Chapter 11

Hunting, Herding, Fishing and Gathering: Indigenous Peoples and Renewable Resource Use in the Arctic

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CONTENTS

11.0 INTRODUCTION AND SCOPE OF THE CHAPTER

Indigenous peoples throughout the Arctic maintain a strong connection to the environment through hunting, herding, fishing and gathering renewable resources. These practices provide the basis for food production and have endured over thousands of years, with cultural adaptations and the ability to utilize resources often associated with or affected by seasonal variation and changing ecological conditions.

Climatic variability and weather events often greatly affect the abundance and availability of animals and thus the abilities and opportunities to harvest and process animals for food, clothing and other uses. Many species are only available seasonally and in localized areas and indigenous cultures have developed the capacity and flexibility to harvest a diversity of animal and plant species. They have, in many cases, also shown resilience in the face of severe social, cultural and economic change, particularly in the last one hundred years.

The longstanding dependence of contemporary indigenous societies on hunting, herding, fishing and gathering continues for several critically important reasons. One main reason is the economic and dietary importance of being able to access customary, local foods. Many of these local foods – fish, and meat from sea mammals or caribou and birds, for instance, as well as berries and edible plants – are nutritionally superior to the foodstuffs which are presently imported (and which are often expensive to buy). Another reason is the cultural and social importance of hunting, herding and gathering animals, fish and plants, as well as processing, distributing, consuming and celebrating them (Freeman 2000).

These activities remain important for maintaining social relationships and cultural identity in indigenous societies. They define a sense of family community and reinforce and celebrate the relationships between indigenous peoples and the animals and environment upon which they depend (Callaway 1995, Nuttall 1992). Hunting, herding, fishing and gathering activities are based on continuing social relationships between people, animals and the environment (Brody 1983, Callaway 1995, Freeman *et al.* 1998, Nuttall 1992, Wenzel 1991). As such, they link people inextricably to their histories, their contemporary cultural settings, and provide a way forward for thinking about sustainable livelihoods in the future.

The significance of hunting, herding, fishing and gathering has wide cultural ramifications. Seal hunting, for example, is not only an occupation and a way of life, but also a symbolic part of Inuit cultures (Nuttall 1992, Wenzel 1991). The cultural role of activities relating to the use of living marine and terrestrial resources is not only of concern to those who depend economically on these activities, but to those who live in towns and are involved in occupations with no direct attachment to hunting, fishing and herding (e.g. Caulfield 1997). Yet whatever the importance for social identity and

cultural life, the primary need for, and use of, animals is based purely on a need for survival.

Arctic communities have experienced, and are experiencing, stress from a number of different forces that threaten to restrict harvesting activities and sever these relationships. The Arctic regions are tightly tied politically, economically and socially to the national mainstream and are inextricably linked to the global economy (Caulfield 2000, Nuttall 1998). Rapid social, economic and demographic change, resource development, trade barriers and animal-rights campaigns have all had their impacts on hunting, herding, fishing and gathering activities. The material in this chapter on the Russian North, for example, illustrates how poaching, oil development and clear-cutting of forests undermine the subsistence base for indigenous peoples. By and large, hunting, herding, fishing and gathering are also being challenged by environmental changes such as climate variability. Despite this, indigenous peoples have reasserted cultural rights and identities, have called for the recognition of self-determination and are achieving significant levels of regional government (Nuttall 1998).

For many Arctic residents, consuming food from animals is fundamentally important for personal and cultural well-being. Indigenous peoples have reported their loss of vitality, decline in health and personal well-being when they are unable to eat traditional/country foods (Wein and Freeman 1992). These problems do not only emerge when climate change denies people access to traditional/country foods, but are very much linked to problems associated with the undermining of local modes of production. The erosion of a person's position as a provider of welfare to family and community also has serious ramifications. A recent study of the importance of whaling for Inuit societies illustrates the negative social, cultural, economic and nutritional consequences of not being able to gain access to, and to eat, traditional/country foods (Freeman *et al.* 1998) and points to the kinds of problems that indigenous peoples may experience if climate change denies them access to food resources.

The conservation of Arctic wildlife and ecosystems depends in part on maintaining the strength of the relationship between indigenous peoples, animals and the environment, and securing the rights of indigenous peoples to continue customary harvesting activities. As this assessment shows, these activities and relationships appear to be threatened by severe climate change. The potential impacts of climate change on harvesting wildlife resources are of fundamental concern for the social and economic well-being, the health and cultural survival of indigenous peoples throughout the Arctic, who live within institutional, legal, economic and political situations that are often quite different from non-indigenous residents. Furthermore, indigenous peoples rely on different forms of social organisation for their livelihoods and well-being (Freeman 2000).

Many of these concerns about climate change arise from what indigenous peoples are already experiencing in some areas, where climate change is an immediate and pressing problem, rather than something that may happen, or may or may not have an impact in the future. For example, Furgal *et al.* (2002) discuss local anxieties over

environmental changes experienced by communities in northern Quebec and Labrador, and argue that the impacts on human health and the availability of important traditional/country foods from plants and animals can already be observed. Indigenous accounts of contemporary environmental change say that such changes in climate and local ecosystems can be noticed not only in animals such as caribou shifting their migration routes and altering their behaviour, but in the very *taste* of animals.

As the various chapters of the Arctic Climate Impact Assessment show, scientific projections and scenarios suggest there will be significant changes in the climate of the Arctic, the character of the environment and its resources. For example, latitudinal shifts in the location of the taiga-tundra ecotone will have significant effects on ecosystem function and biodiversity at the regional scale. One dramatic anticipated change, taking place over several decades to hundreds of years, is the gradual forestation of tundra patches in the present forest-tundra mosaic and northwards shift of the Arctic treeline by hundreds of kilometres. These changes will affect vegetation structure and the composition of flora and fauna and have implications for indigenous livelihoods, particularly reindeer herding and hunting and gathering (See Chapter 6).

The aims of this chapter are:

- to discuss the contemporary economic, social and cultural importance of harvesting renewable resources for indigenous peoples;

- to provide an assessment of how climate change has affected, and is affecting, harvesting activities in the past and in the present;

- through a selection of detailed case studies based on extensive research with indigenous communities in several Arctic settings, to discuss some of the past, present and potential impacts of climate change on specific activities and livelihoods.

These case studies have been selected to provide a sense of what impacts climate change is having in the present, or could have in the near future on the livelihoods of indigenous peoples. It is not possible to provide circumpolar-wide coverage of the situation for all indigenous peoples. Apart from space constraints, detailed descriptions are unavailable for all regions of the Arctic. The material presented in this chapter, especially through the case studies, is illustrative of the common challenges faced by indigenous peoples in a changing Arctic.

Part of the purpose of this chapter, although not its primary aim, is also to assess what adaptations have enabled communities to succeed in the past and what extent these options remain open to them. There is little data published on this area, but based on what is available the chapter shows that while indigenous peoples have often generally adapted well to past climate change, the scale and nature of current and predicted climate change brings an altogether different sense of uncertainty for indigenous peoples, presenting different kinds of risks and threats to their livelihoods.

It should be noted that, compared with the scientific chapters in this assessment, data on the impacts of climate change on the livelihoods of indigenous peoples is limited, particularly in the case of the indigenous peoples of the Russian North. The case studies in this chapter illustrate the complexity of problems faced by indigenous peoples today and underscore the reality that climate change is but one of several, often intersecting problems affecting their livelihoods.

This chapter is, therefore, as much a scoping exercise as it is an assessment of current knowledge. It emphasises the urgency for extensive, regionally-focused research on the impacts of climate change on hunting, herding, fishing and gathering activities, research that will not only contribute to a greater understanding of climate impacts, but will place these impacts within a broader context of rapid, social and economic change.

11.1 CONTEMPORARY USES OF LIVING MARINE AND TERRESTRIAL RESOURCES

11.1.1 Indigenous Peoples, Animals and Climate

Animals, Food and Survival

The indigenous peoples of the Arctic include the Inupiat, Yup'ik, Alutiiq, Aleuts and Athapaskans of Alaska; the Inuit, Inuvialuit and Dene of northern Canada; the Kalaallit and Inughuit of Greenland; the Saami of Fennoscandia and Russia's Kola peninsula; and the Chukchi, Even, Evenk, Nenets, Nivkhi and Yukaghir of the Russian Far North and Siberia (See Chapter 1 and Chapter 9 for an extended discussion). These peoples have subsisted for thousands of years from the resources of land and sea, as hunters, fishers and reindeer herders. Today, many indigenous communities across the Arctic continue to depend primarily on harvesting and using living terrestrial, marine and freshwater resources. In recent decades indigenous peoples have demanded the right to be involved in the policy-making processes that affect their lives, lands and communities. Responding to rapid social change and threats to the Arctic environment, demands for land claims and self-government have been based on historical and cultural rights to lands and resources.

The species most commonly harvested by the indigenous peoples of the Arctic are marine mammals such as seals, walrus, narwhals, beluga, fin and minke whales, and polar bear and land mammals such as caribou, reindeer and musk-ox; and fish such as salmon, Arctic char, northern pike and other species, such as coregonids (whitefishes). Many of these species are used as food, for clothing and other products, as well as figuring prominently in the cash-economy of local households and communities (Caulfield 2000, Dahl 2000, Huntington 1992, Nuttall 1992).

Ringed seals (*Phoca hispida*), bearded seals (*Erignathus barbatus*), and hooded seals (*Cystophora cristata*) are widely hunted in Greenland and Canada. Harp seals (*Phoca groenlandica*) and harbour seals (*Phoca vitulina*) are also used locally. Smaller toothed whales like the beluga (*Delphinapterus leucas*) and the narwhal (*Monodon monoceros*) are hunted in many areas of Canada and Greenland and are prized for their mattak (skin) and meat. Baleen whales like bowhead, minke, fin, gray, pilot, and other larger whales are also a valued source of food. Walrus (*Odobenus rosmarus*) are also commonly taken in Inuit areas, especially in the Bering Straits region and in the Canadian Arctic (Caulfield 2000).

Fish species used by Arctic societies include those that move seasonally from marine to freshwater environments, such as salmon (*Oncorhynchus spp.*) and Arctic char (*Salvelinus alpinus*), which are particularly important for indigenous peoples of Alaska (including Inuit societies around Kotzebue Sound, Norton Sound, and the Yukon and Kuskokwim deltas). The five species of Pacific salmon provide important sources of food and are major sources of cash income for many households (Caulfield 2000). Other Arctic species used locally include Atlantic salmon (*Salmo salar*), lake trout (*Salvelinus namaycush*), several species of whitefish (*Coregonus spp.*), pike (*Esox lucius*), and grayling (*Thymallus arcticus*).

Marine fish are used by Arctic societies both for food and are a cornerstone for contemporary economic life. Arctic cod (*Gadus morhua*) is used for domestic consumption but also has a long history of use for commercial purposes, especially in Greenland. While its numbers today are reduced, it remains an important part of northern economies in Canada, Greenland, Iceland, and Norway. Greenlandic-owned (and largely Greenlandic-crewed) fishing vessels are also fishing in waters beyond Greenland, such as in the Barents Sea. In the Bering Sea, the large fishery for pollock is undertaken mainly by vessels coming from outside the Arctic, but indigenous peoples are increasingly participating in this and other Bering Sea fisheries. Several flatfish, including halibut, Greenland halibut, and flounder are important locally for food and for cash. In Greenland, deep-water shrimp (*Pandalus borealis*) is the major source of export income; indeed, Greenland is the world's largest exporter of shrimp, while the economies of small communities along the country's west coast are increasingly based on fishing for local stocks of Greenland halibut and cod. Capelin (*Mallotus villosus*), which spawns in large numbers on rocky beaches, is a particularly important coastal fish used locally in Canada and Greenland for human and sled dog food.

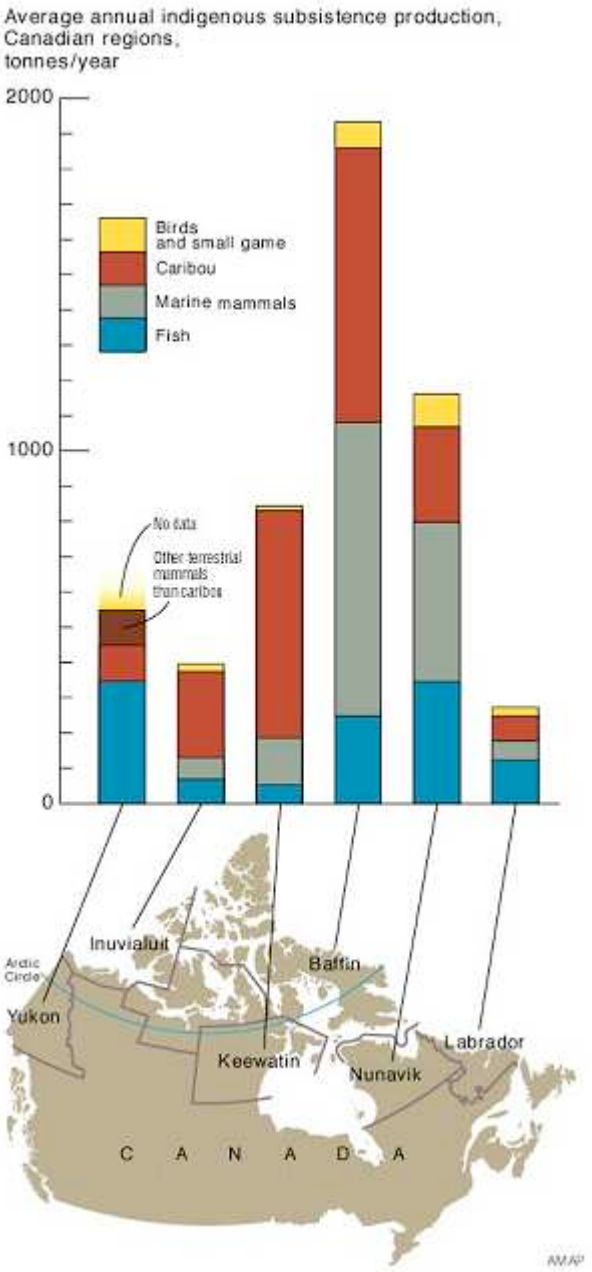
Several terrestrial species—especially caribou, reindeer, musk-ox, and moose—are extremely important in local economies. Caribou (*Rangifer tarandus*), in particular, are hunted widely in Alaska and Canada and in some parts of Greenland, and are used for both food and for other products. Caribou populations are known to vary dramatically over time, and hunters are attuned to the near predictability of their seasonal abundance and migratory routes. Reindeer underpin the culture and economy of herding societies in Fennoscandia and Siberia. Moose (*Alces alces*) are common in the sub-Arctic boreal forest, but their range is expanding into more northerly environments. Other terrestrial species of economic importance to Arctic residents include musk-ox (*Ovibos*

moschatus), grizzly bear (*Ursus arctos*), wolf (*Canus lupus*), arctic fox (*Alopex lagopus*), muskrat (*Ondatra zibethica*) and ground squirrel (*Spermophilus parryii*).

Indigenous peoples have also collected eggs and hunted birds among coastal colonies of auks and other seabirds. For example, Greenlanders hunt Brunnich's guillemot, eiders and king eiders, and kittiwakes, among other species, and take the eggs of all these birds. The eggs of birds not hunted for food, such as the Arctic tern, are also collected.

Literally hundreds of harvest studies have been carried out in the Arctic and sub-Arctic, particularly in Alaska and Canada. The wide range and diversity of plant and animal species used for food by indigenous peoples is illustrated by data from recent studies and surveys from the Canadian Arctic summarised in the Arctic Monitoring and Assessment Programme (AMAP) reports. The figure below shows harvest levels in the different Inuit regions and in the Yukon Territory (AMAP 1998).

In 1989, the total harvest in the Northwest Territories was estimated to be about 5 million kilograms, or 232 kilograms per person per year, excluding commercial fish catches. There is very little information about the harvesting activities of the Dene and Métis communities, with the exception of fur-bearer species and commercially significant fish. Employment figures indicate that subsistence activities are important, as almost 40 percent of the indigenous population in Dene communities were not part of the labour force according to a survey in 1991 (AMAP 1998). Almost 38 percent of people over 15 years of age said they used non-cash activities to provide for their families. A slightly larger percentage said that they had lived on the land in the previous twelve months. An estimate of the per-capita harvest suggests that the communities are self-sufficient in their protein requirements. Yukon First Nations also rely heavily on subsistence activities. About one third of the people in the 1991 Aboriginal People's Survey said that they had lived on the land in the previous year and 30 percent support their families with activities that are not part of the cash economy (AMAP 1998).



Average annual indigenous subsistence production in Arctic Canada.
Source: AMAP 1998 *AMAP Assessment Report: Arctic Pollution Issues* Oslo: Arctic Monitoring and Assessment Programme

The AMAP report shows that studies support the picture of a high reliance on subsistence production throughout northern Canada. Even if store-bought foods are also common, traditional/country foods contribute a significant portion of the daily nutrient intake.

The traditional diets of indigenous peoples in northern Canada are more balanced than a diet of foods imported from southern Canada, which have higher levels of sugar and more saturated fats. Traditional/country foods are regarded by indigenous peoples as

being more economical than purchasing food in the store. This which becomes especially important in communities where many people are not employed or have incomes below the poverty line. Traditonal/country foods are also important for reinforcing social relationships that are central to culture and the subsistence economy.

Diets and food preferences vary between communities and between families, but detailed studies provide some examples of what people eat. In Aklavik in the Northwest Territories, more than half of the Inuit households consume caribou, beluga, hare, muskrat, whitefish, cisco, burbot, inconnu, Arctic char, ducks, geese, cloud berries, cranberries, and blueberries, with caribou being the most common food (AMAP 1998).

The types of food eaten also depend on the time of year. In Aklavik, fall is caribou hunting season, as well as the hunting seasons for Dall sheep, moose, ducks and geese. Winter activities turn to trapping small fur bearing animals and to fishing. When the ice breaks up in April, muskrat are caught for their pelts as well as their meat. The waterfowl return, and are used as food until they begin to nest. Fishing resumes after ice break-up. Spring is the time for gathering roots. Summer is whaling time, and people travel out to the Yukon coast to hunt beluga. Willow tops, bird eggs, and wild rhubarb supplement the diet. As fall approaches again, it is time to dry fish and caribou meat and to pick berries. Among the Dene, a few diet studies have been carried specifically to be able to estimate the amount of contaminants in traditional/country foods. These surveys show, for example, that moose are eaten in summer, barrenland caribou in winter, and ducks in the spring. Other important foods are inconnu, whitefish, cisco, and blueberries. In the winter, moose, rabbit, whitefish, and loche were part of the diet, and in the spring woodland caribou (AMAP 1998). The influence of the fear of contaminants as an impact on food harvesting is an important issue that needs development (Weinstein 1990).

A survey of dietary preferences in the communities of Fort Smith, Northwest Territories, and Fort Chipewyan, Alberta, showed that people ate traditional/country foods six times per week and that animals from the land made up one-third of the diet. In a survey of Yukon First Nation (Haines Junction in the traditional territory of the Champagne-Aishihik First Nation, Old Crow, which is a remote community on the Porcupine River relying heavily on the caribou herds that migrate through their land, Teslin at Teslin Lake, and Whitehorse, which is the territorial capital with a more diverse population), virtually all households in the survey used moose and salmon, as well as berries and other plant foods. Many also used caribou, hare, ground squirrel, beaver, ducks, grouse, chinook salmon, sockeye salmon, coho salmon, whitefish, lake trout, and Labrador tea. In total, mammals accounted for about half of the traditional food, fish for one fifth, berries for one-fifth, other plants for one-tenth and birds for one-twentieth. People got most of their food from hunting and fishing (AMAP 1998).

As the dietary surveys carried out in Yukon First Nations communities show, traditional/country food harvested from the local environment has a central role in the daily lives of individuals, families, households and communities. Traditional/country foods bring about improved diet quality as shown by the lower fat and saturated fat content of the diet when traditional food is consumed. Traditional/country foods also

provide important sources of dietary energy, protein, iron and zinc. The increased physical activity associated with traditional food harvest, and the role of the traditional/country food system in cultural and social support systems are also likely to contribute to health (Receveur *et al*. 1998).

Animals and Cultural Identity

Successful harvesting of all the species used by indigenous peoples requires specialised knowledge of animal and fish behaviour, sea ice and terrestrial conditions, and Arctic weather. The detailed knowledge of the Arctic's indigenous peoples about these factors is widely recognised. Indigenous peoples have detailed and complex systems of classification and knowledge about the natural world which is developed and enhanced through long-term experience and generational transmission (Nuttall 1998). This knowledge has enabled indigenous societies to exploit highly productive ecosystems effectively in the region for thousands of years (Caulfield 2000) and provides a foundation for economic, cultural, spiritual and ethical concerns that guide the use and management of natural resources (Nuttall 1998).

The living resources of the Arctic not only sustain indigenous peoples in an economic and nutritional sense, they provide a fundamental basis for social identity, cultural survival and spiritual life. As such they are as much important cultural resources as they are economic ones. This dependence on animals for food and social, cultural and economic well-being is reflected in community hunting regulations, in herding practices and in patterns of sharing and gift-giving based on kinship ties and other forms of close social relatedness. Participation in family and community hunting, herding and fishing activities contributes to defining and establishing a sense of social relatedness and is important for community and cultural identity, as well as providing a moral framework for relationships between people and between people and animals.

Across the Arctic, the sharing and distribution of meat and fish is central to daily social life and expresses and sustains social relationships, and the case study from Nunavut in this chapter illustrates vividly the sharing practices and networks in one region. Harvesting and its associated processing and sharing activities reaffirm fundamental values and attitudes towards animals and the environment and provide a moral foundation for continuity between generations (Callaway *et al.* 1999, Nuttall 1992, Wenzel 1991).

In seal hunting households in Greenland and Canada, for example, the meat, fat and skin of the seal is utilised. There is rarely much wasted. Complex and precise local rules determine the sharing and distribution of the catch, and seal meat is commonly shared out to people beyond the household, whether those people are related to the hunter or not (Petersen 2003). For Arctic hunting peoples, sharing can only be understood with reference to the sense of social relatedness that people feel they have with each other and with animals and the environment. This has been well documented by recent research on

the consumption of traditional/country foods in Greenland, for example (Caulfield, 1997, Nuttall 1992, Pars *et al*. 2001).

The cultural expression of the relationships between humans and animals is evident in first-catch celebrations. At an early age, boys are taken on hunting trips with their fathers, who begin to teach them the skills and impart the knowledge necessary to be a successful hunter. In small Greenlandic hunting villages, for example, when a boy catches his first seal, he will give gifts of meat to every household in his community and people are invited to his parents' home for coffee or tea and cake. A first catch celebration is not only a recognition by the community of the boy's development as a hunter, it is a statement of the vitality and cultural importance of the hunting way of life (Nuttall 1992). For Arctic hunting peoples such as the Inuit, sharing the products of the hunt is a social event that demonstrates relatedness, affection and concern. Obligations to share underlie customary ideologies of subsistence and contribute to the reproduction of kinship ties and other close social relationships (Nuttall 1992, Wenzel 1991). Climate change not only disrupts hunting activities, it has an impact on such social relationships, as the case study from Nunavut in this chapter shows.

Rich mythologies, vivid oral histories, festivals and animal ceremonialism also illustrate the social, economic and spiritual relationships that indigenous peoples have with the Arctic environment. Animals have a spiritual essence as well as cultural and economic value, and land and water are not just simply regarded as commodities. For indigenous peoples, many features in the landscape are sacred places, especially along migration routes, where animals reveal themselves to hunters in dreams, or where people encounter animal spirits while travelling (Brody 1983).

In Alaska and Canada, Athapaskan oral histories describe how features of the landscape, or the elements, such as the moon, sun, wind, stars and so on, were originally human beings and whose spirits are now embodied in aspects of the natural world. In Greenland, Canada and Alaska, Inuit stories about the origin of the elements, the sun and the moon, and other celestial bodies, are often related to myths about the balance between daylight and darkness, time and space, and between the human and natural worlds. In Siberia and Sapmi, one can find reindeer antlers that have been placed at sacred sites and adorned with gifts, and sacred stones placed on the tops of mountains and near lakes and rivers.

Place, Environment and Climate

Although the Arctic is often labelled one of the last remaining wilderness areas on Earth, this ignores the fact that the Arctic is a homeland for indigenous peoples. The indigenous names for features of the landscape--for streams, lakes, mountains, valleys, plains and tundra meadows—as well as the icescape and features of the sea are not merely geographically descriptive. The names that indigenous peoples have given to the Arctic landscape are multidimensional, in that they contain information about physical features, the availability and movement of animals, community history and historical and

mythological events (Nuttall 1992, 2001). This differs sharply from the practice of naming places by explorers, colonialists and settlers in order to control, own and dominate the landscape.

Often, place names provide information about climate change and significant weather-related events. For indigenous peoples, stories and discussions about the weather and climate are interwoven with stories and experiences of doing particular tasks like hunting, herding and fishing, berry-picking, or travelling (See Chapter 9). Much of this is bound up with memories of past events, of local family histories and of a strong sense of attachment to place and locality (Nuttall 2001). The weather connects people to the environment and to animals.

One example of this is the understanding of *sila* in Greenland. In Kalaallisut (Greenlandic) the word for weather and climate is *sila*. *Sila* is also used to mean 'the elements' or 'the air'. But *sila* is also the word for 'intelligence/consciousness', or 'mind' and is understood to be the fundamental principle underlying the natural world. *Sila* is manifest in each and every person. It is an all-pervading, life-giving force – the natural order, a universal consciousness and a breath soul (Nuttall 1992). *Sila* connects a person with the rhythms of the universe, integrating the self with the natural world. As *sila* links the individual and the environment, a person who lacks *sila* is said to be separated from an essential relationship with the environment that is necessary for human well-being. When people in Greenland experience a change in the weather, this change is experienced in a deeply personal way. And when they talk about their concerns about climate change, they articulate this not only in terms of how their own sense of self, personhood and well-being is changing in relation to external climatic fluctuations, but articulate their concerns for their own sense of self and well-being in terms of climate change (Nuttall in press).

Memories and knowledge of how the weather and climate has changed are also found in oral histories as well as in contemporary observations. For Athapaskan people of Canada's Yukon Territory and South East Alaska, memories of the Little Ice Age play a significant role in indigenous oral traditions. Cruikshank (2001) shows how these stories are 'sedimented' on land just like geological processes. Athapaskan clan histories document travel across glaciers from several directions. Eyak, Athapaskan and Tlingit place names encapsulate information and local ecology and climate now rendered invisible by English names. Cruikshank shows that surging glaciers present navigational, spiritual and intellectual challenges of a sentient 'land that listens.' Stories about changes in the weather, to the landscape and to glaciers persist with a richness, range and variety because of ongoing risks they posed to everyday life well into the 20th century.

Today, as Athapaskan people demonstrate concern with climate change there is a contemporary validity to these stories. They not only record the consequences of climate change, and enrich scientific understandings of past climatic conditions, they also provide information on the responses that helped indigenous communities cope with and adapt to climate change. Observations and understandings of change are invaluable to scientists working on the impacts of climate change and increased UV-B by providing long-term

records of observed changes with which to compare and contrast their results (De Fabo and Bjorn 2000).

1.2 Mixed Economies

In indigenous communities in the Arctic today, households are economic units within villages, settlements and small towns characterised by a blend of formal economies (e.g. commercial harvesting of fish and other animals, oil and mineral extraction, forestry and tourism) and informal economies (e.g. harvesting renewable resources from land and sea). The ability to carry out harvesting activities is not only dependent on the availability of animals, but on the availability of cash as the technologies of modern harvesting activities are extremely expensive in remote and distant Arctic communities. Throughout the Arctic, many indigenous communities (whether they are predominantly seal hunting communities in northern Greenland or Canada, fishing communities in Norway, or reindeer herding societies in Siberia), are increasingly characterised by pluri-activity in that cash is generated through full-time or part-time paid work, seasonal labour, craft-making, commercial fishing or other pursuits such as involvement in tourism that support and supplement renewable resource harvesting activities.

In mixed economies, half or more of household incomes may come from wage employment, simple commodity production, or from government transfer payments (Caulfield 2000, Langdon 1986, Weinstein 1996). Such increasing reliance on other economic activities does not mean that production of food for the household has declined in importance. Hunting, herding, gathering and fishing activities are mainly aimed at satisfying important social, cultural and nutritional needs, as well as economic ones, of families, households and communities (see Bodenhorn [2000] for northern Alaska, Hovelsrud-Broda [2000] for East Greenland , and Wenzel [2000] for eastern Baffin Island).

Research points to the continued importance of harvesting activities despite the fact that a growing proportion of the population of indigenous communities is not directly involved in harvesting (e.g. Usher 2002). Purchased foodstuffs supplement diets composed mainly of wildlife resources (Callaway 1995, Nuttall 1992) and individuals and households that do not have the means or ability to hunt often have regular access to country foods through local distribution channels and networks of sharing (see the case study of Inuit sharing patterns in Nunavut in this chapter).

Nor has money diminished subsistence-oriented production as a central feature of life in the Arctic – indeed cash has made the continuation of hunting, herding and gathering possible in some cases, rather than contributing to its decline (Nuttall 1992, Wenzel 1991, Wolfe and Walker 1987). In parts of the Arctic commercial and subsistence uses of country foods are intrinsically linked. In Alaskan villages fish for the household are often taken during commercial fishing trips, the profits from which are often invested in new equipment for subsistence pursuits (Callaway *et al*. 1999).

Cash is often used to buy equipment for procuring food from harvesting activities (e.g., boats, rifles, snow-machines). Cash also meets demands for a rising standard of living: to purchase oil to heat homes, to buy consumer goods, or to travel beyond one's community. While food procured from renewable resource harvesting continues to provide Arctic peoples with important nutritional, socio-economic and cultural benefits, finding ways to earn money is a major concern in many Arctic communities (Caulfield 2000). The interdependence between formal and informal economic sectors, as well as the seasonal and irregular nature of wage generating activities (such as tourism) means that families and households are often faced with a major problem in ensuring a regular cash-flow. For example, Callaway *et al*. (1999) demonstrate that the abilities to carry out harvesting activities in Alaska – and thus the quality of life in rural communities – are linked to the state's economic and political environments.

The impacts of climate change on formal economic activities will also have implications for renewable resource harvesting activities. In Alaska, recent climate change has increased the cost and risk of subsistence pursuits. On the coast of northern Alaska, where the ice pack has retreated a significantly greater distance from land, North Slope hunters have to cross a greater expanse of open water to reach hunting grounds. The increased time and distance added on to a hunting trip adds to the cost and risk of accessing marine mammal resources. Fuel and maintenance costs are greater because of the longer distance to travel, which also decreases the use and expectancy of the technology used (boats, engines, rifles). For safety reasons, boats with larger engines are required, adding strain to limited budgets (Callaway *et al.*1999).

The economic value of traditional/country food is emphasized by the level of food insecurity common among indigenous peoples. In a major dietary survey in Yukon First Nations communities, 39% of respondents reported having insufficient resources to purchase all the food they would need from the store if traditional food was not available; the average weekly Northern Food basket was priced at $164 in communities, compared to $128 in Whitehorse (Receveur *et al*. 1998). The case study from Nunavut in this chapter illustrates the problems hunters face in gaining access to money. While hunting produces large amounts of high quality food - the Government of Nunavut estimates that it would cost approximately Can$35,000,000 to replace this harvest production. As the case study points out, virtually none of this traditional wealth can be converted into the money needed to purchase, operate and maintain the equipment hunters use. Abandoning hunting for imported food would not only be less healthy but would also be immensely costly.

1.3 Renewable Resource Use, Resource Development and Global Processes

Despite variations in economic and cultural practices, many indigenous communities throughout the Arctic share one important characteristic – their economies are vulnerable to changes caused by the global processes affecting markets, technologies

and public policies in addition to the environmental impacts of climate change. Residents of Arctic communities are increasingly tied to world markets and the growth of the mixed economies of Arctic communities points to widening interaction of Arctic societies with the global economy (Caulfield 1997, Nuttall 1998). Greenland's largest single source of export income, for example, is deep-water shrimp, marketed in Europe, North America, and Japan. Oil from Alaska's North Slope meets 25 percent of total US demand, and provides healthy tax revenues for the North Slope Borough's Iñupiat residents. Development of hydropower has sparked major conflict between Saami in northern Norway and industry and governments to the south (Caulfield 2000). As Caulfield (*ibid*. 497-8) shows,

> Renewable resources are a part of this global dynamic: salmon from Alaska's Bering Sea is found in fashionable restaurants of Boston and Los Angeles within hours of being caught; Japanese technicians advise Greenlanders about how to produce specialized shrimp products ("fantails") for Tokyo markets; wealthy European and North American hunters pursue polar bear in northern Canada for trophies; wilderness enthusiasts in places like Alaska's Denali National Park seek wildlife experiences where subsistence hunting by indigenous peoples is banned; and animal rights activists lobby to keep Inuit hunters from selling seal skins on the European market, no matter how justifiable the practice on biological grounds.

Arctic fisheries represent a good example of how the effects and influences of global processes are increasingly felt in all aspects of social, economic and cultural life in the Arctic today. Many problems experienced by Arctic North Atlantic coastal communities, for instance, can be attributed in part to the global restructuring of fisheries, the balance of competition between different species and different fishing areas, the globalisation of the sourcing of supplies for processing plants and retail markets, and the redistribution of wealth from traditional actors, such as local fishers and local processors, to powerful global players in the form of transnational corporations. Fisheries are being transformed from industries or ways of life subject to the control and regulation of local, regional and national authorities to a global enterprise dominated by a handful of transnational corporations (Nuttall 2000).

Furthermore, industrial development, deforestation and pollution are also significant. In northern Russia, domesticated reindeer populations are decreasing due to the degradation of winter reindeer pastures by deforestation, industrial pollution and overgrazing. Fewer winter pastures are available for reindeer as large territories are being occupied by the mining, oil and gas industries, leading to greater pressure from grazing on increasingly fragile tundra and lesotundra ecosystems (Vlassova 2002). Several ecosystems in northern Russia are already overgrazed by reindeer. The reindeer population in Yamal peninsular, for example, exceeds the carrying capacity of pastures by 1.5 times, with 70 percent of pasture registered as low quality (Vlassova 2002).

In Yukon Territory concern over contaminants and dietary risks include: (1) the risks associated with increased market food consumption (for example, fewer of the protective factors associated with traditional food use, lower nutrient intake and higher

saturated fat intake), and (2) risks associated with exposure to chemical contaminants from the consumption of traditional food. The chemical contaminants considered (organochlorines and heavy metals) are known to be very low in most market food, but are potentially of concern in traditional food. Analyses assume therefore that market food does not contain chemical contamination, and that risk from high contaminant intake from traditional food will be related to the level of exposure: the higher the level of exposure, the higher the supposed risk (Receveur *et al*. 1998).

For some indigenous communities, then, climate change may not be the most immediately pressing issue of local concern. Yet. the interrelations between industrial development, pollution and contaminants, international trade, sustainable development and climate change (and their cumulative impacts) are poorly understood and further research is needed in this area. With an increased focus on sustainable development of both renewable and non-renewable resources in the Arctic future research on how local, regional and national economies throughout the circumpolar North are being affected by climate change will need to contextualise Arctic case studies with reference to the internationalisation of production and exchange, the globalisation of economic and industrial activity, and the activities and influences of transnational corporations and transnational practices.

There is scientific difficulty in stating how far climate change alone has affected Arctic marine ecosystems in the past fifty years, for instance, as the impacts of overfishing and overhunting may be far greater (Sakshaug and Walsh 2000). However, Finney *et al.* (2002) present results that support a strong role for climate forcing in regulating abundance of northeastern Pacific fisheries over the last two millennia. Sockeye salmon return to spawn and die in the lakes in which they were born, casting nutrients into the lake which accumulate in the sediments. By analyzing sediment cores from nursery lakes in Alaska, research reveals the existence of multi-century regimes in salmon abundance The two noticeable multi-century shifts in salmon abundance at ~100 BC (beginning of a sustained period of low abundance) and ~AD 800-1200 (beginning of a sustained period of high abundance) correspond to periods of major change in ocean-atmosphere circulation in the northeastern Pacific. Historical catch records, being of short duration, have provided only a limited understanding of fish population dynamics and their response to climate change. This 2,200 year record demonstrates that very low productivity regimes, lasting for centuries, can occur even without the influence of commercial fisheries, in response to climate changes and associated oceanic changes (Finney *et al.* 2002).

Nor is climate change the only cause of changes to the treeline and the tundra. The overgrazing of reindeer pastures in northern Russia leads to the overgrazing of lesotundra, damaging shrubs, and has an impact on the treeline, pushing it further south in some areas (Vlassova 2002). In Fennoscandia the development of reindeer husbandry over the last hundred years has also increased the risk of overgrazing. The shift from intensive to extensive reindeer husbandry probably reduced pressure on vegetation in some places, however it also meant larger numbers of reindeer could also be kept. In Finland, for example, the number of reindeer rose dramatically in the 1950s, with herds

growing rapidly throughout Fennoscandia during the 1970s. The result was increasing pressure over very wide areas (Bernes 1996).

In Norway, the growing numbers of reindeer and herds, together with the reduction of available pasture, have strongly reduced the most important asset of Saami pastoralists, namely flexibility. As a result, it is increasingly difficult for Saami herders to cope with variations in climate and pasture conditions (Bjorklund 2004). Herders have strategies for dealing with climatic variability or changes in pasture which are becoming harder to utilise because of a number of factors. For example, if pasture becomes too scarce in summer because of growing herd sizes, or if conditions become difficult because of climatic fluctuations one year, herders might leave the area early and keep their reindeer longer on autumn and winter pastures, or move her herds to temporarily vacant neighbouring pasture. This flexibility is becoming increasingly problematic as fences, pasture regulations, a growing number of herds and changing management systems combine to reduce the possibility of using such strategies (Bjorklund 2004).

Human activities, industrial development, resource use regulations and global economic processes have far-reaching consequences for the environment and therefore magnify the likely impacts on indigenous livelihoods due to variations in weather and climate. Indigenous economies are not self-reliant closed systems and although their involvement in global networks of production and consumption may provide avenues to strengthen and extend the possibilities for Arctic communities, it also introduces greater elements of risk and perhaps make people and their livelihoods less resilient to coping with and adapting to climate impacts.

1.4 Renewable Resource Use and Climate Change: Risk and Access to Food Resources

Climate Change Impacts: Some Key Facts

Renewable resources will continue to be central to the sustainable development strategies of numerous Arctic communities. However, renewable resources and the harvesting of renewable resources by indigenous peoples in the Arctic could be affected by global climate change and increased ultraviolet radiation caused by ozone depletion. Climate change scenarios suggest that climate change will have impacts on marine and terrestrial animal populations, affecting population size, structure, reproduction rates and migration routes (IPCC 2001). Arctic residents, particularly indigenous peoples who depend on renewable resources for their livelihoods and cultural survival, will feel these climate change impacts first and most intensely.

However, as this chapter stresses, because of the interdependence between Arctic economies and global markets, indigenous peoples are multiply exposed -- to climate change, to changes caused by the global processes affecting markets, technologies and public policies and to local and regional political and economic situations. It is important to contextualise climate change impacts with reference to other changes experienced by

Arctic residents. Being able to access traditional food resources and ensuring food security will be one major challenge in an Arctic affected increasingly by climate change and global processes.

The chapters in this assessment show that the results of scientific research and evidence from indigenous peoples have increasingly documented climatic changes that are more pronounced in the Arctic than in any other region of the world. Yet although this indicates that the physical environment, as well as the flora and fauna, has been undergoing noticeable change, the impacts felt throughout the Arctic will be unique and will vary from region to region. Different climatic trends have been observed in different parts of the Arctic – while average temperatures in the North American western Arctic and Siberia have been increasing in the last 30 years (e.g. annual temperatures in the Canadian western Arctic have climbed by 1.5°C and those over the central Arctic have warmed by 0.5°C), temperatures in Canada's Hudson Bay and in Greenland, particularly in the Davis Strait area have decreased (Chapman and Walsh 1993), suggesting that climate change involves regional cooling as well as global warming.

If the scientific predictions and scenarios are realised, climate change could have a potentially devastating impact on the Arctic environment and on the peoples who live there, particularly those indigenous peoples whose livelihoods and cultures are inextricably linked to the Arctic environment and its wildlife. Some scenarios suggest that the most direct changes will be noticeable in the reduction of the extent of sea ice and permafrost, less ice in lakes and rivers, pronounced reductions in seasonal snow, and the disappearance of the existing glacier mass, leading to a corresponding shift in landscape processes (Lange, 2000, Siegert and Dowdeswell 2000, Weller 2000).

Scientific research shows that over the last 100 years there has already been a significant reduction in Arctic ice cover extent and thickness. Since 1979 alone, the extent of sea ice throughout the Arctic has decreased by 0.35%, and record reductions of sea ice coverage were observed in the Beaufort and Chukchi seas in 1998 (Johannessen *et al*., 1999, Maslanik *et al*., 1999). Sea ice is highly dependent on the temperature gradient between ocean and atmosphere and on near-surface oceanic heat flow and will react swiftly to changes in atmospheric conditions (Lange 2000). Atmosphere-ocean climate models project a reduction in sea ice of around 60% in the next 50-100 years under a scenario in which CO_2 is doubled. Permafrost will thaw more quickly in spring, but take longer to refreeze in autumn, and permafrost boundaries will gradually move poleward, with most of the ice-rich discontinuous permafrost disappearing by the end of the 21st century.

Climate variability appears to have caused relatively rapid shifts in the organisation of Arctic marine ecosystems. In the Bering Sea ecosystem and the Barents Sea ecosystem climate-driven variability is significant (Sakshaug and Slagstad 1992). There are difficulties, however, in determining what biological changes in marine ecosystems are due to natural environmental fluctuations or human activities. In the eastern Bering Sea upper trophic levels have undergone significant changes in the past 100-150 years, largely due in part to commercial exploitation of mammals, fish and

invertebrates (NRC 1996). Climatic changes may have contributed in part to the changes in animal populations. Higher ocean temperatures and lower salinities, changes in seasonal sea ice extent, rising sea levels and many other (as yet undefined) effects are certain to have significant impacts on marine species, with implications for Arctic coastal communities dependent on hunting and fishing (Weller and Lange 1999).

Most Arctic marine species depend upon the presence of sea ice and many indigenous coastal communities depend on harvesting marine species (marine mammals and fish). The ice-edge is unique among the world's ecosystems in that it moves thousands of kilometres each year, north in spring and south in autumn. Walrus, numerous species of seals and cetaceans such as beluga and narwhals all follow the ice-edge as it moves, taking advantage of the ready access to food and (for the walrus and seals) the availability of ice to haul-out on for sunning, mating and raising pups in late winter and spring (an important time for Inuit hunting communities).

The almost complete elimination of multi-year ice in the Arctic Ocean is likely to be immensely disruptive to ice-dependent micro-organisms, which will lack a permanent habitat. Preliminary results from research in the Beaufort Sea suggest that ice algae and other micro-organisms may have already been profoundly affected by warming over the last 20 years. Research indicates that most of the larger marine algae have died out, and have been replaced with a much less productive community of microorganisms more usually associated with freshwater ecosystems (See Chapter 7 and Chapter 8).

It is anticipated that walrus, seals and whales are likely to undergo shifts in range and abundance, while the migration routes of caribou will be disrupted. This could impact upon the hunting, trapping and fishing economies of many small, remote Arctic settlements. Although warming may increase biological production in some wildlife species, the distribution of many species crucial to the livelihoods and well-being of indigenous peoples could change. Important wetlands may disappear, or drainage patterns and tundra landscapes will be altered significantly, which could affect ducks and other waterfowl. Changes in terrestrial vegetation will have consequences for reindeer herding, subsistence lifestyles and agriculture (See Chapter 6).

Terrestrial wildlife such as caribou and reindeer, two major species important for indigenous communities throughout the Arctic, would be affected by climate change directly through changes in thermal stress in animals, and indirectly by significant difficulties gaining access to food and water. Arctic communities located on coastlines may be affected by rising sea levels, increased coastal erosion, and severe storms. The fortunes of subsistence fisheries will depend on marine fish stocks and their climate related variations (Lange 2000). As the amount of sea ice decreases, seals, walrus, polar bears and other species that depend on it would suffer drastically.

Recent observations have demonstrated that there has been a distinct warming trend in lowland permafrost of 2-4°C over the last 100 hundred years (Fitzharris *et al.* 1996, Lange 2000), leading to disturbances of animal and human activities due to thawing, thermokarst formation and severe erosion. Further warming is likely to continue

this trend and increase the likelihood of natural hazards for people (particularly affecting hunting and herding), buildings, communication links and pipelines. The documentation of widespread thawing of discontinuous permafrost in Alaska illustrates some of these hazards and the implications for habitat change and the physical infrastructure of communities. In western Alaska several communities in low-lying areas, including Shishmaref, Kivalina and Little Diomede are affected by recent climate changes and face severe problems as a result of erosion and thawing of the discontinuous permafrost (Callaway *et al*. 1999).

Unstable sea ice could make ice-edge hunting more difficult and dangerous. Temperature and precipitation changes could affect migration patterns of terrestrial mammals like caribou and alter breeding and moulting areas for birds. Salmon, herring, walrus, seals whales, caribou, moose and various species of waterfowl are expected to undergo shifts in range and abundance (IPCC 2001). Changes in snow cover could affect the growth and distribution of plants essential for survival of caribou and reindeer. Changes in snow cover could also make accessing hunting, fishing and herding areas more difficult by dogsled, snow-machine or other vehicles, making local adjustments in hunting practices and harvesting strategies necessary.

Indigenous Observations of Climate Change

In many parts of the Arctic indigenous peoples are reporting that they are already experiencing the effects of climate change. In Canada's Nunavut Territory, Inuit hunters have noticed the thinning of sea ice and the appearance of birds not usually found in their region; Inupiat hunters in Alaska report that ice cellars are too warm to keep food frozen; Inuvialuit in the western Canadian Arctic report thunderstorms and lightning (a rare occurrence in the region); Gwich'in Athabascan people in Alaska have witnessed dramatic changes in weather, vegetation, and animal distribution patterns over the last 50 years or so; Saami reindeer herders in Norway have observed that prevailing winds relied on for navigation have shifted or that snow cannot be relied on to travel over on trails that people have always used and considered safe (See Chapter 9).

Indigenous peoples in Alaska, for example, have already reported that there has been little snow in autumn and early winter, but substantial snowfall in late winter and early spring (Chapter 9). According to local hunters, the lack of snow makes it difficult for polar bears and ringed seals to make dens for giving birth or, in the case of male polar bears, to seek protection from the weather. The lack of ringed seal dens may affect the numbers and condition of polar bears, which prey on ringed seals and often seek out the dens. People in northern coastal Alaska are concerned that hungry polar bears may be more likely to approach villages and encounter people.

In the Kitikmeot region of Nunavut, Inuit observations of climate change have been recently documented (Thorpe *et al*. 2002). People have spoken of a changed climate in the 1990s compared with previous decades: increasing temperatures with earlier spring melts and later freeze-ups in autumn have meant periods of longer summer-like

conditions, while weather has become variable and unpredictable. This change and variability has had many significant impacts on caribou. Migration routes and the location of calving grounds have shifted and food sources have sometimes become inaccessible. Inuit have recently noticed more frequent short-term changes in temperature, especially in freeze-thaw cycles, which, because these cycles help form an icy layer on the top of snow or tundra, prevent access to vegetation (Thorpe *et al*. 2002).

Consequences of Climate Change for the Livelihoods of Indigenous Peoples: the example of caribou hunting and reindeer herding

The case studies in this chapter provide detailed analysis of the current and potential consequences of climate change for the livelihoods of indigenous peoples. The case study on caribou hunting in Arctic North America, for example, shows how the location of modern-day human settlements to caribou migration routes has consequences for the success of community caribou hunting. Communities like Old Crow in Yukon Territory, located in the centre of the range of large migratory herds, have opportunities to intercept caribou during fall and spring migrations, whereas communities situated on the margin of a herd's range may have access to animals only during winter or briefly during the summer calving and post-calving periods. The range of a large herd can contract at low population levels and expand at high levels, and the implications for local communities situated at a distance from a herd's range can mean a decline in successful hunting and even the abandonment of caribou hunting for several decades. Shifting migration routes because of climate change will have consequences for hunting success.

All caribou and reindeer herds depend on the availability of abundant tundra vegetation such as lichen for forage, especially during calving season. Climate-induced changes to Arctic tundra may cause major vegetation zones to shift significantly northward, as well as having an affect on freeze-thaw cycles. The timing and occurrence of ice crusts due to refreezing of molten snow layers, which might be affected by changes in climate will be a major factor for the sustenance of caribou and reindeer herds (Lange 2000). This will have significant implications for reindeer populations in relation to their ability to find food and raise calves. Future variations in weather and climate could mean a potential decline in caribou and reindeer populations and have an adverse effect on hunting and herding practices. This could threaten human nutrition for indigenous households and threaten a whole way of life for Arctic communities.

Russian historical records from the 1800s and early 1900s provide startling documented evidence of devastating losses of reindeer stocks of Siberian indigenous herders due to occasional and dramatic weather events and environmental changes (Krupnik 2000). Such changes also had severe social impacts, pushing wealthy pastoralists below the poverty line. Declines and increases in caribou and reindeer populations are cyclical. Reindeer populations display consistence instability, indicating that herds and grazing systems are strongly influenced by climatic variation (Chapter 16). Severe weather conditions in spring, or a late snow melt, can have significant effects on reindeer populations, resulting in the death of young or weak animals during winter

periods of starvation (Lee *et al*. 2000). Research suggests that climate change may already be contributing to the decline of caribou and reindeer herds. For example, the caribou disappeared from North East Greenland in 1900 through migration to West Greenland in search of an adequate food supply as a result of climatic changes; this, in turn, caused the arctic wolf to disappear by 1934 from the loss of its main source of food (WCMC 1990).

The disappearance of some caribou on Canada's Banks Island may be linked to climate change according to recent research (see Riedlinger and Berkes 2001, and the case study by Berkes in this chapter) and also the observations of Inuvialuit, as discussed by Nagy (2004):

> 'In the '70s I guess, that's when they really started noticing it, muskox taking over. But [regarding] caribou, sometimes [...] in the fall, we get freeze-up on the whole island. Then, before the snow is really deep, we get our mild weather and rain. Then it's cold enough for the rain to freeze on top the snow and that's when the caribou try to leave the island, even go out into the ocean. 'Cause they were eating mostly ice.
> We were still here when one year it happened. When dogs started seeing the caribou, they'd be running. Nothing wrong with them but they just stop and start kicking. They have too much water in their stomach, their heads are spinning. So a lot of big bulls died off by spring [...]. There was even one year, that worst year that time, the cows didn't have any calves, they didn't. That hit them just before the rutting season.'

> 'I don't think [the muskox] really pushed the caribou away. Like right now the caribou are just dying, now. […] in the fall time, [...] when the weather is not good, the ones that are born, they just freeze when the weather is not good.'

Using the results of Wilkinson et al. (1976), Gunn *et al*. (1991: 192) dismissed forage competition between muskoxen and caribou and linked the disappearance of caribou on Banks Island to changing climate conditions associated to earlier spring snow disappearance, warmer winters that are snowier (hence more difficult for forage); and with higher incidence of freezing rain. Although annual die-offs of 60 to 300 caribou occurred during the winters of 1987-88, 1988-89, and 1990-1991 when freezing rains occurred (Nagy et al. 1996: 213), Larter and Nagy (2000:661; 2001:127) concluded that the drop in number of Banks Island caribou in 1994 and in 1998 happened despite high calf production, high overwinter survival rates of calves and less severe winter snow conditions. Thus, severe winter weather might not be the major cause of caribou decline. According to Nagy (2004), some Inuvialuit think that caribou do not like the strong smell of muskox and prefer to be away from them. Accordingly, some Inuvialuit say that caribou have moved out of the island to avoid muskox. Lent (1999:202) noted that reindeer herders in Alaska believed that "caribou and reindeer will avoid muskoxen, moving away when muskoxen enter their vicinity" but added "there is no quantitative evidence to support this contention, nor has a controlled study been undertaken." Hence expressing some of the distrust wildlife scientists might have towards local knowledge.

As Chapter 16 discusses in more detail, recent modelling indicates that the mean annual temperature over northern Fennoscandia is likely to increase by 0.3-0.5°C per decade during the next 20-30 years, with the annual amount of precipitation increasing by 1-4% per decade. Such changes are likely to affect snow conditions and foraging conditions for reindeer. In Finland there is increasing concern about the effect of a changing climate on the winter snowpack and on the distribution of lichens, the main winter food for reindeer. Climate change is expected to mean that fast-growing vascular plants may out-compete slower growing lichens, which will affect the eating habits of reindeer. In Finland, Saami reindeer herders are aware when reindeer numbers fall due to adverse weather and attempt to preserve their herds by adjusting the number of animals they slaughter (Lee *et al*. 2000).

Concerns Over Irreversible Impacts

Indigenous peoples live with fluctuations in weather and climatic conditions. Experiencing year-to-year changes in weather, ice and snow patterns, animal behaviour and movement, and in hunting conditions is part of life in the Arctic. Yet the trends currently being observed give concern over major, irreversible impacts on indigenous communities and livelihoods. For example, since the late 1970s Alaska Natives in communities along the coast of the northern Bering and Chukchi Seas have noticed substantial changes in the ocean and the animals that live there, particularly in the patterns of wind, temperature, ice, and currents (See also Chapter 9).

A significant collection of indigenous environmental observations was recorded during a study of environment changes in Canada's Hudson Bay region. The results are published in *Voices from the Bay* by the Canadian Arctic Resources Committee and the Municipality of Sanikiluaq, a small Inuit community on the Belcher Islands in the midst of Hudson Bay. Completed in 1996 and published in 1997 (McDonald *et al.* 1997). The study brought together 78 Inuit and Cree hunters and elders from 28 communities on the shores of Hudson and James bays in a series of workshops over three years to describe, record and verify ecological changes in the region, including but not limited to climate change. Observations include wholesale changes in location, number and duration of polynas—open water areas in winter—in eastern Hudson Bay, and changing routes of Canada and snow geese, but the study indicates that alterations in weather and climate are by no means uniform within the bioregion. *Voices from the Bay* and the other observations from indigenous peoples (Chapter 9) illustrates an important and inescapable fact: much of the impact of climate change on northern indigenous peoples will be channelled through ecological changes to which they will have to respond, cope with and adapt to.

As indigenous peoples perceive and experience it, the Arctic is becoming an environment at risk (Nuttall 1998) in the sense that sea ice is now unstable where hunters previously knew it to be safe, more dramatic weather patterns such as floods are occurring, vegetation cover is changing, and particular animals are no longer found in

traditional hunting areas during specific seasons. The weather is becoming increasingly unpredictable and local landscapes, seascapes and icescapes are becoming unfamiliar.

Hunters and herders in some places are already altering their hunting patterns to accommodate changes to ice, tundra vegetation and distribution of marine and terrestrial harvested species (Callaway *et al*. 1999). As the case study from Sachs Harbour in this chapter shows, physical environmental change is immediately observable in terms of reduced sea-ice cover and lack of old (or multiyear) ice around the community in summer, and the melting of permafrost in places. These changes challenge Inuvialuit knowledge and understanding of the environment, and make prediction, travel safety and resource access more difficult. The Inuvialuit, like most indigenous groups who live off the land, rely on their ability to predict environmental phenomena such as snow and ice conditions, the weather, and the timing of wildlife migrations. For the Inuvialuit, as is increasingly reported throughout the Arctic by many other peoples, seasons have become less consistent, and weather events have become less predictable in the last few years (See Chapter 9).

1.5 Responding to Climate Change: Flexibility, Adaptation, Barriers and Opportunities

Climate Change, Flexibility and Adaptation

The Arctic has experienced significant climate change in the past, just as the global climate has changed historically in response to natural variations. What may seem to be relatively minor variations in temperature have produced large positive feedbacks in the environment that have had often dramatic impacts on physical and biological subsystems (e.g. Vibe 1967). The successful long-term occupation of the Arctic by indigenous peoples has been possible, in part, because of their adaptive capacity (in social, economic and cultural practices) to adjust to climate variation and change. Hundreds and even thousands of years ago, Arctic populations adapted to gradual or even rapid environmental change by settling amid favourable climate conditions and along the paths of animal migration routes.

The study of the origins, migration patterns and socio-economic development of Arctic cultures is significant to any assessment of climate change in that it offers insight into long-term environmental adaptations, the impact of environmental change on humans, and in turn how humans have utilised resources and impacted upon the environment (e.g. Sabo 1991). Historical, archaeological and anthropological evidence suggests that Arctic peoples had elaborate ecological knowledge that was crucial to their successful adaptation to changing environmental conditions, as well as to seizing the opportunities presented by climate change. The archaeological and ethno-historical record reveals that, in dealing with climate change, resource availability, social and economic change, and the introduction of new technology, indigenous populations have

developed significant flexibility in resource procurement techniques and in social structure.

Climate change or the overexploitation of animal and fish populations meant that Arctic hunting bands would have been forced to move to other areas in search of game, or to have adapted and diversified their range of subsistence techniques. Odner (1992), for example, has argued that Saami populations in northern Norway coped with the periodic scarcity of wild reindeer in the middle ages by diversifying their subsistence activities, intensifying the exploitation of other species, moving on to other hunting grounds, developing techniques of animal husbandry, or by storing meat.

In the Canadian Arctic, Sabo (1991) has shown how Inuit in the eastern Canadian Arctic coped with climatic change on the population dynamics, distribution and availability of terrestrial and marine resources by rescheduling their hunting techniques and by maintaining flexibility in settlement patterns and social organisation. Developing an ecosystem model and reviewing evidence for climate change over a 1000-year period for southern Baffin Island, Sabo demonstrates that the rescheduling of resource procurement systems and the continuation of a flexible arrangement in Inuit settlement patterns and demographic organisation ensured both the availability and production of food and acted as regulatory social mechanisms which were able to respond to environmental change. Sabo argues that, while there is paleoenvironmental evidence to suggest climate change did affect Inuit subsistence activities on Baffin Island during this period, climate change is only one of several factors contributing to adaptive responses. Rather than resulting in environmental determinism, the ecology and climate of southern Baffin Island enabled successive human populations to develop long-term strategies of environmental diversification. Through the use of a variety of resources and habitats the prehistoric population and historic Inuit retained a resilient human/ecosystem relationship during a long period of continuity and change.

The expansion of the Thule tradition across the North American Arctic, from western Alaska eastwards to the central Canadian Arctic and beyond to Hudson Bay, Labrador and Greenland offers another example of how Arctic peoples have adapted and migrated while the climate has changed. During the Neo-Atlantic Optimum (ca. 1000 AD), the Canadian Arctic passed from a period of 400-500 years (the Scandic Period) during which mean summer temperatures were 1-2°C below current average temperatures to a warmer period with summer temperatures around 2°C higher than the present day. This warming period resulted in the Canadian Eastern Arctic experiencing less summer sea ice and longer open-water and ice free summers. For Inuit groups, access was opened up to maritime habitats with a variety of marine mammals, mainly narwhal, beluga, harp seal and, significantly, the bowhead whale (Wenzel 1995a). While this climatic shift changed the ecology of the Canadian Eastern Arctic the cultural effects of the Neo-Atlantic Optimum on coastal Inuit groups were also far-reaching. Perhaps the most major shift was the replacement of the paleo-eskimo Dorset culture by Thule migrants from the Beaufort/Chukchi seas region, whose subsistence culture was underpinned by their dependence on the bowhead whale (Wenzel 1995a). The eastward movement of these

migrants was facilitated by the changing ecological conditions and the movement of the bowhead whale into previously ice-closed areas of the eastern Arctic (Wenzel 1995a).

The Thule tradition bore the hallmark of what is the essence of successful indigenous resource use systems throughout the Arctic -- flexibility in technology and social organisation and an ability to cope with climate change, responding both to its associated risks and seizing its opportunities. The archaeological record, ethnohistorical accounts and the memories of elders provide detailed accounts of how human life in the Arctic has always been dominated and influenced by periodic, irregular and often dramatic ecosystem changes, triggered by periods of warming and cooling, extreme weather events and fluctuations in animal populations (Krupnik 2000).

Barriers to Adaptation

Change is a fact of life for Arctic peoples, and they have a rich heritage of cultural adaptations to deal with it. Many of the short-term (or coping) responses appear to be based on this tradition of flexibility and innovation. The transition from sedentary to nomadic subsistence livelihoods and vice versa was the key to the survival and sustainability of Arctic indigenous cultures. Cultural and ecological diversity required flexibility and resilient coping strategies during periods of extreme change and subsistence diversity was the outcome of a successful cultural and social response to climatic variation and the resource instability of the Arctic environment (Krupnik 1993).

Yet, a word of caution must be added: while there are success stories in terms of adaptation to climate change, it would be wrong to assume that adaptation is simple and not fraught with difficulties. There are losers as well as winners when climate change challenges Arctic peoples to respond in ways that can mitigate the negative impacts. In the Canadian Eastern Arctic, the Dorset people lost out while the Thule migration was facilitated by climatic change, and as research on the social consequences of climate change in Greenland shows, people living in towns with similar social and economic settings and political and institutional structures showed a marked difference in their abilities and readiness to adapt to changing conditions (see Rasmussen and Hamilton 2001).

Environmental changes, particularly in climate and ocean currents, that have affected fisheries in West Greenland are well documented, as are the associated social and economic changes, especially at the beginning of the 20th century (Hamilton, Lyster and Ottersted 2000). As the waters of southern and west Greenland warmed, seals moved further north, making seal hunting harder for the Inuit population. Cod and other fish (halibut and shrimp) moved into the now warmer waters and made the development of a cod fishery possible. The development of fishing in West Greenland shows how climate change can provide opportunities for some people, some local communities and some local regions. As Thuesen (1999) argues, the political and economic changes taking place in West Greenland at the beginning of the 20th century meant that Greenlanders were now involved in and participating in the new political structures of local municipal

councils and two provincial councils, established in 1908. In 1910 experimental fisheries were taking place in West Greenland and Greenlandic fishermen were learning new skills in fisheries training programmes. The west coast town of Sisimiut was able to take advantage of these new developments, advantageously situated as it is at the northernmost limit of the ice-free waters on the west coast.

For those Greenlanders who embraced change and the opportunities now arising, some were able to benefit more than others because they played crucial roles as local entrepreneurs and took advantage of the opportunities to diversity local economies. Thuesen (1999) argues that the development of Sisimiut as an important fishing centre was due in part to a strong sense of local identity and strong dynamism in the community -- in short people had a willingness to embrace change, to diversity the economic base and work to develop new industries. This stands in contrast to the development of the southwest Greenlandic town of Paamiut around the same time. Paamiut's development was based largely on plentiful resources of cod. With few other resources available in commercially viable quantities, there was little incentive to diversity the local economy (Rasmussen and Hamilton 2001). The concentration on a single resource demonstrated the vulnerability of Paamiut in the face of environmental change. The cod population began to fall, due to a combination of climatic change and overfishing, and economy and population of Paamiut declined as a result (Rasmussen and Hamilton 2001). This illustration points to the importance of recognising that, in any adaptive strategy, local conditions and social differences are considerable factors in the success of a region affected by change, be it from climate or social, economic or political factors. The development of cod fishing in Greenland also shows, however, how climate change and social change go hand in hand. Cod fishing developed at a time when climate change was having an adverse effect on seal hunting, yet the population of Greenland was also growing making it necessary to find alternative ways for the majority of the population to make a living.

Arctic hunters and herders have always lived with and adapted to shifts and changes in the size, distribution, range and availability of animal populations. They have dealt with flux and change by developing significant flexibility in resource procurement techniques and in social organisation. Yet the ecological and social relations between indigenous peoples and animal species are not just affected by climate-induced disruption, changing habitats and migration routes, or new technology. The livelihoods of the indigenous peoples of the Arctic are subject both to the influences of the market economy and to the implementation of government policy that either contributes to a redefinition of hunting, herding and fishing, or threatens to subvert subsistence lifestyles and indigenous ideologies of human-animal relationships.

Today, Arctic peoples cannot adapt, relocate or change resource use activities as easily as they may have been able to do in the past, because most now live in permanent communities and have to negotiate greatly circumscribed social and economic situations. The majority of indigenous peoples live in planned settlements with elaborate infrastructures, and their hunting and herding activities are determined to a large extent by resource management regimes, land use and land ownership regulations and local and

global markets. As the case study in this chapter on Inuit in Nunavut shows, the mobility that Inuit once possessed to move in response to shifts in the pattern and state of their resource base is no longer possible. Inuit in Nunavut now live in communities that are a direct result of Canadian government policy and which represent hundreds of millions of infrastructure and other investment. Clyde River, for instance, which is home to about 800 people and more or less representative of the kind of infrastructure and services found across Nunavut, is the result of some $50 million of government investment. In today's social, political and economic climate, migration to remain in contact with animals and, more broadly, to maintain traditional Inuit hunting livelihoods would seem to be virtually impossible.

Changes to settlement patterns and the ecological relations between humans and animals often arise from government attempts to introduce new economic activities or to sedentarize indigenous peoples. In northern Russia and Siberia, for example, the Soviet authorities 'industrialised' reindeer herding as a way of facilitating the development of the Soviet North. The new settlements and industries in Siberia came to depend on reindeer herders to supply them with meat. Today, in post-Soviet Russia, privatisation and the transition to a market economy bring new challenges to reindeer herding peoples in Siberia and the Russian Far East, highlighting the dependence of Arctic reindeer systems on the complex interlinkages between local, regional and global economies.

In a similar vein, caribou management on the Canadian Barrens became an integral part of a broad programme of social engineering – federal, provincial and territorial authorities imposed management strategies based on their own (rather than Inuit and Dene) ideas about conservation and hunting (Anderson and Nuttall 2004). There are similar stories from other parts of the Arctic. For example, the introduction of reindeer to the Seward Peninsula in western Alaska during 1892-1902 was done to provide meat for Inupiat communities, yet was also intended as a way of transforming Inupiat from being subsistence marine mammal hunters to reindeer herders and thus play an active role in the wider cash economy of the United States (Anderson and Nuttall 2004).

Strict regulatory regimes and management practices imposed by states and federal and provincial agencies increasingly affect hunting and herding (Anderson and Nuttall 2004). Some, while aiming, in principle, to protect and conserve wildlife also restrict access to resources. In Alaska, for example, state and federal policies make subsistence issues extremely complex. State and federal law define subsistence as the customary and traditional non-commercial use of wild resources and regulations limit the prospects of finding markets for caribou meat. Earning money through more commercial channels is not an option for Alaskan subsistence hunters. In northern Fennoscandia, Saami reindeer herders have traditionally ranged far and wide, crossing national borders as they follow their reindeer herds between winter and summer pastures. In modern times, political developments have restricted migration routes over the last one hundred years or so. Economic development in the nineteenth and twentieth centuries, such as mining, forestry, railways, roads, hydro-electric power and tourism have all had their impact on traditional Saami livelihoods.

In Greenland, threats to the cultural and economic viability of hunting livelihoods in small communities come from transformations in resource management regimes and Home Rule government regulations, which conflict with local customary practices and knowledge systems (Dahl, 2000, Nuttall, 2001). Caribou, whales, seals and fish, which have traditionally been subject to common use rights vested in members of a local community, are becoming national and privately-owned divisible commodities subject to rational management regimes defined by the state and the interest groups of hunters and fishers, rather than locally understood and worked out rights, obligations and practices. As is still evident in some parts of Greenland today, it has traditionally been the case that no one owns animals – everyone has the right to hunt and fish as a member of a local community. A caribou, fish or sea mammal does not become a commodity until it has been caught and transformed into private property. Even then, complex local rules, beliefs and cultural practices counter the exclusive sense of individual ownership (Nuttall 2001: 67). However, trends in caribou hunting since the 1980s are illustrative of general wildlife management policies in Greenland, where membership of a territorial, or place-based community no longer gives hunters exclusive rights to harvest caribou. In west Greenland, caribou hunting was largely a family event until the 1970s. Kinship, locality and territory were the mechanisms for regulating harvesting activities. Today, hunting rights are vested in people as members of social and economic associations irrespective of a local focus. Discussing the situation in central west Greenland, Dahl (2000) shows how the traditional hunting territories of various communities are not the same as the administrative boundaries that surround villages, towns, districts and municipalities. The relevant territorial unit for hunting caribou (and other animals such as beluga and narwhal) is Greenland, rather than a place-based community.

Hunters and herders are thus constrained by institutional frameworks and management structures, as well as the legal recognition to resource use rights. They are commonly experiencing a transition from herding and hunting from what we may call a 'way of life' to an occupation and industry. The similarities with commercial fisheries management in the circumpolar North are notable, especially the effects of the implementation of individual transferable quotas (ITQs). The ITQ system is a management response to overfishing and declining catches of major fish species, particularly demersal fish. Although designed to ensure the viability of fish stocks, sustainable catch levels, and economic efficiency, ITQ management results in the transformation of traditional common use rights in fish stocks into privately owned, divisible commodities. As Helgason and Palsson (1997) argue, ITQs represent the idea that both the human and natural worlds can be organised, controlled and managed in a rational way. Nature is not only 'presented as an inherently technical and logical domain, the project of the resource economist and manager is sometimes likened to that of the engineer or the technician' (*ibid*.: 452). Helgason and Palsson describe the public discontent in Iceland with the commoditisation of fishing rights as a consequence of the ITQ system and which has resulted in fishing rights being concentrated in the hands of a few large-operators - a discontent articulated in feudal metaphors such as 'tenancy' and 'lordships of the sea'. The ITQ system, although ostensibly seen by economists and resource managers as a way of achieving the sustainable use of fish stocks, has in reality

a social impact in terms of changing power relations within local communities and regional fisheries, by contributing to the concentration of wealth in the hands of a few large fishing vessel owners. The ITQ system has effectively meant the enclosure of the commons and the privatisation of resources, which allows parallels to be drawn between fisheries and rural land use debates throughout the Arctic.

Opportunities for Adaptation and Responding to Climate Change

Commercial, political, economic, legal and conservation interests have reduced the abilities of indigenous peoples to adapt and be flexible in coping with climatic variability. The contemporary reality for many hunters and herders is that they are placed in very inflexible situations. Faced with climate change they are not necessarily in a position to respond appropriately. However, indigenous peoples have demonstrated resilience and adaptiveness in the face of change. In the climate changed Arctic that this assessment considers, how indigenous peoples are in a position to take advantage of the opportunities that may arise, as well as being able to modify or change their mode of production in response to climatic variability, for example by switching hunting and fishing activities, is a critical research need.

For some peoples of the Arctic, the political and management systems are already in place that could assess the impacts of climate change, allow local and regional governments to act on policy recommendations to deal with the consequences, and improve the chances for indigenous peoples to deal successfully with climate change. Although complex, solutions to environmental problems are potentially realistic

Significant political changes since the 1970s have included land claims in Alaska and Canada and the formation of regional governments in Greenland and Nunavut. Settlements include the Alaska Native Claims Settlement Act (1971), Greenland Home Rule (1979), the James Bay and Northern Quebec Agreement (1975-77), the Inuvialuit Final Agreement (1984) and the Nunavut Agreement of 1992 (the Territory of Nunavut was inaugurated in 1999). These political changes often include changes in the ways that living and non-living resources are managed. A greater degree of local involvement in resource use management decisions has been introduced, including in some cases the actual transfer of decision-making authority to the local or regional level (CAFF 2001).

In addition, significant steps have been taken with innovative co-management regimes that allow for the sharing of responsibility for resource management between indigenous and other uses and the state (Huntington 1992). Examples include the Alaska Eskimo Whaling Commission, the Kola Saami Reindeer Breeding Project, the Inuvialuit Game Council and the North Atlantic Marine Mammal Commission (NAMMCO). Self-government is about being able to practise autonomy. The devolution of authority and the introduction of co-management allow indigenous peoples opportunities to improve the degree to which management and the regulation of resource use considers and incorporates indigenous views and traditional resource use systems (Huntington 1992).

Co-management projects involve greater recognition of indigenous rights to resource use and emphasise the importance of decentralised, non-hierarchical institutions and consensus decision-making. This presents tremendous opportunities for collaboration between indigenous peoples, scientists and policy-makers concerned with the sustainable use of living resources (Caulfield 2000). And it is within this new political and scientific environment of power sharing and dialogue that indigenous communities, scientists and policy-makers can work together to find solutions (such as building flexibility into otherwise constraining wildlife management regimes) to the pressing problems climate change may bring to the Arctic. Some of the case studies presented in this chapter make mention of how evolving forms co-management institutions create opportunities to increase local resilience and the ability to cope with, respond to and deal with change. For example, new governance mechanisms through the Inuvialuit Final Agreement are helping Inuvialuit to negotiate and manage the impacts of change. For instance, the five co-management bodies established by the Agreement provide an effective means for Inuvialuit communities to communicate with regional, territorial and federal governments and, indeed, to the Arctic Council.

The detailed case studies that follow in this chapter show how climate change is having an impact on hunting, herding, gathering and fishing activities. However, the case studies show that some of the impacts have been absorbed through the flexibility of the seasonal cycle and local ways of life. For the Inuvialuit of Sachs Harbour, for example, coping strategies relate to adjusting subsistence activity patterns: modifying timing of harvest activity; modifying location of harvest activity; modifying method of harvest activity; adjusting the species harvested; and minimizing risk and uncertainty. Yet, for indigenous peoples, dependence on animals and involvement in complex global processes, combined with the Arctic's natural vulnerability and the concern with the accelerated nature of climate change, magnify the potential effects of global climate change on their cultures and livelihoods.

11. 2. UNDERSTANDING CLIMATE CHANGE IMPACTS THROUGH CASE STUDIES:

11.2.1. Marine Mammals, Coastal Communities and Life on the Ice

11.2.1.1 Canadian Western Arctic: The Inuvialuit of Sachs Harbour

Fikret Berkes

Introduction and Historical Context

Sachs Harbour makes an appropriate case for this volume because it has been studied and reported upon intensively through the Inuit Observations of Climate Change project, undertaken jointly by the Community of Sachs Harbour and the International

Institute for Sustainable Development (IISD). The Inuvialuit (the Inuit of the Canadian western Arctic) themselves initiated the study because they wanted the documentation of the severe and disturbing environmental changes that they were witnessing. The project was undertaken with several objectives (Ford 1999, IISD 2000, Riedlinger and Berkes 2001):

- to produce a video on how climate change is affecting the people;
- to disseminate Inuit observations to the world;
- to document local knowledge of climate change;
- and to explore the potential contributions of traditional knowledge to climate change research

The project was planned and carried out using participatory research methods. Results are based on a 12-month cycle study of Sachs Harbour covering all four seasons in 1999/2000, with follow-up visits for verification and project evaluation (Jolly et al. 2002). Inuvialuit perceptions shaped the study from the very beginning; the project started with a planning workshop which asked the people of Sachs Harbour *their* objectives and what *they* considered important for the project to focus on. Video documentation plans, research questions and the overall process were all defined jointly by the study team and the community (Berkes and Jolly 2001, Jolly *et al*. 2002).

The community of Sachs Harbour is located on Banks Island in the Canadian western Arctic. It is a tiny community of some 30 households, and the smallest of the six Inuvialuit communities in the region covered by the comprehensive native land claims agreement, the *Inuvialuit Final Agreement* of 1984 (Fast and Mathias 2001). Sachs Harbour, a permanent settlement only since 1956, is an outgrowth of the white fox trade beginning in the 1920s (Usher 1970). Many of the current residents have relations in the Mackenzie Delta area. Some are descendants of the Copper Eskimo of Victoria Island to the east; many are related to the Inupiat (Alaska Inuit) who had earlier moved to the Delta.

There are no previous studies about how climate change may have affected resource use in the past on Banks Island. Major changes in resource use concern the development of the white fox trade and its subsequent collapse with the disappearance of the European fur market in the 1980s, and the dramatic changes in musk-ox and caribou numbers on the island. Musk-ox were in extremely low numbers in the early 1900s, but populations increased in the latter half of the 20th century, giving Banks Island the largest musk-ox population in the world. In the meantime, however, caribou numbers have declined. There is no consensus on the question of whether the caribou decline is related to musk-ox increase. Nor is there agreement regarding the impact of climate change on these two species, but a number of potential negative impacts are possible, including those related to extreme weather events (Gunn 1995).

Although Sachs Harbour, as the permanent village, only dates from the 1950s, local observations, as captured by the Inuit Observations of Climate Change project, go back to the 1930s (Jolly *et al*. 2002). Perceptions of Sachs Harbour hunters and fishers are consistent in indicating that changes observed in the 1990s are without precedent and outside the range of variation that the Inuvialuit consider normal. Before turning to the details of observations of change and how the people have been coping with them, it is necessary to review patterns of subsistence.

Patterns of Subsistence and the Impact of Climate Change

Some 20 species of terrestrial and marine mammals, fish and birds were taken in 1999/2000 at Sachs Harbour. During the winter, people hunted musk-ox (*Ovibos moschatus*) and, to a lesser extent, caribou (*Rangifer tarandus*), Arctic fox (*Alopex lagopus*), wolf (*Canis lupus*), polar bear (*Ursus maritimus*) and ringed seals (*Phoca hispida*). Small game included ptarmigan (*Lagopus spp.*) and Arctic hare (*Lepus arcticus*). As the weather began to warm in March and April, people headed out to numerous inland lakes to ice-fish for lake trout (*Salvelinus namaycush*) and Arctic char (*S. alpinus*).

In May, fishing slowed down as the snow goose season approached. Banks Island supports a large breeding colony of snow goose (*Anser caerulescens*). Goose hunting and egg-collecting were important community activities. Family groups camped at rivers and inland lakes, and the entire community harvested and processed geese, some of it for inter-community trade. The goose hunt was over by mid-June, as people returned to lakes to fish where there still was ice. They also fished for Arctic cod (*Boreogadus saida*) on sea-ice and went sealing. With ice break-up in June and July, people hunted mainly for ringed seals, and some bearded seals (*Eringnathus barbatus*), off the ice floes and from boats in open water. July through early September, people set gillnets for char, Arctic cod and least cisco (*Coregonus sardinella*), and some did rod-and-reel fishing in lakes. In September, people turned to musk-ox and caribou.

In some years, including 1999/2000, the musk-ox hunt is a commercial harvest that employs almost the entire community throughout November. Guiding and outfitting for sport hunting for polar bears and musk-ox also provide employment and cash income. These commercial activities complement the subsistence harvest, and are a major source of cash income for the community.

The actual cycle of hunting and fishing varies from year to year, but the usual pattern has been impacted by environmental changes being observed by the people of Sachs Harbour. These changes, as documented by IISD (2000), Riedlinger and Berkes (2001), and Jolly *et al*. (2002), may be summarized under five headings: Physical environmental change; Predictability of the environment; Travel safety on land and ice; Access to resources; and Changes in animal distributions and condition **(**See **Table 1).**

Physical environmental change is most readily observable in terms of reduced sea-ice cover and lack of old (or multiyear) ice around the community in summer, and the

melting of permafrost in places. These changes challenge Inuvialuit knowledge and understanding of the environment, and make prediction, travel safety and resource access more difficult. The Inuvialuit, like most indigenous groups who live off the land, rely on their ability to predict environmental phenomena such as snow and ice conditions, the weather, and the timing of wildlife migrations. Seasons have become less consistent, and weather events have become less predictable in the 1990s.

Travel safety is closely related to physical environmental change and loss of ability to predict the environment. For example, sea-ice near the community is used for travel, ice-fishing and seal and polar bear hunting. Sound knowledge of the sea-ice and the ability to monitor and predict changes are critical to hunting success and safety. In the 1990s, people in Sachs Harbour observed increased ice movement in winter and spring, changes in the distribution of leads, cracks and pressure ridges, as well as overall thinning of the ice. People say that in the past they rarely had to worry about the ice the way they do now; one has be more cautious than ever before when traveling on ice.

Access to resources is often related to travel access and safety. For example, changes in the rate of spring melt and increased variability associated with spring weather conditions have affected access to hunting and fishing camps. When families go out to camps at lakes for ice-fishing and goose hunting in May, they travel by snowmobile, pulling a *qamutik* (sled), staying on snow-covered areas or using coastal sea-ice and frozen rivers. However, warmer springs have resulted in earlier, faster snow melt and river break-up, making access difficult. The availability of some species has changed due to the inability of people to hunt them under changing environmental conditions. For example, less summer ice means that ring seals are harder to spot and hunt.

However, not all changes in species availability are related to access. Changes in animal distributions have also occurred, with respect to birds (many new mainland species never before seen on Banks Island), fish (two species of Pacific salmon), and insects. Some of the changes may operate through ecological mechanisms. Sachs Harbour hunters discuss and speculate on the impacts of environmental change on species distributions and availability. For example, warmer temperatures and higher amounts of rainfall may have increased summer forage for caribou and musk-ox. But these changes may also increase the risk of extreme weather events such as fall time freezing rain that may cover the ground with a layer of ice, making forage unavailable.

Short-Term and Long-Term Responses to Change

The Inuvialuit of Sachs Harbour draw on accumulated knowledge and experience in dealing with change. They recognize that they have always adapted to change – social, political and economic change, as well as to environmental change. When asked about the impact of environmental change on subsistence activities, most people were quick to point out that they always find some way to deal with changes. Change is a fact of life for Arctic peoples, and they have a rich heritage of cultural adaptations to deal with

change. Many of the short-term (or coping) responses appear to be based on this tradition of flexibility and innovation.

Environmental changes observed in Sachs Harbour are not trivial, and these changes are having an impact on subsistence activities. However, many of the impacts have been absorbed through the flexibility of the seasonal cycle and the Inuvialuit way of life. For the most part, Inuvialuit coping strategies relate to adjusting subsistence activity patterns: modifying timing of harvest activity; modifying location of harvest activity; modifying method of harvest activity; adjusting the species harvested; and minimizing risk and uncertainty. **Table 2** provides examples of each.

Modifying the timing of harvest activity is often related to increased seasonal variability. Hunters adjust their seasonal calendars to deal with change. Since change is unpredictable, hunters also use waiting is a coping strategy; people wait for the geese to arrive, for the weather to improve, and so on. Modifying the location of harvest activity is often necessitated by physical changes**.** Changes related to sea-ice require hunters staying close to the community because of safety concerns. The thawing of permafrost in many areas has left travelers making new trails to avoid slumps and mudslides. As well, hunters have had to use different modes of transport to adjust how they harvest animals.

A major coping strategy is switching species. Reduced fishing opportunity in one area (e.g., spring ice-fishing in lakes) may be compensated for by an increase in another (least cisco). Climate change has brought new potential resources through range extensions. Pintail (*Anas acuta*) and mallard ducks (*A. platyrhynchos*), both mainland species; white-fronted goose or "yellow legs" (*Anser albifrons*) and tundra swans (*Cygnus columbianus*), both historically rare on Banks Island, have been observed in increasingly larger numbers.

Hunters have adopted a number of strategies to minimize risk and uncertainty. In response to increased variability and unpredictability associated with the weather and other environmental phenomena, they monitor ice conditions more closely and take fewer chances. Hunters say that "you really need to have experience to travel on the sea ice now," and describe being more careful when they travel.

The short-term coping strategies summarized in Table 2 are ultimately based on cultural adaptations. Berkes and Jolly (2001) compiled from various sources, a list of cultural practices which are considered to be adaptive responses to arctic ecosystems:

(1) Mobility and group size flexibility;

(2) Flexibility of seasonal cycles of harvest;

(3) Detailed local environmental knowledge;

(4) Sharing mechanisms and social networks;

(5) Inter-community trade.

Table 3 provides a summary of these five sets of adaptive mechanisms and the evidence from Sachs Harbour as to whether they are still viable. The first of these adaptive mechanisms is no longer operative because of settlement of people into permanent villages, but the other four clusters of adaptations seem viable.

The flexibility of seasonal cycles and the creativity with which hunters take advantage of harvesting potentials are backed up by oral traditions and by Inuvialuit cultural values that emphasize the appropriateness of harvesting what is available and acting opportunistically. Regarding local environmental knowledge (traditional or indigenous knowledge) and related skill sets, some have obviously been lost, and some are being transmitted incompletely. Certain kinds of skills that were once universal in Inuvialuit society have become restricted to relatively few families who are active on the land. For example, almost all teenage boys in Sachs Harbour can use guns, but not too many can build snowhouses. The nature of people's practical engagement with the environment has changed; skill sets and land-based knowledge have also changed. For example, hunters use GPS units for navigation and safety, a very recent skill. The use of snowmobiles since the 1970s, also a new skill, has necessitated a greater knowledge of ice conditions because sled-dogs can sense dangerous ice but snowmobiles cannot.

Sharing mechanisms for food and social networks for mutual support are still very much in evidence in Sachs Harbour, especially within extended family units and in providing for elders. A relatively small number of hunters account for most of the harvest; thus, relatively few people are providing for the families of occasional hunters and non-hunters. The imbalance is addressed by new forms of reciprocity whereby food-rich members of extended families share with cash-rich members, thus bringing wage income into the realm of sharing relationships. Inter-community trade is extensive. Sharing between communities does not seem to have declined but rather increased in importance. Sachs Harbour has an abundance of snow geese and musk-ox, and these are exported to other communities, in return for caribou and beluga whale products. These exchanges use the norms of generosity (giving without asking), sharing and generalized reciprocity, and not the Western rules of economic exchange involving cash exchange.

In sum, the Inuvialuit of Sachs Harbour have coped with recent climate change impacts by modifying when, where and how hunting and fishing are carried out. These coping strategies borrow from traditions of flexible resource use, and dynamic traditional environmental knowledge and skills. Also important among adaptive strategies is food sharing through intra-community social networks and inter-community trade. All of these cultural practices are still largely intact in Sachs Harbour and the Canadian western Arctic in general. All of these strategies provide considerable buffering capacity to deal with climate change, or with any other kind of social or environmental perturbation.

Climate Change and Social and Ecological Relations

There is no evidence that climate change, as observed in the 1990s, has altered the ecological relations between the people of Sachs Harbour and their resources, or altered social relations within the community. It has not resulted in increased or decreased pressures on any of the major resources. However, it has had some consequences for the local perceptions of the environment and local cultural understandings of resources. For example, the Inuvialuit of Sachs Harbour are concerned about the impact of the lack of ice in the summer on ringed seal pups. Some of them are also concerned about the risk of extreme events to animal populations, such as the potential impact of freezing rain on caribou forage.

One major impact of climate on the local perception of the environment concerns the issue of loss of predictability. Land-based livelihoods in the Arctic depend on the peoples' ability to predict the weather ("is the storm breaking so I can get out?"), read the ice ("should I cross the river?"), judge the snow conditions ("could I get back to the community before nightfall?"), and predict animal movements and distributions. A hunter who cannot predict the weather or read the ice would be limited in mobility; one who cannot decide what to hunt and where, cannot bring back much food.

Climate change has the potential of impacting indigenous environmental knowledge and predictive ability, thus damaging the self-confidence of local populations in making a living from their resources. Such changes may ultimately leave them as strangers on their own land. Arctic peoples are experts in adapting to conditions that outsiders consider difficult. However, climate change impacts raise the questions of speed and magnitude of change, as compared to how fast people can learn and adapt. The evidence from Sachs Harbour hunters indicates that current environmental change is beginning to stress their ability to adapt. Rapid change requires rapid learning, and unpredictability superimposed on change interferes with the ability to learn. Predictability is impacted by extreme weather events and higher variability, and appears to be an area of climate change research that deserves to be pursued in its own right.

Even though this case focuses on impacts and adaptations associated with harvests and subsistence, climate change also has other economic and cultural consequences. For example, the lack of sea ice not only has harvesting implications, but it also makes some people "lonely for the ice", as the ice is a central feature of Inuvialuit life (Riedlinger and Berkes 2001). Other environmental changes that are permafrost-related (e.g. thaw slumps, soil erosion) may not be a major threat to subsistence, but may have direct impacts on other aspects of community life, such as the maintenance of buildings and roads.

Climate Change Impacts in Context

Inuvialuit society in Sachs Harbour has been impacted by many social and environmental changes in recent decades. Major changes in subsistence and other resource use patterns have been caused by changes in global fur markets (white fox), commercialization of musk-ox (early 1900s depletions) and their subsequent protection followed by population recovery. These changes, plus government policies, have

resulted in major social and economic transformations in Inuvialuit society, turning these migratory hunting peoples into village-dwellers who use mechanized transport to go out on the land. Further changes in recent years have seen the introduction of commercial musk-ox hunts, and sport hunting based on musk-ox and polar bears.

Compared to these major changes, the impact of climate change is relatively minor, at least so far, and not beyond the ability of the community to adapt. However, climate change is a relatively recent event, and the ability of Sachs Harbour Inuvialuit to respond and cope with it, mainly by adjusting subsistence activities, may not be a reliable indication of the community's ability to adapt in the future. How much change can be accommodated by the Inuvialuit and their resource use systems? Elsewhere, we have focused on the *resilience*, or the amount of perturbation that the Sachs Harbour hunting system can absorb, and adapt by learning and self-organization (Berkes and Jolly 2001). The question of resilience is important because little is known about building adaptive capacity in the face of climate change.

Evolving co-management institutions in the area create additional opportunities to increase resilience and the ability to deal with change. New governance mechanisms through the *Inuvialuit Final Agreement* seem to be helping the people of Sachs Harbour to negotiate and manage the impacts of change. There are five co-management bodies established through the *Agreement* that make it possible for the Inuvialuit communities in the area to communicate with the regional, territorial and federal governments, and eventually with the Arctic Council.

Co-management has created linkages that were not possible only a few years ago. For example, indigenous hunters have been interacting with scientists in meetings such as the Beaufort Sea 2000 Conference, organized by one of the co-management agencies, the Fisheries Joint Management Committee (FJMC 2000). Co-management bodies, connecting local-level institutions with government agencies, provide vertical linkages across levels of organization and horizontal linkages across geographic area. Berkes and Jolly (2001) have hypothesized that such governance mechanisms have the potential to contribute to learning and self-organization, and hence to build adaptive capacity to deal with change.

Table 1.

Examples of environmental changes impacting subsistence activities
(adapted from Riedlinger and Berkes 2001; Jolly *et al*. 2002).

1. **Physical Environmental Change**

- Multiyear ice no longer comes close to Sachs Harbour in summer;
- Less sea-ice in summer means that water is rougher;
- Open water is now closer to land in winter;

- More rain in summer and fall, makes travel difficult;
- Permafrost is no longer solid in places;
- Lakes draining into the sea from ground melting and slumping;
- Loose, soft snow (as opposed to hard-packed) makes it harder to travel.

2. **Predictability of the Environment**

- It has become difficult to tell when ice is going to break-up on rivers;
- Arrival of spring has become unpredictable;
- Difficult to predict weather and storms;
- There are "wrong" winds sometimes;
- More snow, blowing snow and whiteouts.

3. **Travel Safety on the Land**

- Too much broken ice in winter makes travel dangerous;
- Unpredictable sea-ice conditions make travel dangerous;
- Less multiyear ice means traveling on first-year ice all winter, less safe;
- Less ice cover in summer means rougher, more dangerous storms at sea.

4. Access to Resources

- It is more difficult to hunt seals because of lack of multiyear ice;
- In winter, cannot go out as far when hunting because of lack of firm ice cover;
- Harder to hunt geese because the spring melt occurs so fast;
- Warmer summers and more rain mean more vegetation and food for animals.

5. **Changes in Animal Distributions and Condition**

- Less fat on the seals;
- Observe fish and bird species never before seen;
- Increase in biting flies; never had mosquitos before;
- Seeing fewer polar bears in the fall because of lack of ice;
- More least cisco caught now.

Table 2.
Short-term or coping responses to environmental change in Sachs Harbour: Changing when, where or how hunting and fishing takes place (adapted from Berkes and Jolly 2001).

Modifying the timing of harvest activity

- Warmer temperatures and unpredictable ice conditions have resulted in hunters going out earlier for polar bear.
- Shorter springs and increased rate snow melt have resulted in people not going out on the land for as long; they return to the community after the goose hunt, rather than proceeding to lakes for ice-fishing.

Modifying the location of harvest activity

- Erosion and slumping at one fishing lake near the community has necessitated fishing at other lakes instead.
- More bare ground and unreliable snow conditions mean families are travelling along the coastal sea ice rather than along inland routes.

- Adjusting how harvesting is done
- Community members describe using all terrain vehicles instead of snowmobiles to travel in spring camps when there is not enough snow.
- Hunters take seals from boats in open water, necessitated by the lack of summer ice on which seals normally haul out.

Adjusting the mix of species harvested

- The community is reporting catching more *qaaqtaq* (least cisco) in nets at the mouth of the Sachs River.
- Hunters are taking different kinds of mainland ducks previously rare in the area.

Minimizing risk and uncertainty

- Monitoring river ice and sea-ice conditions more closely.
- Only the more experienced hunters travel on certain conditions of sea-ice.

Table 3.
Cultural practices which may be considered adaptive responses to the Arctic environment, and evidence of their viability in Sachs Harbour as ways in which the community responds to environmental change. Adapted from Berkes and Jolly (2001).

Cultural Practice	**Evidence from Sachs Harbour**

Mobility of hunting groups; seasonal settlements; group size flexibility with grouping and regrouping of self-supporting economic units	No longer operative because of permanent settlements; compensated for by the use of mechanized transport to increase mobility of family groups and all-male hunting groups
Flexibility of seasonal cycles of harvest and resource use, backed up by oral traditions to provide group memory	Source of major short-term coping strategies, aided by rapid transport and communication technology to monitor animal population movements
Detailed local environmental knowledge (traditional knowledge) and related skill sets for harvesting, navigating and food processing	Underpins ability to change when, where or how subsistence harvesting occurs; loss of universality of some skills; loss of some knowledge and skills compensated for by new knowledge and skills
Sharing mechanisms and social networks for mutual support and risk minimization; high social value attached to sharing and generosity	Sharing of food and associated social values still important, especially within extended family units; special considerations for elders; new forms of reciprocity involving cash
Inter-community trade along networks and trading partnerships, to deal with regional differences in resource availability	Active inter-community networks, especially within Inuvialuit region; more extensive than practiced by previous generations; norms of generosity and generalized reciprocity still alive

11. 2.1.2 Climate Change and Canadian Inuit in Nunavut: the traditional economy, adaptation and ecological instability

George Wenzel

Introduction

The impact of climate on Inuit has been a dominant, if not the predominant, theme in Eskimo anthropology since Franz Boas (1888) undertook research on Baffin Island. In a time when the study of hunter-gatherers has become a virtual sub-discipline within anthropology, the "attribute" that still sets Inuit apart from the Kalahari San and other hunting peoples is the same one that European visitors to Nunavut, from Martin Frobisher to today's Midnight Sun tourist, remark on. That is, how can any people adapt to the Arctic environment, and to most people the arctic environment is epitomized by climate, especially cold and long, dark winters.

This case study focuses on the adaptability (or adaptiveness) of the traditional Inuit economy in Nunavut in a (presumed) time of climate-induced ecological instability. The relationship between Inuit ecology and Inuit economy, on its face, is almost too obvious. Inuit are hunters and the most referenced passage in Boas's seminal *The Central Eskimo* is about the relationship between sea ice, ringed seal distribution, and Inuit hunting and settlement. So a part of this case study will necessarily be about Inuit hunting and wildlife harvesting. In other words, it will speak to the production component of the traditional economy, particularly Inuit hunting and the production of *niqituinnaq* ("real food") including what at Clyde River (the community from which much of the material in this case study is derived) is called *ningiqtuq* – the sharing or, put formally, the Inuit system of resource allocation and re-distribution.

Gaining an understanding of how environmental change due to a warming (or cooling) climate may affect the material aspects of Inuit resource production (the economics, so to speak) is important. And so are the possible effects of climate-induced ecological instability on the traditional economy because it is the sociocultural rules that order who gets what when that make the economy Inuit.

With regard to generating hypotheses, or at least envisioning scenarios, about the former, we have the benefit of the archaeology and palaeoclimatology that has been done over the past forty years in the North American Arctic. Much of this was, in fact, done to answer questions about how climate has influenced the economics of Inuit life. We are less fortunate with respect to Inuit economy as it is impossible to know exactly how a seal or caribou was shared within communities, let alone who received what piece, 500 or 1,000 years ago. However, as Inuit economics and economy are linked, there is at least the possibility, using data about past changes and about how the system currently functions, to model the socioeconomic impact among Nunavummiut (the Inuit of Nunavut) because of a large-scale change of climate.

Inuit Subsistence and Climate: The Long-Term Record

The relations between climate and Inuit material subsistence and cultural adaptation can be examined through what is known from climatology, physical oceanography and biology about two long-term climatic trends. These are the Little Climatic Optimum-Medieval Warm Epoch (also known as the Neo-Atlantic Period, circa A.D. 1000-1250, and the Second Climatic Optimum/Neo-Boreal Period/Little Ice Age, which lasted from ca. A.D. 1550 to 1900 (Vasari *et al*. 1972; Andrews and Andrews 1979; Lamb 1982; Grove 1988).

Data from Northern Europe, Iceland and the Eastern Arctic indicate that during the Neo-Atlantic temperatures across the high North Atlantic region were as much as 2-2.5ºC above the annual average that prevailed in the Eastern Arctic through most of the last century. Conversely, the Little Ice Age involved a significant cooling of this region, with the most pronounced thermal effect coming in summer. Data from northwestern and

middle Europe suggest that summers averaged 0.5-0.8ºC less then those in the preceding moderating Pacific Period. Further north, in Scandinavia, the first half of the 17th century saw thirteen summers at least 1ºC colder then the estimated average for the preceding century (Briffa *et al*. 1990; Pfister 1988).

These episodes also produced large-scale positive feedback in the American Arctic ecosystem. The impact of each on northern physical and biological subsystems in turn correlates with climate-related adaptive adjustments by Inuit (see Dekin 1969, 1972; Barry et al 1977; Maxwell 1985).

The most discussed episode is the Second Climatic Optimum, which warmed the North American polar stage from the Chukchi Sea to West Greenland. This warming, beginning around A.D. 1000, saw the Central and Eastern Canadian Arctic experience a spatial and temporal reduction in the extent of annual sea ice.

In turn, this change in the North's ice regime created extensive new range to bowhead whales (*Balaena mysticetus*) for longer periods. And the expansion of bowheads from North Alaskan waters eastward (while North Atlantic bowheads were able to penetrate farther west) enabled Thule Culture people, the direct ancestors of modern Inuit, with their whale hunting experience, to follow. With a technology adapted to exploit a resource that the indigenous population of this part of the Arctic could not, the migrants rapidly displaced the late Palaeo-Eskimo population that had developed *in situ* over the previous two millennia from the whole of Nunavut, Ungava-Labrador, and Greenland. Thus, while Thule Culture lasted only the few centuries that this extreme warm period allowed large whales passage into most of the Canadian Arctic, many of the technologies that the *Qallunaat* world associates with Inuit - dog traction, the *umiaq* and *qayaq*, and large sea mammal hunting – are Thule legacies.

The Little Ice Age, the deep cold that set in following a transitional cooling from the Medieval Warm Epoch, is the reason why the Inuit culture that Europeans met as they quested for a northern route to Cathay looked as it did (and still looked until about 1970). The long summers with almost ice-free open water were gone and, except on the western and eastern most fringes of the Inuit area, so were bowhead whales. The whole tenor of Inuit life, in fact, changed.

The winter security that came with the harvesting of a twenty or thirty-ton whale was gone and so was the large supply of fuel and building material that came with capturing a bowhead. Instead, Inuit developed what McGhee (1972: 40) somewhat over-generally called a "Netsilik adaptation" based on the exploitation of a variety of seasonally available smaller prey species, chiefly caribou in summer, ringed seals through the winter and anadromous arctic char during their passage to and from the ocean.

In addition, Inuit the pattern of winter settlement across much of Nunavut changed from the land to the sea ice and the Thule Culture Classic Stage semi-subterranean whalebone and boulder house was abandoned in many areas for the snow

igliuk or iglu. Overall, Inuit became less sedentary because large supplies of food could no longer be rapidly developed and the new primary resource suite was composed of species that were highly mobile and/or elusive.

Ningiqtuq: The Traditional/Contemporary Economy

> An economy is the orderly movement of goods and services from producers to consumers (Langdon 1984:)
>
> ...a subsistence economy is a highly specialized mode of production and distribution of not only goods and services, but of social forms.....[Lonner 1980:5]

A full-blown discussion of the economy of Nunavut is well beyond the scope of this case study. Suffice it to say that, other than in the territorial capital and main regional government centers, the term "subsistence", as it is used by Lonner, describes the situation for the rest of Nunavut. Put another way, it is a mixed economy (sometimes mis-described as a dual one) in which traditional and non-traditional resources - represented by wild foods and money, respectively - interact, although "optimal economy" is probably a more accurate descriptive. The reality for most Nunavummiut is that the best return for one dollar comes from hunting, but without a dollar hunting is not possible. What is optimal, i.e., how much of each resource type is best, differs from household to household, but very few households can reasonably manage without some mix of country and imported food. As Fienup-Riordan (1986: 314) has observed, "...[monetary income] is perceived as the means to accomplish and facilitate the harvest, and not an end in itself".

With respect to the traditional economy, this case study concentrates on the social form(s) that organize the material flow of food once it has been captured. To a degree, these same rules find application when money is captured (Wenzel and White 2001). However, this is much more uneven because of the scarcity of money and the costs that are almost always associated with its acquisition.

The System in Outline

Ningiqtuq is not a single defined process by which seal meat or *maktaaq* are distributed. It is generally translated as meaning 'to share', but it is, in fact, a web of social mechanisms for distributing and re-distributing food and other resources. How exactly allocation is accomplished differs across Nunavut (see Damas 1972; Collings et al 1998), but the term is used in almost all regions of the territory to describe the overall process of transferring food between individuals, households and across entire communities.

The following table (Table 1) outlines the array of distributional mechanisms in Clyde River today. It is worth noting that not all the processes included are "traditional". Rather, there are several that the older generation of Clyde people consider the result of modern village circumstances. On the other hand, each form shown was referenced by at least three informants to a traditional type or behaviorial precept (see Table 2).

Table 1: Clyde Inuit *Ningiqtuq* Interaction Sets

Set Type	Flow Direction	Reference
Traditional_:	1a. *isumataq* << *ilagiit* subordinates	*tugagaujuq*_
	1b. *isumataq* >> *ilagiit* subordinates	*tigutuinnaq*_
	2. father-in-law << son-in-law	*tugagaujuq* (?)
	3. *isumataq* >> community	*Nirriyaktuqtuq*/ *minatuq* (?)
Modern[3]:	4. between unrelated hunters	*Uummajusiutiit*
	5. *angijukak* << unrelated hunters	*Taliqtuq*
	6. *angijukak* >> community	*Nirriyaktuqtuq* (?)
Other	7. between unrelated young and elders	*nalaktuq* related
	8. between same generation non-kin; generally among the elderly	inviting in and "gifting"

_ *Tugagaujuq* and *tigutuinnaq* are complementary and participants are generally seen as being *niqiliriiq* (sharers of food).
_ Traditional types correspond to sets 1,2,3, in text.
_ Modern types correspond to sets 4,5,6.
(*Ningiqtuq* has generally come to be seen as a multi-layered strategy by which participants achieve the widest possible intra-community distribution of resources. However, while Damas used *ningiq* to refer only to the social movement of *niqituinnak*, *ningiqtuq* is conceptualized here as a set of socioeconomic operations that also encompass labour and non-traditional resources.)

As Table 2 shows (see also Fig. Two), food sharing at Clyde is a multilevel system that encompasses within it social relations ranging from the action that occurs between paired isolates (as in *akpallugiit)* to means that effectively span the entire community (*minaqtuq*). And while *ningiqtuq*, as practiced today by Clyde Inuit, includes aspects related to the changed pattern of settlement that came about through Canadian government centralization policies in the 1950s and 1960s, the organization of system remains based on traditional principles of, foremost, kinship and, second, intra-generational solidarity.

Table 2: Aspects of Clyde Inuit *Ningiqtuq*

Social Context	Behavioral Directive	Form	Description
1a) Individual	*Ungayuk* (solidarity-affection)	*akpallugiit*	inviting in guests (typically same generation non-kin)
1b)	*Ungayuk*	*quaktuaktuq*/ *niqisutaiyuq*/ *paiyuktuq*	food gifts to close affines and non-kin (generally restricted to elders)
1c)	*Ungayuk*	*niqitatianaq*	*Uummajusiutiit* ("partnered" hunters)
2a) Intra-*Ilagiit*	*Nalaqtuk* (respect-obedience)	*niqiliriiq*	*tugagauyuk-tigutuinnaq* complementary

2b)	*Nalaqtuk*	*nirriyaktuqtuq*	restricted commensalism
3a) Inter-*Ilagiit*/ Community	*Ungayuk*	*nirriyaktuqtuq*	open commensalism
3b)	*Ungayuk*	*minaqtuq*	distribution of stored food
3c)	*Nalaqtuk*	*Katujiyuk*	within task group

In functional terms, virtually every form of sharing encompassed by the concept of *ningiqtuq* has as its basis a social, rather than economic, referent. The greatest sharing activity in terms of social focus occurs within the context of the restricted extended family. Within the *ilagiit* essentially all members are in a *niqiliriiq*, (literally, "those who share food"), relationship. And it is within the *ilagiit* that the *nalaqtuk*, (Damas' [1963: 48] respect-obedience dyad, but which may be conceptualized as responsibility-obligation [Wenzel 1981: 83-85]), directive that structures intergenerational/interpersonal behavior is most apparent.

Whereas *tugagaujuk-tigutuinnaq* activities function almost wholly within the social context of the extended family, as Tables One and Two indicate, mechanisms for the more generalized distribution of food resources are also present. Chief among these is *nirriyaktuqtuq*, or communal meal. Such commensalism may be restricted to the *ilagiit*, particularly when resources are scarce, or may include a large segment of the community. In either circumstance, communal meals are always held in, or immediately adjacent to, the dwelling of the hosting extended family head.

Generalized Reciprocity

One of the reasons for presenting what may seem to be an overly exhaustive review is to dispel the all too common notion that the Inuit traditional economy can be summed up by the term generalized reciprocity. That is no more the case than it is that this review has been exhaustive (it is not [see Damas 1972; Wenzel 1981, 1989, 1995b, 2000; Collings *et al*. 1998]) or that catching a seal sums up the traditional economy.

If anything describes the *ningiqtuq* economy, it is that it is socially complex. This is not to say that some of its forms are not general in their scope – commensalism is one example. But most operations are founded in balanced reciprocal relations, with reciprocity enforced by social precepts that provide not only for inclusion, but also sanction.

Bringing Climate Change Into the Economy Equation

At this point it may seem that there is little, if any, intersection between climate change and the traditional Inuit economy. However, there is the matter that production and allocation go together and that the former, as seals, caribou, polar bear and other animals, are the original stuff of *ningiqtuq*.

Based on what we know from the two most recent major climatic events to have affected Inuit, warming should, on the face of it, be a good thing. After all, the Second Climatic Optimum spurred an amazing cultural expansion, almost literally seeing Inuit explode out of North Alaska and travel nearly 8,000 km in barely 200 years, in the process displacing a cultural tradition nearly 2,000 years old.

This might in fact well be the case if the adaptation Inuit live today originated in the expansion of Thule Culture. However, the "Netsilik-type" hunting adaptation was a response to a cold environment and the *ningiqtuq* economy differs markedly from the economy practiced around bowhead whaling in North Alaska since at least the 19th century (see Spencer 1959; Burch 1984). (This is not to say that a *ningiqtuq*-type of sharing is absent among Inupiat [see Bodenhorn 2000], but rather that it is overlain by a more corporately oriented mechanism). All this suggests that the present warming, should it continue to increase, may not be good either for the traditional economics or economy of subsistence.

The best evidence for testing this proposition comes from the West Greenland work of Vibe (1967) on the effect of climate change on northern biota and Inuit resource use. Using a 150-year database (1800-1950) drawn from Danish colonial meteorological, ice and trading records, Vibe correlated the episodes of warming and cooling that occurred over this century and a half span with the rise and fall in the capture of ringed seals and polar bears. He then compared these data with the observations available on sea ice conditions during this period and noted that at the times when the local climate ameliorated, reducing the annual duration of the ice the capture of both species, as reflected in official trading records, declined (ibid.: 51-54, Figs.32 and 34). Vibe further pointed out that ringed seals are the primary food of polar bear and a stable ice environment is critical to ringed seal ecology, especially for successful spring pupping.

Vibe's study, drawing as it does on the rich scientific and commercial records available from Greenland, is unique in those terms. But his conclusion that ringed seal pup production suffers when increased temperatures seasonally destabilize the ice and that this affects the harvest of polar bears in fact mirrors traditional ecological knowledge statements put forward by Inuit from on their own long empirical experience with both species.

In terms of the contemporary Inuit subsistence system, ringed seals and polar bear are as important as at any time in the past to the economic well being of small Nunavut communities. In this system, the ringed seal, or *natsiq*, is one the principal traditional items in the Inuit diet. Besides being the most abundant marine mammal in circumpolar waters, ringed seals are the present along all of Nunavut's coastline year-round and their presence through the winter offsets the absence of most other important food species for this significant portion of the year. Finally, *natsiq* provide high quality nutrition when little alternative, except the most costly imported foods, are available.

To Inuit, *natsiq* are an all-season, all-year food. Indeed, at Clyde River, where it is one of eighteen species of mammals, fish and birds that are regularly harvested, ringed

seals, from 1979-1983, 54 percent of the edible biomass captured by Clyde hunters (Wenzel 1991: 81, 82). (In 1979, of the 169,000kg of country food that came into the community, 109,000kg [64.9%] were ringed seal [Ibid.: 81]). In the ecological economics of Inuit life, the subsistence consequences if any substantial reduction of the seal harvest were to occur is obvious.

This is even more apparent when the seasonal dietary contribution of ringed seal is calculated. In these terms, it represents 58.0% of the winter food supply and even more in the spring through autumn (66%, 81% and 64%, respectively [ibid.]). Caribou, the next most important food species by edible weight, contributes - 39% of the winter food capture and just 30%, 13% and 18.5% in the other three seasons.

And a substantial loss would also severely affect the overall economy of Inuit subsistence. This is in part because there is no other species present on the land or in the waters of Nunavut that is as abundant or as available as is *natsiq*. Flatly, no other species could biologically sustain the subsistence requirements of Inuit.

But, much more importantly, the cultural meaning of *ningiqtuq* would suffer. This is because *niqituinnak*, real food, is quite literally the stuff of sharing. To hunt, catch and share this kind of food is to an Inuk the essence of living Inuktitut (see Wenzel *et al* 2000). Ringed seal is as much a cultural good in Inuit subsistence culture as it is an item of diet.

Polar bear also play an important role in the contemporary subsistence system. Like seal, it, too, is *niqituinnak*. And, if climate change affects the ecology and even the distribution of ringed seals, it will, as Vibe's analysis showed, affect polar bear.

But, in food terms, polar bear, especially when compared to seal, are at best of minor importance. However, they contribute to Inuit subsistence culture in a way that seal no longer does – as one of the few sources of money that Inuit can access through traditional activities. While polar bear hides have long found a market outside their traditional uses to which Inuit put them, today, a polar bear hunt that is sold to an American, Swiss, Mexican or Japanese sport hunter may bring as much as US$15,000 per bear to a community.

Seals are food, while polar bear, when the hides are sold at fur auction or a trophy hunt to a non-Inuk, have been transformed into a commodity. Today, rifles, snowmobiles and gasoline are part of an effective Inuit subsistence as dogteams, seal oil lamps and fishing leisters were sixty years ago. (Why this is requires looking at Canadian internal colonial policy from 1945 to 1985).

The quandary that confronts every Inuk hunter is how to gain access money at a minimum cost in time. While hunting produces large amounts of high quality food - the Government of Nunavut estimates that it would cost approximately Can$35,000,000 to replace this harvest production – virtually none of this traditional wealth can be converted into the money needed to purchase, operate and maintain the equipment hunters use. Yet

abandoning hunting for imported food would not only be less healthy but would also be immensely costly. But this is in fact no alternative as approximately 30-35 per cent of adult Nunavummiut are unemployed and another 15-20% underemployed or only able to work seasonally.

Polar bear sport hunting helps meet the cash resource needs of many hunters while imposing a minimal cost in time. In 2001, ten sport polar bear hunts at Clyde River brought approximately Can$212,000 into the community, with half going directly into the hands of Inuit – altogether more income then entered Clyde from four years of hiking, kayaking and other forms of ecotourism. And these hunt revenues directly capitalized the purchase of five snowmobiles, a 7m inboard engine equipped boat, a large outboard engine and two all-terrain 4-wheelers, some $75,000-90,000 of equipment, by sport hunt workers for use in sealing and other subsistence activities. (Note: hunt workers purchased one ATV and one snowmobile for relatives not involved in sport hunting; money does enter the *ningiqtuq* sharing system).

If the projected trajectory of climate change is correct, certainly some Nunavut communities, even possibly Clyde River, may find that the traditional and modern pillars of their local subsistence systems being affected in the way outlined by Vibe. Could Clyde's hunters, if access to ringed seal and polar bear were reduced, shift to other subsistence sources, like narwhal, caribou and harp seal, that are at present only of minor importance?

The answer is probably yes, but not easily for a variety of reasons. Firstly, because it is highly likely that at least some potential "fallback" species will also be affected by a continued warming. For instance caribou, now the principal terrestrial resource for Inuit, are highly sensitive to the kinds of wet-cool conditions that may occur in autumn when rain, rather than snow, may lead to the icing over of vegetation and so limit their ability to obtain winter food. This situation occurred in the autumn of 1972 (see Kemp *et al* 1978) on several islands in the High Arctic with the result that caribou disappeared for nearly six years from Bathurst and Cornwallis Islands.

The present reduced state of Peary Caribou, serious enough for a number of Central Arctic communities to limit and even ban their subsistence harvests of the species, may have been triggered by autumn rains that iced the winter food supply and crusted the snow cover. In most areas, musk-ox, which are better adapted to these conditions, have replace the caribou, but they are themselves vulnerable to exploitation.

Narwhal and harp seal may provide some replacement for any reduction in ringed seals. Neither is an arctic winter species, but, if summers come earlier and stay ice-free longer, the harvest of both species may be increased significantly. Certainly narwhal, because its skin (*maktaaq*) is a favored food and the ivory tusk of males has commercial value, would draw increased subsistence attention. And the Northwest Atlantic harp seal herd, which summers between Baffin Island and West Greenland, has grown almost geometrically since southern Canadian commercial exploitation was limited in the mid-1980s.

However, there are serious issues with both. Narwhal, in all likelihood, do not possess the population size to sustain any significant increase in their harvest. Moreover, there are serious Canadian and international regulatory issues that would have to be overcome even if an expanded harvest were solely for food. Similarly, any increase in the use of harp seals, which at present draw very minor attention from Nunavummiut, would undoubtedly re-ignite the political activity that ultimately caused the collapse of markets for any seal products (Wenzel 1991).

One thing is certain. The mobility that Inuit once possessed to move in response to shifts in the pattern and state of their resource base is no longer possible. Inuit in Nunavut now live in communities that are a direct result of Canadian government policy and which represent hundreds of millions of infrastructure and other investment. Clyde River, for instance, which is home to about 800 people and more or less representative of the kind of infrastructure and services found across Nunavut, is the result of some $50 million of government investment. In today's political-economic climate, migration to remain in contact with *natsiq*, polar bear, or, more broadly, to maintain traditional Inuit subsistence culture would be a non-starter for Canada.

Conclusions

Inuit, whether Nunavummiut, Alaskan or Kalaallit, have shown adaptiveness in the face of the incredibly rapid change their cultural environment has undergone as they have passed through stage after stage of colonization in just six or seven decades. If they have been able to muster the social resources to adapt to that kind of environmental change, global warming will be far less formidable. .

2.2. Caribou, Reindeer and Climate Change

2.2.1 The Yamal Nenets of Northwest Siberia: adaptive reindeer management

Bruce Forbes

This case study will not treat historic and pre-historic patterns of indigenous wildlife harvests and subsistence hunting in relation to climate or 'weather' change, as some of the other case studies in this chapter do. Given the lack of data on such patterns, or indigenous perceptions of climate during recent decades, this case study will focus on the potential interactions between climate, land use, and management of reindeer (*Rangifer tarandus*) in the Yamal Nenets Autonomous Okrug (YNAO) of northwest Siberia. This is a region of ice-rich permafrost that has been subject to large-scale

petroleum development during the past few decades, while at the same time giving indications of its sensitivity to decadal and even inter-annual variations in climate.

For at least a millennium (Fedorova 1998), this region also served as the homeland of the Yamal Nenets, nomads who have either hunted or herded reindeer as their main livelihood, supplemented by fishing, hunting and gathering. Nenets have recently expressed great concern in a number of fora regarding their future in reindeer husbandry because of forces largely beyond their control (Forbes and Kofinas 2000; Khorolya 2002; Jernsletten and Klokov 2002). These concerns are discussed here in the context of climate change.

As the case studies in this chapter note, Arctic peoples are experts in adapting to conditions (environmental, social, economic) and recognize their own abilities in this regard. Nonetheless, as this chapter similarly points out with regard to indigenous peoples throughout the Arctic, Yamal Nenets are recently showing signs of stress adapting to the modern barrage of simultaneous changes in their homeland – from health and demography (Pika and Bogoyavlensky 1995), to questions of land tenure (Golovnev and Osherenko 1999), and increasingly severe 'overgrazing', predation and poaching on reindeer pastures (Jernsletten and Klokov 2002). There is a risk that a rapidly changing climate may accelerate ecosystem degradation in ways with which Nenets may be unable to cope, given the constellation of other factors impinging upon their ability to maintain herding as viable livelihood.

Krupnik (1993) argues that indigenous reindeer pastoralism burgeoned in throughout the Russian Arctic during the 18th century as a result of two interwoven factors - socio-economic transformation and environmental change, in particular climate change which resulted in what he refers to as 'ecologically favorable conditions'. The biological factors Krupnik cites which positively affected semi-domestic herd development were improvements in summer pastures and a concomitant increase in reproductive rates, coupled with a drop in summer and winter mortality. Proxy climate data from the past millennium for Yamal are summarized by Shiyatov and Mazepa (1995) and indicate a summer warming trend throughout the 1700's, as described by Krupnik for Eurasia in general.

Shiyatov and Mazepa (1995) also provide late 19th and 20th century climate trends for Yamal and these indicate a warming trend during the early and mid-summer periods between about 1940 and 1960. The total reindeer population began a period of rapid growth around 1950, following the near decimation of the herds during World War II, and this continued through the 1990's (Golovnev and Osherenko 1999). At present there are around 180,000 animals, on the Yamal Peninsula, and more than 600,000 animals in the entire okrug managed by 2618 mostly family-based units with a nomadic lifestyle (WRH 1999).

Since the collapse of the Soviet Union, various collaborative teams of scientists have made available a great deal of data on the relationship between climate and permafrost across the Russian Arctic. The Circumpolar Active Layer Monitoring

(CALM) program is paramount among these efforts to observe changes in the seasonally thawed active layer and near-surface permafrost, including thermokarst erosion (Brown et al. 2000). Although the annual depth of substrate thaw (active layer) poorly reflects contemporary climatic warming on Yamal (Pavlov 1998), inter-seasonal variability is strongly correlated with summer thawing degree-days. At the same time, the frozen ground beneath Yamal is characterized as 'warm' permafrost with its temperature amplitude not far below 0°C and these substrates have been warming in recent years (Pavlov 1994).

With regard to air temperature, combined regional data from the mid-1970's onwards show relatively small magnitude, positive trends in thawing degree-day totals and a rise in mean annual air temperature (Brown et al. 2000). There is evidence that is not the case in other parts of the Russian Arctic, such as neighboring Taimyr and Chukotka in the far east (Kozhevnikov 2000). Some recent modeling efforts predict the onset of a climatic regime that is not conducive to the maintenance of permafrost over extensive areas of northwestern Siberia, with warmer spring and summer temperatures and additional precipitation. The authors have concluded that such a development would have serious ramifications for engineered works in this region, owing to the extensive area underlain by massive ground ice (Anisimov and Nelson 1997; Nelson et al. 2001).

In general, the ecological impact of large-scale climate variability and recent climate change on northern ungulates is well documented. Variations in growth, body size, and survival, fecundity and population rates of increase have all been correlated with major atmospheric phenomena including the North Atlantic and Arctic Oscillations (NAO and AO, respectively). There is evidence from northern Fennoscandia, for example, that both extremely high and low oscillation indices have adverse effects on reindeer (Helle and Timonen 2001). The mechanisms underlying these correlations derive from direct and indirect impacts on grazing conditions for the animals, such as the phenological development and nutritional quality of forage plant species, late lying snow cover in spring and early winter icing events, and the animals' immediate thermal environment (Post and Stenseth 1999; Mysterud et al. 2000).

Regardless of these historical trends in climate impacts and future scenarios emphasizing risk, the overriding concerns for contemporary Nenets herders of Yamal revolve around what is collectively referred to as "the pasture problem" (Jernsletten and Klokov 2002; see also Podkoritov 1995) and related issues pertaining to land tenure (Osherenko 2001). Nenets have constantly adapted to change prior to, during and since the development of intensive reindeer management that became the dominant management regime in the early 1900s. They have survived first Tsarist and later Soviet dreams of establishing state and religious authority over even the most remote human populations. Yet nothing has challenged them like the ongoing search for petroleum beneath their ancestral lands.

Oil and gas development began in the 1960's and intensified steadily through the 1970's and 80's, quickly followed by the collapse of the Soviet Union and, almost simultaneously, the overnight disappearance of the largely artificial market for reindeer

meat, and the replacement of barter with a cash economy. In the confusion of sorting out ownership of animals and title to land in a newly capitalist society, herd sizes continued to increase to historical highs as land withdrawals for industry pushed the animals onto progressively smaller parcels of land and restrictive migration routes, resulting in extensive pasture degradation (Forbes 1999; Golovnev and Osherenko 1999).

The so-called pasture problem is multifaceted and has developed over a long period of time. The collectivization of the herds, which took place under Stalin, is partly to blame, as it instituted the restrictive 'brigade' system of management and sought to maximize meat production for the Soviet 'market'. This took away Nenets' ability to adjust for changing conditions resulting from weather, climate, social relations, and forage conditions, including grazing/trampling impacts. At present there are no fallow or 'reserve' pastures remaining on Yamal, as there was under traditional Nenets management. However, there were reports of heavy grazing in some areas already before the onslaught of Soviet-style management (Golovnev and Osherenko 1999; WRH 1999).

Their emerging after the fall of communism with their culture, their livelihood and their ecosystems more or less intact shows how Nenets successfully adapted to the period of collectivization. However, petroleum exploration proceeded rapidly and relatively unchecked, with a virtual lack of meaningful protocols and lax enforcement of the few new rules (Forbes 1999). The problem now, from the herders' perspective, has first and foremost to do with land withdrawals for petroleum exploration, infrastructure development and related degradation processes such as quarrying for sand and gravel, blowing sand and dust, and off-road vehicle traffic in summer (Forbes 1995; WRH 1999; Khorolya 2002; Jernsletten and Klokov 2002).

Alongside herding, Nenets have always supplemented their diet, clothing and other needs by fishing and hunting. Nenets observe that the massive influx of industrial workers to Yamal and concomitant increase in hunting and fishing pressure has meant the decimation of many freshwater ecosystems and also some preferred game species (e.g., polar fox) in areas around the main gas fields and transport corridors (Okotetto and Forbes 1999).

In attempting to adapt to the heavy grazing pressure on the pastures the herders now see themselves as "racing" along their migration routes (Golovnev and Osherenko 1999). During field research in late summer 1991, the same week as the coup in Moscow took place, the author of this case study met with herders near the main gas field of Bovanenkovo on north-central Yamal. The number of fully loaded sledges scattered around the camp surpassed the number of empty sledges. The head of the brigade explained the reason was that they were breaking camp every 24-48 hours. He explained that as the herds have become larger they must now have the animals on the move almost constantly. One reason is to avoid rupturing the vegetation mat and exposing the fine-grained sand and loess beneath, which are prone to aeolian erosion, another is reduced forage quality.

Assessing the consequences of climate change and petroleum development, either individually or in combination, is particularly difficult for *Rangifer* spp. compared to other ungulates due to the extreme complexity of *Rangifer* ecological relations (Klein 1991; Gunn and Skogland 1997). These involve traditional patterns of migratory movements, resulting in transitory dependence on different ecosystems and special physiological and morphological adaptations that enable them to use a unique food resource. In addition, their complex social structure varies seasonally (Klein 1991).

In the west, reindeer herders and caribou hunters display an acute awareness of the need for coupling indigenous knowledge about wildlife and environment with scientists' efforts to understand climate change and have clearly expressed their concerns as they pertain to traditional livelihoods (Turi 2000; Krupnik and Jolly 2002). Among reindeer herders in northern Russia, impacts other than climate appear to be of more immediate concern and the overall situation has been described as a 'crisis' (Krupnik 2000). This has lead to what has been described as 'passive' rather than 'active' adaptation (Klokov 2000) to the many and drastic changes.

Dmitri Khorolya is himself Nenets and president of the Reindeer Herders' Union of Russia and director of Yarsalinski sovkhoz, the largest collective management unit on Yamal. In his address to the 2nd World Reindeer Herders' Congress in June 2001 he observed that, "the vulnerable ethnic-economical systems of [Russian] reindeer peoples are frequently exposed to hard market conditions, particularly where oil and gas mining has become the principal factor in the development of Arctic areas. Industrial activity in the [Russian] North has resulted in the destruction of many thousands of hectares of reindeer pasture. The process is continuing. In some regions pasture degradation threatens preservation of reindeer husbandry and the anxiety of reindeer herders for their future should be heard by the world community".

In this chapter, Berkes suggests that permafrost-related changes may not be a major threat to subsistence in Inuvialuit. The situation in Yamal has the potential to be different because of the long, restricted migrations involved, void of the traditional Nenets' capacity for flexibility. As several studies have shown, permafrost in the form of massive ground ice is common and the landscapes range from moderately to highly unstable even in the absence of industrial development or intensive reindeer management (Vilchek & Bykova 1992; Nelson & Anisimov 1993). In the case of Yamal, 'what if' scenarios pertaining to climate change must also necessarily include:

- The prospect of early melting/late freezing sea ice in the Ob River delta, as this would cut off access between winter and summer pastures for the main herds (e.g. Yarsalinski sovkhoz);

- Increased traffic from the Northern Sea Route, perhaps inevitable but certainly benefiting from early melting/late freezing sea ice in the Kara Sea. This could accelerate the pace of regional development.

Either of these scenarios risks putting additional stress on the adaptive abilities of the Yamal Nenets. Yet even in the absence of climate change, as Nenets have made clear, in the next two to three decades there are critical and immediate threats from questions of title to land and accelerating changes in land use. The latter include both local and widespread damages from industry, the ecosystem-level effects of reindeer grazing and trampling, in addition to poaching. During this period the different parties must strive together to minimize conflicts (Klein 2000). In the longer term, if the climatic warming already underway continues, we can expect extensive alteration of the existing tundra communities as permafrost begins to thaw and large areas are either denuded by landslide events (Leibman & Egorov 1996) or subject to paludification by melting ground ice via thermokarst. Adaptation to such changes will require: (a) much greater efforts on the part of industry to prevent or mitigate additional disturbance; (b) a flexible system of land use, emphasizing property rights, that is satisfactory to both the Nenets and the State; and (c) additional practitioners' and scientific knowledge on the composition and potential forage utility of emergent plant communities which will necessarily be exploited by the reindeer.

11.2.2.2. The Indigenous Peoples of the Russian North (IPRN): Climate Change and Environmental Degradation

Tatiana Vlassova

Introduction

This case study is based on the ongoing work of the Russian Association of Indigenous Peoples of the North (RAIPON), together with the NorthSet project of the Institute of Geography, Russian Academy of Sciences. This work deals with the assessment of climate change impacts on the indigenous peoples of the Russian North within the context of broader, social, economic and political changes. This case study is based on the very preliminary results of initial research, but it is included in this chapter because it illustrates the tremendous challenges faced by indigenous peoples throughout the Russian North.

The indigenous Peoples of the Russian North have depended on traditional hunting, fishing and gathering for thousands of years and, for several hundred years, many groups have practised nomadic reindeer breeding. Human impacts and environmental transformation in the Russian Arctic have intensified in the last few decades. Significant climate change is also becoming more evident, as is the destructive impact of industry. The biggest sources of pollution are the oil and gas industries, as well as mineral extraction and processing, aggravated by poor purification facilities. The main negative impacts of industrial development threatening the livelihoods of indigenous peoples include:

- The destruction of reindeer pastures and widespread degradation of ecosystems, especially due to the construction of industrial infrastructures and industrial pollution

- Massive toxic and pollution of marine and freshwater environments, affecting the habitats and spawning grounds of fish and the destruction of fisheries

- Deforestation due to the timber industry using concentrated methods of clear-cutting, leading to the destruction of the non-timber forest resources of high cultural and economic importance to the IPRN

- Large scale landscape and soil destruction, erosion (especially thermokarst erosion) along with the degradation of tundra and taiga vegetation as a result of air pollution caused by industrial emissions (especially by enterprises producing non-ferrous metals)

- Flooding of especially valuable subsistence areas due to the construction of hydroelectric power dams

- Anthropogenic forest fires, partly associated with poaching and increased recreational pressure around the regions of industrial development

These impacts have added to the tremendous contemporary problems faced by Russia's Northern indigenous peoples, which can only be understood with reference to Soviet and post-Soviet transformations. During Soviet times, public policies resulted in the resettlement of the inhabitants of small settlements into large villages. This coercive resettlement of indigenous peoples signalled the beginning of the destruction of the social and ecological relationships that characterised indigenous peoples' subsistence lifestyles. Resettlement, the separation of children from their parents in favour of educating them in boarding schools, preservation orders on vital grasslands and reindeer pastures, and the reduced possibilities to engage in traditional activities, together with many other changes, led to a spiritual and social crisis among the indigenous peoples (Vlassova 2002). Since the 1970s, unemployment and alcoholism have become widespread, family structures are breaking down and traditional culture is being destroyed.

In recent years, the destruction of traditional subsistence activities, especially of the most important activity for many indigenous groups, namely reindeer herding, has been continuing apace. The difficult period of transition to a market economy in post-Soviet Russia has brought sharp changes to the economic and social conditions of the IPRN, to which they have had to adapt quickly in order to survive. In the 1990's, when the formation of the market economy and democratisation of society in the Russian Federation began, the situation in reindeer husbandry changed dramatically. This period of transition has seen a rapid decay of collective reindeer husbandry and a partial return to the private ownership of reindeer herds. This has been taking place without the introduction of sufficient legal reforms, particularly affecting agricultural and traditional lands. One major trend has been a significant reduction in the population of domesticated reindeer. Combined with a lack of approaches for the development of a new alternative programme for sustainable development, and faced with increasing climate variability

and change, the situation for the indigenous peoples of the Russian North is increasingly bleak.

Today the Indigenous peoples of the Russian North constitute a mere 2% of the entire northern Russian population. The IPRN number approximately 200,000 individuals belonging to forty different peoples (Haruchi, 2001). The most numerous are the Nenets, who number about 35,000 persons; the least numerous are the Enets with about 209 and the Orok with 109. The subsistence area of the indigenous peoples comprises roughly 60% of the overall territory of the Russian Federation (Kohler 2002). The traditional subsistence activities of the IPRN include reindeer herding, hunting (including sea mammals), fishing, gathering wild plants and, to a certain degree, craft-making and traditional art. Among the IPRN the specific activities vary significantly from region to region.

The indigenous communities are the most endangered social group in the current uncertain period of transition to a market economy. During the decade from 1990 to 2000, the number of indigenous people employed in northern livestock farms, as well as in hunting and fishing, fell by 37 % (Agitaev 2002). In these years of market reforms, the actual rate of unemployment in the indigenous settlements of the North is, on an average, not less than 40-50 % of the economically active population. The situation is much worse for youth in remote areas. Some small villages of autonomous okrugs (for example in the Koryak Autonomous Okrug) face an unemployment rate of 75-80%; in some districts of Habarov Kray the rate of unemployment among the indigenous peoples has increased 6 fold over the last decade.

Social ills associated with unemployment, poverty, disease, family breakdown, crime, suicide and alcoholism are on the rise in indigenous settlements. Mortality among indigenous peoples grew by 35.5 % during the1990s (Abdulatipov 1999). The nature of mortality has changed during the last few decades: the main risk group is no longer children, but young adults. The main cause of death is no longer sickness, but death as a result of injuries, accidents and suicide. It is evident now that the main cause of this situation is the destruction of traditional lifestyles of the indigenous peoples (Vlassova 2002). For Saami living in Lovozero on the Kola peninsula, whose health and livelihoods have been affected by pollution and ecological degradation, the improvement of the environment is an even greater priority than the improvement of housing conditions, which are extremely poor (Afanasieva 2002). According to the Saami, climate is becoming less comfortable to them, and they articulate this in terms of their livelihoods and health. The environment is one in which they dwell and comfortable housing will not improve their health if the climate is changing. During a workshop organised by RAIPON in April 2003 many Saami participants talked about their concerns over the effects of rapid and frequent climate/weather changes on the increase in high blood pressure. As they spoke, they connected health and illness directly to climate variability and change.

Significant shifts have occurred in the unemployment structure. The indigenous share in municipal positions, and in the service, educational and cultural sectors has

increased intensively while their participation in the traditional economy has decreased sharply. The highest level of unemployment is observed in the areas where indigenous peoples retain traditional livelihoods. In larger settlements with a developed service sector, employment tends to be slightly higher among the indigenous population (Agitaev 2002). Yet, such an increasing reliance on service sector activities does not always mean that harvesting renewable resources and production of traditional food for the household has declined in importance. As in other Arctic states, as discussed throughout this chapter, in Russia hunting, herding, gathering and fishing remain traditional activities that satisfy important cultural, social and nutritional needs, as well as the economic needs of families, households and communities.

In this changing social and economic climate, indigenous systems of traditional resource use are under threat. Traditional land use areas have been located mainly within zones of political and economic interests, particularly those of the oil, minerals and timber producing companies and military complexes with nuclear testing sites (Vlassova, 2003). From the initial results of the research being conducted by RAIPON, a majority of indigenous people consider the following to be some of the most significant issues that affect the physical environments and well-being of their communities:

- **Poaching:** Decreasing populations of animal and plant species is a serious concern and it may well be that this is not due to climate and ecological changes alone, but aggravated by poaching, which is a serious problem in several regions.

- **Forest fires caused by humans**: It is known that fires, the frequency and scale of which have lately increased, are either natural or man-made. Today it is estimated that in the Tyumen region alone, which is now being intensively explored for natural resources, over 1.5 million ha of reindeer pastures have been destroyed by fire. One of the causes of escalation of fires in the tundra, taiga-tundra the taiga might also be climate warming, especially summer droughts.

- **Industrial logging**: In recent decades, commercial logging operations have advanced closer to the taiga-tundra zone across much of the boreal forest region. The transformation of the northern parts of the taiga zone into a taiga-tundra, or even tundra zone as a result of human activity is going on in Russia (Vlassova 2002).

- **Clearing of forests for firewood**: The fuel deficit in remote communities is one reason for illegal logging. Very serious ecological problem arise with cutting of forests for fuel in Kovran, Loveozero and Kuumba.

One of the causes of the fall in reindeer numbers is the degradation of the timberline (taiga-tundra) winter reindeer pastures caused by industrial forestry, clearing of forests for firewood and industrial pollution. The traditional ways of life of indigenous peoples are characterised by high adaptability to seasonal as well as spatial differences in the physical environment. Climate changes may interfere with the human-nature cycle of reindeer herding, where herders follow the paths of reindeer between summer grazing lands in the tundra and mountains and winter grazing lands in the timberline zone.

Winter pastures are of great importance for reindeer herding. During the long Arctic winter, reindeer depend upon access to pasture rich in ground lichens, which are their basic food. In the autumn, reindeer start to move to forested areas that provide layers of soft snow that they can dig through to again find the ground lichens. Epiphytic lichens found on old trees are important as reserve fodder when the lichens on the ground can not be reached due to ice layers on or within the snow. The lichens almost exclusively provide these animals with the carbohydrates they need to maintain their body temperature in winter (Vlassova and Volkov 2001).

Another cause of the decrease in reindeer numbers is the overgrazing of tundra and taiga-tundra pastures. Fewer and fewer winter pastures are available for reindeer herding as large territories are being occupied by mining and petroleum industries. This leads to an increased pressure by domesticated reindeer on the tundra and taiga-tundra ecosystems, and thereby to further degradation. Ecosystems are completely overgrazed by reindeer in many areas. The overgrazing of reindeer pastures certainly leads to deforestation of the taiga-tundra winter pastures, especially because of the damage caused to trees and shrubs by reindeer. This has the effect of pushing the treeline south in many areas (Vlassova and Volkov 2001).

Fires are increasingly contributing to the degradation of reindeer pastures and the decline of reindeer herding. The frequency and scale of fires have lately increased. But the interaction of fires with pastures and forest are more complicated, and in the system of total ecosystem management it should be taken into account that fires might play also an important role in the forest regeneration process as they provide important minerals and free soils from leaf litter and ground vegetation cover, which in certain natural conditions inhibit forest growth (Sedyh 1996). It is believed that a decline in reindeer herding could also have a negative impact on the reforestation process as reindeer promote the removal of leaf litter and thereby the ability of new trees to become established.

It is within this extremely complex socio-economic and changing ecological situation that indigenous peoples in the Russian North must deal with climate change issues. RAIPON's initial work in climate change impacts suggests an important way forward: indigenous observations of climate change must be examined together with a greater emphasis on their concerns for environmental degradation and habitat loss due to other factors. This broader understanding of change and discussions of how to deal with it must be used effectively in environmental impact assessments, in environmental policy and in the elaboration of local programmes for sustainable development.

2.2.3 Understanding the implications of climate change for indigenous caribou systems of North America

Gary Kofinas

Caribou hunting in North America is practiced by Dogrib, Koyukon, Gwich'in, Dene, Cree, Chipewyan, Innu, Naskapi, Yupiit, Iñupiat, Inuvialuit, Inuit, and other indigenous peoples from the Ungava Peninsula of Labrador Canada to the Western Arctic of Alaska (Figure 1.). While the cultural role of caribou (*Rangifer tarandus)* differs among these groups, caribou is arguably the most important terrestrial subsistence resource for indigenous hunters in Arctic North America (Hudson et al. 1989; Klein 1989; Kofinas et al. 2000). Annual total harvest by North American hunters is greater than 160,000 animals, with its replacement value as store-bought meat roughly equivalent to $30,000,000.

While this monetary value illustrates the enormous contribution of caribou to the northern economy, it does not capture the social, psychological, and spiritual value of caribou to its users. For many indigenous culture groups, like the Gwich'in, Naskapi and Nunamiut, caribou-human relations represent a bond that blurs the distinction between people, land and resources, and links First Peoples of the North with their history. This intimate relationship between people and caribou suggests that negative impacts from climate change on caribou and caribou hunting would have significant implications to the well being of many indigenous communities, their sense of security and tradition, as well as their ability to meet their basic nutritional needs.

The discussion of this section considers some of the implications of climate change on the socio-cultural systems of indigenous North American caribou hunters. In this short examination, I identify important variables in making climate change assessments on northern caribou user communities, report on recent modeling efforts to project climate change impacts on caribou people, and note some of the problems of projecting impacts of climate change scenarios. Considerations are made about the potential impacts of climate change on indigenous caribou hunting systems as a whole, with special reference made to the caribou production system of the Vuntut Gwich'in First Nation of Old Crow, Yukon, a community of indigenous people with intimate ties to the Porcupine Herd. Some of the discussion is based on the work and findings of the National Science Foundation Sustainability of Arctic Community Project, an integrated assessment in which Old Crow was a partner community.

The Enduring Relationship of People and Caribou

Caribou has for millennia been of critical importance to northern peoples of North America (Burch 1972; Lynch 1997). Archeological evidence suggests that during Wisconsin glaciation, the distribution of *Rangifer* extended across much of the western hemisphere (Banfield 1961; Banfield 1962; Kelsall 1968; Spiess 1979), from as far south as New Jersey to New Mexico and Nevada (Jackson and Thacker 1997; Lynch 1997). Caribou were available to paleo-indigenous hunters' seasonally, with variation in availability related to a herd's ecological rhythms, human territoriality and mobility, and access to others living resources. Shifts in climate regimes that precipitated glacial epics had dramatic effects for caribou and people who depended on them.

The traditional caribou hunting grounds of the Vuntut Gwitchin First Nation is located within the caribou range of the PCH, a region referred to by geologists as the Yukon-Alaska Refugium, and considered to have been unglaciated throughout the four glacial epochs. Paleontological evidence suggests that caribou have continually inhabited the Alaska - Yukon Refugium for over 400,000 years, through Wisconsin Glaciation. Archeological evidence of human habitation in this region is among the oldest excavated in North American. While controversial artefacts have been used to suggest the presence of humans in the area 25,000 to 29,000 years ago (Morlan 1977), confirmed findings at the Bluefish Caves, located on the Bluefish River southeast of Old Crow, Yukon have been dated 17,000 to 12, 000 years old (McClellan 1987: 44-51), including the bones of caribou.

Archeological research linking proto Gwich'in with the present-day hunters identifies a complex of sites on the Porcupine and Crow Rivers, and indicates continual human inhabitation of the region and use of Porcupine Caribou for approximately 2000 years (McClellan 1987). Many of these sites are situated at present-day caribou river crossings, with material culture and subsistence patterns closely related to the caribou resource. Other noteworthy sites include more than 40 caribou fences, strategically located across the southern range of the Porcupine herd, and used by the Gwich'in until the turn of the 19th century (Warbelow et al. 1975; Greer and LeBlanc 1992; McFee no date given).

Social organization of caribou production traditionally reflects the seasonal cycle of caribou movements, overall changes in herd population, and access to other important subsistence resources. In winter, when caribou herds are mostly sedentary, traditional hunting involved small-group hunts and stalking; autumn migration brought large numbers of caribou and was undertaken by larger parties and as family groups, intercepting caribou at traditional river crossings and or directing movements of wild caribou into corrals. High demand for caribou meat supply in preparation for winter required large-scale harvest involving considerable effort by family groups. Summer hunts of young caribou provided lighter hides that were important for clothing. While traditional caribou hunting is often described as cooperative in behavior and egalitarian in social structure, recognition of exceptional hunting abilities was critical to survival. Caribou fences of the Vuntut Gwitchin are reported to have been "owned" by skilled hunting leaders, with a fence complex capable of harvesting as many as 150 animals in a single roundup, and managed by as many as 12 families. Cooperation among groups situated at different fences was necessary for managing the annual variability in migration patterns and uneven hunting success of family groups.

Ethnological studies of Porcupine Caribou users document the central role of caribou in community life (Slobodin 1962; Balicki 1963; McKennan 1965; Slobodin 1969; Acheson 1977; Slobodin 1981). Oral histories are replete with accounts of human migration, exceptional hardship and starvation, due to the unavailability of caribou. While some have argued that over hunting has been a key driver with the decline of many northern wildlife populations (Martin 1978), there is little evidence that over hunting of caribou by indigenous peoples was the sole cause of population declines in large herds.

Given the population estimates of indigenous hunters in the pre-contact period, it is more likely that changes in caribou populations of large herds and shifts in their distributions were driven primarily by climate (Peterson and Johnson 1995), with hunting contributing to these changes at low-population levels.

Modern-day Subsistence Systems

Today, caribou remains a vibrant component of many caribou user communities' mix cash-subsistence economies. For example, harvest data for the community of Old Crow (population ~275) show that per capita caribou harvest can be as high as five animals. Modern-day harvest in that community is generally undertaken during three seasons – fall, winter, and spring, with fall harvest being the most important. During that season, bull caribou are in prime condition (i.e. fat) and the season's cooler temperatures allow for open-air production of drying meat, with use of boats to hunt at crossings. Winter harvesting does occur, but is generally limited because the herd's winter distribution is too distant from the community to allow affordable access. The spring hunt of caribou by the Vuntut Gwitchin provides a supply of fresh meat after the long winter, but is also limited because warmer temperatures constrain caribou production and storage of meat in caches. Governing this behaviour is a strong local ethic against wastage.

The location of modern-day human settlements has consequences for the success of community caribou hunting. Communities , like Old Crow, located in the center of the range of large migratory herds have opportunities to intercept caribou during fall and spring migrations, whereas communities situated on the margin of a herd's range may have access to animals only during winter or briefly during the summer calving and post-calving periods. History shows that the range of a large herd can contract at low population levels and expand at high levels. The consequence to local communities situated distal to the heart of a herds range can result in a decline in hunting success and in some cases an abandonment of caribou hunting for several decades until the herd is re-established at a higher level.

An important mechanism for adaptation and survival of traditional indigenous subsistence economies is systems of reciprocity through the sharing of harvested animals. Data from the Alaska Department of Fish and Game / Division of Subsistence Community Profiles database document the extent to which household sharing occurs in of fifteen Western Arctic Herd (Alaska) user communities (Figure 2). Networks of exchange are internal to communities and commonly kinship based. These networks also extend to residents of neighboring communities and regional centers. Central in this exchange process and in hunting success for many traditional hunters is the concept of luck (Kofinas 1998). Like many hunting peoples, luck in hunting is regarded by many Vuntut Gwitchin not simply as matter of hit-or-miss probability, but also as the consequence of deference and respect to animals, and generosity in sharing harvest with fellow community members (Feit 1986).

Caribou subsistence hunting in indigenous communities of the North is today practiced as part of a dual cash-subsistence economy. Cash inputs (e.g., jobs, transfer payments, investments by Native Corporations) supply essential resources of the acquisition of modern-day hunting tools. The transition to improved hunting technologies (e.g., bigger and faster snowmobiles and boats, outboard motors with greater horsepower, high powered rifles, access to caribou radio-collar distribution and movement data via the internet), allow greater access to caribou than years past, more consistent availability of fresh meat, and thus, change the level and type of uncertainty that has historically been associated with caribou hunting.

Government policies and agreements dictate if and how caribou harvesting enters into the realm of monetary exchange. For example, the State of Alaska and the US-Canada International Agreement for the Conservation of Porcupine Caribou herd (1987) prohibit the commercial harvest and sale of caribou, whereas commercial tags for caribou of other herds are permitted for herds of Northwest Territories, Nunavut, and Quebec, where several for-profit Native and non-native corporations participate. Outfitter caribou hunting is also practiced as a component of local mixed economies in some regions. In others, like Old Crow, Yukon, there is resistance to engage in guided hunting, a local policy that is defended as a need to retain traditional values and avoid commercialization of a sacred resource.

Many have speculated that engagement of subsistence hunters into the cash economy and the overall transformation of modernization would ultimately lead to a decease in participation in the subsistence way of life (Murphy 1986). Yet, evidence demonstrates that in some conditions subsistence hunting can thrive in a modern context (Langdon 1986; Langdon 1991; Kruse 1992). Changes in these systems have, however, had effects on the allocation of time resources, including the time community members spend on the land pursuing their subsistence way of life. Whereas, before 1960 there was great flexibility by families in the allocation of time for subsistence harvesting and trapping, today's pursuit of employment and educational opportunities and its attendant shift to "clock time" is noted by many people at the local level as constraining opportunities for harvesting and affecting the transmission of cultural hunting traditions to younger generations. Relevant in the discussion about climate change and subsistence caribou hunting is the process by which financial resources compensate for the more constrained schedules of today's hunters, by improving technologies for time-efficient travel to hunting grounds. The shift to improved harvesting technologies also suggests that climate change impacts on community caribou hunting be considered within the context of a cultural system that is highly dynamic and with some (but not infinite) capacity for adaptation.

Critically relevant to a community's adaptive capacity is its collective knowledge of caribou and caribou hunting (Berkes 1999), which includes understandings of the distribution and movement of animals in response to different weather conditions (Kofinas 2002). Community ecological knowledge of caribou is local in scale, and provides an important basis for hunters' decisions about the allocation of hunting resources (time, gas, wear and tear on a snow machine) and the quantity of caribou to be

harvested. This knowledge is sustained through the practice of caribou hunting traditions (i.e. time spent hunting and being on the land), and the transmission of knowledge and its cultural traditions to younger generations.

Conditions Affecting Caribou Availability

Understanding the conditions that make for successful caribou hunting is therefore, not simply a question of sustaining caribou herds at healthy population levels, but includes consideration of a complex and interacting set of social, cultural, political and ecological factors. While environmental conditions (e.g., fall storms, snow depth, rate of spring snow melt) may affect the Porcupine Caribou herd's seasonal and annual distribution and movements (Fancy et al. 1986; Eastland 1991; Russell et al. 1992; Russell et al. 1993), so may associated environmental conditions affect hunters' access to hunting grounds (e.g., timing of freeze-up and break-up, shallow snow cover, and the presence of "candle ice" on lakes). As noted above, individual and community economic conditions affecting hunters' access to equipment and free time for hunting were also key elements. Consequently, assessing caribou availability in conditions of climate change requires an approach that is more multifaceted than standard subsistence use documentation or "traditional ecological knowledge" documentation. A partial list of the key variables important in climate change assessments for caribou subsistence systems appears in Table 1, and is drawn from the work of the Sustainability of Arctic Communities Project (See www.taiga.net/sustain).

A model of Old Crow hunting, based on local knowledge and quantitatively based socio-economic data, was constructed as part of the Sustainability of Arctic Communities Project (Berman and Kofinas submitted). The model assesses the implications of a climate change scenario that assumed later break-up conditions on the Porcupine River, an important watercourse for the intercepting caribou during the fall migration. Model runs reveal compensatory levels for households with different types of employment. Figure 3 shows the estimated compensating variation for the possible changes in work and climate patterns. The model suggests that late freeze-up costs the example household the equivalent of about half a day in lost leisure or family time. The loss is modest because caribou were not plentiful for the season in which data were available (1993), so relatively few households would have hunted even under normal climate conditions. The loss is slightly less if no one in the household has full-time work. The compensating variation for having a job turns out to be negative, and about three times as large as the cost of the late freeze-up. This result suggests that obtaining a full-time job in these conditions reduces the household's welfare because it leaves insufficient time to hunt. Had the data been for a year of more plentiful caribou, the cost would have been greater. Not captured in the model is an increased exposure to risk for hunters who attempt to intercept caribou during late freeze-up conditions, which typically include boating up river through moving ice.

The Sustainability of Arctic Community Project's Synthesis Model (Nicolson *et al*. in prep), based on the integrated assessment of 22 scientists and four indigenous

Porcupine Caribou user communities, projected the effects of a forty-year climate change scenario. Scenarios assumed included warmer and longer summers and greater variability in snow conditions, including deeper snow in winter, shallower snow in winter, and fewer "average" snow years. The results of the Synthesis Model show that the combined affects of these conditions result in a significant decrease in the herd's population (Figure 4). The Synthesis model assumes that no harvest restriction is implemented, and that intra-community sharing of caribou and community hunts is organized in years when most of the community households do not meet their target needs. In this climate change scenario, the Synthesis Model calculates that in seven years of the final decade, fewer than one half of the households meet half of their caribou needs (Figure 5).

Keeping Climate Assessment Models in Perspective

Community involvement in the Sustainability Project and documentation of local knowledge on climate change through the Arctic Borderlands Ecological Knowledge Cooperative (described in Chapter 10 (Kofinas 2002), provide insights into the challenges associated with trying to assess the impacts of climate change on subsistence caribou hunting. Despite the effort of researchers to capture the key drivers and stochastic characteristics of the systems, local review of the model points to problems because of broad regional assumptions of climate change. For example, the model assumes that warmer summer temperatures under climate change will result in an increase in insect harassment for caribou and come with an associated a cost to caribou's energy budget. Caribou hunters of Aklavik, NT, who have observed a recent increase in summer temperature, note that they have also observed an increase in summer winds, and thus, a overall *decrease* in insect harassment to caribou (Kofinas in prep). Community members from Old Crow as well as other Porcupine Caribou user communities also question a climate change scenario that assumes an increase in snow depth, since it does note capture the mosaic of landscape variation (*Ibid.*). These and other problems with models not withstanding, the involvement of local communities in an integrated assessment has been useful to all in the identification of data gaps, directing of future research priorities, and the portrayal of assessment results in ways that reflect the uncertainty and complexity of human-environment changes.

Conclusion

Local community hunters of Old Crow and many others across North America have noted an overall increase in variability of weather conditions (Jolly et al. 2001; Kofinas 2002; Thorpe et al. 2002). These observations are coupled with a self-awareness of social and cultural changes in communities. While it will be difficult to make predictions about the trajectories of future climate conditions and their anticipated impacts on caribou and caribou subsistence systems, it is clear that the variability and overall uncertainty that comes with it pose special problems for caribou hunting communities like Old Crow. Indeed, local observations of drying of lakes and lowering

of water levels in rivers, an increase in willow and birch in some areas, and shifts in migrations and distribution patterns suggest that the problems are already being negotiated. While the challenges of climate change and climate change assessment to local hunters and to researchers are considerable, there are clear opportunities for collaboration between groups to ensure sustainability of the subsistence way of life.

Table 2 Key variables when assessing climate change effects on caribou availability

Variable	Implications to climate change
Caribou population level	Decrease in total stock of animals has implication to the total range occupied by the herd; the likelihood hunters will see caribou while hunting, and management policy affecting the allocation and possible restrictions of harvests.
Distribution and movement of herd	Climate conditions are critical in caribous' selection of fall and spring migratory patterns, winter grounds, and calving locations affect community hunters' proximity to caribou.
Time for hunting; time on the land	Time for hunting emerges as an important variable as more community members engage in full-time participation in the wage economy. It is also important functionally in the maintenance and transmission of knowledge of caribou hunting.
Community demographics	Community demographics determine present and future demand for caribou. Out migration of people to distant cities may also affect knowledge base if residence outside the community is for an extended period.
Household structure	Household composition affects resources (people and gear) that can be pooled for hunting. For example, households composed of adult bachelors often serve as important providers for households with non-hunters (e.g., elders, women, full time working members who have limited time or no skill.)
Cash inputs	Cash income provides for both acquisition to gear needed in harvesting and compensation when time restrictions limit hunting opportunities. Where barter and trade allows for monetary exchange, it permits direct acquisition of meat.
Cultural value	Cultural value affects interest in caribou hunting rates of consumption, and ethics of hunting practice.
Sharing	Inter- and intra-community sharing buffers against household caribou shortfall. Indigenous belief of some state that it also ensures future hunting success.
Social organization of the hunt	Hunting as individuals or collectively in "community hunts" are strategies for successfully meeting caribou needs.
Formal state institutions for management of caribou	State institutions, such as a rural or native hunting priority, may provide to be critical when a herd is determined by

	managers to be at low levels because is sets the priority for harvesting.

11. 3. SUMMARY AND FURTHER RESEARCH NEEDS

This chapter has considered existing research on climate change impacts and has illustrated, through detailed case studies conducted in several Arctic settings, some of the most pressing issues faced by indigenous peoples today. Although the material is diverse and extensive, some common themes emerge:

- Indigenous peoples around the Arctic maintain a strong and vibrant connection to the environment through hunting, herding, fishing and gathering renewable resources.

- Hunting, herding, fishing and gathering activities provide the primary means for obtaining and producing food in indigenous communities. These practices have endured over thousands of years, with cultural adaptations and the ability to utilize resources often associated with or affected by seasonal variation and changing ecological conditions.

- Hunting, herding, fishing and gathering remain important for maintaining social relationships and cultural identity in indigenous societies. Hunting, herding, fishing and gathering activities link people inextricably to their histories, their contemporary cultural settings, and provide a way forward for thinking about sustainable livelihoods in the future.

- As the climate changes, the Arctic's indigenous peoples are facing special challenges and their abilities to harvest wildlife and food resources are already being tested. Although this chapter shows that climatic variability and weather events often greatly affect the abundance and availability of animals and thus the abilities and opportunities to harvest and process animals for food, the rate and extent of current and projected change gives cause for alarm.

- Adaptation refers to the potential to react in a way that mitigates the impacts of negative change. Becoming resilient to climate change, and preparing to respond, cope with, adapt to and negotiate climate change and its impacts, risks and opportunities will require urgent and special attention.

- Climate change cannot be understood in isolation from other environmental changes, rapid social and cultural change and globalisation processes. Arctic communities have experienced, and are experiencing, stress from a number of different forces that threaten to restrict harvesting activities and sever these relationships.

- Rapid social and economic change, resource development, trade barriers and animal-rights campaigns have all had their impacts on hunting, herding, fishing and gathering activities. The material in this chapter on the Russian North, for example, illustrates how poaching, oil development and clear-cutting of forests undermine the subsistence base for indigenous peoples.

- Arctic peoples cannot adapt, relocate or change resource use activities as easily as they may have been able to do in the past, because most now live in permanent communities and have to negotiate greatly circumscribed social and economic situations.

- Hunting, herding and fishing activities are determined to a large extent by resource management regimes, land use and land ownership regulations and local and global markets. The mobility and flexibility that indigenous once possessed to move in response to shifts in the pattern and state of their resource base is no longer possible.

- Commercial, political, economic, legal and conservation interests have reduced the abilities of indigenous peoples to adapt and be flexible in coping with climatic variability. However, for some peoples of the Arctic, the political and management systems are already in place that could assess the impacts of climate change, allow local and regional governments to act on policy recommendations to deal with the consequences, and improve the chances for indigenous peoples to deal successfully with climate change. Although complex, solutions to environmental problems are potentially realistic

The material presented in this chapter demonstrates an urgent need for a greater understanding of the scope of these environmental, social, political and economic issues and challenges in a rapidly changing milieu. The chapter is intended to be a scoping exercise as much as it is an assessment of current knowledge. The case studies have been based on extensive work in partnership with indigenous communities, and the chapter as a whole has developed with significant advice, guidance and input from the Permanent Participants to the Arctic Council.

Communities across the Arctic are culturally and economically diverse and are affected by environmental change in different ways. Such diversity also means that local experiences of climate impacts and responses to climate variability and change may not be universal. How do communities, therefore, differ in how they utilise strategies for mitigating negative change and in the effectiveness of their adaptive capacity? Given this question in mind, the case studies in this chapter illustrate the importance for research on localised, regional and circumpolar studies of socio-economic impacts of recent climate change.

The emphasis of scientific research on climate change is to assess the impacts on the environment, ecosystem processes and wildlife. One gap in knowledge is how climate change affects social relations in indigenous communities. This chapter points to this as a critical aspect of climate change research, arguing that a change in the ability of indigenous peoples to access traditional/country food resources can have a corresponding impact for the social fabric of communities. In a very real sense, therefore, the discussion of climate impacts on hunting, herding, fishing and gathering by indigenous peoples is about sustaining human/food resource relationships and activities in indigenous societies, as well as being aware that climate change impacts pose a threat of severe and irreversible social changes. The case studies in this chapter illustrate the complexity of problems faced by indigenous peoples today and underscore the reality that climate change is but one of several problems affecting their livelihoods. Clearly, research should place emphasise on understanding climate change impacts within a broader context of rapid, social and economic change.

Future research on climate change should acquire a deeper understanding of what exactly forms the basis for the social, cultural, political and economic viability of Arctic communities, and attempt to explore the research priorities highlighted by communities themselves. Significant and promising new research initiatives are currently underway that promise to break new ground in contributing the knowledge needed to formulate climate change impact assessments, national policies and adaptation strategies, including the major U.S.-led SEARCH (Study of Arctic Environmental Change) and the Canadian ArcticNet programmes.

The case studies in this chapter have been selected to provide a sense of climate change impacts on indigenous communities and their livelihoods. It has not been possible to provide circumpolar-wide coverage of the situation for all indigenous peoples. Indeed, there is a paucity of good material to do this, especially for the situation in the Russian Arctic.

Part of the purpose of this chapter, although not its primary aim, is to assess what adaptations have enabled communities to succeed in the past and what extent these options remain open to them. There is little data published on this area, but based on what is available the chapter shows that while indigenous peoples have often adapted well to past climate change, the scale and nature of current and predicted climate change brings an altogether different sense of uncertainty for indigenous peoples and presents different kinds of risks and threats to their livelihoods.

Is an ability to respond and cope with climate change, mainly by adjusting subsistence activities, a reliable indication of an ability to adapt in the future? Research is needed on understanding how much change can be accommodated by the existing ways of life of indigenous peoples. Case studies in this chapter have pointed to the *resilience*, or the amount of perturbation that the resource use systems of indigenous peoples can absorb, and how they can adapt by learning and self-organization. The question of resilience is important and further research is needed because little is known about building adaptive capacity in the face of climate change.

Further research is also needed on co-management and governance institutions and whether they can create additional opportunities to increase resilience, flexibility and the ability to deal with change. How can, for example, new governance mechanisms help indigenous peoples negotiate and manage the impacts of climate change? With a capacity-building strategy now being a key objective for the Arctic Council, tremendous opportunities exist for co-operation and constructive dialogue on dealing with climate change between communities, organisations, institutions and governments at circumpolar and wider international levels.

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