International Arctic Science Committee

IASC

THE 1998 IASC ANNUAL MEETINGS

REPORTS

26 - 28 APRIL

FAIRBANKS, ALASKA, USA

Three separate meetings were held in Fairbanks. The Regional Board Meeting, the Annual Meeting and the Council Meeting. Full reports of the Regional Board and Council meetings have been distributed to members and observers at these meetings.

This report focuses on the **Annual Meeting**. As several of the contributions are of interest to a wider audience than those attending the meeting, our intention has been to report more fully from this meeting.

In the **Executive Summary** you will find a brief summary from the Regional Board Meeting, and some highlights from the Council Meeting.

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IASC

1998 IASC Meeting Report
Fairbanks, Alaska, USA

Executive Summary

The following IASC meetings were held in Fairbanks, Alaska:

26 April (afternoon):	Regional Board Meeting
27 April:	Annual Meeting
28 April:	Council Meeting (morning), Information Session and Visits after lunch

See **Enclosure 1** for a list of participants.

THE REGIONAL BOARD MEETING

This body consists of one representative from each of the Arctic countries, and this representative is typically a director or key person of a polar science agency. Their main task is to develop the IASC relationship to Arctic Council and consider science needs as seen from the Arctic countries. The Chairman represents IASC at high level meetings of the Arctic Council, and reports to the IASC Council and Executive Committee in addition to the Regional Board.

Issues at this meeting were: Arctic Council developments (see Council Meeting summary below), Major National Events and Priorities, and the Forum of Operators.

National Events is an information session, whereas the **Priorities** session was to provide mutual information and was also to provide an input to the Arctic Priority Session of the Annual Meeting.

The Forum of Operators was a proposal agreed upon both by the Regional Board and Council last year, aiming at creating a forum for major arctic operators, such as owners of arctic research ships and stations. Members were informed that a first meeting will be held on 28 August this year in Tromsoe, Norway.

THE ANNUAL MEETING had two themes:

- **Impacts and Effects of Global Change in the Arctic,** and
- **Arctic Priorities**

The contents of these sessions are reported fully in this report.

THE COUNCIL MEETING has gradually changed as IASC has developed, and now focuses on policy issues.

Attendance at Council Meetings:
Council agreed that their meetings should be open to invited observers, except for elections or any other item requiring a closed session.

Criteria and Procedures for Evaluating Project Proposals
IASC has developed a project planning guide for leaders of project groups. However, more specific criteria and procedures for evaluating project proposals at various stages are needed. See **Enclosure 2** for details.

Arctic Council (AC)
AC adopted the Rules of Procedure on 4 February, 1998. IASC is one of the accredited observers to AC. The major items on their agenda are:

- Oversight of subsidiary bodies (AMAP, CAFF etc.)
- Oversight of projects (for instance suggested by indigenous peoples)
- Sustainable Development
- University of the Arctic (a network between existing universities)
- Policy issues of importance to Arctic Council members.

IASC Council agreed to be pro-active and provide Arctic Council with the best scientific advice. Some information actions were agreed, as well as initiating a science/policy dialogue.

Arctic Science Summit Week
The main contents of this proposal was to identify a week each year in which arctic science organisations are invited to have their annual or other meetings (back to back). The rationale was to save travel expenses and time (as many are going to several of these meetings), to foster closer contact between organisations, and to attract more funding and policy representatives by making this event *the* meeting place for arctic science.
Council agreed to the proposal, and that IASC should take a lead by inviting other organisations to join in this week (or days).

Next Meeting: During the last week of April, 1999 in Tromsoe, Norway

Election of New Vice President
Dr Alf Haakon Hoel, Norway, was elected as new Vice President, to serve for a 4-year period.

Annual Meeting Report Contents

Session 1

IMPACTS AND EFFECTS OF GLOBAL CHANGE IN THE ARCTIC

Introduction by Dr. David J. Drewry, UK - President of IASC

Climate change is occurring in the Arctic, or rather in parts of the Arctic. Compilation of air temperature over the last decades show a few degrees warming in Alaska, Western Canadian Arctic and Siberia, whereas in other areas of the Arctic the change is less. Global warming is one of the hot political issues (Kyoto), and the Arctic is making a contribution to our knowledge about global changes. However, for both the natural arctic environment and for those living in the Arctic, **the impacts and effects** of these changes are more important than the changes themselves.

A pioneering study in this field in the Arctic was the McKenzie Basin Study (MBIS), which will be presented by Barrie Maxwell, who actively took part in this study. He is also the author of *The Canada Country Study: Climate Impacts and Adaptation, vol. II: Responding to Global Climate Change in Canada's Arctic.*

Inspired by MBIS, IASC initiated the planning of two impact studies: The Barents Sea Impact Study (BASIS) and the Bering Sea Impact Study (BESIS). Both studies cover adjacent land and islands in addition to the seas, and both studies have passed the planning stage and are well into implementation. Dr Gunter Weller, who has been a driving force in both Arctic and Antarctic global change studies, will report on achievements done by BESIS.

Recently, the International Panel on Climate Change (whose past chairman is one of the IASC Council members and Vice President, Dr. Bert Bolin), has adopted a regional approach. The Arctic is one of the regions and their first regional reports are now being published.

AMAP and CAFF held a workshop earlier this year to consider impacts of climate change in the Arctic. They concluded that as rather extensive impact studies are ongoing in the Arctic, they will mainly build on these studies.

BESIS ACHIEVEMENTS

by Dr Gunter Weller, Alaska, USA.

BESIS is supported by the US Global Change Program, and contributes to the Arctic part of their regional assessments. Scientists from Canada, Russia, Japan and China are involved in BESIS in addition to US scientists.

Impacts are important to humans, and the scientists need to communicate with a variety of stakeholders, hence the presentation was built around a number of diagrams used in communication with stakeholders.
Texts from most of the diagrams used are found on the next pages, and they speak for themselves.
One interesting diagram was unfortunately impossible to reproduce properly, namely *Arctic Temperature Trends* 1961-80, Annual Data, and a separate one for Winter Data covering all the Arctic. This compilation done by Dr. John Welsh shows a significant warming for this period for Alaska, Western Arctic Canada, Russian Arctic and Siberia. Greenland and Baffin Island experienced, however, slightly cooler weather. (This and other diagrams may be found on the BASIS homepage).

Further information:

See the BESIS homepage at:
http://www.besis.uaf.edu which can be recommended.

The Report from their latest workshop is now available:

Implications of Global Change in Alaska and the Bering Sea Region.
Published by: Center for Global Change and Arctic System Research, UAF, Fairbanks, Alaska. 155 pages.

Global warming in Alaska

What is the problem? **How serious is it?**

Who will be affected? **What can we do?**

"It would be unwise and potentially dangerous to ignore the mounting concern (about climate change)".

John Browne, CEO, British Petroleum
May 1997

How will warmer temperatures affect Alaska?

Will changing weather affect our forests and wildlife?

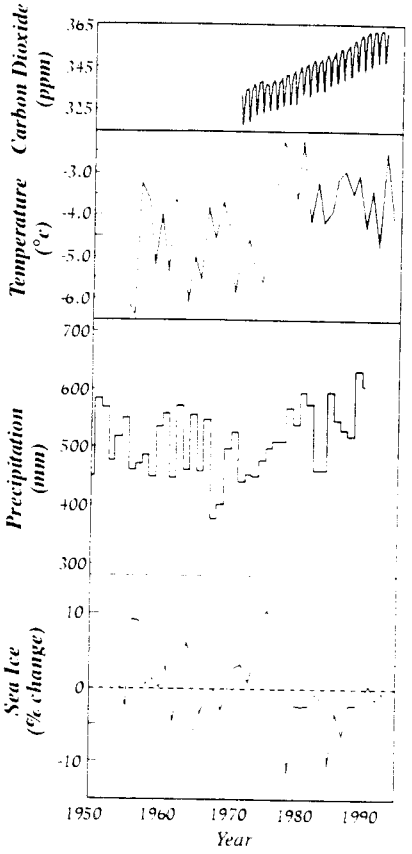
Will warmer water affect our fisheries?

Will summers be drier?

Will permafrost thaw?

What is the Problem?

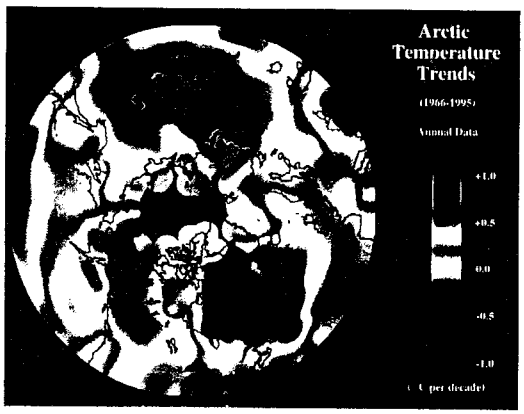
Climate changes for many reasons. Changes in solar energy, increased greenhouse gas concentrations, volcanic eruptions and El Nino phenomenon, all affect Earth's temperature. Variances in rain and snowfall accompany changes in temperature. Human activities have increased greenhouse gas concentrations in the atmosphere. At Barrow, Alaska, atmospheric carbon dioxide concentrations have increased steadily since the 1970's. Across Alaska, temperatures rose abruptly in 1976 and have remained high, and the extent of sea ice in the Bering Sea has decreased. Increased greenhouse gas concentrations are thought to be a major cause of the global warming observed over the last 100 years. Climate models predict further warming with continued increases in greenhouse gas concentrations.



Shown above are data sets from Alaska: Carbon dioxide at Barrow, combined temperatures from four stations, precipitation results from stations throughout Alaska and sea ice changes in the Bering Sea.

In the Arctic:

Most of the Arctic has warmed over the last 30 years, particularly over large land masses. Shown at right are mean observed annual temperature increases per decade from meteorological observations. Warming in winter has been even greater than trends shown here.
(figure from Chapman and Walsh, 1993, updated).



What are Greenhouse Gases?

Gases that trap heat radiated from Earth's surface are commonly called "greenhouse gases". Carbon dioxide, methane, nitrous oxide, and water vapor occur naturally in Earth's atmosphere and make Earth's temperature warmer than it would be if they were not present. The atmospheric concentration of these gases has increased since the industrial revolution. Other gases introduced by humans, such as chlorofuorocarbons (CFC's), also act as greenhouse gases.

Climate Change in Alaska Affects the Nation

Alaska has the largest parks, wildlife refuges and preserves in the U.S. It also produces 20% of U.S. domestic petroleum consumption.

The Bering Sea contributes over half of the United States fishery production. These fisheries support some of the largest populations of seabirds and marine mammals in the world.

How serious is it and who will be affected?

Climate change has already had serious consequences in Alaska. If present trends continue as predicted, these effects will become more pronounced. Some of them will be positive, some negative.

Fisheries

- Salmon catches in Bristol Bay dropped precipitously in 1997, probably due to the climatic effects of El Nino
- Fisheries in other areas may benefit from climate change as fish stocks change location.

Permafrost

- Thawing permafrost leads to the collapse of roads, buildings, and airfields.
- Maintenance costs for roads and other facilities on permafrost, including pipelines, increase.

Subsistence

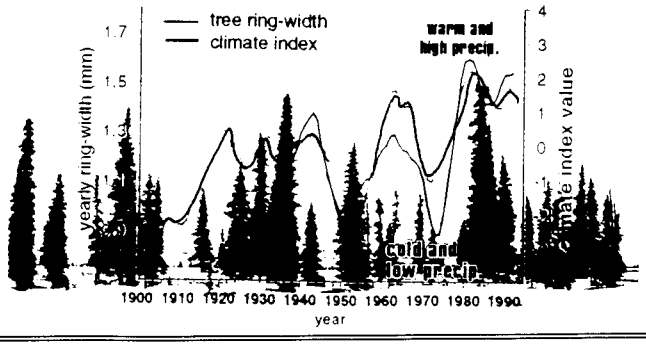
- Changing climate and snow conditions may reduce hunting success for caribou and moose.
- Less and thinner sea ice make walrus, seal and whale hunting more difficult for Natives.

Wildlife

- Changing climate and snow conditions lead to population changes of Alaska's wildlife.
- Habitats, reproduction, food availability, and migration routes may change drastically.

Forestry

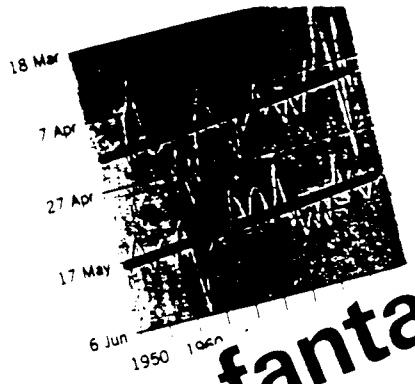
- Forest growth in the interior will further decrease from climatic stresses and higher fire incidence.
- In coastal and mountain regions growth will improve but forests will become more vulnerable to insect outbreaks.



Climate change since the late 1970's has resulted in the best growing conditions for spruce in south-central Alaska in the 20th century (see graph at left), but spruce bark beetles thrive in the new conditions and have killed trees on millions of acres.

Life on the edge

Island villages fight erosion, ponder move to safer ground



Global warming is no fantasy

Gunter Weller

Guest Opinion

The majority of scientists ... studying climate change ... d confidence in the ... concerns about ... f this climate ... tated in a ... over L... ries, ...

Spring comes early to Fairbanks

Phenomena and models give reason for concerns

The deliberations by rep... ...es from more than 160 c... ...ich recently took place i...

Baked Alaska

The icy state is thawing. Will the US Congress now take global warming seriously?

KLIMA

Warnsignale aus der Arktis

In weiten Teilen Alaskas, Nordwestkanadas und Sibiriens heizt sich das Klima auf. Ganze Landstriche verändern ihr Gesicht: Gletscher schwinden, Wälder sterben, der Permafrostboden taut auf. Erster Akt des globalen Klimawandels durch den Treibhauseffekt?

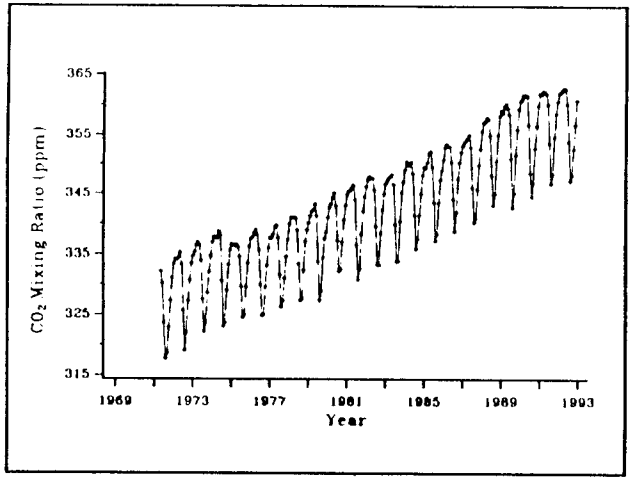
'Seward's Icebox' defrosting

Alaska feels effects of global warming

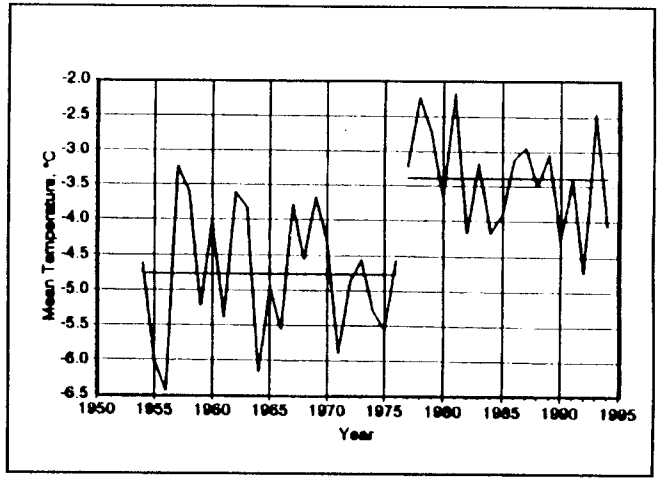
GLOBAL WARMING: Interior heats up

Consensus Emerges Earth Is Warming—Now What?

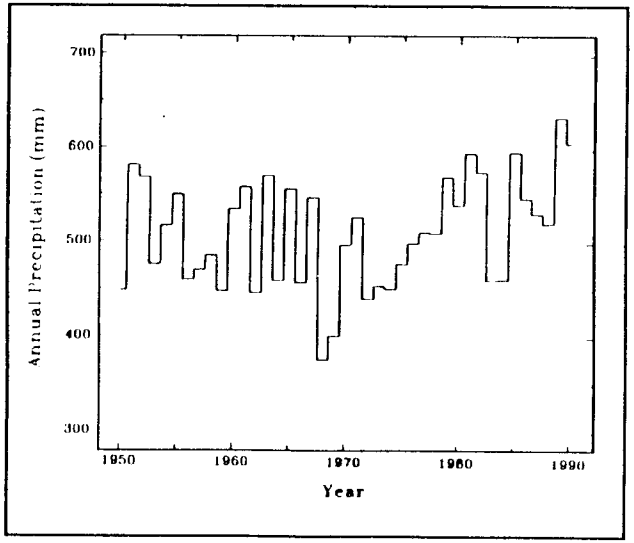
CLIMATE-RELATED OBSERVATIONS IN THE BERING SEA REGION



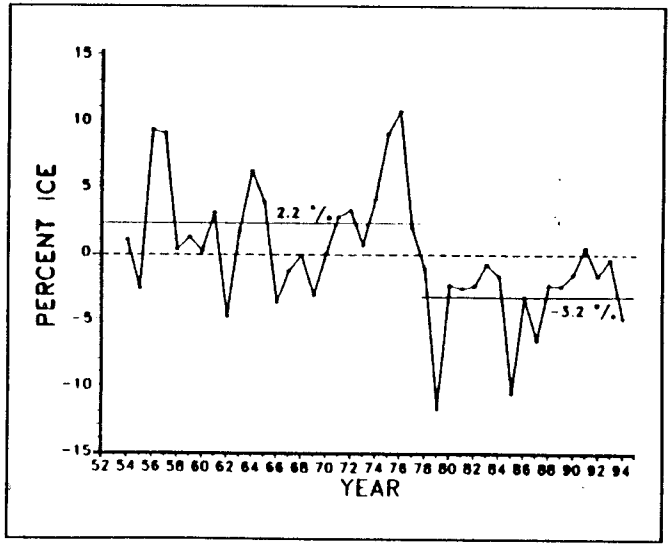
Atmospheric CO_2 concentrations at Barrow (Conway et al. 1994)



Combined annual air temperatures in Alaska (Bowling 1995)



Precipitation in Alaska west of 141° (Groisman et al. 1994)



Changes in sea-ice extent in the Bering Sea (Niebauer 1995)

Observed Changes

- Air temperatures over most of Alaska have increased by 3-4°C in winter/spring from 1961-90, and ~1°C in summer (Chapman and Walsh 1993).

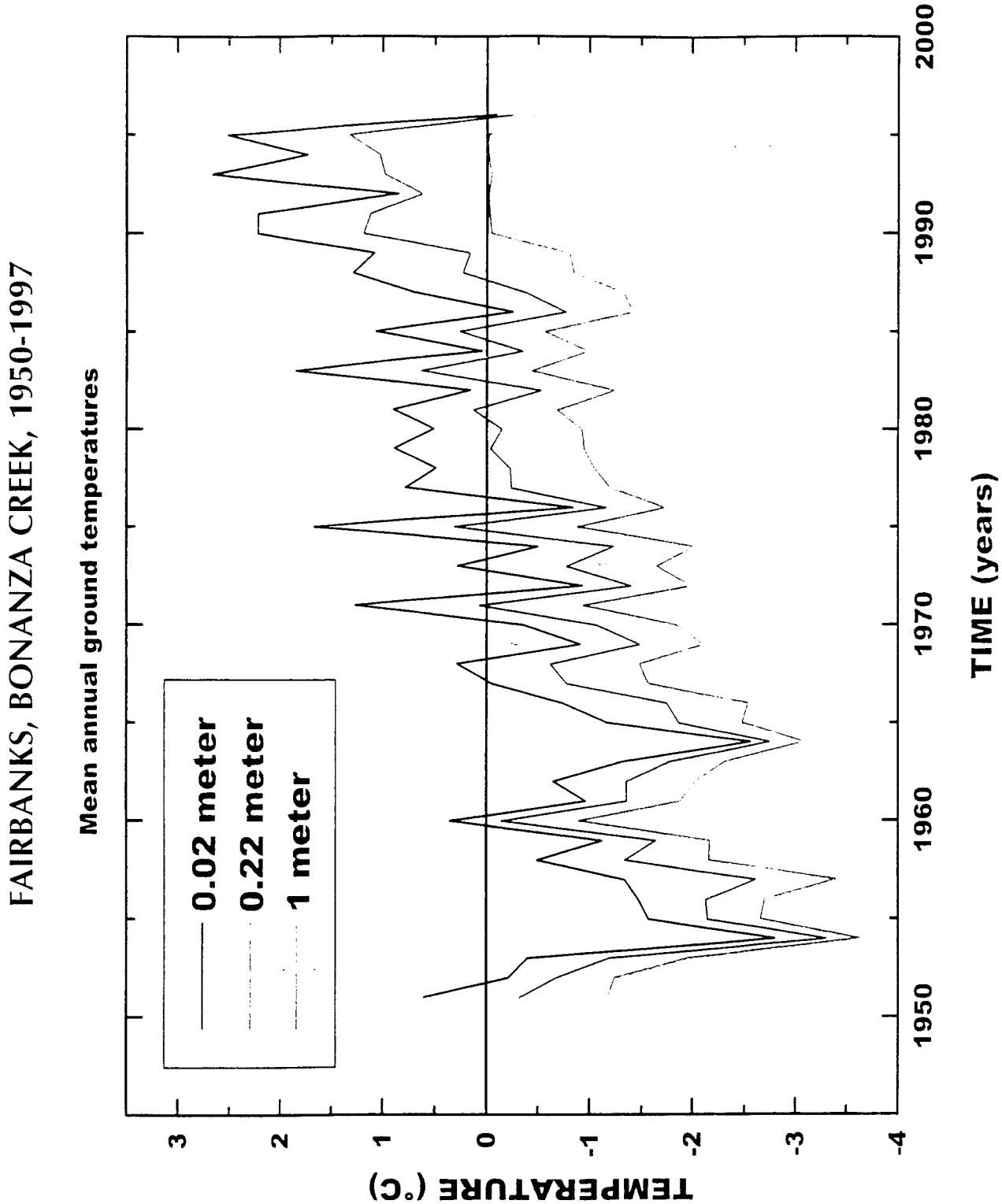
- Annual snowfall has increased from 1950-90 by ~20% in Canada (N of 55°) and ~11% over Alaska (IPCC 1995).

- Cyclone and anticyclone frequency has increased over the Arctic between 1952-89 (IPCC, 1995).

- Sea ice extent in the Bering Sea has been reduced by about 5% over the last 40 years (Niebauer 1995), with the steepest decrease occuring in the late 1970s.

- Glaciers have generally receded, with typical ice thickness decreases of 10 meters over the last 40 years (Harrison 1996).

- Borehole measurements in permafrost have shown warming of up to 2-3°C over the last 100 years in some areas, also thawing at both top and bottom in the discontinuous permafrost areas (Osterkamp 1995).

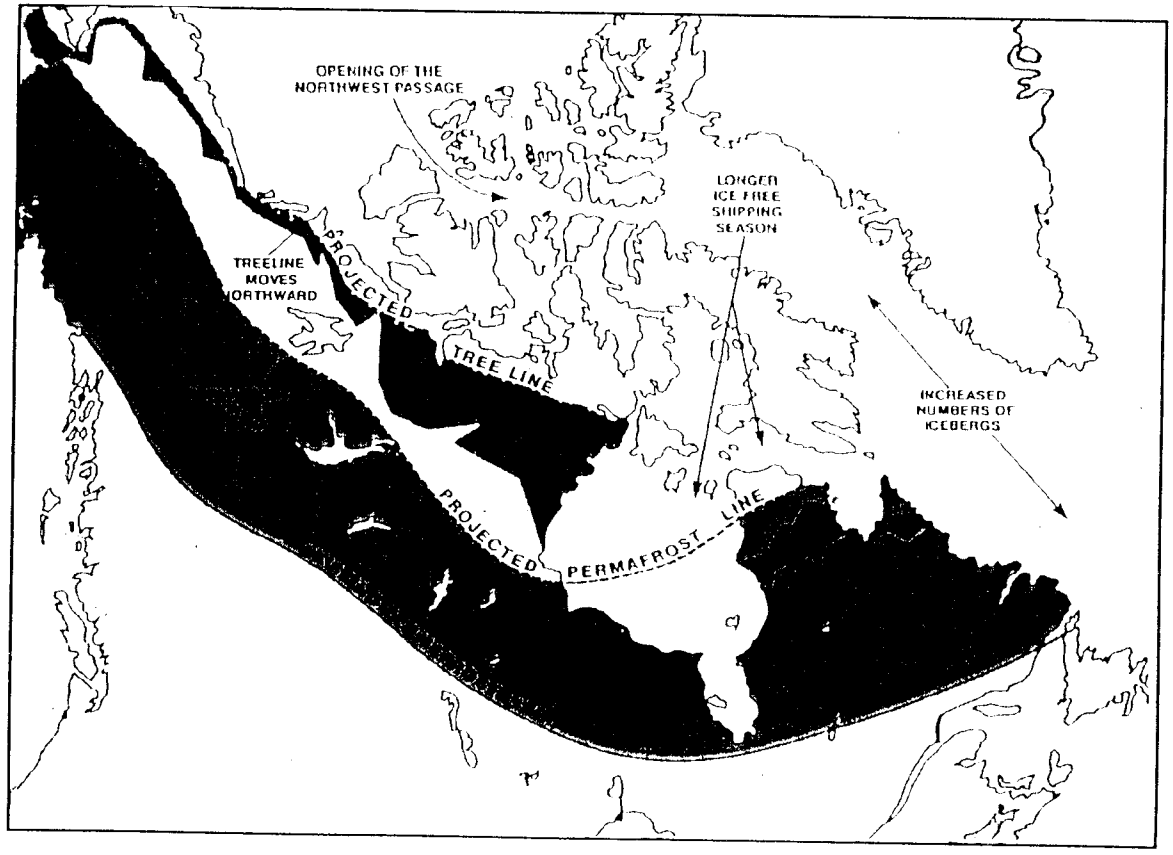

FAIRBANKS, BONANZA CREEK, 1950-1997
Mean annual ground temperatures
0.02 meter
0.22 meter
1 meter
TEMPERATURE (°C)
3
2
1
0
-1
-2
-3
-4
1950
1960
1970
1980
1990
2000
TIME (years)

Expected Changes

(for a doubling of CO_2; from IPCC 1995 report)

- Pronounced reductions in seasonal snow, permafrost, glaciers and periglacial features, with corresponding shift in landscape processes (High Confidence).
- Increases in the thickness of the active layer of permafrost and disappearance of extensive areas of discontinuous permafrost (High Confidence).
- Disappearance of up to a quarter of the present mountain glacier mass (Medium Confidence).
- Less ice on rivers and lakes. Later freeze-up and earlier break-up (Medium Confidence)
- Substantially less sea ice in the Bering Sea and Arctic Ocean (30-50% for the latter) and reduction in ice thickness. (Medium Confidence).
- Poleward migration of treeline and establishment of new ecosystems as entire forest types disappear (High Confidence).
- Change in the migration patterns of polar bears and caribou (High Confidence).
- Fisheries and marine mammal displacements due to ocean temperature and sea ice changes. Many species shift poleward about 150 km for every 1°C temperature increase (High Confidence).

Projected northward movement of the permafrost boundaries and treeline, after a doubling of atmospheric CO2

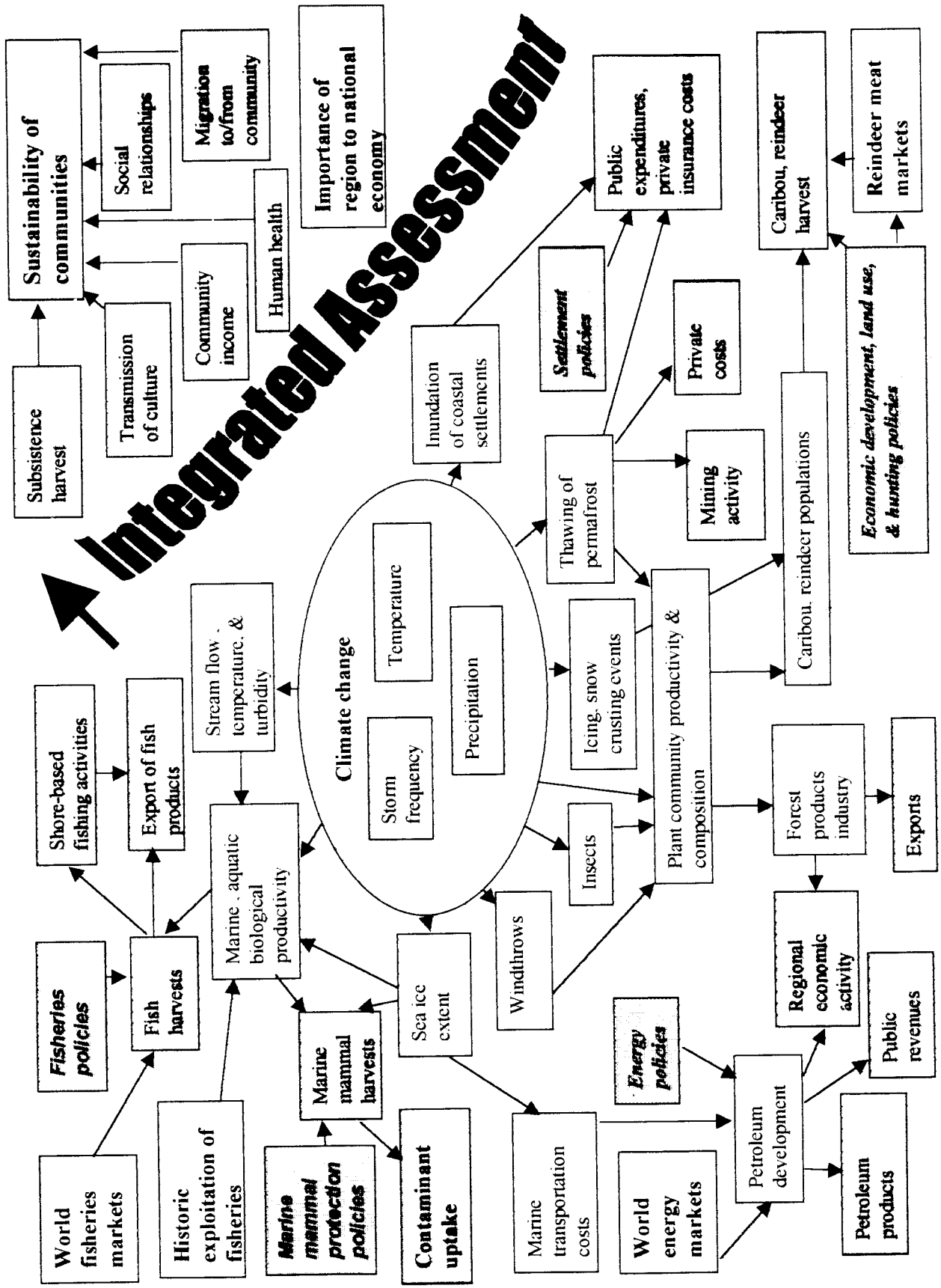


(from Environment Canada, 1989; extrapolated into Alaska)

SOCIO-ECONOMIC IMPACTS THAT HAVE OCCURRED OVER THE LAST DECADE

(indicating whether they have positive (+) or negative (-) impacts on human activities)

- A warmer climate has **lengthened the growing season** for agriculture and forestry, producing higher yields (+)
- **Boreal forests are expanding north** at the rate over 100 km for each 1°C temperature increase, thus increasing potential yields (+)
- With less sea ice in the Bering Sea, storm surges have caused **increased coastal erosion and inundation**, and threats to structures (-)
- Subsistence lifestyles have been affected, for example through changes in sea ice conditions making **hunting on ice more dangerous** (-)
- The **availability of marine mammals for subsistence is lower,** due to changes in oceanographic and sea ice conditions (-)
- A warmer climate has also **thawed traditional ice cellars** in several northern villages in Alaska, making them useless (-)
- Human health problems have increased, due to new **diseases moving north** (-)
- **Major increases in catches of Alaskan salmon** have occurred in recent years, due to the increase of El Niño conditions since the mid-1970s (+)
- The same conditions have **unfavorably affected Pacific Northwest and Canadian salmon stocks** due to increased smolt predation and adverse streamflow (-)
- Accelerated permafrost thawing has led to **costly increases in road damage and road maintenance** (up to $3 million to replace 1 km of road system) (-)
- Permafrost thawing has also caused **major landscape changes** from forest to bogs, grasslands and wetland ecosystems, affecting land use (-)
- **Increased slope instability, landslides and erosion** have occurred in thawing permafrost terrain, threatening roads and bridges, and causing local floods (-)
- But disappearance of permafrost also **reduces construction problems**; in some areas permafrost boundaries have moved north by over 100 km in the last century (+)
- The warmer climate has caused forest problems such as **increased fire frequency and insect outbreaks** which have reduced economic forest yields (-)


Integrated Assessment
Sustainability of communities
Subsistence harvest
Transmission of culture
Community income
Human health
Social relationships
Migration to/from community
Importance of region to national economy
Public expenditures, private insurance costs
Settlement policies
Private costs
Inundation of coastal settlements
Thawing of permafrost
Mining activity
Economic development, land use, & hunting policies
Caribou, reindeer harvest
Reindeer meat markets
Caribou, reindeer populations
Climate change
Temperature
Precipitation
Storm frequency
Stream flow, temperature, & turbidity
Shore-based fishing activities
Export of fish products
Icing, snow crusting events
Plant community productivity & composition
Forest products industry
Exports
Fisheries policies
Fish harvests
Marine, aquatic biological productivity
Insects
Windthrows
Sea ice extent
Regional economic activity
Public revenues
Energy policies
Marine mammal harvests
Marine mammal protection policies
Contaminant uptake
Marine transportation costs
Petroleum development
Petroleum products
World energy markets
Historic exploitation of fisheries
World fisheries markets

What can we do?

Climate change presents unique challenges. We need to develop strategies for responding to these challenges. Where do we begin? What can society and individuals do?

- Become informed about climate change, its causes and consequences.
- Apply knowledge about climate change to federal, state and local planning.
- Prepare to adapt to climate change, e.g., protect coastal areas from erosion.

Reduce greenhouse gas emissions by:

- *developing sound environmental policies.*
- *using alternative energy sources, e.g., solar power.*
- *being frugal in energy consumption.*

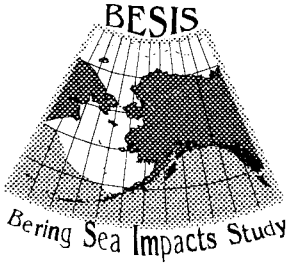
Encourage support of scientific investigations on these issues.

"More research is needed on the detail of cause and effect, on the consequences of what appears to be happening, and on the effectiveness of the various actions which can be taken".

John Browne
CEO, British Petroleum
May 1997

We are just beginning to understand climate change and its possible consequences. Our current knowledge indicates that we cannot ignore these issues. Accurate predictions and increased effectiveness in planning will require further study.

The Assessment of the Consequences of Climate Change in Alaska and the Bering Sea region was funded by the U.S. Global Change Research Program, the National Science Foundation, the U.S. Department of the Interior, and the International Arctic Science Committee.
For more information, contact the Center for Global Change and Arctic System Research at the University of Alaska Fairbanks. **Phone:** (1-907) 474 5698 **FAX**: (1 907) 474 6722
Web site: http://www.besis.uaf.edu



LESSONS FROM THE MACKENZIE BASIN IMPACT STUDY (MBIS)

by Barrie Maxwell, Downsview, Ontario, Canada

The MBIS was undertaken during 1991 to 1996, and was the first major impact study in the Arctic. It was undertaken through the Environmental Adaptation Research Group of Environment Canada, with Dr. Stewart Cohen as Project Leader.

The diagrams on the next pages outline some of the MBIS results and lessons and are mainly based upon the MBIS final report.

If you wish to know more about MBIS you are referred to:

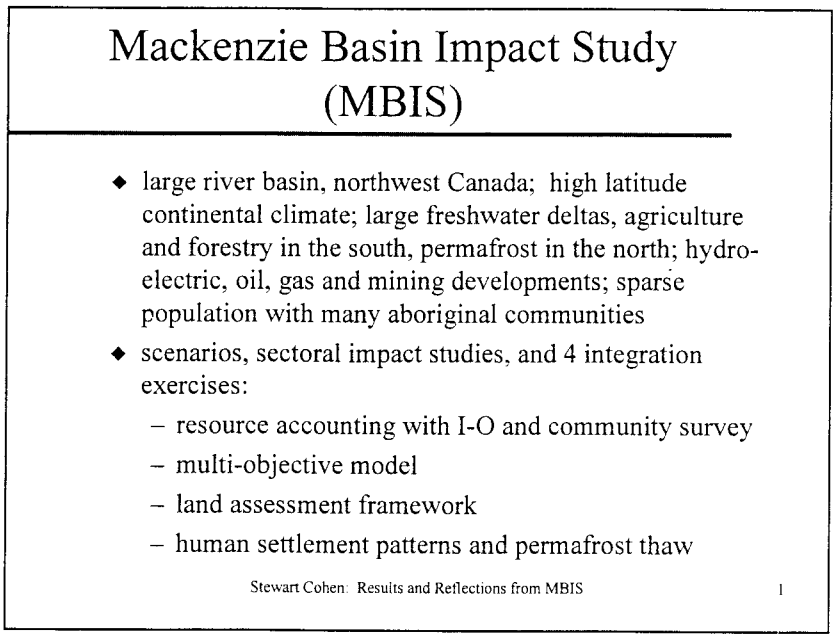
i) Cohen, Stewart J.; ed.
Mackenzie Basin Impact Study. Final Report, North York, Ontario: Environment Canada. 372 p., 1997

ii) Cohen, Stewart J.
What If and So What in Northwest Canada: Could Climate Change Make a Difference to the Future of the Mackenzie Basin? Arctic. Vol. 50, No. 4 (December 1997). P. 293-307

MBIS was one of three regional impact studies initiated by Canada, the others being for the Great Lakes-St. Lawrence River area and for the Praries. These were used as a basis for conducting a national climate change impacts study for the country as a whole - known as the Canada Country Study (CCS). A number of reports were completed as part of the CCS, including 6 regional volumes. Volume II deals with Canada's Arctic.

The Mackenzie Basin Impact Study (MBIS) Final Report is now available on the Environmental Adaptation Research Group (EARG) Web site. Go to the web address: **http://www.tor.ec.gc.ca/earg** and navigate to *publications* and *Stewart Cohen*.

Barrie Maxwell



Observed Climate Change Impacts for MBIS Region

- increase in air temperatures by 1.5 C
- ground surface temperatures rising faster than air temperatures in much of Alberta
- 3400 landslides due to permafrost thaw in Mackenzie Valley and Beaufort Sea coastal zone; 3/4 in sites with ice rich Quaternary sediments; shoreline retreat of up to 100 metres since 1940s at sites near Tuktoyaktuk
- top 5 years for forest fires (area burned) occurred since 1980
- August-Sept. water levels at Great Bear Lake have declined since the early 1960s by approximately 1/3 metre
- residents in Peace-Athabasca Delta have reported decreases in population of muskrat due to lower water levels

Stewart Cohen: Results and Reflections from MBIS 2

Scenario of Climate Change Impacts for MBIS Region (1)

- increased permafrost thaw and landslides, particularly in ice-rich and sloping terrain in Mackenzie Valley and Beaufort Sea coastal zone
- ecosystems may change dramatically; peatlands in Alberta may disappear, while new ones could emerge in the lower Mackenzie Valley; some wildlife may be adversely affected, such as caribou and cold water fish species
- basin runoff projected to decline slightly with an earlier start to spring peak; water levels projected to decline at Great Slave and Great Bear Lakes during fall/winter

Stewart Cohen: Results and Reflections from MBIS 3

Scenario of Climate Change Impacts for MBIS Region (2)

- increased forest productivity, but decreased tree age and forest yield because of increased fire frequency
- there would be increased uncertainty in planning and maintaining infrastructure, such as roads, pipelines, tailing ponds and water-based transportation facilities; a longer summer would not necessarily improve operating conditions for resource extraction industries
- economic impacts are difficult to measure; agriculture may benefit, but other renewable resources (forestry, tourism) may not
- community impacts would depend on permafrost thaw rates, changes in resource potential, future economic and institutional changes; potential responses of aboriginal and resource-based communities to climate change are not yet known

Stewart Cohen: Results and Reflections from MBIS 4

Some "So What" Questions for Stakeholders

- **changing water levels**: implications for water management, ecosystems, parks, navigation
- **changing land & ice capabilities**: how would this change land use patterns, infrastructure
- **changing fire weather**: implications for fire management for current and future land use patterns
- **renewable resource impacts and non-renewable resource development**: would climate change encourage or discourage expansion of the wage economy (or not make any difference)

Stewart Cohen: Results and Reflections from MBIS 5

MBIS Final Workshop: Stakeholder Responses & Recommendations(1)

- the climate change impacts scenario was a new vision of the future for regional stakeholders
- in most cases, this new vision did make a difference to stakeholders, particularly in relation to long term planning
- there was tension during the discussion on responses; some were resigned to reactive adaptation; others preferred proactive adaptation, but this was not defined; there were suggestions to intervene in policy debates within professions (e.g. forestry, permafrost engineering) and at other scales (national? international?)

Stewart Cohen: Results and Reflections from MBIS 6

MBIS Final Workshop: Stakeholder Responses & Recommendations (2)

- global warming represents a different kind of environmental problem, so it requires a different approach to consultation and communication; current mechanisms in governments and aboriginal organizations are not satisfactory
- a specialized atmospheric change secretariat, based in the region, could be a focal point for archiving information, facilitating communication and coordinating activities; this would require regional shareholders
- plain language reporting is needed

Stewart Cohen: Results and Reflections from MBIS 7

Assessment of Integration Process

- successful information exchange across projects, but some missed opportunities
  - coordination, timing of outputs
  - data base formats (including GIS), mismatch of scales
  - aboriginal opinions considered, but TEK not used in quantitative models
  - confidentiality
- integrated modelling exercises did not attract attention
  - methods not well understood
  - limited amounts of information used from other MBIS projects
  - no new insights (due to data limitations and narrow framing of impact scenarios by modellers?)

Stewart Cohen: Results and Reflections from MBIS 8

Lessons for Integrators

- scientist-stakeholder collaboration requires considerable effort, but it improves the integration process; study secretariat very important
- study area could be defined in various ways
- scenarios and assumptions must be consistent across sectoral analyses
- additional criteria needed when reviewing proposals for integration; some models have stringent data needs
- common platform for GIS
- communication must include personal contact between scientists and stakeholders (not just publications or electronic media)
- choice of impact indicators should be specific to each region/country
- no single best method for integration; assessment should be driven by goals/issues, not analytical tools

Stewart Cohen: Results and Reflections from MBIS 9

Next Steps

- regional impacts and adaptation as part of integrated assessment and integrated assessment models
- linkage with existing resource management and policy instruments
- create opportunities for community-based monitoring
- identification of indirect impacts with the focus on places, rather than sectors
- incorporation of local (traditional) knowledge

Stewart Cohen: Results and Reflections from MBIS 10

Impacts on Terrestrial Ecosystems

by Dr Walter Oechel, San Diego, California, USA

Summary:

Following the International Conference on Arctic Research Planning (ICARP) in December 1995, a joint IASC-GCTE (Global Change and Terrestrial Ecosystems) Working Group was established and given responsibility for implementing "Feedbacks from Arctic Terrestrial Ecosystems" (FATE). This group is now also endorsed by IGAC (International Global Atmospheric Chemistry, IGBP), BAHC (Biospheric Aspects of the Hydrological Cycle, IGBP) and ARTERI (Arctic-Alpine Terrestrial Ecosystem Research Initiative).

The goal of FATE is "to understand, quantify, and predict patterns of response of Arctic terrestrial and freshwater ecosystems to global change, and the feedbacks from these ecosystems to the climate system".

Current Activities

Circumpolar flux study map

As an initial step in a five year plan reviewing the current state of arctic trace gas flux studies, the Working Group has established a circumpolar map of past, present and planned CO_2 and CH_4 as well as energy exchange studies. Based on this map, a proposal will be written to cover costs for a workshop on the current state of arctic trace gas studies identifying gaps in our coverage. This workshop should help initiate a number of international science proposals aimed at filling the identified gaps. It is hoped that this in turn will result in these gaps being filled within the proposed five-year period. The map initiative has been endorsed by IGAC and recognition has also been sought from BAHC.

Biodiverstiy workshop

The Working group will organise a workshop on "Biodiversity and feedbacks in Arctic ecosystems". The workshop will focus on the links between species distribution and energy and trace gas exchanges, and identify suitable themes for the development of international research proposals to fill gaps in these areas.

CONGAS

The "trace gas" subgroup developed the CONGAS proposal (Biospheric controls on trace gas fluxes in northern wetlands) as an integrated part of the implementation of FATE. The proposal was announced among the international trace gas community and ended up with participants from Iceland, UK, Denmark, Sweden, Finland and Russia. The CONGAS proposal was favourably evaluated by the Commission and a contract for 1.5 million ECU is currently being negotiated.

IASC-SCAR Global Change Symposium

Cooperation with the Scientific Steering Committee for the IASC-SCAR Global Change and Polar Regions Symposium in Tromsoe in August, 1998 has been established. The Working Group will help organise a special session at this conference on progress within research of direct relevance to FATE and several IGBP (International Geosphere-Biosphere Programme, ICSU) Core Projects (BAHC, IGAC, GCTE).

For more information about this group and their work, please visit their homepage: **http://www.planteco.lu.se/CIG/IASCGCTE**

UVB Effects

by Dr. Edward C. DeFabo, Washington DC, USA

Note: Dr. DeFabo provided copies of transparencies and material he used during his talk for writing an extended summary. However, interesting information would be lost in such a summary, so we include most of the material with a few explanatory notes.

ARCTIC OZONE LOSS - 1997: AN EVER-DEEPENING SCENARIO[1]

For the past five years, stratospheric ozone losses during winter/early spring over northern polar regions have continued to worsen, in some cases on a scale comparable to or exceeding those over the Antarctic (Rex et al., Nature 389:835, 1997; Müller, R. et al Nature 389:709, 1997). While it is important to understand the chemical dynamics of this loss over the Arctic and Antarctic in order to make predictions of future trends, it is not less important to be able to do the same for predicting or evaluating the risk to biological systems and human health as a result of increased UVB radiation. Yet on a relative scale of 1 to 10 with 10 representing funding for atmospheric research, funding for research in the "UVB effects" arena has been consistently hovering near 1 for the past two decades. Without a well-coordinated, reasonably-funded, federally integrated UVB "effects" program, the danger of irretrievably losing base-line data in the Arctic and, indeed, globally continues to rapidly escalate as the following recent data indicates:[2]

- Over the north polar region, total ozone for March 1997 was lower by up to 40 percent than during the Northern Hemisphere winters of 1979 and the early 1980's
- Total ozone has decreased since 1979 over the mid-latitudes of the Northern Hemisphere including the USA, at the rate of about 4 percent per decade
- Decreases of 25 - 40 percent ozone cover a very large area over the Arctic, from Greenland, over the Baltic Sea, to northern Europe and northern Siberia
- Over the United States and northwest Europe, March 1997 values were lower than for the base period (1979-1986) by 10 to 20 percent.

Alaska

- Point Barrow, (71.3N), whose daily total ozone value for March 1997 was about 6% below the previous ten year average. On March 17 and March 18, Barrow showed record low ozone values for that location for a March day.

Antarctic

- The ozone hole in the Antarctic in 1997 expanded in altitude. In early October 1997, no ozone could be detected at 20 km.

A note of special interest: For each 1% loss of ozone there is ~1-2% increase (or higher depending on amount of ozone loss) in harmful solar UVB radiation. Further, distinct organisms will respond differently to varying doses of UVB. Factors such as clouds and pollution affect the actual amount of UVB absorbed by a biological target. Varied effects range from modulating systemic T-cell immunity, to skin and eye disease, to effects on ecosystems. UV dose-response and action spectrum studies are crucial for risk evaluation.

[1] Editor's note: This overview was given by Dr. DeFabo 12-13 November 1997 at the US Climate Forum: The Consequences of Global Change for the Nation.

[2] Northern Winter Hemisphere Winter Summer - 1996-97, NOAA, April 1997

POTENTIAL EFFECTS EXPECTED FROM INCREASED UVB RADIATION

Health

- Perturbations to T-cell mediated immunity
- Increase in skin cancer
- Increase in some types of cataract in humans (and animals)
- Possible exacerbation of certain infectious diseases

Aquatic

- Damage to Phyto- and Zooplankton
- Perturbations to aquatic ecosystems
- Perturbations to biogeochemical processes

Terrestrial

- Changes to plant chemical composition
- Perturbations to terrestrial plant/animal ecosystems
- Perturbations to plant growth

UVB EFFECTS RESEARCH IMPLEMENTATION PLANS AVAILABLE

A series of international workshops have been held over the past 7 years specifically addressing the impacts of increased UVB radiation on the biosphere and human health. These are listed below and are available in limited quantity by e-mailing the chairman at: **drmecd@gwumc.edu**

- 1992 *Effects of Increased Ultraviolet Radiation on Biological Systems,* SCOPE, Paris. In: (ed. E. C. DeFabo) Proceedings of a SCOPE (Scientific Committee on Problems of the Environment) Workshop on Effects of Increased Ultraviolet Radiation on Biological Systems, 17-22 February 1992, Budapest, Hungary.
- 1993 *Effects of Increased Ultraviolet Radiation on Global Ecosystems.* SCOPE, Paris. In: (ed. E. C. DeFabo) Proceedings of a SCOPE (Scientific Committee on Problems of the Environment) Workshop on Effects of Increased Ultraviolet Radiation on Ecosystems, 28 September-3 October 1992, Alghero, Sardinia.
- 1995 *Effects of Increased Ultraviolet Radiation in the Arctic.* IASC, Oslo. In: (ed. E. C. DeFabo) Proceedings of a series of IASC workshops held in Copenhagen, Greenland and Washington, DC (1993-1995)
- 1996 *Ultraviolet International Research Centers.* IASC, Oslo (ed. E. C. DeFabo).

SUMMARY OF STRATOSPHERIC OZONE DEPLETION[3]

- Stratospheric ozone depletion (SOD) has been continuing since 1970 (except over 20°S - 20°N)
- OD is twice as strong in winter-spring than in summer-fall
- Global ozone decline during last 13 years was about 5%.
  Outside the tropics it was:
  6.5% in the Northern and
  9.5% in the Southern Hemisphere
- Over the past 25 years the integrated global ozone loss is about 10%
- The ozone hole in Antarctica has been starting earlier, lasting longer and exceeded 20 million square kilometres during each of the past 7 years (area of North America ~ = 24 million sq. km).
- Greater ozone losses at polar and mid-latitudes are expected until chlorine loading falls back to its pre-ozone-hole values of 2 ppbv. This is expected around the middle of the next century (assumes complete compliance with Montreal Protocol etc.).

Rationale
Stratospheric Ozone Depletion

- Since 1978, there has been a significant decline in stratospheric ozone over most of the globe.
- The decline in stratospheric ozone is largely attributed to the accumulation of polluting chemicals (primarily

[3] Data taken from Review of the State of the Ozone layer. Delivered by Dr. Rumen Bojkov of the WMO, 4 December 1995

chlorofluorocarbons (CFCs) in the upper atmosphere

- The decline in stratospheric ozone leads to increases in UVB radiation and trace level increases of UVA radiation at the earth's surface and in underwater light environments.

UV INTERNATIONAL RESEARCH CENTRES (UVIRC)

- A UVIRC is a location within the Arctic at which scientific studies can be conducted on effects of UV radiation from phytoplankton inhibition, to impacts on terrestrial plants, to damage to human skin, eyes and the immune system.
- UVIRCs will provide access to existing or future UV monitoring and measuring, which is fundamental to any study on UV climatology and radiation impacts.
- UVIRCs should be located in a diversity of places, e.g. a fishing village, an urban community, a non-populated coastal area or an estuarine area.

PROPOSAL

UVIRCs

- will provide access to existing and/or future *UV monitoring and measuring* expertise fundamental to any study on UV radiation impacts
- will be located in a *diversity of places* in order to meet the integrative goals of the proposal, such as an urban community, a non-populated coastal area or an estuarine area.
- will be set-up *new or be a modification of an existing lab* in order to allow for common access to basic equipment and supplies used in all of the integrated studies.
- will allow *investigators from different disciplines* working on individual specific aims characteristic to their specialty, to have the opportunity of having their UV data verified, be it directly at the site when measuring UV, on the skin or eyes of members of the local community, or at some site distal to the UVIRC when, with the aid of transfer standards and UV experts, their field data on UVR would be analysed.
- will accommodate *social scientists* who would have direct access to the experimentalists and provide invaluable expertise on interacting with the local community and vice versa.
- will provide for *data specialists*, such as information managers and computer experts, who would make the data available on site so that this information would be readily available to any other investigators who might have critical use for it.
- will provide the opportunity for such *multidisciplinary scientists* to interact with each other on the same common theme "UV impacts on the Arctic biosphere". Such interactive environments often produce totally unexpected synergistic flows of ideas.

UV EFFECTS

Note: *AMAP - the Arctic Monitoring and Assessment Programme is a circumarctic governmental programme (now under the Arctic Council). AMAP has effects of climate change and UV in their mandate, but so far they have focused on pollution. However, in their next work programme (in progress), they are considering including effects of UV (and impacts of climate change), and for both areas they can benefit from planning and ongoing projects organised by IASC.*

Dr. DeFabo was invited to one of their planning meetings, and the text below gives the recommendations from this meeting with regard to UV Effects.

Ozone depletion in the Arctic has lead to increases in UV levels measured there. Further increases in UV are expected in the next few years. Arctic organisms will therefore be exposed to conditions for which they are not adapted. Effects are expected to include impacts to terrestrial and aquatic ecosystems as well as human health. The approach to assess the effects of UV in the Arctic has been extensively described by IASC, and a specific research implementation plan

There are individual health concerns, public health concerns, community health concerns, social/cultural health concerns, and economic health concerns, all due to an event we currently are **not** prepared to assess or announce, but know **is** a possibility.

First, let me touch on some general themes and then look at particular issues.

SEA AND FRESH WATER ICE CHANGES

- Local hunting platform – 140 whalers stranded last year off Barrow.
- Forms late and melts early and not associated with the timing of traditional hunting activities.
- More snowmachiners going through ice and dying (there are other causes but ice condition is certainly a contributing factor – there was a death just a few weeks ago here in central Alaska).
- Availability of marine mammal subsistence species if the open ocean lead is too wide or is far off shore, summer ice does not transport walrus near communities, summer ice edge is too far from shore for safe small boat hunting of other marine mammals, or it does not freeze early enough in the fall - in Churchill, Canada a late freeze can mean some very hungry polar bears in the community.
- Quality of ice has decreased due to different freezing patterns as well as global and local pollution including soot and dust. Local community runoff and river flows influence the freeze pattern in the region.
- Ice melting is a driver for the marine ice edge ecosystem – subsistence species locations and timing of food sources for seabird chicks, and other young of the year. If ice melts before the sun is at a higher angle will the same productivity patterns occur or will there be significant changes to the availability of food for young of the year?
- Percent coverage by ice is decreasing so storm surge increases, more erosion – increase risk of flooding of coastal communities; Shishmaraf, Kivalina have had major problems this year already.
- Transportation improvement for coastal shipping, increased risks with larger transport ships venturing into and through Arctic ocean ice. Tourists take nuclear icebreakers to the North Pole on holiday. Use of frozen rivers for winter land transportation, window and range will narrow. Likewise the window for ice roads and platforms for community support, development, or research will narrow or disappear.

THERMOKARST

- Floral change – Fauna change - habitat change, moose/caribou ratio linked to percent of water in soil and flora, nesting areas, berry productivity, new locations/ranges – willows are higher on mountains/further north, new species, competition, new prey - sharks, new diseases, additional stress.
- Traditional use areas are changing but land ownership is not.
- Construction – roads, runways, building foundations may need to be re-engineered due to changing conditions.
- Foam pads are used for permafrost but what will they do under buildings and roads where there is discontinuous or no permafrost?
- Metal pipeline cooling supports such as those used on the Trans Alaska Pipeline Service, may not be adequate in a warming trend and therefore compromise the stability and strength; elevated sections may need to be buried for safety.
- Utilidors and pipes above and below ground for water, sewage, and fuel are moving, but how far can they flex before breaking?
- Waste processing in open areas, community dumps and sewage lagoons, may need closer monitoring with changes in water flow and temperature.
- Communities sinking – Kipnuk, increased risk of flooding of coastal and river communities.

- Hunting and other cultural behavioral patterns due to loss of ice cellars Anaktuvuk Pass spring and fall hunt, need for community freezers – Arctic Village means seeking different types of grants.

ATMOSPHERIC - ARCTIC HAZE, PRECIPITATION

- Quality of ice - weaker.
- Quality of flora and fauna – stressed due to global distribution of pollution and depositional areas in the Arctic.
- Storm patterns of icing or deep snow for subsistence animals which paw through for food – reindeer/caribou/muskox, or need to browse or hunt in extremely deep snow - moose/wolves. Ocean storm surge is associated with migratory water bird chick survival.
- There has been an observation that the world is turning faster – inability to use traditional means with the same historic accuracy to predict weather three days in advance.
- Sea storms with icing of vessels makes crab fisheries the most deadly occupation in the U.S.
- Intensity of storms increases the risk of injury and death for all forms of transportation – air, water, roads, and ATV crashes. Headlines "Pilots plead for better weather forecasts." Caleb Pungowiyi of Nome has not been able to make this meeting yet due to a spring storm dropping nearly the entire winter's snow in the past few days.
- Water availability to communities throughout the year. There are reports that the tundra is much dryer. With little precipitation and more evaporation the Arctic may become more like the classic desert with increased erosion and decreases in plant distribution.

TEMPERATURE

- Permafrost – surface melting changing water content of soil, habitat change.
- Extended growing season with the introduction of new species.
- Less harsh winters with the increased survivability, introduction of new species, or changes in plant growth and animal behavior. Hibernating bears came out early this year in Alaska and killed a member of a survey crew in February. In March the Alaska Department of Fish and Game put out an early-season bear advisory.
- Sanitation concerns from dumps and untreated wastes, the warmer the more problems.
- Ice cellars melting and unable to keep food stored over the summer requiring changes in hunting patterns.
- Precipitation – more snow in winter. Increased risk of flooding to river communities.
- Water temperature and the success of fisheries both for subsistence and commercial viability. New species being seen – sharks and tuna

COMMUNITY VIABILITY, VULNERABILITY, FLEXIBILITY, ADAPTABILITY, SUSTAINABILITY

- Economic survival – maintenance and construction costs will go up for some items and down for others depending on the location of the community and the activity under consideration. Total costs will be individual but certainly different than in the past and communities need to plan for the full impact of all such expenses.
- Land restrictions and infrastructures inhibit traditional migratory patterns to follow animals or changing conditions when times require it. Kivalina land swap with NANA is one example but now they face the cost of the physical move - $53 million to move the infrastructure. Other communities may not have alternative sites.
- Flooding and erosion from multiple sources: ocean storms, increased precipitation, swollen rivers, lack of adequate resources to reduce the problem (large rock, restraining devices). RurAL CAP Village Participation Conferences have listed, for the past few years, erosion as second only to education as their highest concern.

- Subsistence foods stressed from multiple factors may cause people to turn to store bought food, increasing economic and cultural stresses, and decreasing general health due to it providing less nutritional value.
- Very limited resources in small communities, with State economic funding going to the rapidly growing and politically strong urban areas.
- Northern populations growing – winters are not so harsh, abundance of water in some areas, better technology to keep the individual and home warm, new economic ventures, electronic ties to the larger world have reduced feelings of isolation, and general community growth inertia is being overcome.

INDIVIDUAL HEALTH

- Poor sanitation for waste treatment with changing temperature and limited water flow.
- Potable water quality and delivery issues compounded with flooding of dumps and fuel storage tank farms, as well as snapping pipes due to land movement or roads that dissolve during breakup.
- Decreasing reliability of ice cellars to keep foods frozen cold enough for long-term, healthy storage.
- Stress in community and home from changes in familiar patterns and increasing costs to maintain infrastructure with decreasing external funding.
- Growing population with births increasing and deaths decreasing. This also raises the question of the sustainability of subsistence food resources.
- Stress on subsistence resources from more people, changing habitat, new prey, changing food supplies, pollution that may be associated with ***immune system suppression and associated illness***. Harbor seal die off in Scandinavia/PCBs/ Phocine distemper – 18,000 in one summer, imagine if that were to occur to bearded seals in Alaska and the impact on Alaska Native diet and health.

And it is not just Arctic impacts. From the NSF report are these questions:

1. How does human harvesting in the Arctic affect resource availability in the mid-latitudes? (Migratory birds or fish.)
2. How do changes in North Atlantic deep-water formation, as influenced by the hydrology and general land use of the Arctic Basin, affect climate and fisheries outside the Arctic? (Silty, warmer, runoff from increased flow over unshaded land and erosion due to northern timber harvesting or tundra drying with melting permafrost)
3. What are the impacts on people outside the Arctic of migratory birds and fish that accumulate Arctic contaminants? (A short biologically active window for the uptake of a year's worth of pollution laying on the surface.)

I was not invited, at least I hope I wasn't in any case, to provide answers on the impacts of global change on human health. There are lots of questions that need some answers or at least need a process so that the most needed answers are obtained or obtainable. It is anticipated that the Arctic Council's Arctic Monitoring and Assessment Programme human health section will enable a similar or comparable effort to be conducted in all eight Arctic nations investigating the levels of contaminants in people and any associated impacts on neurological or immunological development in infants.

The eight-nation Arctic Council is debating the issues surrounding "Sustainable Development." What does this really mean in a rapidly changing environment? Changing not only physically but also socially, culturally, and economically as well.

While there is documentation that our globe has been warming since the late 1700's when it reached the depth of the little ice age, it appears now to have gone above the historic norm. Does this mean "Global warming?" Not to the people of Greenland, who have seen their average temperatures going down over the past three decades. Not to the people of Norway, who have seen no significant change in temperature. Yes to the people of Alaska and central Siberia, who

have seen average temperatures go up several degrees and ground temperatures rising as well. *However, near the Arctic nations' capitols there has been little change in the temperature.* Dr. Weller's data this morning indicates that the rate of warming is exceeding the natural fluctuations and that there appears to be an anthropogenic component for the past 150 years during the industrial revolution.

Global change and climate variability have one common theme. They are known and measured by people. The plants and animals do not know that change is occurring, they will adapt or die and that is the way it is. However, during the past 10,000 years our human cultures have developed. This time period has been one of the most climatically stable in the earth's recent history according to the long-term records. So the upright thinking primate is now faced with the challenge that has faced our ancestors before us, adapt or die. We must use this enlarged collection of neurons to figure out some solutions or go the way of the dinosaur. We fortunately have the ability to think and adapt in ways other animals do not.

We like stability, we grew up with stability, our myths, our stories, and our science are based on things being relatively the same. Understanding change is critical to our survival. The rate and nature of change determines its importance. We need to work to understand how the world is changing, develop ways to adapt, and revise them as conditions continue to vary. In order to survive we need to think about what we do. This is where the latest research needs to be understood by those who make community decisions.

Over the next twenty-five years we will learn many new lessons. We will learn more about our changing planet, such as how well it responds to El Nino as well as how well it responds to the needs of billions of humans and their garbage. We have left some nasty legacies to our children and grandchildren in the form of anthropogenic chemical and nuclear materials that will take millennia to address. We will have to learn far more ***self-control*** than we have ever practiced to date if we are to be successful in dealing with a rapidly changing world. We will need to ***share information*** more ***efficiently*** and ***effectively*** than ever before. We will have to ***think clearly and prioritize our actions***. We will need to identify what the ***common good*** is, so that we can ***all*** work toward it. The impact of global change on humans is not the only issue. We must consider the impact of human actions on a changing globe. Thank you.

ASSESSING THE IMPACTS OF GLOBAL CHANGE: METHODS AND MODELS

by Dr Oran R Young, Hanover, NH, USA

Dr Young's introduction to the discussion follows. The themes were:

- What is natural variability versus real changes?
- What are the causes for changes, and can we distinguish between the drivers?

As shown by Dr Weller earlier, impact assessments are complex and involve both natural systems and human activities. Analysing such systems require natural, human and social scientists, as well as caution in the analysis.

During the following discussion, the complexity and the methodological problems were recognised. The need for seminars and workshops on methodological issues was suggested for scientists involved in impact assessments (or as a part of ordinary project workshops).

The answers to some of the questions raised, can be to make impact studies step by step due to the complexity, and also to select a few fields to analyse at a time (targeted impact assessments).

Measuring the impacts of global change on biophysical or social systems requires an ability to draw causal inferences in situations affording limited opportunities for the conduct of controlled experiments.

SORTING OUT THE SIGNALS OF GLOBAL CHANGE

1. Avoiding type 1 errors - spurious correlations
2. Avoiding type 2 errors - hidden impacts
3. Disentangling the effects of multiple drivers
4. Understanding interactive systems
5. Tracing long causal chains

UNDERSTANDING COMPLEX SYSTEMS

1. Identifying cumulative impacts, triggers, and flips
2. Anticipating surprises
3. Factoring in variations in vulnerability/resilience
4. Recognizing self-defeating prophecies
5. Coping with problems of scale

Session 2

ARCTIC PRIORITIES

Chair: Dr Robert W Corell, National Science Foundation, USA

The intention with this session was to make a contribution to a broader discussion on setting Arctic priorities. As sources are scarce, we cannot meet all needs, and someone has to discuss and set some priorities. Ideally, priorities are set in a process involving users, stakeholders and policy people. Not all arctic countries have initiated such discussions, but they are likely to come - and priority setting will also be an important task for the Arctic Council.

IASC is problem-oriented in its approach, and consequently is looking for arctic priority problems when discussing our science agenda. We believe we are well qualified to organise and implement the science components of most arctic priority problems.

For this session, a number of stakeholders at various levels had been invited to speak on 1-2 arctic priorities. Further, members of the IASC Regional Board had been asked to report on arctic science priorities in their countries. These reports were given in the Regional Board, and a summary report is given below.

A small panel of scientists present were asked to give some immediate comments on the science component of problems presented by the speakers.

We appreciate that so many busy people were able to accept our invitation, and you will find their contributions on the following pages.

ARCTIC PRIORITIES

Caleb Pungowiyi

Eskimo Walrus Commission

Mr Chairman, members of the International Arctic Science Committee, honored guests, my name is Caleb Pungowiyi, I am the Director of the Eskimo Walrus Commission. I am greatly honored and thankful for this opportunity to address this highly respected scientific body. The Alaska Native Science Commission workshop last month on Contaminants and Native Foods identified two priorities or issues of concern: "Global Warming" and "Contaminants". I will only talk about one priority today.

In the old days, if a resource such as walrus or seals became scarce, our people used to think that they were somehow responsible for the cause of the scarcity. They would wonder who among them may have done something bad to the spirits of the animals, or in some manner broke the balance of nature. In the late 1870's and early 1880's, a series of cold winters caused massive starvation in many villages in the Bering Sea.

Captain C. L. Hooper of Revenue Cutter "Corwin" noted in his report in 1881 that he encountered heavy ice in the Bering Sea just north of Nunivak Island in mid June of 1881. He also reports of massive starvation on St. Lawrence Island: "They live directly in the track of vessels bound into the Arctic Ocean for the purpose of whaling or trading; they subsist upon whales, walrus and seals, taking only so much as is actually needed for their immediate wants, never providing for the future. As near as I can learn, over four hundred natives had died of actual starvation on this island within the past two years". According to our oral history, these were the years of extreme cold winter, with the cold weather lasting into the summer season. An unknown shaman laments in his prayer song:

Kiqahneq, Way of Life, whose control is indisputable
Who created what is all useful
What is this evil spirit that roams in our midst
What terrible things have we done
The fist of winter has grasped the warmth of Spring
and refuses to let go
An ice bosom envelopes our shores and we are unable
to feed our people
What have we done that deserves this wrath
Who amongst us is to blame
The breast that fed us is gone and
the cry of hunger echoes in our homes
Kiqahneq, give birth to the land
Lift up the sky
Let the tongue of the ocean lap our shores once again.

While such extreme events will probably never ever happen again in our modern times, the potential impacts from Global warming are of major concern to the indigenous peoples of the Arctic. The fear of the unknown is probably greater than any actual impact which may occur.

Communities like Shishmaref and Kivalina, who are eroding away into the Chukchi Sea, and communities that are dependent on marine resources have the greatest concern on the impacts of Global warming. They do not see any assistance coming from the government similar to the disaster assistance given to the farmers for loss of crops from floods or droughts. Some of the questions asked by the indigenous people are:

1. Will the rate of change be rapid or gradual?
2. What will be the effect on marine mammals?
3. What are the social and economic impacts of Global warming?
4. Can we do anything to prepare for climate change?
5. What will be the effects on fish such as salmon, arctic char, white fish, and other fish species?
6. Will Global warming be necessarily bad?

As in the shaman's prayer song, we are somewhat responsible for the coming wrath of nature. How we address the changes from climate change largely depends on the advice and direction the policy makers will receive from the scientific community. You as leaders in the scientific community have an obligation in addressing the problems or benefits that will have profound effects on the lives of communities, families and individuals. Choices for societal changes and the knowledge needed to make those choices will largely depend upon the quality and certainty of the assessment made by a body such as yours. We all realise the complexity and generational time frame necessary for such assessment but it is a challenge that you and I must all rise up to.

Thank you for the honor of speaking to you. May God bless you and be with you during the rest of your conference.

Comments by the Panel and Others

The Panel acknowledged the concerns expressed by Mr. Pungowiyi over impacts of global warming. As mentioned in another part of this report, IASC has initiated projects on impacts of global change (of which global warming is the main component), and the more specific questions raised will be conveyed to the impact projects.

Mr. Pungowiyi also referred to the Alaska Native Science Commission and their other priority (in addition to global warming), namely native foods and contaminants. As to the latter, IASC has initiated a project on "Contaminants and Human Health". This project is in its initial stage, but the project group has been nominated and they are expected to have their first meeting in a few months.

With regard to both global warming and to contaminants and human health (as well as several other IASC projects), the value of traditional or local knowledge was mentioned.

ARCTIC PRIORITIES AS SEEN BY THE PETROLEUM INDUSTRY

Dr. Gordon N. Cox and Denis Blanchet

AMOCO

Dr Cox was unable to attend, so his contribution was presented at the meeting by the Executive Secretary of IASC, Mr Odd Rogne.

The major problems or priorities for the petroleum industry in the Arctic are summarised below.

Industrial needs are usually directly linked to their operational problems, so also for the oil industry. However, answers to these needs range from basic to applied research. In addition to the priority needs mentioned below, the oil industry in several parts of the Arctic has funded major environmental investigations. These investigations have consisted of a range of purposes such as providing baseline data, a better knowledge about local ecosystems and populations, data about the physical environment, and environmental impact assessments (to comply with governmental requests). Many arctic scientists have been involved (and benefited from) such investigations, and it has often given them an opportunity to include or combine contract work with their own scientific interests.

Industry Arctic Research Priorities

- Petroleum Industry is presently pursuing developments in Northwestern Siberia (Pechora Sea) and Sakhalin areas (Sea of Okhotsk).
- Offshore research focus is on ice conditions, ice loads and bottom conditions for the design of offshore production structures, loading terminals, pipelines, tankers, and mooring systems
- Onshore research focus is on distribution and properties of permafrost for the design of pipelines, roads and pads
- Better instruments, procedures and models for obtaining ice and geotechnical data. Current practices are crude and outdated
- Development of codes and standards for Russian Arctic seas is also of major interest

Offshore Research Priorities

Offshore Structures and Terminals:

- Dynamic and static global ice loads, due to pressure ridges and rubble ice (properties of broken ice masses).
- Response of foundations to dynamic loading
- Design of minimum, less costly structures.

Offshore Pipelines:

- Long-term ice scour statistics (depth and frequency) for determining the burial depth of offshore pipelines. Collecting data during the summer is inadequate due to infilling of scours during storms.

Mooring Systems for Offshore Loading Terminals:

- Ice movement rates and rates of change of ice movement direction
- Mooring systems capable of responding to rapid changes in ice movement rates and direction
- Procedures for mooring and disconnecting tankers from offshore terminals in ice

Icebreaking Tankers:

- Propulsions systems capable of keeping a tanker on location in ice during rapid changes in ice movement and direction
- Optimum hull designs for transit in both open water and ice

Onshore Research Priorities

Onshore Pipelines:

- Distribution and properties of permafrost
- Mechanical and thermal properties of frozen ground

Roads and Pads:

- Location of suitable construction materials in areas of interest
- Better methods to obtain construction materials from frozen quarries
- Techniques to accelerate road and pad construction using fine grain materials

Instrumentation, Methods and Models

- Automated underwater vehicles for obtaining ice scour and pressure ridge keel depth data
- Remote sensing techniques to determine the properties of pressure ridges
- Improved techniques to determine the strength of rubble ice
- Improved ice forecasting (drift) methods for mobilizing drilling rigs and tanker mooring operations
- Better understanding of "limited" pack ice driving forces for determining global ice loads

Codes and Standards

- Existing codes for offshore structures and other infrastructure in Russia are largely for Caspian Sea development and do not adequately address development in ice covered seas.
- Codes and standards need to be harmonized (i.e. ISA).

PRIORITIES AS SEEN FROM A LOCAL COMMUNITY

Mr. Glen W. Sheenan

Barrow, Alaska, USA

SUMMARY:

In addition to presenting the Barrow Environmental Observatory, Mr Sheenan pointed to two problem areas as seen from a local community:

- Protection of traditional lifestyle, and
- Threats to the environment

Traditional lifestyles are in harmony with nature, and constitute a sustainable way of living.

In several local communities the traditional lifestyle is undermined for several reasons.

Threats to the environment

Through traditional lifestyles, many local communities live in and by what the local environment can provide. Research into changes in this environment is therefore important. Effects of climate change can be one important change, pollutants coming into our environment is another example.

CANADIAN SCIENCE PRIORITIES IN THE ARCTIC

Dr. Peter G. Johnson

CANADA

The science priorities outlined in this paper were formulated from discussion within the Board of the Association of Canadian Universities for Northern Studies and from discussions with other northern scientists in universities and government. The synthesis into this brief presentation reflects the views of the author, as no national northern science priorities have been set within Canada. There is currently some pressure on the government of Canada to move towards a northern science policy. In this paper it is intended to address the issue from two perspectives:

- first, from the viewpoint of priorities for the conduct of science; and
- second, what are the major science priorities in the Canadian North?

There are **two major priorities for the conduct of science** in the Canadian North:

- **the need for improved and expanded long term monitoring programs**; and
- **the need to support logistics programs**.

With the former Canadian scientists have recognised for a number of decades the paucity of monitoring networks in the physical, natural and social sciences in the Arctic. Emphasis will be placed here on the physical and natural sciences as the areas with which the author is more familiar. The meteorological, hydrological and glaciological monitoring programs have been far too limited in their coverage of the Canadian Arctic Islands. Ecological monitoring has been sporadic and has not developed any long term data base, for example the excellent monitoring commenced at Hot Weather Creek on Ellesmere Island has for the most part been terminated. Hydrometeorological monitoring has not been adequate to address current questions of climatic circulation and the increasingly important issue of climate change. During the recent period of fiscal restraint in the Canadian Government there has been both a substantial reduction in monitoring effort and an introduction of cost recovery policies. These have occurred at a time when global science questions and the demands of the inhabitants of the region necessitated expansion of monitoring programs. The main aspects of the decline have been

i) budget reductions for the Atmospheric Environment Services and the Hydrographic networks,

ii) elimination of much of the glacier inventory and mass balance programs during shuffles between Government Departments,

iii) a general decline in commitment to the north, and

iv) the introduction of the cost recovery policy for data.

The latter has been most insidious for scientists. The charges for raw data from AES, Canada Centre for Remote Sensing, and Statistics Canada have produced a downward spiral where lower demand for data and products have resulted in more pressure to 'rationalize' networks. The recent elimination of the Mould Bay climate station, at a time when its length of record was becoming useful in climate change studies, also occurred at the time when Canada was considering its position for the Kyoto climate change conference. This is not only symptomatic of a lack of vision and commitment to the North within Canada but of the absence of a science policy in general. An added factor in this scenario has been the availability of more accessible data, particularly from the United States.

The Government is well aware of the problem with respect to data. It has been highlighted in the report of a Federal Government workshop on the coordination of federal northern science and technology (1) which has recommended that the Government "re-evaluate how decisions about cost-recovery apply to data and information".

The recent response to the report "Canada and the Circumpolar World" of the Standing Committee on Foreign Affairs and International Trade (2) suggests that the alternative data being employed is of "inferior quality". The ostrich surely has its head deeply buried in the sand. It is possible that current national and international pressure may lead to a change in the cost recovery policies.

The second priority for science in the Canadian North is the **maintenance of logistics support. The Polar Continental Shelf Project (PCSP)** has been the basis of the physical and natural sciences in the Arctic. PCSP, in common with most other agencies, has been severely impacted by funding cuts. This has been particularly critical for University based research. Much of the Government research has moved to a cost recovery system placing increased stress on department budgets. Efforts are underway to revitalise the logistics program.

The question of what are the science priorities in the north, the second perspective of this paper, can be answered in the same way that most other circumpolar nations respond. I will address **three very broad areas** within which there are a myriad of science questions:

- first, **sustainability of communities**;
- second, **climate change**; and
- third, **contaminants**.

The second and third are obviously elements of the issue of sustainability of communities, but much of the focus must be on the physical and natural sciences. The primary emphasis of the first is on the social sciences and the humanities and the research agenda is driven more by the communities themselves than by the university or government scientists.

Sustainable Development is one of the stated objectives of the Arctic Council and it is building a number of programs addressing the concept. Among the many components of sustainable development or sustainability are science issues such as the sustainability of country foods, environmental impact of development projects and economic initiatives such as tourism, the preservation of indigenous languages and cultures, and the relationships between local knowledge and western knowledge. The stresses placed on communities by the adoption of wage economies is driving the need for appropriate training of northerners in the north. One of the main circumpolar education initiatives is the concept of a University of the Arctic. The Circumpolar Universities Association was asked by some of the circumpolar nations to conduct a feasibility study for a circumpolar University of the Arctic. A working group is now preparing the final feasibility study document for consideration by the Senior Arctic Officials of the Arctic Council. Aurora Research Institute and the Nunavut Research Institute have already developed very detailed research agendas covering all aspects of communities and resources. These agendas will become more important into the next century as devolution of the Northwest Territories is implemented and as landclaims by the First Nations are settled. There is a vast spectrum of research issues to be addressed in the search for sustainability or sustainable development.

Contaminants are a major circumpolar problem because the Arctic is a sink for a range of materials produced throughout the "industrial" world and it has also been used for dumping of large amounts of contaminants. In Canada a large amount of expertise has been devoted to the problem of contaminants in the last few years and there have been ties with the AMAP program (3). The Canadian Arctic Contaminants Assessment Report (4) was published in 1997 by the Department of Indian and Northern Affairs and funding is being sought for the continuation of this program. There are many science questions still to be addressed or further elaborated, from aspects of the transfer of pollutants from source by atmospheric or hydrologic pathways, to long term ecosystem health and particularly the problems of bioaccumulation and human health.

In common with all Arctic nations a major science priority is the identification of **climate change** signals and the prediction of its impacts on ecosystems and sustainability of human systems, and particularly indigenous cultures. There is not only a need for

more natural and physical science, but also integrated science on the ramifications of change and variability on Arctic systems. One model of an integrated program has been the Mackenzie Basin Impact Study (MBIS)(5) which was developed in partnership between governments and First Nations communities. Some of the critical components of this climate change debate are with respect to greenhouse gases. Are Arctic ecosystems a greenhouse gas source or sink? What are the potential impacts of ice rich permafrost melt, thermokarst processes, sea level rise due to ice sheet melt, changes in the precipitation patterns, not just on the physical systems but also on the biological systems which occur on the terrain and the surrounding oceans? For example, how will changes in ocean circulation, temperature, and ice conditions affect the migration routes of the Bowhead Whale or the Beluga?

In Canada our relationships with the indigenous peoples of the Arctic are unique in the circumpolar community. Over the last 15 - 20 years, through the landclaims process and in 1999 with devolution to Nunavut and the Western Arctic, First Nations have re-established their rights to traditional land. This has provided the communities with a dominant voice in the establishing of research agendas in the north. All science in Yukon and the Northwest Territories must be approved by a licensing procedure which includes approval by the indigenous peoples. Proposals must be discussed with the community and results have to be communicated frequently, not just in the submission of the science output, but in meetings in the communities. The abuse of many communities in the past has left a legacy of distrust and scientists must now convince communities of the relevance to them of any research being proposed. There is, therefore, the added responsibility to explain why measuring the temperature of the ground or identifying the diatoms in old lake sediments is important to deciding what has happened to their land in the past and how it might help to predict the future, not just for their descendants but for all the cultures on the globe.

This presentation is, of necessity, summary in nature and only identifies very broad areas of science. It is apparent however that to a greater and greater extent research in the Canadian Arctic must be integrated. This does not imply that all Arctic science will need to be 'big' science. Small teams or even individuals working on fundamental research questions are still needed and still provide excellent value for funds invested.

References

1. Workshop on the Co-ordination of Federal Northern Science and Technology, Feb 17-18, 1998. Prepared by Resource Futures International.
2. Government of Canada Response to the report of the Standing Committee on Foreign Affairs and International Trade "Canada and the Circumpolar World: Meeting the Challenges of Cooperation into the Twenty-first Century." 43 pp.
3. Arctic Pollution Issues. A State of the Environment Report. Arctic Monitoring and Assessment Programme (1997) 188 pp.
4. Canadian Arctic Contaminants Assessment Report. Department of Indian Affairs and Northern Development. Jensen, J., Adare, K. & Shearer, R. Eds. 1997. 460 pp.
5. Mackenzie Basin Impact Study (MBIS) Final Report. Environment Canada. Cohen, S.J.

PRIORITIES AS SEEN FROM THE DEPARTMENT OF THE INTERIOR

Dr. Deborah Williams

SUMMARY:

The Department of the Interior has many responsibilities and consequently also a large number of needs. The speaker focused on priorities from planning and decision needs, and listed the following:

1. What are the impacts (and cumulative impacts) of site specific changes? (such as laying a pipeline, constructing a new road etc.).

2. Inventory monitoring, i.e. how successful was the decision made.

3. Improve data gathering, data communication and data management (incl. traditional knowledge), i.e. many issues have been investigated and data has been gathered, but decision makers have problems finding them when needed.

4. The Bering Sea is important to Alaska with regard to fisheries, for local consumption, and for several other purposes. The decrease of higher species has been observed, and a Bering Sea Ecosystem Research Plan has been worked out.

ARCTIC PRIORITIES: PERSPECTIVE FROM THE REGIONAL BOARD

Dr. Robert W. Corell, Chairman

Members of the IASC regional Board (one from each of the Arctic countries) had been asked to report on national Arctic priorities at the Regional Board Meeting prior to the Annual Meeting.

Most members reported national priorities at this meeting. However, during their discussion they agreed to focus on other aspects important to Arctic research (mainly funding and access) which is summarised below by copies of their transparencies.

National priorities reported by the Regional Board members are recorded in the minutes of their meeting, and this material will be utilised for analysis and planning within IASC.

Priority Discussions

Two Broad Categories Emerged

Access to the Arctic Region: Logistics, Funding, etc.

Scientific Issues: Climate, Environment, etc.

Trends in Funding of Research

Canada

Denmark/Greenland →

Finland ↗

Iceland ↗

Norway ↗

Russia

Sweden →

US

Trends in Access

Environmental Issues, Permits, etc.

Canada ☝

Denmark/Greenland →

Finland ☝

Iceland →

Norway →

Russia →

Sweden →

U.S. →

Impact on Researchers From other Countries (Selectively) ☝

Issues Influencing Access for Research

- ✓ Funding
- ✓ Logistics and Facilities
- ✓ Long Term Monitoring
- ✓ Data Access
- ✓ Environmental Regulation, Parks and Preserves, Permits, etc.
- ✓ National Security Issues
- ✓ Policy/Political Issues
- ✓ Economic Zones