Arctic Dimensions of the
IPCC Third Assessment Report

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Outline

- Observed changes
- Future scenarios of climate change
- Impacts of scenarios on Arctic ecosystems
- Implications for Arctic Communities
IPCC Third Assessment Report--Chapters with Information about Impacts and Adaptation in the Arctic

• **WG I:**
  - Observed trends in ice, snow
  - Scenarios obtained from climate model simulations

• **WGII:**
  - Topical chapters
    - Ecosystems, Water Resources
  - Regional chapters
    - Polar, North America, Europe, Asia
  - Cross-cutting issues
    - Scenarios, Adaptation, Vulnerability
Annual Surface Air Temperature Trends
1961-1990

Source: University of East Anglia
Locations of Observed Changes in Natural Systems

(IPCC, (2001) WGII Summary for Policymakers)
Northern Hemisphere monthly (a) and annual (b) snow cover anomalies (IPCC-TAR, WGI, Fig. 2.13)
Arctic sea ice anomalies (IPCC-TAR, WGI, Fig. 2.14)
Reduction of Arctic sea-ice thickness
(UNEP, based on IPCC-TAR WGI, Fig. 2.17b).
Landslides from permafrost thaw
(Aylsworth and Duk-Rodkin, 1997)

Figure 2a. Retrogressive thaw flow in fine grained sediments near Tuktoyaktuk. Note massive ground ice exposed in the head scarp.

Figure 2b. Landslide along a tributary of the Mackenzie River began as a shallow skin flow and has developed into a deeper retrogressive thaw flow. Area was burnt prior to failure. GSC photo 1996-133D by L.D. Dyke.
Observed Changes in Arctic Ecosystems

- Warming of up to 5°C over land areas during the 20th Century; slight warming over sea ice
- Longer growing season of around 2 weeks (satellite obs.)
- Arctic sea ice extent reduced by more than 5% since 1978; sea ice in Nordic Sea reduced by 30% since 1870s
- Arctic freshwater ice: later freeze-up and earlier break-up, reducing length of ice season by 12 days/100 years
- Reduction of spring snow cover extent by 10% since 1972
- Permafrost thaw and reduction of active layer thickness in some areas (e.g. western North America)
- Increases in area burned by forest fire in North America and Eurasia since the 1970s despite improved detection and suppression
Climate change scenarios: Arctic land areas--winter, spring *(Carter et al., 2001)*
Scenario changes to fire weather
(Hartley and Marshall, 1997; Kadonaga, 1997)
Forest fires and fire fighting in northwest Canada (Rothman and Herbert, 1997)

Forest Land Burned

Fire Fighting Expenditures

Data after 1984 are a broader measure of costs. No data available for BC and Yukon in 1994.
Scenario impacts on white pine weevil hazard
(Sieben et al., 1997)

Figure 9. Weevil hazard in the Mackenzie Basin based on the 1951–80 temperature normals and produced in the IDRISI GIS package. Interpolated temperatures were adjusted for elevation using radiosonde derived lapse rates.

Figure 10. Weevil Hazard in the Mackenzie Basin based on the GISS 2050 temperature scenario and produced in the IDRISI GIS package. Interpolated temperatures were adjusted for elevation using radiosonde derived lapse rates.
Forest pests:
e.g. Douglas Fir Bark Beetle

Climate Change Adaptation Mechanism: Replace all Douglas Fir and other important species with more pest resistant trees? Change fire management strategy? Change harvesting methods?
Scenario Changes in Arctic Ecosystems by 2100

- Warming over land areas of 2 to 10 °C during fall & winter, 1 to 7 °C during spring & summer
- Arctic sea ice extent reduced by up to 60% in summer
- Continued permafrost thaw and development of thermokarst terrain
- Changes in runoff patterns; reductions in glaciers & ice jam flooding in deltas
- Increased biological production due to longer warmer growing season; poleward and elevation shifts in species; increased fire risk; alterations of seasonal distributions, ranges, patterns of migration and reproductive success (winners & losers??)
  - poleward displacement of boreal forests by 150-550 km (compared with observed migration of 20-200 km/century)
Photo from slide show by Don Russell and Joan Eamer, CWS, Whitehorse
Porcupine Caribou Harvest by Village

Figure from slide show by Don Russell and Joan Eamer, CWS, Whitehorse
### Impacts of climatic change on future scenarios for Aklavik (Aharonian, 1994)

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<th>Impact</th>
<th>Continued reliance on subsistence activities</th>
<th>Greater reliance on wage economy &amp; economic development</th>
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<td>Greater flooding</td>
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<td>Muddy road conditions</td>
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<td>Insulation of buildings</td>
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<td>Easier water delivery</td>
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<td>Less time waiting out cold conditions</td>
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<td>Outdoor meat storage</td>
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<td>Uncomfortably hot in summer</td>
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<td>Increased summer insects</td>
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<td>Infrastructure of camps</td>
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<td>Changes in wildlife habitat</td>
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<td>Variability in break-up &amp; freeze-up</td>
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<tr>
<td>Longer ice free season</td>
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<tr>
<td>Shoreline erosion &amp; lowland flooding</td>
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<td>Greater variability in perceptions</td>
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Scenario Changes in Arctic Communities by 2100

• Changes in ecosystems will affect hunting & gathering practices of indigenous peoples
• Increased economic costs are expected for maintenance of infrastructure in response to thawing permafrost & reduced transportation capabilities across frozen ground & water
• Reductions in heating costs
• New opportunities for trade, shipping, and sea-based tourism across the Arctic Ocean; these may lead to economic benefits, as well as increases in pollution (from transportation, resource extraction) & new questions regarding insurance & Arctic sovereignty
Implications for Arctic community development are unclear, and there are alternative views

- Coping capacity is high, so communities will adjust; other issues will be more important

...OR

- Altered subsistence opportunities combined with alternative lifestyles threaten continuity of Arctic indigenous cultures
How can science address alternative views on Arctic climate change impacts & adaptation?

• Need to assess:
  - Changes in risk due to impacts on cryosphere & ecosystems
  - Changes in regional & local capacities to adapt to climate change in the context of future development choices

• Need for new approaches:
  - Integration of traditional (local) ecological knowledge & modern science in assessments of future impacts & responses

• Need for place-based case studies
  - Understand regional/local development context, including history, institutions, cultural ties

• Role of ongoing Arctic Climate Impact Assessment (supported by Arctic Council)
  - Opportunity for detailed regional synthesis beyond IPCC-TAR; expected completion in 2003-04
Conclusions

• Climate change will affect the future of the Arctic, but there is insufficient understanding of its implications for regions and communities, given other forces of change

• In the long-term, there continues to be a need for direct participation of Arctic peoples and institutions in climate change impacts & adaptation research and dialogue

• The Arctic case is an illustration of an opportunity for SBSTA to explore adaptation mechanisms at regional scales