A Teacher's Guide for the Video *Sila Alangotok—Inuit Observations on Climate Change*

A Resource for
Senior 2 Science

Manitoba
Building for the Future

A TEACHER'S GUIDE FOR THE VIDEO
SILA ALANGOTOK—INUIT OBSERVATIONS ON CLIMATE CHANGE

A Resource for Senior 2 Science

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INTRODUCTION

This teacher's guide has been developed for use with the video *Sila Alangotok—Inuit Observations on Climate Change*, produced by the International Institute for Sustainable Development. The issue of climate change affects us locally and globally and is relevant to students in all geographic locations in Canada. While climate change is frequently covered in the news media, this video explores traditional ecological knowledge in climate change science and the cultural and economic impacts of climate change on one Arctic community.

"*Weather* refers to the temperature, precipitation (rain, snow), humidity, sunshine, and wind that occurs at a particular time at a specific location" (Environment Canada, 1995, 11).

Canadians love to talk about the weather. In urban centres, weather is an important topic of conversation because it influences our decisions about what to wear, where to go, and how to get there. We rely on weather forecasts to help us with these daily decisions. In the more remote areas of Canada, understanding weather is a matter of subsistence and survival.

Daily weather patterns in Canada have been monitored since 1873. Today this monitoring is done by Environment Canada. Canadian Aboriginal populations who depend upon reliable sources of information regarding climate also maintain a history of climate through the oral transmission of knowledge. Oral histories document climate-related information over generations, in contrast to scientists who are often working with results from short-term research (often lasting only two to three years). Until recently, scientists disregarded many of the oral accounts of climate because they were viewed as information obtained without a systematic process that ensured reliability and validity. In other words, oral histories were not scientific. Recently, in the last 20 years, Aboriginal and non-Aboriginal people have documented the systematic process of the oral transfer of knowledge in their communities. Although this knowledge may differ from the institutionalized definition of science, the long-term observations and records of climate are worthy sources of information that will lead to a greater understanding of climate and climate change.

"*Climate* is often thought of as the average weather we experience over several years. However, climate is much more than that. It takes into account extremes, surprises, anomalies, and variability. In effect, climate is what you expect, weather is what you get" (Environment Canada, 1995, 11).

> The knowledge systems of indigenous people are quite varied around the world, but there are consistent patterns in the way the knowledge is acquired and in the nature of the content of indigenous knowledge systems. Indigenous knowledge systems are quite different to western science-based knowledge systems. To give but two examples, indigenous knowledge is intensely local in its factual information, whereas science usually must carry out new studies to gain the same information that is already present in indigenous knowledge systems. Science generally has a short-term base of information that it can use, whereas indigenous knowledge can draw on a very long-term base. Thus there is a great advantage to using the two knowledge systems together. (Emery, 2000, 1)

Today some scientists (Aboriginal and non-Aboriginal) and Aboriginal communities are working together to combine scientific knowledge and indigenous knowledge to foster a greater understanding of the world in which we live. Canada is one of the leaders in this collaboration and is a model for the rest of the world.

This teacher's guide may help you and your students explore climate change and its impact on Arctic communities and how collaboration between scientists and indigenous populations can help us develop a better understanding of our planet. Manitoba's science curriculum for Kindergarten to Senior 4 promotes this collaborative approach to the development of scientific literacy.

During their Early, Middle, and Senior Years science education, students achieve the specific and general learning outcomes identified in the provincial science curriculum documents (available online at <http://www.edu.gov.mb.ca/ks4/cur/>). The following general learning outcomes are particularly relevant to this document:

A1. Recognize both the power and limitations of science as a way of answering questions about the world and explaining natural phenomena.

A2. Recognize that scientific knowledge is based on evidence, models, and explanations, and evolves as new evidence appears and new conceptualizations develop.

A4. Identify and appreciate contributions made by women and men from many societies and cultural backgrounds that have increased our understanding of the world and brought about technological innovations.

B1. Describe scientific and technological developments, past and present, and appreciate their impact on individuals, societies, and the environment, both locally and globally.

B5. Identify and demonstrate actions that promote a sustainable environment, society, and economy, both locally and globally.

C4. Demonstrate appropriate critical thinking and decision-making skills when choosing a course of action based on scientific and technological information.

C5. Demonstrate curiosity, skepticism, creativity, open-mindedness, accuracy, precision, honesty, and persistence, and appreciate their importance as scientific and technological habits of mind.

E2. Describe and appreciate how the natural and constructed world is made up of systems and how interactions take place within and among these systems.

This teacher's guide provides curricular links that help identify specific connections between the learning activities in this document and Manitoba's Senior 2 Science curriculum. However, **this guide assumes that teachers have addressed the learning outcomes related to weather and climate so students are already able to define and explain these concepts and have conducted some basic investigations on weather.**

The majority of the curricular links identified in this guide relate to Cluster 4: Weather Dynamics, specifically the following two learning outcomes:

S2-4-07 Investigate and evaluate evidence that climate change occurs naturally and can be influenced by human activities.

Include: the use of technology in gathering and interpreting current and historical data.

S2-4-08 Discuss potential consequences of climate change.

Examples: changes in ocean temperature may affect aquatic populations, higher frequency of severe weather events influencing social and economic activities, scientific debate over nature and degree of change...

A third learning outcome, in Cluster 1: Dynamics of Ecosystems, may also be reintroduced during this exploration of climate change:

S2-1-10 Investigate how human activities affect an ecosystem and use the decision-making process to propose a course of action to enhance its sustainability.

Include: impact on biogeochemical cycling, population dynamics, and biodiversity.

In addition to making curricular links with the thematic clusters, this guide provides correlations for the Senior 2, Cluster 0: Overall Skills and Attitudes learning outcomes. Cluster 0 comprises nine categories of specific learning outcomes that describe the skills and attitudes involved in scientific inquiry and the decision-making process for Science, Technology, Society, and the Environment (STSE) issues. Many of these learning outcomes also incorporate key skills from English language arts and mathematics curricula. The learning activities included in this guide provide an appropriate context to introduce and reinforce these skills and attitudes. Each learning activity in this guide lists outcome reference numbers for Cluster 0. For a complete listing of the Cluster 0 learning outcomes, see Appendix 1.

Section 1:
Background

CLIMATE CHANGE: AN OVERVIEW

Introduction

Climate influences where we live, our growth, and our well-being. Each species of plant and animal has adapted to live within a specific climatic niche. Humans have adapted and expanded into more climatic niches than most other species have. Throughout history, human adaptability has been evident in customs, shelter, clothing, food preferences, agricultural practices, transportation, and settlement patterns. It is also reflected in industrial strategies, recreation, and economic policies. This is why the potential climate change due to global warming is a source of concern for all Canadians.

> We are a land of seasons: spring, summer, fall, and winter flowing in a natural rhythm. The weather of our seasons can vary dramatically from region to region. The unpredictability of our weather brings its share of searing droughts, blinding blizzards, crop-killing frosts and hail, and the destructive wrath of tornadoes and avalanches. (Environment Canada, 1995, 11)

A Brief Explanation of Climate Change

Climate change can be defined as "…a change in the average weather that a given region experiences" (Environment Canada, 1995, 11). Average weather includes elements such as temperature, wind patterns, and precipitation. In the media, the terms *global warming* and *climate change* are often used interchangeably; however, they are not the same thing. Climate change refers to general shifts in climate, including the weather elements already mentioned. These shifts may vary from region to region. Global warming (as well as global cooling) refers specifically to any change in the global average surface temperature. In other words, global warming or cooling is ONE type of planetary scale climate change.

When describing climate change, it is important to distinguish long-term from short-term change. Climate processes are influenced by a complex array of interacting elements. These include the sun, the atmosphere, the oceans, and even volcanic activity and changes in topography. The interconnectedness of these elements results in a system that can be hard to predict. In any location, temperatures, rainfall, and other climatic elements can naturally vary a great deal from one year to the next and still be considered within the bounds of normal climate variability. Therefore, one abnormally cool summer occurring after a series of warm summers does not necessarily indicate a reversal of a trend. Similarly, one unusually hot season does not by itself prove global warming is taking place. It is critical—though often difficult—to distinguish an important emerging long-term trend from an insignificant short-term irregularity in the climate pattern.

A common misconception is that global warming will cause the world to warm uniformly. In fact, an increase in average global temperature will also cause the circulation of the atmosphere to change, resulting in increased warming in some areas of the world and a less than the average warming in others. Some areas can even cool.

The question on everyone's mind is, "Has the world warmed?" The answer is, "Yes!" The average global temperature at the earth's surface has warmed by about 0.6°C since the late 19th century. Because this is an average temperature rise we know that this means the warming has been several times greater than the global average in some places, while in a few areas temperatures have actually cooled. In Canada, for example, there has been an increase in the average annual temperature of about 1°C over the period from 1895 to 1992. According to recent research results for the northern hemisphere, the 20th century is now likely the warmest century, the 1990s the warmest decade, and 1998 and 2001 the hottest years.

Issues Related to Climate Change

The natural regulating system for the temperature on the earth is known as the *greenhouse effect*. This refers to the atmosphere's role in insulating the planet from heat loss, much the way a blanket on our beds insulates our bodies from heat loss. Human activities have the potential to disrupt the balance of this natural system. As human societies become more dependent on technology, the amount of heat-trapping CO_2 and CH_4, among other gases (often referred to as greenhouse gases), in the atmosphere increases. By increasing the amount of these greenhouse gases, humankind has enhanced the warming capability of the greenhouse effect. This human influence on the natural warming function of the greenhouse effect has become known as the *enhanced greenhouse effect*. It is the human-induced enhanced greenhouse effect that causes concern. It has the potential to warm the planet at a rate that has never been experienced.

Human activity has had a direct impact on the amount of CO_2 and CH_4 released into the atmosphere. This activity includes the production and burning of fossil fuels such as coal, oil, and natural gas, and the clearing of forests for building and agricultural land. In particular, since the Industrial Revolution of the 1800s, fossil-fuel burning machines have done work that was previously done by hand and by animal power. Meanwhile, trends such as increased rice production and growing numbers of domestic animals have resulted in increased emissions of CH_4. During this time, the concentrations of CO_2 and CH_4 have increased faster than at any other time in recorded history.

Both local and global consequences are expected with rapid climatic change. In Canada, the shift in climate zones may affect the distribution of plant and animal species. Globally, a rise in sea level, which will threaten coastal cities and settlements all over the world, is possible. Another disturbing consequence of anthropogenic (human-caused) climate change is that it may permanently affect the earth's climate system. We do not fully understand the complex ways in which the elements that influence the climate such as oceans, forests, and clouds interact. "Once interrupted by the initial effects of global warming, they may not easily be restored and, therefore, may not be able to provide the same temperature regulating functions to which life on Earth has become accustomed" (Environment Canada, 1995, 13).

Future Perspectives

As stated in an earlier section, Canada has warmed by 1°C over the timespan of 1895 to 1992. However, the warming trend has not been consistent throughout this entire time. Three distinct phases are apparent in the national temperature record. These include a warming from the 1890s to the 1940s, a cooling from the 1940s to the 1970s, and a resumption of warming from the late 1970s on. The 1980s was indisputably the warmest decade on record in Canada. "The warming that has been observed in Canada over the past century is unquestionably real and significant though its intensity has varied from decade to decade, from region to region and from season to season" (Environment Canada, 1992, 4).

In 2001, the Intergovernmental Panel on Climate Change (IPCC) concluded that without coordinated global action to reduce greenhouse gas emissions, the global average surface temperature relative to 1990 is expected to rise by between 1.4 and 5.8ºC by the year 2100. Even if greenhouse gas emissions from human activities were to stop immediately, temperatures will continue to rise because the effects of past emissions will persist for centuries. It is important to note that temperature changes will occur unevenly around the world and the effects will be far from uniform. In Canada, the annual mean temperature could increase between 5 and 10ºC over the next century (IPCC, 2001, Chapter 11).

The Impact of Climate Change on the Arctic

Rapid climate change has the potential to influence climates directly all around the world, with disturbing and immeasurable environmental consequences. This is particularly true for plants and animals that do not have the ability to adapt to sudden climate changes.

One problem Canadians may have to face is land instability in the North due to the decay of the permafrost layer. Other problems may include the loss of some favourite winter sports, increased disease, pest infestations, urban smog, and summer heat stress. Shifts in global wind and rainfall patterns could affect the timing and frequency of extreme events such as droughts, forest fires, and intense storms. Lower lake levels and changes to river flow could also affect water quality. In the end, it is the unprecedented rate of change and the uncertainties associated with a new climate that make adaptation a challenge.

The "frozen North" will be less frozen as winter temperatures may rise as much as 10°C in northern latitudes. The season for heavy pack ice will be shortened and the ice will be thinner, leading to earlier spring break-up. These changes could cause problems for Aboriginal Canadians dependent on subsistence hunting as wildlife reacts to altered migration routes and habitat. In the eastern Arctic, increased glacial flow off the land will likely result in more icebergs. Reduced sea ice cover may cause problems for marine mammals, including seals, walruses, and polar bears. Fish that are dependent on ice cover and cold water would also be affected. The Arctic region is a key regulator of global climate, and reduction in sea ice and snow extent will affect not only Arctic regions, but also global climate.

Canada's vast wetlands provide important wildlife habitat for waterfowl and a host of other species. Coastal wetlands and marshes, which occur in many river estuaries and bays along both coasts, could be at risk from rising sea levels. The prairie wetlands, so important to migrating and nesting waterfowl, will be in danger of drying out. Their loss will threaten the immediate survival of many North American waterfowl species. There is also the possibility (although remote) of some new wetland habitats being created in the North as permafrost under the tundra melts.

With climate change, there will likely be more precipitation, especially in fall and winter. Snow seasons will be shorter, but the build-up of snow could bury food for northern wildlife and also result in heavy spring flooding along many northern rivers. The slow melting of the permafrost layer that underlies much of the Arctic tundra could turn the ground into a quagmire. This could affect northern transportation, since in many areas, surface travel is possible only when the ground is frozen solid. Buildings and other structures such as pipelines built directly on permafrost may become unstable as well. The way of life of tens of thousands of northern Canadians could be affected.

The Kyoto Protocol

The Kyoto Protocol is a binding agreement between industrialized countries to limit their greenhouse gas emissions by a total of 5% from 1990 levels in the five-year period from 2008 to 2012.

A global concern regarding climate change was articulated in 1988 when the World Meteorological Organization and the United Nations (UN) Environment Programme established the Intergovernmental Panel on Climate Change (IPCC). The idea of creating an agreement among industrialized countries on reducing greenhouse gas emissions to slow down the effects of these gases on climate change was first introduced in 1990. The first framework agreement on reducing greenhouse gas emissions was developed in New York in May 1992 and opened for signature at the Earth Summit in Rio de Janeiro, Brazil, in June of the same year. Canada signed and ratified this agreement, along with 50 other countries.

Conference of Parties (CoPs): Beyond the Kyoto Protocol

The countries that signed the original agreement to reduce greenhouse gas emissions then began meetings to create a document that would outline the requirements for each country on their commitment to the reduction of greenhouse gas emissions. The following timeline describes the major activities related to the Kyoto Protocol between 1995 and 2002.

- The countries first met in 1995 in Berlin, Germany, where it was decided that the original agreement was not adequate to fulfill the greenhouse gas emission target. It was decided that a new document should be created to implement the goal of a reduction in greenhouse gas emissions by a total of 5% of 1990 levels.

- The third Conference of Parties (CoP3) was held in 1997 in Kyoto, Japan, where leaders adopted the Kyoto Protocol, a binding agreement among industrialized countries to limit greenhouse gas emissions by a total of 5% from 1990 levels in the five-year period from 2008 to 2012. For the Protocol to come into effect, 55% of the countries with 55% of the emissions were required to ratify it.
- The sixth Conference of Parties (CoP6) met in The Hague, Netherlands, in 2000 to set goals for implementing the Kyoto Protocol; however, the parties were unable to come to any agreement. The source of the disagreement was the extent to which countries can obtain emission credits for activities that create greenhouse gas "sinks" such as reforestation projects and soil management practices in agriculture. The disagreement was among a group of countries that included Canada, the United States, and the European Union, called the CoP6a.
- The sixth conference was extended to a second meeting in Bonn, Germany, in 2001, but prior to the meeting, the United States, under a new presidency, announced that it was pulling out of the Kyoto Protocol; at this conference (CoP6a) a new agreement was reached that did not include the United States.
- The seventh Conference of Parties (CoP7) was held in October 2001, where parties in Marrakesh, Morocco, agreed to many of the rules under the Kyoto Protocol and the Marrakesh Accords were approved by all parties.
- The eighth Conference of Parties (CoP8) was held in October 2002 in New Delhi, India, where the discussion emphasized adaptation to climate change.

Because the study of climate change is such a rapidly developing area, it is important to stay abreast of the latest information, including developments related to the Kyoto Protocol. The following websites can assist in keeping up to date:

- Climate Change Connection (Manitoba)
  <http://www.climatechangeconnection.org/>
- International Institute for Sustainable Development (IISD)—Linkages
  <http://www.iisd.ca/linkages/climate/>
- Manitoba Energy, Science and Technology—Climate Change
  <http://www.gov.mb.ca/est/climatechange/>

TRADITIONAL ECOLOGICAL KNOWLEDGE

What is TEK?

To begin working with the knowledge held by indigenous communities, it is important to first understand what this knowledge is all about and the terms used to describe it.

> There are many terms in use to describe the body of expertise and knowledge held in indigenous communities. Among these are indigenous knowledge, traditional ecological knowledge, indigenous science, ecological wisdom, and many others. None is wholly adequate or satisfactory. (Inuit Circumpolar Conference <http://www.inuitcircumpolar.com/tek.htm>)

> Traditional [Ecological] Knowledge [TEK] or indigenous knowledge uses the information, advice and wisdom that has evolved over centuries of living as part of the environment. [TEK] is a valuable source of environmental information that allows communities to realize their own expertise, and apply their own knowledge and practices to help protect their way of life. (Minerals Management Service, Alaska OCS Region, *Traditional Knowledge* <http://www.mms.gov/alaska/native/tradknow/>)

> Recently, the Inuit of Nunavut have recognized the many levels of attachment between Inuit culture, language, and knowledge and now use the term Inuit Qaujimajatuqangit or IQ. (Inuit Tapiriit Kanatami <http://www.itk.ca/>)

People in a community who are closely connected to the local surroundings are often the first to notice environmental change. This is because their knowledge is derived from long-term observational data maintained through an oral tradition. It is for this reason that the knowledge held by the community needs to be reflected in local classrooms.

> When we think of something or discover a new fact, we also think of all the interconnections between that fact and everything else. And so it is with our science: it is going to be connected to everything within our culture. (Inuit Tapiriit Kanatami <http://www.itk.ca/english/itk/departments/enviro/tek/enviro_knowledge.htm>)

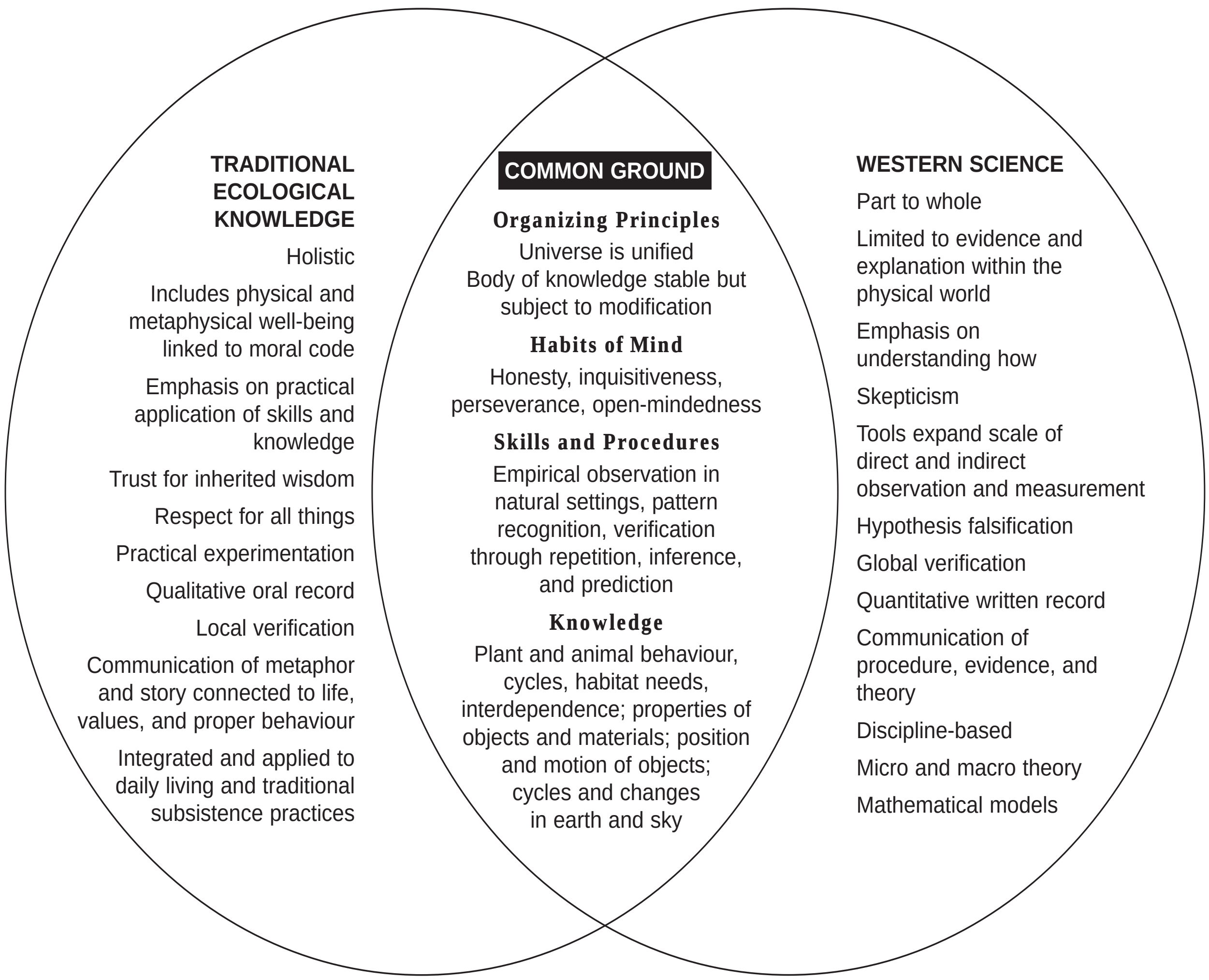
Traditional ecological knowledge (TEK) has been defined as "…the knowledge base acquired by indigenous and local people over many hundreds of years through direct contact with the environment. It includes an intimate and detailed knowledge of plants, animals, and natural phenomena, the development and use of appropriate technologies for hunting, fishing, trapping, agriculture, and forestry and a holistic knowledge, or 'worldview' which parallels the scientific disciplines of ecology" (Inglis, 1993, vi). TEK is similar in many respects to the long-term observational data that have been referred to as natural history. Natural history has contributed to the formation of environmental science, ecology, biology, geology, and geography. Two factors have resulted in a decreased emphasis on this type of data collection. One factor is the emerging importance of "hard data" (quantitative) as part of the scientific method, as opposed to the more qualitative approach of observational data collection. In addition, long-term studies are costly and funding for scientific research is limited.

While various terms can be used to describe the knowledge held by a community, for the purposes of this document the term *traditional ecological knowledge* (TEK) will be used.

TEK and Science

In order to work with TEK and science, it is important to understand their similarities as well as their differences. The following diagram helps to highlight these.

The Shared Characteristics of Traditional Ecological Knowledge and Western Science*



* Adapted, by permission, from Sidney Stephens, *Handbook for Culturally Responsive Science Curriculum* (Fairbanks, AK: Alaska Science Consortium and Alaska Rural Systemic Initiative, 2000) 11. The handbook is available on the Alaska Native Language Network website at <http://www.ankn.uaf.edu/handbook.pdf>.

Berkes (1993, 4) summarizes the differences between Western science and TEK in the following manner:

1. TEK is mainly qualitative
2. TEK is intuitive
3. TEK is holistic
4. TEK is moral
5. TEK is spiritual
6. TEK is based upon empirical observations and accumulation of facts by trial and error
7. TEK is based upon data gathered over a long period of time in the same area

Aboriginal governments value TEK and recognize that it establishes a baseline of information on the local environment. Baseline ecological information is a complete data set of the local environmental ecology and is essential for the maintenance of an environmental monitoring program. However, to date, communities have not had members educated in a system that values local knowledge. Incorporating TEK into the science classroom provides a foundation that validates the local TEK along with Western science.

Community control over the documentation of baseline ecological information is becoming recognized as a crucial component of a system that can identify the effects of human activities on the local environment. Prior to any large development project, Canadian environmental law requires the corporate sector to conduct an Environmental Impact Assessment (EIA). During this process, investigations are conducted to examine the possible environmental impact of a proposed project. Aboriginal communities have created their own programs to monitor the social implications of a development project and possible effects on traditional hunting and fishing grounds and sacred spaces (for example, the Traditional Knowledge Policy of the Northwest Territories government). Refer to Appendix 2 for more details on how TEK is being used in environmental management.

Why Incorporate TEK?

The video *Sila Alangotok—Inuit Observations on Climate Change* provides a model of how scientists can work with community members to incorporate TEK or local knowledge along with scientific knowledge to gain a better understanding of our environment. This reflects a growing awareness among Western scientists of the value of TEK and increased efforts to link it with science, particularly in the area of environmental management.

There are also many opportunities within the science classroom to incorporate and validate other knowledge systems. The *Handbook for Culturally Responsive Science Curriculum* (Stephens, 2000, 7) acknowledges that a culturally responsive curriculum

- recognizes and validates what children currently know and builds upon that knowledge toward more disciplined and sophisticated understanding from both indigenous and Western perspectives
- taps the often unrecognized expertise of local people and links their contemporary observation to a vast historical database gained from living on the land

- provides for rich inquiry into different knowledge systems and fosters collaboration, mutual understanding, and respect
- creates a strong connection between what students experience in school and their lives out of school
- can address content standards from multiple disciplines

While TEK information is not readily available in books and is specific to a local area, teachers are encouraged to incorporate TEK into science classrooms by

- inviting local people to share their knowledge about the local environment, both past and present
- discussing sites within a community or the surrounding area that may contain significance to which only the community would be sensitive
- emphasizing the value of long-term (diachronic) data, a form of information not often present in Western scientific methodology; the combination of traditional ecological knowledge with Western science techniques can only complement each other

Science Teaching and Science, Technology, Society and the Environment (STSE) Issues

STSE focuses on having students make sense of their everyday life and developing decision-making abilities that will serve them well in the present and in the future. In STSE lessons, teachers create a "need to know" attitude in students that can lead to the exploration of scientific concepts and logical reasoning skills (Aikenhead, 1999, Unit 3). Skills development in STSE is in the identification of issues, identification of stakeholders on a given issue, development of action-oriented decisions, and evaluation of the impacts of various decisions. All these skills are necessary for analyzing the complexity of STSE issues and making reasoned decisions.

Much Canadian research has been conducted on the development of educational strategies related to STSE (Aikenhead, 1980; Aikenhead, 1991; Aikenhead, 1992; Orpwood, 1985; Pedretti, 1997; Pedretti and Hodson, 1995). To incorporate TEK with Western science, development of decision-making skills is vital.

Many decision-making models are available for student use in the classroom, including the one provided in *Senior 2 Science: A Foundation for Implementation* (Manitoba Education, Training and Youth, 2001, 11–12). The Blackline Masters section in this document provides another model for the decision-making process (see BLMs 1a and 1b). This model (Aikenhead, 1999, 310–312) involves generating possible alternatives, identifying their associated values, prioritizing alternatives, and choosing and justifying an action.

Section 2:
Suggested Learning Activities

SUGGESTED LEARNING ACTIVITIES

Introduction

This section provides suggested learning activities related to the video *Sila Alangotok—Inuit Observations on Climate Change*. The activities require students to gather information from the video (activating and acquiring knowledge) and to apply and extend their learning. Students are not expected to complete all the learning activities—teachers will select learning activities that are most appropriate for their students. It is recommended that students watch the video more than once, looking for different things each time.

A. Activating Prior Knowledge

This learning activity will help students explore the importance of incorporating local observations on climate change with the work of scientists. Students will begin with an exploration of the concept of traditional ecological knowledge (TEK). The questions from BLM 2 may be used after the video has been viewed or in conjunction with a cooperative learning activity. Suggestions for cooperative learning strategies are provided in this teacher's guide, as well as in the *Senior Years Science Teachers' Handbook* (Manitoba Education and Training, 1997, Chapter 3)—hereafter referred to as *SYSTH*.

Objectives

The students will

- describe why TEK is becoming increasingly important
- activate their thinking related to why observations made by community members may be important to an understanding of climate change
- identify individual actions that may reduce climate change

Senior 2 Learning Outcomes

Knowledge:

S2-4-08 Discuss potential consequences of climate change.

Examples: changes in ocean temperature may affect aquatic populations, higher frequency of severe weather events influencing social and economic activities, scientific debate over nature and degree of change...

Skills and Attitudes:*

S2-0-2a

S2-0-3f

S2-0-8e

S2-0-9f

***Note:** Refer to Appendix 1 for a complete listing of the skills and attitudes outcomes.

Materials

Video: *Sila Alangotok—Inuit Observations on Climate Change*

BLM 2: Video-Related Questions

Appendix 2: Aboriginal Traditional Knowledge and Environmental Management (page 57 only)

Procedure

Opening Question: How can local people's observations be important to scientists as they try to understand climate change?

Part 1: Introduction to Traditional Ecological Knowledge (TEK)

1. Provide students with an intentionally provocative statement such as the following to generate discussion.

   "Aboriginal people's traditional knowledge of the local environment is of great value to scientists today."

   Have students decide whether they personally agree or disagree with the statement and share their views with a partner. The partners discuss their views until they are able to reach consensus. Each pair then joins another pair, repeating the process of sharing and discussing views until they reach consensus.

2. Provide students with the first page of the article "Aboriginal Traditional Knowledge and Environmental Management" (Appendix 2, page 57). After students have read this page, have them complete the following reflection:

   "What surprised me about the article was . . ."

   "What I found particularly interesting about the article was . . ."

Part 2: Video-Related Questions

Have students answer the questions on BLM 2. Suggested responses are provided below for teacher reference.

1. What were some of the observations of climate change made by the community members of Sachs Harbour?

   Some of the changes noted in the video are:
   - *change in temperature*
   - *flies everywhere*
   - *delayed freeze-up*
   - *thunderstorms*
   - *shorter fall and slower freeze-up*
   - *boating in November*
   - *no icebergs in summer*
   - *geese stay for a shorter length of time in spring*
   - *melting faster each spring*
   - *warmer summer*
   - *warmer water*
   - *different insects*
   - *severe storms*
   - *deformed muskox*
   - *erosion*
   - *damage to buildings*

2. Why may the observations of Inuit Elders and community members be important in a discussion of climate change?

   The Elders and community members make observations on a day-to-day basis; therefore, they may observe subtle changes in the local environment. The observations of Elders and community members are based upon their activities related to subsistence living and therefore may not be apparent to a scientist. Scientists usually study a local area for a short period of time (although satellites may change some of these studies and may help with longer-term observations). The observations of community members have been passed down from generation to generation, and have helped community members plan for the arrival of animal and plant species they rely upon for their subsistence. The observed changes in these events are indicators of climate change.

3. How do the observations of Inuit Elders and community members contribute to the understanding of natural climate change and climate change associated with human activities?

   The observations of Elders and community members have been collected over a long period of time, well before the Canadian government began recording and documenting the local weather. These observations are passed down through oral tradition and have resulted in a lifestyle that is dependent upon the timing of environmental occurrences that are in turn dependent upon a predictable climate. The observations of Elders can provide baseline information to compare to current observations.

4. What are some actions you might take (as an individual or as part of a group) to reduce climate change?

   - ***Individual***
     - *reduce gas emissions: reduce recreational snowmobiling*
     - *reduce energy use: turn lights off when leaving a room, set thermostats to lower levels when leaving home*
     - *recycle*
   - ***Group***
     - *reduce gas emissions: reduce recreational snowmobiling, carpool, use public transportation, walk, cycle*
     - *reduce consumption of non-renewable resources: install programmable thermostats and adjust temperature as required*
     - *set up a recycling program*

The final question can serve as a starting point for student research in this area. The results can take a variety of forms, such as posters, oral presentations, newspaper articles, and drama, which can be shared with the class, the school, and the community.

B. Concept Map and Debate

Concept maps help students actively create a visual representation of the relationships between and among concepts in a piece of information. An explanation of the concept map and its uses is available in *SYSTH* (Manitoba Education and Training, 1997, Chapter 11). In this learning activity, groups of students will create a concept map of the key concepts introduced in the video. Once each group has created a concept map, students will apply the information by participating in a debate. Strategies for debating in the classroom can be found in *SYSTH* (4.19).

Objectives

The students will

- identify the relationship between climate- and community-based resources
- define climate
- synthesize information from a media source
- apply information gathered from a resource in the form of a debate

Senior 2 Learning Outcomes

Knowledge:

S2-4-08 Discuss potential consequences of climate change.

Examples: changes in ocean temperature may affect aquatic populations, higher frequency of severe weather events influencing social and economic activities, scientific debate over nature and degree of change...

Skills and Attitudes:*

S2-0-2a, S2-0-2b, S2-0-2c

S2-0-3d, S2-0-3e , S2-0-3f

S2-0-4f, S2-0-4g

S2-0-7c, S2-0-7e, S2-0-7f

***Note:** Refer to Appendix 1 for a complete listing of the skills and attitudes outcomes.

Materials

Video: *Sila Alangotok—Inuit Observations on Climate Change*

BLM 1b: Decision-Making Chart

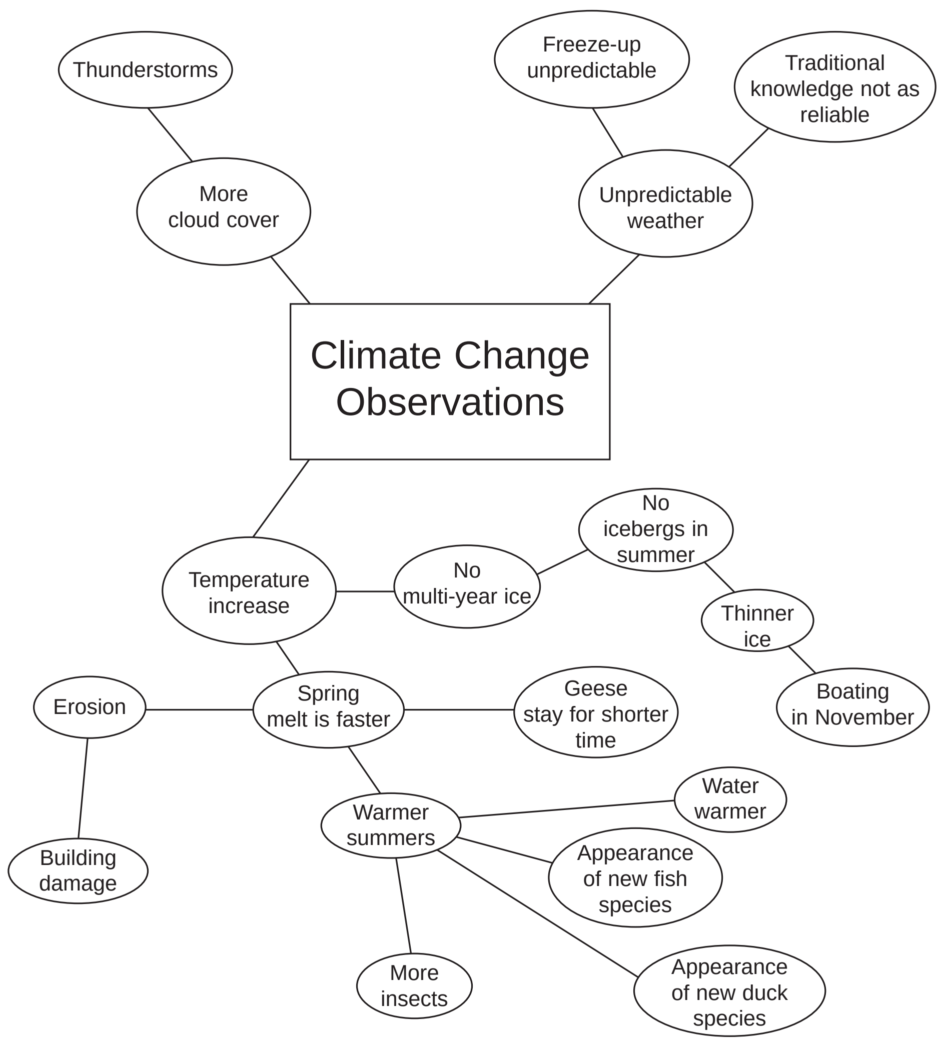
Procedure

Opening Question: Based on your knowledge of the factors that contribute to climate, how do you think climate change will affect northern Canada?

Concept Map

1. Before showing the video, divide students into groups (groups of four work well). Let students know that each group will be required to create a concept map that summarizes the key concepts related to how climate change will affect northern Canada. Have the groups assign roles such as recorder of group discussion and key concepts, concept map recorder, lead debater (for the next part of the activity), and moderator. Give the groups a few minutes to assign roles and decide how they will record the information while viewing the video.
2. Show the video.
3. Provide each group with chart paper and markers. Allow 15 to 20 minutes for groups to share their individual notes and create a flip chart summary.

Sample Concept Map



Note: The concept maps are used as sources of information for the debate that follows.

Debate

1. Divide the class into two groups by combining the concept map groups to create two sides for the upcoming debate.
2. Write the following statement on the board/overhead:

The observations of one community member complement and add to the understanding of climate change.

3. Each group appoints a lead debater. The rest of the group members support their team’s lead debater. One group must be in favour of the statement; the other must argue against the statement. Students might use the Decision-Making Chart (BLM 1b) to help them organize their thoughts.
4. Conduct the debate as follows:
   a. Each lead debater delivers a two-minute introductory argument for his or her team’s position.
   b. Allow five minutes for teams to prepare a one-minute response.
   c. Each lead debater delivers the final one-minute response.

   Note: Refer to *SYSTH* (Manitoba Education and Training, 1997, 4.19) for more information on holding a debate in a science classroom.

Assessment

Have students write a reflective piece on their perceptions of the video and on their participation in the concept mapping and debating activities.

Sample Reflective Questions: How did the observations of the community members in Sachs Harbour enhance the research team’s understanding of climate change?

Sample Self-Assessment: How did you contribute to the debate? What could you improve for the next time? What strengths in debating do you have? What will you retain for the future?

C. Trip Reports Jigsaw

Trip reports were developed to help document the process used to gather observations made by the people of Sachs Harbour related to climate change. (Trip reports are found on the International Institute for Sustainable Development website at <http://www.iisd.org/casl/projects/inuitobs.htm>).

Typical information for each report included the following:

- purpose of the trip and a comment on the trip’s success
- team members
- schedule of activities (broken down into video group activities and science group activities for trips 2 to 5)
- specifics related to the tasks and success of each trip
- next steps
- budget commentary

The trip reports include a wealth of information on the process used by the project team, as well as the specific findings.

In this learning activity students will use a cooperative learning strategy called a Jigsaw to identify and analyze the methods used by the project team to gather information in the community of Sachs Harbour. For more details on the Jigsaw strategy or other cooperative learning strategies, refer to *SYSTH* (Manitoba Education and Training, 1997, Chapter 3).

Objectives

The students will

- evaluate information drawn from a variety of sources
- synthesize information on climate change obtained from a report
- identify and evaluate methods used by scientists to obtain information

Senior 2 Learning Outcomes

Knowledge:

S2-4-08 Discuss potential consequences of climate change.

Examples: changes in ocean temperature may affect aquatic populations, higher frequency of severe weather events influencing social and economic activities, scientific debate over nature and degree of change...

Skills and Attitudes:*

S2-0-2a, S2-0-2c

S2-0-4f, S2-0-4g

S2-0-7f

S2-0-8e

S2-0-9c

***Note:** Refer to Appendix 1 for a complete listing of the skills and attitudes outcomes.

Materials

Video: *Sila Alangotok—Inuit Observations on Climate Change*

Trip Reports (obtained as PDF files from <http://www.iisd.org/casl/projects/inuitobs.htm>): Enough for each group

BLM 2: Video-Related Questions

BLM 3: Trip Report Summary

BLM 4: Trip Report: Reflection Questions

Appendix 2: Aboriginal Traditional Knowledge and Environmental Management (page 58 only)

Procedure

Part 1: Research

Prior to this learning activity, ensure that students have viewed the video and answered questions 1 to 3 from BLM 2.

1. Have students, in groups of four, share their responses to questions from BLM 2. These groups are the "home" groups.
2. Have students in each home group number themselves from 1 to 4. Students then rearrange into "expert" groups (all "1" members together, all "2" members together, etc.). Each expert group is assigned a trip report and is responsible for summarizing and describing the purpose, objectives, methods, and findings for their trip report, using BLM 3.
3. Students return to their home groups to present the information gathered in their expert groups.

Part 2: Trip Report: Reflection Questions

Have each home group complete the questions from BLM 4. Suggested responses are provided below for teacher reference.

1. List the methods used to gather information in the Sachs Harbour community.
   - *Group discussion/brainstorming*
   - *Interviews (both short and general in nature and longer and more specific in nature)*
   - *Scientific measurements*
   - *Videotaping on-the-land activities*
2. The science group found that interviews were a valuable method of gathering information. Summarize the benefits of this methodology.
   - *Gave the initial observations more detail*
   - *Allowed for the separation of climate-related observations from non-climate-related observations*
   - *Placed observations in time and space*
   - *Identified the context of the observations*
   - *Allowed for identification of which community members were observing which phenomena*
   - *Identified which community members were most knowledgeable about climate change*
   - *Helped secure species identifications*
   - *Generally, interviews provided the most detailed information*
3. Using the information from the video and the trip reports, discuss with your group whether the scientists gained valuable information about climate change through this project. Develop a statement that justifies, to funding groups, the use of this costly and time-consuming method of gathering information about climate change from other communities.
   - *Responses should refer to the fact that interviews generate the most detailed and accurate information.*

Part 3: Application

Have each group imagine they are responsible for organizing a “trip 5.” Using the information from trips 1 to 4 and lessons learned, each group will outline the purpose and objectives for the trip and the methods to be used. A set of interview questions should also be developed.

Responses will vary. The purpose and objectives can target a particular area of students’ interest, or a perceived gap in the project to date. For example, information related to the fall season has not been gathered. Methods should include interviews and on-the-land observations/video recording.

Extension

Have students read the second page of the article "Aboriginal Traditional Knowledge and Environmental Management" (Appendix 2, page 58). Have them identify specific examples of how traditional knowledge gathered through interviews has been used.

Sample Summaries of Each Trip

Detailed reports of the four trips that the project team made to Sachs Harbour are available on the International Institute for Sustainable Development website at <http://www.iisd.org/casl/projects/inuitobs.htm>. Summaries of these trips are provided on the following pages for teacher reference.

Trip Report Summary
(For Teacher Reference)

Trip Report Number: 1

Purpose and Objectives:

- Describe the project to the Inuit community.
- Hold planning workshops so that local people can describe their livelihood system.
- Videotape the planning workshop.
- Videotape location shots of the community.
- Plan an article on the contribution of local observation and traditional knowledge to climate change research.

Methods:

The project team met to discuss the trip objectives and the details of the scheduled activities. Prior to holding the workshop, the team was introduced to community Elders by a community member, Rosemarie. The majority of adults in Sachs Harbour attended the workshop—over 30 people in all.

During the workshop, six different activities took place:

- **Issue identification:** Issues were identified by the community.
- **Cause-effect analysis:** Issues were arranged into "trees" or priority areas.
- **Timeline:** Community members and Elders charted the changes in the environment back through time.
- **Ranking:** Participants used coloured dots to prioritize the climate change effects.
- **Annual calendar:** Participants created a circular representation of yearly events and traditional activities.
- **Trip planning:** Participants selected the best time for videotaping and interviews.

Findings:

Observations recorded during the first trip:

- **Changes in birds:** The community provided observations of bird species that had not been present in the past.
- **Changes in marine animals:** Community members observed new species such as salmon and herring and an increase in deformed fish; rock cod was observed to be on the decline.
- **Changes in land animals:** The caribou population was smaller and contained fewer large males; the muskox population had increased, but with higher incidences of deformities than in the past; polar bears left their dens earlier and moved further away from the community; the wolf population had increased; the rabbit population had decreased; a new type of black/red fox was observed.
- **Changes in insects:** Increased number and diversity of insects, increased number of mosquitoes, and longer mosquito season were observed.
- **Changes in weather patterns:** Milder winters, warmer summers, shorter fall, and slower freeze-up were observed; increased rain, summer hail, and occurrence of thunder and lightening were observed; fluctuations in the seasons were noted, particularly an earlier arrival of spring.

Trip Report Summary

Trip Report Number: 2

Purpose and Objectives:

- Videotape Inuit as they perform traditional activities such as sealing and fishing during the short Arctic summer, when the coastline is free of ice.
- Videotape changes to the environment such as shoreline slumping caused by melting permafrost, and appearance of new animal and insect species.
- Videotape interviews with community members about changes in their environment due to climate change and effects of these changes on their livelihood and their ability to adapt to these changes.
- Audiotape longer interviews with selected community members to gather data for the project's journal article.

Methods:

- The videotaping group recorded the seal hunt, the melting permafrost, net fishing, interviews with Elders and the science group, and wildlife shots.
- The science group conducted interviews with community Elders and hunters. The interviews focused on observing the effects of climate change on the summer season, and were structured using the initial workshop as a guide. This group focused on three areas: the traditional knowledge, the relevance of the knowledge to research on climate change, and the development of a process for better communication of Inuit traditional knowledge.

Findings:

By following up on the initial observations from the first trip, the science group found that the interviews

- gave initial observations more detail
- allowed for the separation of climate-related observations from non-climate-related observations
- placed the observations in time and space
- identified the context of the observations
- allowed for the stratification of observations and identification of community members observing phenomena
- identified which community members were most knowledgeable about climate-related change and traditional activities
- gave insight on indicators of change, as used by community members
- helped to secure unclear bird and fish identifications

Trip Report Summary

Trip Report Number: 3

Purpose and Objectives:

- Videotape Inuit as they perform traditional activities during the winter.
- Videotape the environment in the winter.
- Videotape short interviews with community members about changes to their environment that may be caused by increased climate variability, about effects of these changes on their livelihood, and about their ability to adapt.
- Record longer, more in-depth interviews with selected community members.

Methods:

- The group videotaped several sequences, including: wildlife, interviews with community members at winter camp, a traditional muskox harvest, polar bear fleshing, and ice gathering.
- The science team conducted 13 interviews, which built upon enhanced observations and knowledge of climate-related change.

Findings:

Points made after the interviews:

- There is an abundance of knowledge in the community relating to historical and current wildlife populations, their behaviour and health, and the relationship between weather and wildlife.
- Climate-related change is complicated by factors such as harvesting patterns.
- Knowledge of active harvesters contributes to current science-based knowledge of wildlife and climate change.
- While the specific impacts of climate change on wildlife populations may be difficult to assess, it is clear that any wildlife-related changes will also affect the community.

Trip Report Summary

Trip Report Number: 4

Purpose and Objectives:

- Videotape Inuit as they perform traditional activities during the spring and videotape the environment in the spring.
- Videotape short interviews with community members about changes to their environment that may be caused by increased climate variability.
- Record longer, more in-depth interviews with selected community members.

Methods:

- The team videorecorded interviews with community members, taped members running a dogsled team across the frozen ocean, and taped interviews with
  – Rosemarie and Sarah Kuptana
  – Roger Kuptana on observed climate change
  – Stephen Robinson, a geoscientist, on the increased melting of the permafrost
  – other community members on the changes in the shoreline
- The science team interviewed nine community members. The interviews were informal and flexible. All the interviews emphasized permafrost and springtime changes. The interviews also looked at spring seasonal activities such as goose hunting and ice fishing. The science team had community members bring them to places on the land where changes were occurring.

Findings:

The science team drew the following conclusions:

- There is an abundance of knowledge in the community related to historical and current landforms, erosion activity, and permafrost conditions. The knowledge is closely tied to the activities of community members. The community members were able to tell the difference between natural and abnormal climate and erosion processes; the melting permafrost has had less impact on community activities than the rapid spring melt and delayed winter freeze-up have had; the community members discussed the permafrost and its changes using additional variables such as wind, precipitation, temperature, and human activity.

D. The Impact of Climate Change on the Arctic

There are similarities between the observations the Elders and community members made regarding climate change and the projections suggested by Western scientists. The "Executive Summary" in *Responding to Global Climate Change in Canada's Arctic* (Maxwell, 1997, xiv–xvii), summarizes the possible impacts. In this learning activity students will examine climatic change and the projections of Western scientists, along with the observations made in the video.

The next step is to have students think about how they could design a questionnaire or survey to find out the climate change observations of their own community. In Senior 2 English language arts, students are expected to design questionnaires or survey instruments. Some strategies to assist students in developing these instruments can be found in *Senior 2 English Language Arts: A Foundation for Implementation* (Manitoba Education and Training, 1998, Senior 2–220).

Objectives

The students will

- compare and contrast the predictions made by scientists with observations made by Inuit Elders and community members
- design an instrument that will summarize observations on climate change in their own community

Senior 2 Learning Outcomes

Knowledge:

S2-4-07 Investigate and evaluate evidence that climate change occurs naturally and can be influenced by human activities.

Include: the use of technology in gathering and interpreting current and historical data.

S2-4-08 Discuss potential consequences of climate change.

Examples: changes in ocean temperature may affect aquatic populations, higher frequency of severe weather events influencing social and economic activities, scientific debate over nature and degree of change...

Skills and Attitudes:*

S2-0-2a, S2-0-2c

S2-0-4f, S2-0-4g

S2-0-7f

S2-0-8e

S2-0-9a

***Note:** Refer to Appendix 1 for a complete listing of the skills and attitudes outcomes.

Materials

Video: *Sila Alangotok—Inuit Observations on Climate Change*

Appendix 3: Responding to Global Climate Change in Canada’s Arctic (Executive Summary)

BLM 5: Impact of Climate Change on the Arctic

Procedure

Opening Question: Based on your knowledge of the factors that contribute to climate, how do you think climate change will affect northern Canada?

1. As students view the video, have them record (in the first column of BLM 5) all comments made by community members and Elders regarding their observations on climate change in the Sachs Harbour community.

2. Before students read the “Executive Summary” report, discuss the concepts of “direct” and “indirect” impacts of climate change.

3. Have each student then examine the “Executive Summary” report and identify the direct and indirect impacts of climate change by underlining direct impacts once and double underlining indirect impacts. Using this information, students then complete the remaining columns of BLM 5. Student responses will vary.

4. Have students pair up and share their tables with one another, filling in any missing information.

5. Have students complete questions 1 to 3 on BLM 5.

   Note: Sample answers are provided on the following pages for teacher reference.

Sample Answers (for Teacher Reference)

The Impact of Climate Change on the Arctic*

Video—Community Information	Report—Scientists' Information	
	Direct Impacts	Indirect Impacts
Temperature		
– permafrost changes, landslides depicted in the video, discussion of the disappearance of sea ice when collecting fresh water – the open water season – increased change in temperature – later freeze-up – thunderstorms – shorter fall and slower freeze-up – boating in November; no icebergs in summer – geese stay shorter time in spring – melting faster each spring – warmer summer – warmer water	– winter temperature will increase 5 to 7ºC over the mainland and up to 10ºC over Hudson Bay – summer temperature will increase up to 5ºC over the mainland and 1 to 2ºC over Hudson Bay	– increased evaporation, may affect vegetative cover – reduction in flows of rivers – over half the discontinuous permafrost will disappear eventually and boundary will shift northward – increase in shallow landslides – sea ice occurrence will decline – open water season will increase – river ice season will be reduced
Precipitation		
– increase in appearance of insects and greater diversity of insects – deformed muskox – erosion	– increases in precipitation of up to 25% will be spread throughout the year over most of the Arctic	– biome distribution will change – ecosystem composition will change and species diversity will decrease – increase in forest fires, more insects, and longer growing season – populations of caribou may decline due to increase in pests and decrease in availability of forage – shift in distribution of species northward

(continued)

* Climate change data is based on Environment Canada's reports of the Canada Country Study, which assessed the impacts of climate change on the different regions of Canada.

Sample Answers *(continued)*

Video—Community Information	Report—Scientists' Information	
	Direct Impacts	**Indirect Impacts**
	Infrastructure	
	– increased cost in general operations in the Arctic – expansion of roadways – longer shipping season – increased maintenance costs of roadways – reduced power demand for heating and insulation – increased length of construction season – increased length of tourism season	
	Society	
	– traditional knowledge and local adaptations of people may no longer be applicable – health of northerners may be affected	– the weather is no longer predictable based upon traditional ecological knowledge
	Animal and Plant Populations	
	– decline in age and girth of trees – increase in harvests of most fish species	– greater diversity of fish species – catching salmon where salmon were never found before

Sample Answers—BLM 5

1. Note similarities and differences between observations of community members and information from scientists.
   a. Summary of Similarities:
      – *Both information sources provide details related to the landscape and plant and animal species.*
      – *The actual observations reported by the community members relate directly to the predictions made by scientists.*
   b. Summary of Differences:
      – *Not all the scientists' predictions have been observed at this time.*
      – *Community members have observed additional changes that were not included in the scientists' predictions (e.g., deformed species on the rise, greater diversity of species now found).*
      – *The community members did not talk about infrastructure changes.*

Note: Not all the changes observed by community members are necessarily attributable to climate change.

2. Do you think it is important to include information from both scientists and community members when trying to understand something as complex as climate change? Why or why not?

   Answers will vary. Students should recognize the importance of both types of information.

3. Brainstorm two other situations where it would be important to gather information from both scientists and local community members (e.g., To see the impacts of...).

   Answers will vary. Possibilities include:

   – *To see the impacts of a hydro dam development, forestry project, oil pipeline, etc.*

E. Examining the Environmental, Economic, and Social Consequences of Climate Change in the North

Climate change is not only an environmental issue—it also has economic and social implications. Social factors include physical, psychological, spiritual, and social health. In this learning activity students will explore possible social, economic, and environmental consequences of climate change on the community members of Sachs Harbour.

Objectives

The students will

- brainstorm the possible consequences of climate change on northern communities by looking at environmental, economic, and social factors
- use a variety of sources to investigate the consequences of climate change on northern communities

Senior 2 Learning Outcomes

Knowledge:

S2-4-07 Investigate and evaluate evidence that climate change occurs naturally and can be influenced by human activities.

Include: the use of technology in gathering and interpreting current and historical data.

S2-4-08 Discuss potential consequences of climate change.

Examples: changes in ocean temperature may affect aquatic populations, higher frequency of severe weather events influencing social and economic activities, scientific debate over nature and degree of change...

Skills and Attitudes:*

S2-0-1d

S2-0-2a, S2-0-2c

S2-0-5d

S2-0-7f

***Note:** Refer to Appendix 1 for a complete listing of the skills and attitudes outcomes.

Materials

Video: *Sila Alangotok—Inuit Observations on Climate Change*

Materials for presentations, as required

Procedure

Opening Question: Based on your knowledge of the factors that contribute to climate, how do you think climate change will affect northern Canada?

1. Place students in pairs. Have each pair brainstorm and record possible consequences of climate change in northern communities by looking at environmental, economic, and social factors.
2. Introduce the video. Have students watch the video and record, on a separate piece of paper, any additional consequences.
3. Have each pair choose a format for presenting the information they have gathered. Possible formats include a poster, rap, poem, illustration, and newspaper article.
4. Have each group present their findings to the class.

Sample Brainstorming Record of Possible Consequences of Climate Change in Northern Communities*

Environmental	Economic	Social
Temperature – winter temperature will increase 5 to 7ºC over the mainland and up to 10ºC over Hudson Bay – summer temperature will increase up to 5ºC over the mainland and 1 to 2ºC over Hudson Bay **Precipitation** – increases in precipitation of up to 25% will be spread throughout the year over most of the Arctic – increased evaporation may affect vegetative cover – reduction in river flows – over half the discontinuous permafrost will disappear eventually and boundary will shift northward – increase in shallow landslides – sea ice occurrence will decline – open water season will increase – river ice season will be reduced – biome distribution will change – ecosystem composition will change and species diversity will decrease – increase in forest fires – more insects – longer growing season – populations of caribou may decline due to increase in pests and decrease in availability of forage – shift in distribution of species northward	– increased cost in general operations in the Arctic – decreased accessibility of ice roads (a major infrastructure in the North in the winter) – expansion of roadways – increased maintenance costs of roadways – longer shipping season – loss of equipment due to weakened ice roads (a major problem for oil and gas companies) – in the past, ice roads did not need to be flooded as there was enough natural ice formation; now the ice roads need to be flooded to get them thick enough to travel on – reduced power demand for heating and insulation – increased length of construction season – increased length of tourism season – decline in age and girth of trees – increase in harvests of most fish species	– traditional knowledge and local adaptations of people may no longer be applicable – disruption of traditional knowledge systems – disruption of traditional lifestyles/livelihoods – health of northerners might be affected – relocation of communities due to permafrost erosion, especially along the coasts – loss of life (increasingly dangerous to travel on the ice) – more frequent and intense storms increase danger for people in boats along the Beaufort Sea, etc.

* Climate change data is based on Environment Canada’s reports of the Canada Country Study, which assessed the impacts of climate change on the different regions of Canada.

F. The Arctic Ecosystem and Climate Change Observations

In the video, members of the Sachs Harbour community speak of several animal and plant species that are specifically being affected by the change in climate. In this learning activity, students will explore the habitats of a variety of Arctic species by using information available on Environment Canada's website and by predicting some possible impacts of climate change on animals. If desired, the exploration can be adapted to suit the geographic area of the students. In First Nations communities an additional interview component can be incorporated into this exploration by encouraging students to document and record the observations of Elders and hunters on climate change in their own research. Suggestions for a town meeting like the one shown in the video are included at the end of this exploration.

Note: One of Manitoba's recommended resources *Science 10* (Ritter, et al., 2001, 637-638) includes an introduction to issues involving global warming in Canada.

Objectives

The students will

- explore the habitat of species in the Arctic ecosystem and identify the requirements for these species to survive
- predict the possible impacts of climate change on the habitats of Arctic species
- research observations on the impacts of climate change on the habitats of Arctic species

Senior 2 Learning Outcomes

Knowledge:

S2-1-10 Investigate how human activities affect an ecosystem and use the decision-making process to propose a course of action to enhance its sustainability.

Include: biogeochemical cycling, population dynamics, and biodiversity.

Skills and Attitudes:*

S2-0-2a, S2-0-2b, S2-0-2c

S2-0-7e

S2-0-9c

***Note:** Refer to Appendix 1 for a complete listing of the skills and attitudes outcomes.

Materials

Video: *Sila Alangotok—Inuit Observations on Climate Change*

Hinterland Who's Who information sheets of various Arctic species, available from Environment Canada, Canadian Wildlife Service website at <http://www.cws-scf.ec.gc.ca/hww-fap/index_e.cfm>. Suggested species: Canada goose, common eider, greater and lesser snow goose, ptarmigans, whooping crane, Arctic fox, caribou, moose, muskox, polar bear, snowshoe hare, and wolf.

Procedure

Opening Question: Based on your knowledge of the factors that contribute to climate, how do you think climate change will affect the animal populations in northern Canada?

1. Assign each student to a group of four to six students. Each group member will select an Arctic species to research. Have the class decide which features of the habitat each group must examine for their species.
2. Allow students time to research.
3. Have each group member present and discuss his or her research with the rest of the group. Have each group compile a summary of information about their group's species.
4. Have the group predict the possible impacts of climate change on their species. These will be conjectures or hypotheses about how climate change may affect their species.
5. Have students view the video and identify all the species that the Inuit Elders and community members mention as being affected by the observed climate changes in Sachs Harbour.
6. Have students record the observations that scientists, Inuit Elders, and community members made about their selected species and add this information to their research.
7. Have each group create a food web composed of the species studied in their group and create a poster of the food chain that includes explanations of the impact of climate change.
8. Conduct a Gallery Walk of the posters, with peer-assessment sheets for each group. Place a pad of self-adhesive paper at each site so that students can write immediate comments and feedback for their peers and then attach the notes to the poster.

Incorporating Local Knowledge

Some schools may be in a community where students have the opportunity to interview local hunters, trappers, and Elders to help them comprehend the knowledge held within their own community about animal species and climate change. If this is the case, extend this lesson by incorporating an interview component. Have students brainstorm the questions they would ask a hunter or Elder about the changes observed in the local environment. With the students, create an interview protocol they could follow for this investigation and include a discussion of appropriate ways to approach an Elder and ask for information.

Have students include this information on their posters and invite the community members who participated to view the posters. Have students record all the comments made by the community members about their poster and reflect on these comments.

G. Development Project: A Decision-Making Activity

The decision-making process encourages students to evaluate science and technology issues in the context of society and the environment. In the following learning activity, student groups make decisions related to a specific role they will play in a mock open house moderated by the teacher. The objective of the open house is to complete the decision-making process with the input of all the stakeholders. This will be a challenge for the students and the teacher.

Objectives

The students will

- identify the impact of a proposed economic development project on an Arctic community and on climate change
- use the decision-making process to develop a plan regarding a proposed economic development project in an Arctic community

Senior 2 Learning Outcomes

Knowledge:

S2-1-10 Investigate how human activities affect an ecosystem and use the decision-making process to propose a course of action to enhance its sustainability.

Include: biogeochemical cycling, populations dynamics, and biodiversity.

Skills and Attitudes:*

S2-0-1d

S2-0-2a, S2-0-2b, S2-0-2c

S2-0-3d, S2-0-3e, S2-0-3f

S2-0-4f, S2-0-4g

S2-0-5d

S2-0-6d

S2-0-7c, S2-0-7e, S2-0-7f

***Note:** Refer to Appendix 1 for a complete listing of the skills and attitudes outcomes.

Materials

BLM 6: Role Cards for Conference Members

BLMs 1a and 1b: Decision-Making Process and Decision-Making Chart

Access to the Internet

Role-Playing

Scenario

A large oil and gas exploration company named Ready Gas, in partnership with Inuit Oil and Gas, has recently applied to drill for oil close to an Inuit community. This type of partnership is now required for southern-based companies before proceeding to oil exploration and extraction in Canada's North. The oil that is extracted will be sold to the United States, where there is an oil shortage. In the application, Ready Gas agrees to employ community members for the construction of buildings and train community members for the maintenance of the drill. To determine whether the exploration application should be approved, the federal government is holding an open house to give the stakeholders a chance to present their opinions and suggest outcomes regarding the impact the oil project will have on the community and the environment.

1. Have students brainstorm and identify the possible stakeholders that may be involved in the open house.
2. Divide the class into pairs or groups of three. Give one role card (see BLM 6) to each group (or develop role cards as a group). Each group will evaluate the impact of climate change from the perspectives of different stakeholders in the debate by using the decision-making process.
   a. Have students use the Decision-Making Chart (BLM 1b) to identify as many alternatives as they can from their own perspective (based on their role).
   b. Have each group try to predict alternatives that may be proposed by other groups. These should be added to the chart.
   c. Each group should then complete the risk/benefit analysis, logic check, values identification and prioritizing, and action recommended.

   Note: Students will need to research the various perspectives and courses of action they might propose.
3. The objective of the open house will be to generate a possible course of action that will include the action guidelines and an implementation timeline.
4. Hold a mock open house of delegates. The person presiding over the discussions will play the role of the Prime Minister of Canada.
5. Have students reflect on the process involved in the conversations and debates that may have occurred during the open house.

H. Creating a Community Plan to Reduce Greenhouse Gas Emissions

Many cities and towns across Canada have developed their own plans to reduce greenhouse gas emissions. The Federation of Canadian Municipalities (FCM) has actively encouraged the reduction of greenhouse gases of municipal governments. In 1995, the FCM established its "20% Club," which challenged communities to reduce their greenhouse gas emissions by 20% below 1990 levels by 2005. The cites of Ottawa, Toronto, Regina, Edmonton, and Vancouver were the founding members of the 20% Club. The Club has now evolved into the Partners for Climate Protection Program, a joint initiative with the International Council for Local Environmental Initiatives.

For more information see:

- The International Council for Local Environmental Initiatives <http://www.iclei.org/>
- The Federation of Canadian Municipalities <http://www.fcm.ca/newfcm/>

Some local governments have developed community plans that address the reduction of greenhouse gas emissions. The FCM website presents case studies of small northern communities committed to designing community plans that reduce greenhouse gas emissions (e.g., the Oujé-Bougoumou community, Québec; the village of Fort McPherson, Northwest Territories; and the town of Fort Smith, Northwest Territories).

The following learning activity will ask students to explore the initiatives of their local municipal government and design an action plan for their community to reduce greenhouse gas emissions. This activity can be adapted by having students design an action plan for their school rather than their community. The principal or a board member could present information on ways in which the school reduces greenhouse gas emissions.

Note: It is assumed that students have completed a study of weather and climate, specifically greenhouse gases, prior to conducting this learning activity.

If students conducted the previous learning activity, they will have had some exposure to the decision-making process. If not, review the decision-making process prior to this exploration.

Objectives

The students will

- explore the initiatives of their local community to reduce greenhouse gas emissions
- identify possible initiatives that could be taken to reduce greenhouse gas emissions in their local community
- design an action plan to implement initiatives to reduce greenhouse gas emissions
- design a method to evaluate an action plan
- present the action plan to the class

Senior 2 Learning Outcomes

Knowledge:

S2-1-10 Investigate how human activities affect an ecosystem and use the decision-making process to propose a course of action to enhance its sustainability.

Include: impact of biogeochemical cycling, population dynamics, and biodiversity.

S2-4-07 Investigate and evaluate evidence that climate change occurs naturally and can be influenced by human activities.

Include: the use of technology in gathering and interpreting current and historical data.

Skills and Attitudes:*

S2-0-2a

S2-0-3d, S2-0-3e, S2-0-3f

S2-0-4e, S2-0-4f, S2-0-4g

S2-0-5d

S2-0-6d

S2-0-7c, S2-0-7d, S2-0-7e, S2-0-7f

***Note:** Refer to Appendix 1 for a complete listing of the skills and attitudes outcomes.

Materials

Internet access for exploration of local community initiatives to reduce greenhouse gas emissions and the initiatives taken by other communities

Presentation by a local community government member(s) on the initiatives taken to reduce greenhouse gas emissions

Video: *Sila Alangotok—Inuit Observations on Climate Change*

BLMs 1a and 1b: Decision-Making Process and Decision-Making Chart

Procedure

Opening Question: How do you think you can contribute to reducing your community's greenhouse gas emissions?

1. Have students watch the video *Sila Alangotok—Inuit Observations on Climate Change*. During the video presentation, have students identify the impacts of climate change on Sachs Harbour.

2. Have students review what they have learned in previous science lessons about greenhouse gases and brainstorm some of the initiatives their community could be taking to reduce greenhouse gas emissions.

3. Have a local government representative present to the class the community's plan to reduce greenhouse gas emissions. If the community does not have a plan, the representative might present some activities related to greenhouse gas reduction (e.g., recycling programs, heating and lighting of government buildings).

4. Divide students into groups of four. Brainstorm with the class to identify the components of a presentation. Ensure that each group member has a responsibility in the presentation.
5. Have each group of students use the decision-making process to decide on some action to take regarding the community's response to global climate change. (Students may use BLM 1b; however, they will need to provide more details in the Action Recommended portion than space allows.) Have each group design an action plan for their community to reduce greenhouse gas emissions, incorporating the information already obtained from the video and the community presentation. Have students propose possible actions for both greenhouse gas emission reduction and emission credits.
6. Have each student group present the information to the rest of the class.

Assessment

Use the criteria below or student-generated criteria to assess students' presentation skills.

Criteria for Assessing Presentation Skills

Criteria	Exemplary	Accomplished	Beginning
Content	– Presentation is logically or creatively organized. – Main points of action plan are presented in a clear and convincing manner. – Information from video and community presentation is effectively incorporated. – Visuals are used effectively.	– Presentation is organized. – Main points of action plan are presented. – Information from video and community presentation is incorporated. – Visuals are used appropriately and add to presentation.	– Presentation lacks clear organization and structure. – Action plan is not clearly described. – Information from video and community presentation is not incorporated. – Visuals are used ineffectively.
Delivery	– Words are spoken clearly and rate of speech is well paced. – Volume is loud enough to be heard easily. – Keeps the audience's attention.	– Some words are not spoken clearly and rate of speech is at times too slow or too fast. – Volume is loud enough most of the time. – Generally keeps the audience's attention.	– Many words are not spoken clearly and rate of speech is generally too slow or too fast. – Volume is difficult to hear most of the time. – Does not hold the audience's attention.

I. Extension: TEK and Environmental Management

The video *Sila Alangotok—Inuit Observations on Climate Change* highlights one example of how scientists have acknowledged the importance of TEK and are incorporating information gathered from local people into their work. Across Canada there are many examples of the incorporation of TEK into decision-making processes. The following learning activity will allow students to explore some of these examples.

Objectives

The students will

- identify examples where TEK has been used in decision making
- explore one case study

Senior 2 Student Learning Outcomes

This learning activity goes beyond the student learning outcomes identified for Senior 2 Science.

Materials

Appendix 2: Aboriginal Traditional Knowledge and Environmental Management (pages 59 to 61)

Procedure

Opening Question: How can TEK be used in decision making?

1. Have students read the final three pages of the article "Aboriginal Traditional Knowledge and Environmental Management" (Appendix 2, pages 59 to 61).

2. Have students make notes on the types of examples the article contains.

   a. Ask students to select one of the examples cited in the article and use the Internet to gather more information on the project to prepare a summary report containing information that answers questions such as the following:

      - Who was involved?
      - How did it happen?
      - What was the result?
      - Why was this important?

   OR

   b. Have students investigate an example of how local TEK/community members have been involved in a decision-making process. Students can use the questions outlined above to guide the creation of a summary report.

Appendices

APPENDIX 1: CLUSTER 0: OVERALL SKILLS AND ATTITUDES FOR SENIOR 2 SCIENCE*

Overview

Cluster 0 comprises nine categories of specific learning outcomes that describe the skills and attitudes* involved in scientific inquiry and the decision-making process for STSE issues. In Grades 5 to Senior 2, students develop scientific inquiry through the development of an hypothesis/prediction, the identification and treatment of variables, and the formation of conclusions. Students begin to make decisions based on scientific facts and refine their decision-making skills as they progress through the grades, gradually becoming more independent. Students also acquire key attitudes, an initial awareness of the nature of science, and other skills related to research, communication, the use of information technology, and cooperative learning.

In Senior 2, students continue to use scientific inquiry as an important process in their science learning, but also recognize that STSE issues require a more sophisticated treatment through the decision-making process. This process has been delineated in Cluster 0 specific learning outcomes.

Teachers should select appropriate contexts to introduce and reinforce scientific inquiry, the decision-making process, and positive attitudes within the thematic clusters (Clusters 1 to 4) throughout the school year. For example, students will use the decision-making process as they examine an STSE issue related to safe driving conditions in Cluster 3. To assist in planning and to facilitate curricular integration, many specific learning outcomes within this cluster are accompanied by links to specific learning outcomes in other subject areas, specifically English Language Arts (ELA) and Mathematics (Math). There are also links to *Technology As a Foundation Skill Area* (TFS).

Students will...

	Scientific Inquiry	STSE Issues
Initiating	**S2-0-1a Propose questions that could be tested experimentally.** **GLO: C2** **(ELA: S2: 3.1.2)** **S2-0-1b Select and justify various methods for finding the answers to specific questions.** **GLO: C2** **(Math: S2: A-1)**	**S2-0-1c Identify STSE issues which could be addressed.** **GLO: C4** **S2-0-1d Identify stakeholders and initiate research related to an STSE issue.** **GLO: C4** **(ELA: S2: 3.1.2)**

* Reproduced from pages 0.3 to 0.8 of *Senior 2 Science: A Foundation for Implementation, Draft August 2001* (Manitoba Education, Training and Youth, 2001).

	Scientific Inquiry	STSE Issues
Researching	**S2-0-2a Select and integrate information obtained from a variety of sources.** **Include: print and electronic sources, specialists, and other resource people.** **GLO: C2, C4, C6 TFS: 1.3.2, 4.3.4** **(ELA: S2: 3.1.4, 3.2.4; Math: S2-B-1, 2)** **S2-0-2b Evaluate the reliability, bias, and usefulness of information.** **GLO: C2, C4, C5, C8** **TFS: 2.2.2, 4.3.4 (ELA: S2: 3.2.3, 3.3.3)** **S2-0-2c Summarize and record information in a variety of forms.** **Include: paraphrasing, quoting relevant facts and opinions, proper referencing of sources.** **GLO: C2, C4, C6 TFS: 2.3.1, 4.3.4** **(ELA: S2: 3.3.2; MATH: S2-AMA C-1)**	
		S2-0-2d Review effects of past decisions and various perspectives related to an STSE issue. ***Examples: environmentalist and industry group positions on fossil fuel emissions...*** **GLO: B1, C4 TFS: 1.3.2, 4.3.4** **(ELA: S2: 3.2.2)**

	Scientific Inquiry	STSE Issues
Planning	**S2-0-3a State a testable hypothesis or prediction based on background data or on observed events.** **GLO: C2**	**S2-0-3d Summarize relevant data and consolidate existing arguments and positions related to an STSE issue.** **GLO: C4** **TFS: 2.3.1, 4.3.4** **(ELA: S2: 1.2.1, 3.3.1, 3.3.2)**
	S2-0-3b Identify probable mathematical relationships between variables. ***Examples: relationship between braking distance, velocity, and friction...*** **GLO: C2** **(MATH: S2-AMA H-3, CMA F-3[11], PCA H-1,2)**	**S2-0-3e Determine criteria for the evaluation of an STSE decision.** ***Examples: scientific merit; technological feasibility; social, cultural, economic, and political factors; safety; cost; sustainability...*** **GLO: B5, C1, C3, C4**
	S2-0-3c Plan an experiment to answer a specific scientific question. **Include: materials, variables, controls, methods, safety considerations.** **GLO: C1, C2**	**S2-0-3f Formulate and develop options which could lead to an STSE decision.** **GLO: C4**

	Scientific Inquiry	STSE Issues
Implementing a Plan	**S2-0-4a Carry out procedures that comprise a fair test.** **Include: controlling variables, repeating experiments to increase accuracy and reliability of results.** **GLO: C1, C2 TFS: 1.3.1** **(MATH: S2-AMA H-1, 2, CMA F3[11])** **S2-0-4b Demonstrate work habits that ensure personal safety, the safety of others, as well as consideration for the environment.** **Include: knowledge and use of relevant safety precautions, WHMIS regulations, emergency equipment.** **GLO: B3, B5, C1, C2** **S2-0-4c Discuss safety procedures to follow in given situations.** ***Examples: acid or base spill in a lab, use of cleaning products...*** **GLO: C1, C2** **S2-0-4d Interpret relevant WHMIS regulations.** **Include: symbols, labels, Material Safety Data Sheets (MSDS).** **GLO: C1, C2**	**S2-0-4e Use various methods for anticipating the impacts of different options.** ***Examples: test run, partial implementation, simulation, debate...*** **GLO: C4, C5, C6, C7**
	S2-0-4f Work cooperatively with group members to carry out a plan, and troubleshoot problems as they arise. **GLO: C2, C4, C7** **(ELA: S2: 3.1.3, 5.2.2)** **S2-0-4g Assume the responsibilities of various roles within a group and evaluate which roles are most appropriate for given tasks.** **GLO: C2, C4, C7** **(ELA: S2: 5.2.2)**	

Observing, Measuring, Recording

Scientific Inquiry	STSE Issues
S2-0-5a Select and use appropriate methods and tools for collecting data or information. **GLO: C2 TFS: 1.3.1** **(MATH: S2-AMA: H-1, CMA: F-3,1, PCA: H-3)** **S2-0-5b Estimate and measure accurately using Système International (SI) and other standard units.** **Include: SI conversions.** **GLO: C2** **(MATH: S2-AMA: H-2, CMA: D-1)** **S2-0-5c Record, organize, and display data using an appropriate format.** **Include: labeled diagrams, graphs, information technology.** **GLO: C2, C5 TFS: 1.3.1, 3.2.2** **(ELA: S2: 4.4.1; MATH: S2-AMA B-5, 6, D-1, 2, F-1, A-1)**	**S2-0-5d Evaluate, using pre-determined criteria, different STSE options leading to a possible decision.** **Include: scientific merit; technological feasibility; social, cultural, economic, and political factors; safety; cost; sustainability.** **GLO: B5, C1, C3, C4** **TFS: 1.3.2, 3.2.3** **(ELA: S2: 3.3.3)**

Analyzing and Interpreting

Scientific Inquiry	STSE Issues
S2-0-6a Interpret patterns and trends in data, and infer and explain relationships. **GLO: C2, C5** **TFS: 1.3.1, 3.3.1** **(ELA: S2: 3.3.1; MATH: S2: AMA J-2, CMA D-5, F-2, H-4)** **S2-0-6b Identify and suggest explanations for discrepancies in data.** **Include: sources of error.** **GLO: C2** **(ELA: S2: 3.3.4)** **S2-0-6c Evaluate the original plan for an investigation and suggest improvements.** ***Examples: identify strengths and weaknesses of data collection methods used...*** **GLO: C2, C5**	**S2-0-6d Adjust STSE options as required once their potential effects become evident.** **GLO: C3, C4, C5, C8**

	Scientific Inquiry	STSE Issues
Concluding and Applying	**S2-0-7a Draw a conclusion that explains the results of an investigation.** **Include: cause and effect relationships, alternative explanations, supporting or rejecting the hypothesis or prediction.** **GLO: C2, C5, C8** **(ELA: S2: 3.3.4; MATH: S2: AMA J-3, CMA F-2, PCA H-4)** **S2-0-7b Identify further questions and problems arising from an investigation.** **GLO: C4, C8**	**S2-0-7c Select the best option and determine a course of action to implement an STSE decision.** **GLO: B5, C4** **(ELA: S2: 3.3.4)** **S2-0-7d Implement an STSE decision and evaluate its effects.** **GLO: B5, C4, C5, C8** **S2-0-7e Reflect on the process used to arrive at or to implement an STSE decision, and suggest improvements.** **GLO: C4, C5** **(ELA: S2: 5.2.4)**
	S2-0-7f Reflect on prior knowledge and experiences to develop new understanding. **GLO: C2, C3, C4** **(ELA: S2: 4.2.2)**	

	Scientific Inquiry	STSE Issues
Reflecting on Science and Technology	**S2-0-8a Distinguish between science and technology.** **Include: purpose, procedures, products.** **GLO: A3** **S2-0-8b Explain the importance of using precise language in science and technology.** **GLO: A2, A3, C2, C3** **(ELA: S2: 4.3.1)** **S2-0-8c Describe examples of how scientific knowledge has evolved in light of new evidence, and the role of technology in this evolution.** **GLO: A2, A5** **S2-0-8d Describe examples of how technologies have evolved in response to changing needs and scientific advances.** **GLO: A5** **S2-0-8e Discuss how peoples of various cultures have contributed to the development of science and technology.** **GLO: A4, A5** **S2-0-8f Relate personal activities and possible career choices to specific science disciplines.** **GLO: B4** **S2-0-8g Discuss social and environmental effects of past scientific and technological endeavours.** **Include: major shifts in scientific world views, unintended consequences.** **GLO: B1**	

Demonstrating Scientific and Technological Attitudes and Habits of Mind	Scientific Inquiry	STSE Issues
	S2-0-9a Appreciate and respect that science and technology have evolved from different views held by women and men from a variety of societies and cultural backgrounds. **GLO: A4** **S2-0-9b Express interest in a broad scope of science- and technology-related fields and issues.** **GLO: B4** **S2-0-9c Demonstrate confidence in their ability to carry out investigations in science and to address STSE issues.** **GLO: C2, C4, C5** **S2-0-9d Value skepticism, honesty, accuracy, precision, perseverance, and open-mindedness as scientific and technological habits of mind.** **GLO: C2, C3, C4, C5** **S2-0-9e Be sensitive and responsible in maintaining a balance between the needs of humans and a sustainable environment.** **GLO: B5, C4** **S2-0-9f Demonstrate personal involvement and be proactive with respect to STSE issues.** **GLO: B5, C4**	

APPENDIX 2: ABORIGINAL TRADITIONAL KNOWLEDGE AND ENVIRONMENTAL MANAGEMENT*

Over centuries of living in harmony with their surroundings, Aboriginal peoples in Canada have gained a deep understanding of the complex way in which the components of our environment are interconnected. In recent years, a growing awareness among non-natives of the value of this traditional knowledge (TK) has increased efforts to link it with science, particularly in the area of environmental management.

A number of resource-management boards, commissions, projects, and legal agreements—including the *Convention on Biological Diversity* and the proposed *Species at Risk Act*—recognize this value, and encourage the participation of Aboriginal people and the use of traditional knowledge in decision making. Environment Canada is engaged in a variety of efforts to supplement its science with traditional knowledge, and build the capacity of Aboriginal communities to manage their resources.

Aboriginal traditional knowledge has been and continues to be accumulated through time spent living on the land. It encompasses all aspects of the environment—biophysical, economic, social, cultural and spiritual—and sees humans as an intimate part of it, rather than as external observers or controllers. TK is part of the collective memory of a community, and is passed on orally through songs and stories, as well as through actions and observation.

This holistic view of the environment is based on underlying values that support sustainability. They include taking only what is needed and leaving the rest undisturbed, and providing for the well-being of the community without jeopardizing the integrity of the environment. The belief that all living creatures deserve respect has enabled Aboriginal peoples to hunt, trap and fish, while at the same time conserving wildlife populations for future generations.

In addition to an understanding of environmental systems as a whole and knowledge of appropriate techniques for harvesting, TK includes qualitative information on animals, plants and other natural phenomena. While significantly more knowledge is available on species that are harvested (such as caribou, seals, whales and fish), Aboriginal hunters, trappers, fishers and gatherers are also aware of the presence and biology of other species in the local environment. Elders, who are the main knowledge-keepers, are astute at noticing subtle patterns and changes within ecosystems.

While TK was often dismissed in the past due to its anecdotal nature, it is an important piece of the puzzle. It has helped scientists recognize and evaluate species and spaces at risk by providing information on broad trends in species distribution, abundance and seasonal behaviour patterns, and saved time and money by guiding field work.

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* Reproduced, by permission, from *Science and the Environment Bulletin*, Issue No. 32 (September/October 2002): 1-3. Environment Canada <http://www.ec.gc.ca/science/>.

To help break down some of the barriers between TK and science, Environment Canada [EC] researchers and officials working under the Northern Contaminants Program have taken part in several Elder/scientist retreats. The two groups meet in northern camps to share their knowledge and thoughts about changes in the environment. Thanks to such efforts, scientists are now addressing more relevant research questions, and Aboriginal peoples are becoming more comfortable with the concept of sharing their TK.

Environment Canada scientists collect TK in both formal and informal ways. One formal method is by conducting interviews with knowledge-keepers—often with the assistance of staff or community members who speak both the interviewee’s native language and either English or French. To avoid misinterpretation, questions are straightforward, and are often assisted by maps or photographs.

Such interviews have yielded valuable information on historic and present patterns in land use, wildlife and other aspects of local ecosystems. For example, an important component of the Northern River Basins Study was to determine how TK could complement physical-science studies of northern Alberta’s aquatic ecosystem. Hundreds of maps were created from archival records and interviews with long-term residents. In another instance, EC scientists partnered with a local hunters and trappers association to interview Elders in Pangnirtung, Nunavut, about seals, polar bears and ice patterns. The baseline data they provided is being used to monitor the impacts of climate change and contaminants on the region.

Interviews are also useful for collecting TK on the status of species. For example, Gwich’in Elders and fishers helped biologists identify Dolly Varden char as “at risk,” and provided details on the species’ movements and habitat, including spawning areas. This method has proven particularly effective for assessing changes in the distribution and abundance of migratory birds and other species with northern ranges, because of the expense and logistics involved in conducting scientific studies in this part of the country.

In 2001, EC researchers asked Inuit hunters and Elders whether they had seen any changes in the number of Ivory Gulls on northwestern Baffin Island, in Nunavut. When half replied that they had observed fewer gulls in recent years, a survey was carried out, revealing that breeding colonies in the area had declined by some 90 per cent. Interviews about birds and mammals at risk in the region also provided the first evidence in 70 years that Harlequin Ducks were still breeding on the island.

Also in Nunavut, perceived declines in Common Eider populations reported by Inuit hunters near Sanikiluaq led to surveys that confirmed a 75 per cent decline over the previous survey period. The hunters provide detailed observations for the annual life cycle of the Hudson Bay subspecies, and have helped identify important relationships between eider distribution and ice movement, winter mortality and eider age, nesting success and fox occurrence, and physical condition and seasonal changes in diet.

EC scientists and researchers also involve Aboriginal people as guides and assistants in sampling and surveying efforts, with both parties learning from the informal discussions that take place. For example, while working closely with Aboriginal guides in the Northwest Territories to collect fish and water samples, National Water Research Institute scientists have learned much about observed changes in fish health, harvesting, and important features of the fish’s environment.

Since TK loses much of its relevance when removed from the context of its source, many recent efforts to incorporate this kind of information in environmental management include Aboriginal people more actively in decision making. One example includes the numerous co-management boards established by Comprehensive Land Claim Agreements to manage renewable resources in a sustainable manner. Made up of an equal number of Aboriginal and government representatives (including Environment Canada), these boards share scientific and traditional knowledge on everything from wildlife and water to land-use planning. All of their decisions are made by consensus.

Best Practices for Traditional Knowledge

- Respect the ownership, source and origins of the knowledge and the needs and sensitivities of its holders, and obtain their approval and involvement.
- Take the time needed to establish a strong, trusting relationship based on honesty, openness and sharing.
- Work on projects of common interest and benefit.
- Continuously foster communication between partners.
- Provide value-added knowledge back to the community in the form of useful products (such as reports) and services, and share equitably with the holders any benefits arising from the use of TK.

In British Columbia, Environment Canada has been working for several years to build partnerships with Aboriginal peoples to achieve important conservation objectives. A key element of this strategy has been the creation of conservation interns who work with the department to inventory populations and habitats on their territories. Such capacity building is aimed at better equipping Aboriginal communities to handle future resource-management responsibilities.

Aboriginal TK is also a key component of recovery programs for two highly threatened habitats out West: the South Okanagan's pocket desert and the Garry Oak ecosystems of southern Vancouver Island and the Gulf Islands. In the South Okanagan, the Osoyoos Band is helping to preserve some of the last undeveloped and unfragmented desert habitat—a significant part of which is located on their reserve—by developing a cultural centre with interpretive trails and guides. The strategy for Canada's endangered Garry Oak ecosystems incorporates aspects of historic Aboriginal management regimes, such as the use of prescribed fire, active cultivation techniques, and the harvesting of traditional foods on some of the few remaining tracts of these grassy parklands.

On the other side of the country, the Ashkui Traditional Ecological Knowledge Initiative is using the knowledge of the Innu people to examine the landscape and ecology of northern Labrador. With large-scale development pressures in the region increasing, and a lack of scientific information available for environmental assessments, the Innu and Inuit are an important source of ecological knowledge. Environment Canada scientists worked closely with Aboriginal Elders to learn more about elements of the land that are critical to the Innu culture and way of life. Together, they decided to focus their collaboration on *ashkui*—the areas of rivers and lakes that are first to become free of ice each spring.

The first couple of years of the Ashkui Initiative were spent building relationships between Elders and scientists, conducting interviews, shaping the project, and finding study areas of common interest. Meetings were held in camps, with scientists spending several days at a time on the land. Traditional knowledge was compiled into a database, and a series of scientific questions were formulated as the basis for research at 13 ashkui sites. Added value is provided back to the community through such products as newsletters, posters, CD-ROMs, technical reports on water quality and potability, and spring ice-risk maps.

The Ashkui Initiative has spawned several offspring. For one, the project is expanding to study another site of great importance to the Innu—the intersections where caribou paths merge at certain times of year. Scientists are also creating an on-line mapping atlas for Labrador that will enable developers and others to see the value of the landscape to Aboriginal communities. Environment Canada is helping to build capacity within the Innu nation through the university-accredited Environmental Guardians Program, which trains and involves Innu students in planning, report-writing, wildlife monitoring, water chemistry, and other hands-on environmental work. The guardians, who will soon have a permanent office, serve as an important conduit for the flow of information to and from the community.

In the North, Aboriginal people play an active role on the steering committees of such major projects as the Northern Ecosystem Initiative. A variety of efforts under this initiative link traditional knowledge and science. Among them is the Arctic Borderlands Ecological Knowledge Cooperative—a community-based monitoring program that focuses on large-scale trends in climate change, contaminants and regional development in the Porcupine caribou range. Aboriginal assistants interview hunters, trappers and others in their own communities about observations made over the past year of caribou, fish, berries and other environmental indicators. In addition to being part of the department's ecological monitoring network, this information feeds into a number of other programs.

More science projects in the North are also being driven by traditional knowledge. For instance, the Vuntut Gwich'in people, who have traditionally hunted and trapped in the Old Crow Flats of the northern Yukon, told biologists that water levels in the more than 2000 shallow lakes and ponds in the flats have dropped over the past decade. A research team used satellite images and aerial photos to examine the situation, and confirmed that some lakes are draining catastrophically and a large number are drying up—another possible indicator of climate change.

In the South, where traditional knowledge has long been part of consultations with Aboriginal peoples, Environment Canada is taking steps to develop more formalized processes. In Ontario, the last two State of the Lakes Ecosystem Conferences featured special sessions on traditional knowledge, and invited Aboriginal people to provide direction on how science and TK can work together. The result is a co-existence model that recognizes the value of both types of knowledge, and uses relevant information from each to address issues of common interest, such as water quality and invasive species.

While documented TK is already being incorporated into species reports, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) is currently creating an Aboriginal traditional knowledge sub-committee to determine, among other things, how to involve Aboriginal communities more directly. Environment Canada is also in the process of developing a guide on the collection, documentation and use of TK that will establish protocols and high standards of ethics for partnerships and initiatives involving Aboriginal people.

In the meantime, the ongoing use of informal methods to incorporate TK in regional initiatives across the country will continue to reveal best practices for linking this age-old wisdom with scientific expertise. Each piece of the puzzle improves our understanding of the many and complex influences affecting our environment, and the steps we must take to ensure its sustainability for future generations.

APPENDIX 3: RESPONDING TO GLOBAL CLIMATE CHANGE IN CANADA'S ARCTIC (EXECUTIVE SUMMARY)

Executive Summary*

In the Arctic, the Mackenzie area has warmed by 1.5°C over the past 100 years (the warming being most pronounced in winter and spring). The Arctic tundra area has warmed by 0.5°C, but mainly prior to the 1970s. On the other hand, since about 1970, the Arctic mountains and fjords area has cooled slightly, mainly in winter and spring.

Global circulation models (GCMs) suggest increased global annual mean temperature relative to the present of 1 to 3.5°C by 2100 including the possible effects of future changes in atmospheric aerosol content. Pertinent to the circumarctic area are such features as: maximum warming in high northern latitudes in winter, little warming in summer, increased precipitation and soil moisture in high latitudes in winter.

For the Canadian Arctic, winter should see a 5 to 7°C warming over the mainland from west to east and over much of the Arctic Islands, and up to 10°C warming over central Hudson Bay and the Arctic Ocean northwest of the Islands; summer is likely to see up to 5°C warming on the mainland extending into the central Arctic Islands, and 1 to 2°C over northern Hudson Bay, Baffin Bay, and the northwestern High Arctic Islands. There is some suggestion that a modest cooling may occur over the extreme eastern Arctic in winter and spring. For precipitation, increases of up to 25% will be spread throughout the year over much of the region, but mainly in summer and autumn. Some early autumn or spring precipitation currently in the form of snow would become rain.

Potential Impacts on the Physical Environment

- At high latitudes such as in Arctic Canada, **glaciers and ice caps** seem likely to change little in overall size. Enhanced melting at lower altitudes in summer would likely be combined with increased accumulation in higher zones.
- A warmer atmosphere and longer thaw period will be conducive to increased **evaporation** in the Canadian Arctic. Over land, evaporative losses will be modified according to changes in vegetative cover. Recent work for the Mackenzie Basin suggests that evapotranspiration will increase for that area.
- **Northward flowing rivers** throughout the mainland are expected to have decreased flows and levels.

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* Source: *Responding to Global Climate Change in Canada's Arctic—Volume II of Canada Country Study: Climate Impacts and Adaptations*, pp. xiv to xvii, author Barrie Maxwell, Environmental Adaptation Research Group, Environment Canada, 1997. Reproduced with the permission of Public Works and Government Services, 2003.

- Over half the discontinuous **permafrost** zone would disappear eventually. The boundary between continuous and discontinuous permafrost will shift northward by hundreds of kilometers, although the ultimate position and timing are uncertain. The active layer will deepen slowly in the discontinuous zone to perhaps double its current depth. Pronounced thermokarst topography and increased erosional effects on coasts are likely. There will be an increased frequency of occurrence of shallow landslides.
- **Sea ice** occurrence will decline in northern and western areas. A decrease in Northwest Passage winter fast-ice thickness by about 0.5 m (although increased snow cover thickness could temper this) and an increase in the ice-free season of 1 to 3 months are expected. The open water season should lengthen from the current average of 60 days to about 150 days for Beaufort Sea. The maximum extent of open water in summer will increase from its present range of 150–200 km to 500–800 km; and the maximum thickness of first-year ice will decrease by 50–75%. Decreased first-year ice ridging thickness and old-ice incursion frequency (given no change in wind regime) are also anticipated. There will possibly be increased sea-ice extent in the eastern Arctic area in winter.
- **Iceberg** calving rates would likely change little. Concentrations of icebergs in eastern Arctic waters may therefore remain fairly stable.
- **Sea Level**—Overall, much of the Arctic has low sensitivity to such change, as its coastline is generally emergent, but the Beaufort Sea area will be highly sensitive, as will some glacial shores on Bylot, Devon, Baffin, and Ellesmere Islands.
- **Coastal Processes**—An increase in storm surge frequency will impact some areas significantly, such as the Beaufort Sea. In addition, some coastal areas currently protected virtually year-round from wave action by sea ice (such as the northwest Arctic Islands) will be at risk.
- **Freshwater Ice**—The river ice season will be reduced by up to a month by 2050, and up to 2 weeks for larger lakes.

Potential Impacts on Natural Ecosystems

- **Terrestrial Vegetation**—Current global Arctic biomes are expected to change in area as follows: ice-shrink by 12 to 24%, tundra-shrink by 31 to 58% (so that, in Canada, it is mainly confined to the Arctic Islands), taiga/tundra-expand by 16 to 35%. Ecosystem composition will change (more shrubs and moisture tolerant vegetation, less nonvascular plants) and species diversity will decrease. The speed at which forest species grow, reproduce, and re-establish themselves or that appropriate soils can be developed will be outstripped. Shrinking of the Arctic tundra biome will occur hand-in-hand with a northward shift of the treeline, by up to 750 km in eastern Keewatin. An increase in forest fires, along with more insects and a longer growing season, is expected to result in noticeable changes in vegetation in the Mackenzie Basin. Insects now common to southern Canada would move into the Mackenzie Basin area. Similarly the pests which are in the region today would move not only further north but also to higher elevations. Peatlands will be extremely vulnerable to climate change.

- **Terrestrial Wildlife**—In the Arctic, it is the indirect effects of global warming on feed and water availability that will be the more significant for wildlife. Changes in timing and abundance of forage availability and parasite infestations may accumulate to drive populations into decline, with serious consequences for people still depending on them. Bathurst caribou which live north of Great Slave Lake would probably lose weight in part due to heavier snow cover, and in part due to an increase in the number of insects harassing the herd. North of the mainland, High Arctic Peary caribou and muskoxen may become extinct. Predator-prey relations are a critical component of life cycles of Arctic species; such relations will shift where snow cover and snow type distributions change. The summer habitat of shorebirds in the Mackenzie Delta probably would not change much; on balance, projected future changes in climate and environmental conditions are more likely to be detrimental than beneficial to geese.
- **Freshwater and Marine**—Lake temperatures would rise but the effect on fish habitats in freshwater is uncertain. Cold water species might be at greater risks as their potential to adapt is not completely known. Arctic char, for example, is one species which could be affected as the northward expansion of southern fish species, such as brook trout, provides competition. Many species in lakes and streams are likely to shift poleward by about 150 km for every 1°C increase in air temperature. The distribution and characteristics of polynyas (ice-free areas, such as the North Water at the northern end of Baffin Island, Hell Gate between Devon and Ellesmere Islands, in Foxe Basin off the coast from Hall Beach, and in Penny Strait) and ice edges that are vital to Arctic marine ecosystems will change. Impacts on mammals such as polar bears, whales, and seals, or on seabirds may be both positive and negative, even on the same species. The range and numbers of some Arctic marine mammals, such as beluga and bowhead whales, may increase or at worst hold steady. Ringed and bearded seals, sea lions, and walruses require expanses of ice cover for breeding, feeding, and other habitat functions and may suffer population decline through pack ice recession. On the other hand, some species (e.g., the sea otter) could benefit by moving into new territories with reduced sea ice. Consequences for polar bears may be especially of concern—prolonging the ice-free period will increase nutritional stress on the Hudson Bay population until they are no longer able to store enough fat to survive. Should the Arctic Ocean become seasonally ice-free for a long period, it is likely that polar bears would become extinct.

Potential Socio-Economic Impacts

- **Oil and Gas**—Even though climate change is generally viewed as easing the environmental conditions under which exploration and development will be carried out, an increased cost for operations in the Canadian Arctic is likely, due to the conservative nature of the industry.
- **Transportation**—Northward expansion of agricultural, forestry, and mining activities would result in the need for expanded air, marine, rail, and road coverage and related facilities.
  - **Air:** Float planes would benefit from a longer ice-free season, but there would be a correspondingly shorter season for winter ice strips.

  - **Marine:** The impacts in Arctic areas would likely be significant. Benefits would take the form of longer shipping seasons in all Canadian Arctic areas, with the likelihood of easy transit through the Northwest Passage for at least part of the year, deeper drafts in harbours and channels, and the potential for reduced ice strengthening of hulls and/or reduced need for icebreaker support. On the other hand, increased costs would result from design needs to address greater wave heights, possible flooding of coastal facilities in the Beaufort Sea and Hudson Bay, and the generally increased need for navigational aids owing to increased precipitation and storm frequencies and requirements for search and rescue activities.
  - **Freshwater:** The Mackenzie River barge season would increase, perhaps by as much as 40%, but lower water levels would make navigation more difficult.
  - **Land:** Increased permafrost instability will likely lead to increased maintenance costs for existing all-weather roads and rail beds, at least in the short term.

- **Building and Construction**—Increased air temperature will have a number of effects, including: reduced power demand for heating, reduced insulation needs, and increased length of the season for construction activities that occur in summer (heavy construction, which may be confined to winter due to the movement of equipment only being possible on frozen, snow-covered ground, would face a shorter season). Affected in various ways will be: northern pipeline design (negative); pile foundations in permafrost (negative, although depends on depth of pile); tailings disposal facilities (positive or negative); bridges, pipeline river crossings, dikes, and erosion protection structures (negative); open pit mine wall stability (negative).
- **Recreation and Tourism**—Warmer temperatures would be expected to be beneficial for recreation and tourism in the Arctic (with, for example, the likelihood of extended summer activities into September, at least in the southwestern mainland areas). Yet their impact may be counteracted by stronger wind and/or reduced visibility in some areas. For the Mackenzie Basin, sport hunting could be hurt. In Nahanni National Park only minor changes for river recreation such as canoeing and rafting due to changes in the hydrological regime of the area are anticipated. On the other hand, forest fire and ecological changes traceable to climate change could have significant negative impacts there.
- **Settlements, Country Food, and Human Health**—Climate change may affect the distribution of animals and other resources on which the northern economy is based. In addition, traditional knowledge and local adaptations may no longer be applicable enough to rely on. The health of northerners may be affected through dietary dislocations and epidemiological changes.
- **Agriculture**—Opportunities would be presented in the central and upper Mackenzie Valley areas. For example, wheat production could improve although expanded irrigation services would be needed.
- **Forestry**—In the Mackenzie area, average age of trees will decline and the yields from all stands of commercial timber—both softwood and hardwood—will fall by 50%.

- **Fisheries**
  - **Arctic Marine**—There will be increases in sustainable harvests for most fish populations due to increased ecosystem productivity, as shrinkage of ice cover permits greater nutrient recycling. There is potential for establishing a self-sustaining salmon population in the western Arctic.
  - **Northern Freshwater**—There will be increases in sustainable harvests for most fish species, due to longer warmer growing seasons and relatively small changes in water levels. A potential increase in the diversity of fish species that can be harvested sustainably is likely, due to increases in the diversity of thermal habitats available to support new species expanding their ranges from the south.
- **Defence**—Canada's position that all waters within the Archipelago are under its sovereign control could be more seriously tested due to more easy access. Increased surveillance and other activities such as a greater search and rescue capability will be required. A lower probability of extremely cold weather would result in Arctic weather and climate being looked upon by strategists as less of a natural defence in its own right. Military sites such as Alert will face altered costs due to changes in space heating requirement and infrastructure maintenance. Overall, an increased DND [Department of National Defence] role and attendant costs are envisaged.

Adaptation

Human beings, vegetation, and wildlife have shown great ingenuity and resourcefulness in adapting to the environmental conditions which characterize the Arctic, but a rapidly changing climate is almost certain to make some existing adaptation strategies obsolete while creating situations that will require new adaptive responses. Adaptation to the impacts of climate change will also have to occur at the same time as northern communities adjust to numerous other social, institutional, and economic changes related to land claims settlements and the creation of new territorial structures such as Nunavut. Climate change could alter many aspects of life, both subsistence and wage-related, in Arctic communities, and in the coming years efforts will have to be intensified to understand how these changes will come about and what effects they will have. Insights from traditional ecological knowledge as well as from modern scientific inquiry will play a key part in this process.

Future Directions

Much work is still needed to understand more fully not only the relationship of climate to all aspects of the biophysical environment as well as socio-economic activities, but also the impacts of climate change on them. In addition to these specific research needs which are well-document in the literature, there are several general concerns which are pertinent to all such sensitivity- and impact-related research for the Arctic.

- **Environmental Monitoring**—Commitment to continued monitoring of atmospheric and oceanographic variables throughout the Arctic is needed.
- **Climate Scenarios**—There is a need for more credible and detailed regional scenarios than currently available from the GCMs [global climate change models].

- **Geographic Emphasis**—The eastern Arctic is much less well-studied than the other regions of the Arctic.
- **Socio-Economic Sectors**—Existing and potential relationships between climate and socio-economic sectors in the Arctic are even less well-understood than those between climate and the biophysical environment.
- **Traditional Ecological Knowledge**—TEK should be more effectively utilized, particularly in respect to quantifying terrestrial and aquatic environmental sensitivity to climate.
- **Stakeholder Involvement**—Real partnerships between researchers and users that involve both communities actively in the planning, developing, and carrying out of impact-related research for the Arctic are essential.

Blackline Masters

BLACKLINE MASTERS

BLM 1a

Decision-Making Process*

The 10 stages involved in making a thoughtful decision are described below. Use the chart on the next page to work through the stages and to record your work. As you complete the chart, you may return to an earlier stage and add to it, or rewrite it. You may want to fill out the chart in pencil so you can revise it.

Issue:	State the issue.
Decision Question:	Write a precise wording of the question that needs to be answered. The wording can affect the decision you make.
Type of Decision:	A decision may be scientific, technological, legal, political, or moral. It may also be a public policy decision — a general decision that prescribes ways for handling a public situation. A public policy decision is not restricted by moral, political, military, legal, or any other type of decision, but it can be informed by those types of decisions.
Alternatives:	Fill out alternatives as you think of them. Some decisions may only have two alternatives (for example, guilty or not guilty).
Risk/Benefit Analysis:	For each alternative, list the negative and positive consequences of taking the action.
Logic Check:	Double-check the validity of your risk/benefit arguments for each alternative. (How logical are your conclusions? Are they based on false causes? How probable are your conclusions?)
Values Awareness:	If you look closely at each alternative you provided and the associated consequences, you will see that they reflect certain values. Examples of values include: generating wealth for a country, loyalty, being in balance with nature, causing no harm to people, justice, abiding by the laws, and honesty. The values you detect may not necessarily be your own personal values, but you must recognize and clarify them anyway. To help you identify the values, ask yourself the question: What would people highly value if they strongly believed in alternative X?
Personal Priority of Values:	Of all the values you listed above, which value is most important to you personally in this situation? Prioritize the other values from second in importance to least important.
Choice and Reason:	What alternative do you choose after weighing the consequences and considering the logic of your thinking, the probabilities, and your values?
Action Recommended:	In order to carry out your decision, what action should be taken? By whom? When?

(continued)

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BLM 1b

Decision-Making Chart*

Issue:			
Decision Question:			
Type of Decision:			
Alternatives	**Risk/Benefit Analysis**	**Logic Check**	**Values Awareness**
Alternative	Negative Consequences		
	Positive Benefits		
Alternative	Negative Consequences		
	Positive Consequences		
Personal Priority of Values (from most to least important):			
Choice and Reason:			
Action Recommended (what, by whom, and when):			

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BLM 2

Video-Related Questions

Answer the following questions, based on the video *Sila Alangotok—Inuit Observations on Climate Change*.

1. What were some of the observations of climate change made by the community members of Sachs Harbour?

2. Why may the observations of Inuit Elders and community members be important in a discussion of climate change?

3. How do the observations of Inuit Elders and community members contribute to the understanding of natural climate change and climate change associated with human activities?

4. What are some actions you might take (as an individual or as part of a group) to reduce climate change?

BLM 3

Trip Report Summary

Group Members: ______________________________

Trip Report Number:

Purpose and Objectives:

Methods:

Findings:

BLM 4

Trip Report: Reflection Questions

1. List the methods used to gather information in the Sachs Harbour community.

2. The science group found that interviews were a valuable method of gathering information. Summarize the benefits of this methodology. (Hint: Look at Trip Report 2 for specific points.)

3. Using the information from the video and the trip reports, discuss with your group whether the scientists gained valuable information about climate change through this project. Develop a statement that justifies, to funding groups, the use of this costly and time-consuming method of gathering information about climate change from other communities.

BLM 5

Impact of Climate Change on the Arctic

1. Watch the video *Sila Alangotok—Inuit Observations on Climate Change*. Use the first column in the table below to identify observations that Elders and community members of Sachs Harbour make related to the impacts of climate change.
2. Read the "Executive Summary" from *Responding to Global Climate Change in Canada's Arctic* (Maxwell, 1997, xiv–xvii). This Environment Canada report discusses several possible impacts of climate change suggested by Western scientists. Using information from the report, complete columns two and three of the table below, identifying direct and indirect impacts of climate change mentioned.
3. Complete the questions that follow the table.

Impact of Climate Change on the Arctic

Video—Community Information	Report—Scientists' Information	
	Direct Impacts	Indirect Impacts

(continued)

(continued)

Video—Community Information	Report—Scientists' Information	
	Direct Impacts	Indirect Impacts

Questions

1. Note similarities and differences between observations of community members and information from scientists.
   a. Summary of Similarities:

   b. Summary of Differences:

2. Do you think it is important to include information from both scientists and community members when trying to understand something as complex as climate change? Why or why not?

3. Brainstorm two other situations where it would be important to gather information from both scientists and local community members (e.g., To see the impacts of...).

BLM 6

Role Cards for Conference Members

Inuit Trapper/Hunter

Create a name for this individual. ______________________________

This individual has been trapping and hunting in the area for the past 30 years. All members of his or her family have been involved in trapping and hunting as a livelihood for generations. In the winter, Arctic foxes are trapped, the pelts sold to the local Natural Resources office, and the money used to buy food and clothes for a family of six (two adults and four young children). Geese and ptarmigan are often hunted in the fall for food over the winter, in addition to caribou that migrate through the area.

Vice-President of Ready Gas

Create a name for this individual. ______________________________

Ready Gas is a medium-sized gas and oil exploration company that has been involved in Arctic exploration for 40 years. Due to the overwhelming demand for oil in the United States and the abundance of oil resources in northern Canada, Ready Gas has developed an agreement with the United States to supply oil at a highly profitable price. The vice president (VP) is fully aware of the current debate on climate change and the impact suggested by scientists but subscribes to the critics' views on the subject. This individual has been active in a group of companies lobbying the government to change the Kyoto agreement because the recommended emission reductions are too large and will greatly interfere with the operations of their companies. The VP of Ready Gas lives in a large city in Canada and relies upon the information provided by scientists to make decisions regarding explorations.

Community Council Member

Create a name for this individual. ______________________________

The council member has been involved in the economic development of the community for the past five years. In the past, this person created a housing project that employed 40 community members. The unemployment rate of the community is quite high, even taking into consideration individuals making a living off the land (self-employed), and this council member is interested in increasing opportunities for employment in the community. The council member also hunts and traps over the winter as the members of his or her family have done for generations.

(continued)

Role Cards *(continued)*

President of Inuit Oil and Gas

Create a name for this individual. ______________________________

Inuit Oil and Gas is a small-sized exploration company that has been involved in this field for only three years. The president is fully briefed on the Kyoto agreement but has not yet taken a stand on the emission reduction targets. The president lives in a community in the same region as the proposed development. Inuit Oil and Gas was established to provide economic development, under Inuit control, for the region and is very aware of the high unemployment rate in local communities. The president also takes part in trapping and hunting activities with his or her family.

Carpenter

Create a name for this individual. ______________________________

The carpenter was trained by a community-based college program and has journeyman papers. The employment of carpenters has been sporadic in the community in the past 10 years; there was a housing development project that provided employment for the past five years but that project is coming to an end. The carpenter is concerned about future opportunities. Due to the sporadic nature of the work, the carpenter traps and hunts over the winter to provide food for his or her family.

Local Science Teacher

Create a name for this individual. ______________________________

The local science teacher has lived in the community for the past two years. Originally from a different Arctic community, the science teacher moved here for work. In science class the teacher emphasizes the importance of environmental stewardship. The teacher is also a strong supporter of community-based decision making and tries to model this approach in the classroom. In the community the science teacher has been working on instituting an energy conservation program; the council is currently considering the request for funds to begin the program.

(continued)

Role Cards *(continued)*

Environmental Group Leader

Create a name for this individual. ____

For this individual, environmental activism has been a lifelong passion. Currently the leader of GreenCops Inc., a not-for-profit organization, this individual is responsible for investigating policy development that may affect the environment in the North. GreenCops is very knowledgeable about the fragile Arctic ecosystem and has been collecting data from other northern development projects about the impact of oil and gas exploration on both the land-based and marine ecosystems. There are already indications that these ecosystems are being adversely affected by development.

Provincial/Territorial Minister of the Environment

Create a name for this individual. ____

This Minister has the responsibility for developing and enforcing policy related to environmental protection. Concerns have been raised about the rapid development that has taken place in other regions and the environmental impacts that are only just beginning to surface.

Federal Member of Parliament—Environment Minister

Create a name for this individual. ____

As the Environment Minister, this individual has been involved in the federal government's participation in the contracts associated with the Kyoto Protocol and is responsible for promoting Canada's position with provincial/territorial contacts. However, several companies have been placing some pressure on this individual, indicating that they believe the emission reduction agreement includes targets that are unrealistic or too expensive. Ready Gas has been one of these companies.

Local Community Member

Create a name for this individual. ____

This individual's family has lived in the community for a long time. As a family of seven (two adults and five children), they plan to remain there and are concerned about the future impact of an oil and gas company operating nearby. Currently this community member contributes to the health and well-being of the family by assisting in hunting, trapping, fishing, and preparing hides. In addition, the community member works part-time at the local grocery store during the winter.

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