

Progress Report. “Preliminary Science and Policy Perspectives from the ACIA”. Prepared for the Arctic Council’s Senior Arctic Officials Meeting. Svartsengi, Iceland. October 23-24, 2003.

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Arctic Climate Impact Assessment (ACIA)

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Progress Report

“Preliminary Science and Policy Perspectives from the ACIA”

Prepared for the Arctic Council’s Senior Arctic Officials Meeting

**Svartsengi, Iceland
October 23-24, 2003**

Preface and Context:

The Arctic Council is a formal treaty based organization among the eight Arctic Countries (Canada, Denmark, Finland, Iceland, Norway, the Russian Federation, Sweden and the United States of America.) with permanent participation by the six indigenous peoples organizations of the Arctic (Aleut International Association, Arctic Athabaskan Council, Gwich'in Council International, Inuit Circumpolar Conference, Saami Council, Russian Association of Indigenous Peoples of the North). The Ministerial meeting in October 2000 of the Arctic Council, in partnership with the International Arctic Science Committee, established the Arctic Climate Impact Assessment (ACIA) to:

- ***Evaluate and synthesize knowledge on climate variability, climate change, and increased UV radiation and their consequences, and***
- ***Provide useful and reliable information to the governments, organizations and peoples of the Arctic region in order to support policy-making processes and to Intergovernmental Panel on Climate Change’s (IPCC) future work on climate change issues.***

The Arctic Council Ministers in collaboration with the International Arctic Science Committee directed that the assessment include relevant environmental, human health, and social and economic impacts and recommend further actions in a series of formal reports to the Ministers by October 2004. Further, the assessment shall be conducted in the context of other developments and pressures on the Arctic environment, its economy, regional resources, and peoples and shall be based on the best of scientific and technical knowledge, including perspectives of indigenous and other residents of the Arctic. This Background Paper has been prepared by the leadership of the ACIA to provide a context for consideration and informal discussions by the participants in the informal meeting organized by the Norwegian Ministry of Foreign Affairs and the Senior Arctic Officials of the Arctic Council, scheduled for August 5-7, 2003 in Svalbard, Norway. The Paper is organized around two major themes: (i) a preliminary view of the findings derived from the scientific and technical aspects of the Assessment, and (ii) a discussion of issues being addressed during the development of policy aspects and recommendations for action. In both cases, the materials presented in the paragraphs that follow are of a preliminary nature as the assessment documents are currently being submitted to an independent review by scientific, technical, indigenous and other experts not associated with the Assessment in any way, hence the materials herein are drafts and preliminary perspectives prepared exclusively for this meeting.

A PRELIMINARY SYNTHESIS FROM THE SCIENTIFIC ASPECTS OF THE ASSESSMENT:

This document is a preliminary summary or synthesis of the results of the ACIA-process in July 2003, made as a background document for the informal ACIA-meeting in Svalbard August 5-7, 2003. It is emphasized that the statements and conclusions presented here have not yet been formally approved or adopted by the authors, the Assessment Steering Committee of ACIA, or the group responsible for drafting the policy document. Consequently, the document has no formal status, and should be considered as an illustration or example of how the main conclusions and recommendations from ACIA may be presented.

Observed Climate Changes in the Arctic

The climate of the Arctic has been changing rapidly during the last few decades. The observed temperature trends over the three-decade period from 1971-2000 range from a 3°C warming in Alaska, Northern Canada, and Eurasia/Siberia, to a cooling of 0.5°C in southern Greenland/Labrador. Although the observed trends show variations within each region, with some regions even showing cooling, the overall trend for the Arctic is a substantial warming nearly twice the global average over the last few decades. This is in accordance with models predicting that during a global warming the Arctic will be one of the regions with the most significant increase in atmospheric temperatures.

Precipitation has increased in most parts of the Arctic ranging from 10% to 30% increase during the last 30 years.

The year-round ozone trend over the Arctic is about -3% per decade for the 1979-2000 period (about 7% accumulated loss). The spring (March) ozone trend is about -5% per decade for the 1979-2000 period (11% accumulated decline). During episodes that may last for up to two weeks, the ozone values has been 40-45% below normal levels (March-April 1997).

Paleoclimate Insights

Reconstructions of the Arctic climate over thousands to millions of years have demonstrated that the climate of the Arctic has in the past changed considerably, depending on variations in natural forcing. The Arctic climate has changed naturally between glacial periods lasting 10 000-120 000 years and inter-glacials lasting 10 000-15 000 years. Throughout the last million years the Arctic has been through 4-5 of these glacial cycles. The climate variability during the last glacial period that ended 10 000 to 12 000 years was much more pronounced than it is now. When this glacial period ended, the climate changed abruptly (over a 20-40 years period) with an increase in average temperatures of 6-8 °C. During early Holocene (6000-10000 years ago) the average temperatures over most of the Arctic were 1-2 °C higher than they are to day.

Some Additional Observed Changes in the Physical Environment

Many snow and ice features have diminished significantly in extent and volume over the last several decades. Examples are:

- The sea-ice distribution has declined by 10-15% (approximately 1,5 mill km₂) during the last 30 years, and is declining with a decadal rate of 3-5%. The sea-ice thickness has in the same period been reduced with at least 10-20%.
- The distribution of snow cover on the ground has decreased by approx 10% over the last 30-40 years, equal to an annual decrease rate of -61260km₂. Most Arctic glaciers are losing mass. For Alaskan glaciers the estimated annual volume change has been -52 km₃/yr during the last four decades, which is similar to an annual average change in thickness of -0.52m/yr. Repeated measurements for 28 of these glaciers from the mid 1990s to 2000-01 indicate an accelerated thinning of -1.8 m/yr.
- In most parts of the Arctic, the temperature of the uppermost part of the permafrost has increased by 1-2 °C during the last 30-40 years. The consequence is a deeper thaw depth during summer and indications of a declining distribution of Arctic permafrost.
- It is a general trend that the ice season of Arctic lakes and rivers has been reduced. In western Siberian Arctic by as much as one month during the last 150 years. The runoff of Arctic rivers has increased by 10-30% over the last 50 years

Indigenous Observations

Through their way of life, which is closely linked to their surroundings, the indigenous peoples of the Arctic have specific ways of observing, interpreting, and adjusting to weather and climate changes. These peoples possess a rich body of knowledge of their surroundings, based on careful observations, on which to base life-and-death decisions and set priorities. Researchers are working with indigenous peoples to bring together complementary perspectives on many topics, including climate change. Some of the climate variations observed by indigenous groups are shown in Table 1.

Table 1: Some examples of indigenous observations of environmental change

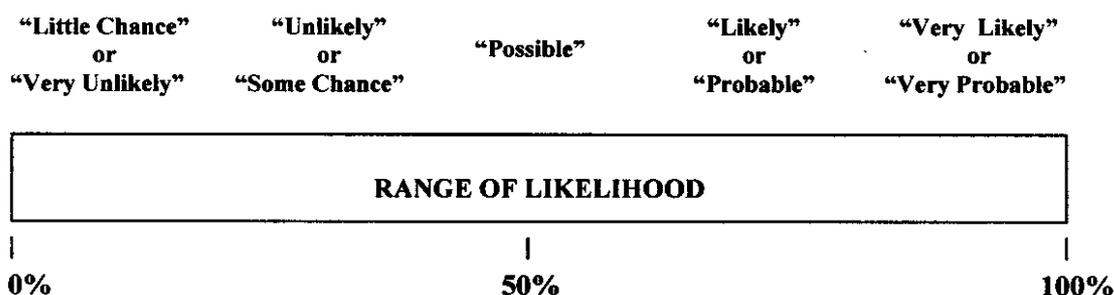
Parameters	Observations	Observed Impacts	
Atmosphere/ Weather/ Winds	More persistent clouds More warm weather Warmer winters in all the regions More extreme weather conditions in last 10-20 years	Sky color is different Later freeze-up Fewer calm days More heavy storms, lasting longer Winds are stronger	Weather patterns are changing so fast that traditional methods of prediction are no longer applicable
Rain/ Snow	Less snow than in the past Snow disappears earlier	Less rain in fall, more rain in spring	Reduced and changing snow cover, including ice layers, affect reindeer herding
Ocean/ Sea Ice	There is less sea ice	Shore-fast ice is	Ice is no longer stable

	and its thinner in winter Later freeze-up and earlier break up	melting faster	in spring and creates dangerous conditions Higher water levels increase erosion of the shoreline
Lakes/ Rivers/ Permafrost	Water levels are lower	Lake ice is thinner	Permafrost thawing is melting ice cellars (Alaska)
Vegetation/ Land	Tree line is moving North into formerly treeless areas (Alaska) Bushes and willows are getting bigger and taller	Land is drier, more susceptible to fire More Arctic cotton and fewer salmonberry plants (Alaska)	Changes in vegetation are affecting animal distribution and hunting practices and success

Indigenous peoples have also made a large number of additional observations on the impacts of climate change on plants and animals. These show the effects of nutritional stresses on many animals, associated with a changing environment and changes in food availability. New species, never seen before in some regions, are coming into the Arctic; these include insects, birds and fish and in some cases mammals like moose and beaver that have increased their northern range.

Levels of Confidence in the Results

In all types of projections, uncertainties of many types can arise, especially for as complex a challenge as projecting ahead 100 years. For the Arctic Climate Impact Assessment we have adopted from a lexicon of terms describing the likelihood of expected changes, as shown below. These terms will be used throughout the ACIA and are based on expert interpretation of the strength and consistency of observational, experimental, and theoretical analyses and results from model simulations that incorporate current scientific understanding.



Projected Future Climatic Conditions

The climate projections of the ACIA are based on results from five global models, each of which has considered the potential changes that would result from two different, but plausible, emission scenarios developed by IPCC (Scenarios B2 and A2). As a group, the models project annual mean temperature increases in the Arctic of about 2.5°C by mid-century and 3.7°C towards the end of the 21st century. In the central Arctic the models project an annual mean increase in temperature of about 5 °C. There is a much larger across-model scatter in projected temperatures for the Arctic than for the rest of the globe, implying that

the uncertainties in the projections are larger here than elsewhere. Temperature increases projected by the five models for the Arctic are nearly twice the projections for global temperatures.

Precipitation is projected to increase by about 8% by mid and about 20% towards the end of the 21st century. The differences among the results from the different models are large, however.

More extreme precipitation events, shorter warmer winters, and substantial decreases in snow and ice cover are among the projected climatic changes.

The models have not been able to simulate abrupt changes in climate which is detected in the paleoclimate records.

Based on model results, ozone levels are likely to show little sign of recovery for the next two decades. In addition, episodes of very low springtime ozone are likely to continue to occur over the next few decades, perhaps with increasing frequency and severity. Ultraviolet radiation in the Arctic is projected to be elevated through the middle of the century due to human-caused ozone depletion.

Projected Future Changes on the Land and Oceans

The model projections indicate an intensification of the recent trends through the 21st century, although the rates of the projected changes vary widely among the models. Models project a 21st century decrease of sea ice by more than 50% in summer; a decrease of snow cover, particularly in spring and autumn; and permafrost degradation over 10-20% of the present permafrost area and a movement of the permafrost boundary northward by several hundred kilometers. Annual river runoff is projected to increase by 5-25%, and the time of peak runoff is expected to come earlier in the year. Earlier break-up of rivers and lakes and later freeze-up, and a sea level rise of several tens of centimeters due to oceanic warming and glacial melting are also projected.

Climate change has already begun to have profound effects on the tundra and boreal forest ecosystems of the Arctic. Over the 21st century, forests are expected to replace a significant proportion of the tundra, a process that will have a very significant effect on the composition of species. While some Arctic species, such as mosses, lichens, some herbivores and their predators, are especially at risk, the number of species is very likely to increase as new species move in from the south and their productivity is very likely to increase due to higher temperatures and CO₂ concentrations. Biodiversity is more at risk in some sub-regions than in others; for example Beringia has a higher number of threatened plant and animal species than any other ACIA sub-region. Freshwater systems in the Arctic are also very likely to experience impacts due to changes in river runoff, river temperatures, and river and lake ice regimes. Changes in water budgets as permafrost thaws will alter the biogeochemistry of many areas and create new wetlands and ponds, in many cases connected by new drainage networks. These changes are very likely to affect the productivity of the systems as well as species composition, with some areas experiencing more robust systems and others experiencing highly stressed systems. Feedback processes are also important; for example, the warming influence of albedo reduction due to forest expansion is likely to dominate over likely moderating influence on the greenhouse effect of increased carbon storage

Increased river runoff is projected to decrease the salinity of the Arctic Ocean, which is very likely to affect sea ice formation, salinity anomalies, and ice export. An ice-free Arctic Ocean in summer is projected by some GCMs by 2080. More open water and the shift of the sea ice boundary away from the coast will affect species abundance and distribution of many arctic

marine ecosystems, including particularly adversely impacting polar bears, walrus, seals and ivory gulls. Assuming there are sufficient nutrients from ocean overturning and river runoff, overall primary productivity appears likely to increase because of the greater area of open water during the warm seasons, and new species are likely to be introduced to the Arctic as a consequence. Northward shifts and changes in the timing of fish migration are likely to occur, increases in fish catches are also possible as a result of higher primary productivity, increased extent of feeding areas, and higher growth rates. However, an increase in the likelihood of serious coastal erosion problems seems likely due to permafrost thawing, increased storm surges due to less sea ice, and sea level rise. This combination of effects is already occurring and is very likely to lead to the need for relocation of vulnerable coastal communities.

A Preliminary Assessments of Impacts on Human Societies

Many Indigenous Arctic cultures depend on hunting polar bear, walrus, seals, and caribou, not only for food, but also as the basis for cultural and social identity. Changes in species ranges and availability, access to these species, travel safety in changing ice conditions, and a growing lack of weather predictability present unique challenges to the future of many cultures. While indigenous peoples have adapted to varying and changing conditions in the past through careful observations and skillful adjustment in subsistence activities and lifestyles, the combined effects of UV- and climate-induced changes and impacts with ongoing social, political, and other environmental stresses will pose serious challenges to them.

Coastal erosion will be a growing problem as rising sea levels and a reduction in sea ice allow higher storm surges to reach shore, and thawing coastal permafrost weakens the land, adding to the vulnerability of coastlines. In some cases, communities will be forced to relocate. Industrial infrastructure in coastal zones also faces increasing risks and costs.

Climate change is likely to have significant impacts on existing buildings, roads, pipelines, and industrial facilities. Degrading permafrost will require substantial rebuilding, maintenance, and investment. Future development will require design elements that will add costs. Transportation and industry on land will increasingly be disrupted by the failure of ice roads and tundra to freeze sufficiently to permit travel.

The projected sea ice retreat is very likely to seasonally open the Northeast and Northwest passages, making trans-Arctic shipping during summer economically feasible within a few decades. Reduced sea ice is also likely to facilitate increased offshore extraction of oil and gas, presenting new economic opportunities as well as environmental concerns.

Commercial agricultural crop production is likely to advance northward throughout the century, with some crops now suitable only for the warmer parts of the boreal region becoming suitable over as far north as the Arctic circle. Average annual yield for all crops will likely increase.

Climate change occurs in the context of other stresses including chemical pollution, oil spills, over-fishing, ozone depletion, and cultural and economic changes. People's ability to adapt is also influenced by a wide variety of factors, and helps determine how vulnerable or resilient they might be to interacting stresses.

Increased UV radiation is likely to directly affect health, including increased incidences of skin cancer, cataracts and viral infections, and effects on the immune system. Climate and UV changes are also likely to exacerbate some other types of health problems, although the

potential for increased availability to advances in technology and emerging disease controls make future projections of these effects difficult to assess.

A Preliminary Assessments of Impacts on the Environment

Retreating sea ice reduces the habitat for polar bear, walrus, ice-inhabiting seals, and marine birds, threatening some species with extinction. Caribou and other wildlife on land will also be increasingly disrupted as a warming climate alters their food sources, breeding grounds, and migration routes. Species ranges are projected to shift northward, on both land and sea.

Treeline is expected to move northward and to higher elevations, replacing a significant fraction of the existing tundra. The summer grazing grounds for caribou/reindeer and the nesting areas of many migrating bird species will thus be compressed. Reduced reflectivity of the land surface due to forest expansion is likely to cause further warming.

Species shifts will alter ecosystems. Increased tree growth in many areas is likely to increase overall carbon storage and provide a greater source of wood products, though in some areas, permafrost thawing will lead to carbon releases. Insect infestations and forest fires are very likely to increase in frequency, severity, and duration.

Projections of Feedback on The Global Climate

Not only will the Arctic be unduly affected as the world warms, but what happens in the Arctic is likely to also have significant impacts on the global climate through different mechanisms, including:

- Melting of reflective Arctic snow and ice (albedo), and increased vegetation on the tundra, increases heat absorption, further warming the planet.
- Increases in glacial melt, precipitation, and river runoff bring more freshwater to the ocean, raising sea level globally and possibly slowing the thermohaline ocean circulation that helps distribute Earth's heat
- Warming of Arctic soils is likely to increase the release of methane, while warming of the Arctic oceans is likely to reduce the uptake of CO₂. These processes may change the Arctic from being a sink to being a source of atmospheric Carbon leading to enhanced increase of greenhouse gases in the atmosphere.

Some Concluding Thoughts from the Scientific Assessment

The Arctic Climate Impact Assessment has completed the first phase of a comprehensive assessment of the consequences of climate change in the Arctic, as the chapters of the scientific and technical document are currently being subjected to the independent external expert review process. An essential conclusion is that climate change is likely to affect every aspect of life in the Arctic region. We should caution, however, that assessment of the expected impacts of climate and UV changes is a difficult long-term undertaking and that the conclusions presented here, while as complete as present information allows, are only a step in what must be a continuing process. There are likely to be future surprises, such as relatively rapid shifts in the prevailing climatic regime shifts or frequency and intensity of extreme events that will be difficult if not impossible to predict. Over coming years, however, as additional data are gathered, as a better understanding of the complex processes, interactions and feedbacks is developed, and as model simulations are refined findings and projections will be able to be made with more and more confidence. As our understanding of the climate system steadily improves, it will be possible to also increase the usefulness of projections of the likely impacts in the Arctic region, allowing more specificity in planning how best to adapt and respond.

CONCLUDING THOUGHTS:

The ACIA process began with the charge issued at the Arctic Council Ministerial meeting in October 2000 and will conclude its formal work by submitting three documents (the Scientific and Technical Document, the Overview Document, and the Policy Document) to the 2004 Ministerial meeting of the Council in the fall of 2004. The process following the August 5-7, 2003 meeting in Svalbard will consist of the preparation of revised drafts of all the documents based on the expert and other reviews conducted in the months ahead in anticipation of submitting revised documents and supporting materials to the Senior Arctic Officials (SAO) for their consideration at the Spring 2004 SAO meeting in Iceland. Further, there will be “in-country” and other briefings on both the science and policy materials from the Assessment during the fall and early winter 2004 months by the leadership of the ACIA. Following the Spring SAO’s meeting, the Assessment Steering Committee will complete the final reviews required by the Implementation Plan and prepare all documents for publication and submittal to the SAOs and the Ministerial meeting of the Arctic Council and to the International Arctic Science Committee in the fall of 2004.