LAND USE AND CLIMATE CHANGE: An Assessment of Climate-Society Interactions in Aklavik NWT.

by

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ABSTRACT

The relationship between climate and society has been studied in Aklavik NWT. in order to illustrate the impact of climate upon the community in general, and to determine the impacts of a warmer future climate. The climate impact assessment literature has revealed a lack of study on the impacts for human settlements, especially in regions such as the Canadian North where Aboriginal peoples continue to rely on subsistence activities. A methodology for studying the community of Aklavik has been explained as well as a review of previous climate impact assessment. Historic and pre-historic settlement of the North American Arctic has been examined to illustrate the relationship between human settlement of northern regions and changes in the regional climate. Aboriginal settlement in the Mackenzie Delta area has been further examined to illustrate both the historic and present use of the land for subsistence activities(hunting, trapping and fishing) by these peoples. A detailed examination of the community of Aklavik revealed a pattern of land use consistent with that of previous generations. These activities were found to be very important for the community as subsistence activities are considered to be a strong form of cultural affirmation. Perceptions of community members to climatic change were examined and revealed a large number of individuals unfamiliar with global warming. Most people do feel that there have been

changes in the regional climate with winters becoming warmer and summers hotter. However, the prevailing attitude is that such changes are due to natural climatic variation rather than anthropogenically-induced climatic change. Given present trends in the community, two future scenarios were proposed centred upon; 1) a continuation of subsistence activities; and 2) a decline in subsistence activities coupled with increased economic development. Future climate warming will produce both positive and negative impacts for the community, with the most serious being impacts upon the biological systems of the region. However, a lack of information dealing with these systems makes future predictions unreliable. The community does appear to be quite resilient to changes in climate. Given time to adapt to changes in the region's biological systems, the negative impacts of climate change can be reduced.

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For the Elders of Aklavik, who offered me a glimpse into a way of life soon to be gone.

INTRODUCTION

On December 31, 1992, most of Canada was caught in the midst of a persistent Arctic air mass which brought temperatures well below seasonal norms to the west coast, the prairies and central Canada. While the city of Calgary coped with daytime temperatures below -30°C, the west coast, which generally experiences temperate winters, was enduring unusually large amounts of snowfall and temperatures below 0°C. At the same time the community of Aklavik NWT., on the western side of the Mackenzie River Delta just above the Arctic Circle, was experiencing temperatures ranging from 1° to 4°C. As the snow became wet and heavy in the above freezing temperatures, the people of this community began to wonder what they would do with the large amounts of meat they had on hand which would quickly spoil in the above zero temperatures. During the winter months, meat which does not fit into home freezers and the large community freezer is left outside where it remains safely frozen for several months. The owner of the general store had about 1000kg of caribou and beluga meat outside in his yard, which would no longer be of any use if thawed. The unusual temperatures continued for two weeks before falling consistently below 0°C again, but not before a large amount of the winter food supply had spoiled.

This was not the first time that warm winter temperatures have caused difficulties for the community of Aklavik. Typically, the community experiences five months of continuous sub-zero temperatures and is accustomed to operating within these particular climatic circumstances. However, there are a number of people in Aklavik - and

elsewhere - who question whether such warm periods are the result of natural climatic variability, or perhaps an overall climatic trend towards warmer temperatures.

Whether this warm period can be attributed to a general climatic change cannot be said with any precision. A number of climatic events during the 1980's have lent credibility to the notion that the earth's climate may becoming warmer due to human activities. The warmest year on record was 1988, and three other record-setting periods have all taken place in the 1980's (Glanz, 1988). These events have placed the issue of global warming at the forefront of environmental awareness and have created controversy over whether or not the earth's climate is actually changing.

At the present time, there is general scientific acceptance of a "greenhouse effect", and it seems likely that human activities are indeed capable of altering the global climate (Canadian Climate Program Board, (CCPB) 1991). However, one of the main issues which must be addressed in climate change studies - whether or not the general warming is due to anthropogenic or natural causes - is what effect a warming trend will have on human communities. Given the uncertainties involved in predicting the future global climate, it has become more important at this time to improve our understanding of the interrelationships between climate and society in general. It is well understood that climate is always changing as part of natural variation. Human societies exhibit constant change as well. Therefore, it is important to understand how societies can cope with climate variability at present, in order to better understand how we might adapt to greater climatic variability and change in the future (Glanz, 1988).

This research contains four primary objectives:

1) To understand whether the residents of a northern community - Aklavik, NWT - are familiar with climate warming, and what their perceptions are towards it. Meeting this objective involves assessing the importance of climatic conditions to the community of Aklavik, and gaining insight into aboriginal peoples' knowledge of climatic change.

2) To determine, through discussions with residents, how aboriginal lifestyles are affected by climatic conditions. This includes aspects such as their hunting, trapping and fishing, transportation, social activities and community cohesion.

3) To determine the ability of the community to adapt to a potentially warmer climate. This involves assessing the extent to which the activities of the people of Aklavik are flexible enough to accommodate a warmer climate and greater climatic variability without adversely affecting the lifestyle of the residents.

4) To conduct a case study of a primarily aboriginal community which is thought to be sensitive to changes in climate, and to illustrate the validity and utility of the traditional environmental knowledge held by aboriginal peoples in assessing the potential impacts of climate change in their environment.

These objectives are based on the premise that the future climate may well be different from that of today, and in order to be prepared for this change, we need to know how well society will respond to climatic change and variability and what social and environmental impacts may occur. In addressing these issues, this project focusses on a case study of the community of Aklavik NWT, which is a predominantly aboriginal settlement in the Mackenzie River Delta. Aklavik is a remote community and its inhabitants rely on traditional hunting, trapping and fishing as their primary activity. This research will describe the perceptions and knowledge of climate and climate change held by individuals in the community, and illustrate the interrelationships between climate and land use. To better understand the implications of climate on the region's history, the historical settlement of the area will be discussed along with an explanation of how climate acted as a major determinant in the location of northern peoples and their

particular cultural adaptations. Finally, aspects of the community which may be vulnerable to future climate changes will be identified, based on the present day interdependencies between climate and the land.

The significance of this work lies in two areas. First, there is a need to better understand how aboriginal peoples may be affected by climate change and how they may be able to adapt to a warmer climate. The second is the importance of conducting research in a manner which draws upon the experiences and knowledge of aboriginal peoples, and includes them in the research process. The significance of such a process lies in its acknowledgement of the historical inequities of aboriginal-white relations in Canada and subsequent attitudes towards research with aboriginal peoples. This research recognizes the validity of aboriginal traditional knowledge and uses it as a primary source of information.

Assessing the social impact of climate change touches upon two issues which deserve further attention: contributing to the field of climate impact assessment in Canada, which has so far neglected the impact on aboriginal peoples; and conducting research with aboriginal peoples. Policy responses to climate change have focused predominantly on mitigation or limitation strategies (Standing Committee on Environment (STOE), 1991; NAS, 1991; Pearce, 1989, 1991) which dictate a variety of strategies to reduce greenhouse gas emissions. Adaptation strategies have received limited attention because it is necessary first to assess the impacts of climate change in a region and then determine its adaptive capability. The primary reason for this is that impact assessment has usually been done on a sector-specific basis. It is much simpler to evaluate the sensitivity of

plants, agriculture, forests, coastal environments, water resources, industry, energy development, human settlements, health and political tranquility in isolation from one another. It is much more realistic - and difficult - to evaluate these factors together in a more holistic perspective showing cumulative effects.

One response to this has been the call for a new direction towards integrated regional studies of the impacts of climate warming in selected regions of Canada such as the Mackenzie River Basin, the Great Lakes Basin and the Prairies/Great Plains (CCPB, 1991). These comprehensive regional studies include a variety of economic, social and environmental factors and feedbacks. Such an approach avoids separating various components of the human and natural systems, and should lead to more appropriate response strategies. The Mackenzie River Basin study (MBIS) has been initiated by the federal government and the results of this research will be included in that study.

The MBIS is a six-year multiagency interdisciplinary research project which intends to produce an integrated regional assessment of the potential impacts of global warming scenarios on the Mackenzie River Basin. Research activities within this study include climate scenarios, hydrologic conditions, soils and surficial geology, terrestrial ecosystems, energy development, transportation and infrastructure, settlements, agriculture and tourism. This thesis will help to provide baseline data concerning impacts on aboriginal settlements, as well as to allow for the concerns of aboriginal people to be revealed.

Chapter one provides an overview of the present understanding of climate change. The greenhouse effect and future climate scenarios are explained as well as projections

of climate change derived from General Circulation Models and composite scenarios. Finally, implications for climate change in Canada's North are described with an explanation of why the North may experience greater climatic variability than more southern latitudes. Chapter two discusses previous work in the area of climate impact assessment and identifies gaps in the research that has been conducted to present. The need for community based social impact assessment is explained in conjunction with the need to involve northern peoples and their knowledge of the environment into such work. Chapter three describes the objectives and methodology proposed for this research and how the methodology was used in the field. The formation of the methodology used for this research is explained as well.

Chapter four provides an overview of the historic and pre-historic settlement of the Canadian North with emphasis on the western Arctic. The role climate has played in determining where northern peoples settled and how they have adapted to their environment is explained, along with a description of differences in the northern climate since indigenous settlement has occurred. Chapters five and six describe the community of Aklavik, its people and history. The spatial extent of community land use and the annual cycle of land based activities are described. The perceptions and knowledge of the community to both climate in general, as well as to climate change are described, and an identification of areas where the community may be vulnerable to changes in the future climate is provided. Future scenarios for Aklavik are discussed in terms of the types of development which may take place in the future and how these may be affected by changes in the regional climate. Finally, the ability of the community to adapt to change

is discussed in terms of possible future climates, based on changes that have occurred in the past.

Chapter One

INTRODUCTION TO CLIMATE CHANGE

A brief overview of the basics of climate change will be presented here. In particular, climate warming and its determinants will be described: greenhouse gases, atmospheric composition and General Circulation Models (GCMs). Possible policy responses such as mitigation and adaptation will be explained. Finally, an explanation of climate change in the North will provide the context for this study of the relationships between climate, climate change, and land use in the community of Aklavik.

The Greenhouse Effect

The primary concern for climate change at present is the possibility of a future increase in the annual mean global temperature, commonly referred to as global warming. Emphasis has been on an increase in the earth's average temperature due to what has become known as the greenhouse effect. This effect is based upon the radiation balance of the earth. The basic mechanisms for this balance are illustrated in Figure 1.

In a steady state system, the overall incoming solar radiation at the top of the earth's atmosphere is balanced over the long term by the output of radiation from the top of the atmosphere to space. The events that take place in between the top of the atmosphere and the earth's surface are more complicated. Of the total incoming incident

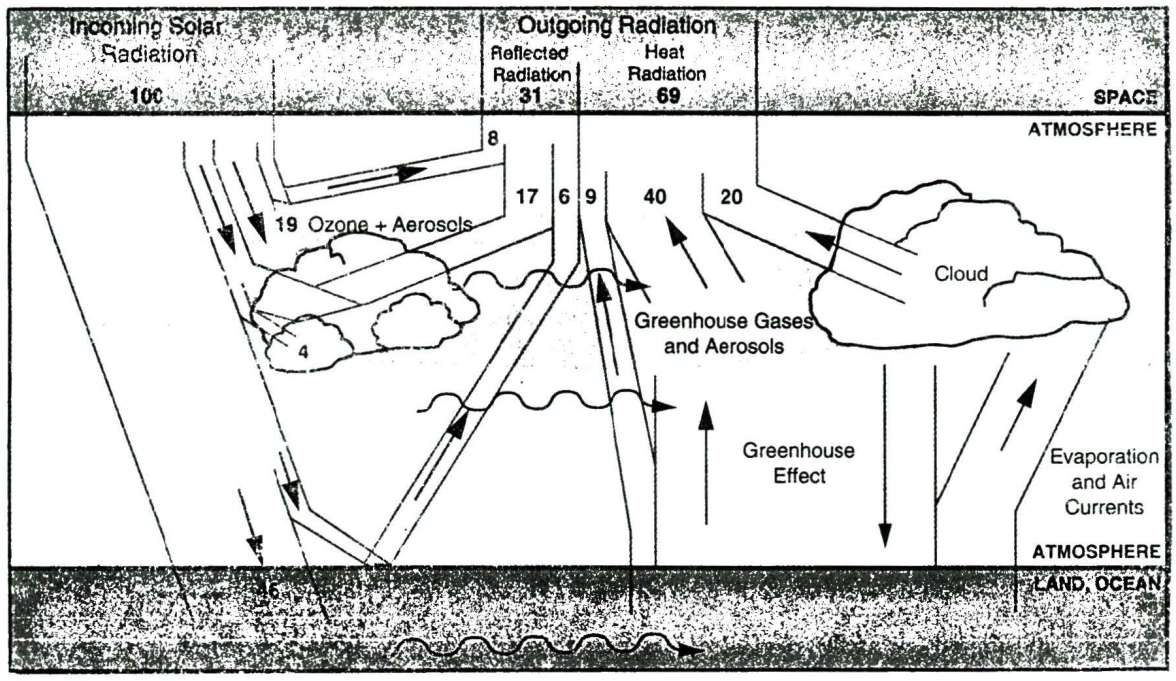

Figure 1 The greenhouse effect (CGCP, 1993:19)

solar radiation, about 25% is reflected back into space by the atmosphere. Another 25% is absorbed by atmospheric gases, 5% is reflected into space from the earth's surface, and 45% is absorbed by the oceans, land, and biotic material.

Evaporation and mechanical heat transfer introduce energy equal to about 29% of incident radiation into the atmosphere. Radiative energy emissions from the earth's surface and the atmosphere are determined by the temperature of the earth's surface and the atmosphere, respectively. Energy radiated upward from the earth's surface is about 104% of incident radiation. Atmospheric gases absorb part of the radiation penetrating the top of the atmosphere and all of the mechanical heat transferred from the earth's surface and the outbound radiation from the earth's surface. Downward radiation towards the earth's surface is about 88%, and outgoing radiation is about 70% of incident solar radiation (National Academy of Sciences (NAS), 1991).

It is important to note that amounts of radiation balance at the earth's surface, the atmosphere, and the top of the atmosphere. For example, 45% absorbed at the earth's surface plus 88% absorbed from downward radiation, is equal to the 104% upward radiation from the earth's surface, and the 29% from evaporation, and mechanical heat transfer. This implies a relatively steady state in the radiation balance. If there were to be an increase in the amount of radiation absorbed in the atmosphere by atmospheric gases, then the upward and downward radiation (black arrows) would not balance, resulting in a greater amount of radiation cycling between the earth's surface and the atmosphere. Certain atmospheric gases (collectively termed "greenhouse gases") are able to trap radiation near the earth's surface as they are relatively transparent to near-infrared

wavelengths which carry incident solar radiation, but are capable of more efficiently absorbing the longer infrared wavelength emitted by the earth. Most of this energy is radiated back to the earth's surface; therefore, an accumulation of atmospheric gases can lead to the accumulation of energy between the earth's surface and the atmosphere. This energy expresses itself in the form of heat.

Greenhouse Gases

There are seven greenhouse gases; water vapour, carbon dioxide (CO_2), methane (CH_4), chlorofluorocarbons (CFCs), hydrogenated chlorofluorocarbons (HCFCs), ozone (O_3), and nitrous oxide (N_2O). Without naturally occurring greenhouse gases the earth's temperature would be about 33°C colder (NAS, 1991). The gases of concern in the global warming are those produced or increased by human activity. Human activity has caused increases in atmospheric concentrations of CO_2, CH_4, and CFCs since pre-industrial times. Given the previous explanation of the earth's radiation balance, it is projected that increases in these gases from human activities may cause an increase in mean global temperature. The atmospheric concentration of CO_2 in 1990 was 353 parts per million by volume (ppmv). Prior to the Industrial Revolution (1750) the concentration of CO_2 was about 280 ppmv, for an increase of about 25%. The concentration of CO_2 is increasing at a rate of about 0.5% per year. Concentrations of CH_4 were 1.72 ppmv in 1990, which is about double that for the period prior to 1750. CH_4 concentrations are increasing at a rate of 0.9% per year (Standing Committee on Environment, 1991). CFCs are not naturally occurring and have only been detected since their development in the

late 1950's . CFCs have been found to be particularly damaging to atmospheric ozone, and there have been calls to ban all production and uses of CFCs by 1997 (IPCC, 1990). Table 1 provides a summary of greenhouse gas characteristics, and their changes in concentration from pre-industrial times.

Table 1 **Summary of key greenhouse gas characteristics**

	Carbon Dioxide	Methane	CFC-11	CFC-12	Nitrous Oxide
Atmospheric concentration	ppmv	ppmv	pptv	pptv	ppbv
Pre-industrial (1750-1800)	280	0.8	0	0	288
Present day (1990)	353	1.72	280	484	310
Current rate of change per year	1.8 (0.5%)	0.015 (0.9%)	9.5 (4%)	17 (4%)	0.8 (0.25%)
Atmospheric lifetime (years)	(50-200)*	10	65	130	150

ppmv = parts per trillion
ppbv = parts per billion (thousand million) by volume
pptv = parts per trillion (million million) by volume
* The way in which CO_2 is absorbed by the oceans and biosphere is not simple and a single value cannot be given.

(IPCC, 1990:5)

General Circulation Models

A number of different scenarios have been developed which depict the earth with a higher average temperature in the near future. These scenarios have been generated by general circulation models of the atmosphere (GCMs), which produce projections from

various scenarios of greenhouse gas concentrations. While these models are the best existing tools to predict changes in global climate patterns, they are not without drawbacks. GCMs are extremely elaborate computational schemes which are able to combine empirical observations, known scientific laws, and implicit representations of the global climate. These models are highly complex and require large amounts of data to be effective. Any mechanisms operating on scales smaller than the smallest elements of the atmosphere, land, or oceans resolved in the GCM are represented by mathematical equations called "parameterizations". A typical GCM will involve hundreds of thousands of equations and dozens of variables (NAS, 1991).

GCMs typically include three main components; a GCM of the atmosphere, a heat and water balance model of the continents, and a mixed layer model of the ocean. The model is run with a specified level of CO_2 until a steady state is achieved. Most models are based on a doubling of CO_2 from pre-industrial levels, about 500 ppmv (parts per million volume), which, if rates of increase remain constant, will be reached in the early to mid-21st century. The results are then compared with a control model to observe changes in a CO_2 enriched world (Palutikof, 1986).

There are however, a number of problems which restrict the use of GCMs for accurate projection of future regional climates. The first is that because of the complexity involved, simplifications are required to allow the models to work within present computational systems. For example, one such model has a prescribed seasonal cycle for cloud cover, and no allowance is made for heat transport by ocean currents (Palutikof, 1986). Such simplification of the real world implies that the resulting computational

resolution may well be unsuitable to provide details of seasonal variations in climate, and smaller regional climates cannot be represented.

Another problem lies in the assumption that there is a steady state in climatic concentrations of greenhouse gases. GCMs are run until a steady state is achieved, whereas in reality, climate is a dynamic process. In actual atmospheric events, there is not an initial period of increasing CO_2 followed by a secondary period where an equilibrium level is allowed to form. Actual increases are continual, and responses of the climatic system will always lag behind due to the effect of the oceans which act as a sink for CO_2 (Palutikof, 1986).

Another concern is the uncertainty of influences such as ocean circulation, hydrologic interactions and cloud cover feedback. These systems are all highly dynamic and are extremely difficult to model accurately due to their temporal variation. Because of this, current GCMs lack adequately validated representations of these factors. As well, it is not known exactly how much influence the ocean has upon atmospheric carbon dioxide. It is known that different ocean layers do act as a sink for CO_2, but this is complicated by the influence of currents and quantities of phytoplankton (NAS, 1991).

Furthermore, there are only about two dozen GCM simulation runs with six independent models on which to base conclusions. Each one of these simulations incorporates various untested and unvalidated hypotheses. As a result, there may be variations that current calculations have not yet revealed. For example, present computer runs exhibit important differences in the treatment of clouds. All runs examined yielded similar results for a clear sky absent of cloud cover. However, their results vary

considerable when clouds are included (NAS, 1991). This results in the current situation of there being too few runs to determine the most likely values within the temperature range, and the possibility of not being able to eliminate temperature changes of less than 1°C or greater than 5°C.

What GCMs have shown is that when operated under the assumption of a doubling in atmospheric CO_2 concentrations from pre-industrial levels, there is a range of global average equilibrium temperature increases from 1.9° to 5.2°C (NAS, 1991). Different GCMs have shown temperature ranges slightly greater and less that this range, but based upon current GCMs, it is reasonable to accept an increase in average global equilibrium temperature of 1° to 5°C. There have been a variety of simulations conducted under different circumstances. Some have no cloud interactions, some have only a simple heat sink in place of oceans, and some have no distinction between day and night. The results have all been very close to the accepted 1° to 5°C range.

Given the limitations of GCMs, it can be seen that they do not provide absolute proof in their projections; however, no model does. They do model seasonal cycles of surface temperature very well, and are able to simulate daily and annual variability in air pressure patterns over large areas. Most models can now depict the broad features of wind patterns and realistic simulations of winter and summer jet streams in the lower stratosphere (NAS, 1991).

The utility of GCMs is to provide a range of temperatures which, given the best information and techniques available at the present, represent a likely outcome under conditions of a doubling in atmospheric carbon dioxide concentrations. It is quite likely

that CO_2 concentrations will double by the middle of the next century if present rates of CO_2 production are not reduced. The temperature increases projected by GCMs do little to provide information on regional or local changes in climate, which are most important for policy and decision makers. Factors of great importance for planning in the presence of climate change are local events such as timing and amount of precipitation, frequency of flood events, and wind and temperature extremes. Important factors for the natural environment such as frost free days, soil moisture content, and timing of exceptionally hot or cold days are far more significant than overall average temperature. However, based on the projections produced through GCMs it is still possible to produce rough assessments for these factors.

International Consensus on Climate Change

Despite the inability of GCMs to deliver precise predictions for future climates in local and regional areas, there is general consensus at the international level concerning the future of the global climate (Burton, 1992; CCPB, 1991). The existence of the greenhouse effect is real and well understood based on established scientific principles (CCPB, 1991). Naturally occurring greenhouse gases keep the earth warm enough to support life, but the continued increase of these gases from human activity and the addition of other gases such as CFCs may act to raise the global annual-mean surface air temperature. Uncertainty exists though, as to the precise rate at which this will occur (CCPB, 1991).

Acceptance of the greenhouse effect is aided by the fact that greenhouse gases have changed naturally over tens of thousands of years, and ice-core samples show that the earth's temperature closely follows that of the concentrations of CO_2 and methane in the atmosphere (Barnola *et al.*, 1987). Changes in the composition of these gases from human activity have taken place over the past 150 years. Carbon dioxide levels are about 50 ppmv higher than they have ever been, and methane is approximately double its pre-industrial level.

Based on a combination of current GCM results and a "business as usual" scenario, where nothing is done to limit human sources of greenhouse gases, the Intergovernmental Panel on Climate Change (IPCC) concluded that the average rate of increase in global mean temperature over the next century is expected to be about 0.3°C per decade (IPCC, 1990). This will result in an increase in global mean temperature of 1.0°C by about 2025, and 3.0°C by the end of the next century (IPCC, 1990).

Changes in atmospheric concentrations of the long-lived, or persistent gases (CO_2, NO_3 and CFCs), adjust very slowly to changes in emissions. Therefore, any change made immediately still commits the earth to increases in these gases for decades or centuries. This means that the longer emissions continue to increase at present rates, the greater the reductions of these emissions will have to be in order for concentrations of these gases to stabilize at a certain level. For example, if a 2% annual reduction in CO_2 were introduced in 1990, atmospheric concentrations would stabilize at 390 ppm (parts per million) by 2040. If the same 2% annual reduction were not introduced until 2010, concentrations would not stabilize until 2090, at which point they would have reached

about 460 ppm (CCPB, 1991).

Policy Implications for Canada

Given strong international consensus on the phenomena of greenhouse warming, there are two broad policy directions which can be taken to deal with climate change: mitigation and adaptation. *Mitigation*, or limitation strategies, deal with reducing greenhouse gas emissions at their source. These include a wide variety of factors which may reduce greenhouse gas emissions directly, such as cleaner technology at a coal burning electrical generating station, or indirectly, through conservation measures which reduce the demand for electricity from that same coal burning station.

Policy decisions aimed at mitigation are quite varied. An example of the extent of policy decisions is illustrated by the policy recommendations made to the Canadian Federal Government by the House of Commons Standing Committee on the Environment (STOE, 1991):

. Energy Policy Formation:
  - should be at the forefront of policy considerations
  - centred on greater efficiency and conservation
  - substitution of fuels for less harmful ones

. A 20% reduction in human sources of CO_2 based on 1988 levels, by the year 2005

. Reduce energy use by 2% each year until CO_2 levels have stopped accumulating.

. Increase the availability of public information on ways to decrease greenhouse gas emissions.

. Base reductions of greenhouse gases on regulatory systems as well as utilizing

market forces.

. Increased Research and Development:
  - for greater energy efficiency and conservation
  - development of substitutes for polluting fuels
  - technology for using fossil fuels in less harmful ways

. Export clean technology to developing countries.

. Use environmental considerations as a filter for foreign trade and aid policies.

. More efficient use of electricity

. Fuel efficiency standards for cars and trucks

. Research and development of more efficient fuels.

. Forestry:
  - ensure that all lands not restocked are replanted
  - plant trees in suitable areas
  - reduce the total amount of deforestation

. Phase out production and new consumption of all CFCs by 1997.

Implementation of these policy recommendations would result in the decrease or elimination of greenhouse gas emmissions into the atmosphere through a variety of different means.

A 20% reduction in the 1988 levels of CO_2 emissions by the year 2005 is not a simple task because it must be decided where that 20% reduction is to be found. It is not just a matter of a 20% reduction across all sectors of the economy; rather, there will have to be careful consideration to which areas of the national economy must be targeted for a reasonable reduction, without harming the economic activity involved.

Mitigation measures are also subject to debate on what mechanisms are most appropriate to achieve emission reductions. Are standard regulatory approaches best, or should a market based incentive system be used? The point to be realized here is that

although there are a number of ways known to limit emissions of greenhouse gases, implementing these systems on a worldwide scale which is equitable will be an extremely difficult challenge for the international community. If any changes are to be effective on a global scale, mitigation measures such as those recommended by the STOE must be adapted on a global level. This becomes difficult because many developing nations are simply unable to implement such measures without seriously restricting their own development. The task then becomes how to implement changes at the global level, which still accommodate the interests of the developing world (Agarwal, 1991).

Adaptation strategies are those that help humans to cope with changes imposed upon us. These are not concerned with the cause as much as they are with the effect. In the case of climate warming, the previous discussion has shown that for every day in which no action is taken to reduce greenhouse gas emissions, we commit ourselves to a greater amount of warming in the future. It can be seen that even if action is taken today, we will still be confronted with some future warming due to the time lag involved and the persistence of certain greenhouse gases in the atmosphere. Given that there will be some degree of warming in the future, it is important that policy considerations include not only reducing greenhouse gas emissions, but also in dealing with the amount of warming we have already committed ourselves to by waiting this long to take action.

There are a number of possible adaptation responses. These include: (1) modifying the hazard, such as channelling rivers that are prone to flooding; (2) preventing or limiting impacts by building dykes for example; (3) moving or avoiding the loss, such as by implementing floodplain zoning; (4) sharing the loss, such as by providing

insurance; and, (5) bearing the loss, such as by losing all or part of a crop (NAS, 1991). Thus it can be seen that there are a variety of ways to adapt; some can be implemented prior to an event, and some are best suited after an event has happened.

Developing an adaptive strategy is difficult because it is necessary first to assess both the potential impacts of climate change in a region, and the region's adaptive capacity. There are a number of factors involved. Assessing impacts has usually been done by individual assessment. It is much simpler to evaluate the sensitivity of plants, agriculture, forests, coastal environments, water resources, industry and energy, human settlements and health, and political tranquillity in isolation from one another. In reality, it is much more realistic and practical to evaluate these factors together in a more holistic perspective. This becomes problematic because it stresses the linkages between these systems, and this type of interactive and integrated research is not easily achieved.

Another factor of importance is the sensitivity of human activities and nature. Many human activities are capable of adapting to a warmer climate, however, natural ecosystems adapt slowly over time to changes in the environment. This comparison does not relate the amount of interconnectedness between the natural environment and human activities. If the natural environment cannot adapt, or adapts very slowly, how easily can human activities adapt, especially when there is strong dependence by human societies upon the natural environment? One response to this has been the call for a new direction towards integrated regional studies of the impacts of climate warming in selected regions of Canada such as the Mackenzie Basin, the Great Lakes Basin, and the Prairies/Great Plains (CCPB, 1991). These comprehensive regional studies should allow for the

inclusion of a variety of economic, social and environmental factors and feedbacks. Such an approach would avoid separating various components of the human and natural environment which should not be viewed individually if we are to develop appropriate response strategies. Similarly, these regional studies should also consider the role of adaptation to natural climatic variability. One way to assess how human societies may cope with future climatic variability and change, is to assess how current societies cope with natural climatic variability.

Implications for Northern Canada

Under a "business as usual" scenario, in which no response is taken to mitigate sources of greenhouse gases, there are a number of probable impacts which will affect Canada's North. A primary concern is that temperature increases are projected to be 50-100% greater than the increase in global mean temperature in high northern latitudes during winter, and substantially less than the global mean in sea-ice regions during summer (IPCC, 1990). As well, precipitation is projected to increase on average in middle to high latitude continents in winter by 5-10%. This implies winters of shorter duration in the North, but with a greater amount of snowfall during the winter period. Summer temperatures will rise, but to a lesser extent than those at lower latitudes. More specific possibilities for the North have been compiled from Roots (1989a) and CCPB (1991):

. High latitude watersheds such as the Mackenzie would probably exhibit higher streamflows and floods during the snowmelt season.

- A shift in forest species northward, and a possible northern shift in the treeline.

- Melting of permafrost which would affect physical structures and pipelines. Fish habitat could be altered by permafrost melt. Slow permafrost decay and thickening of the active layer would result in increased land instability in discontinuous zones.

- The Arctic shipping season would be longer for water routes with a shorter season for transport over winter ice roads.

- Movement of storm tracks northward may result in an increase in Arctic precipitation,especially in fall/winter. Snow seasons would be shorter but accumulation would be greater, causing flooding in Arctic and subarctic rivers.

- Ice duration would be shorter and thickness of the ice would be less.

- Changes in wildlife habitat and migration routes.

- Increased sea level will cause coastal erosion and degradation of shorelines. Low lying areas may become permanently flooded.

Before explaining the importance of climate to native peoples in the North, it is necessary to gain an understanding of factors contributing to the northern climate. Typical perceptions of the Arctic are related to ideas of harsh living conditions in a predominantly cold climate. It is well known that the biodiversity of the Arctic is quite limited when compared to more southern latitudes, and the entire region is considered to be a fragile ecosystem, unable to compensate for changes the way more diverse, southern ecosystems can (Rizzo and Wiken, 1992).

There are three basic phenomena which influence Arctic climate: the planetary heat flux; the geographical asymmetry of the planet; and the role of snow and ice.

The Surface Heat Flux

In the Arctic, solar radiation is received at a very low angle. In winter, no direct radiation may be received at all and heat is lost to outer space from the top of the atmosphere. In polar regions, there is a net loss of energy mainly in the form of long wave radiation from the tops of clouds and layers of stratospheric ice crystals. The loss of energy is made up through the transport of heat from low latitudes by atmospheric circulation and ocean currents. This makes the Arctic region highly dependent on the north-south transport of heat by atmospheric currents and the heat trapping effects of clouds and greenhouse gases (Roots, 1989a). Any changes to the global energy balance or circulations which may have an effect on these transport mechanisms may have an exaggerated effect on the climate of the Arctic.

Planetary Geography

The natural asymmetry of the earth has placed most of the land masses and oceans in the northern hemisphere. This grouping of land masses towards the north end of the planet has created a unique set of circumstances for the Arctic. Unlike the Antarctic which is surrounded by oceans, the Arctic is comprised of the tops of two large continents surrounded by a small ocean which has restricted communication with the other world oceans. This planetary asymmetry affects the Arctic because heat delivered by the oceans comes into arctic regions through only one point - the northeast Atlantic. The energy carried here keeps the surface from freezing even to the north of Svalbard (Lat 82°N). The atmospheric route delivers much less energy to the North, generally through well

known storm tracks that pick up energy from mid-latitude oceans and land masses on an east-west flow.

The importance of these energy transfer routes can be seen when one ignores the typical Mercator projection of the earth, and visualizes it as it actually exists on a globe. The Arctic is a small area of the earth's surface, only one tenth the size of the earth's tropical regions, and very vulnerable to changes in the rest of the planet due to the direction of energy flows (Roots, 1989a, 1989b).

Snow and Ice

The annual surface air temperature in the Arctic is below 0°C. This means that the water on the land, in the air, and in the ground, is more often frozen than not. This has profound effects on the climate of the area due to a number of factors: (1) The cover of snow on the ground increases the albedo, or degree of reflectance. The amount of incoming energy which is already low, is further reduced by the efficient reflectance of the snow surface; (2) Most of the energy gained at the earth surface is used for phase change - melting, freezing or sublimation - rather than contributing to temperature change. Therefore, there is a significant temperature lag when compared to energy transfers in lower latitudes. Even though the most energy is absorbed in June, the highest temperatures are not seen until July or August in most parts of the Arctic; (3) Low level clouds are composed of ice crystals rather than water droplets. This condition alters the ability of clouds to absorb and transport pollutants and changes the ability of clouds to transmit and reflect energy of different wavelengths (Roots, 1989a).

These factors result in the climate which we commonly associate with the Arctic today. Thus, the long-term climate appears to be influenced by temperatures in the Gulf Stream and the north Atlantic, while the short-term climate appears to be influenced by changes in currents of the north Atlantic and Pacific oceans, and atmospheric flows over mid-continental regions. Therefore, climatic changes in the different non-Arctic areas of the world may produce profound effects on the climate of the Arctic region.

Impacts for Northern Peoples

Aboriginal peoples in Canada continue to maintain links to lands which they have occupied, despite changes imposed upon them by southern society. This attachment to the natural world is an acknowledgement of the importance of the environment to the traditional lifestyle of native peoples. Aboriginal cultures and societies have evolved within the cycle of the natural environment, and are inextricably linked to a set of natural conditions which have shaped their way of life. Given the relationship between climate and activities such as trapping, hunting and fishing, it is obvious that any change in climatic conditions may have profound impacts upon traditional native societies.

The importance of the climate on aboriginal peoples in the Arctic can be best illustrated by the importance of the natural environment in their traditional lifestyle. In often eloquent testimony, aboriginal peoples explain their relation to the land:

> Our Dene Nation is like this great river [the Mackenzie]. It has been flowing before any of us can remember. We take our strength, our wisdom and our ways from the flow and direction which has been established for us by ancestors we never knew, ancestors of a thousand

> years ago. Their wisdom flows through us to our children and our grandchildren, to generations we will never know. We will live out our lives as we must, and we will die in peace because we will know that our people and this river will flow on after us.
>
> We know that our grandchildren will speak a language that is their heritage, that has been passed on from before time. We know they will share their wealth and not hoard it...We know they will look after this land and protect it, and 500 years from now, someone with skin my colour and moccasins on his (sic) feet will climb up the Ramparts and rest, and look over the river, and feel that he, too, has a place in the universe, and he will thank the same spirits that I thank, that his ancestors have looked after his land well, and he will be proud to be a Dene.
>
> Frank T'Seleie, Chief of Fort Good Hope (Berger, 1977:145).

Aboriginal peoples have also expressed their concern over changes in the climate and how it may affect them:

> Our skills on the land, our hunting, trapping and fishing, and ability to survive are what give my people confidence. Our life on the land is the root of Gwich'in culture. Our society will survive as long as we can hunt, eat caribou, fish, trap, and sell our furs...If these things happen [climate warming], our society would be threatened. If our men are not able to hunt, those who do not have jobs or the means to look after their families will lose their self respect. (Climate Institute, 1990: 114-115).

The health of the land is of great importance to native peoples because without it they feel their culture will be lost. Any change in climate may have serious effects on natives in the North because if the wildlife they hunt, trap and fish are effected by a warmer climate, this may disrupt the natural balance which they have adapted to over thousands of years.

Research done to better understand how climate warming may impact the North must take into account the position of the natives peoples of the region and how they utilize the land as both subsistence and economic activities are dependent on the land for

their survival. Environmental conditions relating to climatic change must be considered along with social changes that may impact native peoples. Research done for policy measures must be aware of how native societies will be affected by the environmental impacts of climate change.

The North is a critical area to study not only because of its fragile ecosystem, but also because of its unique human environment. Many aboriginal peoples in the North continue to rely upon the land for their traditional pursuits of hunting and trapping. The views and knowledge held by these northern peoples are important for research on climate change because they have the potential to be adversely affected by a warmer climate, and their own knowledge of the natural environment can be of great importance for determining how changes in the climate may affect their lives and their environment.

Chapter Two

EXISTING WORK IN CLIMATE IMPACT ASSESSMENT

Climate impact assessment is a recent addition to a family of interdisciplinary studies that focus on the interaction between nature and the human environment. Kates (1985:4) states that given the interdisciplinary nature of climate impact assessment, it must draw upon theory, methods and research findings from all areas of science including physical, biological and socio-behaviourial sectors. The challenge here lies in how to integrate research from these different domains of science, which is crucial for evaluation of nature-society problems. Integration of different scientific domains has been discussed in the context of conducting climate impact assessment (e.g. Kates *et al.*, 1985; Glanz, 1988), yet in practice, most study has tended to focus on specific sectors of the natural environment with little emphasis on social impacts and integration of these impacts with other impact assessments. As well, the role of adaptation to changing climatic conditions has not been explored to a large extent.

Typical climate impact assessments utilize the results of global circulation models and base their impact studies upon scenario construction from these models. Research so far has examined a broad range of the environment from physical and biological studies to factors related to the human environment such as shoreline impacts and use of water resources.

Physical and biological studies have examined factors such as forest response to changing climatic conditions (Botkin & Nisbett, 1992), the relationship between global warming and wildland fire (Torn & Freid, 1992), implications of warming for Great Lakes ice cover (Assel, 1991), impacts of climate warming on wetland tundra (Rouse *et al.*, 1992), and impacts for freshwater fish yields in eastern Canadian lakes (Minns & Moore (1992). Impacts relating to the human environment have focused on factors such as the use of water resources (Cohen, 1991), water level fluctuations in the Great Lakes (Cohen, 1988), the risk of drought (Sheer, 1988), impacts for agriculture (Rosenberg, 1992) and effects on energy development (Lonergan & Young, 1989). These studies have been relatively sector-specific, dealing primarily with a particular feature of the natural environment. For example, Cohen (1991) examines the physical and hydrological relationships involved with projected climate warming scenarios for the Saskatchewan River sub-basin. However, emphasis is on determining runoff, rates of flow and basin discharges. Little emphasis has been placed on the hydrological demands of the physical environment, or human uses of the water resources. Cohen (1991:312) does state, however, that "a framework for a complete impacts study of a major watershed...would show many interconnections between climate, hydrology, water resources and various sectors of the regional economy". The logical extension of such assessments has been to integrate them together to more accurately reflect the interrelationships existing between the natural and human environment.

Integrated studies have only recently been initiated, however. The Canadian Climate Program Board (CCPB, 1991) has recommended that as part of the research and

data needs for Canadian climate impact studies, integrated multi-sectoral analyses for selected regions should be carried out. The Mackenzie Basin Impacts Study described previously is one of the suggested studies, along with the Great Lakes Basin and the Prairies/Great Plains. In the United States, the Missouri, Iowa, Nebraska, Kansas project, known as the MINK study (Crosson and Rosenberg, 1993) has conducted an integrated assessment for the region using a methodology designed to overcome some of the problems typical of more sector-specific studies. These regional studies should allow for economic, social and physical factors and feedback to be incorporated, as well as to consider response strategies (CCPB, 1991).

A precursor to the Mackenzie Basin Impacts Study was an integrated assessment of climate change and transportation in northern Canada (Lonergan, Difrancesco & Woo, 1993). This study used analytical models for long-term impact assessment, and to estimate potential impacts of projected climate warming in the region. An integrated approach linked projected climate warming with the physical and economic systems to be impacted, using transportation as a focus. Lonergan, Difrancesco and Woo (1993) state that the next step would be to incorporate a dynamic framework into the socio-economic impacts section, to account for expected demographic, economic and social changes that may occur. A similar approach to integration has been utilized by the Mackenzie Basin Impacts Study in response to the number of single-sector, southern-based climate impact assessments that have taken place in Canada. Only a small number have dealt with the North, and most of these have focused on permafrost, the boreal forest and tundra ecotones (Cohen, 1992).

The MINK study has utilized an innovative analytical approach for climate impact assessment. Five sectors of the region have been studied: agricultural systems; forestry; water resources; energy; and economic considerations. These separate sectors have been linked together through an approach which stresses the linkages between these systems. The study addressed four methodological limitations of previous climate impact assessment (from Rosenberg, *et al.*, 1993:9):

a) *The climates of tomorrow are imposed upon the world of today.* Climate change scenarios are imposed upon the subject regions as they exist today. Since significant impacts of climate change are unlikely for at least the next two or three decades, it is likely that the economic base of these regions, their vulnerabilities and capacity for adaptation will be different than they are today. Therefore, the impacts and responses would be quite different as well.

b) *The natural temporal and spatial variability in climate is largely ignored.* 'Broad-brush' scenarios of climate change are imposed on the subject regions. Based upon the predictions of GCMs, mean temperature is increased and precipitation is increased or decreased uniformly across very large areas. Thus the natural spatial and temporal variability in climate is ignored and the full complexity of impacts is not exhibited.

c) *The complexity of impacted regions and industries are not fully considered.* The resource sectors impacted by climatic change are treated too simplistically. Climate is adjusted, as explained above, and regression or process models are used to calculate the impact on particular crops. Variations in crop performance attributable to rotation, soil and management are rarely considered. As well, no region depends entirely on a single natural resource-based industry or sector. Thus the impacts of the climate change on all important sectors and the interactions between them must also be considered.

d) *The management responses to climate change are generally untested.* The industrial and natural resource sectors do not today exist in a 'climate-free' world. Farmers, foresters and water resource managers are continually adjusting to the daily weather and to climatic variations from season to season and year to year. Prior studies have not considered how the full range of technologies, management techniques and policy tools now available might be used to lessen the impacts of a climate change and/or to capitalize on positive impacts, if any.

For the MINK region an analytical framework was designed consisting of four

components (Rosenberg et al., 1993:12):

a) *Baseline cases.* Information was provided on how regional-scale natural resource-based industries and economies function currently and how they are likely to evolve in response to changing technical and and economic conditions apart from climate change.

b) *First-order effects.* The ways in which climate change may affect the baseline cases were analyzed by identifying the effects on resource productivity, i.e., crop production, forest output, runoff to rivers and water storage.

c) *Second-order effects.* These were the ways in which the primary enterprises affected (e.g. farms, timber companies, water resource districts) reacted to the first order effects.

d) *Third-order effects.* These took account of the linkages between the primary enterprises and the rest of the economy to study the impacts of climate change on the economy as a whole.

An important component of the MINK study was the treatment of future scenarios. Rather than simply impose a future climatic scenario on the region, the region was first considered in terms of the changes expected to take place regardless of climate change, as well as under a scenario of climate change with adaptation and then without adaptation. This allowed for identification of a wide range of possible alternatives from a worst-case scenario to one which is tempered somewhat by expected means of adapting. Each scenario was also based upon the future given expected changes in society and the economy. This provides a more realistic base for assessing impacts of future climatic change, thus overcoming one of the primary shortcomings of traditional climate impact assessment (Rosenberg *et al.*, 1993).

An area that has received little study is the response of human settlements to climate change. The MINK study goes far in terms of addressing the methodological limitations of climate impact assessment, yet still, it does not examine in any detail direct

impacts upon human settlements. In the case of northern Canada, the impact of climatic change upon human settlements, especially those still active in subsistence activities, has not been the subject of any previous research.

Assessing impacts of climate change on human settlements, and society in general, is difficult due to the complexity of human societies and the interrelationships existing between society and the natural environment. Kates (1985) explains at length methods for studying the interactions between climate and society, and it is worthwhile to examine the complexity involved in integrating these various interactions. Kates (1985) discusses three basic approaches centred upon interaction models of climate and society. Figure 2 illustrates these three models. The basic model examines the single sequence of climate society interactions resulting from climatic and social variation and the resulting impact on a population. This model is overly simplistic as it fails to take into account the responses of human societies to given changes in both climate and society. Adjustments or adaptations resulting from these changes are reflected in the interactive model with feedback. This more accurately represents the way in which adjustments and adaptations can act to alter the biophysical or the social characteristics of the interaction (Kates, 1985).

The final model goes one step further to include the underlying processes of nature and society which actually drive the variables described as `climatic variation' and `societal variation'. The inclusion of these underlying processes are important for reliable impact assessment. When viewed in isolation, impacts may be quite different from when they are viewed with respect to other changes which are taking place in both nature and

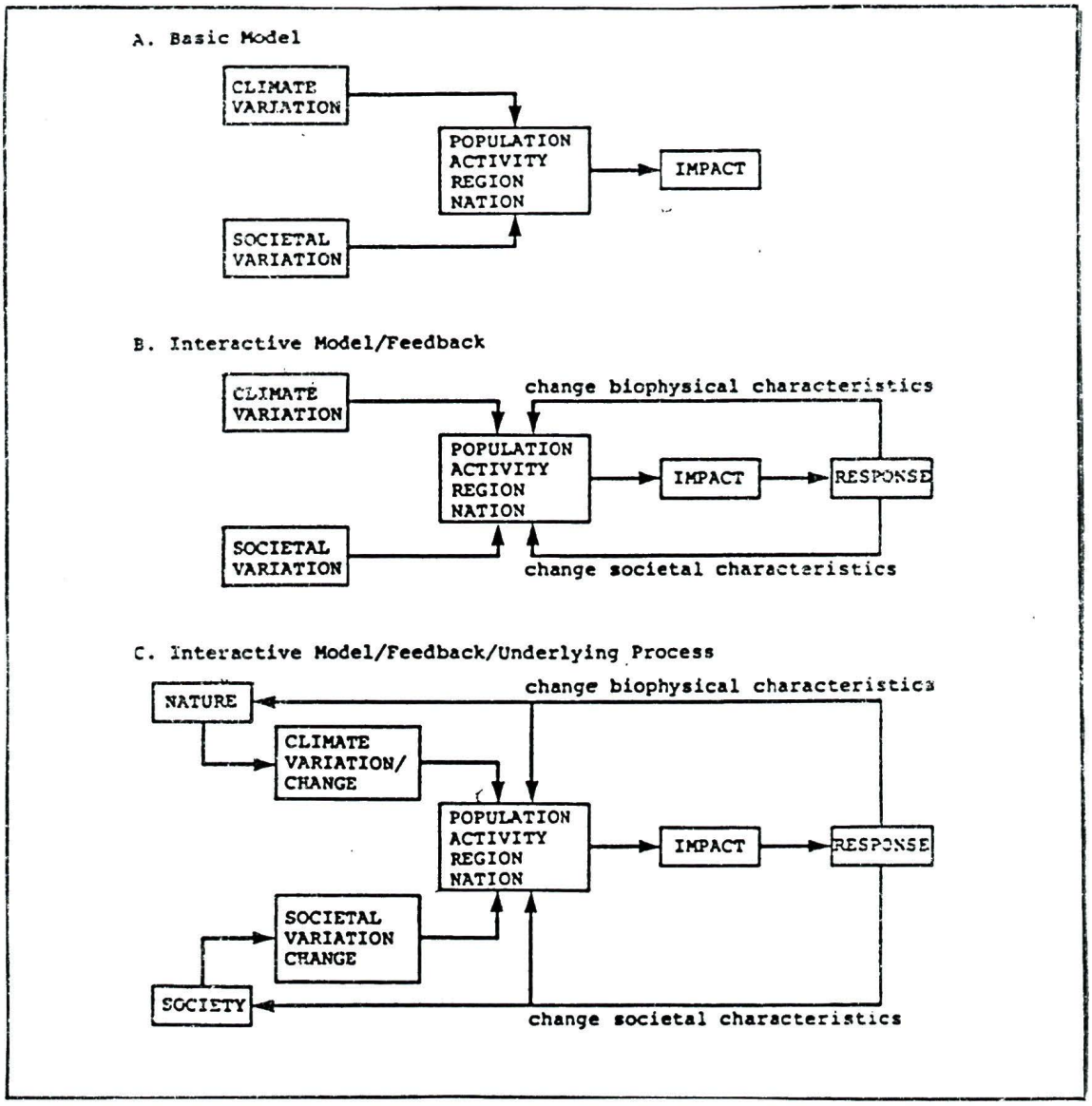

Figure 2 Interaction models

Three types of interaction models stressing: A) simple interaction. B) feedback to the social activity, and C) feedback to underlying physical and social processes.

(from Kates et al, 1985:13)

society, especially when considered in a cumulative manner. The SCOPE Workshop on Climate/Society Interface in 1978 (from Kates, 1985:12) states that:

> ...a change in either climate or society affects impact. Since both climate and society are constantly changing, the magnitude and character of impacts is also not constant. Impact studies must, therefore, involve investigations of climatic variability and social change. The question to be addressed to any society at any time is: `Is the society becoming more or less vulnerable to climatic variability?'. Or to put the matter differently, `Will any specific proposed social change or development have the effect of increasing or decreasing vulnerability?'.

These concepts are important within the context of this thesis due to the society being studied. Aboriginal societies in the North American Arctic have experienced vast social changes from the middle 1850's to the present, especially within the last 40 years (these are explained further in Chapter five). To study impacts of climatic change on such a society requires taking into account past changes, both social and environmental. Glanz (1988:407, 409) states that:

> Because we are concerned about the local and regional effects of the responses to a global climate change, there is a need to identify how well societies in the past have dealt with local climate-related environmental changes, regardless of the cause. In order to add to the body of knowledge about societal responses to possible global climate change, it is important to know what the body looks like with respect to societal responses to climatic variability and to extreme meteorological events...Societies are constantly changing and they will continue to do so regardless of whether the global climate changes. It is important to take societal changes into account when considering societal responses to the impacts of climate variability, climate change and extreme meteorological events.

This implies that to adequately assess the impacts of a future change in climate, one should first be aware of how a society responded to both past climatic changes as well as to presently existing natural climatic variability. However, research on the relationship

between human communities and climate is lacking in the climate impact assessment literature. The complexity of studying a large human settlement and its relationship with the past climate and present natural climatic variability presents enormous obstacles, the least of which is the existence of reliable data. Past records of historical climate data are often non-existent or are available for only a recent period of time. As well, the complexity of modern society can make the relationships between climate, the natural environment, and society, difficult to determine.

This thesis is concerned with Aklavik NWT, a small aboriginal community in the Mackenzie River Delta in the Canadian Arctic. The community is small enough to allow for understanding of the relationships between society and the environment. Historic climate data exist as far back as the 1920s. There has also been study of prehistoric relationships between climate, human settlement and cultural development in the North. These studies will be further examined in chapter four which discusses historic climatic and cultural changes in the North American Arctic. Climate impact assessment with respect to aboriginal peoples is lacking, although there have been studies done for pastoral and agricultural indigenous societies (e.g. Borkar and Nadkarni, 1975; Chambers, 1982; Jodha and Mascarenhas, 1985; Spitz, 1980).

Jodha and Mascarenhas (1985) have studied adjustment to climatic conditions by self-provisioning societies in India and Tanzania. Their work focused on the variability of climate from one year to the next and over short groups of years, and the problems which these variations cause for self-provisioning societies. While different from self-provisioning agricultural societies in India and Tanzania, subsistence societies in northern

Canada share many characteristics with these societies which are reflected in the approach taken by Jodha and Mascarenhas.

Two primary steps in discussing adjustment to climatic variability by self-provisioning societies are: "to define or identify such societies, and to understand their perception of the phenomena of climate variability" (Jodha and Mascarenhas, 1985:438). They go on to explain a self-provisioning society as one in which its members manage their production and consumption requirements by themselves and the market, or formal exchange transactions, has little place in the system. This definition can also apply to the subsistence activities of aboriginal peoples in the Canadian Arctic as their hunting and trapping activities exist primarily for their own consumption, with only limited exchange of furs for cash as the fur industry has been greatly reduced over recent years (Usher, 1975; 1987).

Jodha and Mascarenhas (1985) continue to discuss two features of self-provisioning communities which have significant bearing on their adjustment to climate variability. First, the production and consumption decisions of a household that is both a major supplier of production inputs and a major final user of the outputs, are quite interlinked. Thus, integration of the household as a family unit and farm as a production unit, helps to offer greater internal flexibility for sustaining the impact of climate variability.

Second, the lesser dependence of farm households on the market implies their lesser integration with the rest of the economy. This in turn reduces the capacity of farm households to transmit shocks of climatic variability to others (Jodha and Mascarenhas,

1985). This implies that unless helped by external agencies or some form of relief project, farmers in self-provisioning societies must bear climate-induced risk on their own. As well, since their dependence on the market for purchase and dispersal of products is limited, climate-induced uncertainties are more significant than price or technology-related uncertainties in shaping their adjustment strategies (Jodha and Mascarenhas, 1985).

These features of self-provisioning farming communities in India and Tanzania are analogous with the subsistence activities of aboriginal peoples in the Canadian Arctic as they too are open to more flexibility in responding to climate-induced uncertainties as they are not constrained by a market system. Similarly though, if the shocks of climatic uncertainty are large enough to surpass the resiliency of their own subsistence system, they often have no choice but to bear the loss themselves.

A final aspect of climate impact assessment which must be acknowledged is the general lack of detailed research on adaptation to climatic changes and variability. The Task Force on Climate Adaptation (TFCA, 1993) finds that the current state of knowledge about human adaptation to climatic variability and change is not strong. There is some information taken from the field of hazards research into adjustments taken in response to catastrophic events. There is also some information on impacts of particular climatic anomalies such as the 1988 drought which affected much of central and eastern North America. The TFCA (1993:50) states that "most of the research in the area of impacts of climatic change has: a) focused on future climate scenarios, and has given only modest attention to variability which is relevant to both future and current conditions, and; b) has tended to assume the presence (or absence) of adaptation rather than analyze actual

processes of adaptation." As such, TFCA (1993:iii) recommends that:

> Research in the field of adaptation to climate focus on actual past and current economic activities and decisions in light of variable climatic regimes, and recognize the role of other forces in fostering or hindering adaptation.

These factors suggest a framework within which a northern aboriginal community can be studied to examine the relationships existing between climate and human settlements. Historical and prehistoric adaptations to climatic changes can be examined, as well as examination of how society today adapts to present day climatic variability. This in turn, can suggest how society may adapt to, and be impacted by, projected climate warming scenarios. As well, any future scenarios should take into account the changes which will occur regardless of climate change before imposing a future climate scenario. While this is not a large scale study, the information derived from it should be able to be integrated with other physical and biophysical studies, thus emphasizing the interrelationships existing between human societies and the natural environment. Such an approach will help to fill the void in climate impacts assessment which has tended to ignore explicit societal relationships and the role of adaptation by humans to changing climatic conditions.

Chapter Three

DISCUSSION OF METHODOLOGY AND METHODS USED

In order to meet the objectives for this research as outlined in the introduction, a research design and methodology had to be formulated which would satisfy the need to incorporate the views and concerns of the community involved. Doing so requires an understanding of the implications of conducting research with aboriginal peoples and the need for an approach which can integrate the information held by the community with the broader objective of conducting social and climate impact assessment.

Methodological Considerations

There exists a long history of aboriginal-white relations in Canada which illustrates the manner in which aboriginal peoples have been viewed by Europeans and the subsequent Western-European culture which developed into Canada. Only from the late 1970's on have these relations changed to begin providing a more equitable distribution of benefits and power for aboriginal peoples. This study will not explain these relations, as they are well exemplified in Crowe (1991), Brody (1988, 1991), York (1989), and York and Pindera (1991). The significant aspect of aboriginal-white relations to be dealt with here is that of the utility of aboriginal knowledge and the overall disregard for this

knowledge in political and academic circles until very recently.

Knowledge of the natural environment by aboriginal peoples has not been utilized by non-aboriginals except in a few circumstances. Historically, this knowledge has been used by early explorers and settlers. The Hudson's Bay Company used this information to develop much of the fur trade in Canada (Crowe, 1991). aboriginal peoples and their knowledge of the environment were used to locate and trap furs, and as guides for explorers. The first instance of Canadian research which used aboriginal information for policy and decision making on a large scale was the Berger Inquiry (Berger, 1988) into the Mackenzie Valley pipeline in the early 1970s (named after Thomas Berger, then British Columbia Supreme Court Justice, who headed the committee). This inquiry listened to the testimony of hundreds of aboriginals from the Mackenzie region, and in doing so, revealed to other Canadians the extent to which there is a different type of lifestyle in Canada's North. The Berger Inquiry set the stage for the development of Canada's aboriginal peoples into a true First Nation by recommending that there be a ten year moratorium on any pipeline construction in the Mackenzie Valley in order to first settle aboriginal claims to the land (Berger, 1988).

Subsequently, aboriginal information has been used exclusively in various projects to aid the land claims process. Significant projects have been the Dene Mapping Project (Asch, 1982), the Tungavik Federation of Nunavut Land Use and Occupation Study (Riewe, 1988), and the Inuit Land Use and Occupancy Project (Freeman, 1976). These projects were significant because they used the information and accounts of aboriginal peoples to show the extent of their land use in order to plan for the lands selection

process as part of land claims. These works are not typical of research that has taken place in the past. Brody (1988, 1991) illustrated occasions where non-aboriginal researchers arrived in aboriginal settlements to acquire information, asked questions and left. Often, the information asked of aboriginal communities was for the purpose of mineral exploration or political exploitation, and was kept secret from the community members. In the past it was typical for aboriginal peoples to be the last consulted where northern development was concerned. The Inuit and Cree of James Bay were not consulted at all during the early 1970s when the Quebec provincial government proposed the James Bay hydroelectric project; their first news of the disruption to their land was on local radio news from southern Quebec (York, 1989). As well, aboriginal peoples were not consulted when the Quebec government decided they should be centralized into communities as part of the James Bay hydroelectric project. These communities were planned by non-aboriginals, and did not take into account the types of services which would be needed by, or suitable for aboriginal peoples (York, 1989).

Aboriginal-white relations have since moved beyond the point where aboriginal peoples were viewed as primitives, needing to be "Christianized" and educated in the European tradition. A major implication of this was that research done with aboriginal peoples today must be done with the approval and cooperation of the aboriginal groups involved. Furthermore, the scientific community is now realizing that even though aboriginal knowledge is based on a different worldview from their own, it is still valid information, and can often be used for scientific purposes. To this end, attempts are now being made to document and record aboriginal knowledge in a unified manner. The goal

here is to unify western scientific knowledge with indigenous peoples' knowledge in order to better manage natural resources and the environment. Two examples of this are Tek Talk (Tek standing for traditional ecological knowledge), a newsletter produced through UNESCO, and the Indigenous Knowledge and Development Monitor, produced through the Centre for International Research and Advisory Networks. These documents have the final goal of incorporating indigenous knowledge into development and planning with regard to the natural environment and the use of natural resources.

The Nature of Aboriginal Information

The entire notion of aboriginal information can be difficult to comprehend. aboriginal information (also known as indigenous or traditional knowledge) is knowledge obtained by aboriginals through their contact with the land and the retention of knowledge passed on through elders. Traditional knowledge such as this is not knowledge gained through formal education, but through actual use of the land for subsistence. Subsistence societies with dependence on hunting and gathering in their immediate areas have accumulated long series of historical observations of relevence sustainable resource use and conservation of biodiversity (Gadgil *et al.*, 1993). Many northern aboriginals still maintain significant land-based activities, and their entire culture is based upon use of the land. The quality of information they hold relating to natural features, land use, wildlife and ecosystems is quite advanced when compared to those who learn this information through formal education. This knowledge is an important cultural trait and is shown by

the knowledge of the environment they occupy, and is illustrated through their toponomy, or place names (Spink & Moodie, 1976). The utility of this information lies in its quality and comprehensiveness with regard to the natural environment, and its ability to be utilized by the scientific and political communities.

The problem with utilizing this information lies in the translation of knowledge traditionally communicated in oral form into information readily accepted by the scientific and political communities which adhere to typical western approaches to decision-making. Western values are rooted in a system that assumes facts must be learned through empirical observation and adhere to accepted laws and theories. Western values differ from the values of aboriginals peoples who do not feel the need to prove their own knowledge, and have values based upon experience and stories passed on in the form of legends and myths.

Cruikshank (1986) states that the fundamental problem with reconciling oral tradition and scientific information is that the two systems of knowledge are arrived at through different processes. aboriginal oral traditions are rooted in a system of values which are timeless rather than chronological. Scientific research is based upon the observation of specific events at specific points in time. Strict adherance to the approaches of the scientific community would dismiss traditions rooted in legends and myth as coming from value systems which have nothing to contribute to scientific inquiry. However, it is pointed out that there is an increasing field of inquiry which has utilised oral tradition as an aid in the depiction of history, and for the description of environmental information. Oral tradition can be a practical source of information

because it is persistent and can be highly technical. As well, it accounts for observations of natural phenomena over an individual's lifetime, which include all seasons and a multitude of different conditions, unlike scientific fieldwork which often takes place in the northern summer.

An example of the utility of information passed through an oral tradition is a study of glaciers and impounded lakes described by Cruikshank (1986). Following the retreat of the Wisconsin glacier, the drainage of the Shakwak Trench in southeastern Yukon was periodically stopped by the damming of rivers by ice-clogged lakes. In the case of recent Lake Alsek, scientists have been trying to determine the number of times the lake has filled due to ice clogging. aboriginal traditions about the creation of the lake have provided additional information.

The Athapaskan Indians originally named the Lowell Glacier, Naludi, meaning "fish stop". The name itself serves as an indicator that the movement of the glacier across the Alsek River frequently stopped the migrations of salmon from the Pacific Ocean. Traditional stories spoke of the blockage taking place due to a young boy making fun of a Shaman. The Shaman then released the torrent of water to kill the Yakutat Tlingit peoples camped downriver. This story dates around 1852. Subsequently, it was determined the original ice dam burst around 1850, flooding a large area. There are also several other tales of Naludi which speak of ice dams and flooding, all of which correspond to scientific estimates at the times when these ice dams were thought to have formed. In this context, the importance of traditional information is its ability to substantiate scientific theories, and provide previously unknown information about the

number of times that these ice dams actually formed.

There are, however, a number of barriers to the inclusion of aboriginal information as an aid to scientific inquiry. aboriginal traditions passed on orally are based upon a premise different from that of western science, and often cannot be properly interpreted outside this context. Many traditions are passed on in the form of a story, often rich with allusion and symbolism, and the real meaning may be lost through translation. The treatment of time is also different in oral tradition. Causality and materiality[1] are treated as secondary characteristics of the universe, whereas science incorporates these factors into the core of all investigation. Cruikshank (1986) states that because of these problems, oral tradition cannot be used by itself, but only in combination with a number of other sources, in comparative ways.

In defining a research process which is suited to the setting of aboriginal peoples, one finds that there is little to follow by way of example. With the exception of the major works mentioned previously, there has been little research done in a formal sense which has addressed the problems of utilizing aboriginal information, and conducting research with the full consent and participation of the aboriginal peoples involved.

QUALITATIVE RESEARCH METHODS

The perspective requiring science to be based on observed, verifiable events dominated the sciences until qualitative approaches were set forth as alternatives to

[1] Materiality is concerned with the origins of physical form or matter.

positivist science (see Westkott, 1979; Jackson and Smith, 1984; Johnston, 1986; Donovan, 1988; Eyles, 1988; Cloke, Philo & Sadler, 1991). These different approaches have served as alternatives to positivist science and allow for qualitative approaches which can reveal the validity of information held by individuals which may not be easily interpreted through strictly quantitative methods.

There are a set of basic assumptions to human geography which form the basis for qualitative research methods. The first has to do with recognizing the humanity of the geographer, and the second to do with recognizing the humanity of the people the geographer studies. In the first case, special attention is paid to the geographer as an individual who enters actively into his or her research. In the second case, importance is placed on the crucial role played by people in the real world as perceiving, interpreting and shaping the human geography of their surroundings (Cloke, Philo & Sadler, 1991).

Qualitative research allows for study of the human world through methods which accept the idea that humans are not purely objective, but are interested in, and have biases towards, the research being undertaken. The basic premise is that men and women are not particles acted upon by exogenous forces, but are purposeful, goal-seeking, feeling, meaning-attributing and meaning-responding creatures (Walker, 1985). Similarly, if one is to interpret the human world, it may be helpful for the researcher to fully engage his/her subjects rather than to adopt a stance of uncommitted neutrality.

In practical terms, this approach is advantageous because it allows for flexibility in the research process. This can be problematic with a more rigid research design which cannot accommodate the experiences of human subjects. With qualitative research

methods it becomes useful to collect information and experiences from the participants, make comparisons between them, construct categories which emerge from the themes identified within the data, and finally to pattern or structure the combination of elements into a unified whole (Kirby & McKenna, 1989). The primary advantage of this approach lies in its ability to accommodate unexpected or unanticipated directions for which the research should follow. If during the research process, the participants reveal an unanticipated area of inquiry, worthy of study, this approach allows for it to be easily accommodated. Similarly, this approach allows the research subjects to play an active role in determining the types of questions to be asked, and in identifying further areas of inquiry.

Kirby and McKenna (1989) explain a number of research issues which are relevant to this study because of historical attitudes towards aboriginal peoples which have forced most aboriginal groups to screen research taking place directly with them. Typical survey methods and formal interviews do not work well with aboriginal peoples because they do not respond well to a formal, structured form of data collection such as a survey questionnaire. Questionnaires have been used, though. Some very successful survey questionnaires were used in Alaskan coastal villages; however, these research projects cost into the millions of dollars, due in large part to the use of interpreters and translating the questionnaires into regional dialects, which unfortunately, is beyond reach for this research[2]. Interpretive approaches are preferred for this type of research because they can

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see Joseph G. Jorgensen, Oil Age Eskimos (1990: University of California Press).
The extensive use of surveys in Alaskan Eskimo villages has been discussed in draft reports done by Jorgensen for the Mineral Management service of the United States Department of the Interior, in particular, Social Indicators Studies of Alaskan Coastal Villages: II. Research Methodology: Design,

be informal and allow the researcher to delve into areas of information which may not be easily answered by a precise, succinct question. The primary points described by Kirby and McKenna (1989) will be discussed within the context of conducting of this research in Aklavik.

Standpoint Epistemology

At a basic level, the idea of standpoint epistemology begins with the notion that less powerful members of society have the potential for a more complete view of social reality than others because of their disadvantaged position. This means that in order to survive, those people who are subordinate are attentive to the perspective of the dominant class, as well as their own (Nielsen, 1990). This is an important consideration for aboriginal peoples because traditionally they have not been allowed to maintain control over their own affairs, and it is only through learning how non-aboriginal society operates that they have begun the process of self-empowerment and self-determination. This affords a more complete perspective because it combines a unique view of the traditional aboriginal world with that of the non-aboriginal world. In this respect, it can be said that aboriginal peoples have the ability to be more knowledgable than those that comprise the dominant class. This may not be agreed upon by all, the point being that many aboriginals have a strong perception of both their own natural world which contains a wealth of environmental information, as well as that of the non-aboriginal society in

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Sampling, Reliability and Validity. Final copies should be available through the Mineral Management Service, Alaska Outer Continental Shelf Region, U.S. Department of the Interior, Anchorage Alaska.

which they now live. Researchers must work through a research process with aboriginal peoples in order to begin to understand an often foreign life-world.

Research Questions

In order to involve the people of Aklavik in this process, it is crucial that all participants involved in interviews and discussion participate from an informed position and are cognizant of what the research is about and the destination of the information at the conclusion of the project. This implies a type of research which is fully participatory, by both the researcher and the research subjects. In this case, the residents of Aklavik were made fully aware of what the information is to be used for and why. This was done by sending copies of the proposal to the community for acceptance prior to undertaking the research, and by discussing the uses of this information with all persons spoken to. Further, it is crucial that the people involved help to determine the actual questions to be asked. It is only through such an approach that the actual concerns of the community will be determined. This implies that the participants may aid the researcher by helping to suggest questions or a focus for discussion, as well as access to other participants, interpretation of material and access to data sites. Participants not only provide data but they participate fully in the formation of research questions, the selection of data gathering methods, and the analysis and presentation of the results. As well, the data collecting process must be flexible and informal to allow for a new focus or question to be used during the process, as opposed to being strictly predetermined. To this end, the people of Aklavik reviewed the methodology to accommodate their interests and concerns.

Researcher Bias

Human individuals have their own beliefs and biases, and often, prejudgments and expectations can be of use in the research process. Each research technique contains the bias of its creator(s) (Kirby and McKenna, 1989). This can be avoided by using the appropriate method for a given situation, such as depth interviews or participant observations, however, each individual is biased, and it is important that the researcher acknowledge his/her bias and allows it to be used in the research process. This can be done by evaluating what Kirby and McKenna (1989:32) call "conceptual baggage". Conceptual baggage is a record of the researchers' thoughts and ideas about the research question at the beginning and throughout the research process. In this process, the researcher states his/her assumptions about the topic and the process. This adds another dimension to the data, one which is always there, but which is rarely acknowledged. This allows for an understanding of the researcher's personal bias and how it changes over the course of the research process. Recording one's own conceptual baggage will allow for identification at a later point of whether or not certain assumptions or goals may be influencing how the research is developing. When the goal of the study is to promote change or awareness, this can be of great value.

Hypotheses

An important feature of research which is based on full involvement for the research subjects is that there may not necessarily be a predetermined hypothesis to be proved or disproved over the course of the research period. Information gathered from

a variety of sources will take its own shape and lead the researcher to make certain conclusions. "Since there is no pre-established hypothesis to jeopardize, there is only information that leads to a variety of conclusions specific to the setting in which it has been gathered. The data will speak its own voice" (Kirby and McKenna, 1989:78-79). In such cases, a hypothesis may not be formed because the precise questions to be asked may not be formed until the researcher has become familiar with the research subjects. In these cases it is not until after the data have been gathered that a possible hypothesis can be formed (Burgess, 1984). For this study there was no pre-established hypothesis to prove or disprove.

Verification

Brody (1988) has discussed examples of past research in the North American Arctic where researchers have gone into communities to collect data without explaining the purpose of the questions, who would use the information and for what use it would be put. This is clearly inappropriate for research that is supposed to be considered honourable. When aboriginal peoples are being used as a source of data, the information gathered must be returned to the community after it has been interpreted, and verified by the participants themselves. If interpretive research is to present the actual views of aboriginal peoples, the only way in which to verify the quality of the interpretation is to return the information. This not only leads to a more accurate interpretation, but also aids in the task of conducting fully cooperative research. As part of this study, a report of the research findings was presented to the community and verified and commented upon by

interested individuals.

Research Method

There are a number of established qualitative approaches to data gathering such as group interviews, depth interviews, participant observation and surveys. In the case of this research participant observation was the logical choice as there was an extended period of fieldwork involved. As well, participant observation where the researcher is not strictly an observer or a participant, but a combination of both, allows for a very flexible approach which can combine interviews with informal and formal discussion. When dealing with aboriginal peoples an outsider may not necessarily be trusted initially. This approach allows for interaction which leads to acceptance in the community, and thus the formation of trust between the researcher and the research subjects. Some have argued that in such a case, those being researched will tend to behave in a manner which is not normal because they are aware that they are being observed. This approach stresses direct communication and an overt relationship so there is less chance of subject deception because there are not really any subjects of research. If the approach has been open enough and all participants are involved, then there is no need for deception on the part of the research subjects. The participation of informed subjects ensures that research is done with and for the participants rather than on them (Kirby and McKenna, 1989).

Given the issues discussed here, this research was proposed using an interpretive approach based on participant observation and depth interviews/discussions. It was essential for the research to create a sense of familiarity between the researcher and the

community, therefore, informal interaction was be required. Once this had been accomplished, more specific questions were asked; however, because this was an equal research process and interaction between the researcher and the research subjects was crucial, they were allowed to lead the conversation and the direction that the information took.

Employing these assumptions and techniques, field work was done for a period of five and one-half weeks in Aklavik, from the end of July until early September, 1992. This work was undertaken in conjunction with the Mackenzie Basin Impact Study, and with full cooperation from the aboriginal groups in Aklavik; the Aklavik Community Corporation (Inuvialuit Regional Corporation, representing the Inuvialuit), and the Aklavik Indian Band (Gwich'in Tribal Council, representing the Dene Indians). Unstructured and informal conversation was used initially to make the community aware of the questions to be asked and the purpose of the research. These methods are important due to their flexibility which allows the respondent to be actively involved in the conversation rather than for the researcher to follow a specific path of questioning. Once there was familiarity with the work being conducted, informal interviews and depth interviews were used to ascertain what knowledge the community members have of climate change, what they feel the impacts will be upon their community and their lifestyle, and how they may adapt to these changes.

Within Aklavik it was important to receive information from a cross section of the community. While there was no specifically defined sample of people to work with, community members of both Inuit and Dene background (the Inuvialuit and Gwich'in

peoples) were utilized, as well as the accounts of both women and elders within these groups. Information from elders was emphasized because it was thought that it may be possible to use the oral histories of these peoples to examine past climatic events which have had significant impacts upon these people. An important aspect of this approach is that there was full disclosure of what this research is about and where its findings may be put to use. Only those persons wishing to discuss these issues did so, and upon initial arrival in Aklavik, concerns that the community members wished to be addressed within the research were dealt with. Initially, there was a period of about two weeks where familiarity was established between myself and the people in Aklavik, and the research being conducted. Once familiarity had been established, more specific questions where asked in order to examine past changes in climatic activities and their affects on Aklavik. The knowledge held by elders in the community was able to provide some information showing changes which had taken place in the past and how they were adapted to. Moving towards the present time, questions were centred upon the present climate and the perceptions and attitudes of people concerning the existence of a greenhouse effect and its impacts. In order to determine the impacts of future changes in climate, a set of scenarios were presented focused on those listed earlier from CCPB (1991) and Roots (1989a). Questions were structured informally around the following statements:

1) What would be the result of the Mackenzie River having higher streamflows and floods during the snowmelt season?

2) What would be the result of a shift northward in forest species and the treeline?

3) What would be the effects if permafrost were to melt or decay?

4) How would a longer water shipping season and a shorter winter ice road system affect the community?

5) What would be the result of greater snowpack accumulation over a shorter winter season?

6) What would be the results of ice with less thickness lasting a shorter period of time?

7) How would changes in wildlife patterns and migration routes affect the community?

8) What would be the impacts of increased coastal erosion and possible flooding of lowland areas?

Respondents were then asked about the ability of the community to adapt to such events in the future climate.

Use of Methodology in the Field

The methods described previously formed the basic structure for this research. However, the nature of the methodology used and the assumptions held when going into the field allowed for the possibility that there might be some changes in the approach taken, or even the questions asked. This turned out to be the case. Once in Aklavik it became apparent that in order to satisfy the objectives for this study, there would need to be several changes in the focus of the information being obtained.

Throughout the five week period of field work in Aklavik, a total of 78 persons were spoken with who provided data for this research. A breakdown of these respondents is provided in Tables 2 and 3. The 1989 population of Aklavik was 783 (Outcrop, 1990),

although community administrators state that the number is now closer to about 900. The final composition of the group of respondents was due to the guidance of the respondents themselves, rather than a prescribed survey sample.

Table 2 **Respondents in Aklavik by Sex and Status**

	Male	Female
Elders	11	8
Active in subsistence activities	30	24
Not active in subsistence activities	1	4
sub-total	42	36
total	78	

Throughout the period of field work, special attention was given to speaking with a cross-section of the entire community. In general, through the course of a discussion, the respondent would say "you should speak with this person" or "go down the road and talk to this person, they're probably interested in this." A list of names was quickly formed of people that would be sources of good information. However, care was taken to ensure that both women and men were spoken with, as well as elders of both sexes and the non-aboriginal members of the community. More important was the necessity to speak with people considered to be active hunters and trappers as well as those not as active in subsistence activities. Doing so allowed for a reasonable representation of views

from the Gwich'in people, the Inuvialuit and non-aboriginals, as well as both men and women of all ages from these groups. This was important because if only active hunters and trappers were spoken with, the views of people less active on the land may not have been represented.

Table 3 **Breakdown of Respondents According to Cultural Background and Sex**

	Inuvialuit		Gwich'in		Non-aboriginal	
	Male	Female	Male	Female	Male	Female
Elders	8	7	3	1	0	0
Active in subsistence activities	16	15	12	9	2	0
Not active in subsistence activities	0	2	0	2	1	0
Totals M/F	24	24	15	12	3	0
Sub-totals	48		27		3	
Total	78					

Respondents have been classified into three broad groups: elders, those active in subsistence activities, and those not active in subsistence activities. Those persons comprising the group of elders are somewhat difficult to define. Elders are older people in the community (generally over 50 years) who, due to their age and experience, maintain a position of respect and priviledge not offered to younger people. In Aklavik

a number of elders live in the elders home, which is basically a care facility for these people. Several others reside in the homes of family.

The group of respondents that are active in subsistence activities range in age from their late teens to about mid-fifties. Specific ages were not recorded as that level of detail was not felt to be important. This group encommpassed a large number of people and included both those that have wage employment as well as those who do not. The extent to which an individual participates in subsistence differs greatly. This group includes those who are active on both a part-time basis as well as those who consider themselves full-time hunters and trappers. The group of individuals who are not acvtive in subsistence activities stated that they do not participate in any hunting trapping or fishing activities.

Because the research process was intended to be as fully participatory as possible, draft copies of the proposal were sent to the aboriginal bands in Aklavik for their comments and consent. These revealed no major concerns and consent to begin the research was given. It was not possible, however, to know what the people of Aklavik would know about the research topic or how well they would respond to the questions as set forth in the research proposal. The ability to be flexible, and not to be confined by a predetermined hypothesis was crucial for this study because it was soon realized that questions relating to the climate and future climate change were not viewed as relevant or understood by the majority of the people spoken with.

The first step in determining how to approach the people of Aklavik was to inform the community of the research being undertaken. This involved making an announcement

on the community radio station, attending the local Bingo games (which are well-attended social events, where an announcement concerning this research was made), and posting a notice on the bulletin board at the post office. These actions were quite successful in making the research known to the community, as information tended to disseminate rapidly. Contacts within the community took some time to develop, with about two weeks passing before discussions which resulted in useful information began. When community members were asked to talk about their views and perceptions on climate and climate change, it became apparent that they had little interest for, or knowledge of, the topic. Previous research experience with aboriginal peoples had shown that if there is no interest in a topic, it is extremely difficult to engage in a discussion. As well, the list of questions used to examine future impacts of climate warming, were inadequate for identical reasons. However, it had been previously determined from conversations with community members, that there was knowledge about the climate and its impacts on the land. Subsequent discussions revealed that while there was not a great deal of interest in climate change *per se,* there was interest in discussing land use (subsistence activities such as hunting, fishing and trapping) and implications of climate upon the land. This, in turn, resulted in what now appears to be the more logical approach of discussing how individuals use the land and their perceptions of the impact of climate on their activities. Though it appears obvious in retrospect, it was found that people were willing to discuss matters which were relevant to them and their lifestyle, i.e. use of the land, while questions about climate change and how they feel the future climate may differ from the present were viewed as being irrelevant by the majority of the people spoken with.

Therefore, the focus of this research shifted slightly from examining how projections of the future climate may impact the community, to evaluating the land use of the community and how it is related to climate, and subsequently, where these activities may be vulnerable to future changes in climate. Once a rapport had been established around the topic of land use, it became possible to ask about perceptions of climate change and whether or not there were any perceived changes in the climate, which was not possible prior to focusing on the land use of the community.

Using this focus on land use, the primary questions asked during discussions incuded the following:

1) Can you explain your annual cycle of land based activities?

2) What species do you hunt fish and trap, when and where?

3) Are their any particular times of year when the climate causes difficulties for these activities and the community?

4) Do you feel that the climate is changing at all?

5) What do you feel is responsible for these changes?

6) Are you familiar with the greenhouse effect or global warming?

As more information was gathered, it became clear that there were several areas which were significant to the people of Aklavik in terms of their land use and its corresponding dependence on the regional climate. First, the cyclical nature of the community land use became apparent, and the dependence upon a familiar set of seasonal conditions. In many cases questions did not have to be asked concerning periods when the climate causes difficulties as the respondent identified these periods themselves. This

led to questions being asked about the timing of break-up and freeze-up in the Mackenzie Delta, as well as the timing of the changes in between each season. Secondly, there was some variance in perceptions regarding the past climate. Therefore, as a means of verifying the information provided, as well as to study any possible trends, daily climate data for Aklavik were obtained from Environment Canada's Climatological Services branch in Edmonton, Alberta. This information provided maximum, minimum and mean daily temperatures, as well as rainfall, snowfall and total precipitation. A Hudson's Bay trading post had been established in Aklavik in 1926. Records exist from that time to the present, although there are some gaps in the data.

A point of some significance is that the process of asking people about their annual land based activities always led to a large amount of information being discussed. Topics included the length of time it takes to get to camps, which types of outboard motors are better then others, which locations are preferred, differences between previous years in terms of harvests, and a wide variety of personal anecdotes. Intertwined amongst these topics were descriptions of temperatures and climatic features such as wind and cold, thus precluding the need to ask detailed questions concerning the climate in many cases. As this information was usually discussed throughout the course of a conversation, it was simply a matter of filtering the significant portions and recording them on paper. Several initial conversations were recorded using a dictaphone; however, not all respondents seemed not to be at ease during its use, therefore it was no longer used.

By allowing the respondents to guide the direction of the questions in this manner, it also became apparent that there was information on how these people came to be living

in Aklavik and the particular circumstances that led to their location there. Subsequent research showed that the prehistoric settlement of the Arctic was strongly influenced by climatic factors, as have a number of cultural variations among northern indigenous peoples. These historical settlements and cultural variations will be discussed in Chapters four and five.

Finally, an unanticipated classification for this study was revealed while organizing and classifying the information gathered from discussions and interviews made while in Aklavik. When discussing their land use and the seasonal nature of their activities, many individuals discussed their ability to adapt to seasonal changes. Similarly, some individuals discussed where their activities are vulnerable to changes in climate and where these activities are most resilient to changes. Some individuals used the actual terms "vulnerable" and "resilient", which led to the use of these terms as a form of classifying and explaining the relationship between land use and climate. This classification follows those described in Kates (1985) and Burton (1992), and are further discussed in Chapter six.

Given the changes which arose during the period of field work, there were ultimately two stages of data gathering. The initial and most important stage was the field work in Aklavik, which was based upon discussions and interviews with people living in the community, as well as observations made throughout the entire stay in the community. The interviews used to gather information were quite informal and were more along the lines of general discussions than informal interviews. In order for respondents to feel comfortable, discussions began with a description of the research being

done as well as personal information about this researcher. Conversations eventually drifted into some form of stories or anecdotes about some aspect of hunting and fishing. This, in turn, enabled questions to be asked about how much hunting and trapping individuals participate in, where and when they practise these activities, and how they are affected by the seasonal nature of subsistence activities. Discussion of climate was not always made explicitly, as there were always comments made about the weather and the seasonal influences upon land-based activities. The implicit role of climate revealed substantial information about perceptions of climate on subsistence activities and community life in general, which often did not have to be the subject of specific questions.

The second stage of data gathering followed field work in Aklavik. The interviews described previously revealed aspects of the community which needed to be further explored. These were the prehistoric settlement of indigenous peoples in the Arctic, and the historic settlement of people into the community of Aklavik. Important relationships were found in the role of climatic conditions upon settlement, as well as other social changes which have occurred in more recent history.

In the end, changes made to the research process in the field illustrate the importance of utilizing a methodology which is flexible enough to allow the research subjects to define the direction the research takes. Had there been a strictly defined hypothesis, or a specific survey instrument, this research would not have been possible. It is worth noting that while the community administration consented to this research from the outset, not all community members shared the familiarity with the topic that those

who consented to the research do. The ability to speak with community members in the field allowed the study to follow their needs and interests. This allowed for the retrieval of information which would have otherwise been extremely difficult to obtain.

Role of Standpoint Epistemology and Researcher Bias

A point worth explaining in greater detail was the role that standpoint epistemology and researcher bias played in this research. These factors were expected to play a more explicit role in this research process; however, their function turned out to be much more implicit in the end.

This researcher had certain expectations when entering the field, such as the notion that most people would have a good knowledge of global warming and would probably express great concern over climatic changes. As explained, these preconceptions were inaccurate, but they played an important role in order to shift the focus of this study. It became necessary to learn from the people being researched how they view climate and its function in their lives. By evaluating personal preconceptions and contrasting them with those of community members, it was possible to obtain a greater appreciation of how the perceptions of respondents in Aklavik differ from those of people who's everyday lives are less dependent on the natural environment.

Linked to this appreciation of differing perceptions is the implicit role of a standpoint epistemology. This notion reflects the idea that the knowledge and perceptions of respondents may offer a more "complete" view of the world as they are knowledgable about both the natural world as well as well as the more economically developed world

experienced by most non-aboriginals. Had this research been more dependent on specific oral histories or was trying to collect information previously thought unacceptable (such as aboriginal stories and myths), then the notion of standpoint epistemology would have played a more explicit role. For this study, standpoint epistemology has played an implicit role based upon respect for the knowledge of the people spoken with and the value of their experiences and perceptions.

Chapter Four

CLIMATIC CHANGE AND CULTURAL CHANGE IN THE NORTH AMERICAN ARCTIC

Before examining the community of Aklavik NWT and the relationship that exists between its land use and the regional climate, it is worth examining the role that climatic change has played in the development of human settlements in North American Arctic regions. Research in Arctic archaeology has shown the importance of climatic conditions and has suggested impacts upon cultural development and change (McGhee, 1970, 1978, 1981, 1989; Dekin, 1972; Dunbar, 1976; Barry *et al.*, 1977; Gribbon and Lamb, 1978; Maxwell, 1985; Jacobs, 1986; Crowe, 1991). Other sources have discussed the relationship between prehistoric human settlement and climate, as well as climatic influences on cultural development (e.g. Graburn & Strong, 1973; Jacobs, 1975; Bryson, 1978; Sabo and Jacobs, 1980; Fitzhugh & Lamb, 1985; Zegura, 1985; Schledermann, 1990; Fang & Guo, 1992). This chapter will present an overview of climatic factors which have influenced indigenous settlement of the North American Arctic, and illustrate how climatic change has impacted the cultural development of these peoples, in particular, the Thule (Eskimo)[1] culture for whom the most information exists. However, it must be

[1]In this thesis, the use of the terms Inuit and Eskimo are used according to the historic use of terminology and preference of the present-day group. Therefore, the Mackenzie Eskimos are not referred to as Inuit, as the term Inuit was not in use during the existence of those peoples. However, Eskimo peoples in Alaska are still referred to as Eskimo. This is their preference as the term includes their own

noted that the intention here is to illustrate some basic climate-society interactions, rather than to enter into a detailed discussion of often confusing and controversial Arctic anthropology. Some of the dates mentioned here are thought to be correct while others have been disputed due to different dating of artifacts and other information concerning prehistoric peoples. These discrepancies are noted where appropriate.

Indicators of Past Climatic and Cultural Change

In Arctic regions, environmental factors have had significant impacts upon human populations. The ecosystem of the North is a "simple" one in which there are few alternatives for food, fuel and raw materials. Therefore, Arctic populations have learned to adapt to an ecosystem subject to strong control by the physical environment and vulnerable to the effects of changes in the environment. Archaeological research examining the effects of environmental changes on cultural development has identified two basic factors of importance to prehistoric Arctic peoples; the climate and the marine environment (Barry *et al.*, 1977). Climate and the marine environment are closely interrelated, as climate is ultimately responsible for factors such as the seasonal extent of sea ice and longer term fluctuations in sea level. Sea level fluctuations are affected by both changes in the hydrologic cycle as well as isostatic rebound following the release of ice mass from the land. Due to the lag time involved in such factors, it is often desirable for study of the palaeoenvironment to view climate and the marine environment

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various sub-groups. In Canada, the descendants of the Thule people are now referred to as Inuit, not Eskimo, as this is their own preferred name.

separately, while acknowledging the central dependency upon climate (Barry *et al.*, 1977).

This separation is significant due to the manner in which Arctic prehistory has been pieced together. In order to determine where climatic and cultural changes have taken place, palaeoenvironmental factors such as sea ice have been considered separately from climatic events due to the lag time involved. The fundamental technique in examination of such prehistoric events has been to take evidence of environmental changes and plot them chronologically, searching for points in time where related cultural changes occur (Dekin, 1972). This helps to understand the cultural behaviour associated with certain archaeological artifacts, and to provide insight on how environmental processes have affected these artifacts following their deposition.

The primary information for these studies have come from archaeological sites located throughout the Arctic, and subsequent dating of materials found at these sites. Paleoclimatic inferences have been provided from several sources: (1) on-going glaciological, geological and climatological studies in the Arctic; (2) isotopic analyses and radiocarbon dating of ice cores; (3) Holocene palynological data from areas of the Canadian Arctic, subArctic and Greenland, and (4) studies on tree-line movements over time (Barry *et al.*, 1977; Dekin, 1972). However, the dating techniques used in these studies are not entirely accurate. Therefore, it is possible for an event or stage in time, such as a presumed cold period, to be several centuries off from its actual occurrence. As well, differences in radiocarbon dating techniques and a lack of undisturbed artifacts has led to some confusion in the precise dating of certain archeaological sites. However,

given the length of time being studied, these data are sufficient to provide a general understanding of both the stages of prehistoric Arctic occupancy and climatic episodes which have occurred during that time. Table 4 provides a general view of the relationship between climatic episodes and paleoeskimo cultural development. The actual dates provided are a conglomeration of information from McGhee (1970), Dekin (1972) and Barry *et al.* (1977), and are corroborated with data from Maxwell (1985) Zegura (1985) and Schledermann (1990). All three sources are similar with small variations in their precise dating of events. As the purpose here is to emphasize the relationship between climatic changes and cultural changes rather than the precise timing of these events, these chronological periods are considered satisfactory. The following section will explain a somewhat confusing process of prehistoric settlement of the Canadian Arctic, and the role of climatic changes in that process based upon the chronological events of Table 4.

Arctic Prehistory (30,000 to 5,000 B.C.)

Most of Arctic Canada was covered by ice sheets of the last glaciation from about 30,000 to 15,000 B.C.. The only area to remain primarily unglaciated was the western side of Banks Island in the Beaufort Sea and an area running north to south, immediately west of the Mackenzie River Valley. However, it is likely that at certain times during this period glaciation did encompass this area (Zegura, 1985).

Table 4 **Climatic and cultural changes in the Canadian Arctic**

DATE	CLIMATE	CULTURAL CHANGES
8000-4000 B.C	warmer	
4000-3000 B.C.	thermal maximum	
2500-1500 B.C.	cooler then previously but warmer than present	Large scale migration of ASTt* across Arctic
1500-1100 B.C.	colder	Disappearance of Independance 1 sites from high Arctic and southward movement of Pre-Dorset peoples
1100-700 B.C.	warmer	Expansion of Dorset peoples across Arctic
700-200 B.C.	colder	Disappearance of Independance 2 sites from high Arctic. Dorset move southward into Labrador and Newfoundland
200 B.C. - 400 A.D.	warmer	Largest spatial exent of Dorset peoples, extending into Newfoundland and Northern Manitoba.
400-800 A.D.	cooler	
800-1200 A.D.	warmer	Rapid movement of Thule peoples across Arctic from west to east. Norse settlements appear in Greenland.
1200-1600 A.D.	cooler	Widespread occupation of Arctic by Thule peoples.
1600-1850 A.D.	colder	Distinct Inuit groups develop across the Arctic.

* ASTt - denotes peoples of the Arctic Small Tool tradition

(compiled from Barry *et al.*, 1977; Dekin, 1972; McGhee, 1974, 1978)

About 15,000 B.C. these ice sheets began to melt as the climate warmed, and by 10,000 B.C. the western Arctic had been deglaciated. By about 7,000 B.C. the glaciers had retreated to approximately their present position. The period from about 5,000 B.C. to the present has experienced a number of climatic fluctuations which were probably the primary catalyst for significant variations in the cultural development of the original peoples to settle in the Arctic. McGhee (1978) and Maxwell (1985) provide a detailed description of likely scenarios culminating in the populating of the Canadian Arctic,

although even these generally agreed dates have been subject to recent debate (see Lewin, 1987; Morell, 1990). Approximately 30,000 years ago much of the Arctic waters were locked in the ice sheets of the last glaciation, thus exposing a land bridge between what is now Alaska and eastern Siberia. Palaeolithic Siberian hunters crossed this exposed ground to become the first human occupants of North America. Crude bone tools from these peoples have been found in the Old Crow Flats area of the northern Yukon (McGhee, 1978). These peoples eventually migrated southward to become predecessors of the American Indians. Unfortunately, meagre human skeletal representation from this region prior to about 12,000 B.C. makes occupation dates difficult to confirm. As a result, no consensus has emerged concerning exactly when transplanted Siberians actually became the first Americans, "although it is generally agreed that these first Americans were ancestors of the American Indians rather than of the later appearing Aleut-Eskimo population system" (Zegura, 1985:8). By about 15,000 B.C. the climate warmed, thus enabling the glaciers to melt, and vegetation to reclaim the land. The period from 8,000 to 4,000 B.C. probably experienced a warmer climate than at the present, as it is estimated that the northern tree line was considerably farther north than today (Zegura, 1985). Land animals such as caribou moved north during this period, followed by the first humans to occupy the central Arctic.

These Indian hunters spread across much of northern Canada, from north of the Gulf of St. Lawrence, and into Labrador. Others of this same group spread north into what are now the Barren Grounds of the Arctic, from east of the Mackenzie River Valley to Hudson Bay. These people, occupying the northern forest, developed the Shield

Archaic Tradition based upon fishing and inland hunting and were successful in big game hunting and fishing (McGhee, 1978). A lack of Archaeological remains suggests these peoples did not reach beyond the forest environment (McGhee, 1981). Indeed, during the period from 8,000 to 4,000 B.C., McGhee (1978) suggests the Arctic regions were suitable for human habitation and were warmer than at present. Climatic warming culminated with a thermal maximum in the Arctic dated sometime between 4,000 to 3,000 B.C., however, no archaeological evidence exists to show that this area was occupied during that period (Barry *et al.*, 1977; McGhee, 1978). McGhee (1978, 1981) suggests this lack of occupation was due to the length of time necessary for peoples in Alaska and Siberia to adapt to a way of life beyond the tree line, and develop suitable technologies allowing for hunting caribou and more importantly, fish and sea mammals of Arctic waters.

Eskimo Origins (6,000 to 2,000 B.C.)

As stated previously, the warmest climatic period following the last glacial episode is estimated to have occurred sometime between 4,000 and 3,000 B.C. (Barry *et al.*, 1977). During this period, Indian hunters populated the lower continental area of North America, while human settlement of the Arctic was restricted primarily to the coastal areas of Alaska and the Aleutian Islands, peopled by the Aleuts. These peoples of coastal Alaska most likely represent the origins of today's Inuit people (McGhee, 1978). The original name given for these people by non-indigenous peoples was Eskimo.

Anthropological and archaeological work has shown that the Eskimo people were closely related to the Chukchi, Koryak and Kamchadal peoples of northeastern Siberia (McGhee, 1978, 1989). The earliest-known archaeological remains from the coast of the Bering Sea were found at Anangula Island on the eastern edge of the Aleutian islands chain. Artifacts found here have been dated around 6,500 to 5,000 B.C., and represent occupation at a time and place which corresponds well to the theory of a gradual migration across the Bering land bridge (McGhee, 1978). If these people were indeed ancestral to Eskimos, then it is likely that Eskimo peoples developed from this population, developing their own culture as they spread east and southward along the Alaska coast.

Archaeological evidence reveals occupation along the Alaska coast as long ago as 4,000 B.C., resembling the remains found at Anangula Island. While it can be assumed that this was the beginning of Eskimo occupation in the Arctic, it is not clear how these early Eskimos came to be widespread across the Arctic as archaeological evidence suggests that populations of the Canadian Arctic and Greenland were different than those of the early Alaska coast (McGhee, 1978). It is possible that Eskimos may have developed from those peoples who migrated across the Bering land bridge and lived in Alaska as long ago as 4,000 B.C.. It is also possible that those early Eskimos were a different race altogether and the first Eskimos to populate the Canadian Arctic migrated across the Bering straight as recently as 2,000 B.C. (Maxwell, 1985) .

Either way, it is presently known that the immediate ancestors of today's Canadian Inuit migrated across the Arctic from Alaska about 1,000 years ago. Prior to this migration the Arctic was populated by peoples of the Arctic Small Tool Tradition (ASTt),

who expanded east from Alaska about 2,000 B.C. (McGhee, 1978, 1981; Maxwell, 1985). From this period on there is significant information concerning the relationship between cultural development of the Arctic and the influence of climatic conditions on settlement.

The Arctic Small Tool Tradition (2,000 to 800 B.C.)

The first extensive occupation of the Canadian Arctic is attributed to those peoples of the ASTt. It is not certain whether or not these people were ancestral to the Eskimos, but their spatial distribution was widespread throughout the central and high Arctic (McGhee, 1978). ASTt sites have been found in north Alaska, across the northern Arctic, the Arctic islands, Labrador and coastal Greenland. The sites appear to have been numerous from about 2,000 B.C. on. At some point prior to or during their expansion, the ASTt peoples adapted to life beyond the tree-line, hunting caribou, musk-ox on the Arctic islands, and seals (McGhee, 1978). Musk-ox and seals are present throughout the Arctic winter and the ability to hunt them would allow these people to remain above the tree-line throughout the winter season.

Although the thermal maximum was reached between 4,000 and 3,000 B.C., evidence also suggests a major warming episode within the period 2,600 to 1,600 B.C. (Barry *et al.*, 1977). This coincides with the period during which the ASTt carried out their large scale habitation of the Arctic. The ASTt actually developed into two streams of people who may represent two different migrations from Alaska to the east. The Independence 1 culture lightly populated the high Arctic, while the Pre-Dorset culture

populated the lower Arctic regions more densely (McGhee, 1978; Maxwell, 1985).

Independence 1 camps are thought to have been located in northern Greenland, and across Ellesmere, Devon and Cornwallis Islands in the high Arctic. These people were important because the period from about 1,600 to 1,400 B.C. was the first significant climatic episode following the spread of the ASTt across the Arctic. At this time a distinct cooling trend occurred, substantiated by neoglacial moraines on Baffin Island (Barry *et al.*, 1977). During this cool period, the Independence 1 culture appears to have disappeared, while at the same time the Pre-Dorset culture moved south into the barren grounds of the central Arctic (Dekin, 1972; Barry *et al.*, 1977; Maxwell, 1985). This cooler period was followed by a warmer and perhaps drier interval lasting from about 1,200 to 800 B.C. (Barry *et al.*, 1977). During this period there began a large spatial expansion of the Dorset people; basically an extension of the Pre-Dorset which moved south during the previous cool period. By about 800 B.C. the Dorset occupied a large area across the central Arctic and into Greenland. In high Arctic areas the Independence 2 culture expanded where its previous counterpart had contracted during the previous cooler period (Dekin, 1972; Barry *et al.*, 1977; Maxwell, 1985).

The change from Pre-Dorset to Dorset is important because it is likely that Pre-Dorset peoples settled in the central Arctic were affected indirectly by climatic changes. McGhee (1978) suggests those people living in the barrens were dependent upon caribou for their survival. A shift to a cooler period, such as that proposed around 1,000 B.C. by Barry *et al.* (1977), with corresponding movements in the tree-line south and changes to caribou migrations, may have led to mass starvation and a return to more northern coastal

areas where sea mammals could be hunted. The areas of Hudson Straight and Foxe Basin are where the Dorset culture flourished, these being rich in marine resources (Dekin, 1972).

The Dorset Culture (800 B.C. to 1,000 A.D.)

By about 700 B.C. the Dorset culture had replaced the Pre-Dorset as a warmer climate allowed for expansion across the Arctic once again. Dekin (1972) suggests that "climatic changes may have caused shifts in subsistence adaptations and other cultural changes which then were spread to other regions by increased cultural interaction or even migration during the warmer period." At this point there was general cultural homogeneity across the eastern Arctic, represented by the Dorset culture (Dekin, 1972).

The period from about 700 to 100 B.C. represents a major change in climatic conditions across the entire Arctic (Dekin, 1972; Barry *et al.*, 1977; Maxwell, 1985). This period of cooling may be responsible for a southward retreat in location of the tree-line, and a sudden disappearance of Independence 2 sites in the high Arctic (Barry *et al.*, 1977; Schledermann, 1990). This period also saw the spread of Dorset people southward into southern Labrador and Newfoundland (Maxwell, 1985).

A warming trend from about 100 B.C. to 500 A.D. coincided with a period during which Dorset settlement became more widespread covering an area from Newfoundland as far north as Greenland and Melville Island, and south into northern Manitoba (Dekin, 1972; Schledermann, 1990). This period represents what was probably the greatest extent

of Dorset culture, including even the high Arctic (Schledermann, 1990). The following period was to bring about a change in climatic conditions. However, this was an important episode because McGhee (1978) suggests that as the climate cooled slightly, Dorset settlement was not affected, indicating adaptation of a level that allowed for survival under colder conditions.

The Thule People (1,000 A.D. to 1,600 A.D.)

The precise origins of the Thule culture are difficult to identify, however, it is assumed that the Thule people developed in the Alaska area, from where they migrated rapidly across the Arctic to the east during a period of climatic warming (McGhee, 1978). From about 900 to 1,200 A.D. evidence shows climatic change throughout the northern hemisphere, with mean summer temperatures about 1^0 to 2^0C warmer than at present (McGhee, 1970). Northern Canada experienced similar temperature increases with a corresponding movement in the tree-line about 100 km north of its present position. Drift ice was reduced in the north Atlantic, and pack ice rarely extended as far south as the coast of Iceland. This lack of drift ice allowed for the Norse to settle on the coasts of southern Greenland (Maxwell, 1985) at the same time that the Thule culture made a single rapid migration across the Arctic from Alaska to Greenland (McGhee, 1970).

McGhee (1970) and Maxwell (1985) suggest the development of Thule culture was strongly linked with the development of techniques for hunting large whales from boats in open sea conditions. This knowledge was present in Alaska prior to 1,000 A.D. but

was not of much advantage until the warm period from 900 to 1,200 A.D.. A longer ice free season resulted in greater open leads in northern waters, thus allowing greater numbers of marine mammals to be harvested (Maxwell, 1985). Given the large size of a bowhead whale, which was most frequently hunted, there was ample food to provide for the winter season. The same ice free conditions of this warmer period allowed these large whales to migrate further into Arctic waters than before, thus providing resources for the expanding Thule people. McGhee (1970) Dekin (1972) and Maxwell (1985) have suggested that with warmer conditions, bowhead whales moved further along the north Alaskan coast towards the Beaufort Sea. The migration of Thule people eastward may have been a result of their following the bowhead whales in order to enable hunting all summer long. This may have been necessary because as the whales moved further along the coast, they became numerous along coastal Alaska only during the short spring and fall, rather than spending entire summers in that area.

By 1,200 A.D. there was a return to colder conditions lasting until about 1,600 A.D.. This period also witnessed the greatest spatial extent of Thule culture, with these peoples being widespread across the northern coastal Arctic. While a strong dependence upon whaling has been indicated by dwellings made of whalebone and sod at Thule sites, there was also a gradual transfer to a system of subsistence where whaling was less important (Maxwell, 1985). Ringed seals where hunted when colder conditions increased pack ice or in areas where whaling was not possible (McGhee, 1970). By the end of this period, permanent sod/whalebone houses had given way to the use of snow houses and

the quarmat[2] in many areas. As climatic conditions continued to become cooler, more importance was placed upon winter seal hunting rather than whaling.

The Inuit (1,600 to 1,900 A.D.)

The Thule people are responsible for the cultural heritage of the Inuit which is based upon a way of life that originated in Alaska and spread rapidly across the Arctic as far as Greenland (McGhee, 1978; Maxwell, 1985). The similarity in these peoples can be seen in both their general subsistence patterns and languages which are based upon the Inuktitut dialects spoken by all Inuit from Greenland to the Bering Straight. The first knowledge of these indigenous peoples was provided by early European explorers who described a number of different Aboriginal groups across the Arctic. These different groups were actually small regional variations of the overall Thule peoples resulting from the formation of local Inuit groups following what became known as the "Little Ice Age" between 1,600 and 1,850 A.D.. This cold episode saw a change from whaling to winter seal hunting as well as a trend towards larger communal housing (McGhee, 1978; Schledermann, 1990). This cold period also eliminated the Norse settlements in Greenland along with Thule occupation of the high Arctic.

During this cold period, glaciers advanced on the Arctic islands and the tree-line shifted south to its present position. The extent and duration of sea ice in the Arctic increased significantly to the point where whaling was practically impossible (Maxwell,

[2] The quarmat was a skin-roofed sod/stone, snow or ice block structure originally used as a temporary autumn dwelling.

1985). The disappearance of bowhead whales, combined with an increase in ringed seal populations which live and breed beneath winter ice, resulted in a shift to seal hunting as well as hunting caribou and musk-ox in the interior. These species became the mainstay of Inuit subsistence even in areas where their ancestors had hunted whales from boats in open water (Maxwell, 1985).

The response of the Inuit to environmental changes was to develop a series of local cultures, each adapted to their own area, thus resulting in the scattered series of Inuit groups across the Arctic first discovered by European explorers. Figure 3 shows the general groupings of Inuit occupation as recently as 100 years ago. Each of these groups developed subsistence activities particular to their local environment. For example, the Labrador Inuit changed from the traditional Thule style of winter house to the large rectangular house designed to hold several families. This was an indicator of increased dependence upon the communal hunt which was no longer supported by whaling, as ice conditions made whaling more difficult (McGhee 1978).

As in Labrador, the Inuit of Baffin Island were dependent upon whaling for their primary form of subsistence, however, during the little ice age they moved to larger multi-family dwellings which enabled scarce resources to be shared. The Inuit of the central Arctic differed markedly from other Inuit as they developed subsistence patterns based upon hunting caribou and walrus, which were more plentiful in their region (Maxwell, 1985). The Mackenzie Eskimos were similar to the Alaskan Eskimos, maintaining

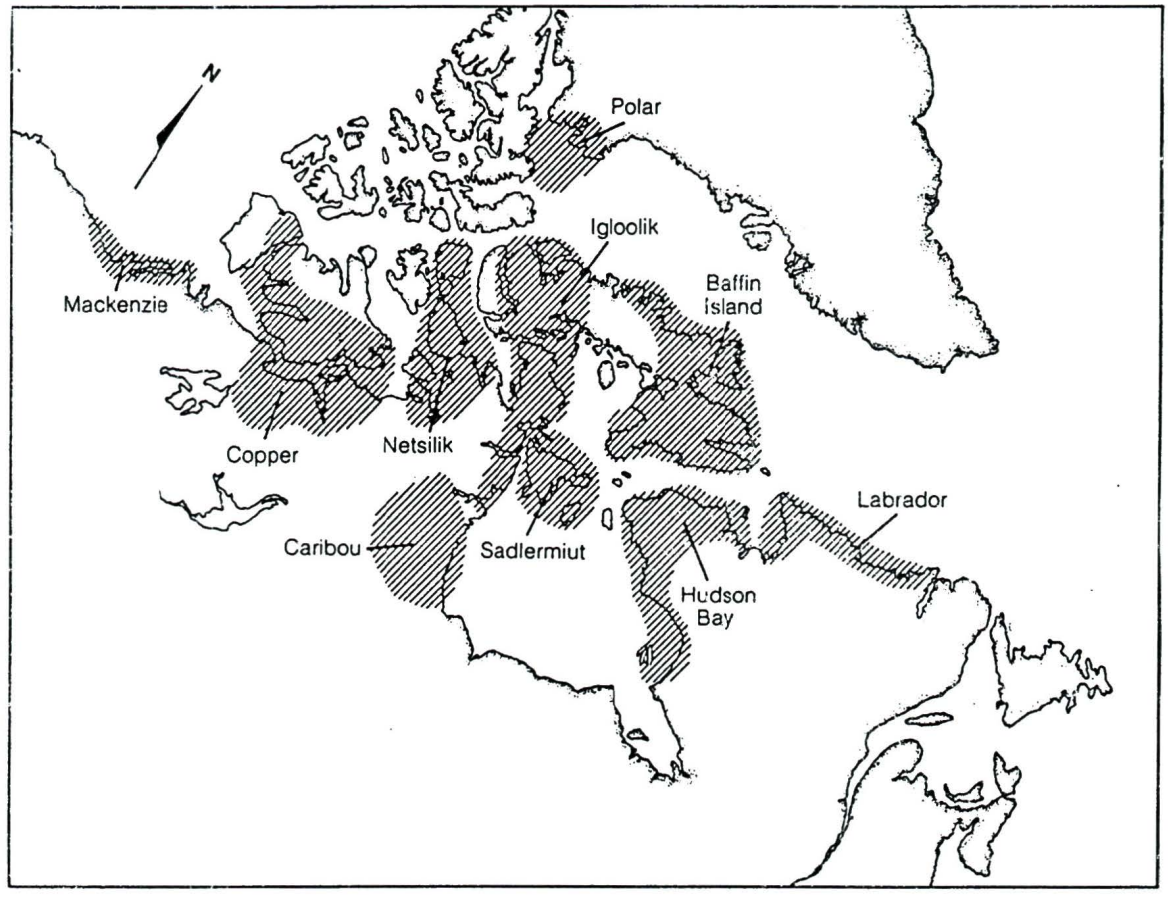

Figure 3 Historic Inuit groupings of Arctic Canada (McGhee, 1978:104)

subsistence based on whaling in the Beaufort Sea as well as some hunting of inland caribou.

The Thule people and their Inuit descendants represent the most advanced form of indigenous adaptation to Arctic environmental conditions, where even the cold climate of the little ice age resulted only in a movement away from the high Arctic, followed by strong adaptation to particular regions occupied by each sub-group (McGhee, 1974).

The Significance of Climatic Conditions

Throughout this often confusing history of prehistoric Arctic occupation, it is important to note that some of the ideas presented here are speculation, based on the limited information known about these peoples and the environment in which they either thrived or declined in both numbers and spatial occupation. Paleoeskimo culture in the eastern Arctic can be described as an expansion and contraction of cultures given environmental conditions for which climate was a significant factor. Barry *et al.* (1977:199) describe the eastern Arctic as "consisting of a core area of cultural and resource continuity surrounded by marginal areas which have undergone repeated periods of occupation followed by abandonment." This climatically induced model suggests that favourable conditions allowed the expansion into marginal areas, followed by a retreat to the core area during colder climatic conditions. This model is overly simplistic because there are other factors such as adaptation which resisted the negative affects of climatic deterioration.

Indeed, on two occasions, a colder climate did not result in a reduction of spatial occupation. The Dorset culture continued to flourish during the cool period of 100 B.C. to 500 A.D., as did the Thule culture during the cold period from 1,200 to 1,600 A.D. In both cases adaptation to climatic conditions allowed for areas where subsistence was marginal, to remain occupied with only minor negative effects on the overall population (Barry *et al.*, 1977; Maxwell, 1985).

The primary points to consider here are that even our limited knowledge of palaeo-eskimo history reveals the importance of climatic conditions upon the survival of these peoples, and adaptation has been a major factor in the development of the indigenous cultures which inhabit the Arctic today. More work needs to be done in terms of dating prehistoric settlements in the Arctic to increase our knowledge of where and when these people actually lived, however, it is also obvious that there have been several instances where climatic conditions are known to have been responsible for cultural development and displacement. The abandonment of the high Arctic during a cold interval by the Independence 1 culture and the elimination of Norse settlements from northern Greenland are two such examples.

With a basic understanding of the significance of climatic conditions upon the historical occupation of the Arctic, a community in the present day Arctic can now be examined in detail. Strong similarities can be seen to exist between the present occupants of the Arctic and their historical ancestors. The role that adaptation continues to play is important not only in terms of climatic conditions, but also for the cultural survival of these peoples.

Chapter Five

PAST AND PRESENT LAND USE OF THE PEOPLES OF AKLAVIK

Prehistoric settlement of the Arctic described previously was influenced by constantly changing environmental conditions. These changes shaped the spatial extent of indigenous occupancy in the North and the cultural traits associated with these peoples. Recent history of the western Arctic (1850 to present), particularly the Mackenzie River Delta area, has been more strongly influenced by changing social and economic factors. Despite these changes, the spatial extent of land occupied by these people and used for subsistence activities has remained basically unchanged, illustrating the importance of these activities. This chapter will describe the recent history of indigenous settlement, culminating with the present day community of Aklavik. The continued importance of subsistence activities and the spatial extent of the community's land use will be described in relation to socio-economic changes which have taken place from 1850 to the present.

For this discussion, land use refers to the spatial area occupied by indigenous peoples and used for subsistence activities (hunting, trapping, fishing and gathering). Prior to large scale settlement in communities beginning in the 1950's, most Aboriginal peoples lived in seasonal camps, changing locations to correspond with wildlife movements and the seasons. The exception would be the Mackenzie Eskimos, some of whom occupied a single location year round (McGhee, 1974).

The community of Aklavik NWT. is located on the western side of the Mackenzie River Delta at approximately 68°N, 135°W; about 2000 km north of Edmonton, Alberta, by air. The area surrounding the community is boggy, containing over 25,000 small lakes (Lesack *et al.*, 1989). Vegetation is dominated by the most northerly reach of white spruce forest and small plants common to the Delta area such as lichens, crowberry, labrador tea, arctic bearberry and bilberry plants (Pearce, 1989). The Delta is a complex arrangement of lakes and channels located within the zone of continuous permafrost. These lakes occur at a number of different elevations relative to the main river channels; some at or below mean channel level, and others a number of metres above mean channel level. This natural variability among lake levels is an important feature in the hydrological regime of the Delta; the lakes rely on annual flooding to recharge and exchange nutrients as annual precipitation is not sufficient for a positive water budget. Main river channel levels, and ultimately lake levels, are driven by: (1) snowmelt and rainfall run-off in the overall Mackenzie Basin; (2) ice jams in the delta; and, (3) storm surges in the Beaufort Sea (Marsh & Hey, 1989).

Annual flooding is important for the Delta hydrology; however, it has caused serious problems for Aklavik. One of the deciding factors in the creation of "New Aklavik" (Inuvik) was the flooding which threatens the present community of Aklavik each year. A regular ten-year flood has resulted in strict building codes within the community, which requires each building to be elevated at least six feet above ground level (otherwise they do not qualify for insurance). Serious flood events have caused large numbers of residents to be evacuated from the community for several days at a

time during spring ice break-up. The annual climate is cold, with an average annual temperature of approximately -10°C. Below freezing temperatures are typical from October through late April, with extremes reaching into the -40s and -50s. Spring break-up in the Delta generally occurs in early June, with the warmest months being June and July. Temperatures do not rise above 20°C frequently, but they have reached up to 33° and 34°C on several occasions. August sees the return of cooler temperatures with nights exhibiting below freezing temperatures. Freeze-up in the River generally occurs in early October with frozen ground and snow accumulation by late in the month. Annual precipitation is low in comparison with more southerly latitudes. The period of June through October receives about 60% of the annual precipitation while the winter months are relatively dry (Smith, 1993). Aklavik receives approximately 260mm of precipitation per year, as compared with 488mm annually for northern Alberta.

The Origins of Aklavik NWT.

At present, the community of Aklavik is comprised primarily of two aboriginal groups. Out of a total population of about 780 (Outcrop, 1990), the majority of the people in the community are Inuvialuit; the Inuit of the Western Arctic (59%). The Gwich'in people, a group of the Dene Indians, form the next largest proportion (29%). There are also a small number of Metis and non-aboriginal individuals (12%) (Outcrop, 1990). In order to understand the development of Aklavik and the present land use in the community, the historical development of the Mackenzie Delta and Aklavik will be

explained following the development of the two primary groups found here; the Gwich'in and the Inuvialuit.

Prior to the fur trade which began about 1840, The Mackenzie Delta was a relatively unoccupied area, acting somewhat as a buffer zone between the Mackenzie Eskimos [Inuit (Inuvialuit)] to the north and the Kutchin [Gwich'in Indians (Dene)] to the south (Usher, 1970). Although both these peoples occupied the northern and southern sections of the Delta for certain parts of the year, the central area of the Delta remained unoccupied; the focus of their activities remained elsewhere.

The Gwich'in

The Indians of the western Arctic occupy a region from east of Yellowknife to the western side of the Mackenzie River Valley and northwest following the Mackenzie River Valley. These Indians are now known as the Dene Indians of which there are five sub-groups in the Mackenzie Valley. In the northern Mackenzie Valley there are two groups; the Sahtu and the Gwich'in. The Gwich'in people are the most northerly of these groups and have traditionally occupied an area to the west of the Mackenzie River, extending into the mountains between the Peel and Yukon River drainage basins (Usher, 1970). The Richardson and Ogilvie Mountains formed the primary hunting areas for these people. Prior to being called Dene Indians, the people now referred to as Gwich'in used to be known as Kutchin, or sometimes the Peel River or Red River Kutchin.

The Kutchin had occupied this area for at least several hundred years prior to the mid 1800s. They were a hunting people, following caribou for much of the year. The

primary hunting season was in winter when caribou would travel into the Richardson Mountains to feed. Fishing and small game hunting filled the void at times of the year during which caribou were not plentiful, although those occasions were rare. Muskrat trapping took place in the lower Peel River and the upper Delta, but the central Delta area remained unoccupied (Usher, 1970).

The advent of the fur trade caused changes to the Kutchin in that they now had a reason to travel more frequently to Fort Macpherson, where a trading post had been established in 1840 (Usher, 1975). Their land use was subsequently modified to include trips to Fort Macpherson to trade furs and skins. However, it was not until the Klondike Gold Rush of 1898-99 that there was a significant change in the land based activities of the Kutchin.

The gold rush caused a change in the spatial extent of land use away from the Peel River to the Klondike, where many Kutchin went to guide prospectors to Dawson City. This change lasted about three decades, as many of the Kutchin who guided prospectors to Dawson City remained on the other side of the mountains to hunt and trap. It is estimated that about half the Peel River Kutchin moved to Dawson City during this time (Crowe, 1991). These people were encouraged not to return to the Peel region because of the high price to be received for meat in Dawson City, and the chance of acquiring discarded gear from failed gold miners (Usher, 1968). Following 1910, the Dawson City gold boom ended and the Kutchin gradually returned to their more traditional areas around the Peel River. At this time the fur trade began to expand into the Delta and more of the Kutchin became involved in trapping activities in the upper and central Delta,

where there had been no year round occupancy until the fur trade began to boom in the early 1910s (Usher, 1968). By the 1920s the Kutchin commonly travelled into the central Delta area to hunt and trap furs and trade at posts located in Fort Macpherson and Aklavik.

The Inuvialuit

Respondents in Aklavik of Inuvialuit background explained their position amongst the aboriginal peoples of the Arctic. The Inuvialuit are the Inuit of the western Arctic. The Inuvialuit are significant to the western Arctic because they successfully ratified a comprehensive land claim agreement in 1984 which gave them title to a large area of the Mackenzie Delta-Beaufort Sea[1]. Six communities are present in the Inuvialuit Settlement Region, and Aklavik is the most southerly of these, bordering an area for which a land claim was recently ratified by the Gwich'in Tribal Council representing the Gwich'in Indians. The Inuvialuit now living in Aklavik are descendants of Alaskan Eskimos who migrated into the region in three waves over the past 100 years. The original inhabitants of the lower Delta and coast were the Mackenzie Eskimos who were largely wiped out by disease, and acculturated by the migrating Alaskan Eskimos (Freeman *et al.*, 1992).

A detailed examination of Inuit history in the western Arctic is provided below to explain how the majority of the residents of Aklavik came to be there, as well as to illustrate their pattern of land use.

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[1] The Inuvialuit Final Agreement was ratified in 1984 and defines the Inuvialuit Settlement Region as well as cash compensation, resource rights, land administration and social services.

The Mackenzie Eskimos

Prior to the arrival of Europeans in the 19th century, the Mackenzie Eskimos populated the coast of the western Canadian Arctic from Barter Island to Cape Bathurst (Figure 4). Some estimates of their population range as high as 4000, although it is now thought that the actual number was probably closer to 2500 (McGhee, 1974, Usher, 1970). That number is still larger than all the Eskimo people thought to inhabit the Arctic from west of the Mackenzie River Delta to Hudson Bay at that time. Despite their large numbers, there is little known about these people due to a period of severe epidemics which swept through the region in the late 19th and early 20th centuries. By about 1910, only a few survivors remained, and these became scattered amongst Alaskan Eskimos as they migrated into the Mackenzie Delta in the company of European traders and whalers (McGhee, 1974).

Figure 5 illustrates the five groups of the Mackenzie Eskimos as described by Usher (1970) and McGhee (1974). Information on these peoples is compiled from existing limited sources: the memories of a few elders who recalled late 19th century life; casual descriptions by early explorers and traders; the works of Father Emile Petitot, whose knowledge is now thought to be rather superficial; and ethnographic notes taken by Stefansson, Jenness and Rasmussen (McGhee, 1974). Each of these five Eskimo groups occupied a distinct area of the western Arctic coastline and adapted land use particular to their locations (McGhee 1974). Each group is described based upon their

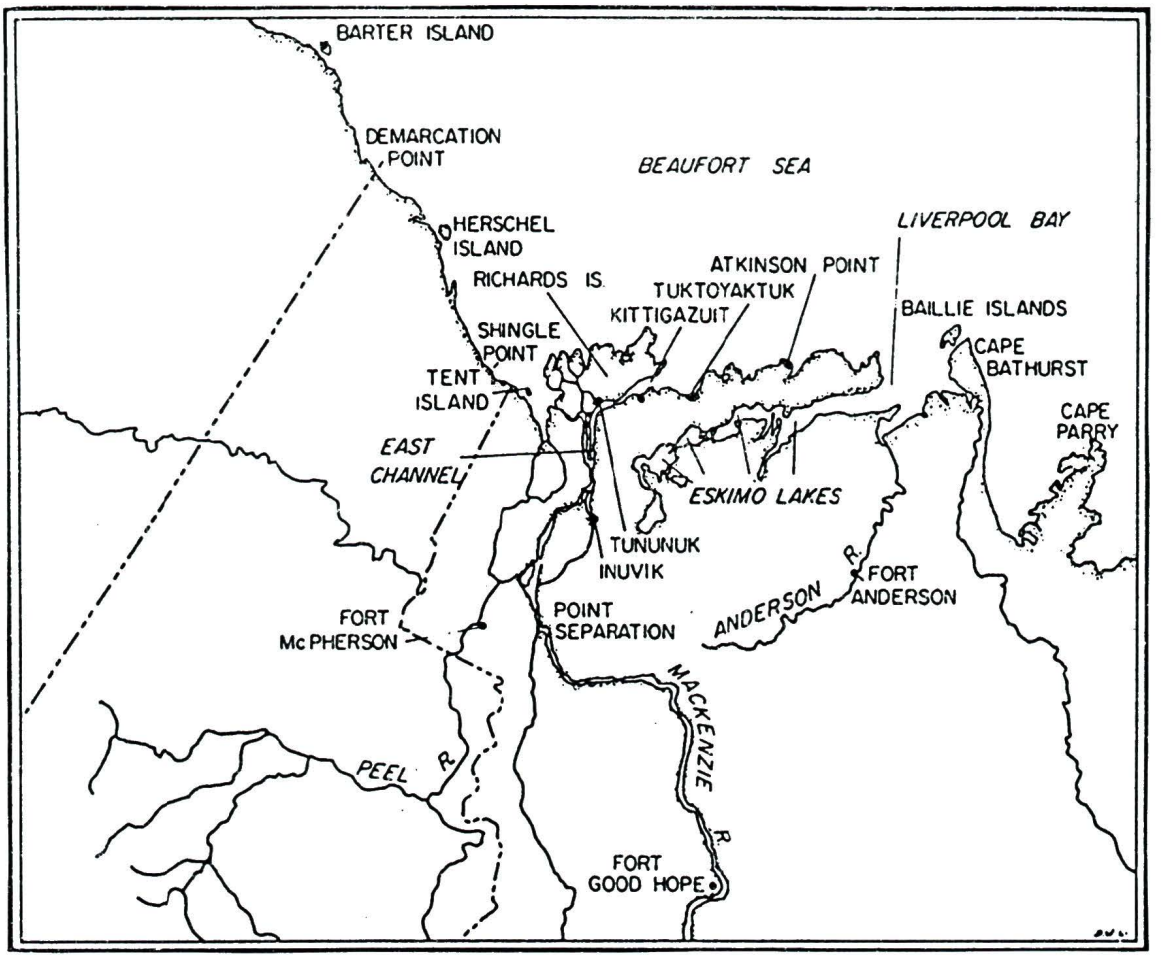

Figure 4 Modern place names in the Mackenzie Delta area (McGhee, 1974:3)

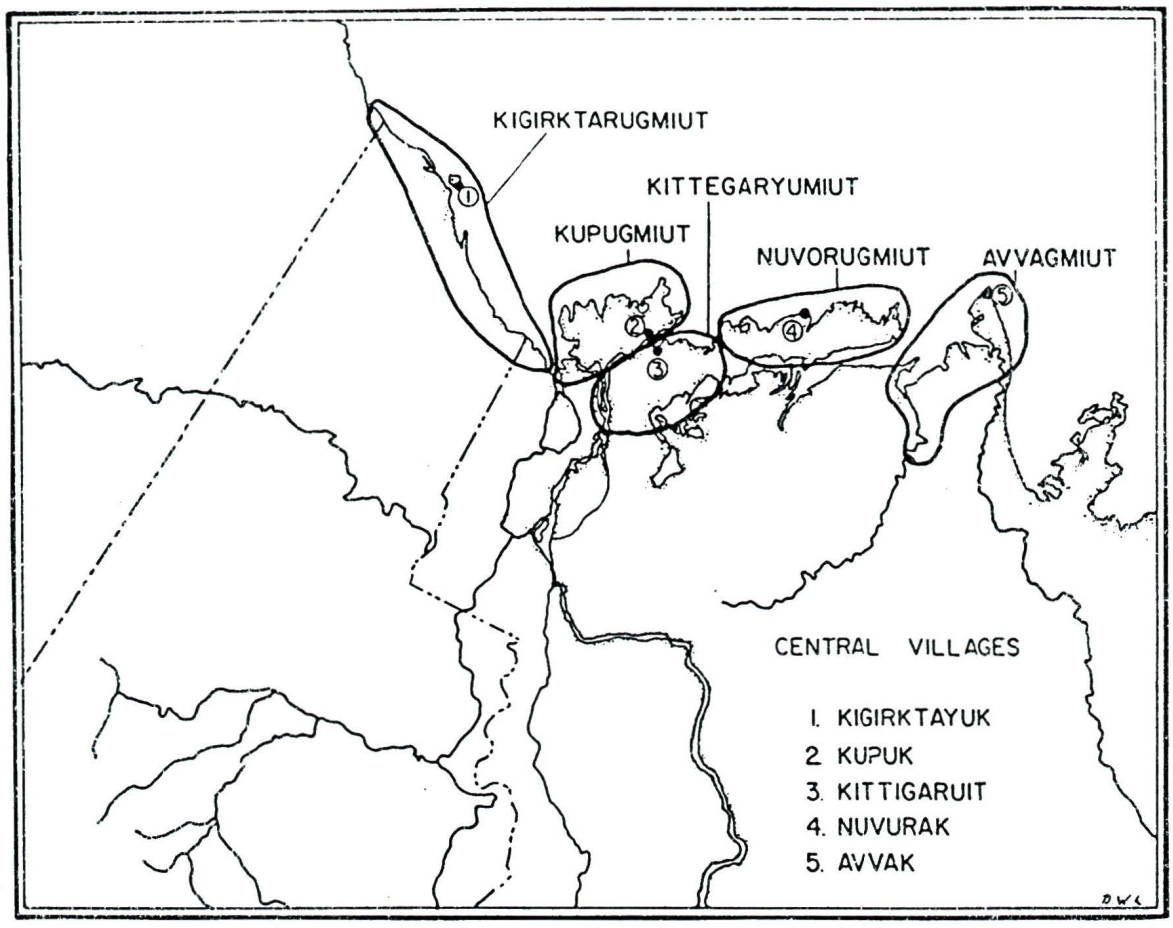

Figure 5 Historic groupings of the Mackenzie Eskimos (McGhee, 1974:9)

location from west to east:

1) The Kigirktarugmiut were the most westerly of these groups and numbered about two to three hundred persons (McGhee, 1974). They occupied the coastal area from Shingle Point west to Demarcation Point, probably in small camps of several families. These camps were most likely located in good fishing areas, as the ocean provided much of their diet. Fishing with gill nets as well as hunting seals and beluga whales were their primary activities. Caribou were also hunted as they approach the coast in this area on a nearly year-round basis. As well, it is likely that whenever possible, a bowhead whale would have been taken, although these were not as plentiful as beluga. With the wide variety of resources available to them, it is thought that these people did not have seasonal camps, but were able to remain in one primary location year round.

2) The Kupugmiut were the second of these groups occupying Richards Island at the mouth of the East Channel of the Mackenzie Delta. Confusion exists regarding the existence of these people and the third group, the Kittegaryumiut, as it is thought that they practised very similar seasonal activities, but had somewhat of a feuding tradition (McGhee, 1974). The major distinction is that the Kupugmiut hunted on Richards Island while the Kittegaryumiut hunted around the Anderson River.

3) As described previously, the Kittegaryumiut shared similar activities with the Kupugmiut, but in a slightly different location. They occupied the east channel of the

Mackenzie River as far as Tuktoyuktuk, and southward to include the Eskimo Lakes. Their main settlement, Kittigaruit, was reported to be the largest settlement in the region, with a summer population of about 800 to 1000 people (McGhee, 1974). The summer months would have seen some use of the forested area of the Delta as far south as the narrows near Arctic Red River, which was a boundary of sorts between the Eskimo territory and that of the Kutchin. Subsistence for these people was based primarily on beluga and fish, as well as some caribou and small game. The beluga hunt during mid-summer was a communal event, as after whaling season the population dispersed to separate on inland areas where they would fish and hunt caribou.

4) The fourth group were the Nuvorugmiut which occupied the general area of the Tuktoyuktuk Peninsula. Their land use differed from the previous groups as they were not whalers, but subsisted primarily on caribou and fish. These were taken from inland locations during the summer months, followed by winter locations on the coast where they would fish and catch seals. It is also thought that this group travelled to Kittigaruit during the early winter to trade their caribou and seal skins for beluga skins.

5) The Avvagmiut were the most easterly of the Mackenzie Eskimos, occupying the Cape Bathurst area and the inland area southward towards the Anderson River. These people were thought to have been highly dependent on hunting bowhead whales in summer, as well as seal and walrus. In autumn, caribou hunting took place inland, but people would move to the coast again in late winter to hunt seals on the sea ice. This would continue

until break-up when they would hunt caribou inland again until it was time for the bowhead hunt in mid-summer.

McGhee (1974) states that these five groups of the Mackenzie Eskimos were probably the most complex of the Eskimo groups to be found in the Canadian Arctic. Their location on the Beaufort Sea provided a diverse range of resources from both the sea and land, and allowed for most to live in large groups almost year round with only small seasonal movements (Crowe, 1991). It is thought that due to their location in an area rich in both food and fuel, they established strong cultural traits and a level of technology more advanced than Inuit in the eastern Arctic who had fewer resources to use for subsistence. These people were able to live in larger groups with only minimal seasonal movements, thus allowing for a more elaborate social life. Features particular to these people were large homes built of logs and dirt, kayaks of a different design from those found in the eastern Arctic and clothing and social rituals which were much more elaborate than Inuit of the eastern Arctic (Crowe, 1991).

Outside Contact (ca. 1840)

In 1840, the Hudson's Bay Company built Peel's River Post (Fort Macpherson) at the head of the Mackenzie Delta; however, it would be another decade before the Mackenzie Eskimos had any contact with Kutchin Indians and the trading post. By the 1850s, a small number of Eskimos would travel to trade at the post but direct contact was rare as the Kutchin and Eskimos did not exhibit friendly relations at the time. It is likely

that the Kutchin were trying to monopolize trade at Fort Macpherson, as several instances of Kutchin firing upon and killing Eskimos were reported in the area. Another explanation has also been that the Eskimos did not like to trade there as they felt the Indians had all been poisoned by "fire-water" (McGhee, 1974).

White traders realized that strong potential existed for trade with the Eskimos, therefore, despite a slow and steady growth in trade at Fort Macpherson, a new trading post was established at Fort Anderson in 1861. This post was successful but closed in 1866 with the post at Fort Macpherson experiencing a substantial increase in business thereafter. At this time the feuding differences between the Eskimos and Kutchin became less important as their need to trade became more significant. As well, during this period the first of several large measles epidemics struck the Eskimos. Traders at Fort Anderson were affected by this disease in 1865, and in 1868 and 1871 subsequent epidemics were serious enough for the Eskimo whale hunt to fail for two years in a row (McGhee, 1974).

The Whaling Industry (1848 to 1910)

These epidemics which were affecting the Mackenzie Eskimos were only the beginning of their population decline. The whaling industry in the Beaufort Sea brought about devastating changes for the indigenous peoples of this area. In 1848, the ship *Superior* sailed into Bering Strait and discovered a largely unexploited stock of bowhead whales. The Alaskan Eskimos had been hunting the bowhead from at least 500 B.C., but the following sixty years would see both the bowhead and several Eskimo peoples reach the verge of extinction (Bockstoce, 1986).

By 1875, the outlook for the Arctic whaling industry was bleak. The seemingly endless numbers of bowhead to be taken from the Bering Sea had been reduced to the point that catches for the whaling fleet were poor at best. The invention of steam powered ships enabled the whaling fleet to travel much further into the Chukchi Sea where short summers and pack ice had made travel there almost impossible. By the 1880s, whalers had heard rumours from Eskimos that there were large numbers of whales further east of Point Barrow on the north slope of Alaska, but again, they were extremely difficult to reach. The fleet did sail the waters of this area east of Point Barrow, but ice prevented them from reaching further than Barter Island in 1886 (Bockstoce, 1986). The following year a single whaleboat headed east from Barter Island on the accounts of Eskimo hunters who said they had seen large numbers of whales in Mackenzie Bay. This single ship overwintered in the Delta and returned with news that not only were the whales "thick as bees", but that there was a good supply of driftwood and an excellent harbour to be found at Herschel Island (Bockstoce, 1986).

Until 1889, ships had been reaching almost into the Beaufort Sea and Mackenzie Delta, but it was not until late 1889 that the whaling fleet began to overwinter at Herschel Island. This event coincided with the start of the first of three large waves of Alaskan Eskimo migration. Previously, there existed a large amount of dependence on the whaling ships by Alaskan Eskimos. These people had become dependent on the ships for goods such as firearms, ammunition, wood working tools, needleclothes, knifes and other items. In return, many Eskimos were employed by the ships as deckhands, or as hunters to supply them with fresh meat. This interaction also led to the negative effects of alcohol

and disease (Bockstoce, 1986).

When ships began wintering at Herschel Island, Eskimo employment in the whaling industry increased rapidly. Whaleboats would employ entire families of Eskimos to work on board as well as to hunt caribou to feed the crew. The pressure for employment was great enough that many Alaskan Eskimo families followed the whaling ships along the coast from Point Barrow to the Mackenzie coast. By 1895, the need for hunters was so great that most of the Point Barrow Eskimos were at Herschel Island, as were nearly one hundred from Point Hope. Many others simply moved to Herschel to live (Bockstoce, 1986). This migration was made much more necessary by the fact that the whaleboats had already reduced the number of bowhead and beluga off the north slope of Alaska, as well as other important subsistence resources such as caribou (Freeman *et al.*, 1992).

The Rise of Trapping (1910 to 1950)

The whaling industry at Herschel Island was short-lived. By 1910 there were few bowhead left in the region, and the once numerous ships retreated back to San Francisco, leaving behind only those individuals who remained to trap. At this time the fur industry was beginning to boom in the Delta region. As the whaling industry drew to a close, some whalers supplemented their activity with increased involvement in the fur industry. As a result, when the whaling industry collapsed completely, most of the whalers remaining in the area were already involved in trapping. The Eskimos formerly employed by the whalers were left with no choice but to trap for furs in order to maintain access

to needed trade goods. Over time, most of the whalers-turned-traders left the coast altogether (Freeman *et al.*, 1992).

By this point, the few remaining Mackenzie Eskimos had been completely replaced by Alaskan Eskimos who migrated with the whalers (Freeman *et al.*, 1992). The Mackenzie Eskimos, who once numbered around 2500, are thought to have been reduced to about 250 in 1905 and 150 in 1910. This was due primarily to two devastating measles epidemics in 1900 and 1902 (Usher, 1968). Those left by 1910 were simply acculturated into the Alaskan Eskimos as they moved along the Arctic coast from Alaska and into the Mackenzie Delta.

The second wave of Alaskan Eskimo migration took place from 1913 to 1923. With the end of whaling, the trading which used to take place between the whalers and aboriginals was replaced by trading for furs. One important whaler, Captain Pedersen, remained in the region until 1936, trading from his ship. He was credited with preventing the Hudson's Bay Company from obtaining a complete monopoly over trading in this region until he too left. Pedersen's independent trading company kept the post at Herschel Island supplied as well as those at Point Hope and Point Barrow. These trading posts along with those in the Delta at Aklavik and Fort Macpherson became central points during the fur boom. Aklavik itself became the central trading centre for this region (Usher, 1970). During this time more Alaskan Eskimos moved into the Delta because of the need to trap furs in order to maintain their trading. By 1924, 75% of the people in the Delta were of Alaskan origin, primarily from the Kobuk and Noatak River drainages, and from coastal communities from western Norton Sound, Bering Straight, Point Hope

and Point Barrow (Freeman *et al.*, 1992). This migration was brought about not only because of the need to trap and trade, but also because these subsistence resources were no longer available in the traditional areas in Alaska, having been depleted by the need to feed the crews of the whaling ships. The Delta however, was found to be an area of great abundance for trapping and hunting with its access to both the Delta and the Arctic coast.

During the 1920s and early 1930s the fur trade flourished in the Delta. Settlement was basically scattered with most aboriginal peoples living in seasonal camps throughout the Delta, while non-aboriginals were centred around the communities of Aklavik and Fort Macpherson. During this period of growth in trading, many of the Alaskan Eskimos were among the wealthiest people, with annual incomes well into the tens of thousands of dollars. These peoples were known to have learned from their experiences with the whalers how to conduct trade and financing. Of the 45 Eskimo families trading at Aklavik in 1923, most were reported to own schooners valued at between $2000 and $7000 each, and some had bank accounts in Seattle (Freeman *et al.*, 1992). By 1924, the fleet of vessels owned by Eskimos in the Delta numbered 35 schooners and 28 whaleboats valued at a total of $128,000, all of which had been purchased with the proceeds from trapping within the previous five years (Freeman *et al*,. 1992). "The 1930s represented the heyday of Aklavik as schooners came in from Banksland (Banks Island) after breakup and Delta Eskimos came in to trade muskrats before setting off for summer (beluga) whaling camps" (Wolforth, 1971:66). Today, the remains of a schooner still sit in a grassy lot near the centre of Aklavik.

In the late 1930s and early 1940s the third and final wave of Alaskan migration took place. Fur prices took a sudden drop, resulting in the end of traders coming to Herschel Island. Captain Pedersen quit his trading business in 1938 and as a result a number of outposts to the west of Herschel Island were left with no place to trade. The last Alaskan Eskimo people to travel to the Delta did so in order to continue their trading, which by this time occurred solely in Aklavik. By 1949-50 there were 36 trappers of Alaskan origin living in Aklavik; they had secured their position as the primary Inuit group in the Delta, maintaining Aklavik as their centre of activity (Freeman *et al.*, 1992).

The Modern Era (1950 to present)

By the 1950s Aklavik was the predominant centre in the western Arctic. Its development had been such that it was more than an "alien" outpost. At its inception, Aklavik was a trading post for the Hudson's Bay Company and the Northern Trader's company at Pokiak Point, opposite the present location of the town (Usher, 1970). The posts were moved across the river when it was found to be too shallow for docking. Besides the typical trading post, churches and R.C.M.P. office, Aklavik was the first community in the western Arctic to have a post office, a physician, a government sawmill, schools, hospital and a military radio station. In 1929, scheduled air service to Fort McMurray, Alberta, was implemented providing eight mail deliveries each winter rather than the two formerly brought in by dog team (Arctic Summer School, 1975).

Aklavik, however, was becoming less suitable as the capital of the western Arctic due to its size limitations and flooding problems. While trapping was becoming a much

less important activity and all but the large trading posts had closed, the federal government maintained five departments there; Resources Development, Transport, Health and Welfare, Defense and the R.C.M.P. The expansion of those facilities resulted in major building problems for the community (Arctic Summer School, 1975). Inadequate sewage facilities, river bank erosion, flood risk and inadequate space for roads and building pads restricted future growth. The federal government formed the Advisory Committee on Northern Development which decided to move Aklavik to a new location. In 1953, initial preparations for the building of New Aklavik were made.

The name "New Aklavik" was changed to Inuvik when it became apparent that not all those living in Aklavik would leave. The town remained as a fur trade centre, but this activity has declined steadily since the 1950s. By the mid 1950s the aboriginal peoples, both Inuit and Kutchin, were beginning to settle more frequently in Aklavik and Inuvik, as they offered schools, health care and social services. In 1974, the population was 780, with 520 classified as aboriginals, including Indian, Metis and Inuit. The 1986 census lists the population as 783, with 88% of the total population being aboriginal (GNWT, 1991). At the present time the town administration estimates the population to be about 900, with an even greater proportion of the total being aboriginal than in 1986.

Facilities today include water supplied from a nearby lake which is delivered by truck to each building in the community, and electricity supplied by a diesel generating station in town. There is also an R.C.M.P. detachment, hospital and community centre. Supplies for the town are provided primarily by barge from Hay River during the open water season from July to October. Regularly scheduled flights to Inuvik deliver mail

three times per week. As well, there is schooling available from kindergarten through grade nine. Those who continue past that level travel to Inuvik or Yellowknife for high school or further education.

Community Structure

The Inuvialuit and Gwich'in residing in Aklavik do not exist as two separate groups. In Aklavik, the community is managed by an administration which incorporates both groups. The actual Hamlet of Aklavik sits on municipal lands under the ultimate control of the government of the Northwest Territories. The Hamlet administration oversees operations of public services and is funded by the territorial government as well as the Inuvialuit Regional Corporation and the Gwich'in Tribal Council.

The wage economy is minor when compared to a similarly sized community in southern Canada. Given the present approximate population of 900, there are only about 150 wage jobs available in the community. These are primarily for services such as the two stores, aboriginal band offices, school, health care facility, and provision of water and fuel. There is some employment in handicrafts, transportation, oil and gas exploration, and tourism, however, these opportunities are quite limited and often seasonal. The primary economic activity in the community is hunting and trapping. Trapping is practised primarily for food subsistence, as recently, the low prices available for furs have almost eliminated trapping as an economic activity.

Importance of the Subsistence Economy

Traditional activities play an important role for the peoples living in Aklavik. These activities are centred upon hunting and fishing for subsistance, as well as some trapping for cash income. Wage employment is limited in the community, therefore, the ability to supplement their diet with country food is seen as crucial. The Inuvialuit land claim focused primarily on having guaranteed access to lands for hunting and trapping, as did the recent land claim for the Gwich'in.

A recent study undertaken in Aklavik (Freeman *et al.*, 1992) illustrates the importance of the traditional historic Inuvialuit bowhead whale hunt, and the dependency of these people upon country food for subsistence. In a sample of Inuvialuit households in Aklavik, Freeman *et al.* (1992) found that 89% included the presence of either a full time or part time hunter or trapper. Similarly, it was found that the primary occupation of 20% of the male household heads was hunting or trapping. Wage employment status for male household heads was found to be full time for 23%, part time for 60%, and not employed for 17% Female household heads reported 29% employed full time, 21% part time, and 50% not employed (Freeman *et al.*, 1992).

Freeman *et al.* (1992) also found that food preferences were much greater for traditional country foods than for store bought foods. The best liked foods were caribou dry meat, bannock, caribou tongue, arctic charr, beluga muktuk (blubber), caribou meat, and dry fish. Least liked foods were store bought white bread, wieners, canned meat, moose, sheep, meat balls with macaroni, and canned fish. Some residents listed

homemade bread among their favourite foods, while store bought white bread (often referred to as "white man's bread") was listed as a least favourite food. Actual food consumed by households in Aklavik is consistent with their preferences. Freeman *et al.* (1992) found the overall frequency of traditional food use was 676 times per household per year, or 1.85 times per day. The single most frequently consumed food was caribou, at 145 times per household per year. This was almost double that of the second most frequently consumed food, beluga whale. Other species used frequently were rabbit and muskrat. Commonly consumed fish were whitefish, along with cisco (herring), burbot, inconnu (coney), and arctic char. Geese were often consumed with ducks and ptarmigan also being important. Berries such as cloudberries (yellowberries), cranberries and blueberries were also frequently consumed.

An important factor in evaluating the consumption of country food in Aklavik is the cost of store bought food. On average, the cost is about 49% higher than in the nearest major southern centre; Edmonton (Freeman *et al.*, 1992). Canned goods are the least expensive with fresh produce being the most expensive. With only two stores in the community, the variety and quality of foods available for purchase in a more populated centre are simply not available in Aklavik.

Although the Freeman study dealt specifically with Inuvialuit households in Aklavik, it was found during the field work for this thesis that the Gwich'in households exhibit strong similarities to the Inuvialuit in terms of quantity of country food consumed. Preferences tended to be similar but with less preference for beluga, as more of the Gwich'in hunt and trap in the Delta and tend not to practise whaling as much as the

Inuvialuit.

The reliance on country food as a primary source of nourishment is not merely a way to avoid paying the high cost of food in the North. Hunting is the activity which sustains the full expression of both Inuvialuit and Gwich'in values and identity. Even those individuals who rely on full-time wage employment and spend most of their time in the community still consider hunting to be very important. Hunting allows people to engage in activities which comprise their sense of identity and their cultural distinctiveness. Hunting, when practised on a weekend or infrequent basis, still contributes strongly to the maintenance of social, cultural, psychological and spiritual well-being (Freeman *et al.*, 1992). Brody (1991) discusses how the Inuit still regard hunting as one of the ultimate forms of human achievement. The hunting, distributing, and consuming of animals confirms the status of these people as Inupiat or Inummariit (real, or genuine, people). In Aklavik, this was readily apparent by the excitement with which people discussed their hunting camps in the bush and how they still viewed these camps as an integral part of their home. Many people described their home as an area, rather than a particular dwelling, often referring to the entire area utilized for hunting as their home.

It can be seen that the term "subsistence" refers to more than merely "the bare means of surviving". Individuals involved in hunting must have knowledge concerning the environment and animal behaviour, as well as stalking and tracking skills. Other skills are required to maintain and utilize the necessary hunting equipment. Most important is knowledge of the organizational aspects of co-operative hunting groups, and

the social values, attitudes and behaviour needed to function properly within these groups. In these terms, subsistence becomes "the patterned acquisition and use of local resources in such a way as to enhance the social relationships existing among a community of people" (Freeman *et al.*, 1992:44). This enhancement is important in order for the community to reproduce and develop the cultural traditions which lie at the centre of existence for these people.

Current Land Use Practised by the People of Aklavik

Respondents in Aklavik provided detailed accounts of where, when and how much they hunt, trap and fish each year. The wildlife harvesting activities practised by the residents of Aklavik illustrate the large extent to which they rely on country food, and the large amounts of time spent on this activity. The spatial extent of these activities is important because while the community is relatively small, the area used by its people is quite large, as illustrated in Figure 6. The area mapped in Figure 6 is based upon description of the areas used for subsistence activities by respondents in Aklavik. As well, it became apparent through descriptions of the seasonal cycle of land use that the single most important regulatory factor in these activities is the regional climate.

Detailed descriptions of the seasonal nature of land use were provided by respondents in Aklavik during the field work for this research. This information was

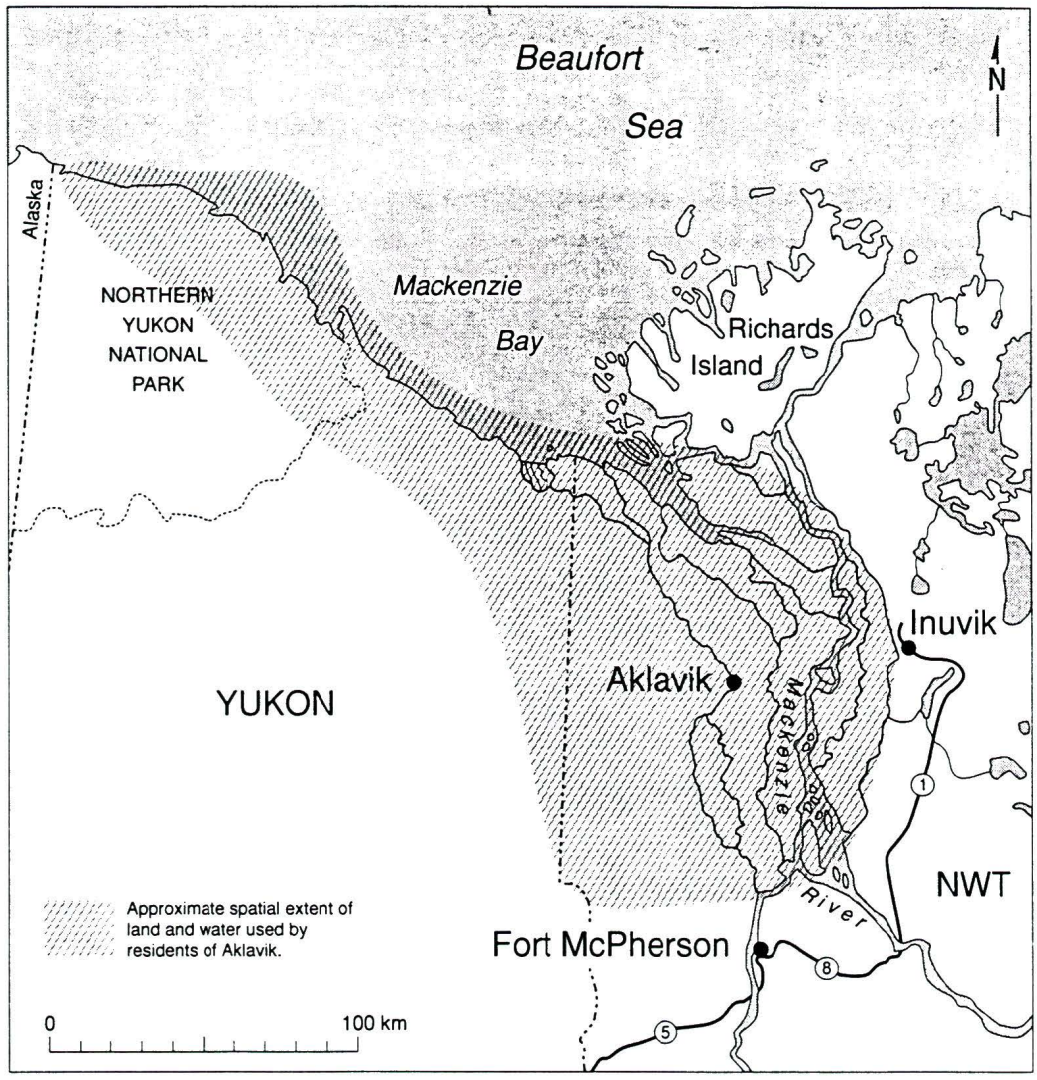

Figure 6 Current spatial extent of land used by Aklavik residents

provided by both active hunters and elders. Quantitative records have been maintained since July 1986 by the Inuvialuit Harvest Study (Fabian, 1991) and were helpful in illustrating the numbers of species taken. It should be noted that for Aklavik, the harvest study includes all hunters, regardless of whether they are Inuvialuit or Gwich'in, reflecting the similar land use practised by both these peoples.

During autumn, which is August through October, fish are caught with gill nets. In August, whitefish and arctic charr are most frequently caught, along with cisco and herring. This period marks the return of caribou to the Richardson Mountains where they are most numerous, especially in late autumn. In September the fish catch begins to decline from the levels caught during summer. Several moose may be taken at this time, as well as caribou. This month sees the beginning of fur trapping with rabbits being taken. As well, birds such as snow goose, and a variety of ducks are caught. October is usually a period of major caribou hunting, often with over 200 animals taken by the community in that month alone. Whitefish and herring are also caught at this time.

November through March is the winter season. November is primarily a caribou hunting period with some fishing. This is the period during which trapping takes place as the frozen ground allows for easier travel and access to traplines. Primarily fox and mink are trapped at this time. Fishing takes place with gill nets being placed under the ice in a number of areas throughout the western side of the Delta, while most caribou are taken from the Richardson Mountains and the flats to the west of Aklavik. December sees little fishing, except for a few individuals who maintain nets under the ice. Several people jig for fish through the ice (fishing with a hook) as well. The number of caribou

caught falls sharply during this month as the herd usually begins to migrate back towards their spring calving grounds in the north slope area of Alaska. Trapping increases in December as winter takes hold. Wolf, wolverine, fox, lynx, mink and rabbit are all taken. January and February are the least productive months with little hunting taking place. This period sees most of the people actually staying in the community, and is usually a period of extremely cold temperatures. A few fish are caught, as are several moose and caribou. Caribou can be hunted year round as there are usually a few remnant members of the main herd which remain in the mountains throughout the year. Only a few numbers of fur-bearers are trapped at this time, with rabbit being most frequent during the cold winter months. In March the number of caribou harvested increases slightly.

April and May comprise the spring period. During this time fur bearers are trapped and the return of birds in May allows for a significant number of geese and ducks to be taken. Late spring sees the return of significant fishing as well, with whitefish, inconnu and pike being common. Shortly before break-up traps are set for muskrat, and several hundred are taken in May and June.

June and July comprise the Arctic summer and see a return to large scale fishing with gill nets, especially whitefish, charr, cisco, herring, inconnu, loche and pike. Pike are taken primarily as food for dogs, although many indigenous people noted that non-Aboriginal people will eat pike. The most significant event of the year takes place from late June to early August when the majority of the hunting community moves to Shingle Point on the Arctic coast where beluga whales are hunted. Fish and caribou are also taken from the coast at this time, but the beluga hunt is the most important activity at this

time, with between 12 and 25 whales usually being taken. As the summer comes to an end, geese and ducks are taken and the caribou hunt increases as the yearly cycle begins to repeat itself.

In general, the Inuvialuit use the area to the west and north of Aklavik, up the Arctic coast, to Shingle Point and as far as Herschel Island. The Gwich'in use the area to the west and south of Aklavik following the Peel and Husky Rivers. Some Gwich'in do fish on the coast though, and both peoples use the flats to the west of Aklavik and into the Richardson Mountains to hunt caribou and trap furs. Given the limited number of people living in Aklavik, the range of land utilized is significant, and is evidence of the continued importance of subsistence activities for these peoples. The Delta area in particular is occupied on a semi-permanent basis by people living in camps, which are located throughout the Delta and towards the Richardson Mountains. The northern Delta is well utilized with camps on many of the river channels and fishing areas such as the Big and Little Fish Rivers and the Moose River system.

The type of activity practised by the people of Aklavik today is similar to that of their ancestors; the Kutchin Indians, the Mackenzie Eskimos and the Alaskan Eskimos. These people use the Delta for fishing and trapping, and still rely on summer whaling for a large supply of food. Even though their permanent location is now within the Delta, they are able to continue the coastal activities of their ancestors by means of power boats which can make the trip from Aklavik to Shingle Point in less than six hours. The total area used for hunting and trapping is now larger than before people settled permanently in Aklavik because of the availability of modern transportation. Power boats and

snowmobiles allow for more frequent trips to the Arctic coast for whaling and fishing, and further into the Richardson Mountains for trapping and hunting caribou. Improved mobility allows for a greater variety of subsistence activities to be practised, and offers greater resilience against the natural variability of the seasons and wildlife movements.

The seasonal nature of land use is governed by a set of climatic conditions which the people of this area have adapted to since their first settlement in the Delta. The actual number of species harvested in any month varies from year to year and variability is expected and anticipated. Many respondents stated that their knowledge of the local environment allows them to be prepared for variations in the number of species caught at any point in the year. For example, this variability was utilized in the fall of 1989 when for unknown reasons, there were very few caribou in the Richardson Mountains. To maintain the food supply, a greater number of mammals such as moose and bear were taken, and more fish were caught and dried for the winter.

Subsequent description of their land based activity revealed the interconnectedness between harvesting activities and the regional climate, as well as how they have been affected by changes in the regional climate. Investigation of these areas illustrates how regular variability in the climate has been adapted to, as well as where the community may be vulnerable to climatic changes in the future. These will be examined in the following chapter.

Chapter Six

CLIMATE-SOCIETY INTERACTIONS IN AKLAVIK

Chapters four and five illustrated the process through which the community of Aklavik arrived at its current settlement and spatial distribution of land use. From a large scale perspective encompassing Alaska and the Canadian North, prehistoric settlement was examined in relation to climatic episodes, descending to a smaller regional scale of the Mackenzie Delta area, and finally, the community of Aklavik. Climate has shaped prehistoric settlement in the Canadian Arctic through adaptation by indigenous peoples who populated the region. While the precise catalyst for these adaptations is not known, there is a general understanding of the movements of peoples throughout the North, and cultural modifications made in relation to changing climatic episodes over the past 10,000 years. More recent northern peoples such as the Mackenzie Eskimos adapted to conditions in their own specific regions, as seen through information gathered from archaeological sites in coastal areas surrounding the Mackenzie Delta. The current seasonal regime of land use practised by the people of Aklavik is not entirely different from that of their ancestors; indeed, it is strikingly similar, and serves as evidence of further adaptation to changing environmental as well as socio-economic conditions.

This chapter will present an evaluation of interactions between climate and the community of Aklavik. These interactions will then be evaluated in terms of a climate

which in the future may experience a warming trend and variability greater than that of the recent and past climate. Past climate here is defined as that which people currently living in Aklavik have experienced or can recall through the oral histories passed down by community elders. To aid in analysis of the interactions between climate and society, the perceptions of community members have been examined to reveal whether or not they perceive changes in climate beyond those of natural variability and whether or not they are familiar with the notion of global warming. Climate data from Environment Canada for Aklavik exist, albeit sporadically, from 1926 to present. Temperature averages have been examined for correlation with the perceptions and recollections of community members. Finally, based upon the interactions between the community and climate, as well as the social and economic changes which are presently taking place, two scenarios will be presented to illustrate possible impacts of future changes in the regional climate.

Vulnerability, Resilience and Adaptation

Before looking at the specific interactions between climate and society in Aklavik, it is worth examining the context through which these interactions will be examined. The three basic concepts through which these interactions have been set are *vulnerability*, *resilience*, and *adaptation*. This framework was not identified as part of the original methodology as it was not until the data were being collected that these themes became apparent. As the data from community respondents were being grouped and categorized, it became evident that many individuals were identifying aspects of their activities which

were vulnerable to environmental changes, and that adaptation to these changes forms a customary component of their yearly cycle of activity. In light of the information gathered, it was found that the concepts of vulnerability, resilience and adaptation would serve as useful tools to assess the community as they arose from the information gathered during interviews and conversations with people living in Aklavik.

Vulnerability can be explained as the capacity of a society to be wounded by perturbations which stress that society (Kates, 1985). Similar definitions of vulnerability are "the degree to which a system, or part of a system, may react adversely to the occurrence of a hazardous event" (Timmerman, in TFCA, 1993:34); or more simply, to be susceptible to damage (Burton, 1992).

Resilience has been explained as the capacity to bounce back, or to have the power of recovery (Burton, 1992). More specifically, Burton (1992:14) describes resilience as "the ability of a region to absorb negative changes or impacts and to recover from them in ways that enhance the health and well-being of the economy and the society, but not necessarily by returning to the original condition". A key factor in resilience is the characteristic of not necessarily returning to the original state prior to the perturbation. This implies the ability to make *adjustments* or *adaptations* following perturbations to the system. The distinction between adaptation and adjustment is obscure at best. *Adjustment* generally refers to short term, or non-permanent responses. Such responses are designed to ameliorate, compensate or avoid the impacts of undesirable occurrences (TFCA, 1993). Kates (1985) describes both incidental and purposeful adjustments. *Incidental adjustments* are those actions which serve to reduce vulnerability,

although their origin is for a non-hazard-related purpose. An example of this can be a community that restricts residential development of a waterfront area because the community wishes for it to be left as "green space". Doing so appeases the local citizens while reducing vulnerability to flooding and coastal erosion. *Purposeful adjustments* take three basic forms; accepting losses and sharing or bearing them; reducing losses by either preventing events or modifying their effects; and undertaking basic changes in livelihood or location systems (Kates, 1985).

Adaptation can be described as cumulative, long-term responses to natural hazards (Kates, 1985). Adaptation can be both biological or cultural. Biological adaptations often lie on a very long-term scale, as with the concept of biological evolution; however, smaller scale biological adaptations to climate do exist, such as body heat and evaporation control (Kates, 1985). More important here is cultural adaptation, as it is through cultural variations that human societies have adapted to the different climates that we now inhabit. An important aspect of human or cultural adaptation lies in the ability of humans to plan and direct adaptation (TFCA, 1993). Unlike most biological organisms, which are essentially reactive to perturbations, human actions are both reactive and proactive. Human adaptation can take place in an anticipatory manner, thereby including perceptions of the environment and risk evaluation in the process of deciding upon an adaptive strategy.

As with adjustments to environmental perturbations, adaptation can be both incidental and purposeful. An expansion of the three basic types of purposeful adjustments listed previously is important because purposeful adaptation is most prevalent

within the community of Aklavik. TFCA (1993:37) describes five types of purposeful adaptations or coping strategies:

(1) Prevention of Loss: taking actions intended to reduce the vulnerability of sectors and regions to environmental changes.

(2) Tolerating Loss: loss or impact is accepted in the short run because it has not exceeded the absorptive capacity of the system.

(3) Spreading/Sharing Loss: actions are taken to distribute the burden of impact over a larger scale (both spatial and social) beyond those directly affected by the perturbation.

(4) Changing Use/Activity: structural changes which are intended to assist human social systems in persisting in areas which are no longer suitable for the types of uses which existed prior to the perturbation.

(5) Changing Location: as an alternative to changing one's activities. In som cases, the preservation of an activity is more important than the desire to maintain a particular location, therefore, migration will occur to areas more suitable for the desired activity.

These five types of adaptive strategies form the basis for evaluation of adaptation to changing environmental conditions for the community of Aklavik.

Interactions Between Climate and Society in Aklavik

Climate-society interactions may be considered obvious, as is the relationship between the use of heating during colder temperatures. However, actions taken because of variations in climatic conditions are often not acknowledged as being significant because climatic conditions are taken for granted, and are usually expected. To assess the impact of future changes in climatic conditions, it is necessary to be aware of actions taken as part of normal climatic variability in order to understand where vulnerabilities

exist, especially if future climatic changes are expected to be greater than existing climatic variability.

Historically, the Mackenzie Eskimos, described in Chapter five, are known to have adapted well to conditions on the coastal areas of the Mackenzie Delta. The five groups of Mackenzie Eskimos developed an elaborate culture utilizing the resources of the Mackenzie area (McGhee, 1974). Adaptation for the Mackenzie Eskimos has been comprised primarily of changing subsistence activities to meet the provisions of the environment, as well as to change locations on a small scale in the form of seasonal camps. In the event of poor wildlife harvests, it is known that there was extensive trading between these groups which allowed for sharing of food and fuel in times of short supply (McGhee, 1974). In terms of the climate itself, these people learned to simply tolerate the negative aspects of a cold climate. The severe cold of winter was tolerated through large settlements which allowed for sharing, and the use of lamps which burned whale blubber to help provide warmth. The types of dwellings were also adaptations to the local climate. Whalebones were used for larger structures capable of housing large families, while smaller sod and log homes were utilized by those groups not as dependent upon whaling.

Adaptation to the cold climate in which they lived allowed the Mackenzie Eskimos to become less vulnerable to climatic changes than were their prehistoric ancestors. Their resilience to changing conditions was a combination of both improved hunting skills and techniques, as well as the advantage of location in an area with abundant land and marine resources. Cumulative adaptation to the environment which began with the earliest

prehistoric peoples around 5,000 B.C. allowed the Mackenzie Eskimos to reduce their vulnerability to environmental changes greatly. Not only were they relatively unaffected by the colder period from 1,600 to 1,850 A.D., but they also thrived during this period. The success of these people in adapting to a severe climate continued until the mid-eighteen hundreds, when contact with non-aboriginals brought about the changes discussed in chapter five. From this point onward, adaptations have still been made to environmental conditions, but these have been predominated by radically changing social and economic systems. Examination of adaptation from the mid-nineteenth century onward reveals that changes in socio-economic conditions have necessitated extreme adaptations by northern aboriginal peoples. These changes have altered aboriginal culture significantly, but have also made these people somewhat less vulnerable to changes in the natural environment.

At the present time, there are two broad groups of interactions between climate and society in Aklavik. These have been termed *community interactions* and *subsistence interactions*. *Community interactions* refer to aspects of community organization based upon the infrastructure of the community, such as roads and buildings, and the provision of services for the community. *Subsistence interactions* refer to those activities practised primarily (though not exclusively) by the aboriginal people of the community. These are basically subsistence activities, centred around use of the land for hunting, trapping and fishing. These activities are also practised by non-aboriginal members of the community; however, aboriginal peoples consider them to be critical for the survival of their culture.

These interactions were identified during discussions with respondents in Aklavik.

As respondents talked about their subsistence activities, and subsequent climatic factors, other information was brought forward concerning areas where the activities and lifestyle of community members are affected by and connected with climatic conditions. The range of information provided identified two broad streams of interactions: those dealing with the day to day functions of the community itself and its infrastructure, and those dealing with the subsistence activities of the community. Personal observations also revealed information on how climate affects the community.

Community Interactions

Interactions between the community and the regional climate reveal an annual pattern of constant adaptation to normal climatic variations. These interactions are determined largely by two factors; the differences between each season, and climatic extremes occurring within each season. Within this cycle, the two most significant events identified by respondents are regular flood events and the timing of break-up and freeze-up in the Mackenzie Delta.

The physical infrastructure of Aklavik has been constantly adapting to the annual climate. Even though the community has existed since about 1926, few older structures remain standing. They have gradually been replaced by more modern structures capable of withstanding cold winter temperatures. These structures are now elevated at least six feet above the ground surface due to the presence of continuous permafrost and regular spring flooding. The basic infrastructure of Aklavik has been shaped by the local climate.

The types of transportation available, roads, construction of buildings and the supply of services have all been developed to operate as efficiently as possible within a wide range of climatic extremes. Summer temperatures can reach over 30^0C, while winter temperatures can reach below -40^0C.

Flood Events

Aklavik is built on deltaic sediments and subject to very poor drainage. The highest elevation in the community is about 14 metres above sea level. The mean elevation is about 10 metres above sea level. This has resulted in significant flooding of the community on a somewhat regular basis (Kriwoken, 1983). As stated in Chapter five, one of the factors contributing to the creation of Inuvik as a replacement for Aklavik was flooding which restricted growth of the community. Kriwoken (1983) has documented a historical flood review of several communities within the Mackenzie River Basin, including Aklavik. The community has experienced severe flooding during spring break-up at approximately ten year intervals. Recent severe flood events (one for which the water rises above 10 metres) have occurred in 1992, 1982, 1973 and the early 1960's (Kriwoken, 1983).

Respondents described flooding as the result of several factors; (1) thick ice in the Peel Channel and other parts of the Delta; (2) an accumulation of snow which helps to insulate the ice; and, (3) heavy runoff. Under these conditions, ice in the Peel Channel (where Aklavik is located) does not always break up before runoff begins, resulting in elevated water levels. Flooding is exacerbated by ice jams in the Peel channel and the

main channel of the Mackenzie River across the Delta. For example, in June 1982, three ice jams occurred on the main channel of the Mackenzie River. Subsequent backwater flow was diverted down the Peel channel to Aklavik where ice was jammed near the community. The resulting floodwaters persisted for four days before water levels began to recede following break-up of the ice jam (Kriwoken, 1983).

Flooding was described as beginning in the low-lying area north-west of the community and working its way toward the central area of Aklavik. The highest land in Aklavik is directly above the riverbank, therefore most of the community back from the river can be flooded in a large flood event. In June 1992 the flooding was severe enough to evacuate most people from the community including elders living in the elders home, located on the highest point of land in town.

During these flood events, activities in Aklavik are completely disrupted. As a result, all buildings must now be elevated at least six feet above the ground otherwise they do not qualify for insurance. As well, attempts have been made to reduce the amount of mud which forms when the roads become wet. Calcium chloride has been spread over road surfaces which helps bind together soil and gravel particles. With enough use, vehicles can actually compress the dirt into a fairly hard surface, however, the roads still become muddy when wet, though to a lesser degree than prior to the calcium treatment . Before the use of calcium, roads required over one week of dry weather to recover following flooding. Even a regular rainstorm made the roads nearly impossible to walk upon, with "mud up to your knees". Today, following a rainstorm, the mud only covers one's boots. As a result, some of the main streets of Aklavik have

wooden boardwalks constructed for pedestrians; unfortunately, these cover only a small portion of the community.

Break-up and Freeze-up

The occurrence of spring break-up and autumn freeze-up in the Mackenzie Delta were identified by respondents as significant events for Aklavik. Break-up can take place from about mid-May until early June and often coincides with the flooding described previously. It also signals the availability of a return to water transportation. Large materials brought into Aklavik such as building supplies and fuel are delivered by barge from Hay River NWT on Great Slave Lake. The ice-free season on the Mackenzie River generally lasts for three months; June through August. It is only during this time that large bulk materials can be delivered to the community.

Freeze-up usually takes place from early to mid-October. The faster freeze-up occurs, the more advantageous it is for the community as a slow freeze-up results in the river freezing over and breaking up several times before becoming permanently frozen for the season. During this period there can be no transportation by water or over the river ice by snowmobile. Following freeze-up, access to hunting and trapping areas of the Delta is improved as snowmobiles can travel over the frozen rivers, lakes and muskeg.

Following freeze-up, the supply of water for Aklavik is changed from a lake west of the community to the river itself. The lake used for water during the ice free season freezes solid during winter, thus necessitating the use of water from the river. Lake water is preferred due to the large amount of sediment in river water.

Break-up and freeze-up are only two of the significant factors in the annual cycle of climatic events. Climatic extremes during each season were also identified as playing an important role in creating conditions which must be adapted to. Extremes in temperature are often more important than average daily or monthly temperatures. Average temperatures are anticipated by the community and are expected. Extremes outside the expected range of temperature can be problematic. Most respondents feel that hotter temperatures in summer are more problematic than extreme cold temperatures in winter, as once temperatures fall below about -30°C, it becomes too cold for most activities anyhow. Extreme cold temperatures do pose problems for the community though.

The delivery of water is made more difficult by cold temperatures. There are no pipelines in Aklavik, and therefore, in order to transport water to buildings in the community, water is heated at a pumping station before it is loaded into a truck for delivery. This usually allows for several deliveries before it refreezes. This process slows water delivery considerably; however, there is no other alternative currently available. Similarly, not all buildings are well suited for extremely cold temperatures. The quality of structures in the community varies, with many of the older buildings and home made structures being poorly insulated.

Responses to extreme cold by the people living in Aklavik are simple; when the temperature goes below -40°C, most people do not go outside unless absolutely necessary. January and February are the two months of the year during which most of the community members are actually at home. During these months there is little activity

outside except for some trapping and hunting.

Extreme warm temperatures in winter are problematic as well. As stated in the introduction, temperatures above freezing in winter can cause meat stored outside to spoil. Similarly, if surface snow and ice begin to melt, travel by snowmobile is more difficult, and dangerous if ice thaws for several days. When this occurs, people generally wait until the warm episode passes and colder temperatures restore the ice for safe travel. Many people in Aklavik complained that extremely warm temperatures in summer (above 30^0C) are uncomfortable; however, there is usually little that can be done except tolerate the heat. As well, if there has been precipitation prior to hot weather, blackflies and mosquitoes can become unbearable. On river channels or open water there is usually some relief, but most people will not travel in the bush when it is unusually hot due to the abundance of insects.

Precipitation is not as critical as extreme temperatures, but is necessary for building and maintaining winter roads. Following freeze-up, a winter road is constructed along the river channels to link Aklavik with Inuvik, across the Delta. This road requires enough snow to pack down into a surface that vehicles can travel over. The road is not usually ready until December, but in the absence of enough snow, building of the road is delayed sometimes into January. Winter ice roads are important for the community as fuel and other large items that may be needed during the winter months can be brought by truck from Inuvik.

Excessive rainfall also impacts the roads in Aklavik. As stated previously, dirt roads (there are no paved roads) are treated with calcium to bind the soil and gravel

particles together; however, following as little as one full day of rainfall, the roads become extremely muddy. Unless a vehicle is available, movement within the community becomes difficult as walking can be dangerous, especially for older community members. Often, it takes several days of sunshine for the roads to dry completely.

When viewed on an annual basis, Aklavik is quite resilient to normal climatic conditions. The community infrastructure and services have been built in order to maintain efficiency within extreme changes in temperature. The seasonal differences dictate whether local transportation outside the community is made by boat or snowmobile. These differences also determine whether or not one must fly out of the community to Inuvik, or use the winter ice road. Services such as the delivery of water and fuel are made more difficult in winter, but are still available.

The most significant period of vulnerability is experienced by the community during break-up and freeze-up. In years when there is a flood event, the community is vulnerable to both the amount and duration of flooding. Most structures do not suffer extreme damage but disruption to the community is significant. In large floods much of the community is evacuated to Inuvik until water levels recede. During this time activity in Aklavik is completely disrupted until the flood event is over.

The actual process of break-up and freeze-up is another vulnerable period for the community. During break-up the community must be alert to the possibility of flooding. Equally important is the disruption to travel outside the community. Prior to break-up travel can be made on frozen river and lake surfaces. Once ice melts to the point where travel is unsafe, there can be no travel at all until break-up occurs and the river is

sufficiently clear of ice for safe travel by boat. This can take several weeks at a time, during which the community can do nothing but wait. Air service is still available to Inuvik, however, travel to camps within the Delta is suspended until break-up is complete.

During freeze-up similar circumstances exist. Once the river and lakes freeze over, sufficient time must be allowed for the ice to thicken before travel can commence with snowmobiles over the frozen surface. During years when temperatures do not remain consistently cold, it can take several weeks until the ice forms a surface safe for travel. Again, in these circumstances the community can do nothing but wait.

Within the seasonal pattern of land use and interaction with the regional climate, patience is one of the most important responses to climatic variability. Waiting and tolerating the loss, if any, is a common response to periods when travel cannot be made safely outside the community. This occurs during flood events, extremely cold temperatures and when insects proliferate. In the case of flooding, adaptations have been made to reduce the impacts of these events. However, patience is a common and important response to events which take place regularly within the annual cycle. The existence of a lifestyle and social environment which permits time for waiting out extreme events has helped increase the resilience of the community to these events, and must not be underestimated as an important part of regular climate-society interaction.

Given the present scenario, Aklavik has adapted well to the environment in which it is located. Flood events, which were a major factor in the creation of Inuvik as an alternate town, have been adapted to, although the community is still quite vulnerable to

these events. Normal variability in both temperature and precipitation is both anticipated and expected. In the case of extreme variation, or events which take longer than expected (break-up and freeze-up) the ability to be patient and tolerate the loss has resulted in the community of becoming quite resilient to normal climatic variability.

Subsistence Interactions

Subsistence activities are more vulnerable to climatic conditions than community activities. Aklavik exhibits a dualistic nature; on the one hand it exists as a small northern community providing services for its inhabitants; on the other hand, the aboriginal people living in Aklavik practise a large amount of subsistence activity which results in many people spending extended periods of time outside the community. This can be seen in the patterns of subsistence activity explained in Chapter five. Although Aklavik is their "home", many hunters and their families spend over half of each year living in camps located throughout the Delta and on the Arctic coast. Life in these camps exists without the amenities provided in Aklavik, and is far more vulnerable to variation in the local environment. Like the community, these activities are also affected by break-up, freeze-up and flooding; however, subsistence activities are more vulnerable to these events than are community activities.

Subsistence activities were described by respondents as being comprised of the gathering, preparation, distributing and consuming of fish and wildlife as country food. These activities involve movement from Aklavik to hunting and fishing locations, which

themselves are often far from hunting and fishing camps. Distances travelled can be quite large, as seen by the spatial extent of land use in Figure 6 (Chapter 5). Harvesting is accomplished through the use of traps for fur bearers, rifles for large animals such as caribou, and gill nets for fishing. Once wildlife has been harvested, it is transported back to bush camps or to Aklavik where it is divided up amongst one or more families. Finally, some food is prepared and consumed when fresh, while much of it is stored until needed.

Climate affects subsistence activities both directly and indirectly. Mode of transportation is directly related to climate. Prior to break-up travel is by snowmobile. Several families still rely upon dog teams for travel in winter as well. Following the period during break-up when there is little or no travel at all, the mode of transport changes to boat for the summer season.

The type of shelter used in camps depends upon whether or not it will see winter use. Some camps use large canvas tents while others used throughout the year are actual cabins with wood burning stoves. The amount of time spent travelling is also dependent upon climate. Wind storms make travel within the Delta difficult in smaller boats, while those travelling to the Arctic coast must often wait out storms until they can travel. Again, patience is a key factor in adapting to these natural variations.

Indirect relationships are more important for subsistence activities as wildlife are directly affected by climate. People who rely on country food as a regular supplement to their diet are dependent on a source of wildlife which in turn, is dependent on an environment conducive to their survival. Natural variations in numbers of species are

expected; however, if a species becomes scarce for any reason, there is cause for concern among the peoples of Aklavik. Caribou is the most important species for these people. Caribou is also known to be sensitive to certain climatic features. During summer, caribou prefer to frequent warm, windy locations which provide relief from insects. In winter, it is crucial that food is available. Caribou will dig under snow to reveal plants and lichens upon which they feed. A common condition potentially devastating to caribou is a warm winter during which the snow thaws and refreezes. This leaves a layer of ice over the snow which caribou cannot dig through, restricting access to food. Winters where this has occurred have seen a drop in the number of caribou harvested.

Birds and waterfowl migrate north to the Delta and the Arctic coast to nest during the summer. Their movements are influenced by the temperature and availability of wetlands suitable for nesting sites. Similarly, fish movements into the Delta correspond with temperature changes in the water. High runoff in autumn can slow fish movements into the Delta from the Beaufort Sea. Runoff increases the downstream flow of river channels and increases sediment loading which impedes the ability of fish to swim upstream, thus delaying the expected arrival of certain species at expected locations.

Sediment loading in the Delta has implications for subsistence activities as identified by several respondents who stated that certain river channels are slowly filling with sediment, rendering them useless as fishing areas and for navigation by larger boats. Flood events increase both sediment loading and erosion in the Delta. Hunting and fishing camps are vulnerable to changes in sedimentation as they may be rendered useless if there is no longer good fishing nearby. Changes in the hydrology of the Delta

determine where boats can actually travel and where suitable fishing areas are located. Local hydrology is affected by both local and upstream runoff and precipitation.

An important and often overlooked interaction is that between climate and the perceived state of the natural environment. Respondents explained that knowledge of the natural environment held by aboriginal peoples is maintained and built up through experience and recollection. The annual seasonal movements of wildlife are anticipated given environmental conditions at certain times of the year. At a basic level, most aboriginal people active in subsistence activities have learned when, where and how it is best to harvest wildlife. The decision to embark on hunting or trapping activities is determined by environmental conditions expected to result in the presence of fish or wildlife at known locations. This decision is made by assessing the state of the environment including local temperature, precipitation, state of the physical landscape and how these conditions correspond with known requirements for the availability of wildlife. Climatic variability is an important part of these decisions as environmental conditions are not expected to be identical from year to year. Vulnerability here lies with how much variability can exist in environmental conditions before rendering the expectation of locating fish or wildlife as inaccurate.

Subsistence activities, therefore, are extremely vulnerable to variations in normal climatic conditions as they are affected indirectly by influences on wildlife. Infrastructure such as shelter and suitable transport can easily adapt to changing climatic factors; however, the availability of local wildlife is beyond the control of local peoples. Historically, subsistence has been based on moving to where wildlife were located.

Presently, modern transportation such as power boats and snowmobiles allow hunters to maintain a permanent base in Aklavik and make trips to camps, often far from the community, to harvest wildlife. If wildlife are not present when and where they are expected, subsistence activities are made more difficult; however, historical adaptations of aboriginal peoples to wildlife harvesting have included the development of environmental knowledge which allows hunters to be aware of other sources of wildlife in times of shortages. Historically, this often resulted in migration to avoid possible starvation. Today, this has been overcome by supplementing country food with store bought food, although this is not a preferred solution.

Thus, the resilience of subsistence activities is completely dependent on environmental factors influencing the location of local wildlife and the ability of hunters to gain access to areas where wildlife are abundant. Human adaptations have been made to compensate for past irregularities in wildlife movements in the form of moving to different harvesting sites and utilizing alternate resources. At present, the most common response is to tolerate and/or share the loss, and wait for expected conditions to return.

Perceptions of Climate

Perceptions of climatic variability and change held by the people of Aklavik can help explain their attitude and relationship with the regional climate, as well as to provide insight into how they may adapt to future climatic changes. It is through perception and evaluation of risk that humans are able to make adaptations in a proactive manner.

Knowledge of global warming can be attributed to a common perception that over the last several decades winters have been less severe and summers have been hotter. Extreme events such as drought in Africa and recollections of past winters with greater snowfall than present help fuel the notion that the global climate is changing (Hare, 1985). Perceptions of people living in Aklavik reveal an attitude toward the environment which is remarkably uninfluenced by common awareness of global warming or climatic change. Interviews and discussions with residents of Aklavik revealed a predominant attitude that there are indeed changes in the regional climate; however these are attributed to natural variability rather than to climatic change.

Respondents in Aklavik felt that both the winter and summer seasons are warmer than they used to be. The single most common perception of respondents was that winters are not as cold as they used to be (64 of 78 respondents). This was followed by the feeling that summers are hotter than they used to be (57 of 78 respondents). Other important perceptions were that there is greater variability in the weather than before 55 of 78 respondents) and that changes between each season have become more inconsistent (51 of 78 respondents).

Of 19 elders spoken with, 17 explicitly recall winters being much colder in the past, with greater snowfall. Elders and older community members described dog sled races which used to take place at Sachs Harbour (on Banks Island) in June. Most people do not recall there being enough snow in June for sled races over the past two decades.

Many respondents[1] explained that the transition from winter to summer and summer back to winter used to be fairly rapid. Once the weather turned cold in late September, temperatures would remain below freezing and freeze-up would occur quickly, often in less than two weeks. Likewise, the return of warm weather in May would occur rapidly, and temperatures would stay consistently above freezing, resulting in a short break-up period. Most people feel that over the past ten years these changes between seasons have taken longer and have been more inconsistent. In particular is the feeling that freeze-up is later than it used to be and the length of time necessary for freeze-up to take place is longer. Respondents explained how often the ice will freeze and thaw several times before freezing over completely, resulting in a longer freeze-up period. Similarly, many people feel that break-up in spring takes longer as well, with ice thawing earlier, but more slowly than it used to.

Another common perception is that variability in the climate is a normal occurrence. Despite the perceptions described above, not one respondent attributed the perceived phenomena to global warming or climate change. The predominant attitude amongst respondents is that climate is always changing, that there are always differences from one year to the next, and that adaptation to these differences is a normal part of life. This was by far the most common attitude towards explaining differences between the past and present climate in Aklavik, reflected in statements by 59 respondents.

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[1] The precise number of respondents with this perception is difficult to state. Of 78 people, 61 expressed some notice of a difference in the timing of seasonal changes including break-up and freeze-up, tending towards greater inconsistency. The extent to which they felt this varied somewhat, with many respondents noticing significant changes, and others being aware of some change, but not too sure of the precise time period or the degree of change. Therefore, the terms "many" and "most" are used to described this overall group of individuals.

When asked if they had knowledge of climate change, global warming or a greenhouse effect, most people stated they had heard of these phenomena, but were not familiar with what they actually are. There were exceptions though. Twelve of the people interviewed had a good sense of global warming and were familiar with the ideas behind it. Among these 12 individuals the most common concern was the effect warming might have on fish and wildlife. Other concerns identified within this small group were; an increase in the occurrence of severe flood events (11); unexpected changes in the timing of break-up and freeze-up (8); increased coastal erosion (3); increased rates of sedimentation in Delta channels (2); greater intensity of the sun (2); and the psychological and behaviourial effects on local people (2).

However, this group which expressed concerns over future climate change was not representative of the community. Most of these people were in administrative positions with the aboriginal councils in the community, and several were non-aboriginals. These are people having access to information that is generally lacking within the community. Of the people interviewed, nine had no familiarity at all with global warming. These were aboriginal people of a variety of ages, from high school students through to elders. Most of the active hunters and trappers had only vague familiarity with the concept of climate change (39 of 54). Several elders interpreted the term "climate change" as "change" in general, referring to both environmental and socio-economic changes in the community. Of the entire group of respondents, 57 had heard of climate change or global warming, but were not familiar enough with it to explain its concepts.

Evaluation of the perceptions of these people requires more than simply

interpreting numbers of individuals knowledgable about global warming. Examination of the social structure of the community and the background of its residents is necessary to better understand the perceptions of the community. Formal education within the community is limited to grade nine schooling. If further education is required, it is available in Inuvik or Yellowknife. Most people living in Aklavik have not had much formal education. Elders and older community members have had little or no education, while many middle-aged (approximately 30 to 45 years) individuals have had only limited schooling. Of the total 1986 census population of 780 (GNWT, 1991), 500 people were older than 15 years. Of those over 15 years of age, only 275 had received education greater than grade eight, for a total of about one third of the entire community. Education on issues such as global warming is simply non-existent for most of these people, and knowledge must be gained through other sources, most notably the media. Most every home in Aklavik has a television, some with satellite dishes capable of receiving numerous stations. Without a satellite dish, television reception is limited to local and national versions of the Canadian Broadcasting Corporation, and an American station from Detroit, Michigan. Several people explained that their knowledge of climate change was gained through television news or newspapers. Within Aklavik though, there are no national newspapers available. A weekly newspaper from Inuvik is sold at the store and a Dene newspaper from Yellowknife is available; however, print media is almost completely lacking in Aklavik. News is received either on television or on the radio. Written information must be brought in from outside the community.

Given the limited availability of information from the outside world into Aklavik,

an outsider may find it odd that community members do not wish for better access to additional forms of media. An understanding of life in Aklavik is essential for interpretation of this situation by an outsider unfamiliar with life in the North and with aboriginal peoples.

Perceptions of time and space are quite different in Aklavik from that of a southern non-aboriginal community. During the mid-summer where sunlight lasts for an entire 24 hours, it is not uncommon to find children playing outside at three o'clock in the morning. Likewise, people can be found arriving or departing on the river to or from camps at all hours of the day. Within the community, the only people who appear to be concerned with the actual time are those holding wage jobs requiring punctuality. For most others, the 24 hour sunlight allows for activities to be carried out at any time. Conversely, the darkness of the winter season is a period during which little activity takes place. The darkness and cold temperatures of December through February are regarded as a somewhat dismal period, during which there is little hunting and trapping activity, and most time is spent indoors. This is the period during which several people expressed concern over the psychological impacts of darkness and cold upon the behaviour of local people. Life in the community is generally slow and unhurried. The pace at which activity takes place is leisurely at best, and differentiation between weekdays and weekends is best determined by whether or not the post office is open. Activities do not follow a "nine to five" routine; rather, they take place whenever they are necessary. This approach to life in Aklavik encompasses a different "lifeworld" from that which many non-aboriginals or non-northerners are used to. Perceptions of time and space and the

interpretations of experience are unique to this type of community, and an appreciation of this is necessary for evaluation of the manner with which local peoples perceive the natural world. These perceptions are based on experience and recollection, of which variability has played a constant role.

People in Aklavik are used to seasonal differences as well as variations within each season. They have adapted their subsistence activities to this variability and, so far, have not seen changes tending toward a long-term warming in the regional climate. An interesting question is whether or not the perceptions of the community would be different if there were greater familiarity with the greenhouse effect and global warming. In such a scenario, perceived variability may then become attributed to global warming; however, at present, this is clearly not the case.

Correlation Between Perceptions and Actual Climate Data

As an aid in determining the accuracy of community perceptions, climate data for Aklavik have been examined for correlation with the perceived climate. Data provided by Environment Canada have been collected in Aklavik from mid-1926 until the present, with a twenty three year gap from 1962 to 1985. The records evaluated were for mean, maximum and minimum daily temperature. These data were compiled on a monthly basis for evaluation. As an analog for Aklavik, data for Inuvik have been examined for the period 1958 to 1992 where Aklavik records are missing or inconsistent.

Mean monthly temperatures for Aklavik from 1926 to 1962 do not tend to

substantiate the perception that temperatures were cooler in the past. Figure 7 illustrates monthly averages for February, typically, the coldest month of the year. While there appears to be a large degree of variability, there does not appear to be a trend toward warmer mean monthly temperatures. Data for Aklavik from 1985 to 1992 are sporadic, but they too do not suggest an increase in mean monthly temperatures. More recent records from Inuvik have provided maximum, minimum and mean daily temperatures for the period from 1958 to 1992. Given the close proximity of Inuvik to Aklavik, it is felt that these offer a good analog for temperatures in Aklavik. Examination of daily means does not provide indication of a trend towards increased temperatures. However, examination of the maximum and minimum extremes in temperature during this period reveal a greater occurrence of record maximum temperatures over the last ten years.

The occurrence of record maximum daily temperatures appears to be more common over the last ten years, especially for the months February, March, April, May and December. Table 5 illustrates the number of times during the period from 1958 to 1992 that a record has been set for maximum daily temperature, within the last five and ten years. For example, data for February from 1958 to 1992 show that of the highest maximum temperatures recorded for each day of the month, 16 of the 29 highest maximum temperatures have occurred from 1982 to 1992. Similarly, of those 16 maximums set over the past ten years, 14 have occurred over the past five years. These data suggest that while mean monthly temperatures may not be increasing, over the past ten years there have been a large number of record maximum daily temperatures set in

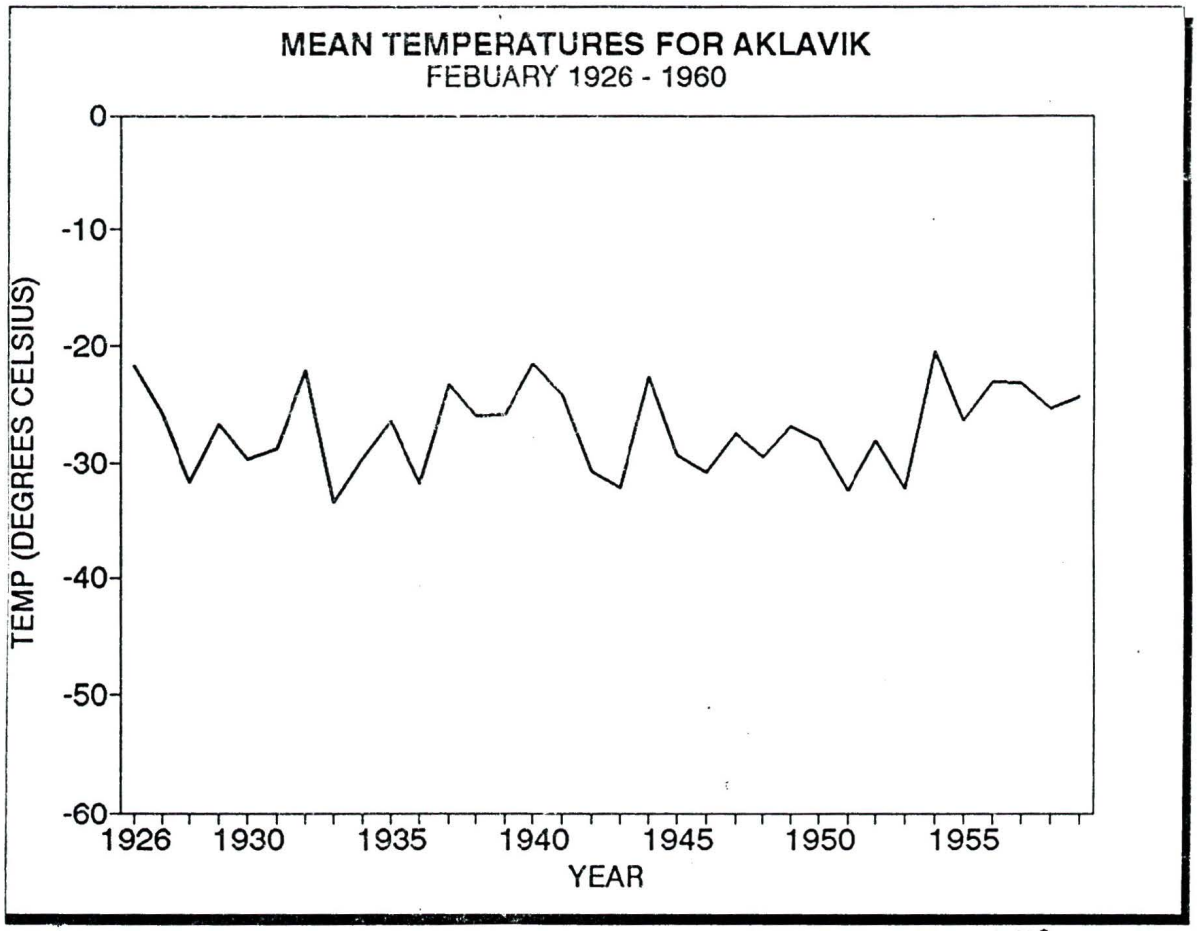

Figure 7 Mean February temperatures for Aklavik 1926-1960*

* Based upon climatological records provided by Environment Canada. Records are missing from 1961 - 1985, and sporadic until 1990.

Table 5 **Frequency of occurrences for record maximum daily temperatures within the last five and ten years (Inuvik NWT 1958-1992*).**

Month and number of days	Number of days in each month for which a max. temp. record has been set over the last ten years. (1982-1992)	Number of days in each month for which a max. temp. record has been set over the last five years. (1987-1992)
January (31)	5	4
Febuary (29)	16	14
March (31)	18	14
April (30)	15	11
May (31)	12	11
June (30)	9	4
July (31)	11	7
August (31)	9	8
September (30)	9	4
October (31)	8	7
November (30)	3	2
December (31)	11	6

*(Climatological data provided by Envoronment Canada Climatological Services, Edmonton, December, 1992)

the winter and spring months. This may suggest greater variability tending towards higher temperatures over the most recent ten years of the 34 year period from 1958 to 1992.

This phenomenon offers an explanation for perceptions of the people of Aklavik. While their views toward recent winters and summers being warmer are not substantiated

by an increase in mean monthly temperatures, they are supported by a greater number of record maximum temperature occurrences. This also provides support for the notion that extremes are more important for perception than are means, especially when those extremes are recent, as in the case here. It is possible that because there have been a greater number of maximum temperatures in the winter and spring months, people have perceived the seasons to be warmer than they actually are in terms of mean temperature. As well, because these extremes have occurred more frequently within the past ten years, they are more easily recalled than the events preceding them.

Lack of awareness or familiarity with the phenomena of climatic change or global warming is indicative of a society more concerned with their own local environment and their subsistence activities than with news and information from the outside world. This is not to suggest that the majority of people living in Aklavik do not care about news from outside their own region. Matters concerning the local community and activities unique to aboriginal culture take precedence over news from the outside world. Until such a time when the community perceives there to be negative affects of changes in the regional climate, climatic change will not be of major concern or interest to most community members.

Possible Impacts of Future Climatic Change

Predictions of future changes in the regional climate are difficult because of limitations in data provided by general circulation models, as explained in Chapter one.

Possible impacts can be explored though, through the use of scenarios based upon a given set of climatic characteristics. For Aklavik, two future scenarios have been formed based upon information provided by Lonergan and Young (1989), Roots (1989a, 1989b), Lonergan, Difrancesco and Woo (1990), Rizzo and Wiken (1992), Smith and Cohen (1992) and Smith (1993). Climatic information from these sources has been used to determine a possible future scenario, which when combined with information on vulnerabilities, current climatic conditions in Aklavik and socio-economic conditions, illustrates future vulnerabilities given a warmer regional climate.

Recalling from Chapter one, it is worth repeating possible characteristics of a warmer future climate for the Canadian Arctic compiles from CCPB (1991) and Roots (1989a):

- High latitude watersheds such as the Mackenzie would probably exhibit higher streamflows and floods during the snowmelt season.
- A shift in forest species northward, and a possible northern shift in the treeline.
- Melting of permafrost which would affect physical structures and pipelines. Fish habitat could be altered by permafrost melt. Slow permafrost decay and thickening of the active layer would result in increased land instability in discontinuous zones.
- The Arctic shipping season would be longer for water routes with a shorter season for transport over winter ice roads.
- Movement of storm tracks northward may result in an increase in Arctic precipitation, especially in fall/winter. Snow seasons would be shorter but accumulation would be greater, causing flooding in Arctic and subarctic rivers.
- Ice duration would be shorter and thickness of the ice would be less.
- Changes in wildlife habitat and migration routes. This may have serious repercussions for aboriginal subsistence and way of life.

. Increased sea level will cause coastal erosion and degradation of shorelines. Low lying areas may become permanently flooded.

Lonergan, Difrancesco and Woo (1993) have suggested that warming in the Mackenzie River Valley and the Mackenzie Delta will be most pronounced during the winter season with temperatures rising by 5 to 15°C. Spring and summer increases may not be as great. Similarly, winter precipitation can be expected to increase by 11 to 64% with smaller increases for spring and summer. Rizzo and Wiken (1992) suggest western Arctic ecosystems will be replaced by ecosystems characteristic of the western sub-Arctic, exhibiting longer ice free seasons with a slight increase in precipitation. Based upon the Canadian Climate Centre GCM, Smith and Cohen (1992) and Smith (1993) have suggested a future climate for the northern Mackenzie River Basin centred upon the Delta area. An increase in precipitation of 10% is suggested, as well as an increase in annual temperature of about 5°C. Given these suggested climatic factors and possible effects proposed by Roots (1989a, 1989b), socio-economic characteristics can be included to provide a future scenario for Aklavik.

Two scenarios are proposed for Aklavik, not to accommodate different climatic scenarios, but to accommodate two distinctly different socio-economic futures for the community. In the first of these scenarios, population in Aklavik will continue to grow but development within the community will remain as it is today; limited primarily to the provision of basic services, with most of the aboriginal population maintaining an active role in subsistence activities. The second scenario is based upon a shift within the community to a move away from subsistence activity, and more emphasis on economic development and wage employment. The future of Aklavik is influenced by

environmental factors, but also by the demographic profile of the community, the state of subsistence activity, overall development within the northern Mackenzie River basin, and economic development within the community. Table 6 illustrates possible impacts for both future scenarios and whether or not they are expected to be of a positive, negative or indeterminate nature. These impacts were identified through discussions with respondents in Aklavik and through observation of the community.

Future Scenario - Continuation of Subsistence Activities

Positive Impacts

Despite the possibility of permafrost melting, warmer temperatures would reduce the amount of time spent waiting for cold weather to subside, and structures would be easier to heat during the cold months.

Negative Impacts

If both winter temperatures and precipitation are increased, it is likely that runoff will increase as well. A shorter winter season with greater snowfall may result in river and lake ice being thinner, but slower to melt due to the insulating effect of snow. The effect of greater snowfall combined with greater runoff will likely increase the rate and duration of spring flooding. If flooding is serious enough, it may result in the relocation of people away from the community to areas less vulnerable to flooding. Increased runoff will also increase the rate of sedimentation within the Delta. This may lead to sedimentation of channels currently used for water transport, as well as shifts in the

Table 6 **Impacts of climatic changes on future scenarios for Aklavik**

Impact	Continued reliance on subsistence activities.	Greater reliance on the wage economy and economic development.
greater flooding	-	-
muddy road conditions	o	-
insulation of buildings	+	+
easier water delivery	o	+
less time spent waiting out cold conditions	+	+
outdoor meat storage	-	-
uncomfortably hot in summer	-	-
increased summer insects	-	-
shorter winter road season	o	o
longer water shipping season	o	+
mode of transport	o	o
infrastructure of camps	-	o
location of camps	-	o
changes in wildlife habitat	-	o
increased sediment loading	-	-
thinner ice	-	-
greater snowfall	o	-
variability in timing/consistency of break-up and freeze-up	-	-
longer ice free season	o	+
shoreline erosion and lowland flooding	-	-
greater variability in decisions/perceptions	-	o

+ indicates a positive impact
- indicates a negative impact
o indicates the impact is indeterminate

patterns of fish movements.

The timing of break-up and freeze-up will shift forward, with the possibility of greater inconsistency in the timing and duration of these events and a corresponding increase in the amount of disruption for travel outside the community during these periods.

Melting of permafrost may disrupt the stability of some structures in the community. Discontinuous permafrost is more susceptible to frost heave which is not a major problem in Aklavik today, as it is presently located within the zone of continuous permafrost. Similarly, Egginton (1992) suggests melting of permafrost may induce subsidence and initiate slope failures. This is not a problem within the community but may affect areas on the Arctic coast which are used for fishing and whaling camps.

Coastal ice in the Beaufort Sea may experience a much shorter season than at present. Agnew (1992) suggests a warming trend could result in dramatic changes to the sea ice cover in areas such as the Beaufort Sea coastal zone. The ice free season may increase from the present average of 60 days to approximately 150 days. As well, the maximum ice thickness may decrease by 50 to 75% and wave heights during the open season may increase from 15 to 40% (Agnew, 1992). This would have a positive effect on oil and gas exploration. It may also lead to more erratic conditions for water transport, especially in small boats, and may influence the migratory patterns of beluga and bowhead whales which are important for aboriginal subsistence.

Freshwater ecosystems will need to adapt to changing environmental conditions in Delta lakes and channels. Welch and Hamilton (1992) propose it is likely that in some

cases the existing fish and invertebrate communities will no longer be those most adapted to the altered conditions, resulting in reduced yield to humans from those systems. The impact of climate warming upon fish ecosystems in the Delta are extremely difficult to predict due to the variety of life found in the Delta and a lack of data for these systems. A supply of fish is crucial for subsistence activities though, and changes in fish habitat may adversely affect those who depend upon them.

Other negative impacts include a shorter below-freezing period of time available for storing meat outside, uncomfortably hot temperatures in summer, and a greater abundance of insects. As well, changes in the climate will probably adversely affect the decisions and perceptions of those involved in subsistence activities. A change in climatic conditions may lead to inaccurate perceptions of when and where certain species can be harvested, thus rendering decisions regarding when and where to hunt and trap as possibly inaccurate.

The effect of warming upon wildlife may be detrimental to the continuation of subsistence activities. Unfortunately, few data exist to determine implications of warming upon wildlife patterns and movements. Migratory birds and waterfowl are dependant upon the wetlands and coastal areas of the Delta, which in turn are sensitive to small alterations in the water table, especially those found on northern permafrost (Nicholson *et al.*, 1992). Similarly, land mammals are sensitive to changes in the terrestrial ecosystems and biomes which they utilize. Climate warming is expected to have serious impacts on the ecosystems of the boreal forest. Nicholson *et al.* (1992) suggest an increase in the intensity and frequency of fire, increased forest growth on suitable sites,

and reduction in soil moisture and runoff to lakes and rivers. Although the impacts of changes on wildlife within these ecosystems are difficult to predict, good data exist for the most important species harvested in Aklavik: caribou.

Detailed information exists for the Porcupine caribou herd, which is the herd used by the people of Aklavik. Russell (1993) has explained that caribou are highly sensitive to three phenomenon; spring snowmelt, summer insects and winter snowfall. In a warmer climate, early snowmelt may be beneficial to caribou by reducing the period that animals must survive on poor spring range following their migration north of the treeline. However, Russell suggests the "timing of the burst of highly digestible nutrients and minerals is critical to meet the demands of peak lactation" (Russell, 1993:77). This implies that while an earlier snowmelt may be beneficial in early spring, it could prove detrimental by mid-June when energy and nutrient requirements are greater than at any other time of year, and the food supply has already been depleted. To avoid this problem, calving sites may be moved north of their present location to an area where snow melts about ten days later.

An increase in summer temperature of up to 5^{0}C will probably increase mosquito activity which is known to cause stress in caribou, resulting in less time spent feeding and more time spent moving. Presently, insects become prolific when caribou are on the north Alaska coast where winds offer some relief. By mid-July, the herd enters the northern Yukon and travel into the northern Richardson mountains where cool temperatures and high humidity offers reduced harassment from insects and more abundant vegetation for feeding (Russell, 1993).

Winter snow depth is known to have a profound effect on feeding times and the amount of energy expended on obtaining food from under the snow. During periods of deep snow, caribou will spend more time lying and less time feeding, thus trading off between energy input and energy output (Russell, 1993). During winters of normal to deep snowfall, caribou occupy the Richardson Mountains and the Ogilvie/Hart River basins. These areas experience less snow depth due to high winds and their location in the snow shadow of weather systems from the Gulf of Alaska. During years of low snowfall, the lichen-rich areas of the Whitestone/Eagle River basins are almost universally used (Russell, 1993). Russell predicts that with greater precipitation and snow depth, caribou will reduce use of areas with greater snow depth, even though they are high in biomass (such as the Whitestone/Eagle River basins), in favour of less productive areas with less snow (Richardson Mountains and Ogilvie/Hart River basins). These shifts in the timing of migration and the spatial areas utilized for feeding are potentially disruptive to subsistence activities if they alter known patterns of caribou movements. Given the importance of caribou for the peoples of Aklavik, this could be a very serious consequence of climatic change.

Indeterminate Impacts

There are a number of impacts for which the repercussions of warmer temperatures are indeterminate for subsistence activities. Warmer temperatures would improve the ease with which water can be transported within the community, and thinner ice would make the collection of water easier. Increased winter precipitation would make construction of

the winter road to Inuvik easier, but it would be used for a shorter period of time given a shorter winter season. As well, warmer temperatures would imply that community buildings would be easier to heat during the cold months. The emphasis on a particular mode of transport may shift to a greater reliance on water transport as the cold period during which snowmobiles are used may be of less duration. As well, it is possible that greater snowfall will be experienced over the course of a shorter winter season. The final impact of these possibilities upon subsistence activities cannot be accurately determined, although it is likely that their impact will be less noticeable than the previously described positive and negative impacts.

Given the scenario presented, it is likely that the community will be able to adapt to changes in the climate unless certain events are taken to extremes. If flooding increases to a point where there becomes a serious flood every spring, a worse case scenario may see an exodus from the community to a drier location. For other than flooding though, the community infrastructure will most likely be capable of adapting to a warmer climate.

Subsistence activities have the potential to be adversely affected by climatic change. However, there is simply not enough information known to predict the impacts of a warmer climate on fish and wildlife, with the exception of caribou. Disruption of fish in the Delta would cause the loss of an important food source for local peoples. As well, changes affecting beluga whales on the Beaufort coast may disrupt whaling activities. Most important is the effect of climate warming on caribou. If caribou shift their pattern of movement the community will probably be able to adapt; however,

harvesting may be made more difficult as the shifts suggested by Russell (1993) move the Porcupine caribou herd to locations further away from Aklavik than at present. If changes in the northern ecosystem occur gradually, allowing for adaptation to new conditions, subsistence activities may not be affected adversely. During the time needed to identify new hunting and fishing areas, people living in Aklavik can supplement their diet with store bought food, if absolutely necessary. It is important to note that this is not a popular response though, and is seen as a significant threat to the culture of aboriginal peoples. A worse case scenario may see a large drop in the number of caribou harvested, thus placing pressure on other species, and disrupting a culturally significant activity.

Subsistence activities will be much less resilient to changes in fish and wildlife under a warmer climate. There will have to be a conscious effort to adapt to new locations and possibly new species. If adaptations cannot be made, it is possible that migration will occur to areas that allow for the continuation of these activities; however, given the importance of the community in providing services, it is doubtful that many people will actually leave the community. It is also possible that the spatial extent of land used for subsistence may increase to accommodate more erratic wildlife movements. However, a loss in the ability to harvest certain species may simply be tolerated. Any shift away from harvesting does imply negative effects for aboriginal culture though.

Future Scenario - Greater Economic Development and Wage Employment

The second scenario to be considered here does not present a different climatic scenario. The difference here is a shift in the future development of Aklavik away from the status quo - ie. maintaining subsistence activities - and a move towards a community that is more dependant on wage employment. A scenario such as this must be considered because of several socio-economic factors present during field research in the summer of 1992.

It is possible that the number of people engaged in subsistence activities may be reduced greatly once the group of people presently under the age of fifteen reach an age over 25 years. A social situation discussed by many older people in Aklavik was the lack of participation in subsistence activities by this younger generation. This does not intend to suggest that all young people are no longer interested in hunting and trapping, but that a portion of this group are not becoming involved in the practise of wildlife harvesting. There are a number of reasons for this, such as the need to leave the community for further education, and the lure of a lifestyle more typical of that found in a larger southern community. A detailed examination of this phenomena is beyond the scope of this research, but the existence of this situation must be considered when evaluating future scenarios.

Another serious departure from the present society found in Aklavik is the possibility of greater emphasis on the wage economy. Given that 35% of the 1989 population was under the age of fifteen, it is anticipated that there is going to be a large

population increase when these people have children of their own. This fact has not gone unnoticed amongst the administration of Aklavik and the two aboriginal councils located in the community. Some people have suggested they would welcome the development of the Mackenzie highway linking Inuvik with Yellowknife, and the possibility of renewed oil and gas exploration in the Mackenzie Delta and Beaufort Sea. There is a feeling among some community administrators that given the expected rise in population, there will have to be an expansion of the wage economy to provide a future for these people.

If Aklavik experiences an increase in the community's economic base, combined with a new generation of people less interested in subsistence activities, how would the climatic scenario described previously affect the community? In all likelihood, the community would survive and even thrive, up to a certain point. The infrastructure of Aklavik would need to be improved to accommodate a larger number of people. The northern climate which may be less severe given warmer conditions, can be adapted to in terms of community infrastructure.

Positive Impacts

Warmer temperatures would result in easier water supply and delivery to the community. An above-ground water supply system could be installed if necessary, and buildings can be made to withstand permafrost shifts. Roads in the town could be paved well to overcome the muddy conditions which prevail today. Less severe cold would result in easier heating for the community buildings as well as less time spent waiting for

cold weather to subside. Sedimentation in the Delta can be overcome with dredging, and water transport would be improved with a longer ice free season. With less emphasis on subsistence activities, the community would not be as vulnerable to changes in fish and wildlife habitats, indeed the resilience of the community to natural climatic variations may be improved.

Negative Impacts

There are strong indications however, that Aklavik may not be able to withstand a greater frequency of flood events. At present, the community has little room for expansion, as most remaining land is extremely vulnerable to flooding. Even if northern development were accelerated by renewed oil and gas exploration and highway development, the community is simply unable to grow far beyond its present physical limits. As stated previously, this was the primary reason for the creation of Inuvik. It is likely that increased resource activity would increase wage employment in the community, however, further growth is unlikely. If the community infrastructure is improved, vulnerability to flood events can be reduced, but this is restricted by existing physical limits of the landscape. Beyond that point, increased flooding, which is likely, may have adverse impacts on the community.

As with subsistence activities, summer temperatures may be considered too hot by many community members. Increased insect activity will also be a nuisance along with the possibility of a greater accumulation of snow over the winter season. Similarly, the timing of break-up and freeze-up will continue to be a period of vulnerability for the

community.

Indeterminate Impacts

Impacts such as a shorter winter road season and changes in typical modes of transport are unable to be determined at this point, and may well be negligible. The negative impacts suggested previously for subsistence activities are difficult to determine as the precise level of future subsistence activity is not known. Obviously, less dependence upon subsistence activities will reduce the importance of the negative impacts associated with those activities. However, under this scenario, the loss of subsistence activities would be detrimental to the cultural survival of the community's aboriginal peoples.

The major differences in the impacts identified for both scenarios are based in the emphasis on either subsistence activities or the community itself. Under the first scenario, the largely unknown impacts upon fish and wildlife play a significant role in determining the extent of vulnerability or adaptation required. The emphasis here is on the spatial area currently utilized by the community for hunting trapping and fishing. The emphasis of impacts under the second scenario is based primarily upon the actual community itself and how the infrastructure can adapt to changing conditions. With less importance placed on subsistence activities, the primary factor becomes the physical limits of growth for the community.

Under both scenarios, adaptation will continue to play an important role regardless of the community's socio-economic future. Under the first scenario, subsistence activities

will be placed under stress while adapting, if possible, to new environmental conditions. Under the second scenario, subsistence activities play a much less important role in community life, but similarly, aboriginal culture is still threatened. The community infrastructure can adapt to a warmer climate in both scenarios with the major determining factor being the extent of future flooding. Regardless of which scenario is closer to future reality, the impacts of future climatic change cannot be examined in isolation from socio-economic factors within the community. Subsistence activities will continue to exhibit much more vulnerability to climatic factors than the community infrastructure; however, it is likely that Aklavik is as vulnerable to changes within the social fabric of the community as it is to climatic factors.

Chapter Seven

CONCLUSIONS

The role climate plays in shaping human society remains an area of little study. The linkages and interrelationships existing between climate and human societies are complex and often hidden by environmental and social influences. Examination of historical and present relationships between the regional climate and the community of Aklavik has revealed a complex history of adaptation to changing climatic conditions, as well as to suggest areas of vulnerability to future changes in the regional climate. This research helps to fill a void in climate impact assessment. Past and present societal adaptations to climatic conditions have been examined to illustrate the importance of adaptive strategies and have identified areas of vulnerability and resilience to climatic variability. These areas of vulnerability can help to suggest impacts of projected future climate scenarios, which have tended to ignore the importance of societal relationships and change. The limitations of this study serve well to illustrate the complexity of these interrelationships and areas where future research is required.

The role of adaptation cannot be understated in the existence of the community of Aklavik today. As a remote northern community, its development has been guided by the environment in which it exists. Overlain on the natural environment is a complex history of social development and change, which plays an extremely important role in

projecting the future of the community. Historically, Aklavik has been resilient to the northern climate. The community infrastructure has been developed to withstand the extremes of the Arctic environment, resulting in a community resilient to the possibility of a warmer climate in the future. The subsistence activities practised by many residents are more vulnerable to changes in climate as they depend directly upon the natural environment for hunting and trapping, which is an important economic and cultural activity.

The physical infrastructure of Aklavik is most vulnerable to the effects of spring flooding. If greater flooding is a result of future climate change, the continued existence of the community becomes questionable. The subsistence activity of the community's aboriginal population is especially vulnerable to any changes affecting fish and wildlife. The subsistence economy is crucial to the survival of these peoples in terms of supplying both food and additional income to many families, although the value of trapping has been steadily decreasing over recent years. In general, the community infrastructure is much less vulnerable to climatic variability and change, than are subsistence activities.

The role of adaptation has been important for the survival of aboriginal culture, as well as the development of a community capable of providing the services necessary for its residents. Subsistence activities practised by prehistoric societies in the North have been strongly influenced by climate, and will continue to be dependent on a set of climatic conditions capable of sustaining their needs. In recent history, the most dramatic changes have been to the social fabric of native societies, which have resulted in the community of Aklavik as it exists today.

In the future, it is likely that changes in the regional climate will be adapted to as long as they occur gradually. Past changes have shown that subsistence activities have been able to adapt to changing environmental conditions due to the abundance of resources in the area, as well as the knowledge of local peoples which has allowed for the development of substitutes and alternatives. As well, waiting, tolerating and sharing small losses have been extremely important responses to expected climatic variability. In the future, it is unlikely that migration will play as important a role as it has in the past; however, the availability of modern equipment such as guns, snowmobiles and power boats allows for a large geographical area to be utilized for hunting and trapping. If changes need to be made in the spatial extent of the community's land use, they can probably be accommodated.

The physical infrastructure of Aklavik has adapted to the northern climate, and the impacts of a possibly warmer future climate will probably be more positive than negative. Transportation systems and the provision of services will be made easier with winters of less severity. The largest obstacle for Aklavik's future is its limitation for growth as there is simply not enough space left in the community for expansion. This poses a problem regardless of changes in climatic conditions.

Study Limitations

Limitations in this study can be attributed to a lack of adequate data and a short season of field work. Ideally, a detailed examination of the relationship between the community and climate should be done with field work being undertaken in all seasons.

This study took place during the Arctic summer and relied upon information provided by community members to explain the year round cycle of activity. While this has been adequate for the task of identifying relationships between the community and the regional climate, more specific detailed information could be gathered with a longer study period.

A lack of consistent data has made it difficult to gather some information. Analog data from Inuvik was necessary in order to evaluate a 30 year period for which Aklavik records do not exist. Similarly, hydrologic data for the Delta which could have identified patterns between the annual climate and flood events do not exist. Monitoring stations in the Delta have not been in operation long enough to provide reliable data from past flood events, and changes in the location of these stations has made existing data inconsistent.

The single largest obstacle to assessing the future impacts of climate change in Aklavik is a lack of understanding of the systems on which the community is dependent. While historical and present day adaptations have been examined, a lack of information on impacts for fish and wildlife and biophysical systems restricts the ability to make predictions for the future. At present, there is simply no way of knowing what the precise impacts of greater climatic variability or change will be. The best way to evaluate the future is through the development of scenarios based upon the best existing knowledge of the natural and social world.

Future research in this area will need to concentrate on fish and wildlife systems, as well as the biophysical systems on which they depend. Social changes within the community are equally as important. Future work should concentrate on the socio-

economic status of the community and the direction which future development will take. If the community does eventually move towards greater dependence on wage employment and economic development, then the importance of impacts on subsistence activities is greatly reduced. The relationship between the subsistence economy and the wage economy needs to be examined further to identify where linkages actually exist and to determine the precise extent to which the subsistence economy is depended on for survival, both financially and culturally.

The perceptions of the community to climate and climatic changes are extremely important. At present, climatic variability is viewed as being due to natural variability in the environment, which has been taking place as far back as can be remembered. The role of extreme events and perception needs to be examined further to evaluate why it is that people feel temperatures are warmer than before, yet they are not being attributed to climatic change. There is not a great deal of knowledge on climatic changes or the phenomena of the greenhouse effect. If this knowledge changes in the future, it will be important to see if attitudes towards causes of climatic variability change as well.

The perceptions of climate held by community members are specific to the area of the Mackenzie Delta and the Arctic coast. The context with which they are viewed is in terms of the history of this region. For this reason, the perceptions of the community probably should not be generalized for other northern communities. The knowledge held by the residents of Aklavik is unique to a particular spatial area, with a particular historical background. While the attitudes held by aboriginal people concerning the land and their culture may be generalized, it would not be reliable to state that all

northern peoples have similar perceptions, rather, attitudes and perceptions are probably site and context-specific.

Despite these limitations, this work has still been able to document the historical and present land use of the people of Aklavik, and to explain where they are affected by climate in general, as well as to suggest where they are vulnerable to changes in the future. In general, subsistence activities are vulnerable to any climatic change, as they will require time to adapt. Past events indicate that unless natural systems are severely disrupted, adaptation can be successful. However, at this time it is impossible to accurately predict the degree of disruption to natural systems caused by future climate change. The future of Aklavik depends equally as much on the natural environment as it does on socio-economic factors. Given the young population and the possibility of a shift away from subsistence activities by this generation, social changes must be addressed as part of any further work on climate-society interactions. Indeed, the recent past has seen aboriginal societies adapt to enormous changes in the fabric of their social systems. That they have continued to survive is testimony to the resilience of their culture to these changes, and indicates that vulnerabilities to changing environmental conditions must take into account both natural and social systems as part of their evaluation. In Aklavik, the importance of subsistence activities to the cultural survival of these peoples indicates that even if social changes create a society less dependant on these activities, they will never be eliminated completely. It is likely that adaptation will be the key to the continuation of these activities in light of both changing climatic and social systems.

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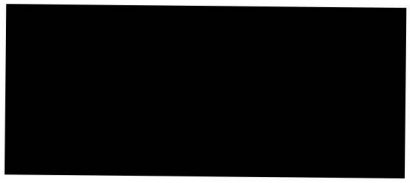
Author: 

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