Global Environmental Change 16 (2006) 145–160
Global Environmental Change
www.elsevier.com/locate/gloenvcha

Vulnerability to climate change in the Arctic: A case study from Arctic Bay, Canada

James D. Ford*, Barry Smit, Johanna Wandel

Department of Geography, University of Guelph, Guelph, Ont., N1G 2W1 Canada

Received 28 June 2005; received in revised form 25 November 2005; accepted 25 November 2005

Abstract

This paper develops a vulnerability-based approach to characterize the human implications of climate change in Arctic Bay, Canada. It focuses on community vulnerabilities associated with resource harvesting and the processes through which people adapt to them in the context of livelihood assets, constraints, and outside influences. Inuit in Arctic Bay have demonstrated significant adaptability in the face of changing climate-related exposures. This adaptability is facilitated by traditional Inuit knowledge, strong social networks, flexibility in seasonal hunting cycles, some modern technologies, and economic support. Changing Inuit livelihoods, however, have undermined certain aspects of adaptive capacity, and have resulted in emerging vulnerabilities in certain sections of the community.

Keywords: Vulnerability; Adaptation; Adaptive capacity; Arctic; Inuit; Climate change; Environmental change; Communities; Climatic risks

1. Introduction

The Arctic Climate Impact Assessment (ACIA) suggests that future climate change will be experienced earlier and more acutely in polar regions (ACIA, 2004; Kattsov and Kallen, 2005). These changes will occur on top of recent climate change, which has been documented by instrumental records and indigenous observations in the Arctic (Ford, 2005; Huntington and Fox, 2005; McBean et al., 2005). There is general agreement that indigenous peoples in the north are being affected by climate change and that future changes in climate are likely to pose serious challenges. However, the nature of these risks is poorly understood and assessing vulnerabilities was recently identified by the ACIA as a major area where further research is required (ACIA, 2004; McCarthy and Martello, 2005).

This paper presents an approach to characterize the nature of vulnerability to climate-related conditions in Arctic communities. The approach characterizes the ways in which people experience, respond to, and cope with environmental phenomena, in the context of livelihood assets, constraints, and outside influences. The approach is applied in a case study of the Inuit community of Arctic Bay, Nunavut, Canada, focusing on the important social and economic livelihood of hunting. It is used to provide answers to the following questions: Who and what are vulnerable? To what stresses does vulnerability exist? In what way does vulnerability manifest itself? What are the determinants of vulnerability and how have they changed over time? What capacity exists to cope with changing risks? The paper begins by evaluating the nature of the problem posed by climate change in the Arctic, and reviews existing research on the human dimensions of climate change in the Arctic.

2. Climate change in the Arctic

There is evidence that climate change is already occurring at high latitudes (McBean et al., 2005). Over extensive land areas, significant warming, increased precipitation, alterations in sea-ice dynamics, and a change in climatic variability and the occurrence of extremes have been recorded by instrumental records and indigenous

*Corresponding author. Tel.: +1 519 824 4120x54174; fax: +1 519 837 2940.
E-mail addresses: jford01@uoguelph.ca (J.D. Ford), bsmit@uoguelph.ca (B. Smit), jwandel@uoguelph.ca (J. Wandel).

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doi:10.1016/j.gloenvcha.2005.11.007

observations (Krupnik and Jolly, 2002; Johannessen et al., 2004; Overland et al., 2004; Ford, 2005). These changes are posing significant risks and hazards to communities throughout the circumpolar north. Indigenous residents have expressed growing concern (NTI, 2001; Bell et al., 2002; Simon, 2004). Many of these risks are associated with harvesting activities. In indigenous northern communities, people spend significant time hunting and travelling on the land and rely on livelihoods that are being affected by climate change. For Inuit hunters in Canada's Nunavut Territory, climate change has meant that their traditional knowledge, which underpins safe and successful hunting, is less dependable (Ford and Smit, 2004). In the small Inuit community of Kugluktuk, for example, unusual ice conditions have been linked to the deaths of two residents who went through the ice on a snowmobile in 2004 (CBC, 2004). The changes have also made access to hunting areas increasingly difficult (Fox, 2002, 2005). Other risks are associated with infrastructure. Throughout the Arctic, coastal erosion and retreat, and melting permafrost have damaged infrastructure and cultural heritage sites (Shaw et al., 1998; Couture et al., 2002).

Future climate change is predicted to be experienced earlier and more acutely in the polar regions (Holland and Bitz, 2003; Kattsov and Kallen, 2005). Predicted changes include the following: increased temperature and precipitation; alterations to the frequency, magnitude, and geographic distribution of climate-related events; reduced areal extent and thickness of the sea ice and permafrost; and a reduction in the number of animal species (Houghton et al., 2001; Derocher et al., 2004; Johannessen et al., 2004; Kattsov and Kallen, 2005). Even under the most aggressive emission control measures, current greenhouse gas emissions commit the earth to continued climate change (Metz et al., 2001; Hansen et al., 2002). The likelihood of adverse impacts has created a growing urgency to improve the understanding of how indigenous peoples in the Arctic will be affected by these changes, and how they might deal with, or adapt to them (Nuttall, 2001; Duerden, 2004; Ford and Smit, 2004; Kofinas, 2004).

3. Human dimensions of climate change in the Arctic

Much of the information on the implications of climate change for communities in the Arctic is in the form of broad studies conducted by government agencies (Cohen, 1997) and reviews in the Intergovernmental Panel on Climate Change (IPCC) Third Assessment Report and the Arctic Council's ACIA (Maxwell, 1997; Anisimov and Fitzharris, 2001; ACIA, 2004). Information is also available from specific studies of the implications of changes for certain biophysical systems (Shaw et al., 1998; Nelson et al., 2002). These studies have focused largely on predicting how certain biophysical systems are being affected by, and will respond to, climate change.

While this research has increased our understanding of how climate change will affect biophysical processes, our current level of knowledge about its implications for human activity and societies remains limited (Duerden, 2004). The consequences of a shift in climate for humans are not calculable from the physical dimensions of the shift alone; they require attention to human dimensions through which they are experienced (Rayner and Malone, 1998). People have learned to modify their behaviour and their environment to manage and take advantage of their local climatic conditions over the course of human history (Adger, 2003a). Research has shown that indigenous groups in the Arctic have historically demonstrated adaptability and resilience in the face of changing conditions (Balikci, 1968; Sabo, 1991; Cruikshank, 2001). Oral histories and research have also demonstrated limits to coping with climate change, variation, and extremes (Brody, 1987; MacDonald, 1998; Krupnik, 2000).

Much of the work on climate change in the Arctic focuses on climate in isolation from other conditions which influence the implications of climate change for communities (Nuttall, 2005). The way in which people experience, respond to, and cope with environmental phenomena occurs in the context of social, cultural, economic, and political conditions and processes (Blaikie et al., 1994; Thomas and Twyman, 2005). In the Arctic, there have been dramatic changes in livelihoods in the latter half of the 20th century (Condon et al., 1995; Nuttall, 2000; Csonka and Schweitzer, 2004), which have affected many of the mechanisms by which Inuit communities manage climatic conditions. Livelihood changes are predicted to continue and further alter Inuit communities and well-being (Fenge, 2001).

There has also been limited research incorporating community perspectives on the human implications of climate change. For Arctic communities, many risks are associated with harvesting activities. The changes that people identify as being important are those which affect their safety while harvesting or their ability to harvest (Fox, 2002, 2004; DSD, 2003). Assessing the vulnerability of Arctic communities to climate change requires documentation of climate-related conditions that are relevant to people, how they affect people and their livelihoods, and the management strategies they employ.

4. A vulnerability-based approach

4.1. Conceptual model of vulnerability

The 'vulnerability approach' has evolved in the field of climate change impacts and adaptation to address the research needs highlighted above (Kelly and Adger, 2000; Burton et al., 2002; Ford and Smit, 2004). The vulnerability concept has been widely adopted in the climate change field because it is explicitly referred to in the United Nations Framework Convention on Climate Change (UNFCCC, 1992) where commitments are made by countries to promote adaptation to address vulnerable regions and peoples (Smit and Pilifosova, 2003). However,

the principles underlying the determinants of vulnerability are broadly consistent with those underlying models of resilience (Gunderson and Holling, 2002; Kofinas, 2004) and sustainability science (Turner et al., 2003).

In the natural hazards field, hazards are considered to be socially constructed, reflecting both extreme physical events and their effects, and the economic, political, and social conditions that influence people's ability to deal with hazardous conditions, sometimes termed 'social vulnerability' (Hewitt, 1983, 1997; Liverman, 1994; Comfort et al. 1999). Related fields such as political ecology also consider broader social, economic, and political conditions that influence exposure of people and their adaptive capacities. Vulnerability here is related to the ability of people to cope with and respond to stimuli, particularly as this relates to livelihoods, access to resources, and power relations (Blaikie et al., 1994; Pelling, 1999, 2002; Adger et al., 2001).

The scholarship on entitlements and security also focuses on access to resources as determinants of vulnerability, so that disasters are not due only to exposure to natural events, but also to social, economic, and political conditions that make people susceptible (Sen, 1981; Dreze and Sen, 1990; Bohle et al., 1994; Homer-Dixon and Blitt, 1998; Adger and Kelly, 1999). Watts and Bohle (1993) conceptualize vulnerability as a function of exposure, capacity, and potentiality. The main components of the vulnerability framework of Turner et al. (2003) are exposure, sensitivity, and resilience (or response capacity). The ACIA (McCarthy and Maretello, 2005) also frames vulnerability in terms of exposure, sensitivity, and resilience or capacity to adapt. The IPCC (McCarthy et al., 2001) defines vulnerability as a function of the climate conditions to which a system is exposed, its sensitivity, and its adaptive capacity.

These concepts are consistent with and are captured in the model of vulnerability employed here, where our system of interest is the community (Fig. 1). Vulnerability is conceptualized as a function of exposure-sensitivity of a community to climate change effects and its adaptive capacity to deal with that exposure.

One central element in the model, exposure-sensitivity, reflects the susceptibility of people and communities to conditions that represent risks, including those associated with climate change. Exposure-sensitivity is dependant upon both the characteristics of climatic conditions and the nature of the community in question. The characteristics of climate-related conditions include magnitude, frequency, spatial dispersion, duration, speed of onset, timing, and temporal spacing of conditions. The nature of the community concerns its location and structure relative to the climatic risks. It is also strongly linked to livelihood conditions and strategies and will vary among groups in the community. In Arctic communities, different species will be harvested in different locations at different times of the year on account of individuals' knowledge of the environment, past experience, differential time constraints, and access to technology. This results in differential exposure-sensitivity. Exposure-sensitivity is clearly dynamic, changing as the community changes its characteristics relative to the climatic conditions, and changing as the stimuli

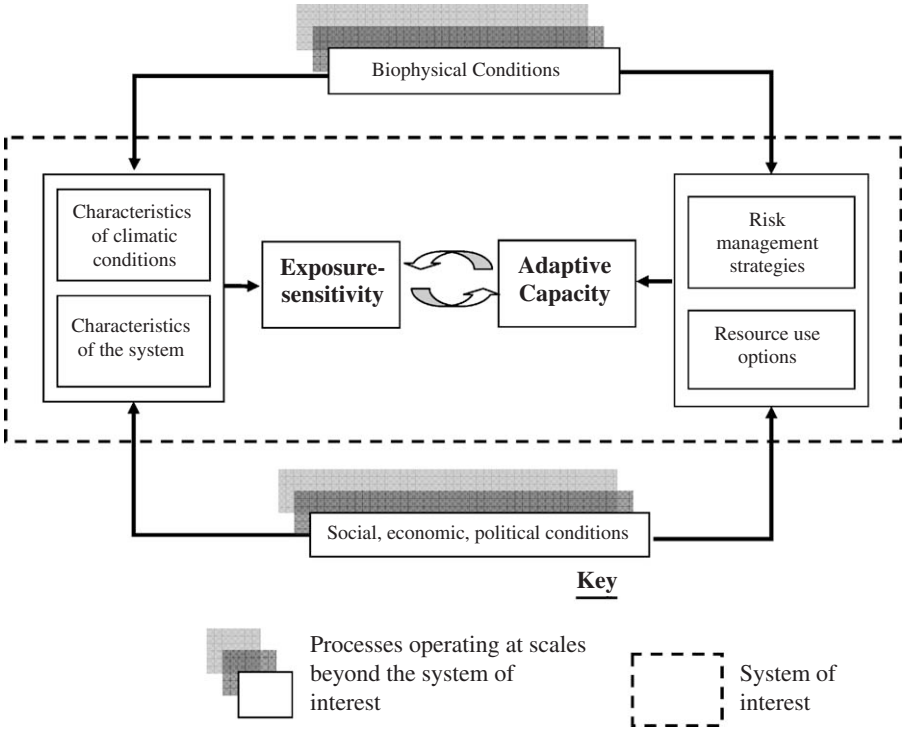

Fig. 1. A conceptual model of vulnerability. Components of vulnerability identified and linked to factors beyond the system of study and operating at various scales.

themselves change. It also reflects human and biophysical conditions and processes operating at broader scales, which elsewhere are called 'root causes' (Blaikie et al., 1994), 'external drivers' (Folke et al., 2003), or 'influences acting on place' (McCarthy and Martello, 2005). Social and economic changes, for example, filter through the particular attributes of groups or individuals to influence decisions such as where to hunt, what to hunt, when, and what equipment is taken along. Climate change interacts to affect the characteristics of climate-related conditions, changing the nature of the potential risks or exposures posed.

Adaptive capacity (Fig. 1) refers to a community's potential or ability to address, plan for, or adapt to exposure-sensitivity (Smit and Pilifosova, 2003). It is essentially synonymous with resilience as used by Turner et al. (2003), Kofinas (2004), and the ACIA (McCarthy and Maretello, 2005). People have learned to modify their behaviour and their environment to manage and take advantage of their local climatic conditions. Most communities, therefore, are adaptable to normal climatic conditions and a range of deviations around norms (Ford and Smit, 2004). This ability to adapt reflects resource use options and risk management strategies to prepare for, avoid or moderate, and recover from, exposure effects (Hewitt and Burton, 1971; Jones, 2001; Smit and Pilifosova, 2003). It is influenced by characteristics of the human system including economic wealth, social capital, infrastructure, social institutions, experience with previous risk, the range of technologies available for adaptation, and equality; these may facilitate or constrain the ability of a community to deal with climate-related risks (Barnett, 2001; Adger, 2003a; Smith et al., 2003; Ford and Smit, 2004; Robards and Alessa, 2004). These determinants are interdependent and are influenced by human and biophysical conditions and process operating at various scales from the local to global. Adaptive capacity is also dynamic, varying over space and time with the characteristics of the human system.

Exposure-sensitivity and adaptive capacity are not mutually exclusive (McLeman and Smit, 2005). Exposure to repeated climate-related conditions, for instance, can develop experience of how to manage the climatic conditions, and enables 'response with learning,' thus increasing the adaptive capacity of the system (Gunderson and Holling, 2002). Frequent exposure to risk can also lead to what Chambers (1989) described as the 'ratchet effect' of vulnerability, where each succeeding event reduces the resources a group or individual has to resist and recover from the next environmental shock or stress. This is similar to the accumulation of risk argument proposed by the UNDP (2004) and the 'social amplification of risk' (Kasperson et al., 1988). Certain adaptive strategies can also change the nature of the community (location, structure, organization) such that the community is more or less exposed-sensitive, or exposed-sensitive in a different way. Note also that the factors that influence adaptive capacity also influence exposure. For example, the range of technologies available for adaptation may enable exposure to be managed. The same technology, however, may also affect risk evaluation strategies and result in more risk taking behaviour.

4.2. Analytical framework

The model of vulnerability recognizes that exposure-sensitivity and adaptive capacity of communities are continually influenced by social and biophysical conditions and processes operating at various scales. The experience of, and response to, future climate-related exposures will be facilitated and constrained by similar, if not the same, factors (Glantz, 1988, 1996; Adger, 2003a; Naess et al., 2005). To learn about how future climate change may affect communities, the starting point here is the present and the past, in order to identify those conditions that are significant for the community and to establish a baseline as to how the community deals with them. The analytical framework follows Ford and Smit (2004). The first stage starts with the community itself, incorporating the knowledge and observations of local residents to assess current vulnerability by documenting current exposure-sensitivities and current adaptive capacity. The second stage assesses future vulnerability by estimating directional changes in exposure-sensitivity and assessing future adaptive capacity on the basis of past behaviour and identification of future adaptation options, constraints, and opportunities. This paper applies the framework in the community of Arctic Bay, Nunavut.

5. Arctic Bay case study

5.1. Arctic Bay

Arctic Bay is a coastal Inuit community of 646 people located on north Baffin Island, Nunavut, Canada, approximately 700 km north of the Arctic Circle (see Fig. 2). Ninety-three per cent of the population is Inuit (StatsCanada, 2002). The settlement has expanded dramatically since the 1960s, and the economy has shifted from one based entirely on subsistence activities to a mixed economy where both the informal and formal economic sectors assume an important role (Damas, 2002). The operation of a zinc mine at nearby Nanisivik from the late 1960s to 2002 provided employment and income to the community, acting as a catalyst in the transformation of Inuit life, including the creation of an uneven distribution of wealth in the community (DSD, 2002). Harvesting of renewable resources continues to be a valued activity among Arctic Bay Inuit and contributes significantly to the food supply (Reeves, 1993; DSD, 2002; Pratley, 2005). Narwhal, ringed seals, arctic char, and caribou are the mainstays of the wildlife harvest in Arctic Bay (NWMB, 2001). Except for a period of open water from mid-July and early October, travel and harvesting is largely

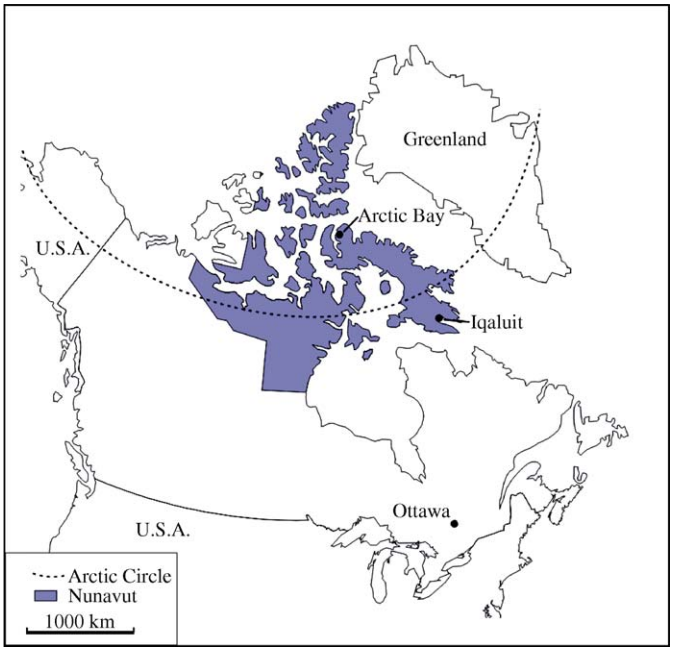

Fig. 2. The Canadian Territory of Nunavut with Arctic Bay highlighted.

performed on sea ice. Considerable time is spent by most community members 'on the land' (a term used by Inuit to refer to any traditional activity (hunting, camping, or travelling) that takes place outside the settlement).

Hunting has social, cultural, and economic significance to Inuit in Arctic Bay, helping to maintain cultural identity and strengthen social relationships within the community. Practices surrounding hunting which remain important today include teaching, learning, and sharing of hunting skills and knowledge; sharing of traditional food within the extended family unit; processing of animal skins to produce clothing; and spiritual beliefs connecting the hunter and 'the land.' These traditions and practices have endured many generations and serve to preserve and transmit cultural traditions, maintain Inuit identity and self-esteem, promote community well-being, strengthen family relationships, reinforce intergenerational links, and facilitate Inuit survival in the harsh Arctic environment (Brody, 1987; Wenzel, 1991; Furgal et al., 2002). There are signs, however, that despite the importance of the traditional domain, fewer younger generation Inuit are participating in the subsistence economy. Although as Condon et al. (1995) argue in their work with Holman Inuit in the Northwest Territories, the ideology of subsistence still remains important among the younger generations in Arctic Bay, providing continuity with the past and a sense a self-worth to those struggling to find a new identify in a changing world.

5.2. Methods

Sixty-five semi-structured interviews were conducted in 2004 to identify those conditions and risks that people have had to deal with, and are currently dealing with; to provide insights into the resource use options and risk management strategies employed to manage these conditions; and to identify those factors that influence the ability to manage risks. The data collection was undertaken with two Inuit collaborators. Interviews were conducted in Inuktitut and English with the majority taking place in the homes of interviewees, although some were undertaken at summer camps 'on the land.' For preliminary verification and validation, after each interview the key points raised were reviewed with the local assistants. The interviews were complemented with experiential trips with Inuit 'on the land' and informal meetings with key informants. Analysis of secondary sources, including government reports, newspaper articles, books, and journal articles, was used to add historical context on risks and adaptation. A second field session was undertaken in early spring 2005. The results and interpretation from the first field session were evaluated and reviewed with people interviewed during the first trip.

The following sections summarize the information gathered from Inuit about their vulnerabilities. The descriptions are those of the residents of Arctic Bay, summarized by the authors, and related to concepts and examples reported by others, where appropriate.

6. Current vulnerability

6.1. Changing exposure-sensitivity

In Arctic Bay, a combination of changing climatic conditions and changes in livelihoods has altered, and tended to increase, the exposure-sensitivity of the community to climatic risks. The majority of community-identified exposure-sensitivities documented in this research are associated with harvesting activities. Others are associated with community infrastructure (roads, houses, sewage system) and health, although these were less frequently identified. Our analysis focuses on vulnerabilities specifically related directly or indirectly to hunting and living on the land.

6.1.1. Changing climatic conditions

Inuit in Arctic Bay are perceiving and experiencing changing climatic conditions. These changes, along with changes in livelihoods documented in the next section, have amplified the magnitude and frequency of hazardous conditions that people have to deal with. This has had implications for safety while hunting and travelling, particularly during sea-ice freeze-up and break-up. Before going out on the land, hunters will typically look at the clouds, including their height, form, and the direction they are moving. This information, as well as observations of wind direction and other environmental conditions, is used to forecast the weather, decide if it is safe to go out, and identify precursors to hazardous events.

> We have two main winds: one from the south and [one from the north]. If we get [a] south wind it will be windy, blowing and snowing and all that, but when the north wind starts blowing it clears up the bad weather—Muktar Akumalik

Prediction is essential; the ability to anticipate and respond to dangers, opportunities, and changes is important for safe travel. Strong winds, for example, can be dangerous while boating on open water in summer, can cause whiteout conditions in winter, and can rapidly disintegrate the ice during sea-ice break-up. The traditional knowledge used to make predictions, however, has become less dependable as the result of changing climatic conditions and has made hunting more hazardous (see Table 1).

> Nowadays my traditional knowledge, I can't use [this] knowledge now—Lisha Levi
>
> More lives are in danger because of these unpredictable conditions [and] change[s]—Leah Kalluk

Accessibility of resources is also sensitive to changing climatic conditions. Community access to hunting areas from October to July depends on the condition of the sea ice and snow, and in summer on the state of inland trails and the ability to use boats. Thin snow cover on the land in winter is restricting access to inland caribou hunting by snowmobile. Hunters have damaged snowmobiles and sleds while travelling on trails where the snow was thin. Later and longer ice freeze-up is changing the timing at which harvesting can take place. Harpoon seal hunters and ice fishers have to wait longer before they are able to travel on the ice. In summer, melting permafrost is making trails to inland caribou grounds extremely muddy. Other changes are affecting accessibility by making travel dangerous. Stronger and more unpredictable winds are also limiting access to hunting grounds by boat in summer; the small boats used locally do not offer protection in rough water. The changes in accessibility have important ramifications for the community as locally harvested animals and plants (known as 'country food') have a significant social, cultural, and economic importance. Seal hunting, for example, not only provides food, but is a way of life, an occupation, and a symbolic part of Inuit culture (Furgal, 2002).

6.1.2. *Changing livelihoods*

There have been dramatic changes in Inuit livelihoods in the last half of the 20th century as a result of the transition of a traditional subsistence Inuit lifestyle to a 'dual society' or 'mixed economy' characterized by the co-existence of a market and traditional sector (Wenzel, 1991; Condon et al., 1995; Damas, 2002; Chabot, 2003). Associated with this transition has been settlement of semi-nomadic groups in centralized permanent villages, increasing importance of the federal government in people's lives, the development of formal economic sector activities, participation in, and dependence on, external markets, and compulsory schooling for children. In Arctic Bay, the operation of the Nanisivik zinc mine from the late 1960s to 2002 and oil exploration during the 1970s also played an important role in changing Inuit livelihoods (DSD, 2002). The following examples illustrate how these broader developments associated with changing livelihoods have compounded the problems caused by changing climatic conditions to increase exposure-sensitivity to climate-related risks in Arctic Bay.

As a result of government promotion of fixed settlement in the 1960s, hunters found their spatial access and associations with their traditional resources considerably altered (Damas, 2002). This resulted in the increased use of, and dependence on, imported technology such as snowmobiles and motorized boats; these are used to travel beyond the limited zone of exploitation imposed by fixed settlement (Wenzel, 1991). A corollary of this has been a progressive replacement of dog teams with snowmobiles.

Table 1
Harvesting activities sensitive to observed changing climatic conditions

Activity	Time of year	Hazardous conditions	Implication of changing climatic conditions for hazardous conditions
General hunting/ travel on the sea ice	October–December	Thin ice	New areas of open water, areas of unusually thin ice, and a change in the location of leads[a] have increased the dangers of travelling on sea ice and lake ice. People have lost and damaged equipment
	October–July	Weather	More unpredictable weather and sudden weather changes have forced hunters to spend extra unplanned nights on the land Unusual weather—rain in winter, extreme cold in spring—is dangerous because hunters are not prepared
Narwhal hunt	June–July	Ice break-up	Sudden and unanticipated wind changes causing sea ice to unexpectedly disintegrate. Incidences of hunters being stranded on drifting ice[b] and having to be rescued by helicopter
General hunting/travel by boat	July–September	Waves/stormy weather	Sudden changes in wind strength and direction, combined with stronger winds, have forced hunters to spend extra nights out on the land waiting for calm weather to return to the community

[a]A crevice or channel of open water created by a break in a mass of sea ice.
[b]Drift occurs if the ice is blown away from ice that is attached to the land.

The use of snowmobiles requires knowledge of where the safe and unsafe ice is located, because, unlike dog teams, snowmobiles cannot locate and avoid dangerous ice. Interviewees talked about the dangers of snowmobile use; since their introduction, there have been incidents where hunters have been unable to identify ice thickness, and have gone through thin ice. From personal observation and experience, hunters have managed these risks by knowing the location of dangerous ice and times of the year to be careful. With increasingly unpredictable ice conditions, however, snowmobile travel has become even more risky.

Modern hunting requires substantial monetary investments and has resulted in increased dependence on monetary resources (Chabot, 2003). Traditionally, hunters supported themselves almost exclusively from hunting and trapping, and trading skins and furs for equipment (Wilkinson, 1955; Damas, 2002). Increased prices of equipment combined with declining markets in Europe for seal skins (Wenzel, 1991), however, have resulted in hunters seeking to secure an income from different sources to support their harvesting activities, including the commercial exploitation of narwhal for the tusk ivory. Currently, narwhal tusks sell for approximately US$80–150 per foot (Armitage, 2005). At the same time, government quotas on narwhal limited the catch of this commercially important species (Kemper, 1980; Armitage, 2005). As a result of these two trends, and facilitated by the use of snowmobiles, hunters have attempted to maximize their chance of catching narwhal before the quota expires by hunting them as soon as they arrive in the region. This usually occurs during June and July from the edge of the ice that is anchored to the shore (known as the floe-edge) when the ice is breaking up. Traditionally, hunters would have avoided this time, waiting for the narwhal to migrate closer to the community where they can be hunted close to the shore and safely (Wilkinson, 1955; Brody, 1976; Kemper, 1980). The floe-edge is a highly unstable environment and break-up is the most dangerous time to be on the ice.

> The people want to get [a] fast buck, [so] they start going out on the floe-edge [in late spring]. But when I was growing up, the elders used to tell us not to do the narwhal hunting at the floe-edge [in late spring]—Kik Shappa

The behaviour of hunters in Arctic Bay exposes them to the risk of getting stranded on drifting ice when it detaches from the landfast ice (ice that is attached to the land). There have been numerous incidents of hunters being stranded and having to wait on the drifting ice until rescued or until ice re-attaches to the landfast ice (see Ford, 2005). Using experience and knowledge to identify precursors to hazardous conditions, hunters manage the risks of narwhal hunting; a south wind, for example, is avoided. With the increasing unpredictability of the wind, however, accurate recognition of precursors is increasingly problematic.

Inuit risk assessment when making decisions regarding hunting has also changed in other ways, with people more likely to harvest in spite of poor weather conditions today. This is partly due to the reduced time available to harvest. Many hunters have full- or part-time jobs in addition to hunting activities. Time off from work, which is used for hunting trips, has to be booked weeks, if not months, in advance. Weather or safety concerns may, therefore, be superseded by consideration of time availability when harvesting decisions are made. When a trip has been planned and time taken off, hunters are strongly motivated to proceed with hunting, even in the case of poor weather or unsafe hunting conditions. More risk-taking behaviour is also associated with technological developments. Global Positioning Systems (GPS), two-way radios, and the functioning of a community search and rescue group, which provide a safety net if problems are encountered, have resulted in less caution and overconfidence. Consequently, hunters are now travelling and hunting in conditions that would have traditionally been considered dangerous.

The exposure-sensitivities of Arctic Bay residents are dynamic and reflect the interaction of climate and other environmental conditions, with social, economic, political, and technological changes which affect Inuit livelihoods.

6.2. *Adaptation to changing exposure-sensitivity*

Changes in exposure-sensitivity are being managed in numerous ways. Hunters are making additional preparations before going out in response to the increasing risk of getting stranded. Many are taking extra food, gas, and supplies, as well as identifying safe areas where they can get shelter during summer boating.

> Since the weather is unpredictable now you have take extra everything, extra grub and extra gas—David Kalluk

Other responses seek to reduce the likelihood that dangerous conditions will be encountered while out 'on the land.' People are becoming more risk averse, avoiding travelling on the land or water if they have reason to believe the weather is going to be bad, avoiding dangerous areas, avoiding travelling at dangerous times of the year, returning quickly if out on the land when weather conditions turn, and generally being more vigilant when engaged in day-to-day activities. Some have stopped taking part in the floe-edge narwhal hunt altogether; an option not taken lightly given the social and cultural importance of narwhal hunting to Inuit in Arctic Bay. Technological adjustments are being undertaken by those who can afford them. These include the following: the use of GPS when hunting at the floe-edge to detect if the ice is moving; the more widespread use of vhf radio even on short trips to allow the community to be contacted in emergency situations; and the consultation of satellite images of the sea ice provided in the local town offices prior to travel on

the ice in spring, which identify areas of high risk of ice break-up. Equipment used in harvesting has also been modified. More powerful outboard boat engines to allow for shorter time spent on exposed water are being used and hunters are taking along small row boats to safeguard against the risks of getting stranded on drifting ice.

> When I am going down to the floe edge I [now] carry a boat—Anonymous

Losses associated with lost or damaged equipment are often shared within the household unit. In response to changes in accessibility of hunting areas, the timing and location of hunting has changed. For example, with the sea ice freezing up later in the year, the ice fishing season is being delayed and the open water fishing season extended.

These strategies are largely behavioural and have been undertaken by individuals in response to changes that are being experienced, and in anticipation of future change. Responsibility for these strategies largely rests with the more experienced hunters who encounter, adapt to, and respond to changing climatic conditions through frequent trial and error experience out on the land. This knowledge is transferred through informal channels; young or inexperienced hunters often travel with or seek advice from these 'local experts' before hunting, and the knowledge will be communicated in person. Expert knowledge is also communicated informally through radio communications and will be discussed between friends and family.

Not all have equal access to these adaptation strategies. Technological adaptations, for instance, are only available to those who can afford them. Furthermore, technological developments, particularly those associated with snowmobiles, have probably also contributed to inequalities in the community. Those with the financial resources to employ the technology are able to travel earlier and further on the ice, capture the resources, and particularly for animals with a quota, preclude others from having access. For narwhal, for example, many hunters traditionally waited for the narwhal to migrate close to the community where they would be hunted from cracks in the ice or by boat in open water (Brody, 1976; Kemper, 1980). Now, those with money for snowmachines, sleds, supplies, and GPS travel long distances to the floe-edge to hunt narwhal earlier in the season, exhaust the quota, enhance their income, leaving other community members without access to this resource. In this way, the technology has aided the adaptation for some, but limited the opportunities for others. The effectiveness of adaptation also varies. The use of more powerful boat engines allows sheltered areas to be reached if the weather suddenly changes while on exposed water. However, the same adaptation technology can also increase exposure-sensitivity by increasing dangerous boating activities (high-speed travel), and leads to activities in more dangerous conditions.

6.3. Determinants of adaptive capacity in Arctic Bay

Adaptations are manifestations of a system's adaptive capacity. The ability of the community of Arctic Bay to cope or deal with changing climate-related exposure-sensitivities is indicative of the community's adaptability. The adaptive capacity of Arctic Bay is facilitated by traditional Inuit knowledge and skills, strong social networks, flexibility in seasonal hunting cycles, and economic and institutional support. However, as will be documented in Section 6.4, certain aspects of adaptive capacity have been undermined and have resulted in emerging vulnerabilities in certain sections of the community.

6.3.1. Traditional skills and knowledge (Inuit Qaujimajatuqangit)

Environmental circumstances inevitably vary between hunting trips, which are characterized by unpredictability and change (Wenzel, 1991). *Inuit Qaujimajatuqangit* (IQ), traditional Inuit knowledge and a code of behaviour based on time-honoured values and practices, has evolved in this context to manage environmental conditions, including variability and unpredictability. While the nature of IQ has altered with changing livelihoods, it remains important today in Arctic Bay, and contributes to the adaptability of hunting and harvesting livelihoods. Competence on the land and in the skills and technology necessary for safe and successful hunting are a highly valued aspect of IQ. These aspects are developed and transmitted through experiences on the land, and from listening to and learning from elders and experienced individuals. This collective social memory is drawn upon to deal with routine events and respond creatively to novel events (McIntosh, 2000; Davidson-Hunt and Berkes, 2003). Hunters manage risks by knowing the dangers of hunting, by taking precautions, knowing precursors to certain hazardous conditions, knowing how to survive if they are caught in bad weather, knowing what equipment to take along and what preparations to make, and, especially for the more experienced hunters, knowing how to navigate using traditional means if they are caught out in bad weather (Nelson, 1969; Aporta, 2002, 2004; George et al., 2004; MacDonald, 2004). The knowledge embodied in IQ goes beyond what is essential for success. This is reflected, for example, in the equipment hunters take on trips. Hunters learn from a young age to take along survival equipment even on short trips and to prepare above what is necessary. When faced with an emergency situation, extra preparation enhances chances of survival; if stranded by bad weather, the extra food, naphtha, and warm clothes that hunters take along increase safety.

Like other forms of indigenous knowledge, IQ is dynamic, continually evolving and being updated and revised in the light of observations, trial and error experience, and the incorporation of non-traditional knowledge alongside the traditional (Stevenson, 1997; Berkes, 1999; Usher, 2000). Emerging out of experience

with increased exposure and successful adaptations, and collective discussion of them, IQ has evolved and changed in response. Increasing unpredictability of climatic and environmental conditions is now part of the collective social memory that frames individual practice and decision-making in Arctic Bay.

> I think the hunters now are more aware of [the changing climatic conditions] so they are preparing—Tagoonak Qavavauq

Moreover, as a repository of accumulated experience and knowledge of changing conditions and experience of successful adaptations, IQ allows 'response with experience' to changing exposure. This increases adaptive capacity (Berkes et al., 2003; Tengo and Hammer, 2003). It is this dynamic nature of IQ, its ability to learn and adapt to change, which confers adaptability. However, as will be discussed in Section 7, there are limitations to adaptability conferred by Inuit knowledge, and inequality in the extent to which it has been transferred.

6.3.2. Social networks

Social networks refer to the relations of trust and reciprocity that enable people to act collectively (Woolcock and Narayan, 2000; Adger, 2003b). They are a key component of adaptive capacity, enhancing security and reducing risk (Robards and Alessa, 2004; Tompkins and Adger, 2004). In the context of unpredictable and pervasive environmental change, complex networks of sharing, reciprocity, collective action, and exchange characterized traditional Inuit communities (Boas, 1888; Stefanson, 1913; Damas, 1963; Balikci, 1968). These networks evolved from the challenges of living in the extreme Arctic environment (Balikci, 1970; Callaway, 1995). Sabo (1991), for instance, studying how Inuit on south Baffin Island managed environmental changes during the Little Ice Age, found that food sharing, among other factors, contributed to adaptability in the face of external stress.

While the complex social networks described above are not now readily evident in Arctic communities, the 'economy of sharing,' as Wenzel (1991, p. 99) describes it, remains central to Inuit livelihoods (Condon et al., 1998; Chabot, 2003; Usher et al., 2003). In Arctic Bay, there is a high level of interdependence within the extended family unit, and a sense of collective community responsibility and mutual aid; sharing remains an affirmation of Inuit cultural identity. These networks facilitate the sharing of food, equipment, knowledge, and ensure rapid response to crisis.

> That's the only way we survive, by supporting one another—Lisha Qavavauq

With regard to the sharing of food, the extended family unit forms the primary unit of resource production and consumption, with material transactions structured through rules of kinship and age relations. Re-distribution and transfer are the primary mechanisms through which food is shared. Premised partly upon the knowledge that a person may expect to receive reciprocal treatment from others, food-sharing enables the risks associated with the highly unpredictable nature of hunting to be managed (Damas, 1972; Wenzel, 1991). During periods of scarcity or environmental stress, the success of one person benefits others who are part of the extended family sharing network. Moreover, with changing climatic conditions making certain areas inaccessible to people who do not have the equipment, money, knowledge, or time, shared food underpins country-food security, if not economic security.

Equipment, such as GPS, radios, and other safety equipment, is shared within the extended family unit and occasionally with friends. In coping with changing climatic conditions, this is particularly important given the limited employment opportunities in Arctic Bay and the expense of equipment. The sharing of knowledge facilitates the communication of information about risks and adaptive strategies. Those knowledgeable and experienced on the land act as an 'institutional memory', maintaining and transmitting local knowledge and providing information during periods of change. Knowledge is shared on hunting trips, back in the community, and over the radio. Providing such guidance and information is considered an affirmation of Inuit identity, and the responsibility is taken seriously. A strong sense of collectivism and mutual aid among the local population facilitates community response in times of crisis. If someone is lost on the land, or is having difficulties, the community mobilizes to send out a rescue team. However, the infusion and growth of a market economy has meant that those families who have access to income (through a wage or sale of hunting products) have more wealth, a difference not overcome by social sharing.

6.3.3. Resource use diversity and flexibility

Diversity and flexibility in resource use are widely recognized strategies for managing risk (Adger, 2000; Barnett, 2001; Colding et al., 2003). The propensity of Arctic environments to undergo fluctuations has created incentives for individuals to master a diversity of hunting skills and procurement activities (Krupnik, 1993; Berkes and Jolly, 2002). Balikci (1968, 1970), for example, demonstrates how, during periods of ecological pressure, the Netsilik Eskimos (traditional name for an isolated group of Inuit hunters) would historically utilize alternative hunting strategies. Sabo (1991) has shown how Inuit on south Baffin Island coped with environmental stresses of the Little Ice Age by re-scheduling their hunting techniques and utilizing a sequence of procurement activities.

In Arctic Bay today, harvesting is opportunistic: hunters will harvest what is available when it is available and where it is available, making ad hoc changes to take advantage of game availability and specific local conditions during hunting. Climate change creates new situations which are taken advantage of through the inventiveness and opportunism that are characteristic of the human ecology of hunting. If the caribou hunt in August and September fails,

for example, other species, such as walrus or seal, will be harvested. Substitution not only allows people to cope with variations in animal numbers but also enables them to manage variations in environmental conditions. If the freeze-up is late, then hunters will extend fishing season and wait until it freezes to resume normal on-ice activity; if certain areas are not accessible due to limited snow cover for snowmobile travel, then people will go to different locations. This flexibility in hunting has been a traditional strategy that is being called upon more and more with changing conditions in recent years.

6.3.4. Economic and institutional support

For indigenous communities in the Arctic, the high costs of subsistence capitalization and operating costs require substantial cash investments (Condon et al., 1995; Chabot, 2003). In the light of changing exposure, investment in GPS, vhf radios, and more powerful boat engines is required for safety purposes. Such investments require significant capital outlay, and individuals who lose equipment in hunting accidents have to replace lost machinery to continue harvesting. This places a burden upon northern indigenous communities which have limited employment opportunities and high rates of unemployment (Nuttall, 2000). Unemployment in Arctic Bay in 2001 was officially 22% (StatsCanada, 2002) and unofficially probably much higher. The closure of the Nanisivik zinc mine, an important source of income to Arctic Bay from the late 1960s to 2002, has further reduced employment opportunities. The majority of jobs held by residents in Arctic Bay are now government related (municipal services, education) or in local retail. Other sources of income which are drawn upon to support hunting include selling traditional Inuit carvings in the community and to outside markets, the selling of hunting products, and tourism (largely in the form of sport hunting).

Financial support in the form of federal government monetary transfers, and emerging institutional support from the Nunavut Government and Lands Claim Institutions, plays an important role in providing financing to cover purchase of equipment, including equipment to cope with the changing exposure (The Lands Claim Institutions were set up to oversee the Nunavut Lands Claim Agreement which provided specific land, resource, and mineral rights and ownership to Inuit, along with $1.1 billion in cash compensation). The Nunavut Harvester Support Program, for instance, provides annual lump-sum payments to a limited number of hunters to help cover costs of equipment and supplies. While this enhances the adaptive capacity of the recipients, it has heightened some inequalities and contributed to the emergence of conflict and social tension in the community, with negative implications for adaptive capacity (discussed in Section 6.4). For instance, with only a few people a year benefiting from Harvester Support, conflict has emerged over the distribution of money, especially where it is perceived that those not 'in need' of financial support (i.e. those hunting part-time with a waged income) are benefiting from the programme at the expense of those 'in need' (i.e. those hunting full-time without a waged income).

6.4. Emerging vulnerabilities

Limitations to adaptation are already evident. Flexibility in group size and group structure, for example, was utilized throughout history by Inuit as part of their resource utilization strategies to cope with climate variability and unpredictability (Balikci, 1968; Sabo, 1991; McGhee, 1996). These strategies are no longer available due to settlement in permanent communities promoted by the government in the 1960s. The increasing cost of technological adaptation measures also limits adaptation to change. Purchase of safety equipment to cope with changing climate conditions is expensive, and although institutional support plays an important role, it is nonetheless insufficient to cover all the additional costs. In other areas, those characteristics of Inuit society that traditionally facilitated adaptability have been altered as a result of radical changes in lifestyle over the last 40 years. For certain sections of the community in Arctic Bay, particularly younger generation Inuit, there has been some erosion of adaptive capacity.

The traditional mode of knowledge transfer and learning by which Inuit develop the skills to hunt safely and successfully no longer functions effectively. Much has been written about this since the 1960s (Condon et al., 1995; Newton, 1995; Condon et al., 1998; Aporta, 2004; Takano, 2004). While initial predictions of the 'Death of Hunting' (Nelson, 1969, p. 383) may have been premature, and indeed wrong (Wenzel, 2001), the skills and knowledge possessed by younger generation Inuit have, nonetheless, eroded. Two main reasons for this in Arctic Bay are discussed here.

While subsistence activities remain important to younger generation Inuit, in Arctic Bay fewer are displaying the same degree of commitment or interest in harvesting.

> [The younger generations] are not out there hunting—Tommy Tatatuopik

The decline in participation and interest in hunting has been attributed to numerous factors: boys in their adolescence are no longer becoming physically involved in harvesting because of southern educational and cultural requirements; there is increased dependence on waged employment; language differences now exist between generations; there is an increasing lack of funds to purchase equipment; and hunting now competes with alternative activities such as computer games and TV, and the desire among youth to follow 'Western' social norms (Condon et al., 1995; Kral, 2003; Takano, 2004). This disconnection from the land has had wide ranging implications. The processes by which IQ is developed and learned require experience being regularly out on the land and observing others. Few young generation Inuit are learning this way. While many go out on the land during late spring and the

summer months or when they get the chance, this is insufficient for effective transmission and learning.

The disconnection of youngsters from the land is reinforced by the emergence of intergenerational segregation between young and older generations. Older generations have an important role; they act as an 'institutional memory,' maintaining and transmitting IQ, and taking younger generations on the land. Interviewees in their 40 s and 50 s recollected how they were taken out hunting regularly when they were young whether they wanted to or not: their fathers made them. This role is increasingly absent from the young people's world. Young interviewees complained of never being asked or told to go hunting. The decrease in involvement of older generations has numerous explanations: English has replaced Inuktitut as the dominant language among younger generations, older generations think that young Inuit are not interested in learning the traditional ways, and the Euro-American social norms of youth are far removed from the traditional upbringing of older generations (Kral, 2003).

The shift from the traditional mode of knowledge transfer is seen as a loss of adaptive capacity for hunting among younger generations. Certain skills necessary for safe and successful harvesting have been lost, including traditional forms of navigation and the ability to make snow shelters. Skills and information on what to do in certain dangerous situations, how to dress appropriately, what to take along on trips, and the ability to identify precursors to hazardous conditions are not being effectively transferred between generations.

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

This is buffered to a certain extent by inexperienced hunters often opting to hunt or travel with more experienced people. When younger generations go out on the land in absence of more experienced hunters, however, they are at increased risk.

The adoption of new technology and equipment tends to counteract the erosion of traditional skills; the use of GPS means knowledge of traditional forms of navigation is no longer required, vhf radios allow the community to be contacted in case of an emergency, snowmobiles allow easy access to hunting grounds, and tents negate the need to know how to make an igloo. Technology, however, is in many ways a double-edged sword. While helping to buffer risk, it creates new risks, exacerbates others, and generates new vulnerabilities. For example, if a GPS fails and people do not know how to navigate the traditional way. Concerns were also expressed that modern 'gadgetry' is replacing detailed knowledge of the land.

Moreover, the dependence on such equipment for harvesting has increased the importance of monetary resources. This ties the community to the volatility of external markets and government transfers which are responsible for the majority of Arctic Bay's income. The recent closure of the Nanisivik mine, which in the years before its closure brought in $1.2 million in wages a year to Arctic Bay (DSD, 2002), highlights the economic vulnerability of northern communities. In the absence of other employment opportunities, the loss of income has forced many former employees to sell their hunting equipment which they can no longer afford. Particularly for young Inuit, the lack of monetary resources limits the opportunities to take part in harvesting activities, thus further reenforcing the decline in participation and erosion of traditional skills.

The functioning of social networks is influenced by, among other factors, the distribution of endowments and relationships between community members (Pelling, 1999; Adger, 2003b; Tompkins and Adger, 2004). In Arctic Bay, the decrease in importance of the extended family, the emergence of intergenerational segregation, decline in practice of traditional cultural values, concentration of resources in fewer hands, and the emergence of social tension have tended to weaken the relations of trust, reciprocity, and exchange that have facilitated sharing and the pooling of risk.

> We don't share as much as before—David Kalluk

This weakening of the 'moral economy' can be viewed in the context of changing Inuit livelihoods. The development of a waged economy has, over time, resulted in rising inequality, individualized behaviour, and withdrawal from the traditional subsistence economy. One consequence has been the development of a small group of full-time hunters who supply most of the country food to the community. New forms of reciprocity have emerged to balance this trend, including the sharing of equipment and pooling of resources in the extended family between those with a cash income and full-time hunters. However, as Chabot (2003) comments of Inuit communities in northern Quebec, these new forms of reciprocity are not always easy to fulfil. Many younger generations with full-time jobs are no longer prepared to share their income within the household unit. The sustainability of reciprocity is threatened in such instances. The importance of money, along with externally imposed harvesting quotas, has created division and social tension. On the one hand, people want to commercialize resource harvesting (e.g. by selling the narwhal tusk and seal skins, sports hunting, etc.), and on the other hand, others see such development as counter to Inuit ways.

Institutional support, to an extent, has emerged to fill the weakening of social networks. In some ways, this has increased adaptive capacity—people no longer starve in years where there are no animals, an occasional occurrence in the past. External institutional support, however, cannot provide an equivalent substitute for the erosion of internal, culture-based support provided by traditional sharing networks. There is also evidence that such support has heightened some inequalities in the community, further reenforcing a weakening of social networks.

7. Vulnerability to future climate change

Analysis of current vulnerability indicates that Inuit harvesting practices in Arctic Bay are sensitive to conditions of the biophysical environment, which affect the accessibility of the hunting areas, hazardousness of hunting, and availability of country food. Community-identified climatic risks associated with ice thickness, stability, and duration are expected to increase with climate change (see Table 2). Flato and Brown (1996), for instance, suggest that warming will cause a decrease in landfast ice thickness of about 0.06 m per 1 °C, and increase in open water duration by 7.5 days per 1 °C increase (delayed ice freeze-up and earlier break-up). For the Arctic Bay region, this could result in a decrease in mean maximum ice thickness of 50 cm, a decrease in ice duration of 2 months by 2081–2100, and decreased stability of the ice (Dumas et al., 2005). Activities involving travel on the sea ice, particularly the late spring narwhal hunt, are sensitive to ice thickness and stability, and projections could increase the dangers of sea-ice use and limit access to hunting areas at certain times of the year. Community-identified climatic risks associated with summer precipitation and weather extremes are predicted to increase (Houghton et al., 2001; Kattsov and Kallen, 2005) (see Table 2). Sensitivities to weather extremes are already acute, and increasing storminess would limit the potential to travel and hunt by boat in summer and make hunting at the floe-edge more dangerous. Other community-identified risks are associated with wind speed and direction. The available analyses in the literature are insufficient at present to justify any firm conclusions about their possible changes in the 21st century (Kattsov and Kallen, 2005).

The social, cultural, and economic importance of country food in the diet of Arctic Bay Inuit makes them sensitive to changes in the abundance and spatial distribution of animals important in subsistence activities (see Table 2). Seals, important in Inuit diet and a source of food all year round, are predicted to decrease in numbers (Stirling and Smith, 2004). Caribou is also a biological resource of significant physical and cultural importance to Inuit and is hunted year round. There is great uncertainty about how climate change may affect caribou, although past episodes of caribou die-off associated with freezing-rain episodes in winter offer a portent of what may happen (Miller and Gunn, 2003; Harding, 2004): these unfavourable conditions are expected to happen more frequently with climate change (Dumas et al., 2005). Laidre and Hiede-Jorgensen (2005) indicate that narwhal may be vulnerable to changes in sea ice. Predicted increased sea-ice concentrations in narwhal wintering areas in Baffin Bay, for instance, could delay the numbers and timing at which narwhal arrive in the Arctic Bay region. Combined with earlier sea-ice break-up in the Arctic Bay region, this could make floe-edge narwhal hunting no longer possible. Polar bears, which are an important economic resource, are also expected to be affected by climate change, although there have been limited studies on the Lancaster Sound polar bear population which are harvested by Artic Bay hunters. It is generally agreed, however, that polar bears will reduce in numbers in a warming climate (Derocher et al., 2004).

Analysis of current adaptive capacity indicates that the ability to deal or cope with these changes will vary among different groups in the community. Experienced hunters with economic resources have considerable adaptive capacity. They draw upon traditional Inuit knowledge to manage routine events and respond creatively to novel events, utilize a diverse array of hunting strategies to ensure successful hunting, and have a strong sense of collective responsibility. This will facilitate hunting in the light of more hazardous conditions and reduced access. Potential limitations to adaptability stem from a lack of monetary resources to purchase equipment necessary to access hunting areas and to hunt safely in the light of changing conditions. Adaptive capacity among young generations is limited. Current experience shows that when faced with dangerous and novel situations, young Inuit are often ill-prepared and do not know what to do. There is also evidence that youth are involved in more risk-taking behaviour and engage in more dangerous hunting practices. Climate change will increase the consequences of

Table 2
The implications of future climate change for community-identified climatic risks

Climatic risks	Climate change predictions	Implications
Thin ice	Decrease in sea-ice extent and thickness (Johannessen et al., 2004; Arzel et al., 2006; Walsh, 2005)	• Travel on ice more dangerous especially in fall and late spring • Reduced access to hunting areas
Ice break-up	Reduced stability of sea ice (Walsh, 2005; Dumas et al., 2005)	• Travel on ice more dangerous • Floe-edge narwhal harvest more dangerous
Weather	Increases in mean precipitation, precipitation intensity, and spring precipitation (Kattsov and Kallen, 2005)	• Dangerous if hunters are not prepared for wet conditions • Muddy inland trails will make travel more difficult
Waves/stormy weather	Potential increase in weather extremes, storminess (Houghton et al., 2001)	• Increased danger of summer boating • Decreased access to summer hunting grounds

a lack of knowledge and more risk-taking behaviour. The adaptability of younger generations to future climate change will depend upon the strength of IQ. Re-assertion of cultural values may counter the erosion of traditional knowledge. In the Inuit community of Igloolik, for instance, 'Land Camps,' whereby elders take young Inuit on the land for weeks at a time throughout the year and teach hunting skills, have been successful in developing essential survival skills and strengthening intergenerational relationships (Wachowich, 2001; Takano, 2004). Such formal initiatives are absent in Arctic Bay at present, although elders report taking more pro-active steps to promote IQ in the community in 2004. The economic means and equality of access to resources are also fundamental in influencing the adaptive capacity of younger generations.

8. Conclusion

Although climate change presents important vulnerabilities for numerous aspects of community life (infrastructure, health), the vulnerabilities highlighted through this research are largely associated with harvesting activities. A combination of changing climatic conditions and changing livelihoods has affected climate-related exposure-sensitivities in Arctic Bay. In several ways, harvesting is now more dangerous and access to hunting areas is increasingly difficult and unequal. Inuit have demonstrated adaptability in the light of these changes. This adaptability is facilitated by traditional Inuit knowledge, strong social networks, flexibility in harvesting behaviour, and economic support. The social, cultural, and economic implications associated with changing Inuit livelihoods, however, have undermined the adaptive capacity of certain groups in the community. The break-down of knowledge transfer and learning of land-based skills, for example, has been particularly pronounced among younger generations, who have limited ability to deal with current risks. Social networks have also been weakened by rising inequality of access to resources associated with the development of a waged-based economy and the external imposition of harvesting quotas. The experience of, and response to, future climate change will be facilitated and constrained by similar factors that have influenced past and present exposure and adaptive capacity. Analysis of current vulnerability indicates that future vulnerability will differ between groups, will be affected by social, cultural, and economic conditions and processes, and according to the nature of climate change.

The work presented in this paper is the first component of a comprehensive vulnerability assessment in the Arctic. Largely through local eyes, it identifies and characterizes Inuit vulnerability to climate change. It provides a foundation for a more detailed exploration of those factors that influence exposure, and constrain and facilitate adaptive capacity. It also provides a framework for assessing the nature of climate change vulnerabilities across the Arctic.

Acknowledgements

The insights and generous hospitality provided by residents of Arctic Bay and Igloolik are gratefully acknowledged, particularly the contributions of Mishak Allurut, Harry Ittusujurat, John MacDonald, Kevin Qrunnut, Leah Otak, and Kik Shappa. The contributions of Jamal Shirley of the Nunavut Research Institute and Eric Loring of Inuit Tapiriit Kanatami are also acknowledged. Thanks to Sue Belliveau, Lea Berrang Ford, Robert McLeman, Tristan Pearce, and George Wenzel for academic input and comment, and Luke Powell for Fig. 2. The research was supported by ArcticNet, a Seed Grant from the Integrated Management Node of the Ocean Management Research Network, and the Social Sciences and Humanities Research Council of Canada. The research was undertaken as part of the Global Environmental Change Research Group at the University of Guelph, and was conducted under Nunavut Research Institute License #0203204N-M. Anonymous reviewers provided detailed and constructive suggestions.

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