

## **Module 10: Climate Change Effects on Sustainable Development in Northern Economies**

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### **Overview**

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Climate change is impacting the socio-economic development of northern communities and threatening their long-term sustainability. Impacts of climate change are likely to increase in the future, but specific impacts of these changes have not yet been thoroughly researched by social scientists. The limited knowledge that exists points to negative impacts of climate change on physical infrastructure, reindeer herding and traditional harvesting activities of Indigenous peoples of the regions. These latter impacts could have serious implications on the health of Indigenous peoples. Possible positive impacts include increased access to natural resources and increased production in the fisheries, forest and agriculture industries. The reasons for this lack of knowledge vary, but one of the most important is that effects introduced by climate change are part of a large number of transformations occurring in these communities. Further, researchers and communities are often forced to devote limited resources to other social and economic problems. Social scientists can be useful in assisting these communities ensure sustainable development in the face of climate change by assisting with community empowerment and capacity-building. They are the most sensible long term solutions to potential climate change impacts.

### **Learning Objectives**

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Upon completion of this module, you should be able to:

1. Explore the expected effects of climate change on physical infrastructure, transportation and natural resource production.
2. Understand potential impacts of climate change on agriculture, fishing, forestry and reindeer herding in the circumpolar North.
3. Illustrate how subsistence activities have changed in response to climate change.
4. Discuss ethical issues surrounding an increase in mining and petroleum development in the circumpolar North.
5. Understand why there is less research on the impacts of climate change done by social scientists compared to other sciences.
6. Suggest possible solutions to increase the North's ability to develop sustainable communities in the face of climate change.

## Required Readings (including web sites)

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## Key Terms and Concepts

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- Arctic Sovereignty
- Climate Change
- Forest Encroachment
- Increased Access to Natural Resources
- Northern Infrastructure
- The Resource Curse
- Physical, Human, Social and Financial Capital
- Social Science and Climate Change Research
- Sustainable Development
- Traditional Subsistence Activities and Climate Change

## Learning Material

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### Introduction

There is a strong belief among most researchers that climate change will have important socio-economic impacts on the sustainable development of communities in the Arctic. If the specific situation of communities in most of the North is examined, current research levels on the issue do not allow a high degree of confidence about what these impacts will be. Current research notes effects such as increased access to natural resources and transportation routes, deterioration of community infrastructure and regional transportation routes, negative effects on traditional food harvesting and its cultural and health implications, and the increased occurrence of extreme events. While research has been increasing over the past few years, it is evident that knowledge about the socio-economic impacts of climate change is less developed than that of the physical sciences.

There are a variety of reasons for this lack of research, including fewer research projects being funded, great complexity surrounding the issue due to a large degree of local variation in climate change impacts and the adaptive responses of communities. One of the most important reasons is the effects introduced by climate change are part of a large number of changes occurring in northern communities. When forced to prioritize due to limited resources, researchers and communities often devote attention to what communities perceive as more pressing social and economic problems. Few societies have undergone social and economic transformations at the rate many northern communities have experienced over the past 50 years. These changes introduced a great deal of stress accompanied by a range of social and economic problems. Climate change is adding to these challenges, but its impacts are often hidden behind other issues.

This does not mean that social scientists cannot be of assistance in developing answers to potential negative impacts of climate change on northern communities. While more precise solutions will emerge as social research is done in the region, given the current lack of knowledge about the social impacts of climate change, the most effective solution available is to assist northern communities gain control of their social and economic development. For thousands of years these communities have shown the ability to deal with change. Increased variability that accompanies climate change means these communities require increased capacity to deal with these changes. This is especially important since impacts will vary by region. The best way for northern communities to deal with the impacts of climate change is to increase their ability to access human, social and physical capital.

### **10.1 Effects of Climate Change on Physical Infrastructure, Transportation and Natural Resource Production**

For many years' scientists studying the earth's climate have noticed general warming appeared to be occurring. In the 1980s, concern about the implications of general warming of the earth's climate began to develop. The United Nations Environmental Program (UNEP) and the World Meteorological Organizations (WMO) established a special panel to investigate the issue. The Intergovernmental Panel on Climate Change (IPCC) was established in 1989 to prepare a comprehensive review and recommendations with respect to the state of knowledge of the science of climate change, social and economic impact of climate change, possible response strategies and elements for inclusion in a future international convention on climate. The IPCC produced a series of assessment reports pointing out that the Arctic was one of the regions experiencing the greatest degree of climate change.

When the Arctic Council was created by the eight Arctic nations, one of the first tasks it undertook was to join the International Arctic Science Committee to create the *Arctic Climate Impact Assessment (ACIA)* to study climate variability, climate change, increased ultraviolet radiation and their consequences. In November 2004, the report concluded that the Arctic was warming at nearly twice the rate of the rest of the globe, and increasing greenhouse gases from human activities were projected to make it warmer. Other findings included:

- In Alaska, Western Canada and Eastern Russia average winter temperatures increased as much as 3 – 4° C (4 – 7°F) in the past 50 years and are projected to rise 4 – 7° C (7 – 13°F) over the next 100 years.
- Arctic summer sea ice is projected to decline by at least 50 percent by the end of this century with some models showing near-complete disappearance of summer sea ice. This will likely have devastating consequences for some Arctic animal species e.g., ice-living seals, and local people for whom these animals are a primary food source. At the same time, reduced sea ice is likely to increase marine access to some of the region's resources.
- Warming over Greenland is projected to lead to substantial melting of the Greenland Ice Sheet contributing to global sea-level rise at increasing rates. Over the long term, Greenland contains enough melt water to eventually raise sea level by about 7 meters (23 feet).
- Should the Arctic Ocean become ice-free in summer, it is likely polar bears and some seal species will be driven to extinction.

- Over the next 100 years, climate change is expected to accelerate contributing to major physical, ecological, social and economic changes (ACIA News Release, November 8, 2004).

These changes come when the region is trying to find ways to ensure the sustainability of northern communities. To be sustainable these communities must develop in a way that “meets the needs of the present without compromising the ability of future generations to meet their own needs” (Brundtland Commission, 1989). Even without the challenges of climate change, northern communities face a large number of barriers to achieving sustainable development. These barriers result from difficult geographic, demographic and economic conditions. This module outlines social impacts climate change is having on the ability of northern communities and their economies to achieve sustainable development.

While the ACIA included some observations about potential social impacts of climate change, most research noted knowledge of these issues is less developed than knowledge about the impacts of climate change on the physical environment. One of the first reviews of the subject was a report for the *Northern Climate Exchange* in 2000, which noted “There is fairly good information on the impacts of climate change on physical processes (such as permafrost); fair information for biological systems (e.g. community ecology) and less information for socio-economic systems” (10). In 2004, Duerden noted that while physical evidence of climate change at high latitudes is overwhelming, “uncertainty best characterizes our current level of knowledge about its impact on human activities” (204).

Ford et al. (2007) noted that despite the importance of climate change being well recognized, research on how to help communities adapt to these changes is surprisingly absent. The Arctic Climate Impact Assessment (ACIA, 2005) “highlights our limited understanding of the vulnerability of Arctic communities and contains little substantive discussion of adaptation policy” (150). The update of the ACIA commissioned by the WWF International Arctic Programme underlines that in regards to the human dimensions of climate change impacts “profound uncertainties remain” (2008:91).

### Learning Highlight 1

Very little research exists on the socio-economic impacts of climate change on the North.

Research on the socio-economic impacts of climate change on northern communities is limited, but has been growing over the past ten years. A literature review by the Northern Climate Exchange in 2000 noted research dealing with impacts on the structural integrity of buildings, changes in the economic bases of communities, impacts on traditional harvesting and transportation, and increased extreme events such as flooding, erosion in coastal communities, forest fires and landslides (2000). Duerden (2004) notes a series of studies on specific sectors of the regional economy pointing to increased access to oil and gas reserves, expansion of northern agriculture and changes in forest resources. A great deal of writing has been devoted to the potential impacts of climate change on increased shipping and the possible opening of the Arctic to commercial traffic has the potential to transform northern communities.<sup>1</sup> The greatest

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<sup>1</sup> While most discussions of this issue highlight Canadian national security issues, some studies have started to discuss the potential impact of increased shipping on Northern communities. See Coates, K., P.W. Lackenbauer, G. Poelzer and W. Morrison. 2008 *Arctic Front: Defending Canada in the Far North*. Toronto: Thomas Allan Publishers.

concentration of research studied negative consequences of climate change on traditional harvesting activities.

### 10.1.1 Climate Change and Northern Infrastructure

A key consideration of governments when looking at climate change is the cost of damage to existing physical infrastructure. A warming climate causes damage to infrastructure in a number of ways. The Alaskan village Shishmaref is often used as the poster child of negative consequences of climate change in the Arctic. Increased temperatures have reduced the amount of sea ice around Shishmaref. This sea ice used to protect the community from storm surges. Less ice means surges are causing an increased rate of erosion and the community is slowly collapsing into the sea. The erosion is aggravated by melting permafrost upon which the community is built.

#### Learning Highlight 3

Climate change will result in more Northern natural resources being exploited.

These impacts are not limited to Shishmaref. Other Arctic communities have experienced destruction of physical infrastructure caused by climate change. In November 2009, Greenpeace Russia released a report warning of infrastructure problems due to melting permafrost (Greenpeace Russia). As temperatures rise and soil thaws, pile-buildings become less reliable and dwellings, bridges and pipelines deform and collapse. In oil wells in the Khanty-Mansiysk district an average of 1,900 accidents per year occur as a result of thawing permafrost and in West Siberia, 7,400. The report noted Russia now spends 55 billion roubles annually on pipeline maintenance and repair of damage related to permafrost thaw.

#### Learning Highlight 2

Climate change is likely to result in a large increase in costs to repair infrastructure

A study by the Institute of Social and Economic Research at the University of Alaska, Anchorage recently developed a model to predict the cost of climate change impacts on publicly owned infrastructure (Larson and Goldsmith, 2007). It estimated climate change would cost the State of Alaska \$3.6 to 6.1 billion between 2007 and 2030. Most costs related to maintaining or replacing roads, runways, and water and sewer systems as these are the most vulnerable to thawing permafrost, erosion and extreme events such as flooding. The costs did not include moving the villages of Shishmaref, Kivaluna and Newtok, which will be forced to relocate over the next 10 to 15 years due to climate change.

### 10.1.2 Climate Change and Increased Transportation and Access to Natural Resources

Some believe climate change will have positive impacts on the region. An often cited positive aspect is increased access to natural resources through increased shipping. Warmer temperatures in the Arctic mean less sea ice and a reduction of extreme cold. According to a report on the impact of climate change by the Conference Board of Canada, this change “will bring with it vast economic opportunities in terms of resource exploration, international shipping and trade”(Roberts et al., 2006).

With melting sea ice navigation becomes easier and off-shore drilling in Arctic waters becomes less hazardous. The potential exists to significantly decrease the cost of extracting oil and gas and making exploitation of Arctic reserves more viable. Access to minerals becomes easier as these can be easily transported out of the region. This is extremely important to areas such as Greenland and Nunavut which have few options for economic development (NEF, 2008). Development of these resources promises a better future for youth due to better employment opportunities.

Increased exploitation of the Arctic's natural resources could be advantageous to some, but not necessarily to those living in the North. In the past natural resource development failed to produce sustainable communities in the North (Rea, 1976; Page, 1986). The "resource curse" identified in other regions of the world has been present in the Arctic (Banta, 2007; Collier, 2007). The benefits of production in the form of profits and employment often go to those outside the region. Resource production often threatens the northern environment upon which the traditional economy of Indigenous populations still depend (ACIA, 2004; Berger, 1977). Added to this resource curse are attempts by Indigenous populations to ensure traditional activities and cultures are maintained in the face of multiple stressors. Resource development has often been linked to increased disruption of these communities leading to a variety of social and health challenges (Ritter, 2001; Niezen, 1993).

While new natural resource opportunities open and shipping increases, the area becomes subject to security concerns as the potential exists for sovereignty conflicts as various powers scramble to access resources and secure new shipping routes through the region (Huebert, 2003; Coates et al., 2008).

Increased shipping also brings opportunities for the tourism industry. Cruise lines would be able to access greater areas of the Arctic bringing greater numbers of tourists to the region. This could be a positive impact for local tourism operators and arts and crafts producers. However, increased tourism could bring increased negative cultural and environmental impacts.

## **10.2 Impacts of Climate Change on Agriculture, Fishing, Forestry and Reindeer Herding**

Other areas which expect positive impacts from climate change in the Arctic are agriculture, forestry and fishing. A recent British government report on the economics of climate change notes that in higher latitudes, such as Canada, Russia and Northern Europe, rising temperatures may initially increase production of some crops (Stern, 2006).

### **Forestry**

A recent study by Carinna Keskitalo of climate change adaptability in Northern Fenno-Scandia looked at potential impacts of climate change on the forestry, fishing and reindeer industries (2008). Several studies show increased forest growth will result from a longer growing season (57). This will mean larger timber production, but a potential decline in quality. A warmer climate will result in better seed crops and greater reproduction of forests. However, the changing climate may result in potentially negative impacts such as destruction of soils from increased rainfall and a change in the types of trees grown.



## Fishing

Studies done for the IPCC note climate change has the potential to significantly increase the productivity of fisheries in the circumpolar North. Warming seas should result in increased biological production, longer growing seasons and increased growth rates (Keskitalo, 2008). However, a danger exists to spawning grounds. The introduction of new species could create problems in the region and the higher portion of fresh water entering the oceans from melting ice could collapse fish stocks.

### Learning Highlight 7

Climate change increases barriers to traditional harvesting as changing conditions increase dangers.

## Reindeer Herding

The impacts of climate change on reindeer herding are likely to be mostly negative. As forests encroach on the tundra there will be less area for reindeer to graze. As temperatures warm, lichens and mosses upon which reindeer depend will be replaced by plants and shrubs. Changing climate conditions cause increased periods when the ground is covered by ice crusts making it more difficult for reindeer to move and access their food (Keskitalo, 2008).

Threats posed by climate change to reindeer herding will have negative consequences for the social, economic and cultural survival of the region's Indigenous peoples who depend on reindeer herding. As Nuttall et al. note in the Arctic Climate Impact Assessment report, "These activities remain important for maintaining social relationships and cultural identity in Indigenous societies. They define a sense of family and community..." (650).

Chapter 12 of the ACIA discusses the potential impact of climate change on the Nenets of the Yamal region of Russia. The authors note that Indigenous peoples such as the Nenets have shown great capacity to adapt to changing social and environmental conditions, but recent changes have tested their capacity. Economic and political changes and questions of land tenure, severe overgrazing, predation and poaching have produced enormous stresses in these communities (Nuttall et al., 2005). Climate change impacts will likely add to the problems facing these communities, perhaps resulting in their collapse.

### Learning Highlight 6

Climate change will have a negative effect on reindeer herding communities as the tundra shrinks.

The Saami of Northern Fenno-Scandia are particularly effective at informing the world of dangers their reindeer herders face from climate change. Climate change is bringing new and unpredictable weather to the region making it difficult to use their traditional knowledge. According to Saami reindeer herder Olav Mathias-Eira,

"Climate change is threatening our economy as reindeer herders... Because this is part of our traditional way of life, if the economy goes, probably the entire Sami culture would go with it...The [weather] is so unpredictable, so unusual. It can rain in the winter when it usually didn't rain before...traditional knowledge is no good any more, we just can't trust the ice" (The Independent, May 10, 2008).

Likely this statement is also true for other Indigenous reindeer herding peoples and caribou harvesting peoples.

### 10.3 Climate Change and Traditional Subsistence Activities

While the extent of research on many of the above potential impacts is largely limited to conjecture, increasing research in recent years indicates climate change is significantly impacting traditional harvesting activities. This was noted in the *Inuit Observation of Climate Change* project in 1999 and 2000 at Sachs Harbour in the Northwest Territories. Local inhabitants stated climate change was having its greatest impact on traditional activities such as hunting, fishing, travelling on traditional lands and other types of subsistence activities (Riedlinger, 2001). Climate change made conditions unpredictable and it was more difficult to travel on land or sea ice. The lack of safe hunting conditions is an important factor in restricting access to food and cultural resources.

Wildlife patterns were shifting making it harder to predict where resources could be harvested. According to Riedlinger, while the community was coping with these changes, restriction of these activities could have detrimental effects on the “physical and cultural health” of the community (97). Existing social networks are increasingly strained by unequal abilities to deal with climate change related obstacles to traditional harvesting (Ford et al., 2007).

Subsequent research dealing with other Indigenous communities has resulted in similar findings. Similar to the situation with reindeer herding, many Indigenous peoples in Northern Canada and Alaska depend on caribou for the survival of their communities. While caribou harvesting is important economically to these peoples, the economic value of the harvest “does not capture the social, psychological and spiritual value of caribou to its users” (Nuttall et al., 2004). A study projecting the impact of climate change on caribou herds in northwestern Canada and northeastern Alaska suggests there will be substantial declines in caribou populations over the next 40 years, which will have a serious impact on the ability of many Indigenous communities to survive.

In recent years researchers have pointed to the importance of traditional or “country” foods on the health of Indigenous communities in the North. The introduction of non-traditional foods into these communities has had negative impacts on community wellness (Bjerregaard and Young, 1998). Recent efforts by Indigenous peoples and some governments have resulted in an increasing awareness of the healthy benefits of locally harvested foods. Climate change now threatens the ability of communities to harvest these foods in a safe manner (Furgal and Seguin, 2006). More accidents are occurring due to the unpredictability of ice conditions. Changing wildlife and plant growth patterns also have a negative impact on the ability of communities to access these food sources. Communities are also reporting other health related impacts. Respiratory problems are brought on by warmer weather and there is concern about the increasing possibility of infectious diseases being spread more easily in the North because of climate change.

### 10.4 Ethical Issues Surrounding Climate Change and Development in the North

While research indicates that climate change is creating problems for some northern communities it is not the most important problem or causing the most concern. Communities face a wide range of social, economic and health problems not directly related to climate change. Many believe solutions to these problems can only be achieved through economic development. Without viable economies, communities will continue to experience social problems. The need for employment places communities in a difficult ethical situation. Industrial exploitation of



fossil fuels and other minerals are the main reasons for the climate change negatively impacting their lives. However, the most viable hope for economic development and survival of communities comes from continued development of these resources. Restrictions placed on their ability to develop natural resources will only add more stress to that currently being experienced by some communities.

December 13, 2009

### Inuit have mixed views on CO2 cuts

By CBC News

A rift is developing among the many Inuit who have travelled from Canada, Greenland and Alaska to attend meetings in Copenhagen, where world leaders have been trying to reach a new agreement to cut greenhouse gas emissions.

The debate causing the split is over the development of oil, gas and uranium mining. All Inuit leaders agree climate change is having a big impact on their communities, with the melting of sea ice, permafrost and glaciers. They're calling on the countries at the United Nations summit in Copenhagen to take action and make serious cuts in greenhouse gas emissions.

But some Inuit leaders argue that if those cuts go through, their communities shouldn't have to comply. Maliina Abelsen, the minister of social affairs for Greenland's self-government, said Greenland needs revenue to achieve full independence from Denmark and meet the needs of its people. To do that, Greenland is counting on developing its oil, gas and mineral sector. Abelsen said the territory can't do that without an increase in its CO2 emissions.

"We have a situation that is fairly comparable to developing countries and economies in transition," she told CBC News this weekend. "Our position is also very similar to that of the developing country."

Abelsen is now the second Inuit leader to call for an emissions exemption for northern communities. A few days ago, the Alaska chair of the Inuit Circumpolar Council made the same suggestion.

That worries Nobel Prize nominee Sheila Watt-Cloutier, an Inuk activist who has travelled the world and won many awards for her work on climate change. The Arctic is feeling the serious effects of a warming climate, she said, and all the world needs to make cuts, including Inuit.

"We must not [be] looking to the quick fixes and not looking at what it is we're going to lose as we move towards the quick fixes," she said.

Watt-Cloutier said there's a contradiction between what some leaders are asking for and what they're willing to do. She called for a meeting of all Inuit leaders from the Arctic, saying they need to discuss the matter in depth.

## 10.5 Problems Facing Social Research on Climate Change in the Circumpolar North

While the above mentioned research projects have added much to the knowledge of socio-economic impacts of climate change they are much more limited in scope than studies conducted by the physical and biological sciences. There are many reasons for the relative absence of social science research.

One reason is the difficulty northern social science projects have obtaining funding. Funding application success rates for social science and humanities research projects are lower than the natural sciences. As the Canadian Final Report to SSHRC and NSERC of the Task Force on Northern Research noted, northern research is extremely costly (2000).

Duerden wrote it is extremely difficult for social scientists to study the impacts of climate change for two reasons (2004). First impacts vary widely by locality. It is extremely difficult to talk about general system wide changes since climate change will be experienced differently by communities in varying environmental zones. These experiences will also have different impacts within communities depending on age, culture and economic position. For some climate change may present new opportunities to resolve current problems communities are experiencing.

### Learning Highlight 8

Social research on climate change is limited due to higher priority being placed on other challenges.

Duerden's second reason highlighted that impacts depend upon the community's ability to respond to changes brought by climate change. Humans are not passive actors. Climate change will bring about responses for any issues created. It is difficult to determine what these responses will be. Duerden underlines an important aspect of social research on climate change in the Arctic will be investigating "determinants of community responses" (206).

Another important factor for the relative absence of social research on climate change in the North is that it is not as high a priority for communities as other social and economic issues. The rapid pace of change the region has experienced over the past 50 years means a range of concerns and stressors affect northern communities. Limited socio-economic research resources have been devoted to studying more discernable problems. Fox notes while "climate change is clearly a concern for the Inuit...it is important to recognize that there are other often more pressing problems facing communities" (2002). As the final report of the Arctic Climate Impact Assessment notes, any attempt to understand potential socio-economic impacts of climate change must also understand other forces with which these communities are dealing. "Indigenous peoples are multiply exposed – to climate change, to changes caused by the global processes affecting markets, technologies, and public policies, and to local and regional political and economic situations" (2005). The report also states it is important to "contextualize climate change impacts with reference to other changes experienced by Arctic residents."

## 10.6 Dealing with Climate Change Impacts in Communities

While there have been barriers to social science's ability to contribute to an assessment of climate change impacts on sustainable development of northern communities, existing research can be helpful for communities dealing with these changes to ensure sustainable development. Consensus seems to be developing that greater community involvement and empowerment is the most appropriate long term solution to assisting communities dealing with these impacts. Any strategy regarding sustainability of Arctic communities must discuss increasing human, social and physical capital.

### Learning Highlight 9

The most effective way of helping communities is by increasing human, social, physical and financial capital.

Much research on impacts of climate change on communities underlines the impacts vary greatly by community. Northern communities need the capacity to deal with the local variant of impacts.

Enabling communities to deal with issues will be more effective than a uniform top-down centralized solution.

Many communities do not yet have the tools necessary to deal with these impacts. While political empowerment of northern communities has increased, capacity issues still need to be addressed. Davidson et al. note northern communities are most vulnerable to climate change impacts because of the degree of physical impacts and lower levels of human and social capital mean they have less capacity to deal with changes (2003). Research by Ford et al. notes the adaptive capacity of northern communities needs to increase for them to better deal with changes brought about by climate change (2007). Referring to Inuit communities in Canada's North, they note the importance of increased Inuit knowledge and land-based skills, support for social networks based on an economy of sharing, flexibility in resource use through local control of resource management, monetary transfers and institutional capacity.

Furgal and Sequin's (2006) highlight the importance of increasing capacity of northern communities as a solution to dealing with the impacts of climate change.

“The ability to overcome changes in access to or availability of country food resources, which are important for nutritional and sociocultural well-being, is significantly influenced by an individual's access to economic resources and technology. The ability to invest more in the required tools and equipment for hunting and traveling, or the access to other forms of transportation (e.g., snow machine, four-wheel all terrain vehicle, flat bottom or larger boat) allows individuals to adapt more easily to changing environmental conditions ...” (1968)

They also stress the importance of generating and sharing of various forms of knowledge as keys to increasing the ability of communities to adapt (1968).

While social science research on climate change impacts in northern communities is limited and additional research will allow more precise discussions of solutions to these impacts, existing research states assistance that helps communities increase their local political, social, cultural and economic empowerment is likely to increase their ability to deal with impacts. In particular, increasing the human capital of communities through education and training programs appropriate to traditional cultures and community knowledge is likely to enhance the ability of communities to meet future challenges imposed by climate change.

## Conclusion

This module discussed the main issues surrounding climate change effects on sustainable development in northern communities. Research on these impacts has been limited. Increased costs will likely result from damage to existing physical infrastructure as melting permafrost contributes to increased erosion in coastal communities and damage to roads, pipelines and buildings. Less sea ice will mean increased access to natural resources and isolated communities. This may increase resource production in the circumpolar North, but be of little benefit to northern communities due to profits and jobs going to people from outside the region. Increased conflicts over sovereignty may result as oil and gas reserves and shipping lanes become more accessible.

Climate change may have a positive impact on fishing, forestry and agriculture, but uncertainties surround these impacts. Reindeer herding is likely to be negatively impacted as are traditional subsistence activities as tundra is diminished by encroaching forests and weather becomes

increasingly unpredictable. Health concerns will rise as a result of climate change related barriers to traditional harvesting.

Despite evidence of significant negative impacts of climate change on northern communities, these communities are uncertain about increasing restrictions on natural resource production. Employment is necessary to ensure sustainable futures and by creating barriers to development of northern resources problems will be added to those caused by climate change.

Social and economic research on the impacts of climate change have been limited for a number of reasons including scarcity of research funding and other higher priority social and economic issues. Social sciences can offer solutions to social, economic and cultural challenges to sustainable development of northern communities and economies created by climate change. While communities have been successful adapting to new situations, the cumulative impact of multiple stressors means communities need increased access to physical, human, social and financial capital. The more communities can increase their level of empowerment, the more they will be able to adapt to challenges brought on by climate change or other forces of change.

### Discussion Questions

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1. To ensure sustainable development, should there be less resource development in the Arctic?
2. What are the most important social impacts of climate change on the sustainable development of northern economies?
3. Are all communities in the Arctic negatively impacted by climate change? How do impacts vary according to region?

### Study Questions

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1. What are the expected effects of climate change on physical infrastructure, transportation and natural resource production?
2. Describe the potential impacts of climate change on agriculture, fishing, forestry and reindeer herding in the Circumpolar North.
3. Illustrate how subsistence activities have changed in response to climate change.
4. Discuss ethical issues surrounding increases in mining and petroleum development in the Circumpolar North.
5. Why is there less social science research on climate change impacts compared to other sciences?
6. Suggest possible ways to increase the ability of the North to develop sustainable communities in the face of climate change.

### Glossary of Terms

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**Sustainable Development:** Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

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