

**Development of a  
Coastal Community  
Climate Change Action Plan  
for Arviat, Nunavut**

By  
Darren Thomas

A Thesis  
Submitted to the Faculty of Graduate Studies  
In Partial Fulfillment of the Requirements  
For the Degree of

**Master of Natural Resource  
Management**

**Natural Resources Institute  
University of Manitoba  
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FACULTY OF GRADUATE STUDIES  
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**Dedicated to my Dad**

## Abstract

This thesis presents the foundation for the establishment for a coastal community climate change action plan for Arviat, Nunavut. The study involved researching current climate change literature and collecting local observations about climate change. Personal semi-formal interviews were used to document the local observations. This thesis focuses upon the possible effects climate change can have on Arviat, based upon literature reviews and discussions with local community members. The thesis provides a brief overview of Arctic climate change and outlines the steps needed to be taken in order to fully develop and implement a coastal community climate change action plan.

The thesis has shown that Arviat is starting to become aware of climate change and possible impacts and is starting to enquire about the possible effects that climate change has at the local level. The thesis has also determined that Traditional or Local Knowledge has a place in predicting local climate change impacts. In some areas, climate change science and predicted impacts are in direct conflict with the locally observed changes. Local knowledge must be included in determining the possible impact of climate change in order to create a fully functional and locally relevant action plan. The thesis has examined the possible social, economic and cultural impacts facing Arviat due to climate change and found that all aspects of life in Arviat can potentially be affected; however even with these potential effects the community was optimistic about the future. The thesis assisted in creating a framework for the development of an action plan that is cultural appropriate and acceptable to the people living in Arviat, and has

identified future research needed to support a full coastal community climate change action plan.

The conclusion of the thesis is that Arviat possesses the basis to develop a coastal community climate change action plan. However, the community needs to develop key foundation areas in order to start to develop action plans suitable for Arviat. The data presented here is intended to act as a framework to assist the community in developing and implementing an action plan. The framework can also act as a guide to assist the gathering of relevant information and impact prediction. The final sections of this document provide recommendations for the community in the development of the plan.

## Acknowledgements

I would like to acknowledge the Hamlet of Arviat and to all those who participated for being involved in this important research and sharing with me their experiences, their stories of the Arctic, their culture and their local cuisine. I left Arviat, however Arviat will always have a special place in my heart. All of you made me feel welcome and made me feel at home. "Thank you all."

I would also like to thank my advisors, Professor Thomas Henley, Dr. Helen Fast, Dr. Peter Kulchyski and Mr. Denis DePape, for their support, guidance and assistance. Thank you to all of the agencies that provided support and financial contributions to this project: Fisheries and Oceans Canada, Manitoba Hydro, Ocean Management Research Network, Natural Resources Institute and the University of Manitoba.

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I would like to also thank my extended family for their kindness, support and patience through this long journey. To my mom, my sister and my brother "Thank You; you have stood by me during this journey and gave me the right amount of criticism to keep me going." And to my grandparents and to my Nohkom and Mosom "I will miss you; may you rest in peace."

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## **Table of Contents**

### **ABSTRACT**

### **ACKNOWLEDGEMENTS**

<b>CHAPTER 1.....</b>	<b>1</b>
PREAMBLE .....	1
STUDY AREA .....	3
PURPOSE .....	6
OBJECTIVES.....	7
SCOPE AND LIMITATIONS .....	7
RESEARCH APPROACH .....	9
<b>CHAPTER 2.....</b>	<b>15</b>
METHODOLOGY.....	15
<b>CHAPTER 3.....</b>	<b>27</b>
CLIMATE CHANGE 101.....	27
CLIMATE CHANGE IN THE ARCTIC .....	30
ARVIAT OBSERVATIONS.....	49
<b>CHAPTER 4.....</b>	<b>67</b>
POSSIBLE PHYSICAL IMPACTS OF CLIMATE CHANGE ON ARVIAT .....	67
POSSIBLE SOCIAL EFFECTS OF CLIMATE CHANGE ON ARVIAT .....	81
POSSIBLE CULTURAL IMPACTS OF CLIMATE CHANGE.....	86
<b>CHAPTER 5.....</b>	<b>95</b>
CLIMATE CHANGE ACTION PLANS.....	95
<b>CHAPTER 6.....</b>	<b>100</b>
THE DEVELOPMENT OF A COASTAL COMMUNITY CLIMATE CHANGE ACTION PLAN FOR ARVIAT, NUNAVUT .....	100
RECOMMENDATIONS AND CONSIDERATION .....	101
<b>CHAPTER 7.....</b>	<b>117</b>
SUMMARY AND CONCLUSIONS .....	117
<b>CHAPTER 8.....</b>	<b>124</b>
FINAL THOUGHTS .....	124
<b>REFERENCES.....</b>	<b>132</b>
<b>ATTACHMENTS.....</b>	<b>I</b>
APPENDIX 1 .....	I
OUTCOMES AND PARTICIPANTS OF INITIAL PROJECT MEETING .....	I
APPENDIX 2.....	II
INFORMATION AND CONTACT SHEET .....	II
APPENDIX 3.....	IV
INTERVIEW SCHEDULE.....	IV
APPENDIX 4.....	VIII
SUBMITTED ETHICS APPROVAL REPORT .....	VIII
APPENDIX 5.....	X
RESEARCH CONSENT FORM.....	X

**List of Figures**

Figure 1: Map of Nunavut .....	2
Figure 2: Map of Kivalliq Region of Arviat .....	3
Figure 3: Reconstructed Temperature Graph.....	30
Figure 4: Taken from IPCC, 2001.....	31
Figure 5: Temperature departures from normal in the winter of 2005/2006.....	33
Figure 6: Projected changes in the extent of sea ice cover in the Arctic.....	35
Figure 7: Ocean Current System – Thermohaline Current System.....	39
Figure 8: Extent of Permafrost Coverage in Canada.....	41
Figure 9: Projected retreats in sea ice between 2010-2090 and the effects on shipping routes.....	68



# **Development of a Coastal Community Climate Change Action Plan for Arviat, Nunavut**

## **Chapter 1**

### **Preamble**

The *Oceans Act* mandates the Department of Fisheries and Oceans (DFO) to guide the management of Canada's estuarine, coastal and marine ecosystems (Government of Canada, 1997). A policy and operational framework for integrated management of estuarine, coastal and marine environments in Canada has been developed to underpin this work (Government of Canada 2000a). The integrated management planning process involves defining and assessing a management area; engaging affected interests; developing an integrated management plan; getting endorsement of the plan by decision-making authorities; implementing the plan, monitoring and evaluating outcomes (Government of Canada 2000b).

On October 3-4, 2001, Fisheries and Oceans Canada (DFO) hosted a meeting in Rankin Inlet, Nunavut (NU) to discuss the formation of a working group for integrated management planning for Hudson Bay. Participants agreed to form the Hudson Bay Oceans Working Group<sup>1</sup> (HBOWG). Participants of this meeting can be found in Appendix 1. The HBOWG was made up of members from communities in the Hudson Bay region, along with DFO. The HBOWG's mandate was to develop an integrated management plan for Hudson Bay, with an initial focus on the western coastal communities (Kivalliq Region).

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<sup>1</sup> Participants at this meeting included Nunavut Inuit Organizations, Nunavut Land and Resource Management Boards, Inuit Wildlife Organizations, Nunavut Government, hamlet municipalities, and federal government departments.



area still relied upon traditional foods, or “country foods”, such as whale, seals and caribou for much of their needs. There were concerns on how climate change will affect their access to these “country foods”. Since oceans resource management along the Hudson Bay was an active issue for DFO; and if climate change can affect northern

# Communities in the Hudson Bay

resources (such as animal populations, and community infrastructure), then elements of climate change should be looked at from a resource management perspective.

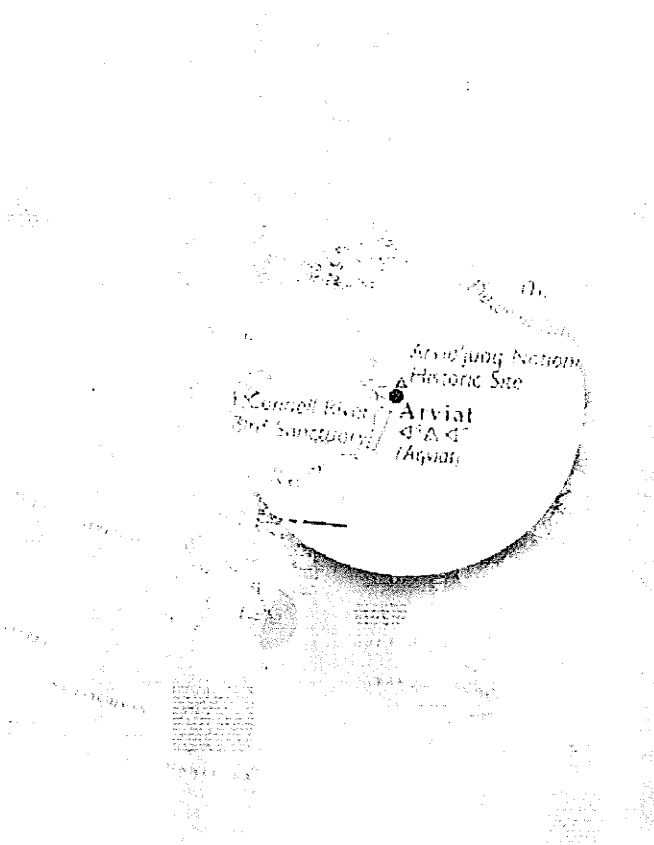
## **Study Area**

The community of Arviat is located along the Hudson Bay coast in the Canadian Territory of Nunavut (Figure 1). Nunavut was created April 1, 1999 as a result of the Nunavut Land Claims Agreement (Government of Nunavut, 2006a). Nunavut means 'our land' in Inuktitut. Nunavut is comprised of two million square kilometers. The Inuit represent about 85 percent of the population. None of the Nunavut communities are accessible by road or rail (Government of Nunavut, 2006a).

Arviat is located within the Kivalliq Region of Nunavut (Figure 2).

## **History**

The history of Arviat is not the focus of the research; however it is important to recognize the existence of two distinct cultures within Arviat. One culture based on the land and one culture based on the sea.



**Figure 2: Map of Kivalliq Region of Arviat**

Source: Government of Nunavut(b), 2006

When talking to the Elders, these are members of Arviat 50+ years of age who experienced life on the tundra, it was not difficult to determine the background of the Elder, whether their background was inland or coastal. On occasion during the interviews, the Elders would state that their experience was with the inland animals and their comments on the sea life was based upon limited knowledge and may not be accurate. This was also true for those with coastal backgrounds. This was the way with many of the Elders. They would comment upon what they knew about the climate and the area but always inserted a caveat in their response. They always said that this is what they believed and what was told to them, but it could be untrue and others may have more information than they have provided.

With each of the Elders there was a sense of great knowledge and wisdom; however this was tempered with great humility. They were comfortable enough to state that they were unsure about the accuracy of their information and stated that this was their belief and may not be accurate. There was also concern about the changing environment and that their information may no longer be relevant.

### **Infrastructure and Services**

The Kivalliq Region is home to 8,000 people living in seven hamlets (Government of Nunavut, 2006a). Arviat was formerly known as Eskimo Point until June 1, 1989. Arviat comes from the Inuktitut word '*arviq*', the Inuit name for the bowhead whale (Government of Nunavut, 2006a). The community of Arviat is composed of 2,060

residents of mainly Inuit. Ninety-four percent of Arviat's population is comprised of Inuit, with only six percent made up of non-Inuit (Statistics Canada, 2006).

Arviat houses an all-season airport; which consists of a tarmac landing strip and an all-weather airport facility (Government of Nunavut 2006a). Arviat also has a community dock used by the local community members to launch their boats. The community also utilizes a wharf for the loading and off-loading of the summer barges that travel Hudson Bay and deliver goods and materials to the coastal communities. The summer barges help to offset the cost of northern living by reducing the need for airfreighted materials and goods. Much of the fuel used year-round by the community is delivered by barge (David Ukatuk Jr 2003).

Arviat youth attend school in the hamlet. Arviat houses an elementary school (Levi Angmak, grades K-6) and a secondary school (Qitiqliq, grades 7-12); with a new secondary school being currently constructed (David Ukatuk Jr 2003). Arviat also houses a post-secondary school. The Nunavut Arctic College selected Arviat to be the home of a northern campus as well as the College headquarters (Nunavut Arctic College 2005).

Since the creation of Nunavut there has been a decentralized territorial government. Arviat had been selected to be the headquarters for Education (responsible for Curriculum and School services as well as Adult Learning, Career & Early Childhood Services) and Housing Departments (responsible for housing in Nunavut, issues such as adequate housing and overcrowding).

Located within Arviat is also a Co-op and Northern store, used for groceries and other personal items. These stores are the main supply for goods and services within the community. Both the Co-op and the Northern Store supply basic needs such as flour and milk but can also supply larger items such as snowmobiles and furniture. Arviat also has a hotel and two bed & breakfast accommodations. These are primarily used for out of town visitors (David Ukatuk Jr 2003).

Other community infrastructure and buildings located within Arviat include two coffee shops, a community hall, an arena, a pool (used only in summer), a post office, a lumber supply, a health centre, an elders' residence, an RCMP detachment, a Sustainable Resources office, a sewing centre, a community radio station and a community drop-in centre.

### **Purpose**

The original purpose of this research was to develop a coastal community climate change action plan for the community of Arviat, however this was modified when this proved to be impractical due to the scope of the original intent.

The purpose of this research was modified to: "providing background information on climate change from literature reviews and local observations and to providing guidance on the development a coastal community climate change action plan for the community of Arviat in the Canadian Territory of Nunavut."

## **Objectives**

1. To broadly determine the current understanding of climate change impacts in Northern Canada.
2. To determine the place local knowledge or Traditional Knowledge has in predicting climate change impacts.
3. To examine the social, economic and cultural impacts of climate change from the perspective of local residents.
4. To create a framework and provide guidance for responding to climate change and for preparing an action plan appropriate and acceptable to community members.
5. To determine further research needs required for the development of a Coastal Community Climate Change Action Plan for Arviat, Nunavut.

## **Scope and Limitations**

The types of impacts likely to be felt as a result of climate change may affect subsistence food sources, social, cultural and economic impacts including transportation and community infrastructure (A rigorous quantitative assessment of the economic implications for this community was beyond the scope of this project). Some examples of how climate change will affect the community include the following:

### *Subsistence food supply*

- The distribution and number of animals and other resources may change and so alter access to subsistence resources. Changing temperatures may cause fish species to move from their present ranges. Exotic species may move into areas as temperatures

change. Changing ice cover and less predictable travel and hunting conditions are likely.

- The health of animals may be affected as a result of climate change.

*Social and cultural impacts*

- Reduced abilities to hunt and fish may contribute to dietary problems and increased medical costs through elevated levels of cardiovascular disorders, diabetes, and vitamin-deficiency disorders. Reduced physical activity associated with less time spent on the land will exacerbate these conditions, and further reduce the quality of life for coastal residents.

*Economic impacts including transportation and community infrastructure*

- Reduced abilities to hunt and fish may impose financial burdens on residents who must now use money to buy a food staple.
- Changes in sea level may impact coastal structures, boat launches, sewage facilities, roads, and water access.
- Existing water supply systems may need to be re-designed as wastes in the permafrost thaw.
- Winter roads may become more costly to maintain, assuming they are still viable.

Given the original broad purpose, the original scope could not be met with the time and resources given to the project. Each of the points identified above need a rigorous assessment and in some cases required expertise outside the field of knowledge of the researcher. This research identifies the full range of potential climate change impacts on Arviat in considerable detail. However the thesis does not present a quantitative assessment of their implications.



## **Research Approach**

The primary information source selected was “personal climate change observations” from the members of the community of Arviat. “Personal observations” were selected due to the limited research on the local socio-economic effect of climate change in the Arctic. Personal observation would provide the best source of information regarding climate change and its effects in the immediate region. The research method used to obtain the personal observations was semi-formal open-ended interviews. Questions asked during these interviews can be found in Appendix 3.

The observations by community members regarding climate change are qualitative by nature. The information is intertwined with recollections, memories and stories. The type of information gathered in its raw form does not easily lend itself to statistical analysis. The interview schedule (list of interview questions) and the methods used would have to be altered and redesigned to undertake any statistical analysis.

Since the information required is contained in memories and stories, the methods of data collection must be able to extract the information efficiently. In this research the observation is the key, not the statistical significance of the observation. The information gathered was not focused on exact dates or temperatures. For this type of information, a personal open-ended ‘semi-formal’ interview is the best method of extracting the required data.

### *Question Development*

Open-ended questions were chosen as a method of extracting the information. It was felt that open-ended questions would help to eliminate any possible researcher bias in the response during the interview portion. In developing questions, there is a possibility for a researcher to direct the response of an interviewee by limiting their choices in available answers, such as in closed-ended or multiple-choice type questions. Open-ended questions allow the interviewee to respond to the questions in their own words. Also, open-ended questions allow for the introduction of new points of views that may have not been seen during the development of the questions. As people respond to questions, they may offer some insight to the research, or highlight an issue that was not considered.

However, open-ended questioning can have some drawbacks. One draw back is that open-ended questions are difficult and time consuming, both during the interview and the analysis. In a closed-ended format the responses can be coded and entered into a database quickly. In an open-ended format the responses have to be analyzed by hand, and they must be reviewed and analyzed by experienced researchers. Open-ended questions are more of a conversation about the topic. If the researcher is not prepared or experienced enough with this method, then the results can be limited and/or biased. If the researcher is too quick to accept any answer then the required information may not be uncovered. The researcher must have skills to be able to interpret and to ask the same question in different ways, without changing the meaning of the question. The researcher must be able to gather information without being too aggressive or intrusive. Also the researcher must be able to control the interview. In many open-ended interviews the

possibility for off-topic conversations is high and the researcher must be able to refocus the interview.

The researcher must be able to control the conversation without being rude or limiting the interviewee. The researcher must be able to track all the questions; in some interviews upcoming questions may be answered in previous responses, and the researcher must be able to keep track in order to avoid duplication in the questions asked.

### *Interview Format*

Personal 'semi-formal' interviews were selected as the method of extracting the required information. The term 'semi-formal' relates to the way the questions are presented and not to the research method. The interviews all followed an interview schedule (Appendix 3) that outlined the information to be extracted. The questions were developed ahead of time, approved by the University of Manitoba and the Nunavut Research Institute. The way the questions were presented was not exact in each interview. This was done in order to avoid duplication in topics discussed. In the open-ended interviews, the order of the questions on the interview schedule was difficult to follow since the response varied from interview to interview. Even though the interview schedule was not followed in order, it was managed in a way to ensure all questions or ideas were asked during the interview.

The interview schedule developed was subjected to a pre-test to ensure cultural appropriateness and to help identify any cultural biases or misunderstandings. In this case the questions were pre-tested by the community leadership and the selected

individuals (interviewee 1 and 2). The questions were found to be culturally appropriate and required no further adjustment. Interviews 1 and 2 were integrated into the total interview sample.

Eleven out of the fifteen interviews were translated by the community-based researcher as the interviews were conducted. This allowed for community members to respond in a way that made them comfortable and allowed the researcher to dialogue further with the interviewee as questions arose. The somewhat simultaneous translation allowed for a more free-flowing dialogue to occur.

### *Sampling Method*

In this project the snowball sampling method was used in determining participants. Snowball sampling is a technique used for finding research subjects. It begins with the identification of one participant who meets the requirement and then they refer a peer; one subject gives the researcher the name of another subject, who in turn provides the name of a third, and so on (Vogt, 1999, Atkinson and Flint, 2001).

In this case the research began with the identification of a community-based researcher. The community-based researcher then helped to identify those within the community who met the requirements of the study.

Snowball sampling was applied because it can be easily applied to an unknown population and it can be used to make inferences about a population (Atkinson and Flint, 2001).

The snowball method was slightly modified to try to overcome some of the negative aspects of the methods. One negative aspect is cluster sampling: the referral of friends and family, even though they may not have the requirements to be participants or all participants share the same background, recollection or stories. This problem can occur, especially in cases such as this one where honorariums are given to the participants. In many cases budgets dictate the amount of interviews to be conducted; therefore each interview must add value to the project.

In this project the interviewee suggested or referred other potential candidates. Once the interview was completed the researcher and the community-based researcher analyzed the referral. Knowledge of the community was a skill required of the community-based researcher; this played an important role in identifying community or family groups. The community-based researcher has experience with the community norms and structures so he was able to help in determining proper interviewees to be selected out of all referred individuals.

### ***Social Relevance***

The project is socially relevant because climate change impacts northern societies in their day-to-day lives. Information about climate change and the cultural impacts climate change will have / is having on northern communities is limited (Fast and Berkes 1998). While selected areas in the High Arctic have recently been reviewed for climate change impacts (Krupnik and Jolly 2002), no such work has been undertaken for the Hudson Bay

communities. As a result, coastal residents are left asking questions about the impact likely to occur in their communities. With greater knowledge they will be better equipped to anticipate and mitigate change.

## **Chapter 2**

### **Methodology**

#### **Literature Review**

The literature pertaining to climate change and northern community impacts was used throughout this report in relevant sections and is not discussed in this section. Below is a list of the documents, publications, journals and websites used during the literature review.

A printed literature review was conducted on current research about the Canadian Arctic, coastal impacts of climate change, Inuit culture and history, climate change, the Territory of Nunavut and the community of Arviat focusing on climate change and its impact to Arctic coastal communities. The literature review looked at government documents, newspapers, magazines and peer-reviewed journals. Some of the journals researched were Science, Arctic, Arctic Circle, Arctic Research of the United States, WWF Arctic Bulletin. The literature review also looked at Traditional Knowledge literature as it pertains to environmental observations and observed environmental, meteorological and climatic changes and adaptations. The literature review was limited to the English language.

The literature search also relied on the Internet as a source of current information. The following search terms were identified as possible terms to use in Internet searches:

Aboriginal	Effect/s	North/ern
Adapt/ive/ation	Environment/al	Northern community
Arctic	Global warming	Permafrost
Hudson Bay	Impact/s	Resource/s
Climate/Climatic/	Inuit	Resource management
Climate change	Land/land use	TK/IK/TEK
Coast/al/s	Inuit/inuk	IEK/IQ/IEK
Econom/ies/y/ic/ics	Kivillaq/Keewatin	

For all of the searches, the keywords (Aboriginal or Inuit\* or Inuk\* or Indigenous people\*) and climate\* and change\* were included, as these were the main subjects and would focus the search, retrieving desired results.

Searches were conducted of a variety of resources. These were chosen for their focus (e.g., environment, Aboriginal, natural resources), authority (include peer-reviewed resources, government documents), and depth. The following resources were searched:

Search engines:

- Vivisimo - <http://vivisimo.com/>
- Profusion - <http://www.profusion.com/index.htm>
- Teoma - <http://www.teoma.com/>
- Google Scholar - <http://scholar.google.com/>
- JSTOR (Journal Archives) – <http://www.jstor.org>



## **Field Visits**

The field component was an important part of the research. Since, at first, research regarding the local climate change impact in the Canadian Arctic was limited, primary data would have to be collected. A series of three field visits were conducted. The purpose of these visits was to establish a community steering committee, to conduct research and document findings as they relate to the objectives, to establish a working relationship and develop institutional credibility with the community and to ensure that all community and Territorial protocols are met. Follow-up visits were conducted to ensure correctness, to allow for community input and to present the final findings to the community at large.

### *Preliminary Visit*

There were three field visits conducted in order to carry out the research. The first visit was conducted in March 2003 to allow for a presentation of the project to selected members of the community as well as to the Hudson Bay Oceans Working Group. The preliminary visit helped to establish a working relationship and develop institutional credibility with the community. The visit also helped to ensure that all community and Territorial protocols are met and allowed for the community to provide feedback and comment on the project at an early stage.

The preliminary site visit enabled the author Darren Thomas to start the process of selecting a Community Based Researcher (CBR) to help in the coordination and gathering of knowledge. The visit also allowed for notice to be given about the formation

of a community steering committee. The role of the community steering committee was to guide the creation of the documentation and to ensure intellectual property was protected. The preliminary visit also helped establish a baseline into climate change awareness and gain insight into the community.

### *Community Based Researcher Selection*

An information poster was created and was sent to the community for mass distribution, with information regarding the CBR position. The role of the CBR was to assist in research and to act as a community liaison, translator and a community information person.

Posters had been distributed to interested members and posted on community billboards. The roles and responsibilities of the CBR were clarified as well as the expected timelines of the research phase. During conversation with other Natural Resources Institute students the name David Ukatuk Jr. came forward as a potentially qualified CBR. During conversations with hamlet officials, David was recommended. David had acted in a research assistant role in the past and has undertaken research of his own regarding the history of Arviat. David was knowledgeable about the community and its customs and spoke the language fluently. David Ukatuk Jr. was selected as the new CBR. David announced the project on the local radio and started to solicit names of interested community members for interviewees. David provided to the community details and updates about the project.

David compiled a list of interested members of the steering committee; however the selection of the final members was left until the primary visit was conducted. Face-to-face meeting of potential individuals allowed for the discussion of the project and the selection of the appropriate community member.

### **Primary Visit**

The primary field visit was conducted in December 2003 and the objectives were to gather primary data on the environmental change observation of the community of Arviat. The primary community visit had two main goals. One was to gather the climate change observations and Traditional Knowledge from the community and the other objective was to disseminate climate change information requested by the community. The visit offered the researcher an opportunity to interact with the community and this personal interaction helped to facilitate two-way lines of communication.

### **Tours and Activities**

Once in Arviat, the author Darren Thomas engaged in many community activities. Darren felt that it was important to be involved in the community, to build a sense of trust and openness. Darren participated in many activities such as community crafts sales, community gatherings, and community events, such as the local snowmobile race. The activities allowed many community members to get to know Darren Thomas outside of the research and on a personal level. This allowed the interview process to become more fluid and dynamic. Once trust was built, then information sharing becomes second nature.

### **Interviewee Identification**

Darren Thomas and David Ukatuk Jr. appeared on the local radio station to promote the research project and ask for participants with climate change knowledge. Almost immediately community members called in to ask questions or sign up. Darren Thomas and David Ukatuk Jr. also approached members of the community at different community locales such as coffee shops.

Darren Thomas and David Ukatuk Jr. wanted to identify those community members who would have a great deal of climate change knowledge. However the research was designed to ensure a wide variety of community observations were collected. Darren Thomas wanted to ensure that a cross-section of the community was obtained for the report. To avoid bias Darren Thomas selected interviewees that represented the community, such as women, men, Elders, youth, traditional resource users, and employed community members.

Non-residents and government officials were also interviewed but with another focus. The focus of these interviews was to establish community infrastructure and capacities.

### **Interviews**

Personal interviews were conducted with a variety of community members in order to obtain community information regarding climate change. The interviews were formatted in a way as to be open ended and non-leading. The interview schedule that was

developed was subjected to a pre-test to ensure cultural appropriateness and to help identify any cultural biases or misunderstandings. The interviews were held at locations at which the interviewees felt comfortable. On almost all occasions the interviews were held at the homes of the interviewees. Darren and David would travel to the homes of the interviewees; the time at which the interviews were held varied according to the availability of the interviewee.

Many of the community members felt more comfortable speaking Inuktitut. Many of the interviewees understood English; however, they wanted to respond in their own language. David acted as an interpreter, translator and helped to clarify words with no direct translation. As Darren asked the questions, David would translate, as responses were given Darren documented the responses in a notebook. In all cases the interviews were digitally audio recorded to ensure that the notes were accurate. The interviewee agreed to audio recording under the conditions that the interview recordings are returned to the interviewees once the report was completed. Access to these recordings is only with the direct written explicit permission of the interviewee.

After each interview Darren Thomas and David Ukatur Jr. reviewed the responses and shared their own interpretation of the interview, this allowed for a better understanding of the interview and of the responses. This process helped to clarify topics and expand on the interview notes.

There were ten Elders, five Resources Users and three Youth. Within these three groups, men, women and employed members of the community were selected that were interviewed during the primary visit. There were also two hamlet officials that were interviewed regarding community infrastructure and risk evaluation. The responses of the Elders, Resources Users and Youth are presented here in no discernable order. Common themes and stories were grouped together; any differences in observations are discussed during the relevant sections. The hamlet official's interviews are used to gauge the community awareness and concern about climate change impacts. Community readiness can be discerned from the responses. However, a detailed analysis is needed for a completed understanding of the community risks in terms of infrastructure impacts.

### **Analysis**

Since Arviat is comprised of two distinct cultural backgrounds, the interviews (mainly the Elders and the stories of the Resource Users) were focused on areas of expertise (sea livelihood versus land livelihood). For the purpose of this study there were no discernable differences in the method used to interview the Elders. Whether the Elder's background was ocean-based or land-based, the same questions were asked and all responses were documented. The focus of this study was not to identify the difference in responses between the two cultures, but to document the observations witnessed by the community of Arviat. The analysis of the observations was done identically for each interview. All interviews and observations documented were treated the same.

All the information collected during the interviews was not data that could be placed into an equation or be easily quantified in terms of weather data such as temperatures or accurate dates of extreme events. Much of the data was stored in stories, and not easily extracted. Many Elders used stories or incidents to help disseminate the information that was requested. Questions regarding warming trends in the weather often began with stories about the weather when the Elder was young. These stories were then followed by comparing past observations to the current conditions.

Once the interviews were collected, the information that pertains to the current research had to be separated from more personal information. The interviews were individually analyzed. Each interview was reviewed and the information sorted into two broad categories. These categories were: information relevant to the thesis topics; and sharing of personal information.

The information relevant to the research was separated from the personal information. The personal information was removed from the research and no further analysis was done. The personal information shared was information about cultural issues, community issues, family issues or problems, personal preferences, personal reflections not related to the research topic, ideologies, theological discussions and personal advice to the researcher. This information was not meant to be part of the CCCCAP.

As the data were being collected (during the interviews), common themes started to become noticeable. The interviewees talked about common occurrences or incidents that

took place. After reviewing the interviews, Darren Thomas started to identify and group common themes from each interview.

The analysis of the interviews was done in such a way as to minimize the ability of anyone to link any specific comment or statement with any individual. Darren felt that linking the interviewees to their statements would not add any value or help to validate the information. Therefore the information was analyzed in such a way as to keep it general, without losing any of the pertinent information.

The anonymity of the interviewee is common in research that involve personal information or if the research is deemed controversial or considered taboo by the community. This research was neither controversial/taboo nor does the information given by the participants need to be protected from unauthorized viewing. However the premise that was presented to the interviewees before the interviews was that of anonymity. In the past few years some of the Elders that had taken part in the interviews have passed on. It would be inappropriate to change the underlying understanding of privacy without having all participants agree with the change. Since some of the Elders have now passed on, complete agreement on the process of changing the anonymity is not possible. So it was felt that to change anything in terms of anonymity could be unethical. This included identifying participants by name, including their interview notes or transcription in the thesis. Records of the interviews do exist and will be returned once the thesis is complete.



### **Follow Up Visit**

Darren conducted a follow up visit in the beginning of 2006. The follow-up visit was to establish that the findings of the research were reflective of what was heard. This visit allowed Darren Thomas to ensure that the statements made in the research report were accurate. Darren Thomas traveled back to the community of Arviat in August 2006.

Prior to the visit David had started to disseminate information about the date and purpose of the follow up visit. Darren forwarded a copy of the research report to David in order to start the feedback process. David reviewed the document first and started to share the findings with the community members. This helped to increase the interest in the follow-up visit and the project as a whole.

During the follow up visit, Darren held an open house to showcase the final report and the findings. The open house was held in the local community center. The center was available and offered by the hamlet office. Darren and David had sent out and posted notices about the community meeting to showcase the findings of the final report. Darren felt that an open house would be the most flexible option to showcase the findings. An open house would allow community members to participate during a convenient time. Darren understood that many community members have personal and business commitments and an open house would allow community members to participate.

The open house was held from 8 a.m. until 10 p.m. Many community members walked in to see what the project was about. Darren and David shared their experience about the

project and answered some of the questions on climate change impacts. Overall the open house helped to generate discussion about climate change, allow for other community members to share their own observations with Darren and other community members. By the end of the open house there were no major concerns with the type or the way the information was shared. Darren ensured that all participants were aware that once finalized the report would be available either through Darren, David, the hamlet office or through the institute.

## **Chapter 3**

### **Climate Change 101**

#### **Weather versus Climate**

*"Climate is what you expect and Weather is what you get".*

*- Mark Twain*

#### **Introduction**

In order to understand the effects that climate change can have on our lives, we must first understand the difference between weather and climate. Climate and weather are terms often used interchangeably. However they refer to distinct aspects of our world. Weather is a term used to describe the current conditions experienced in an area, whereas climate tends to describe the overall average conditions for a region (Natural Resources Canada, 2004).

#### **Weather**

Weather is basically the daily changes that occur at the earth's surface. Changes such as temperature, wind velocities and direction, and the occurrence of precipitation (rain or snow) are considered weather (IPCC, 2001).

Weather is a complex system of interactions between solar heat, radiation and the earth's rotation (IPCC, 2001). However the goal is not to understand why weather changes; the goal is to understand that there is an occurrence at the surface of the earth that impacts temperature, wind velocities and direction, and the occurrence of precipitation.

Weather is not stationary and is highly unstable (IPCC, 2001). The weather in a particular area can change very suddenly. Different weather conditions exist over different regions of the earth's surface (IPCC, 2001). Even within a small area there can be variable weather conditions. One set of weather conditions may exist in an area, however if this interacts with another set of weather conditions or weather system, then the weather over the entire area can change. This interaction may create an entirely new set of conditions (Natural Resources Canada, 2004). Weather is unstable and very difficult to predict with absolute accuracy.

### **Climate**

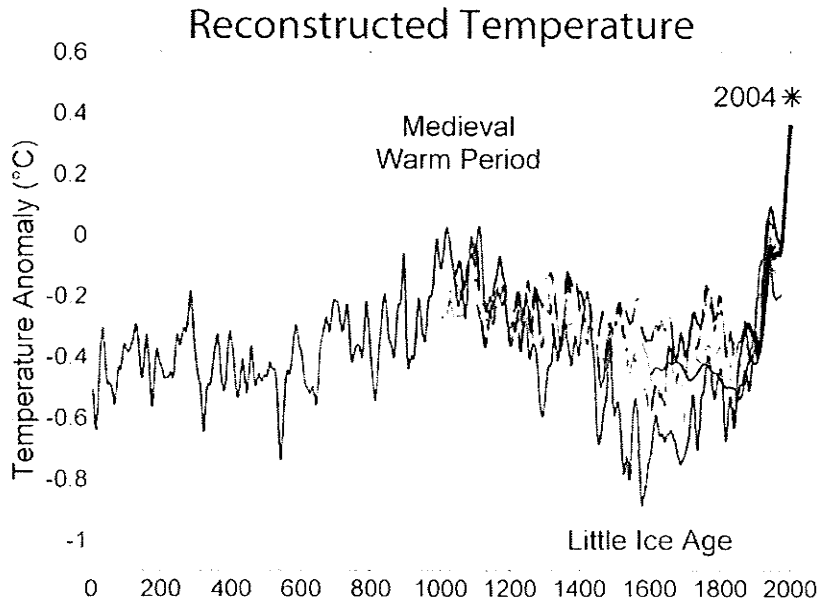
Climate is the weather conditions over a certain region observed/monitored over a length of time (Natural Resources Canada, 2004). The time the weather is observed is usually in the order of several decades (IPCC, 2001). The local weather patterns are amalgamated together to create a local average of the weather conditions over time (Natural Resources Canada, 2004). As the time the region is observed and the more data is amalgamated together, the average weather conditions of a certain region becomes more defined. However as the average conditions become increasingly more defined, the daily weather conditions become more obscure. Knowing the climate of a particular region can give you an idea of the typical weather patterns for that region, but cannot tell you the daily weather patterns for that region (Natural Resources Canada, 2004). Daily weather patterns can greatly deviate from this average.

Weather is variable and changes daily or even hourly. Climate, on the other hand, is very slow to change and remains relatively static in relation to weather; however, this is not to say that the climate itself is static. Climate is not static and is susceptible to change; as weather patterns change and long-term weather conditions remain prevalent, then climate can also change. Other factors may also have an impact on climate.

### **Climate Change**

Just as weather may change from day to day, climate can also be variable. The climate involves many natural systems such as the oceans and the atmosphere. If there is variability in these types of systems, there can be variability to the climate. The Hudson Bay climate has shifted from tropical areas to frozen tundra over a period of many millennia. Recently science is uncovering a link to human activity and shifting climate properties (Natural Resources Canada, 2004). The United Nations Framework Convention on Climate Change (UNFCCC), defines “climate change” as: “a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods” (IPCC, 2001).

Climate change is a natural phenomenon, regions have undergone many changes over the life of the earth, however now there is concern with the rate climate components are changing. Through the studies of ice and sediment cores, scientists have been able to compile information regarding the climatic information of past eras. Figure 3 below shows the global climatic condition (expressed as mean temperature) of the past two millennia.



**Figure 3:**  
**Reconstructed Temperature Graph**  
Graph shows temperature data for the past 2 Millennia

Source : Robert A. Rohde  
[http://www.globalwarmingart.com/wiki/Image:2000\\_Year\\_Temperature\\_Comparison.png](http://www.globalwarmingart.com/wiki/Image:2000_Year_Temperature_Comparison.png)  
Accessed May 31, 2006

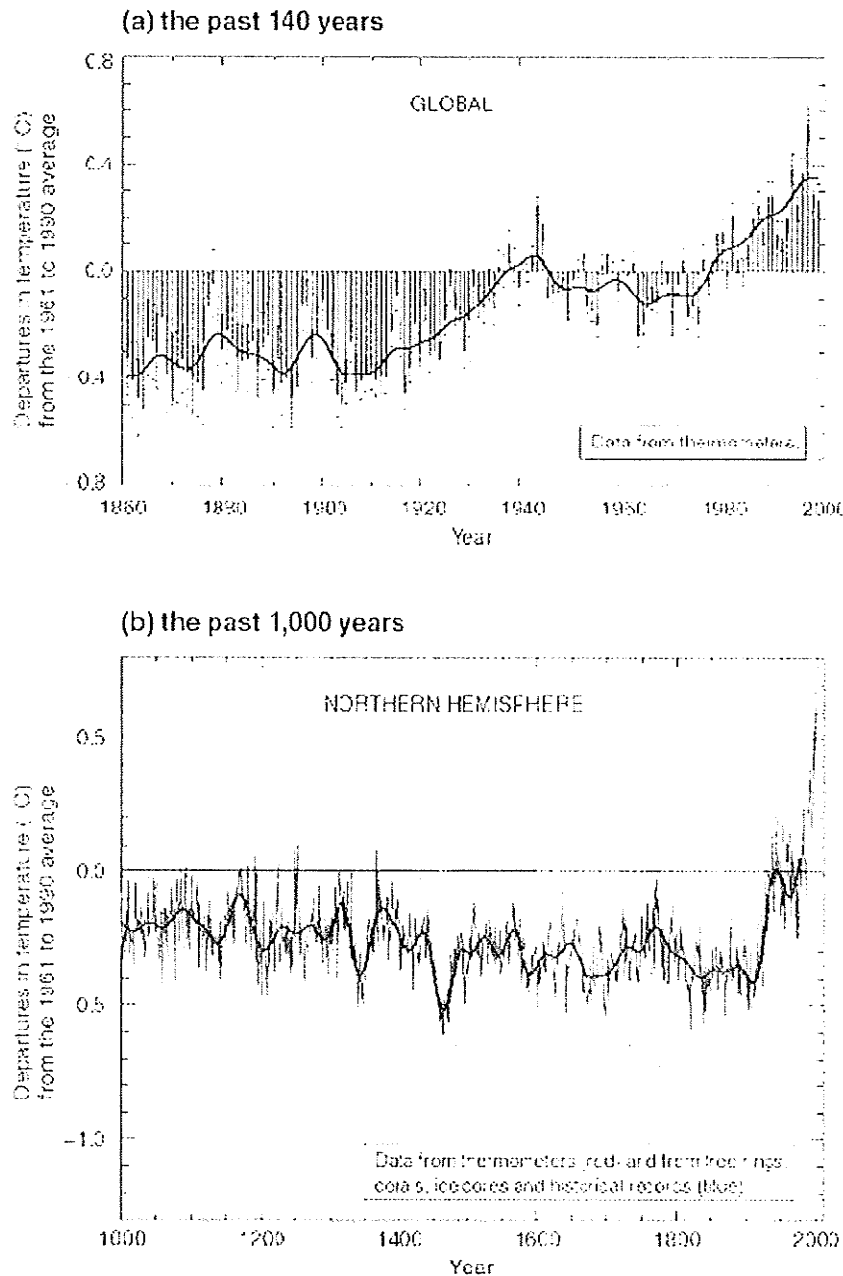
Figure 3 shows that the average temperature in 2004 is higher than at any time in the last two millennia. Figure 3 also shows that this temperature increase has occurred over a short time frame: approximately 150 years.

### Climate Change in the Arctic

Recently there has been an increase in climate change studies that predict that the Arctic will be the most affected by changing climate (Maxwell, 1997). Predictions indicate that in the next 150-200 years, the average daily temperature of the Arctic will rise approximately 5-10°C, precipitation in the Arctic will change, ice and snow cover may start to decline, permafrost may start to melt and animals will start to migrate (ACIA, 2005).

Figure 4: Taken from IPCC, 2001

# Variations of the Earth's surface temperature for:



## Temperature

The temperature of the globe is predicated to increase due to climate change (Weller et al. 2005). However in recent history there has been a dramatic increase in the average global temperature. Figure 4 shows variations in the Earth's surface temperature for the last 140 years (a) and the last 1000 years (b). Each graph shows a marked increase in the average temperatures in the past 150 years.

The Intergovernmental Panel on Climate Change (IPCC) indicates that natural environmental factors, such as volcanic activity and

variations in solar radiation, do not explain the observed increase in temperatures. There is a relationship between an increase in human activities and the increase in warming (Mitchell et al., 2001). By the year 2100, global temperatures are expected to increase by 1.4 to 5.8 °C above 1990 levels (Giorgi et al., 2001). The effects of such a temperature shift will have an impact on most of the world, however not all regions will experience the same effects (IPCC, 2001).

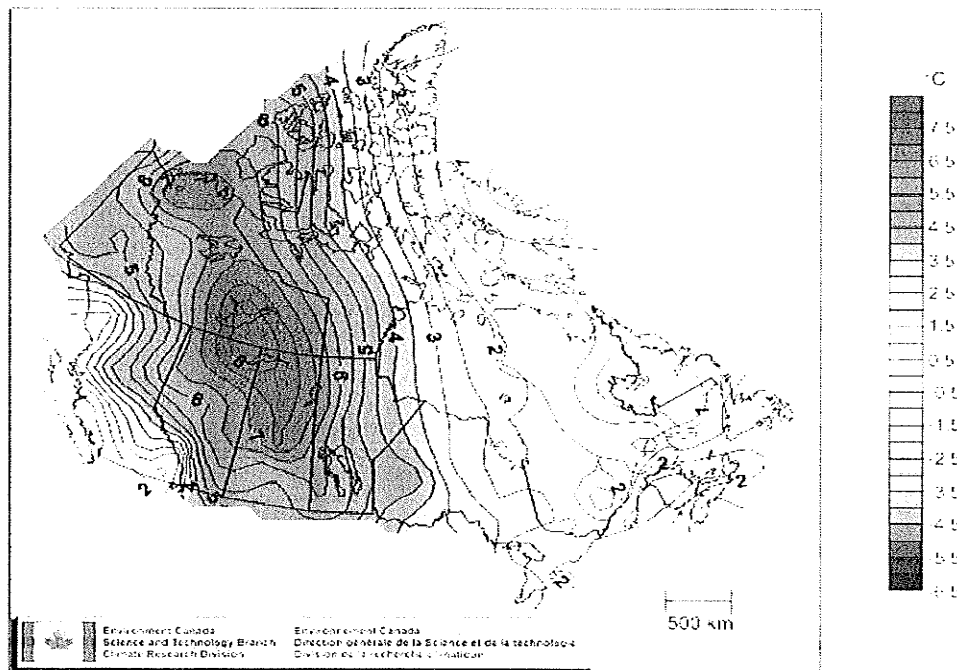
For example, warming in the northern regions of North America is predicted to increase by more than 40% over the predicted global mean average and, in contrast, southern regions of the globe will experience warming trends that are less than the predicted mean global average (Giorgi et al., 2001). The annual average temperatures are predicted to rise across the entire Arctic region. In many regions of the arctic the temperature is predicted to rise as high as 10°C over 1990 levels (ACIA, 2005). Studies show that the average annual summer temperature may rise as much as 3-5°C over land areas and up to 7°C over ocean areas (ACIA, 2005). However these numbers are greater for the winter seasons. It is predicted that winter temperatures will increase 4-7°C over land areas and as much as 7-10°C over ocean areas (ACIA, 2005).

It is predicted that climate change will impact temperatures around the globe and the Arctic region will experience the greatest deviation of temperature from the norm (Weller et al. 2005). Figure 5 shows departures from normal temperatures in the 2005-2006-winter season occurred in several regions across Canada (Environment Canada, 2006).



Although no direct relationship can be taken from the data from one season, it shows that differential warming can occur in regions of Canada.

**TEMPERATURE DEPARTURES FROM NORMAL**  
**Winter (Dec, Jan, Feb) 2005/2006**  
**ANOMALIES DE LA TEMPÉRATURE PAR RAPPORT À LA NORMALE**  
**Hiver (dec, jan, fev) 2005/2006**



**Figure 5: Temperature departures from normal in the winter of 2005/2006**

Source: Environment Canada, 2006

### **Precipitation**

The annual precipitation in the Arctic regions is predicted to increase. Most regions have experienced increases in precipitation since at least the 1950s (IPCC, 2001). The amount of precipitation predicted to fall over the Arctic will increase 20% by the end of the century and much of this precipitation will fall as rain (ACIA, 2005). There have been studies that indicate that there has already been a statistically significant increase in the amount of precipitation during spring, summer and fall (ACIA, 2005).

An increase in precipitation may translate into an increase in the runoff potential (IPCC, 2001). It is predicted the amount of runoff will increase in the winter seasons as warmer temperatures increase the likelihood of precipitation falling as rain or that snow cover will melt (IPCC, 2001). An increase in the regional temperatures and the increase in warmer freshwater may cause problems with the formation of sea ice or ocean currents during the winter season (IPCC, 2001). Impacts on sea ice formation and ocean currents will be discussed further in the report.

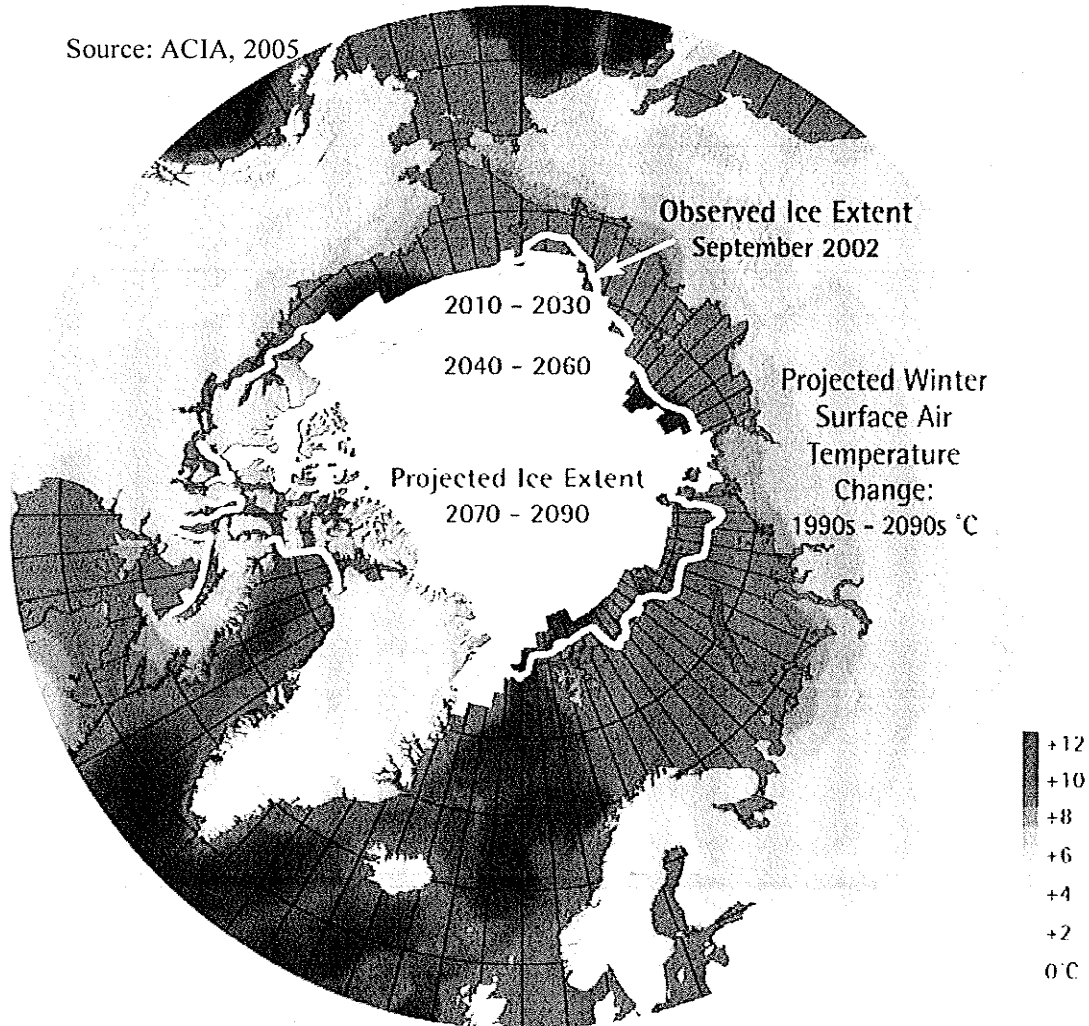
### **Ice and Snow Cover**

Sea ice in the Arctic is melting as a result of average higher temperature. It has been found that there has been an increase in the number of melt-days in the sea ice seasons (Smith, 1998). In the past 30 years there has been an increase in the number of melt days by 5.3 days per decade (Smith, 1998). Figure 6 shows the projected changes in the extent of sea ice cover in the Arctic to 2090.

Figure 6 shows a significant reduction in the amount of predicted ice cover over the entire Arctic region. The extent of ice cover will decrease from the observed extent of ice cover in September 2002 to the projected ice cover in 2070-2090.

Figure 6: Projected changes in the extent of sea ice cover in the Arctic

Source: ACIA, 2005



The ice in the Arctic is not only melting but the composition of the ice is also changing (IPCC, 2001). Over the last 30 years, the extent of annual average sea ice in the north has decreased by 8%, and losses of late-summer ice coverage ranges between 15 and 20%. Some models project that summer sea ice will decline by greater than 50% by the end of the century (IPCC, 2001; ACIA, 2005). Not only has the extent of the ice cover

decreased, there has also been a decrease in the ice thickness of the Arctic (IPCC, 2001). Evidence indicates that the depth of sea ice during late summer and early autumn has decreased by 40% between the 1960s and late 1990s (ACIA, 2005). Evidence suggested that there is great variability in the amount of thinning occurring throughout the Arctic; however there has been a general thinning trend in the past 30 years (IPCC, 2001).

It has been found that there has been a reduction in the amount of snow cover in the northern hemisphere. Since 1972 the amount of snow cover has been reduced by 10% (IPCC, 2001). It is further predicted that the amount of snow cover in the northern hemisphere will decrease an additional 20-30% by the end of the century (ACIA, 2005).

The decrease of ice and snow cover may contribute to the increase in the regional warming of the Arctic. This decrease in the ice and snow cover will expose the darker water and darker land under the snow and ice (ACIA, 2005). The increase in exposure will allow for an increased amount of solar radiation to be absorbed by the darker surface (Smith, 1998). This increase in absorption will increase the temperatures in the region and increase the melting rate of the snow and ice cover. This regional warming will also help to accelerate warming at a global scale (ACIA, 2005).

Warmer temperatures also translate into shorter snow seasons and less snow storage potential of an area (IPCC, 2001). Higher temperature translates into quicker seasonal melts. As the temperature increases the total amount of snow stored in an area decreases as the snow melts periodically due to fluctuating temperatures (IPCC, 2001). A decrease

in the storage of an area can translate to less spring runoff and less available moisture in the spring.

### **Water Levels**

In the last 100 years, global sea levels rose between 10 – 20 centimetres (IPCC, 2001). It is projected that average global sea-levels will rise 10 – 90 centimetres between 1990 and 2100 due to the melting of ice caps and glaciers (IPCC, 2001). Rising sea levels are responsible for observed coastal flooding and erosion in areas such as the British Columbia Coast, the Arctic Coast, the Great Lakes Basins, and in the Atlantic Provinces (Natural Resources Canada, 2004).

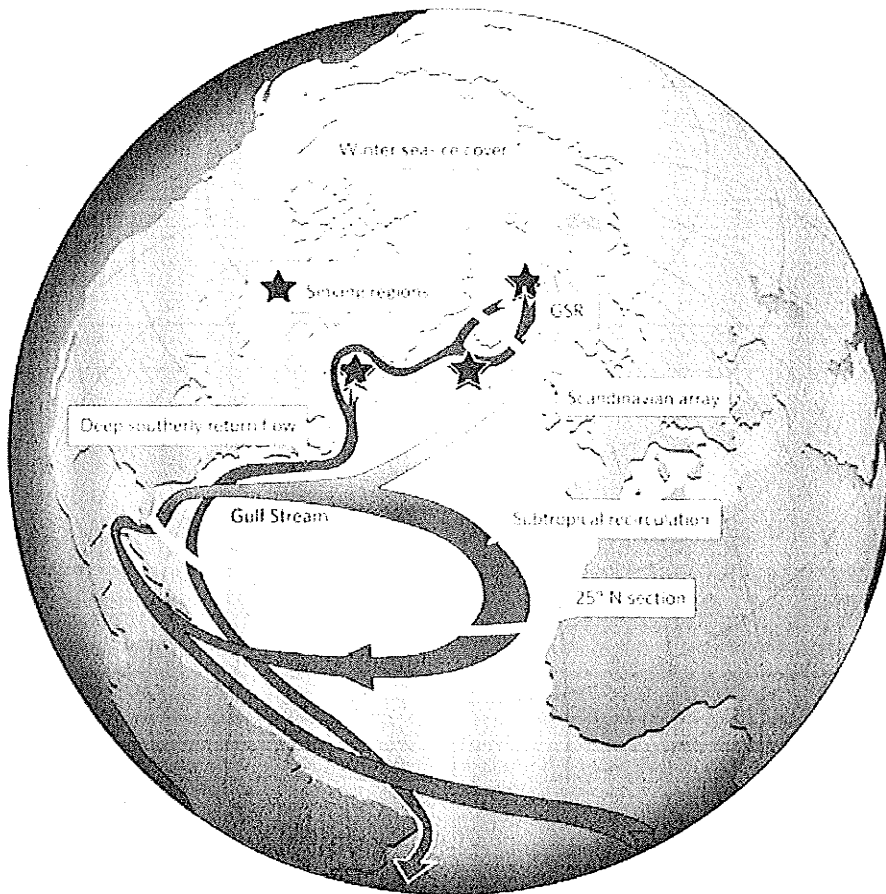
Coastal erosion can affect coastal stability, especially in low-lying areas that have soft sediment shores (Natural Resources Canada, 2004). It can also cause damage to existing infrastructure in coastal communities and may affect archaeological or cultural resources that are located in coastal areas. However, the specific impacts of sea-level rise on coastal erosion are still not known, studies are currently underway in the Atlantic region by provincial and federal government departments, universities and communities to look at the impacts of sea-level rise on coastal communities in New Brunswick (Natural Resources Canada, 2004).

## **Ocean Systems**

Fresh water accounts for as much as 10% of the upper 100m in the Arctic Ocean (Aagaard, 1999). As the rate of surface runoff increases due to melting, the concentration of fresh water in the ocean will also increase. This increase in the concentration of fresh water may have an impact on ocean systems. Ocean systems such as ocean currents and circulation are based upon heat and salt levels of the water. Figure 7 shows part of the ocean circulation model. This particular ocean circulation system is a thermohaline system, thermohaline referring to thermo=heat and haline=salt. This ocean circulation system transfers solar radiation from the equator to the poles.

The thermohaline cycle: cold water in the north sinks to the ocean floor due to an increase in density (down welling). The increase in water density is attributed to a decrease in temperature of the water and an increase in salt content. As the water moves from south to north evaporation occurs and temperatures in the north cause the formation of sea ice; all of which increase the salt content of the seawater. The water then becomes so dense that it sinks to the sea floor. This dense water then travels back to the equator through underwater systems; just as on the surface, valleys direct streams and rivers, the ocean topography directs the dense water towards the equator. Once at the equator the water warms and is mixed with fresh water, this warming and mixing of fresh water lowers the density and the water rises to the surface. As down welling occurs in the north, water is pulled from the equator northward and as this warmer water flows north, it releases heat into the surrounding environment. This circulation helps to transfer heat and control weather systems throughout the world.

Figure 7: Ocean Current System – Thermohaline Current System



Source:  
[http://bioage.typepad.com/shared/image.html?photos/uncategorized/thermohaline\\_large.jpg](http://bioage.typepad.com/shared/image.html?photos/uncategorized/thermohaline_large.jpg)  
Accessed: January 2006

If the saline content of the water is affected either due to an increase in temperature causing the formation of sea ice or if there is an increase in the amount of freshwater delivered to northern oceans, the water will not reach the proper density and downwelling may slow or even stop and this will have an impact on the entire circulation (ACIA, 2005). This will have a large impact on the transfer of heat to the northern regions and cause regional cooling for certain areas.

The ocean currents allow for the distribution of heat and energy to northern regions (Aagaard, 1999). The down welling of the northern water allows for carbon dioxide to be trapped into the ocean; a slowing or stoppage of this down welling will increase carbon dioxide levels in the atmosphere and thereby increasing the effects of climate change (ACIA, 2005).

### **Permafrost/landscape features**

Permafrost is a layer of earth and rock that is frozen year round. This layer remains frozen for 2 or more consecutive years (Environment Canada 2000). This layer of frozen earth and rock plays a vital role in the ecosystem functions of the Canadian Arctic and Subarctic regions. The permafrost controls plant production by regulating the moisture content, surface hydrology and temperature of the soil (Environment Canada 2000). It is estimated that at 50% of Canada's land mass is comprised of permafrost (Natural Resources Canada 2004)

The figure below shows that a form of permafrost covers half of Canada. The figure also shows that most of the Arctic is covered by continuous permafrost.



Source: Natural Resources Canada, 2006  
[http://gsc.nrcan.gc.ca/permafrost/communities\\_e.php](http://gsc.nrcan.gc.ca/permafrost/communities_e.php)  
Accessed March 26, 2006



**Figure 8: Extent of Permafrost Coverage in Canada**

The permafrost found today was formed many years ago (Environment Canada 2000). The permafrost that was formed many years ago represents the climatic conditions of the time the permafrost formed and not of those found today. Since much of the permafrost was formed at times when the air temperature was cooler, at the last ice age (Environment Canada 2000), permafrost is very susceptible to degradation if exposed to current conditions.

The layer of ground above the permafrost layer insulates the permafrost from the current air temperatures (Environment Canada 2000). This insulating layer allows the permafrost to continue to exist even though the climactic temperatures have increased. Permafrost

is only degrees away from its melting point and any increase in temperature can cause the permafrost to become unstable and melt (Environment Canada 2000).

Since permafrost depends on climate and climate is not static, permafrost has undergone significant changes. During period of climatic cooling the range and extent of permafrost was great, both in range and in thickness. In times of climatic warming these areas of permafrost have decreased and in some areas the permafrost has disappeared completely. This can have an effect on landscape features, terrain, slope and coastal stability, surface and ground water dynamics and ground cover. Greenhouse gas sources and sinks (peat lands, soils, gas hydrates) may also be affected if permafrost begins to melt (ACIA, 2005).

### **Landscape Futures**

The effects of permafrost melting will be important to regions where permafrost is ice rich (Natural Resources Canada, 2004). The thawing of ground ice can result in the loss of ground strength and stability (U.S. Arctic Research Commission Permafrost Task Force, 2003). The instability of the ground can have far reaching effects for many landscape processes such as terrain, slope and coastal stability. As the permafrost melts, the ground located above the permafrost can become mobile and very unstable (U.S. Arctic Research Commission Permafrost Task Force, 2003). This instability can make it difficult for transportation, infrastructure, and construction. Melting permafrost can even have an impact on landscape features, such as hills, valleys and cliffs or even shorelines (U.S. Arctic Research Commission Permafrost Task Force, 2003). As the surface

becomes more mobile, landscape features are at risk of slumping, sinking, moving and are more susceptible to erosion.

Permafrost degradation can change the surface hydrology of the region (IPCC, 2001). The permafrost layer is an impermeable layer and tends to trap water (Jorgenson et al., 2001). The results of melting permafrost vary from region to region, depending on the surrounding drainage patterns (Watson, 1996). The melting permafrost, in areas of poor drainage can increase the level of water within the soils. As the ground becomes over saturated, surface flora such as trees will begin to die (Jorgenson et al., 2001). Permafrost degradation on well-drained areas will further increase the drainage properties of the area (Watson, 1996). This increase in drainage will lead to a decrease in the ground water content of the area. The increase in the seasonal frost layer tends to increase the mobility of both surface and subsurface water.

In some areas, the inland lakes and rivers that were once held in place by permafrost will now drain (Watson 1996). This will effect the surrounding environment in many ways. Animals will have to travel further to obtain drinking water and community members will have to travel further to engage in traditional activities such as hunting and fishing. The draining of the water may cause flooding and other problem down flow; areas down flow will receive more water than in the past. As water starts to percolate through the ground, it may start to increase the melting of the permafrost layer, which can further exacerbate the problem (Watson, 1996).

## **Animals**

Species such as the woodland caribou are particularly vulnerable to climate change and are becoming increasingly stressed as their habitat becomes altered (Brotton and Wall, 1997). Weather conditions such as warmer falls, warmer summers, and earlier spring break-up will have a negative impact on the migrating caribou causing dangerous traveling conditions (Brotton and Wall, 1997). For example, crossing the ice during the warmer winter will be more dangerous for the caribou. Climate change will also affect the accessibility of food sources for the caribou (Natural Resources Canada, 2004).

The woodland caribou's major food source consists primarily of lichens, as well as shrubs, grasses, and willows. The woodland caribou's food source can be negatively impacted by changing weather patterns, for example an increase in snow depth during the winter makes it harder for woodland caribou to dig through the snow, reducing the availability of food (Fancy and White, 1985). In some cases the melt and freeze cycles can cause layers of ice to build up and may impede the ability of the animal to access food sources (ACIA, 2005).

Many Arctic animals are dependant on certain environmental conditions. Polar bears are reliant on the sea ice for food. On the sea ice the polar bear can hunt their main food source the ringed seal (Polar Bears International 2006). Polar bears spend their lives on the sea ice hunting for food. The polar bear only comes on land to raise their young and while on land the polar bear does not eat anything, this translates into 5-7 months of no

food (ACIA, 2005). Only when the sea ice forms again in the fall does the polar bear travel back out on ice floes to hunt (Polar Bears International 2006).

With the later formation of sea ice in the fall and the earlier break-up in the spring the polar bear is trapped on land and must go without food for longer periods of time (Stirling, 1999). Both the Arctic and the scientific community have witnessed the impacts of a shifting climate on polar bears. It has been observed that the polar bear weight has been dropping. The average weight of the polar bears in the Hudson Bay region has dropped by 15% in the last 2 decades (Stirling, 1999). The shifting climate has also been responsible for a drop in the regional birth rates of cubs (Stirling, 1999). The reproductive success of polar bears is related to fat stores (Stirling, 1999). If a polar bear cannot spend enough time hunting for food on the sea ice, she cannot build up the required fat reserves for successful reproduction. There has been a 15% drop in the number of cubs born in the Hudson Bay region in the last two decades (Stirling, 1999). If a polar bear succeeds in reproducing offspring, the offspring are often smaller and less likely to survive (ACIA, 2005). In the spring, the late formation of sea ice causes the polar bears to swim to feeding areas. In some cases the young polar bears are not able to swim the distances required (ACIA, 2005). These factors have lead to a decline in the poplar bear population.

Seals, such as the bearded, ringed and ribbon seal, are greatly dependant on the sea ice (ACIA, 2005). These seals rely on the sea ice to give birth and nurse their pups (ACIA, 2005). Seals such as the ringed seals are the mostly likely to be threatened by climate

changes since so much of their lives are tied to the sea ice. Ringed seals give birth and raise their pups in dens made of snow on the sea ice. If the sea ice melts or the ice is unsuitable for use, the ringed seal has no alternative habitat. In this case the seal will have to move to more suitable areas. The ringed seal spend their lives on and around the sea ice and rarely come on land (ACIA, 2005). The conditions for sea ice are changing across the Arctic.

A decrease in ice cover, ice thickness and less predicted snow cover for much of the Arctic can decrease the suitable habitat for seals (ACIA, 2005). With a decrease in suitable habitat available to raise their young, the population of seals may decline. Even if suitable habitat is found, there are also concerns about the duration of the sea ice. Early breakup can cause the pup to be separated from the mother and starve (Krupnik and Jolly 2002). Inuit observations have not noticed a decline in the number of seals, but could become an issue with the milder winters (Krupnik and Jolly 2002).

As temperatures increase, the north may become more accessible or suitable to southern species (ACIA, 2005). This influx of new species will cause competition for resources since food resources are limited in the Arctic. With an increase in the number and types of species utilizing common resources, there is a threat that these resources will become scarce. Certain animals may start to migrate out to more remote or northern areas to find suitable habitat or resources for survival (ACIA, 2005). The Arctic Climate Impact Assessment reported that some species of birds, fish and butterflies have already started

to relocate as southern species move north and predicted that some populations of seabirds, mosses and lichens will likely decline as warming increases.

The north may witness an increase in the amount and variety of insects due to increased migration. Migration of new animals into the north and an increase in temperatures may introduce new insects and diseases into the region (Nickels et al., 2005). Communities have already witnessed an increase in the amount and types of insects seen in the region. New species such as the black fly have been witnessed in the community of Repulse Bay in Nunavut (Nickels et al., 2005). Insects and diseases common in the south may have unknown effects on the animals of the north (ACIA, 2005).

### **Vegetation**

It is expected that the forest may migrate northward as the climate shifts, with forests replacing a significant portion of existing tundra (IPCC, 2001). The warming of the last 100 years has caused the tree line to shift upslope in the central Canadian Rockies (Natural Resources Canada, 2004). This trend is expected to also occur in the Arctic regions. The current vegetation in the area is comprised primarily of bare ground, small shrubs and ground plants (ACIA, 2005). Models suggest that the climate of the Arctic could warm significantly and therefore change the growing conditions of the north. An increase in temperature will promote the growth of dense vegetation such as shrubs and trees (ACIA, 2005). Temperature, however, is not the sole control on species distribution, and temperature changes cannot be considered in isolation. Other factors, including soil characteristics, nutrient availability and disturbance regimes, may prove to

be more important than temperature in controlling future ecosystem dynamics (Natural Resource Canada, 2004).

As the climate changes, soil conditions can change and become more conducive to the growth of dense vegetation (ACIA, 2005). In some areas forests may tend to move into the tundra regions (IPCC, 2001) and in others areas the soils and climatic conditions may become suitable to agricultural activities. Under certain conditions agriculture will have the potential to expand northward due to a longer and warmer growing season (ACIA, 2005). As with the movement of the forests into the arctic, agriculture is also based upon the changes such as soil characteristics, nutrient availability and conditions favorable to seed germination occurring (Natural Resource Canada, 2004).

The warmer temperatures and the decrease in the snow cover may allow plants a longer growing season (Natural Resource Canada, 2004). This may allow for the growth of forest or allow for future activities such as agriculture to occur in the arctic. However, a decrease in snow cover may hinder the growth of some plants and expose the plants to harsh winter temperatures. Many species of plants are dependant upon the insulating effects of snow (Pomeroy and Brun, 2001). Exposure to the cold winters may affect the plants' ability to survive during the winter months (Pomeroy and Brun, 2001). In some cases the reduced snow cover will result in drier conditions (e.g. low runoff potential) in the spring and could affect the germination of seeds (ACIA, 2005). These drier spring conditions coupled with a decrease in the insulating effect of the snow in the winter months could affect the growth or establishment of new vegetation (ACIA, 2005).



## **Arviat Observations**

In the following section, results of the interviewees are utilized. In areas where explicit numbers are used, such as “three out of ten Elders stated”, it does not mean the other seven Elders stated something different. It translates into seven Elders did not have a direct comment on the topic or did not directly state the topic.

### **Temperature**

In the community of Arviat all ten of the Elders indicated that there are natural variations in the annual temperature patterns. Some years the temperatures during the winter seasons are cold and yet in other years the temperatures are mild. The Inuit have acknowledged this cycle and have understood the variability to be natural. The Elders have experienced that the weather and temperature felt in any one year could be different than that felt three to five years later.

In the, past records were kept year to year, mainly on events that occurred in the winter. These records were used to compare the amount of precipitation and the temperatures of present and past years. One Elder demonstrated a traditional method of recording cold temperatures or cold days. He stated that the Inuit would use a braided sinew to mark cold temperatures for certain days. They would tie knots on the braid to mark cold days. The exact temperatures in the past were unknown, but the knots were used to count the number of cold days and not the temperatures that occurred.

There was a common theme in the ten Elder and five Resource User interviews. The community of Arviat has noticed a warming trend over the last few decades. The Elders indicated that the seasons are generally getting milder and are not as cold as in the past. This change is different from the natural variations that they have witnessed in the past. All the Elders interviewed believed that the climate is changing. In the past the weather was colder, the winter season longer and the Elders indicated that the climate is now warmer than it was when they were younger. The Youth (ages 17-30) are the only group that stated that there has been no notable change in the weather. One youth stated that the weather is always changing from year to year.

Seven of the ten Elders interviewed indicated a decline in the number of cold days occurring in the winter. In the past there were many cold days and now there are less. Three of the Elders interviewed stated that there are now more warm days occurring during the winter. All the Elders and Resource Users have indicated that the start of the cold season also begins later and ends sooner.

Five of the Elders interviewed stated that they are unsure if the actual temperatures reached on the cold days have changed. One Elder indicated that in the past the Inuit would wear caribou clothing and kamiks, which are warmer than the clothes worn today. This coupled with greater activity and a healthier diet in the past made the Inuit "stronger" and able to withstand more extreme temperatures according to the Elder. He stated that today people eat less raw foods, wear less warm clothing, and are less active outside and this new lifestyle may have weakened the younger Inuit. So even if the

young Inuit feel that it is cold outside in the winter it may not be as cold as it was in the past.

Eight of the Elders interviewed and three of the Resource Users stated that they feel that the temperature in the summer is also increasing. The number of warm days is increasing during the summer season. Warm days are occurring earlier in the spring and later in the fall. This has shortened the length of the winter season. The three Resource Users and eight Elders stated that the sun is hotter than it was in the past. Three Elders stated that in the past the heat of the sun was not a concern, but now people are worried about exposure to the sun.

The youth of the community have not noticed a change in the temperatures or weather patterns. Many of the youth interviewed stated that the temperatures and weather patterns felt by them when they were young are similar if not the same as the weather today. The older interviewees (Elders and Resources Users) have noticed a change in the temperature and weather patterns. These observed changes started to occur approximately 20 years ago according to seven Elders and four Resources Users. The Elders stated that the amount of cold days have started to decrease, the time of freeze-up occurs later in the season and the breakup of the ice occurs earlier. Four of the Elders and three of the Resource Users stated that they have noticed that in the last 5-6 years the temperature has definitely become warmer than normal. They cannot say whether this warming trend is permanent or just a natural cycle, but they are worried about the effects if the trend continues to occur.

## **Precipitation**

The interviewees, mainly the Elders and Resources Users, have noticed a change in the precipitation levels. Precipitation levels both during the summer and the winter have decreased. Seven of the Elders and five of the Resources Users have indicated that in the summer season, there has been a decrease in the amount of rainfall. A decline has also been observed with snowfall in the winter. When Elders compare current snow cover to those witnessed in their youth, they feel that there has been a definite decline in precipitation levels.

Eight of the Elders and four of the Resource Users stated that there has been a change in the amount of storms in the area. Two of the Elders explicitly stated that there were a lot of thunderstorms and rainfall in the past, when they were young, but now there are fewer. The Elders indicated that during their youth the fall would bring many storms, but now there are noticeably fewer storms. The Elders and Resources Users also witnessed a change in the time that the rain falls. Elders indicated when they were young and out on the land, the fall (September) would bring a lot of rain and many storms. The Elders and Resource Users felt that currently there are fewer storms and less rain in the fall season and that in the spring there is less rain than in the past.

Elders, Resource Users and the Youth have all stated that the surrounding lakes and streams have lower water levels than normal. It was felt by the interviewees that lack of spring rain and summer storms has affected the water levels in the area. Four of the

Elders also feel that the lack of rain is affecting the regional vegetation along with the animals. Four of the Elders stated that caribou have been getting thinner in recent years. They stated that this is because their food source, lichen, has not been growing well, due to less rain.

Ten of the Elders and the five of Resources Users in Arviat have noticed a decline in the amount of snow that falls during the winter. Some of the Elders and Resource Users interviewed remember in the past when snowdrifts would be high enough to bury houses to the point where you could not see then anymore. It was told by three of the Elders interviewed that when outside people would travel to the community by Bombardier during the winter, they would sometimes travel over houses without knowing it. Two of the Resource Users shared stories about their youth when they would have to crouch to walk under overhead lines due to large snow drifts. Three of the Resource Users stated that there has been a definite decline in the amount of snow that accumulates on the ground.

Seven of the Elders stated that the timing of the snowfall has changed. They said that snow is starting to fall later in the season and that the snow is falling later and later every year. They stated that with the warmer fall temperatures most of the early snow melts soon after it falls. The changes in fall temperatures and the change in the timing of the snow fall are causing a change in the texture of the snow, according to six Elders and four Resource Users.

Six of the Elders explicitly talked about changes in the texture of the snow. The Elders stated that the snow that falls now is not the same as snow that fell in the past. According to the all of the Elders the snow of today is the wrong texture; it cannot be used to make igloos or shelters. The Elders stated that it is difficult to find suitable snow to create shelter. The hunters now have to use tents or cabins if they want to go hunting during the winter. Elders stated that in the past the hunters would make snow shelters wherever they needed to set up camp.

Seven Elders stated that the snow is melting faster now than in the past. The Elders stated that it is a mixture of the increase in temperature in spring, the decreasing amount of snow and the change in the snow texture that makes the snow melt faster. According to six Elders and four Resource Users, the snow in some areas melts in a matter of days.

The Elders have noticed a change in the winter storms occurring and even the direction of the wind. Five Elders have even observed that the winter storms are less powerful or intense than they were in the past. One Elder indicated that in the past there were storms so powerful that you could not even see your own feet as you walked. Now these types of storms are less frequent. Four Elders explicitly stated that they have also noticed a change in the wind. The wind used to blow from the north or northwest, but now the wind is starting to blow from the south or southeast direction. The Elders have noticed that in the past five or six years winds are now more powerful when compared to the winds in the past. Four Elders stated that they have also noted that there are more windy

days now than in the past. The Elders are concerned about these changes in the storms and wind direction and strength.

### **Ice and Snow Cover**

Observations in Arviat have indicated that the ice formation on inland lakes and rivers has started to change. Elders stated that with the decline in cold days and the increased temperatures in the last few years, the ice has started to form later and later in the season. Two of the Elders and three of the Resource Users shared that the ice on Maguse Lake usually formed in October, now freeze-up sometime does not occur until November. The Elders and Resource Users also shared that the ice that forms on the surrounding inland streams and lakes, such as Maguse Lake, is becoming thinner. With the thinner ice on the lakes and creeks people are becoming wary of crossing the ice early in the season.

Five of the Elders and three of the Resources Users stated that the sea ice is also changing. They stated that as with the inland ice, where the formation of ice is starting to occur later, the sea ice is also starting to form later than usual. Six of the Elders and five of the resource users feel that with the increase in temperature and the decrease in the amount of cold days that the ice will continue to form later and later. With warmer falls the ice forms later and is now thinner than it was in the past.

Seven of the Elders and three of the Resource Users stated that they have observed a change in the time of break up of the ice on the Hudson Bay. The Elders have observed that the ice is starting to breakup earlier and a lot faster than it did in the past. The Elders

and Resources Users started to notice that the Bay is ice-free earlier in the season. Seven of the Elders and three of the Resource Users indicated that it was normal for ice on the Bay during the middle of July, now the Bay around Arviat is ice-free by mid-June. The time the Bay becomes ice-free is not the only observation they have noticed in terms of ice conditions. The speed at which the ice leaves the bay around Arviat has increased. Three of the Elders and two of the Resource Users stated that in the past the ice would tend to breakup and then flow out to sea. In recent years the ice may no longer breakup before it leaves. In some cases the ice simply disappears from the area. In the spring of 2002, an Elder shared that he had wanted to travel out on the land, for one last trip before the ice was gone. However when he awoke in the next morning the ice on the Bay was completely gone. The ice had completely left the area that night as he slept. This has raised concerns about safety and the length of the hunting seasons.

### **Water**

The Elders and the Resource Users stated that the level of water in the Hudson Bay is lower now that it was in the past. Traditional routes along the bay have changed due to more exposed rocks. It was shared by two Resource Users that there was a small channel on the point across the inlet from Arviat where hunters and fishers would take their boats. This channel was a shortcut to other locations and an alternative route during rough waters on the sea. The hunters and fishers would not have to travel out on the bay to get around the point; they could use the channel to decrease their travel time and to be able to travel safely. The water levels in the Bay have decreased such that the channel is now exposed rock and no longer accessible by boat.



Three of the Elders also tell of a time when the water levels in the Bay were substantially higher. They say that stories passed on to them indicated that the area where Arviat sits now was under water. The Elders state that there are areas that were once traditional fishing grounds where their grandfathers set nets, which are now "10-15 miles inland".

There have also been observations of lower water levels on the inland lakes and rivers. Five of the Elders and three of the Resource Users state water levels in lakes such as Maguse Lake are lower now than they were in the past. They have also observed that the rivers and streams flowing into the lakes and the Bay are also lower. Four of the Elders and three of the Resource Users stated that some of the smaller creeks and ponds have dried up. Maguse Lake was once filled with Arctic Char according to four of the Elders and three of the Resource Users. Now with water levels lower in both the lake and the rivers the Arctic Char no longer migrate into Maguse Lake.

Four Elders and three Resource Users believe that it is the decrease in precipitation and the increase in summer heat that is responsible for the lower water levels in the inland lakes and streams. They feel with less winter snow cover and less spring rainfall, less runoff is feeding the streams and therefore less flow is traveling to the surrounding lakes. Some of the Resource Users and the Elders also believe that not only the lack of rainfall and snow cover is leading to the lower water levels in the Hudson Bay; they also feel that the water levels are being affected by iso-static rebound. They state that the land is rising causing the water levels to drop in the area.

### **Permafrost/Landscape**

The community members of Arviat have not noticed any drastic changes to the permafrost and landscape in the surrounding areas. All of the Elders stated that there has not been any increase in slumping or landslides in the area. The area surrounding Arviat is relatively flat and does not have any steep hills or valleys. According to the Elders, slumping and landslides are not a concern. The Elders, however, have heard stories of other areas in the Arctic that have seen large impacts due to melting permafrost. They are concerned about what the impacts will be if the permafrost melts around Arviat.

Three of the Resource Users and three of the Elders stated that the land surrounding Arviat is becoming softer. They stated that the top layer of the ground is softer longer and is affecting traditional activities and mobility of community members. One Elder indicated that in the past when people would use dog teams they would put moss on the runners of the sleds so they could glide over the permafrost. This was done in the spring and fall as the snow started to melt/accumulate. The Elder stated that this is not possible today; in some areas the runners sink too deep into the ground and even the moss will not help.

Three of the Elders and two of the Resources Users explicitly stated that they are concerned that an increase in permafrost melt will further lower the water levels in the inland area and cause some of the smaller water bodies to disappear. Although they indicated that the decline in the water levels was caused by a decrease in precipitation

levels and not by melting permafrost, they feel that this may become a major issue in the future when permafrost begins to melt.

The youth have not noticed any changes to the landscape. Within the past 5-10 years the environment has been somewhat stable, with only minor fluctuations. Four of the Elders and two of the Resource Users discussed the observations of the youth. It was said that their observations were limited due to their age and experiences. In many cases the Elders and Resources Users started to notice a change in the environment 20-30 years ago. The youths have not seen the environment in the past and cannot comment on the changes. They can only comment on the current environment, and this environment is subtly changing. The other comment was that the youth rarely spend time on the land. Some of the youth do not engage in many traditional activities. Those youth that do engage in traditional activities often do it in short intervals. Many do not spend much time on the land, compared to the Elders or the Resources Users. So therefore the observation of the youth may be limited.

### **Animals**

There has been a change in the composition of the animals in the area of Arviat. All the Elders and Resource Users have witnessed changes in animal migration, in population, and even changes in animal behavior and health. Six of the Elders and four of the Resource Users interviewed seemed to conclude that most of the changes in the animals have stemmed from a change in the environment surrounding Arviat.

The Elders and the Resource Users have witnessed a change in migration patterns of many animals around Arviat. According to four Elders and four Resource Users the migration routes of the caribou have changed. The caribou are becoming more scattered and harder to find. One of the Elders stated that there was an area where community members would wait for the migration of the caribou. The caribou use to cross at a certain point in the river near the community. In recent years the caribou do not use this crossing. The Elders stated that traditional hunting grounds are no longer used due to lack of animals. They stated that community member now have to travel further to hunt caribou. In some cases hunters come back from long hunting trips empty-handed.

All the Elders and the Resource Users have stated that there is a general decline in the number of animals in the region. They stated that they feel that there is not a decrease in the population (amount of animals) but there is a change in their location. Many of the animals relied upon for food have moved on the other areas. The Elders and Resources Users feel that many animals are migrating northward, where it is still cold. One of the most drastic changes in terms of animal migration was seen with the walrus.

Two of the Elders stated that in the past walrus were located in the Bay just outside the community. However, now there are no walrus found in the region and this decline occurred many years ago. The Elders stated that walrus was a traditional food for the community of Arviat 30-50 years ago. The Elders stated that the walrus was so abundant in the region that hunters would have to make a lot of noise to keep the walrus from their boats and kayaks. According to the Elders walrus hunting is not as common as it was in

the past. Those that still do hunt walrus have to travel far north to find them. In many cases the hunters have to travel past Chesterfield Inlet to find walrus.

The walrus had many uses for the people of Arviat. The walrus provided food, for both people and their dog teams, the fat and oils were used to make candle and provide heat and light. According to the Elders many factors contributed to the decline or more accurately the relocation of the walrus. Modernization of hunting techniques such as the use of boats, motors and firearms has created a noisier environment in the Bay which was disturbing the walrus. According to the Elders a changing environment has also contributed to the relocation of the walrus. The Elders have stated that the waters and the temperature around Arviat have become warmer and walrus need a colder climate, so they had migrated northward seeking colder temperatures.

Six Elders and four Resource Users stated that there are fewer ptarmigan in the region. Three of the Elders stated that the ptarmigan has a natural cycle, there were times in the past where the ptarmigan were abundant and other times were they were scarce. The Elders stated that the ptarmigan relocated from time to time, however with a change in the environment they fear that the ptarmigan may not return.

All of the Elders and Resource Users have also noted that there has been a decline in the population of fish, beluga whales and seals. Three Elders specifically stated that Arctic char is starting to decline in the area. Three of the Elders and three of the Resource Users stated that the migration of the Arctic char is being hindered by the decrease in water

levels of the surrounding lakes and rivers. It is feared that Arctic char may decline to the point where they will not be able to gather anymore. Beluga whales are also on the decline. Many of the whales are traveling further north, further from the community. The same can be said about the seals in the region. As with the walrus, the whales and the seals are moving away from the increased activities in the Bay and to find more suitable habitat, according to Elders.

Not all populations of animal species have decreased. There are animals that have increased in numbers and even new species that have appeared in the area according to Elders and Resource Users. Elders and Resource Users stated polar bears have increased in numbers when compared to the past. The community as a whole has witnessed an increase in the number of polar bears in the region. Many of the Elders feel that the polar bears are coming from the Churchill area. This is because in the town of Churchill polar bears are trapped when they come to town. These trapped polar bears are then released in the tundra north of Churchill. Four of the Elders and two of the Resource Users feel that these polar bears are migrating into the area around Arviat.

There were stories told of moose being sighted in the region. During hunting trips south and west, near the tree lines, moose have been spotted in the tundra. According to many of the Elders and Resource Users moose are still an uncommon sight in the area surrounding Arviat, however the stories about sightings are increasing. In even one occasion a community member shot a moose and brought it back to the community. Community members of Arviat do not know how to utilize the moose. The Elders stated

that this is why the moose is not hunted, even when it is sighted. The Elders are concerned that with the changing environment that animals not traditionally hunted may become common and force the Inuit to adapt and change their traditional activities.

Three Elders and two Resources Users stated that they have noticed an increase in sightings of non-native species during times of large forest fires in the south. When large forest fires are burning, many animals have no choice but to come north. In some cases these animals do not return south, but instead roam the tundra. There is a concern with warm and drier summers, more forest fires may start to push more animals and insects northward. This may lead to displacement of many of the animals the Inuit rely upon.

Migration patterns and populations are not the only changes the community of Arviat has witnessed in terms of animals; the behavior of animals is also changing. Elders and Resource Users stated that many animals are becoming accustomed to human activity. Caribou in the past use to flee when a hunter approached, but now the caribou may even start towards a hunter. According to the Elders and Resource Users the caribou have become less afraid of the hunters, and have become more curious. In the past, snowmobiles could not be used to hunt caribou. The sound would cause caribou to flee, and in some cases the emission from the exhaust would cause the caribou to alter their routes when they came across an area where a hunter was traveling.

According to the Elders, Resource Users and the youth, the polar bear have become more interested in human activity. In the past the polar bears would avoid humans and only

observe them from a distance. Now the polar bears are known to travel towards hunters and in many cases follow human tracks (snowmobile or footprints) back to the community. The Elders and Resource Users have stated that the polar bear now associate human activities with food. They are attracted to waste sites such as garbage dumps. According to the Elders the polar bears are now starting to pose a danger to Arviat.

Eight Elders and five Resources Users have observed health changes in many animals. In many cases these health changes are found in the meat of the animal. According to the Elders and Resource Users, the animals themselves do not seem unhealthy, however the meat has changed. Animals such as caribou were lean and the muscle was a deep red color, now the color has lightened up and in many cases there are white spots on the muscle. Two Elders blame the health of the caribou on the lack of precipitation. They state that with less rainfall there is less fresh lichen growth and this forces the caribou to eat old growth lichen, which is less healthy. This they believe has led to a decline in the health of the caribou. The warmer drier summers also affects the health of the caribou. According the Elders and Resources Users, with warmer summers there are there are more flies. Caribous have to move around more to keep flies off their bodies. This increase in movement leads to caribou having swollen feet and in some case they can become lame.

According to the Elders and the Resources Users the flesh of the Arctic char has changed from what it was in the past. In the past the flesh of the fish was a bright orange or red. Now the flesh is often pale or white in color. Many of the Elders feel that it is changes in



the environment that are causing the shift in the meat of the animals. The Arctic char are subjected to warmer water and are limited to where they can spawn due to lower water levels; all of these factors have led to decline in the meat of the Arctic char

### **Vegetation**

There has been a general decline in the vegetation in the area. Eight of the Elders interviewed stated that they have related the decrease in vegetation to the decline in the amount of precipitation in the area. They feel that the lack of early rainfall and snow cover has led to a decrease in the amount of vegetation in the area.

According to the Elders and Resource Users, when there was a lot of rainfall there were lots of berries and lichen growth. In more recent years, with a decline in rainfall, the amount of berries found in the region has declined. Cloudberries are an important berry to the community of Arviat but are becoming harder to find. The berries that grow today are smaller and scarcer. The Elders and Resource Users stated that community members have to travel further to find cloudberries. In some cases, people have to travel by plane further inland to find berries. According to the Elders, the lack of rainfall causes less new growth in lichen to occur and this has an impact on the health of the caribou. If less lichen is found in the region, the caribou may begin to relocate to other areas.

Within this section there have been many similarities between the scientific observations and research and the Arviat observations. Both the literature and local observations agree on the increase in annual average temperature, the decrease in ice and snow cover, and migration of animal observations. In certain areas there was non-agreement. In some

areas such as precipitation, literature states that there will be increase in spring, summer and fall precipitations, however the local observations have witnessed a decrease in all precipitation falling in the region surrounding Arviat. Local observations also differ in the area of sea level rise. Observations from Arviat state the sea level is decreasing relative to the shore, however literature states that sea level will increase in the Arctic. Other areas where the observations differed were in areas of permafrost and vegetation change. These areas are not in disagreement because the community of Arviat has not witnessed any significant changes in these areas. More research is needed to determine why the predicted effects differ from the local observations. The community of Arviat may need to start collecting its own data to quantify observations.

## **Chapter 4**

### **Possible Physical Impacts of Climate Change on Arviat**

Climate change will have an impact on many aspects of the Arctic. Some of the effects of climate change on the environment have already been explored in other sections of this report. The general and direct effects that climate change can have on the community of Arviat and its members are the focus of this section.

#### **Increased Access to Arviat**

Increased access and security issues are a concern for the Inuit living in the Arctic. With a decrease in Arctic sea ice because of warmer temperatures, longer navigation seasons could allow for more shipping routes to be available, and ports, such as the Port of Churchill in Northern Manitoba, to remain open longer. The opening of shipping routes may have major implications for access to natural resources on the traditional lands of Inuit people (ACIA, 2005). Figure 10 shows the projected sea-ice retreat and the effects this will have on the Northwest Passage and the Northern Sea Route (ACIA, 2005).

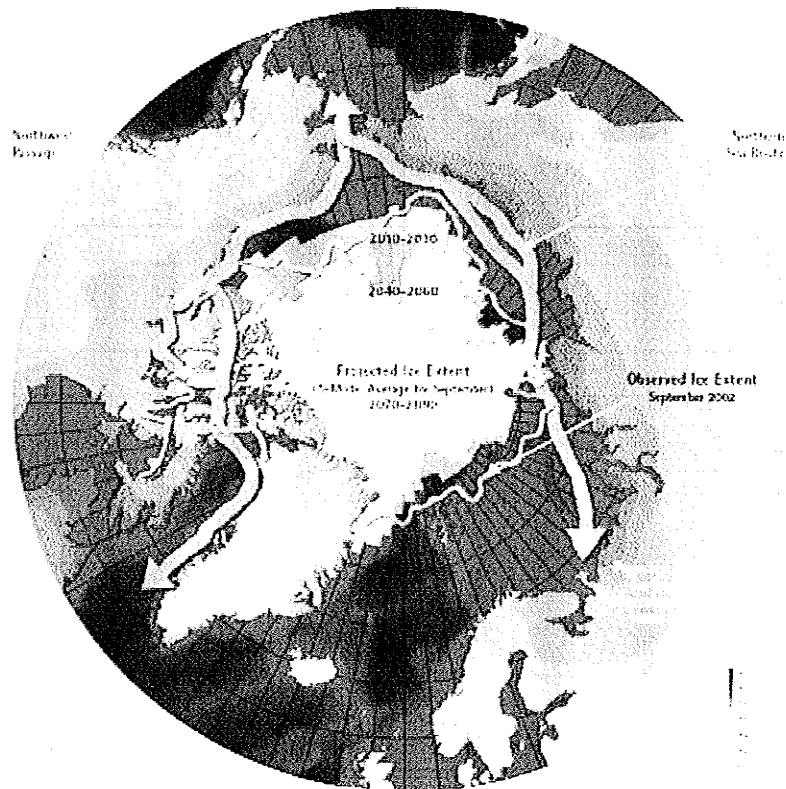


Figure 9: Projected retreats in sea ice between 2010-2090 and the effects on shipping routes

Source: ACIA, 2005

More shipping traffic may infringe upon Aboriginal rights to fish and hunt for seal and other marine life by displacing animals or traditional lands or routes and lead to conflicts. An increase in the number of shipping routes may threaten migration patterns of birds, mammals, and fish in the north (ACIA, 2005). Safety concerns related to increased accessibility for ships include the threat of more oil spills in northern waters.

Increased access by water may increase the amount of tourism travel to Arctic communities. Communities such as Arviat may see an increase in tourism and more

visitors to local attractions, such as the McConnell River Migratory Bird Sanctuary. This may have a positive economic gain for the community; however, this may lead to ecosystem impacts if not implemented in an environmentally sustainable manner. The Chief Administrative Officer stated that in the event of increased tourism, Arviat would benefit economically with jobs as guides, interpreters and tour operators, the local bed and breakfasts and hotel would see an increase in guests. This increase in tourism would not only benefit the service industry but also the artists. Local artists would have a wider audience to sell and showcase their art and talent.

An increase in tourism may impact sensitive ecosystems areas of the Arctic tundra. As large groups of tourists travel through the region, the effects could include trampling of plant life, compaction of topsoil, increased garbage disposal and introduction of foreign diseases.

### **Snow and Ice Cover**

As temperatures increase, the amount of ice cover starts to decrease (Natural Resource Canada, 2004). Changes in sea ice cover will likely be the most significant direct effect of climate change on the Arctic coastline (Natural Resource Canada, 2004). A decrease in sea-ice cover would increase the extent and duration of open water. An increase in open water seasons can have an effect on the traditional way of life for Arviat. Since Arviat is heavily reliant on country foods and is located along the coast of the Hudson Bay it is predicted that climate change will affect Arviat hunting abilities/opportunities, travel, access to traditional areas, and personal safety.

Longer open water seasons can lead to increase in shipping seasons. The longer the water is open the more shipping activity can occur in Arviat. More shipping activity can lead to an increase in tourism. Arviat may benefit economically from more open water in terms of shipping and tourism.

The decline in depth and coverage of sea ice has serious implications for wildlife such as the polar bear, seal and the walrus and for hunters who depend on the sea ice as a means to safely hunt these and other animals (Natural Resource Canada, 2004). Animals will have to travel to different areas to seek food if the sea ice moves or disappears. Community members who rely on these animals will need to find alternative game to hunt in order to supply their community needs or may find that pursuing traditional activities may become economically unfeasible.

Open water can lead to a decrease in hunting activities. Seals are reliant on sea ice. The less sea ice in the area, the less seal activity, therefore hunters will have to travel further to hunt seals. With a decline in seal population in areas immediately surrounding Arviat and an increased cost of hunting cost due to increased distances required for seal hunting, may cause hunters to reduce their seal activities. If these conditions continue to increase, seal hunting may become a outdated activity as it did with the walrus.

Polar bears can pose a danger to the community late in the summer and fall seasons. Polar bears rely on sea ice to hunt and gather food. If the open water seasons increase, the polar bear must spend more time on land. Polar bears may start to look for food on

land and the community of Arviat would offer a food source in the form of its garbage areas. Polar bears traveling to the community searching for food can pose a safety risk to members of Arviat.

### **Water Levels**

An increase in temperature can lead to an increase in extreme weather events, such as storm surges and an increase in higher wave energy and activity. As storm surges and wave activity increase, the likelihood of coastal erosion also increases. Marine geological surveys show that coastal zones have been retreating on average by at least 0.5 m/year for several thousand years (Shaw, 2001). The coastal areas surrounding Arviat may become eroded and flooded. Even if lower water levels exist, larger more intense storms can produce strong wave action.

In a severe case, the community may need to be relocated inland to avoid the problems associated with rising sea levels and erosion. Community infrastructure and coastal cultural sites may be at risk of being lost, destroyed or flooded if storm surges increase and wave activities increase and coastal areas become eroded.

According to general climate change models the water level may increase in the area surrounding Arviat. However many coastal models are now showing differential sea levels, relative to ground levels. It is still unclear whether Arviat will experience an increase or a decrease in the relative sea level, however Arviat will need to prepare for either case. An increase in sea levels can affect the infrastructure and the safety of

coastal communities. Coastal infrastructure such as docks and wharfs can be damaged. This may impact community activities such as recreation, fishing, economic development and transportation. Arviat may also suffer a decrease in economic activity such as shipping or receiving goods via barges if coastal infrastructure becomes damaged or flooded.

There are significant costs associated with rebuilding damaged community infrastructure, such as home and buildings, or re-engineering community flood protection such as dikes and levies. If sea levels rise, Arviat may become prone to flooding and damages. Arviat may have to engineer flood protection, beyond the current levels.

In the case of a rising sea, Arviat will need to begin to survey the community to identify areas that are flood prone and vital community infrastructure where an increase in protection is needed. Flood protection is very costly but essential in terms of sea level rise, therefore Arviat will experience a drain on their operating capital due to sea level rise. Arviat will need to begin planning on how to fund flood protection and identify funding sources to be used to repair and re-engineer community infrastructure.

Coastal flooding/erosion may lead to a loss of cultural and social activities. Many social activities in Arviat are associated with the coastal areas, community infrastructure and buildings. Any changes to the coastal areas or damage to community infrastructure may affect community activities such as community gathering, dances, craft sales, snowmobile races and all other community events. With erosion of shorelines and an



increase in water levels many coastal events may have to be relocated or altered. Damage to docks or wharfs will affect fishing and travel for community members. Damages to other community buildings can affect a variety of community activities. In Arviat there are important community structures such as the Northern Store and a variety of churches located close to coastal areas. Any damages to these buildings can cause some hardship to members of Arviat.

Climate change also can result in a loss of coastal ecosystems, including wetlands and spawning grounds for fish. Coastal areas such as estuaries, where fresh water meets seawater, are critical habitat for a variety of different species (Natural Resource Canada, 2004). These areas require a balance of fresh water and seawater. As sea levels increase the balance between the fresh water and the salt water can be altered. These critical regions may no longer be useful to certain species and many not be as productive. Members of Arviat who rely on these areas for traditional activities will no longer be able to use these areas.

There are concerns in Arviat about a drop in sea level as well. According to the Elders the sea level has been declining and Arviat could be an area that experiences sea levels that differ from the global prediction of a general rise. A drop in the relative sea level would also have negative impacts. The Chief Administrative Officer (CAO) has indicated that on at least one occasion the sea level dropped to a level where the barge could not use the community wharf. The barge had to “dock” far out in the Bay. The goods had to be brought over land to the shore area. The lower sea level also put the

local fuel farm in jeopardy, due to the increased distance between the barge and the refueling area. This caused the refueling of the fuel tanks to require more fuel lines than usual. The community just happened to have enough fuel lines to refuel the tanks. If the sea continues to drop this fuel transfer method may no longer be feasible.

There are not only concerns with the increase need in fuel lines, but also a concern regarding how a spill on the sea floor would impact the environment if a line was to rupture. The CAO stated that Arviat is examining a method of refueling that would decrease the chances of a fuel spill in the event of another lower sea season.

The wharf would suffer damages due to an increase in sea level; however the wharf would be rendered useless if the sea level were to drop. The deliveries of goods relies on the wharf; if water levels drop a new method of delivery would be needed. The CAO stated that the current barge system relies on a wharf for delivery. The barges are not equipped for a surface transfer. If the wharf is not accessible the current barge delivery system will have to change. The CAO stated that changing the current delivery method is difficult to prepare for since it is unknown whether the sea level will rise or fall.

### **Permafrost and Landscape Features**

As permafrost melts water levels in the seasonal frost layer of the ground increases, this layer becomes saturated and unstable and this can cause the ground to shift and to slump (Natural Resources Canada, 2004). As the permafrost melts the surface soil becomes unstable; this results in landslides and slumping in hilly areas (Natural Resources Canada,

2004). These landscape movements can threaten older buildings, communal roads, transportation, water supplies and waste disposal structures.

### *Infrastructure*

The surface layer of soil in the Arctic region is susceptible to constant freeze/thaw cycles. This causes problems, such as frost heaving and frost wedging (Natural Resources Canada, 2004). Buildings and homes cannot be built on the surface; alternative methods have been developed for these communities. Since the permafrost does not melt it can be used as a base for construction of houses and buildings. Piles are driven into the permafrost layer to create a solid base for construction. In many areas of the arctic region the permafrost layer is thick and widespread.

In recent years it has been found that this permanent frozen layer is melting in various areas of the Western Arctic. As the temperature warms, the ground is now heating to a higher temperature and the seasonal frost layer is increasing. This can have implications for community infrastructure such as older buildings, communal roads, transportation routes, water supplies and waste disposal structures (Natural Resources Canada, 2004; ACIA, 2005).

As the permafrost level becomes unstable, so does the foundation used to build homes and other community buildings. Homes will have to be built using alternative methods. Older homes will be susceptible to damage from melting permafrost. These homes will have to be re-engineered or adapted to counter the effects of the melting permafrost. The

cost of adapting and rebuilding community infrastructure may be more than the community can afford. Arviat may have to prioritize which elements of the community can be re-engineered or repaired when damaged. Arviat will have to take a proactive approach to this issue of permafrost, before massive failure occurs. Some of the older buildings may be lost due to lack of funds to save them. Arviat may be faced with the possibility of the loss of some community infrastructure or buildings, since repairing and replacing damaged infrastructure is costly.

At this time there is no noticeable change in the permafrost layer in and around Arviat. The hamlet officials stated that there are no plans to change the current building methods. The CAO of Arviat however indicated that there are plans to examine the risk that melting permafrost poses for the community and its infrastructure.

Permafrost melting can also affect communal roads used for local transportation and local distribution networks. As the permafrost layer decreases the top seasonal layer becomes more mobile and this can affect roads and pipelines. Roads and pipelines are not flexible in terms of movement; any large movement of the ground can cause these types of infrastructure to fail. Arviat will need to monitor the movement of the ground in the community to ensure that these problems are identified before any incidents of failure occur. If pipeline distribution systems fail, large-scale contamination can occur. Arviat houses a large fuel storage depot for the entire community. These large tanks are connected by a series of pipes. If the pipes fail or rupture, contamination of the surrounding environment can occur.

Melting permafrost can also affect water and waste sites. Water and wastewater stored in reservoirs or lagoons depend on solid impermeable layers for containment. If permafrost melting causes slumping or movement of the ground layers, the impermeable layers may become breached. This breach can cause contamination of the water supply and surrounding areas. Arviat must explore the threats that permafrost melting and ground movement have on water and waste sites within the community. These sites may have to be moved or re-engineered.

In the community new methods of construction may require new equipment and new training. Also re-engineering older homes will require materials. Many homeowners will have to spend an increased amount of money in order to save their homes and businesses. The community itself may be required to increase tax rates to help cover the cost of the new developments, equipment and materials and to cover the cost of repairing or moving existing infrastructure.

### **Animals**

As was examined in a previous section warmer temperatures will alter habitats, shift distribution areas, and change migration patterns. As habitats change, the migration of new species to the area may have an effect on established species. With the introduction of new species, competition for available resources becomes a factor and in some cases, new species may be able to out-compete established species. Established species may then migrate to find alternative habitats and may become extirpated from an area.

Community members of Arviat may have to travel further to engage in traditional activities. This increased in travel may lead to a decrease in traditional activities due to the cost of the increase travel and the time required to participate in these activities.

The effects of climate change on species will affect the economy, and the livelihood of the people of Arviat. As species migrate into new areas, traditional foods may become scarce, therefore increasing the reliance on store bought foods. The financial implications of this change in diet are not quantified here but are a concern to the community residents. The cultural and social implications of this change are discussed in further sections. Species relied on for traditional food and other uses may no longer be available. New species that migrate into these areas cannot be used as replacements without jeopardizing traditional customs or ceremonies.

Climate change is expected to have significant effects on fish populations and sustainable harvest levels (Natural Resources Canada, 2004). Fish have a distinct set of environmental conditions under which they experience optimal growth, reproduction and survival (Natural Resources Canada, 2004). As conditions change in response to a changing climate, fish may be affected both directly and indirectly (Natural Resources Canada, 2004). Climate change may affect water temperatures, water levels, extent of ice cover, and occurrence of extreme weather events and this in turn may affect the fish population levels. If population levels of fish change, traditional harvesting numbers may no longer be viable and either the community will need to reduce their fish catches, or change the types of fish used.

There is evidence that marine ecosystems are relatively resilient to changes in the environment, (Kennedy et. al., 2002) and that freshwater fish will adjust their habitat and range to deal with changes in temperature regime (Magnuson, et. al. 1997). Fish species with longer life cycles are usually better able to survive in an environment less favorable for reproduction (Beamish, 2002) whereas species with higher reproductive rates and faster maturity rates are more likely to recover from prolonged population decline (Hutchings, 2002). Even with these adaptive capabilities of the fish species, there are concerns that the rate of climate change may overwhelm the ability of aquatic systems to adapt.

### **Vegetation**

With the decrease in precipitation, increase in temperature and drier conditions vegetation around Arviat is changing. These changes are affecting the vegetation such as cloudberry. Cloudberry are becoming scarce around Arviat. This is a concern to the members of Arviat. Berries not only provide a food source for the people, they are also associated with social activities. The picking of the berries is a social activity and many families travel out together to gather the berries. This helps to bring the community closer together. With a lack of berries many members are worried that people will not share the location of berry patches and therefore not socialize when picking. This will affect the social fabric of the community.

With a decrease in the berries in the area, community members will have to travel further to gather berries and other plants such as medicines or herbs. The cost associated with further travel may cause many members to withdraw from the traditional activity. This will affect social aspects as well as the personal aspects of the community. People will no longer socialize while picking berries and people will be forced to find alternative foods, medicines or herbs.



## **Possible Social Effects of Climate Change on Arviat**

Climate change is having an impact on the environmental conditions throughout the world and Canada. The effects of climate change can be seen in all aspects of Inuit lives including physical (infrastructure) aspects, cultural activities and Traditional Knowledge bases, and social effects such as health and safety. The social impacts of climate change are becoming more apparent as the understanding of climate change increases. Climate change will have an effect on traditional diet, and on the health and safety of individual people. Discussed here are ways that climate change can have an impact on health and safety on the people of Arviat. The following discussion is not meant to be an exhaustive list of climate change impacts and implications.

### **Effects on Human Health**

Temperatures are predicted to increase in all regions of Canada (Natural Resources Canada, 2004). An increase in temperature can affect the community in many ways. As temperatures in the region increase the problems associated with increased heat become an issue. Since many people within Arviat do not have air conditioning units, an increase in the summer heat and an increase in the heat wave events are a major concern. Without adequate shelter from increasing heat, problems such as heat stroke, heat exhaustion and even death may occur. Certain members of Arviat are more at risk than others; the elderly and very young are susceptible to increase in temperatures (McMichael et al. 2001).

An increase in heat and dry conditions, especially in the south, increases the likelihood of forest fires. Increased forest fires do not pose any direct threat to Arviat, however the smoke and ash emitted by large-scale forest fires can pose a threat to the health of the community. Increasing temperatures in the summer leading to extreme heat waves and an increase in smoke and ash may affect the respiratory systems of some members of the community, including youth, seniors, and the sick (McMichael et al. 2001; Last et al., 1998).

### **The Effects of Climate Change on Diets**

The Inuit traditionally consumed a diet that consisted of food that they hunted, fished, trapped and gathered on the land. Many people within Arviat still consume a traditional diet, but the effects brought on by climate change threaten this way of life. Climate change will affect the distribution, abundance and behavior of animal and plant species in the Arctic. Climate change can affect the range and distribution of traditional foods, increases the reliance on store bought foods and reduce physical and traditional activities. As this trend continues it is predicted that illnesses and diseases associated with diet and reduced activities will increase in Arviat.

A reduction in the traditional food gathering activities will increase the reliance on store bought foods, which are expensive and nutritionally different than traditional foods. Diabetes in Aboriginal communities is becoming an epidemic and even occurring in children (Public Health Agency of Canada, 2003). Diabetes is being attributed to a change in the diet from a traditional “country foods” diet to a store bought “processed

foods" diet. The rate of diabetes can be attributed to a change in diet and activity. In Arviat the Elders stated that the youth are quickly adapting to a diet of processed food and decreasing the level of physical activities and there is a fear that issues such as diabetes may increase.

A decrease in physical activities, such as hunting, hiking or even recreational activities (such as hockey or dogsledding), can lead to an increase in health problems. Climate change can decrease the amount and types of traditional activities, and can also have an impact on the amount of recreational activities for youth. In warmer winters, ice in the local rink may not freeze and therefore skating and activities on the ice will not be possible. Summer heat and increases in insect migration may affect outdoor activities by decreasing the comfort level during summer activities and by exposing community members to health risks associated with insect-borne diseases such as West Nile Virus and malaria.

### **Effect on Human Safety**

As ice cover becomes unstable or unpredictable due to an increase in temperature, travel over the ice becomes more of a hazard. In times of freeze-up or breakup, unstable weather patterns can change the length of the season. If hunters travel on the ice too early, dangerous conditions can be encountered, such as open water and thin ice. In times of breakup, hunting expeditions can become isolated if temperatures increase too fast and expedite time of breakup. The Elders have stated that the knowledge about times of freeze-up and breakup are not as accurate as they once were. Extra care is needed when

traveling near the beginning or end of the winter season but now ice thickness is a consideration even in the middle of winter as ice conditions are no longer predictable or stable.

As the climate changes, Arviat will be affected. Changing snow and ice conditions on lakes, rivers, and on the sea can lead to unpredictability and possible drowning or loss of equipment. An Elder shared his experiences with the rapid changes in the ice conditions. It was shared that he was to set out on the ice in the morning of the next day. When he awoke he found that the ice was gone. He had indicated that it could have been dangerous for him to venture out. The time frame in which people travel out on the ice is shortening. People are more cautious when traveling out on the ice, especially early and late in the season. With the unpredictability of the ice conditions it is predicted that incidents of falling through the ice may increase. This means an increase in the loss of equipment or even the loss of lives.

The animals themselves can suffer from longer open water seasons. For example, polar bears need sea ice to launch hunting expeditions for ringed seals, their primary prey, but longer open water seasons restrict the time they can hunt each year. If polar bears are forced to remain on the land longer, they can pose a health risk to coastal communities. If polar bears are stranded on land for a longer period of time, the search for food becomes vital and polar bears may start to look toward coastal communities for food, and this may put people, pets and the community at risk.

In Arviat there is a chance that the water supply may become unusable. As water levels rise in the region or more extreme weather events occur, the chances of storm surges increase. The water in Arviat is held in a reservoir. During extreme events the reservoir may become inundated with seawater, rendering the water useless. Melting permafrost may also impact the community water supply. As the ground becomes permeable the likelihood of water seeping out, or of contaminants seeping in, the water supply increases.

## **Possible Cultural Impacts of Climate Change**

### **Inuit Qaujimajatuqangit (IQ) And Climate Change**

Inuit Qaujimajatuqangit (IQ) is the Inuit form of Traditional Knowledge (TK). IQ, as with TK, is accumulated over generations and passed on by word of mouth and through direct experience. IQ has played an important role in cultural activities and cultural heritage of the Inuit people, and is acquired through many years of observations and experiences and is used in everyday activities. Traditional activities and heritage also feed back into the development of this knowledge base.

IQ is an evolving knowledge base as information and observations are always being added. There is an understanding that the environment is always evolving and is not static, therefore IQ cannot be considered static. In the face of climate change however, IQ is being challenged as a result of the rapid rate at which global temperatures are rising and the effects this has on the environment (IPCC, 2001; ACIA, 2005).

Many Inuit are expressing concern over the changing environment. Many of the traditional ways of life and traditional activities are threatened. Much of the knowledge held by the communities is environmentally-based. Methods of predicting weather and environmental conditions are being threatened. The surrounding environment is changing so rapidly that the evolution of IQ cannot keep up.

As a result of climate change, many traditional activities are under the threat of changing and the knowledge base that has been developed through these activities may no longer hold as much relevance or applicability.

### **The Importance of IQ to Inuit**

Inuit people who have close relationships with the land are keen observers of the natural environment due to their reliance on it for economic, cultural, social and subsistence ways of life. Extensive studies have been completed on the extent and intensity of land use by northern First Nations and Inuit people and their knowledge of such aspects as animal behavior and biology, harvested vegetation species, and ecological relationships (e.g. ACIA, 2005; Watson et al., 2003; Ashford and Castleden, 2001; Moller et al., 2004).

As with Aboriginal people in the south, IQ to the Inuit functions and is recognized as the same type of knowledge base. Aboriginal people rely upon a complex set of indicators to illustrate the state and health of the natural environment and to enable them to operate within it (Fenge, 2001). Traditional Knowledge (TK) of the land held by Aboriginal people was once dismissed by many experts as anecdotal and unreliable but is now broadly recognized as legitimate, accurate and useful. Federal statutes, international agreements, national and international organizations, such as the *Canada Oceans Act*, *Species at Risk Act*, *Canadian Environmental Protection Act*, *Canadian Environmental Assessment Act*, Convention on Biological Diversity, The Arctic Council, The International Arctic Science Committee, United Nations Framework Convention on

Climate Change and other United Nations bodies recognize and use TK in reporting and decision making.

Inuit repeatedly offer to share what they know of their environment with the hope and expectation that their observations will assist others in their engagement with the environment. Passing information and hunting-based skills from one generation to the next provides a partial picture of the past rarely provided by comprehensive scientific monitoring programs (Fenge, 2001). Traditional monitoring methods may be qualitative but they complement science-based approaches because they are founded on observations over long time periods, incorporate large sample sizes, and are inexpensive. Traditional monitoring methods often invite the participation of harvesters as researchers, and sometimes act as checks for scientifically observed resource and ecosystem change.

### **The Effects of a Changing Environment on IQ**

Climate change will bring variability to precipitation levels, temperatures, weather events, and other physical processes associated with ecosystems. This variability in the environment is threatening the reliability of IQ for the Inuit. The observations of the Inuvialuit in Sachs Harbour summarize the following impacts of climate change on the predictability of the environment (ACIA, 2005):

- It has become difficult to tell when ice is going to break up on rivers
- Arrival of spring has become unpredictable
- It is difficult to predict weather and storms
- There are 'wrong' winds sometimes



- There is more snow, blowing snow, and whiteouts

The uncertainty of IQ presents problems for traditional activities, especially for the hunting and harvesting of wildlife and plant species. Hunters are finding it hard to predict ideal hunting conditions or migration patterns of birds and wildlife species (Jolly et al., 2001). The uncertainty of IQ also presents safety issues for the Inuit. Knowledge of ice conditions is becoming less reliable with variable snow and ice conditions. This variability threatens the safety of fishers and hunters who travel on the ice. Preliminary research on three Inuit communities on James Bay indicates that hunters from these communities take increased risks when traveling on the land, particularly along the coasts, due to changes in the climate (George, 2004). Hunters in these areas are taking different routes to avoid danger but this adaptive strategy may not work over time, as increasing temperatures create more instability on the ice. Members of Arviat have indicated that predicting the freeze-up and breakup of the ice is become increasingly difficult.

Changes in plant and animal distributions are affecting IQ and activities that take place in the environment. As the climate changes, there are disruptions of natural communities leading to changes in animal and plant distribution. Inuvialuit observations have been noted for shifts in migration, more caribou drowning, and higher death rates because of overheating and exhaustion (ACIA, 2005). Members of the community of Arviat indicated that the Caribou have altered their migration routes. Hunters have had to alter their hunting areas.

The impacts of climate change on IQ may effects the relationships the Inuit share with the environment. Many traditional activities, practices and predictions based on years of knowledge passed down through generations may no longer be sufficient to ensure the protection and continuation of the Inuit economic, cultural, social and subsistence ways of life. Rapid changes in the environment may render IQ ineffective for various uses.

### **The Effects of Climate Change on Land Use and Traditional Activities**

As the environment changes, the activities carried out in that environment will also change. The Inuit have a relationship with the land; their livelihood is taken from the land, their culture is derived from the land. A decrease in the amount and type of traditional activities could lead to a decrease in culture. Culture is tied to IQ and traditional practices. As traditional practices and customs are forgotten, culture too begins to fade.

There is a threat to the Inuit culture as the climate changes. The ways of the land may become no longer sustainable. New methods of hunting, fishing, trapping and gathering will need to be developed. Just as with dogsleds and igloos become an old way of life and are replaced by portable wooden shelters and snow machines, current ways of hunting, current fishing areas may also change. The current methods used only hold a portion of the 'old ways'. If new methods are developed the teachings associated with the 'old ways' of doing things may be under threat of being lost permanently. Traditional teachings are used to teach younger generations about the environment. These teachings are the basis for the formation of the relationship to the land. Inuit teachings help the

young generation develop a respect for the environment and teach them about environmental stewardship.

### **The Effect of Climate Change on Hunting and Gathering**

Traditional activities of Arviat will be affected by climate change as a result of the northward shifting of ecosystems or the disappearance of species due to physical changes on the land. For example, the agricultural ecosystem may shift northward due to warmer temperatures in the north. This may lead to economic benefits for northern communities that want to participate in the agricultural economy. As the surrounding environment changes, Arviat may have to alter its cultures and traditional activities to follow suit. Teachings and lessons passed on to younger generations that were once associated with the activities of hunting or gathering may not be passed down. As traditional activities change, the associated teachings may not survive the transitions. In Arviat, agricultural activities will not replace the loss of the traditional food source. The loss of the traditional food source will occur long before any agricultural activities surface in the region. These types of changes may occur over a number of generations. However, if these changes occur then the traditional culture as it exists today will be lost.

Wildlife habitat will be threatened as a result of changing ecosystems, which is important for traditional activities such as hunting or for social and cultural activities related to wildlife or their habitats (Cohen, 1997). As habitats change due to climate change, wildlife patterns will also change. Wildlife species will adapt to the new environment and will change their migration patterns and calving grounds. Communities are not as

mobile as they once were long ago. Communities have a difficult time relocating to areas of abundant wildlife. In Arviat it has been observed that the location and abundance of certain animals has changed. The walrus, once an important food source has all but disappeared from the region. The community members fear that this will occur to many other species as climate change progresses.

The traditional activity of collecting plants and berries is under threat because of climate change. Vegetation will likely be negatively affected by climate change, as a result of changes in temperature, moisture, insects, disease, and ecosystem shifts. Many Inuit communities may experience the disappearance of local sources of plants, or perhaps even extinction of entire plant species because of climate changes. In Arviat there were concerns over the abundance of berries. Many community members spoke of the decrease in the vegetation cover and the amount of berries found in the region. Areas once abundant with berries were now bare. Community members need to travel further in order to gather berries and other plants needed.

Traditional lifestyles are being threatened by other factors besides climate change, such as over-exploitation of natural resource-based industries (e.g. forestry, mining), changes in wildlife harvesting opportunities, inability to pass on IQ to youth because of the death of Elders who possess this knowledge, poverty, and loss of traditional languages. If changes due to a warming climate occur quickly, or are unpredictable, they will intensify the impacts of some of these already existing threats to traditional lifestyles. The impacts of climate change on the environment will leave all Aboriginal communities in a

vulnerable position and traditional activities would be at risk of disappearing (Cohen, 1997).

The impacts felt as a result of climate change has affected subsistence food sources, has affected social and cultural activities, and has affected the local economy including transportation and community infrastructure.

The distribution and number of animals and other resources have changed and has altered access to subsistence resources. It is predicted that further changing temperatures will cause animals and fish to move from their present ranges, become altered or unhealthy. Exotic species have been spotted and may move into areas as temperatures change. Changes to ice cover have been observed and this has lead to less predictable travel and hunting conditions. These environmental changes have reduced the ability of the community to practice traditional activities. Reduced abilities to hunt and fish have contributed to dietary problems. The dependence on processed food, especially by the young generations, can lead to an increase in medical costs through elevated levels of cardiovascular disorders, diabetes, and vitamin-deficiency disorders. Reduced physical activity associated with less time spent on the land can exacerbate these conditions, and further reduce the quality of life. Reduced abilities to hunt and fish will impose financial burdens on residents. Many residents are on fixed incomes and supplement their food stock with country foods. Climate change may lead to less country foods in the area causing the residents to purchase more food from the local store.

Changes in sea level will affect coastal structures, boat launches, wharf, harbors, sewage facilities, roads, and water access. Existing water supply systems may need to be re-designed as wastes in the permafrost thaw and sea level changes. Arviat is facing a myriad potential impact in the light of climate change, however all impacts here are discussed in general and this is not meant to be a comprehensive view of the future of Arviat. Further research is needed to determine which impacts are most likely to occur and what the time frame for the impact could be.

## **Chapter 5**

### **Climate Change Action Plans**

#### **Introduction**

Climate change is an internationally recognized problem. Communities throughout the world are starting to realize that climate change will have an impact on all aspects of daily lives. Changes in weather patterns or even changes in the overall climatic conditions of a particular region will affect all aspects of society. However even though the entire globe is susceptible to climate change, it will not affect the entire globe the same. Certain regions will experience greater changes in terms of climate and climatic variability, which may lead to a change in the local environment; in other areas the overall climate may not change, however weather patterns may range from one extreme to the next; more droughts, more flood, more storms (Natural Resources Canada, 2004).

The Arctic is expected to experience the most change of any region. The Arctic is expected to warm over the next few decades and some models predict that the Arctic will reach as much as 10°C above the current temperature ranges (IPCC, 2001). This will cause a great change in the northern ecosystem. Every community will be affected differently and the capacity to respond will also be variable.

Government sponsored scientific climate change research is being conducted in the Canadian Arctic; however the focus is not on the impacts of climate change on a local level. The research that is being done in the Arctic regarding climate change and its associated effects has primarily focused upon the science of a changing climate. The

limited research that exists on local impacts is primarily based upon the Western Arctic (Fast and Berkes 1999). Little is known about the observations of the Eastern Arctic in areas surrounding the Hudson Bay. This thesis has expanded the realm of knowledge about local impacts in the Arviat region.

### **Coastal Community Climate Change Action Plan**

As a response to climate change and its effect on northern coastal communities, a plan was initiated to develop a Coastal Community Climate Change Action Plan (CCCCAP) for the community of Arviat. A CCCCCAP is a document to help coastal communities in the face of climate change. Climate change and its associated impacts can have an effect on all aspects of a community. Identifying possible climate change impacts that may occur at a local level is the first step to the CCCCCAP.

### **History or Background of a Climate Change Action Plans**

Climate change is a global issue. Many communities around the globe are concerned with what climate change could mean to their community and way of life. There is no ideal “one size fits all” solution to help communities deal with climate change. Many international government bodies and organizations are looking at climate change in hopes of finding a common solution to the problem. Much of the focus of climate change research is based upon the reduction of greenhouse gases.

Many international governments and organizations have come together to try to combat climate change. An international accord on climate change known as the “Kyoto



Protocol” was created to try to get nations to reduce their greenhouse gas emissions. This agreement was a voluntary commitment to reduce the amount of greenhouse gases a nation produced by a certain deadline. Canada committed to the Kyoto Protocol, and promised to reduce Canada’s greenhouse gas emissions by 6% below the 1990 levels (Environment Canada 2005). However recent political events have put this commitment in question.

Many in the scientific community feel that reducing human induced greenhouse gases in the atmosphere will reduce the total effect climate change will have on the planet. Many plans are being developed a national level and focus on the reduction of the national GHG emissions. Many of these are seen as a climate change action plan.

In some nations there are two types of action plans. One type focuses on national commitments to the reduction of greenhouse gas emissions and the other are focused upon the nation’s vulnerability to climate change and the identification of solutions or plans to mitigate the national vulnerability. Countries such as Uruguay have developed climate change action plans to help identify vulnerabilities and solutions (Ramos et al. 1998). Within this plan the national vulnerabilities were examined such as coastal regions and agricultural sectors. A national inventory was also conducted to identify key government and non-governmental organizations. This plan outlines the strength and threats to Uruguay and then created solutions to solve the issues.

Many of these national plans are far removed from the community concerns. National plans may reduce a nation's vulnerability to predicted climate change impacts, but may not reduce vulnerabilities at a community level. Many communities have unique concerns that cannot be addressed in national plans. Each community will have different needs and it will be difficult to meet all those needs at a national level. This is especially true for a large country such as Canada. In Canada, not only does the geographic size make the implementation of a national strategy difficult for communities to adopt, but also the multicultural needs of each region or each community make it difficult for a national strategy to be implemented at a community level.

At a national level there is nothing actively being done in the area of community climate change action plans. Community climate change action plans are not common. Climate change research is actively underway for most of Canada. The community of Arviat is one of the lead communities taking climate change research to the next level. Preparation for climate change effects is not yet the focus of science, yet Arviat identified a need to prepare for and to mitigate impacts that may arise from climate change. This research will help in the development of a full scale plan, where Arviat can ready itself for impacts of climate changes using the strengths and the resources available. Using community strengths and resources, Arviat will be able to respond to climate change impacts as they arise.

### **Need for a Community Based Climate Change Action Plan**

The development of community climate change action plans are needed so that communities can take a proactive role and control over their vulnerability to climate change and its predicted impacts. In Canada, national implementation strategies are focused on reduction of greenhouse gases. With the vast geographic areas of Canada, coupled with its diverse communities, a national climate change action plan will not be adaptable to all areas. In regions of the north with little greenhouse gas emissions, national strategies will not be applicable and communities will still be vulnerable to climate change effects.

Northern communities, such as Arviat, feel that something should be done to help northern communities prepare for climate change, in a proactive manner. Communities in the Arctic have expressed a desire to prepare for climate change before changes occur and people suffer hardships. There is a need for the development of a CCCCAP in northern communities.

A northern climate change action plan can be similar to national climate change action plans developed by countries such as Uruguay. These climate change action plans can be based on coastal communities and the predicted climate change impacts that will occur in these communities. A Coastal Community Climate Change Action Plan can be developed in order to help communities become more proactive to climate change and help limit vulnerabilities of the communities.

## **Chapter 6**

### **The Development of a Coastal Community Climate Change Action Plan For Arviat, Nunavut**

#### **Background**

With many nations developing national climate change action plans, a need has arisen to address the local impacts of climate change. Global models and predictions are not always applicable to all communities. The national plans developed will not always meet the needs of a community. Communities have started to realize that the communities themselves have the ability to help themselves. With climate change action plans a community can take a proactive role in the mitigation or adaptation to climate change and its associated effects.

The development of a CCCCAP can be viewed in two parts; the first aspect dealing with the predicted climate change impacts and observations for northern coastal regions of Canada; the second aspect dealing with the identification of plans to minimize or mitigate the predicted changes. In order to develop useful plans of action to mitigate and adapt to climate change, climate change and its effects on the local environment must be understood. Without a clear understanding of the impacts at a local level the plans will not be as effective. The research and findings of this thesis provide a useful understanding of the type of impacts that could emerge in the Arviat area. However a better understanding of the likely extent of the impacts is still needed which can only be done using a quantitative assessment.

Two types of action plans can be created. Mitigation plans that focus on mitigation or minimization of direct climate change impacts, such as sea level rise. Adaptation plans are another type of plan that can be created, which focus on the indirect impacts of climate change such as changes to subsistence lifestyles.

The information provided in this thesis is not comprehensive enough to develop a full scale action plan. However Arviat can begin the development process of creating a CCCCAP by researching current climate change information and documenting local observations on changing environmental and climatic conditions. The information provided in this thesis in conjunction with a quantitative assessment can help in the development of an effective action plan for Arviat. This section provides recommendations and considerations for the development of a CCCCAP. These recommendations will act as guidelines and outline the next steps Arviat will need to follow to develop an effective CCCCAP.

## **Recommendations and Consideration**

### **Recommendation 1: Climate Change Coordinator**

The community of Arviat should create a position to lead the creation and maintenance of the CCCCAP. This position could pick up where this thesis leaves off. The position can start to undertake a rigorous quantitative assessment of the potential impacts identified in this thesis. The position could be responsible in implementing the recommendation of this thesis and could ensure that the CCCCAP is periodically updated and reviewed.

**Recommendation 2: Coastal Community Climate Change Steering Committee**

The development of a CCCC Steering Committee made up of local members, Resources Users, Elders and Youth. The elected leadership of Arviat should select community members to form a steering committee. The committee could meet regularly to discuss the concerns of the community and provide direction to the Climate Change Coordinator. This committee would be responsible in focusing the efforts of the Climate Change Coordinator in terms of research and knowledge needed in the community.

**Recommendation 3: Community Climate Change Knowledge and Awareness**

The community must understand the basics of climate change. The entire community does not have to become climatologists to be able to contribute to the development of a CCCCAP. However some awareness of climate change must exist in each member of the community. Without an idea of climate change and its potential impacts, a community member cannot appreciate the need for a CCCCAP. With knowledge of climate change and local observations community members can dialogue with the CCCCAP steering committee to discuss issues and concerns. The steering committee can then direct the coordinator to conduct further research in areas of concerns.

*Community Workshops*

The community must create workshops and information sessions to help ensure that the community members in Arviat are educated and aware of climate change and its associated impacts. These meetings could also serve to highlight any new development

in climate change research. Information sessions such as these can stimulate dialogue and interest in the project and in the development of a CCCCAP.

#### **Recommendation 4: Review and Documentation of Climate Change Impacts and Observations**

In order to start to develop action plans to minimize the impact of climate change, the community must understand climate change effects. Understanding climate change effects can be done by documenting local observations and reviewing current climate change science. Arviat is only starting to document local observations and local changes. This research is the beginning of this documentation. This project also provides a start to the research in current climate change science. Climate change science is beginning to focus on the Arctic region and many nations around the world are interested in the findings. The people of Arviat will need to continue to update their knowledge about climate change as it becomes available.

As the scientific understanding of climate change increases, the community awareness must also increase. There must be a system in place that allows for the collection and analysis of current climate change research. There must be a constant review of new climate change research and a continual update of this knowledge within the community. The climate change science research will have to be done in a manner that ensures continuation. Continuation meaning that it is not dependant on a specific person: this is to ensure that the research will continue even with changes in personnel.

Along with the continual update in the current climate change research, there is a need for the continued and systematic documentation of local observations on climate and environmental change. Local knowledge is the key to understanding the local impacts. With western science lacking insight on local climate change impacts in the Canadian Arctic, local knowledge can help to expand the understanding. Local knowledge can take general plans and understandings and transform them into local plans and solutions that are made for the community.

There needs to be a continuation of interviews with members of Arviat. These interviews should aim to document climate change observations. However the local knowledge or IQ pertaining to other areas could also be gathered for other purposes. This would avoid duplication of interviews and work.

#### **Recommendation 5: Community Monitoring**

It is possible for the community to collect empirical data to help in the development of a local climate change impact model. The community will need to develop and instigate monitoring plans. The community can utilize local citizens to start to gather empirical evidence of climate change. This type of community-based monitoring could be done by all members of the community.

#### *Monitoring Plan A: Arviat School Involvement*

Utilizing the local schools in Arviat, monitoring programs could be developed for various environmental features around Arviat. The community can utilize the school to create a



historic temperature graph and look for general trends in the mean monthly temperatures. One grade in the elementary school can be selected to gather and plot the data. This selected school grade can remain constant every year so that all the children that pass through that grade have a chance to learn about local temperature and climate change. The school can continue to utilize that data from the local weather station located at the airport. On a weekly basis the children can plot the average weekly temperature on the graph and start to monitor the graph for trends. This type of empirical data collection can help in determining if there is a general warming trend and how fast the average temperature is changing.

This model can be used for other areas of concern, such as sea levels, length of ice seasons and permafrost depths. The classes can take actual readings/measurements from a local area and record the data. This data then can be averaged and monitored to highlight any changes from the expected norm. Water levels can be taken directly from the bay surrounding Arviat. The time of freeze up and break up of the ice on the bay could be recorded every year. The thickness of the permafrost in the ground surrounding Arviat could be documented in the summer and in the winter.

*Monitoring Plan B: Arviat Resource Users*

Arviat Resources Users could be utilized to record a variety of different data on the changing environment. Methods for this monitoring plan could include direct observations and mapping. Direct observations could be used to help identify health issues in the plants and animal used by Arviat. The community could utilize biologist to

help train Resource Users on field techniques used to identify health issue in animals. As the Resource Users collect country foods they can take some measurement and record the data. This data could be collected and compiled by the Hamlet or local Hunters and Trapper Organization. This data would start to identify issues or changes that could arise in the health of the plants and animals used by Arviat. This type of empirical data could be used to help create local plans.

Mapping could also be utilized in Arviat. Arviat Resource Users could begin to document locations of animals. These documented locations could be of important game animals and of new exotic species. The Resources Users could utilize National Topographic System paper map sheets (NTS map sheet) or even hand-held GPS units while out in the tundra.

All this data could be plotted from year to year. As patterns begin to form Arviat would be the first one to highlight this change. The community would then be in a better position to respond to the change in the environment and be able to change this adaptation or mitigation plans. Either one of these models would take many resources to implement. The local resources are there and may need supplementary resources such as education or some small equipment. As the youth become involved in this type of data gathering the knowledge is taken home and shared with family members. This can also help with the dissemination of climate change information.

**Recommendation 6: Gap Analysis**

Understanding the capacity of the community involves an analysis of the strengths and limitations of the community. The community must undertake an inventory of the knowledge and infrastructure the community holds. The community must understand its knowledge baseline in terms of climate change and its capacity to develop that knowledge base. The community also needs to undertake an assessment of the current infrastructure. The community needs to understand which infrastructure is currently failing, outdated or requiring repair, which infrastructure is current, and which is needed to be developed. The community will also need to analyze their workforce and identify needs in the face of climate change.

As local solutions are developed to mitigate or adapt to a changing environment, Arviat must know what tools it has to undertake these changes. The success of the action plans will be dependant on the availability of the required resources. There needs to be an understanding of what the needs are to implement the solutions. As plans are developed and solutions identified, an inventory of the community's capacity to implement the solutions has to take place. Each plan will have specific needs and requirements in order for them to be implemented.

Required resources could be as simple as having enough community members to participate in the plan, such as reactive flood protection measures, or sand bagging to prevent an area from being flooded. The resources could be technical or mechanical.

such as the need for computer access, or access to machines such as bulldozers or backhoes. The resources could be less tangible, such as education and training.

The community will identify strengths and limitations to implementing the proposed solutions. With an understanding of the plan and the impact that the plan is trying to minimize, it is easier to identify what is needed for the plan to be a success. Both strengths and limitation will shape how the plans will look and feel.

Community limitations may help to modify plans to limit the use of the resources that the community lacks. The identification of limitations may also help the community to plan to strengthen these areas or for the community to seek outside help in these areas. The earlier that these limitations are identified, the earlier that the community can create solutions to bridge these gaps either by increasing the internal capacity through training, education, through the acquirement of technology or the development of partnerships. Also if the area of limitation is so specialized and the community will not benefit by creating the internal capacity, agreement with outside agencies can be created. Arrangements with outside agencies can be a long process and in the event of a sudden need for resources this can be a hindrance. The early development of partnership may help to minimize the problem.

An understanding of the strengths and limitations of Arviat will help in the successful creation of climate change action plans. The identification of strengths may cause the plans to be altered in ways to utilize strengths in an efficient manner. Developing plans

that focus on community strengths will help the community become more self-sufficient. The identification of limitations can help Arviat create partnerships or increase capacity to address these areas. Proactive planning is a key to successful action plans.

### **Recommendation 7: Development of Response Plans**

Utilizing the community assessment of vulnerabilities and predicted impacts, action plans can be identified for either the mitigation of or the adaptation to the predicted impact. Some plans will focus on the development of actions in order to minimize the vulnerability to the predicted impacts, whereas others will offer possible solutions on how to prepare for changes that cannot be minimized or avoided.

#### Mitigation plans

These plans will either eliminate or minimize the community vulnerability to the predicted impacts. These plans will focus on community infrastructure and physical works. Plans identified in this section will include plans for adjustment of community infrastructure such as roads, electricity distribution lines, fuel storage and distribution systems, water source and water distribution systems, sewage storage and collection systems, modification of building and engineering techniques for community infrastructure and relocation or modification of coastal infrastructures, such as wharfs, docks, boat launches and marinas.

### Adaptation Plans

Another type of action plan is for areas that cannot be mitigated or minimized. These impacts are beyond the control of the community and can impact “softer” aspects of the community, such as social, societal or cultural areas. Plans within this section can include modification to social aspects of the community such as relocation of community events that may occur on the waterfront or on the sea ice. Plans can be put in place to help the community adapt to changes in societal aspects such as changes in seasonal community migration patterns such as travel to fishing or hunting camps. Plans can also include the implementation of programs to help mitigate lifestyle changes such as changes in diet and physical activity. There can be changes to cultural practices as well; changes to hunting and gathering techniques, modification of traditional travel routes, modification of species utilized for traditional purposes and utilization of various methods of transportation.

### **Recommendation 8: CCCCAP Management**

A Coastal Community Climate Change Action Plan (CCCCAP) is proactive. These plans are developed in response to future climate change events. These plans can be a useful resource to help identify possible future climate change effects, solutions to minimize impacts, resources needed to carry out solutions, and possibility personnel or organizations that could be relied upon to help implement solutions. These plans are not static but living documents.

Action plans are living documents open to change and created to be adaptable. In order for these plans to have meaning or significance they will have to be open to change. As science grows so does the knowledge base that exists about the planet and the surrounding environment. Science is advancing daily and new or revised ideas are introduced that change the way we view the world. As fundamental knowledge develops or changes, so do the theories and assumptions based on that fundamental knowledge. As knowledge about climate change and its associated impacts are better understood, assumptions made may change or gaps may be filled.

As these gaps are filled or the fundamentals of climate change are better understood, ideas and plans have to be revamped and reformatted. As the knowledge used to create mitigation plans or to help identify resources or possible solutions to climate change is rewritten, so should the plans. Solutions, ideas or knowledge contained within the CCCCAP must be able to change in order to remain applicable to the community.

Arviat will need to develop a system of review/update of the CCCCAP. This system will need to be periodic and constant. In order for the plan to be effective it must be kept up to date. The system will need to be independent of specific personnel or leadership changes.

#### **Recommendation 9: Cultural Values and Viewpoint Knowledge Transfer**

The community of Arviat has expressed a concern over the potential change in the environment and also the impacts that this change may impose on their way of life.

There is fear that the traditional ways and values may be lost if the traditional methods or ways of doing things become obsolete. There are teachings about the environment and about the Inuit way of life associated with certain actions. The hunting and gathering allows the Elders to pass on the knowledge about the environment that has been passed on to them and share some of the experiences they have gained. The values associated with hunting and gathering shows the youth the importance of the land and teaches them to respect the earth. Elders fear that these values will be lost if people are not hunting and gathering. If the traditional values and viewpoints are to be passed down to the youth a method needs to be developed so that this can occur, regardless of the climate change impacts.

The community of Arviat can in the face of climate change pass on those teaching and values. This can be done through the school and education system. There needs to be an examination of integration of Elders and traditional teachings into the school system. In today's society the youth are educated more in schools than out on the land. The logical step is to bring these teachings into the school system. These teachings could be taught by Elders and Resource Users. This can ensure that the youth will still retain the traditional values and viewpoints even when the activities once used to pass on this knowledge are practiced less.



**Consideration 1: CCCCAP Continuity**

As government changes there can be changes to programs, projects and focus areas.

The CCCCAP must be a project that is able to survive changes in local and regional governments. The CCCCAP must be developed in a way to ensure its continuation even in the event of a change in government. The CCCCAP must belong to the community, driven by the community and independent of governmental changes. Since climate change will happen regardless of government agendas, the CCCCAP must be beyond political issues and agendas.

**Consideration 2: Community Involvement and Ownership**

CCCCAP must be a locally created document. This document must be initiated, developed, implemented and owned by the community of Arviat. The community must be involved in every level of its creation. In order to create a community document, there must be community involvement. The leadership of Arviat must undertake a process that ensures community involvement and ownership.

All community members must be aware of the project and where they can contribute. There must be in-depth community consultations and awareness regarding this project. The project must have a system of reciprocal information exchange. The community must be able to contribute to the creation of the CCCCAP. Also the community must have access to information regarding the plan and associated projects. There has to be a level of transparency for all community members. The community must feel that they have the ability to contribute or know where to go to get answers for questions. The

community must also feel that they have control and ownership over the process and the documentation. Ownership and control of the process and the document must be clearly communicated and reinforced. Community members must be able to take ownership of the document. The document must be developed in a way so that it is custom tailored to the community.

If community members are not supportive of this project then critical information about the local observation will not be forthcoming or complete. Without the local knowledge and observations then the information is not complete. Without complete information, there can be no development of detailed plans to avoid or minimize climate change and its associated effects. If there are large data gaps, the plans developed will not address the impacts and effects of climate change. These plans will not be as effective and may not be correct for the particular region.

### **Consideration 3: Partnership Development**

The action plans created for Arviat, by either local or external partners must be done in a way that uses the strengths of Arviat. Plans developed must be designed, when applicable, to use the strengths identified by the 'gap analysis'. In cases where Arviat does not have the capacity to undertake an action plan, a partnership must be developed so this "gap" can be addressed.

Partnerships development can be a long process and requires a great deal of coordination. The partnership must be done far in advance of any negative effect occurring.

Partnerships must be proactive and created and formed in times of little to no need for the partnerships. The partnerships must be designed in a way as to be quickly and easily implemented when needed.

The community will have to ensure that the partnership meets the needs of the community in a way that is acceptable to the community. This aspect can be easily overcome with proper communication and guidelines developed by the community. Roles and responsibilities must be clearly defined and negotiated to ensure that all parties know what is expected of them. Roles must be assigned that encompasses the strengths and specialty of each partner. This will avoid confusion when the time comes to implement these partnerships.

These partnerships must be done in a way as to also survive community changes. As the CCCCAP must survive political changes, partnerships need also overcome political changes. A system of constant review should be developed to ensure that each party still knows their roles and responsibilities. The periodic review will also allow for cancellation of the partnership agreements in the event of capacity changes, either with Arviat or the external partner or in case of party withdrawal. Periodic review will allow for Arviat to renegotiate or find new partners in the event of dissolution of partnership, well in advance of a need for partnership.

Following this framework, Arviat will be well on its way to start to increase its resilience to natural disturbances. Resilience development is one key to surviving natural

disturbances. The CCCCAP is one way of preparing for climate change but can be also seen as a tool to help increase the community's resilience to natural disturbances and environmental change.

## **Chapter 7**

### **Summary and Conclusions**

The information contained in this report was created to meet the objectives set out by the project. The objectives for the project were developed to meet the needs of Arviat. The objectives of the project are:

- To broadly determine the current understanding of climate change impacts in Northern Canada.
- To determine the place local knowledge or Traditional Knowledge has in predicting climate change impacts.
- To examine the social, economic and cultural impacts related to climate change from the perspective of local residents.
- To create a framework and provide guidance for responding to climate change and for preparing an action plan appropriate and acceptable to community members.
- To determine further research needs required for the development of a Coastal Community Climate Change Action Plan for Arviat, Nunavut.

The data in this report was presented to the community for review and for community input. A workshop/open house was held in order for the community to review documented local observations and the CCCCAP guidelines and provide corrections, input and suggestions. The input received from the workshop/open house was incorporated and the final report was changed accordingly. Any corrections on observations or any revisions to the CCCCAP guidelines are present within this report.

Climate change in the Arctic is a present reality and rapidly occurring. The Arctic ecosystem is changing as a result of climate shifts and changing weather patterns. Effects of climate change are observed more and more as each season passes. Climate change effects are observed throughout the entire Arctic environment. This phenomenon is widespread and has the capacity to impact the entire Arctic ecosystem. As a result of this change, the people of the Arctic must also shift or adapt to the changing environment.

Climate change research is very limited in the Arctic especially in the Eastern Arctic, along the western shores of the Hudson Bay. There has been very little research done in this region. The scientific data that does exist for these regions are general and based on global models. These models are lacking details of climate change impacts on a local level. This thesis builds upon this knowledge and can be used as a preliminary baseline for the community of Arviat.

Within communities there are those who have witnessed the changing environment, in many cases these people are Elders. These observations are a kind of baseline data in terms of environment and climate change. Local knowledge has an important role within climate change research and documentation. Science is now starting to document climate change and its effects on the environment. However without local baseline data, science cannot determine how much the current climate has shifted from the norm and this may skew future predictions. Local knowledge can help fill in the gaps of modern research and when combined with current findings, can create a greater understanding of climate change and its impacts.

The changes in climatic conditions have been observed within the community of Arviat. Climate change has the ability to affect all aspects of the community. The community of Arviat has already noticed changes to all aspects of their community and to their livelihoods due to a changing climate.

The impacts felt as a result of climate change has affected subsistence food sources, has affected social and cultural activities, and has impacted the local economy including transportation and community infrastructure (A rigorous quantitative assessment of the implications for this community is beyond the scope of this project.)

#### **Subsistence food supply**

The distribution and number of animals and other resources have changed and has altered access to subsistence resources. It is predicted that further changing temperatures will cause animals and fish to move from their present ranges, become altered or unhealthy. Exotic species have been spotted and may move into areas as temperatures change.

#### **Social and cultural impacts**

Changes to ice cover have been observed and this has led to less predictable travel and hunting conditions. These environmental changes have reduced the ability of the community to practice their traditional activities. Reduced abilities to hunt and fish have contributed to dietary problems. The dependence on processed food, especially by the young generations, can lead to an increase in medical costs through elevated levels of cardiovascular disorders, diabetes, and vitamin-deficiency disorders. Reduced physical

activity associated with less time spent on the land can exacerbate these conditions and further reduce the quality of life.

**Economic impacts including transportation and community infrastructure**

Reduced abilities to hunt and fish will impose financial burdens on residents. Many residents are on fixed incomes and supplement their food stock with country foods. Climate change may lead to less country foods in the area causing the residents to purchase more food from the local store. Changes in sea level will impact coastal structures, boat launches, the wharf, harbors, sewage facilities, roads, and water access. Existing water supply systems may need to be redesigned as the permafrost thaws and sea level changes.

The community of Arviat will benefit from the development of a Coastal Community Climate Change Action Plan. The action plan will allow for the community to monitor and record observations on climate change. These records will allow the community to track changes and begin to develop mitigation and adaptation plans for the observed changes before problems occur.

The community of Arviat is in the preliminary stages of developing a CCCCAP. The information contained within this document will help start to develop a CCCCAP that is relevant and acceptable for Arviat. The recommendations and considerations outlined within this document will serve as a guide for Arviat to follow while developing its own CCCCAP. The CCCCAP will allow the community to take the local observations



witnessed and integrate the “western science” to develop an understanding of impacts and how the local environment may change. The global models developed for climate change predictions are complicated; scientists, universities and computers create these models. There are no models that can predict the effect climate change will have on a local level; however using large regional predictions, such as sea level changes and local observation, the community can start to piece together how climate change can affect the local environment.

The Coastal Community Climate Change Action Plan will allow for the development of adaptation plans that are developed for the community needs. The CCCCAP will allow the community to adjust to climate change impacts in a socio-economic and cultural acceptable way. Within the CCCCAP, the community will undertake a self-assessment to identify strengths and limitations. This self-assessment combined with the identification of potential climate change impacts can highlight areas where the community may be vulnerable to environmental change. Socially and culturally appropriate action plans can be created to address the community vulnerabilities, building on the identified community strength. The self-assessment of the community will help highlight areas where the community is self-sufficient and areas in which the community needs to develop capacity. In cases where the threat is greater than the capacity of the community, the community can then enter into partnerships with other communities or organizations that can assist in reducing the threat.

Development of community capacity can be done by either increasing the internal strength or by engaging outside agencies to increase capacity. The development of partnerships can be a key component to the success of the implementation of a plan. Partnership can take a long time to solidify, so in the event of a reactionary situation, long-term beneficial partnerships may not be able to be developed. Taking a proactive approach in developing long-term partnerships and ensuring that these partnerships are in place is beneficial so that when an event does occur these partnerships can react in a timely manner.

There is a time limitation to development of a CCCCAP. Much of the information about the potential effects is drawn from community observations on environmental changes, usually from the Elders. As time passes, that knowledge base erodes. Elders are currently passing away and in many cases their knowledge is passing with them. Without the Elders' observations, the CCCCAP cannot be as effective as it could be.

Arviat will need to establish the required baseline information about climate change, its effects and the community strengths and threats before any management plans can be developed. Arviat will also have to get community support for the project so that the community can own the entire process and be involved at every stage. Community involvement is the key, in both documenting observations and in the identification of strengths and weaknesses of the community. Community involvement will ensure that the project is a success.

This project gives the community of Arviat a starting point in terms of the climate change effects at a local level and the documentation of Elder observations. The community of Arviat will now have to take ownership and further the research and begin to formulate action plans for adaptation or mitigation of climate change and its impacts.

## **Chapter 8**

### **Final Thoughts**

#### **Arviat and Resilience**

The Inuit have always showed some form of resilience to environmental change (Berkes and Jolly 2001). In this paper we have discussed the changes that are predicted to occur in the area surrounding Arviat. However Arviat have always faced changes or alterations in the environment. Resilience is defined as the ability of a system to absorb a disturbance, reorganize and still maintain essentially the same function, structure, identity and feedbacks (Berkes 2007). Climate change may be a large scale change the current adaptation methods used by Arviat may not be able to overcome.

Berkes (2007), identifies four clusters of factors relevant to building resilience: first learning to live with change and uncertainty, second nurturing various types of ecological, social and political diversity for increasing options and reducing risks, third increasing the range of knowledge for learning and problem-solving and lastly creating opportunities for self-organization, including strengthening of local institutions and building cross-scale linkages and problem-solving networks.

In developing and increasing resilience these relevant four clusters are key and can be seen in Arviat. Arviat has naturally developed the first two clusters, living with change and uncertainty and incorporating diversity to reduce risks (Berkes 2007). Arviat has learned to live with change and uncertainties as outlined in cluster one. In traditional societies that depend on the environment for much of there resources, there is an inherent

amount of uncertainty attached. People in Arviat have learned to adapt to changes in the environment from changes in weather patterns to changes in animal ranged and migration routes. Over the years the environment around Arviat has changed and the community has adapted to these changes and has incorporated change into their daily lives. Flexibility has given the community of Arviat the ability to survive in this region

Cluster two is closely linked to cluster one in a traditional society. Cluster 2 deals with embracing diversity in ecological, social and political arenas to increase options and reduce risks (Berkes 2007). Depending on the natural environment requires societies to live with a level of uncertainty and incorporate that into their daily lives, but also this lifestyle requires members to seek alternative methods or sources of resources to survive. Out of necessity Arviat has developed the second cluster naturally. According to the Elders, in years where ptarmigan are scare they do not hunt ptarmigan. They would utilize other more abundant food sources. Another example of this flexibility and diversity is when the walrus migrated north from the area, Arviat found alternative sources to replace the walrus. Arviat has adapted to periodic changes in animal populations and incorporated diversity of the environment to adapt to the changes.

Cluster three involves increasing the range of knowledge for learning and problem solving (Berkes 2007). Arviat has already started to increase their range for learning. In the past global issues and problems had little bearing in the community – however now the global issue of climate change is talked about by all. The community of Arviat is now expanding their knowledge of climate change and this research provides the

community with a base knowledge and helps to address the basic questions of climate change impacts. The research also outlines recommendations that will help the community develop a system to help further increase that knowledge base. The research recommends a method be developed where the community is actively researching both climate change science and observed changes. This information can then be disseminated to the community via community workshops or through the local school system. This system increase the knowledge base of the community but it also increases the problem solving ability of the community. The knowledge gained through the research, the community can then develop adaptation or mitigation plans suitable to the predicted or observed local impacts.

Cluster four, creating opportunities for self organization, including strengthening local institutions and building linkages and networks (Berkes 2007), is starting to be addressed by Arviat. In this research, recommendations are made to increase the strengths and reduce the risks and vulnerabilities of the community. It is recommended that Arviat conduct a self assessment to help determine where it can strengthen its own internal capacity and start to organize itself. It is also recommended that Arviat start to create partnerships at address the risks and vulnerabilities of Arviat where internal capacity building does not make economic, social, environmental or political sense. In these areas the community should look to external partners to increase Arviat's capacity. With knowledge and partnerships to provide support or knowledge Arviat can begin to increase it resilience to climate change.

Arviat will not be able to mitigate all impacts of climate change but will be able to increase the resilience of the community so the same essential functions will still exist. This research is a starting point for the community and its recommendations can be used to develop an action plan that not only increases the community's resilience but also outlines plans of actions to help reduce the vulnerabilities and risks to the community. It is out of this I believe that the community has optimism. The research did not provide the optimism felt by the community but assists to organize and formulate a framework with which the community can respond to climate change.

#### **Voice of Arviat – Final Teachings**

The community of Arviat has great concerns about the impact of climate change. With limited knowledge of the local effects and with local observations that indicate that climate change may be presently occurring, Arviat is greatly concerned with the possible outcomes. There is much discussion on the potential environmental impacts on Arviat, however there is limited discussion on how the community feels about these potential impacts. This section will attempt to relay the feelings of the community. As with any climate change scenario, there are few positive considerations. Even in the face of extreme environmental changes, the viewpoint of Arviat was still that of optimism. The Elders state the environment is always changing and the Inuit have always changed with it. Learning about climate change had made me realize that the livelihood of this small hamlet was to be altered in a way that they have never faced; yet talking to the Elders I felt that they were optimistic of the outcome. They talked about resilience and past

environmental changes that the community has overcome. They felt that climate change was just another event that the Inuit will have to overcome.

There is an understanding that climate change is occurring and will alter their way of life, but there was also a strength exhibited when the Elders talked. There was talk about how the environment has always changed and the Inuit way of life has overcome these changes. The strength that they showcased was evident in their attitude and stories. The Elders talked about a time when walrus were abundant in the area, then something changed and the walrus were no longer abundant and gathering walrus required great time and effort. The community overcame this change and switched their food source to animals that were abundant. This, the Elders say, was something that was needed to be done in order to survive. In some years, there were no ptarmigan in the area, according to the Elders, so the community did not have ptarmigan; they simply switched their focus to what was available until the ptarmigan returned. The community has always adapted to the environment and integrated changes into their livelihood. They didn't seem to dwell on what they didn't have but instead focused on what was available to them. It was this optimism that made me appreciate the Inuit culture, their strength and their resilience.

The community was concerned with learning about the impacts that they faced; however the main goal was not only to learn about the impact but to start to prepare for these changes. Learning about what could happen in the region, their concerns were divided equally between the environmental impacts and the social and cultural impacts that they were to face. The impact to the livelihood of the community was as important as the



effects on the culture, values and language. It was felt that protecting the community from flooding or melting permafrost is as important as ensuring the culture, language and values continue to be passed on to the next generations. They wanted the CCCCAP to ensure not only environmental impacts were examined but the social and the cultural as well.

Some interviewed talked about a loss of their way of life. Some talked about the old ways, when they lived out on the land and how the formation of the community of Arviat ended that way of life. They talked about this change not in a negative way but in a way that it was an inevitable change and that they had to adapt to this new lifestyle. They talked about how they held on to their traditional values, even when the traditional ways were only followed by few. As snow machines replaced dog teams they ensured that the values associated with activities on the land were passed on to the youth regardless of the methods used. They see climate change as inevitable, something that has to be accepted and prepared for. They wanted to focus their energy on adapting to the changes and to ensuring that their culture, language and values survive. They did not talk about who or what brought about this change and why they should have to shoulder more of the impact than others, they want to talk about the future and how to ensure the Inuit way of life survives in some form. However their concerns were not only limited to environmental or climate changes but to outside influences as well. They see climate change impacts and the effects of outside influences as a 'hand in hand' issue that could be addressed in one plan.

The community talked about not only climate change impacts and how their lifestyle is being affected, but also about “southern” influences. They feared that climate change will impact their access to country foods and make it less accessible, but also the change in the youth and their preferences for convenience or processed foods. They felt that both of these could impact the values associated with the consumption and the act of gathering the country foods. They see this project as a way of maybe addressing this concern. By preparing for climate change and ensuring that the values and teachings associated with the current way of life can continue if the environment changes, they can also utilize this system in case ideologies change in the youth. In this thesis a recommendation is made to develop a system within the school system that utilizes the Elders of the community to ensure that the traditional culture, language and values survive the predicted changes.

The overall view once you analyze the potential impacts of climate change can easily lead to a conclusion of hopelessness. However when you talk to the community they only see potential and time to prepare for these changes. As the rest of the world tries to cope with why is this occurring and which party is more responsible, it is these northern communities that are faced with the most extreme changes. But it is these communities that show the most optimistic view, in spite of physical, cultural and social changes.

I am neither from Arviat, nor am I from the North but I am from a culture that derives much of its identity from the land and the surrounding environment. I found it hard to discuss with the Elders and with the community what could happen to their livelihood and to show that their way of life may be forever changed. However I was surprised to

witness the strength these communities had in face of such great change. I only hope that I do them justice in describing their positive attitudes and their forward thinking. Even undertaking this project is 'light years' ahead of other communities and even other nations, including Canada. To understand climate change effects and to begin to adapt does not take much – only a will to survive and a positive outlook. I for one learned so much from Arviat and I only hope that this document can help them in some way prepare for the possible changes that may occur.

## References

- Aagaard, K., and E. C. Carmack, The role of sea ice and other fresh water in the Arctic circulation, *J. Geophys. Res.*, 94(C10), 14,485–14,498, 1989.
- ACIA, 2005. Arctic Climate Impact Assessment. Cambridge University Press, 1042p.
- Ashford, G., and J. Castleden. 2001. Inuit observations on climate change—final report. International Institute for Sustainable Development, Winnipeg, Manitoba.
- Atkinson, Rowland and John Flint, 2001. Accessing Hidden and Hard-to-Reach Populations: Snowball Research Strategies, *Social Research Update*. Issue 33, summer 2001, Department of Sociology, University of Surrey
- Beamish, R.J. and Noakes, D.J. (2002): The role of climate in the past, present and future of Pacific salmon fisheries off the west coast of Canada; in *Fisheries in a Changing Climate*, (ed.) N.A. McGinn, American Fisheries Society, 319 p.
- Brotton, Janet and Geoffrey Wall, 1997. "Climate change and the Bathurst Caribou Herd in the Northwest Territories, Canada", *Climatic Change* 35: 35-52.
- Canada, 1997. Canada's Oceans Act
- Canada, 2002(a). Canada's Oceans Strategy: Our Oceans our Future
- Canada, 2002(b). Canada's Oceans Strategy: Policy and Operational Framework for Integrated Management of Estuarine, Coastal and Marine Environments in Canada.
- Cohen, S.J. (ed.), 1997: Mackenzie River Basin Impact Study (MBIS) Final Report. Environment Canada. Toronto, ON, Canada.
- Fancy, Steve G. and Robert G. White, "Energy expenditures by caribou while cratering in snow", *Journal of Wildlife Management*, 49(4):987-993, 1985
- Fast, H. and Berkes, F. 1998. Climate change, northern subsistence and land based economies, in *The Canada country study: climate change impacts and adaptation*, N. Mayer and W. Avis (eds.)
- Fenge, T. 2001: The Inuit and climate change; Isuma: *Canadian Journal of Policy Research*, Winter 2001 issue, p. 79–85.
- Berkes, Fikret. 2007. Understanding uncertainty and reducing vulnerability: lessons from resilience thinking. *Natural Hazards* (2007) 41: 283-295.

Berkes F, Jolly D. 2001. Adapting to climate change: social-ecological resilience in a Canadian western Arctic community. *Conservation Ecology* 5(2): 18. [online] URL: <http://www.consecol.org/vol5/iss2/art18>

George, J. 2004. Climate change threatens hunting trails. *Nunatsiaq News*

Giorgi F, Hewitson B, Christensen JH, Hulme M and 5 others (2001) Regional climate information—evaluation and projections. In: Houghton JT, Ding Y, Griggs DJ, Noguer M, van der Linden PJ, Dai X, Maskell K, Johnson CA (eds) *Climate change 2001: the scientific basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, p 583–638

Hutchings, J.A. (2002): Collapse and recovery of marine fishes; *Nature*; v. 406, p. 882–885.

IPCC, 2001: *Climate Change 2001: Impacts, Adaptation, and Vulnerability. Contribution of the Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change* [McCarthy, J.J., O.F. Canziani, N.A. Leary, D.J. Dokken, K.S. White (eds.)] Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 967pp.

Jolly, D., Berkes, F., Castleden, J., Nichols, T., Harbor, T.C.O.S., 2001. We can't predict the weather like we used to: Inuvialuit observations of climate change, Sachs Harbor, western Canadian Arctic. In: Krupnik, I., Jolly, D. (Eds.), *The Earth is Faster Now: Indigenous Observations of Arctic Environmental Change*. Arctic Research Consortium of the United States, Fairbanks. pp. 92– 125.

Jorgenson, M.T., Racine, C.H., Walters, J.C., and Osterkamp, T.E., 2001: Permafrost degradation and ecological changes associated with a warming climate in central Alaska. *Climatic Change*. 48(4), 551-571.

Kennedy, V.S., Twilley, R.R., Kleypas, J.A., Cowan, J.H., Jr. and Hare, S.R. (2002): Coastal and marine ecosystems and global climate change: potential effects on U.S. resources; report prepared for the Pew Center on Global Climate Change, 52 p.

Krupnik I. & Jolly D. (eds.). 2002. *The Earth is Faster Now: Indigenous Observations of Arctic Environmental Change*. Arctic Research Consortium of the United States, Fairbanks, Alaska, USA.

Last, J., K. Trouton, and D. Pengelly, 1998: *Taking Our Breath Away: The Health Effects of Air Pollution and Climate Change*. David Suzuki Foundation, Vancouver, BC, Canada, 55 pp.

Magnuson, J.J., Webster, K.E., Assel, R.A., Bowser, C.J., Dillon, P.J., Eaton, J.G., Evans, H.E., Fee, E.J., Hall, R.I., Mortsch, L.R., Schindler, D.W. and Quinn, F.H.

(1997): Potential effects of climate changes on aquatic systems: Laurentian Great Lakes and Precambrian Shield region; *Hydrological Processes*, v. 11, no. 8, p. 825–871.

Maxwell, B. 1997. Responding to global climate change in the Arctic. Canada country study: Climate impacts and adaptation, Vol. 2. Ottawa: Environment Canada.

McMichael, A., Githeko, A., Akhtar, R., Carcavallo, R., Gubler, D., Haines, A., Kovats, R.S., Martens, P., Patz, J. and Sasaki, A. (2001): Human health; in *Climate Change 2001: Impacts, Adaptation and Vulnerability*, (ed.) J.J. McCarthy, O.F. Canziani, N.A. Leary, D.J. Dokken and K.S. White; Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, p. 451–485

Mitchell, J. F. B., D. J. Karoly, G. C. Hegerl, F. W. Zwiers, M. R. Allen, and J. Marengo. 2001: Detection of climate change and attribution of causes. IPCC 2001: *Climate Change 2001: The Scientific Basis*. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change. J. T. Houghton, Y. Ding, D. J. Griggs, M. Noguer, P. J. van der Linden, X. Dai, K. Maskell, and C. A. Johnson, Eds., Cambridge Univ. Press, Cambridge, UK, 695-638.

Moller, H., F. Berkes, P. O. Lyver, and M. Kislalioglu. 2004. Combining science and traditional ecological knowledge: monitoring populations for co-management. *Ecology and Society* 9(3):2.

Natural Resources Canada, 2004. *Climate Change Impacts and Adaptation: A Canadian Perspective*. Ottawa, Canada.

Nickels, S., Furgal, C., Buell, M., Moquin, H., 2005. *Unikkaaqatigiit – Putting the Human Face on Climate Change: Perspectives from Inuit in Canada*. Ottawa: Joint publication of Inuit Tapiriit Kanatami, Nasivvik Centre for Inuit Health and Changing Environments at Université Laval and the Ajunnginiq Centre at the National Aboriginal Health Organization.

Parkinson, A.J. and Butler, J.C. 2005. Potential impacts of climate change on infectious diseases in the Arctic. *International Journal of Circumpolar Health*. 64(5), 478-486.

Pomeroy JW, Brun E, 2001. Physical properties of snow. In: *Snow Ecology: An Interdisciplinary Examination of Snow-Covered Ecosystems* (eds Jones HG, Pomeroy JW, Walker DA, Hoham RW), pp. 45–126. Cambridge University Press, Cambridge.

Ramos Mañé C, Giordano S, Vitoria C (1998) Development of climate change action plans in Uruguay. Final report of the second phase of the Uruguay Climate Change Country Study. Comisión Nacional sobre el Cambio Global. Montevideo, Uruguay.

Shaw, R.W. 2001. Coastal Impacts of Climate Change and Sea-Level Rise on Prince Edward Island Climate Change Action Fund project CCAF A041 Synthesis Report, Ottawa, pp74

Smith, D.M. 1998, Recent increase in the length of the melt season of perennial Arctic sea ice, *Geophysical Research Letters*, 25 (5), 655–658.

Stirling, Ian, Nicholas J. Lunn, and John Iacozza, 1999. "Long term trends in population ecology of polar bears in western Hudson Bay in relation to climatic change", *Arctic* 52(3):294-306

United Nations Environment Programme, 2005. Ad Hoc Open-Ended Inter-sessional Working Group on Article 8(j) and Related Provisions of the Convention on Biological Diversity. Composite Report on the Status and Trends Regarding the Knowledge, Innovations, and Practices of Indigenous and Local Communities.

U.S. Arctic Research Commission Permafrost Task Force, 2003. Climate Change, Permafrost, and Impacts on Civil Infrastructure. Special Report 01-03, U.S. Arctic Research Commission, Arlington, Virginia.

Vogt, W. P. 1999. Dictionary of Statistics and Methodology: A Nontechnical Guide for the Social Sciences, London: Sage.

Watson, A., L. Alessa, and B. Glaspell. 2003. The relationship between traditional ecological knowledge, evolving cultures, and wilderness protection in the circumpolar north. *Conservation Ecology* 8(1):2.

Watson, R. T., Zinyowera, M. C., and Moss, R. H. 1996, Impacts, Adaptations, and Mitigation of Climate Change: Scientific-Technical Analyses, Report of Working Group II to the Second Assessment Report of IPCC, Cambridge University Press, Cambridge.

Weller G, Bush E, Callaghan TV, Corell R, Fox S, Furgal C. et al. 2005. Summary and Synthesis of the ACIA. In: Arctic Climate Impact Assessment. Cambridge, UK:Cambridge University Press, 989–1020.

## **Websites**

Environment Canada, 2000. Climate Change Overview: What is the Kyoto Protocol. <http://www.ec.gc.ca/climate/kyoto-e.html>. Accessed May 2004.

Environment Canada, 2000. Permafrost. [http://www.ec.gc.ca/water/en/nature/perma/e\\_prmfit.htm](http://www.ec.gc.ca/water/en/nature/perma/e_prmfit.htm). Accessed May 2004.

- Government of Nunavut, 2006(a). Our Land.  
<http://www.gov.nu.ca/Nunavut/English/about/ourland.pdf>. Accessed May 19, 2006.
- Government of Nunavut, 2006(b). Arviat Map. <http://www.gov.nu.ca/arviatmap.htm>  
Accessed May 19, 2005.
- Mikilaaq Centre, 2005. History. <http://www.mikilaaqcentre.com/history.html>.  
Accessed May 19, 2006
- Nunavut Arctic College, 2005. About the College.  
[http://www.nac.nu.ca/about\\_the\\_college/about\\_college.htm](http://www.nac.nu.ca/about_the_college/about_college.htm) accessed January 2005
- Nunavut Tourism, 2006. Arviat.  
<http://www.nunavuttourism.com/site/default.asp?id=107> Accessed April 25, 2006
- Polar Bears International, 2006. Polar bear feeding habits.  
<http://www.polarbearsinternational.org/polar-bears-in-depth/feeding-habits> Accessed  
May 4 2006
- Public Health Agency of Canada, 2003. Diabetes in Aboriginal Communities,. In:  
Diabetes in Canada: Second Edition. [http://www.phac-aspc.gc.ca/publicat/dic-dac2/english/50chap6\\_e.html](http://www.phac-aspc.gc.ca/publicat/dic-dac2/english/50chap6_e.html). Accessed January 11, 2006.
- Republic of the Maldives. 2003. Averting Catastrophe, Ministry of Home Affairs,  
Housing & Environment. [http://www.environment.gov.mv/catas\\_arti.htm](http://www.environment.gov.mv/catas_arti.htm). Accessed  
June 23, 2005
- Simonsen, B.O., S. Peacock, J. Haggerty, J. Selter, and F. Duerden. 1997. Report of  
the First Nations Cultural Heritage Impact Assessment and Consultation. Component;  
Bamberton Town Development Project. First Nation Management Committee.  
Submitted to The Environmental Assessment Office, Province of BC and Greystone  
Properties Ltd. <http://www.racerocks.com/racerock/rreo/rrefer/bamber/toc1.htm>  
Accessed January 20, 2006.
- Statistics Canada, 2006. Community Highlights for Arviat. Taken from  
[http://www12.statcan.ca/english/profil01/CP01/Details/Page.cfm?Lang=E&Geo1=CS  
D&Code1=6205015&Geo2=PR&Code2=62&Data=Count&SearchText=arviat&Sear  
chType=Begins&SearchPR=01&B1=All&Custom](http://www12.statcan.ca/english/profil01/CP01/Details/Page.cfm?Lang=E&Geo1=CS&D&Code1=6205015&Geo2=PR&Code2=62&Data=Count&SearchText=arviat&SearchType=Begins&SearchPR=01&B1=All&Custom) Accessed July 3, 2006

### **Personal Communications**

- Ukatuk, David Jr., 2003. Personal Communication



## **Attachments**

### **Appendix 1**

#### **Outcomes and Participants of Initial Project Meeting**

Arviat is one of the seven HBOWG committees. This committee supported the letter of interest drafted in response to NRCan's call for letters. In September 2002, at a meeting in Churchill, the Research Committee approved development and submission of the full proposal, recommending Arviat as the community of choice for the project's focus. Participants at the September committee meeting included the following:

- Sid Bruinsma, Area Manager, Environment Canada, Iqaluit
- Don Cobb, Marine Environmental Quality Coordinator, Fisheries & Oceans, Winnipeg
- Helen Fast, Integrated Management Coordinator, Fisheries & Oceans, Winnipeg
- Miriam Fleming, Researcher, Environmental Committee of Municipality of Sanikiluaq, Sanikiluaq
- Steve Newton, Integrated Management Planner, Fisheries & Oceans, Winnipeg
- Bob Reside, Park Warden, Parks Canada, Churchill
- Dan Shewchuk, Regional Wildlife Manager, Nunavut Department of Sustainable Development, Arviat
- Glen Stephens, Manager, Environment and Contaminants, Indian and Northern Affairs Canada
- Gary Stern, Contaminants Research Scientist, Fisheries & Oceans, Winnipeg

## **Appendix 2**

### **Information and Contact Sheet**

#### **Development of a Coastal Community Climate Change Action Plan for Arviat Nunavut Summer, 2003**

The Natural Resources Institute and The Department of Fisheries and Oceans are working together in Arviat, Nunavut. This information sheet will briefly describe the role of these institutions and the focus of the research

#### **The Natural Resources Institute, University of Manitoba**

The Natural Resources Institute (NRI) trains graduate students in practical natural resources management. Students learn to address issues of public concern through interaction with both experts and interest groups.

The institute is involved in a wide range of natural resources areas. Research is conducted in conjunction with government, business and private groups. The Institute's research process allows for involvement of client groups, and provides a valuable outreach function by bringing together university faculty and practicing resource professional. All research conducted at the NRI is available to the public.

The work of graduate students will help advance the programs objective of both these institutions. The collaboration between these two institutions will also allow for greater flexibility and diversity in carrying forward on issues of marine coast ecosystem health and sustainability.

#### **Darren Thomas, Researcher – NRI/DFO**

This research project stems from the introduction of the Oceans Act of 1997, the goal of which is to maintain the sustainability of Canada's oceans for the benefit of current and future generations. While working with coastal regions in the north, it was identified that climate change impacts are an import issue to these coastal communities.

#### **Department of Fisheries and Oceans**

The Department of Fisheries and Oceans (DFO) is an agency of the federal government, with jurisdiction over Canada's freshwater and marine environments. The *Oceans Act* of 1997 gives the DFO the primary roles in addressing marine activities and issues.

DFO oceans activities will involve the integration of perspectives from local people, governments, First Nations and interested parties in making decisions and policies affecting Canada's oceans. The first phase of the *Oceans Act* will examine the benefits of integrated management as an effective strategy for specific regions across Canada. This research will be available to the public.

*Objective*

To develop a coastal community climate change action plan for the community of Arviat, Nunavut.

*Methods*

By meeting with community members and using current literature on northern climate change impacts, key issues and possible impacts can be identified. With this knowledge recommendations can be developed, in conjunction with the community members, on possible mitigation strategies.

*Justification*

This research will be used to better understand local climate change impacts in the north, and help DFO's overall examination of the benefits of integrated management.

This researcher is working under the supervision of Prof. Thomas Henley (NRI) and Dr. Helen Fast (DFO). He can be reached at the Natural Resources Institute in Winnipeg Manitoba at (204) 474- 6169

**Project Contacts**

Darren Thomas

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## **Appendix 3**

### **Interview Schedule**

#### **Background of Interviewee**

1. What is your name?
2. Where and when were you born?
3. Where did your parents live?
4. Are you male or female?
5. How much formal education do you have (what grade, year in university, etc)?
6. What is your current occupation?
7. Are you Aboriginal or Non Aboriginal?
  - a. Inuit, First Nation, Metis?
  - b. Status or Non Status?
  - c. Land Claim Beneficiary?

#### **Traditional use areas**

8. Can you describe the area you used to go during the different seasons when you where a child, youth, young adult, now?

#### **General Weather**

9. Do you thing there has been a change in the weather since you where a child?
  - a. How has it changed?
  - b. When did you first notice the change?
10. Did your parents say anything about changing weather before you were born?
11. Has any weather changes affected your activities?
  - a. How?
  - b. How have you had to change the way you do things?

#### **Temperature**

12. Have you seen any changes in the amount of cold/warm days?
  - a. What changes have you seen?
13. Have you seen an increase/ decrease in temp in various seasons?
14. Is it colder/warmer in the seasons?
15. Is the temp as stable as it was in the past?

#### **Rain**

16. Is there any change in the amount of rain the area gets?
  - a. Is it more or less?
  - b. Is it constant?
17. Does it fall in the same seasons as it did in the past?
18. Is there more/less thunderstorms?

#### **Snow**

19. Is there any change in the amount of snow the area gets?
  - a. Is it more or less?
  - b. Is it constant?
20. Does it fall in the same seasons as it did in the past?
21. Is there more/less blizzards?
22. Has the amount of snow cover changed in the different seasons (quicker melting)?

23. Has the quality of snow cover changed in the different seasons (good snow for shelter, sledding)?

**Wind**

24. Has there been a change in the wind?
- a. The direction it blows?
  - b. The speed it blows?
  - c. The amount of windy days?

**Seasons**

25. Has there been a change in the season length?
- a. Spring?
  - b. Summer?
  - c. Fall?
  - d. Winter?

**Sea and inland Ice**

26. Have there been any changes to the timing of the freeze-up and breakup of the ice (sea and inland)?
27. Has the thickness of the ice changed from when you were young (sea and inland)?
28. Has the ice changed (clear, foggy, uniform density, slushy) (sea and inland)?
29. Have there been changes in the amount of multiyear ice/single year ice?
30. Has this change in ice cover affected your ability to practice traditional activities?

**Permafrost/landscape features**

31. Have you noticed a change in the permafrost?
- a. What changes?
32. Have there been changes in inland lakes and rivers?
33. Has the landscape changed from when you were a child (more/less hills, deeper/shallower valleys, more/less lake and rivers.)?

**Travel**

34. Has the change to the area affected travel in the different seasons (snow too deep in winter, no snow in spring)?
35. Has there been a change in the distance that the community has to travel to follow traditional practices?
36. Are the roads affected by melting permafrost?
37. Are the roads affected by rising/lowering sea levels?
38. Are there plans to move or alter the roads due to this possible impact?
39. Has there been any changes in the way that the community has built, maintained, roads?
40. Are the winter roads still usable?
- a. How long are they open?
    - i. Has this changed from the past?
41. Are community water infrastructure (boat launches, ports, wharfs, dock) susceptible to changing sea level?
- a. How are they susceptible?
  - b. Is this common (sea level fluctuation year to year)?
  - c. Has there been a trend in sea level (rising or falling)?
  - d. Are there plans in place to compensate for the changing sea level?

**Animals**

- 42. Are there new animals that you don't remember being here when you were young?
- 43. Are the animals you remember being here when you were still here?
- 44. Where have they moved?
- 45. Why have they moved?
- 46. Have these new animals affected traditional practice of gathering food?
- 47. Have the movement of the old animals affected traditional practice of gathering food?
- 48. Has there been a change in the way you prepare and store animals?
  - a. What changes have occurred?
- 49. Have you noticed any strange thing about the animals (sickness, behavior, mutations)?

**Waste handling**

- 50. Where does the community put its waste (garbage, sewage, hazardous waste)?
- 51. Are these facilities licensed?
- 52. Are these facilities susceptible to melting permafrost, rising or falling sea levels?
  - a. Are there any plans in place to deal with this issue if the facility is impacted?
- 53. Are there any old waste sites (garbage dumps, landfills, hazardous storage area, chemical spills areas, etc) that may be affected by melting permafrost?
  - a. Are there any plans to try to clean up these sites before a problem occurs?
  - b. Are these sites a danger to the community?
  - c. Are these sites a danger to community infrastructure?

**Fish**

- 54. Have you noticed in changes in fish, types, amount and quality?
- 55. What changes?

**Birds**

- 56. Have you noticed in changes in birds, types, amount and quality?
- 57. What changes?

**Plants**

- 58. Are there new plants that you don't remember being here when you were young?
- 59. Are the plants you remember being here when you were young still here?
  - a. Why have they disappeared?
- 60. Have these new plants affected traditional practice of gathering food and medicines?
- 61. Have the disappearance of the old plants affected traditional practice of gathering food and medicines?

**Insects**

- 62. Have you noticed a change in amount of insects?
  - a. Is there more insects (mosquitoes, horseflies etc)?
  - b. Are there any new insects in the area?
    - i. How long have they been here?
  - c. Have any insects gone missing?
    - i. Why have they left the area (change in animals food source, too dry/wet)?

**Water**

- 63. Have you noticed any changes in water levels in the rivers and lakes?
- 64. Have you noticed any changes in water levels in the sea/ocean?
- 65. Have the quality of water in these bodies changes?
  - a. What has changed?
- 66. Has the town water changed in quality (taste, color, clarity, odor)?
- 67. Is the community's water supply affected by melting permafrost?
- 68. Is the community's water supply affected by rising/lowering sea levels?
- 69. Are there plans to move or alter the community's water supply due to this possible impact?

**Fire**

- 70. Have there been any changes in the amount or length of tundra fires?
  - a. Does this concern you?
  - b. Why?

**Health**

- 71. Has there been a change in the amount of time the community spends on the land?
  - a. Why has there been a change?
- 72. Has there been a change in the amount of country food eaten by the community?
  - a. Why has there been a change?
- 73. Has there been a change in the amount of store food eaten by the community?
  - a. Why has there been a change?
- 74. Has there been a change in serious sicknesses in the community as compared to the past?
- 75. What type sicknesses (diabetes, heart problems, pneumonia, cancers, breathing problems, increase in allergies....)?
  - a. Why have people been getting sick?
- 76. Have there been changes in the amount of other health impacts to the community, such as sunburns, snow blindness, and common colds?

## **Appendix 4**

### **Submitted Ethics Approval Report**

#### **Required Information About Research Protocol**

##### **1. Summary of Project**

###### **Purpose**

The purpose of this research is to develop a coastal community climate change action plan for the community of Arviat in the Canadian Territory of Nunavut.

###### **Methods**

The research will include:

A literature review

- The establishment of a community steering committee
- An extensive community visit with a number of field trips to various locations
- A series of local semi structured interviews
- A number community meetings and workshops to provide updates and information

A literature review will be conducted in the English language. The literature review will focus on what is known about climate change and its impact to northern coastal communities. The project will also include the establishment of a steering committee to help guide the research process. The steering committee will be made up of select community members. These members will be selected to ensure that a wide range of views and experiences from the community are represented. An extensive community visit will be conducted once the proper community guide, community steering committee and appropriate project approval have been obtained.

During a later community visit a series of semi formal semi structured interviews will be conducted. Personal interviews will be conducted with a variety of different community members in order to obtain community information regarding climate change. The interviews will be formatted in a way as to be open ended and non-leading. An interview schedule will be developed to help guide the researcher in the interview but however this will be open to change and adaptation following a pre-test. A number of community meetings and workshops will be planned. These workshops will be open to community members to share their experiences and allow the community to ask questions regarding the project. The gathering of larger groups may allow for information to be gathered that may have been missed during the interviews.

##### **2. Research Instrument**

Attached is the copy of questions to ask the interviewee. The format of an open-ended, informal interview may require the restructuring of the interview schedule. Some of the questions may be answered by other questions, which would make asking certain questions redundant so modification may be needed. Some questions may be removed or added upon completion of a test interview.



### **3. Study Subjects**

The number of subjects involved in the project will be 40. These 40 subjects will represent a cross-section of the community. They will range from youth (18-30), Elders, hunters, trappers and resources users, municipal and government representatives, women.

### **4. Informed Consent**

Informed consent will be acquired in writing. Attached is a copy of the consent form. The project will be described to each participant and any issues of clarification will be handled before the interview commences.

### **5. Deception**

The project will not use any deception at any time.

### **6. Feedback/Debriefing**

Feedback and debriefing will occur after the interview. Once all data is analyzed and compiled the research will return to verify all information with interviewees to ensure accuracy and completeness.

### **7. Risks and Benefits**

There is minimal risk to participants or to a third party.

### **8. Anonymity and Confidentiality**

Anonymity and confidentiality will be ensured at times when requested by interviewee. In cases where the interviewee feels that they would be better suited to remain anonymous then every effort will be made to protect their identity. The researcher will secure all information and all access will be restricted. Access will only be granted in the case of researcher and interviewee consent. All information will be held and controlled by researcher at all times.

### **9. Compensation**

Compensation will be offered to participants. This remuneration will be offered to help participants compensate for their time while participation in the project. All interviewees will be compensated; as well the research assistant and the community steering committee will be pay for their time and efforts.

## **Appendix 5**

### **Research Consent Form**

**Research Project Title:** Development of a Coastal Community Climate Change Action Plan for Arviat Nunavut  
**Researcher:** Darren Thomas  
Natural Resource Institute  
**Sponsor:** Department of Fisheries and Oceans

This consent form, a copy of which will be left with you for your records and reference, is only part of the process of informed consent. It should give you the basic idea of what the research is about and what your participation will involve. If you would like more detail about something mentioned here, or information not included here, you should feel free to ask. Please take the time to read this carefully and to understand any accompanying information (see attached sheet for project information).

This research has been approved by the Joint-Faculty Research Ethics Board. If you have any concerns or complaints about this project you may contact any of the above-named persons or the Human Ethics Secretariat at 474-7122. A copy of this consent form has been given to you to keep for your records and reference, throughout your participation.

Darren Thomas  
Primary Researcher  
University of Manitoba  
70 Dysart Rd  
Winnipeg, MB, Canada  
R3T 2N2

Email:

Professor Thomas Henley  
Advisor  
University of Manitoba  
70 Dysart Rd  
Winnipeg, MB, Canada  
R3T 2N2  
(204) 474-6169  
Email: [Henley@ms.umanitoba.ca](mailto:Henley@ms.umanitoba.ca)

Your signature on this form indicates that you have understood to your satisfaction the information regarding participation in the research project and agree to participate as a subject. In no way does this waive your legal rights nor release the researchers, sponsors, or involved institutions from their legal and professional responsibilities. You are free to withdraw from the study at any time, and /or refrain from answering any questions you prefer to omit, without prejudice or consequence. Your continued participation should be as informed as your initial consent, so you should feel free to ask for clarification or new information

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Participant's Signature

Date

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Researcher and/or Delegate's Signature

Date

## CONSENT FORM INFORMATION SHEET

### **Development of a Coastal Community Climate Change Action Plan for Arviat Nunavut Summer, 2003**

The Natural Resources Institute and The Department of Fisheries and Oceans are working together in Arviat, Nunavut. This information sheet will briefly describe the role of these institutions and the focus of the research

#### **The Natural Resources Institute, University of Manitoba**

The Natural Resources Institute (NRI) trains graduate students in practical natural resources management. Students learn to address issues of public concern through interaction with both experts and interest groups.

The institute is involved in a wide range of natural resources areas. Research is conducted in conjunction with government, business and private groups. The Institute's research process allows for involvement of client groups, and provides a valuable outreach function by bringing together university faculty and practicing resource professional. All research conducted at the NRI is available to the public.

#### **Department of Fisheries and Oceans**

The Department of Fisheries and Oceans (DFO) is an agency of the federal government, with jurisdiction over Canada's freshwater and marine environments. The *Oceans Act* of 1997 gives the DFO the primary roles in addressing marine activities and issues.

DFO oceans activities will involve the integration of perspectives from local people, governments, First Nations and interested parties in making decisions and policies affecting Canada's oceans. The first phase of the *Oceans Act* will examine the benefits of integrated management as an effective strategy for specific regions across Canada. This research will be available to the public.

The work of graduate students will help advance the programs objective of both these institutions. The collaboration between these two institutions will also allow for greater flexibility and diversity in carrying forward on issues of marine coast ecosystem health and sustainability.

#### **Darren Thomas, Researcher – NRI/DFO**

This research project stems from the introduction of the *Oceans Act* of 1997, the goal of which is to maintain the sustainability of Canada's oceans for the benefit of current and future generations. While working with coastal regions in the north, it was identified that climate change impacts are an import issue to these coastal communities.

#### **Objective**

To develop a coastal community climate change action plan for the community of Arviat, Nunavut.

### **Methods**

By meeting with community members and using current literature on northern climate change impacts, key issues and possible impacts can be identified. Your participation will be needed to obtain community information regarding climate change. A personal interview will occur in order to gather this information. These interviews will vary in length and duration. With this knowledge recommendations can be developed, in conjunction with the community members, on possible mitigation strategies.

### **Justification**

This research will be used to better understand local climate change impacts in the north, and help DFO's overall examination of the benefits of integrated management.

### **Risk**

There is minimal risk to participants or to a third party

### **Interview Medium**

The interview will be recorded on paper, as the interview is conducted. The researcher may utilize devices such as audio and/or video recorders. The audio and/or videotape will only be used to analyze the interview and help to capture important information that may have been missed by the note taker. Please feel free to decline the audio and/or videotape recorders.

### **Anonymity and Confidentiality**

Anonymity and confidentiality will be ensured at times when requested by interviewee. In cases where the interviewee feels that they would be better suited to remain anonymous then every effort will be made to secure the identity of the interviewee. The researcher will secure all information and all access will be restricted. Access will only be granted in the case of researcher and interviewee consent. All information will be held and controlled by researcher at all times.

### **Feedback and Debriefing**

Feedback and debriefing will occur after the interview. Once all data is analyzed and compiled the research will return to verify all information with interviewees to ensure accuracy and completeness.

### **Compensation and Remuneration**

Compensation will be offered to participants. This remuneration will be offered to help participants compensate for their time while participation in the project. The compensation will occur in the form of an honorarium of \$100.00 for their time and efforts.

This researcher is working under the supervision of Prof. Thomas Henley (NRI) and Dr. Helen Fast (DFO). Prof. Thomas Henley can be reached at the Natural Resources Institute in Winnipeg Manitoba at (204) 474- 6169

**Project Contacts**

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