

Human implications of climate change in the Canadian Arctic: A case study of Arctic Bay, Nunavut

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Abstract

This paper presents a vulnerability based approach to characterize the human implications of climate change for Arctic communities. The approach explicitly incorporates the knowledge, experience, and observations of Inuit to identify current exposures and adaptive strategies, and to assess future risks and adaptation needs. The model is applied in a case study for the community of Arctic Bay, Nunavut. The interviews indicate that, in the face of changing climatic conditions, Inuit have demonstrated significant adaptability. Coping strategies involve risk minimization, risk avoidance, modification of the timing and location of harvesting activities, and sharing of loss. This adaptability is facilitated by traditional skills and local knowledge of the environment, strong social networks, flexibility in seasonal hunting cycles, and institutional support. While the community is managing changing climatic conditions, the social and cultural implications of the transition of a traditional Inuit society to a 'dual society' have placed many of the coping mechanisms under stress. This context of social, economic, and political processes and conditions, will constrain or enhance the ability to manage changing climatic conditions.

1. Introduction

It is now widely accepted that the evidence of climate change at high latitudes is overwhelming (Comiso, 2003). These changes are posing significant risks and hazards to communities throughout the circumpolar north (Ford and Smit, 2004). Models predict that future climate change and its effects will be felt earliest and strongest in the Arctic (Holland and Bitz, 2003). As a consequence, climate-related risks, which already pose challenges to Arctic communities, are expected to increase. While 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, the nature of these risks is poorly understood (Ford and Smit, 2004). This paper presents a vulnerability based approach to characterize the human implications of climate change for Arctic communities. The approach is applied to the Inuit community of Arctic Bay, Nunavut, to characterize vulnerability to changing climatic conditions.

2. Climate change and human implications: Existing research

Much of the information on the implications of climate change for communities in the Arctic is in the form of broad studies conducted by the government and the IPCC (Anisimov and Fitzharris, 2001), and from specific studies of

the implications of changes in certain biophysical systems (Nelson et al., 2002). These studies have largely been preoccupied with predicting how certain biophysical systems will respond to climate change. While this research has served to increase our knowledge of how climate change will affect biophysical processes, our current level of knowledge about its implications for human activity 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. Changes in physical environments are problematic to the extent that they exceed the ability of people to manage them.

Much of the work focuses on climate change in isolation from other conditions which influence the implications of climate change. How people experience, respond to, and cope with environmental phenomena, however, occurs in a context of social, cultural, economic, and political conditions and processes. In the Arctic, changes in livelihoods in the later half of the twentieth century have been profound (Fenge, 2001), and have stressed many of the traditional mechanisms by which communities manage climatic conditions. These are predicted to continue and further alter Inuit livelihoods (Fenge, 2001). Nuttall (2001, 27) likens this to a “double exposure,” where people will be confronted both by climate change and by the consequences of social change.

There has been limited research which has explicitly incorporated community perspectives on the human implications of climate change. For Arctic communities, risks are often associated with harvesting and livelihoods. Identification of these conditions and how they are managed requires documentation of conditions that are relevant to people and the management strategies they employ.

In the climate change field, the vulnerability approach has evolved to address these needs; the approach focuses on community relevant vulnerabilities and the processes through which change is managed in the context of livelihood assets, constraints, and outside influences. It starts with an assessment of the vulnerability of the community, in terms of who and what are vulnerable, to what stresses, in what way, and what capacity exists to adapt to changing risks (Ford and Smit, 2004).

3. A vulnerability based approach

3.1 Conceptual model of vulnerability

The conceptual model of community vulnerability to climate change outlined here is based upon Ford and Smit (2004). It conceptualizes vulnerability as a function of exposure of a community to climate change effects and its adaptive capacity to deal with that exposure. It focuses on the way communities experience changing conditions and the processes by which they are managed. The model highlights how human and biophysical conditions and process operating at various scales affect exposure and adaptive capacity.

The first element in the model, exposure, reflects environmental or climate related conditions that people and communities have to deal with and which represent potential risks. It is dependant upon both the characteristics of the climatic conditions, and nature of the community in question. The characteristics of climate related conditions include magnitude, frequency, spatial dispersion, duration, speed of onset, and temporal spacing of conditions that people have to deal with. The nature of the community concerns its location relative to the climatic risks. A community's exposure to tropical cyclones, for example, reflects both the occurrence of cyclones and the location and structure of the community. Exposure is also strongly linked to livelihood conditions and strategies and will vary between groups in the community. In Arctic communities, full-time hunters and part-time hunters hunt different species in different locations at different times on account of their differential time constraints, knowledge of the environment, past experience, and access to technology. This will result in these groups being exposed to different climatic and environmental conditions. Exposure of a community, group, or individual, in turn, is related to broader human and biophysical conditions and process operating at various scales. 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 and when. Climate change interacts to affect the nature of the environmental conditions.

Adaptive capacity refers to a community's potential or ability to address, plan for, or adapt to, exposure (Smit and Pilifosova, 2003). Most communities can cope with normal

climatic conditions and a range of deviations around norms. People have learnt to modify their behavior and their environment to manage and take advantage of their local climatic conditions. This ability to cope is referred to as the ‘coping range’ in the literature, and reflects resource use options and risk management strategies to prepare for, avoid or moderate, and recover from, exposure effects (Smit and Pilifosova, 2003). The ability to adapt is influenced by characteristics of the human system including economic wealth, social networks, infrastructure, social institutions, experience with previous risk, managerial ability, the range of technological adaptation available, and equality; these may facilitate or constrain the ability of a community to deal with climate related risks (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. They vary over space and time, and contribute to the environment within which decisions are made.

3.2 Research framework and methods

The research framework to empirically apply the model of vulnerability involves two main phases. The first phase involves identifying the conditions and risks that people (individuals, households, groups) have had to deal with (and are currently dealing with) in their lives. This phase provides insights into the resource use options and risk management strategies employed to manage these conditions and identifies those factors that constrain or enhance the ability to manage risks (Ford and Smit, 2004). This is achieved not by assuming important conditions, processes, and management strategies, but from the knowledge, experience, and observations provided by local residents. These can be documented using a variety of ethnographic techniques, including focus groups, interviews, and participant observation. Information on risks and adaptation strategies can also be derived from content analysis of government reports, newspaper articles, and the insights of experienced land and resource use managers.

The second phase involves an estimation of how those exposures identified as being pertinent to the community will change. These relevant conditions can be considered by climate modeling, sea ice modeling, demographic analysis, key informant interviews, and others to assess the likelihood of changes. The response of communities to anticipate or respond to reduce the risks

associated with a changing exposure can be established through evaluating the scope and limitations of existing strategies, and through community identification of future adaptation options and constraints to adaptation. This information can form the basis of an assessment of future vulnerability. The following sections focus on *current* vulnerability in the case of Arctic Bay.

4. Arctic Bay case study

Arctic Bay is a coastal Inuit community of 646 people, 93% Inuit, located on north Baffin Island, Nunavut, Canada. The settlement has expanded dramatically since the 1960s and the economy has shifted from one based entirely on subsistence to a mixed economy where both waged labor and harvesting activities assume an important role. Hunting underpins the social, cultural and economic fabric of the community and contributes significantly to the food supply (DSD, 2002). During spring 2004, 65 semi-structured interviews were conducted with a cross section of community members. A purposeful sampling strategy was employed to ensure that all social groups in the community were represented. The interviews were complemented with experiential trips on the land and informal meetings with key informants.

5. Current vulnerability

5.1 Current exposure

A combination of changing climatic conditions, superimposed on changes in harvesting behavior, have increased the exposure of the community to climate related risks.

5.1.1 Changing climatic conditions

The interviews indicate changing climatic and environmental conditions beyond expected natural fluctuations and variability (Table 1). These changes have amplified the magnitude and frequency of dangerous conditions that people have to deal with in their everyday lives and have made access to hunting grounds increasingly difficult.

5.1.2 Harvesting behavior

The last half of the twentieth century has witnessed dramatic changes in Inuit hunting strategies (Wenzel, 1991; Condon et al., 1995) which have exposed hunters to new risks and compounded the problems caused by changing climatic conditions. As a result of government

Aspect of Change	Reported change	Implications
Weather predictability	Increasing unpredictability More extremes of temperature	Harvesting more dangerous Traditional knowledge no longer a reliable guide to today's conditions
Wind	Changes to the direction, strength, and frequency of the wind More unpredictable Stronger wind	Dangers when boating on exposed water in summer – people stranded Problematic for floe edge narwhal hunt - cases where wind has changed stranding hunters on drifting ice Making seal hunting difficult –can't hear the seals
Sea Ice	Later freeze-up, earlier break-up Less stable – breaks up suddenly Thinner in places	Floe edge narwhal hunt more dangerous Difficult to access certain hunting grounds Timing of hunting – ice fishers have to wait to longer for freeze-up
Snow	Less snow on the land Snow harder	Difficult to access inland hunting grounds by skidoo in winter Hides thin ice
Rainfall	More summer rainfall	Summer hunting trails muddy - difficult to use ATVs

Table 1 Summary of reported changes in climatic and environmental conditions and implications for community members

policy in the 1960s, hunters found their spatial demography to their traditional resources considerably altered (Wenzel, 2004). This resulted in the increased use of, and dependence on, imported technology such as snowmobiles and motorized boats: used to escape the limited zone of exploitation imposed by fixed settlement (Wenzel 2004). A corollary of this has been a progressive replacement of dog teams with snowmobiles. The use of snowmobile requires knowledge of where the safe and unsafe ice is located, because, unlike dog teams, snowmobiles cannot locate dangerous ice. This has not traditionally been a problem; due to personal observation, experience, and knowledge passed on by elders and shared between friends and family, hunters know the location of dangerous ice and times of the year to be careful. It is only with increasingly unpredictable ice conditions that the risks associated with snowmobile travel have fully emerged. This is reflected in the increasing loss of equipment while harvesting in recent years (MacDonald, pers.comm.).

Subsistence activities require substantial monetary investments (Chabot, 2003) and have resulted in an increased dependence on monetary resources. Initially hunters supported themselves almost exclusively from hunting and trapping, trading skins and furs for equipment. Increased prices, however, combined with the declining markets in Europe for seal skins (Wenzel, 1991; Barnabas pers.comm.) resulted in harvesters seeking to secure an income from different sources to support their harvesting activities, including the commercial exploitation of narwhal for the tusk ivory. Around the same time, externally imposed quotas on narwhal limited the catch of this commercially important species. As a result of these two trends, the increasing

importance of monetary resources in harvesting and the imposition of quotas on narwhal, hunters have attempted maximize their chance of catching narwhal before the quota expires by hunting at the floe edge during break-up. Traditionally, hunters would have avoided this time, waiting for the narwhal to migrate closer to the community and for the ice to retreat (Brody, 1976). The floe edge is a highly unstable environment and break-up is the most dangerous time to be on the ice. As expressed by Theo Ikkumaq, this exposes harvesters to the potential for being stranded on drifting ice.

“It’s breaking off when they are hunting! That is why they get stranded”

The dangers of hunting at the floe edge are well known, and hunters manage the risks using their experience and knowledge to identify precursors to hazardous conditions; a south wind, for example, is avoided. With the increasing unpredictability of the wind, however, accurately recognition of the precursors is increasingly problematic. In 2000, 52 hunters were stranded when the wind suddenly shifted, causing the floe edge ice to detach from the landfast ice and drift out (George, 2000).

5.2 Adaptation to climate related risks

The community of Arctic Bay is managing these risks in numerous ways. Hunters are making additional preparations before going out in response to the increasing risk of getting stranded due to unforeseen conditions. Many are taking extra food, gas, and supplies, and in preparation for summer boating are identifying safe areas where they can get shelter. Other responses seek to reduce the likelihood that dangerous conditions will be encountered while out on the land. Hunters are becoming more risk averse, avoiding traveling on the land or water if they have reason to believe the weather is going to be bad, avoiding dangerous areas, avoiding traveling 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. Indeed, some have stopped taking part in the floe edge narwhal hunt altogether. Technological adjustments are being undertaken, and include 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, and the consultation of satellite images provided in the Hamlet Office prior to travel on the ice. Equipment used 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. Losses associated with lost equipment are sometimes shared between family and friends. This usually involves the lending of equipment or the re-allocation of money in the household unit to purchase new equipment.

These strategies by which increased exposure have been managed are largely behavioral and have been autonomously 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 and elders who encounter changing climatic conditions and respond to them by being out on the land frequently and adapting through trial and error experience. This knowledge is transferred through informal channels; young or inexperienced hunters usually travel with or seek advice from these 'local experts' before going out, and the knowledge will be communicated in person. This information is also communicated over the radio and will be discussed between friends and family. Technological adjustments have also been utilized, the responsibility for which lies, in many instances, with younger Inuit who introduce the technology and demonstrate how it is used.

5.3 Determinants of adaptive capacity in Arctic Bay

Adaptations are manifestations of a system's adaptive capacity, and the ability of the community of Arctic Bay to manage the climatic risks is indicative of the community's resilience. The adaptive capacity of the community is facilitated by traditional skills and extensive knowledge of the environment, strong social networks, and flexibility in seasonal hunting cycles. These characteristics of Inuit society have enabled Inuit to live and

thrive in the Arctic for millennia (Sabo, 1991; McGhee, 1996), and are influenced by broader socio-economic and political conditions and processes (as will be evaluated in the next section).

Environmental circumstances change from one trip to another and unpredictability and change defines the very nature of Arctic hunting (Wenzel, 1991). *Inuit Quajimajunganit (IQ)*, traditional Inuit knowledge and a code of behavior based on time-honored values and practices, has evolved to manage unpredictability and variability. Survival in the harsh Arctic environment has depended on this (Robards and Alessa, 2004). Competence on the land and in the skills necessary for safe and successful hunting are a highly valued aspect of *IQ* and are nurtured from a young age. Through experience of being on the land, from knowledge passed on by elders and communication with others, hunters know the dangers of hunting and will take precautions; they know precursors to certain hazardous conditions, will not take unnecessary risks, know how to survive if they are caught in bad weather, and, especially for the more experienced hunters, they know how to navigate using traditional means if they are caught out in bad weather (MacDonald 2004). The body of knowledge embodied in *IQ* goes beyond what is essential for success and includes significant redundancy; hunters learn from a young age to take along survival equipment even on short trips and to prepare above and beyond what is necessary. When faced with an emergency situation this redundancy is drawn upon to ensure survival; if stranded by bad weather, for example, the extra food, naphtha, and warm clothes that hunters take along guarantees their safety.

IQ is dynamic, continually evolving and being updated and revised in light of observations, trial and error experience, and the incorporation of non-traditional knowledge alongside the traditional (Fast and Berkes, 1999). Through first hand experience of changing climatic conditions, and from communication with others, the knowledge embodied in *IQ* has adapted to changing climatic conditions. As expressed by Tagoonak Qavavaq, the fact that the weather is no longer predictable by traditional means, that the weather may suddenly change, or the precursors to certain hazardous conditions are no longer apparent, is the new 'norm' and individuals prepare accordingly.

“I think the hunters now are more aware of it [changing conditions] so they are preparing”

The propensity of Arctic environments to undergo fluctuations that are unpredictable has created incentives for individuals to master a diversity of hunting and fishing skills and procurement activities (Berkes and Jolly, 2002), harvesting what is available when it is available and where it is available. Hunting as practiced is in many ways opportunistic; hunters may set out to hunt caribou in August and September when the meat and fur is good, but if they are hard to find or numbers low then other species will be harvested. This 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 activity; if certain areas are not accessible due to limited snow cover for snowmobile travel then people will go to different locations.

Social networks, the norms and networks that enable people to act collectively (Woolcock and Narayan, 2000), facilitate the sharing of information, the sharing of losses, and the sharing of food, providing security in the context of pervasive and unpredictable environmental changes (Robards and Alessa, 2004). While the complex networks of sharing described by Boas (1888) and Damas (1963) can no longer be discerned, the “economy of sharing,” as Wenzel (1991) describes it, remains central to Inuit livelihoods (Chabot, 2003). The sharing of country food, in particular, underpins Inuit cultural identity and is still considered obligatory, occurring between friends, family, and at certain times of the year to anyone in the community. The sharing of equipment such as GPS, radios, and other safety equipment is widespread and allows for safe travel on the land (DSD, 2002). Social networks also provide mechanisms for the rapid and effective community dissemination of information on dangerous conditions. After returning from a good hunting ground, experiencing dangerous conditions, or noticing thin ice, these personal observations will be passed on to others in the community.

In addition, institutional support underpins adaptability. In light of changing exposure, investment in GPS, vhf radios, more powerful boat engines, and safety equipment, are required for safe and successful hunting. This requires significant capital outlay. Further,

individuals who lose equipment in hunting accidents have to replace lost machinery. This places significant burden upon Northern indigenous communities which have limited employment opportunities and high rates of unemployment. Well developed institutional 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 both in facilitating the ability of people to engage in hunting and in covering the purchase of new equipment necessary to cope with the changing conditions. Nunavut Tunngavik’s Hunter Support Program, in particular, has facilitated the purchase of machinery.

5.4 Emerging vulnerabilities

The community is managing changes in exposure in conjunction with opportunities and challenges posed by social, cultural, and economic changes. These have posed challenges and opportunities to the ability of the community to manage exposure.

Much has been written in the literature about the erosion of knowledge and skill sets, which have underpinned Inuit adaptability, especially among younger generations (Nelson, 1969; Condon et al., 1995). In Arctic Bay, while subsistence activities remain important to younger generation Inuit, fewer are displaying the same degree of commitment or interest in harvesting.

“They’re [younger generations] 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 requirements, there is increased dependence on waged employment, language differences between generations, and lack of funds to purchase equipment (Condon et al., 1995; Ohmagari and Berkes, 1997). The decline in participation has had wide ranging implications. Knowledge of the environment and associated skills were not traditionally taught through formal education but through learning from experience of being out on the land and through observing others. With age, inexperienced hunters would be encouraged to repeat the skills; interviewees recalled how they would be put in charge of returning home in bad weather or navigating through thin ice at a young age, under the guidance of their parents. Through observation, experience, and trial and error, the

skills necessary for safe and successful hunting would be developed. Continuous application of these skills helped to maintain them. Few younger generation Inuit have been brought up this way and, for those who have, fewer opportunities exist to maintain these skills in later life. Many of the younger generation go out on the land during the summer months or when they get the chance but don't go out enough for effective transmission and development of these skills. This has resulted in a loss of certain skills necessary for safe and successful harvesting and travel, including traditional forms of navigation, and how to make snow shelters, and incomplete transmission, including 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.

The erosion of skills is buffered to a certain extent as inexperienced hunters will usually 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 greater risk.

“It is more dangerous for them [younger generation] because they don't know the conditions, what to avoid” - Kautaq Joseph

The adoption of new technology and equipment also plays an important part in buffering the erosion of traditional skills among younger generations; 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, snow machines 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 edge sword; while helping to buffer risk it also creates new risks and exacerbates others. Technology creates dependency; if the GPS fails and people don't know how to navigate the traditional way, then they get into difficulties, and if people don't have a snow machine they can't go hunting. 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 the community's income. Particularly for young Inuit, the lack of monetary resources limits the opportunities to take part in harvesting activities, thus further re-enforcing the decline in participation and erosion of

traditional skills. Lack of money is also constraining the ability to adapt to change; many interviewees acknowledged that they would like to take along extra supplies and equipment in response to increased unpredictability but they cannot afford to.

The social networks that facilitate sharing have been weakened by changes in Inuit livelihoods including the growth of formal employment, the commoditization of production, and the imposition of quotas. A consequence of this has been the emergence of inequality within the community. There are, for example, sections of the population who do not have access to the formal or informal economy; they don't have the school qualifications to get a job and don't have the resources to purchase harvesting equipment or networks to borrow equipment. The importance of money also creates division; on the one hand people want to exploit resources through developing commercial harvesting, while others see such development as counter to Inuit ways. Social structures have also changed; many young Inuit aren't involved in household subsistence activities and often refuse to share money for such purposes, and there is less communication between elders and younger generations. Consequently the communal allocation of resources and pooling of risk has been undermined. This is most noticeable in the sharing of equipment.

“[with regards to equipment] we don't share as much as before” - David Kalluk

What causes most concern, however, is the lack of communication between elders and the younger generations; young people are going out alone more and are, in many instances, not consulting the elders or more experienced hunters before they go.

“They're [younger generation] not listening to the elders” – Attagutak Ipaelee

It is through such communication that important skills and knowledge for safe and successful hunting are transferred.

Conclusion

The research demonstrates that a combination of changing climatic conditions, superimposed on changes in harvesting behavior, have increased the exposure of the community to climate related risks. In the face of changing climatic conditions the residents of Arctic Bay

have demonstrated significant adaptability. The coping strategies that have been employed are similar to those used by Inuit communities elsewhere in the Arctic (Berkes and Jolly, 2002), and include modification of the timing and location of harvesting activities; sharing of losses; changing how hunting is done; avoiding dangerous areas; making extra preparations before going out; and sharing food, information, and equipment. The ability to cope is facilitated by characteristics of Inuit society that have underpinned Inuit survival in the unpredictable Arctic environment: traditional skills and extensive local knowledge, flexibility in harvesting, and strong social networks. In addition, institutional support has increasingly played an important role in the later half of the twentieth century. There are, however, emerging vulnerabilities; in recently years there has been a dramatic increase in the number of people getting into trouble on the land and needing to be rescued. Changing climatic conditions are in part responsible; the environment is more variable and less predictable today. The increase in vulnerability, however, comes not so much from changing climatic conditions but from challenges posed by social, cultural and economic changes which have transformed Inuit livelihoods. These have served to modify those attributes of Inuit society which have facilitated adaptive capacity. There has been a gradual erosion of traditional skills which are vital for safe travel on the land, a dilution of traditional sharing networks which help in the pooling of risk and the allocation of resources, and an increasing dependence on outside support. In particular, younger generations and inexperienced Inuit who go on the land alone, or without more experienced people, are at risk.

The research indicates that the ability to manage future climatic changes will depend on social, cultural, economic, and political processes and conditions which affect how Inuit interact with the environment. Changes in these conditions will constrain or enhance the ability to cope with future climate change.

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