ACIA Arctic Climate Impact Assessment

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Statement
by
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Organized by the Arctic Council and the International Arctic Sciences Committee
and
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before
The Committee on Commerce, Science, and Transportation
United States Senate
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Introduction:

Mr. Chairman, Members of the Committee, thank you for the opportunity to participate in today's Full Committee hearing on the release of the Arctic Climate Impact Assessment's report entitled, "*Impacts of a Warming Arctic*[1]". I am Dr. Robert W. Corell, Chair of the Arctic Climate Impact Assessment (ACIA) and I am honored to testify before you today on behalf of an international team of 300 scientists, other experts, and elders and other insightful indigenous residents of the Arctic region who have prepared this comprehensive analysis of the impacts and consequences of climate variability and changes across the Arctic region, including the impacts induced by increases in UV radiation arising from depletion of stratospheric ozone in the region.

The scientific analysis and assessment conducted in the ACIA is documented in two reports, both published by Cambridge University Press.

- **A Scientific Report:** A series of assessment reviews and analyses has lead to a more integrated understanding of climate variability and change for the Arctic region (across sectors, sub-regions, indigenous and local interests). This scientific document is fully referenced, and is composed of detailed scientific and technical information describing current understanding of climate change, climate variability and increased UV radiation and their consequences over the entire Arctic region. This 1200 plus page report has been completed and is in final production for release in the weeks ahead. This report provides the scientific foundations for the Overview Document.
- **An Overview Report:** This 140 page document, which is titled "*Impacts of a Warming Arctic*", is a comprehensive plain language summary of the scientific aspects of the assessment and is designed to synthesizes the key findings of the assessment and place those insights in a policy-makers framework. It states our collective consensus of understanding and knowledge concerning the consequences of climate change over the

[1] 2004 "Impacts of a Warming Arctic", Arctic Climate Impact Assessment (www.acia.uaf.edu), Cambridge University Press (www.cambridge.org),

entire Arctic region. This report was released last week in Reykjavik, Iceland at the ACIA Scientific Symposium (Nov. 9-12) and provides the foundations for our discussions here today.

The ACIA is a comprehensively researched, fully referenced, and independently reviewed evaluation of arctic climate change and its impacts for the region and for the world. It is the first such assessment ever conducted for the Arctic. As we reported to you and your committee in March of this year, the Arctic Council[2] called for this assessment in 2000, and charged two of its working groups, the Arctic Monitoring and Assessment Programme (AMAP) and the Conservation of Arctic Flora and Fauna (CAFF), to conduct this assessment in cooperation with the International Arctic Science Committee[3] (IASC).

The Scientific Report: The scientific report is organized around eighteen chapters that address a broad range of issues concerning climate and UV changes across the circumpolar Arctic. These chapters are:

1. Introduction
2. Arctic Climate – Past and Present
3. The Changing Arctic: Indigenous Perspectives
4. Future Climate Change: Modeling and Scenarios for the Arctic Region
5. Ozone and Ultraviolet Radiation
6. Cryospheric and Hydrologic Variability
7. Arctic Tundra and Polar Desert Ecosystems
8. Freshwater Ecosystems and Fisheries
9. Marine Systems
10. Principles of Conserving the Arctic's Biodiversity
11. Management and Conservation of Wildlife in a Changing Arctic Environment
12. Hunting, Herding, Fishing and Gathering: Indigenous Peoples and Renewable Resource Use in the Arctic
13. Fisheries and Aquaculture
14. Chapter 14: Forests, Land Management and Agriculture
15. Human Health
16. Infrastructure: Buildings, Support Systems, and Industrial Facilities
17. Climate Change in the Context of Multiple Stressors and Resilience
18. Summary and Synthesis

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[2] The **Arctic Council** was established on September 19th, 1996 in Ottawa, Canada. A high level intergovernmental forum, the Council provides a mechanism to address the common concerns and challenges faced by the Arctic governments and the people of the Arctic. The members of the Council are Canada, Denmark, Finland, Iceland, Norway, the Russian Federation, Sweden, and the United States of America. The Association of Indigenous Minorities of the North, Siberia and the Far East of the Russian Federation, the Inuit Circumpolar Conference, the Saami Council, the Aleutian International Association, Arctic Athabaskan Council and Gwich'in Council International are Permanent Participants in the Council. There is provision for non-arctic states, inter-governmental and inter-parliamentary organizations and non-governmental organizations to become involved as Official Observers. The Arctic Council is a high-level intergovernmental forum that provides a mechanism to address the common concerns and challenges faced by the Arctic governments and the people of the Arctic as a means of improving the economic, social and cultural well being of the north.

[3] The **International Arctic Sciences Committee** was founded 28 August 1990 by national science organizations in all the arctic countries. It provides the major venue for national science organizations, mostly academies of science, to facilitate and foster cooperation in all fields of arctic research. It currently brings together scientists from Canada, China, Denmark, Finland, France, Germany, Iceland, Italy, Japan, The Netherlands, Norway, Poland, Republic of Korea, Russia, Sweden, Switzerland, United Kingdom, and the United States of Americ**a.**

The Overview Report: The Overview Report, entitled, "*Impacts of a Warming Arctic*", provides the foundations for our discussions today and concludes that:

> "The Arctic is now experiencing some of the most rapid and severe climate change on Earth. Over the next 100 years, climate change is expected to accelerate, contributing to major physical, ecological, social, and economic changes, many of which have already begun. Changes in arctic climate will also affect the rest of the world through increased global warming and rising sea levels".

These climate changes are being experienced particularly intensely in the Arctic. Arctic average temperature has risen at almost twice the rate as the rest of the world in the past few decades. Widespread melting of glaciers and sea ice and rising permafrost temperatures present additional evidence of strong arctic warming. These changes in the Arctic provide an early indication of the environmental and societal significance of global warming.

An acceleration of these climatic trends is projected to occur during this century, due to ongoing increases in concentrations of greenhouse gases in the earth's atmosphere. While greenhouse gas emissions do not primarily originate in the Arctic, they are projected to bring wide-ranging changes and impacts to the Arctic. These arctic changes will, in turn, impact the planet as a whole. For this reason, people outside the Arctic have a great stake in what is happening there. For example, climatic processes unique to the Arctic have significant effects on global and regional climate. The Arctic also provides important natural resources to the rest of the world (such as oil, gas, and fish) that will be affected by climate change. And melting of arctic glaciers is one of the factors contributing to sea-level rise around the globe.

Climate change is also projected to result in major impacts inside the Arctic, some of which are already underway. Whether a particular impact is perceived as negative or positive often depends on one's interests. For example, the reduction in sea ice is very likely to have devastating consequences for polar bears, ice-dependent seals, and local people for whom these animals are a primary food source. On the other hand, reduced sea ice is likely to increase marine access to the region's resources, expanding opportunities for shipping and possibly for offshore oil extraction (although operations could be hampered initially by increasing movement of ice in some areas). Further complicating the issue, possible increases in environmental damage that often accompanies shipping and resource extraction could harm the marine habitat and negatively affect the health and traditional lifestyles of indigenous people.

Another example is that increased areas of tree growth in the Arctic could serve to take up carbon dioxide and supply more wood products and related employment, providing local and global economic benefits. On the other hand, increased tree growth is likely to add to regional warming and encroach on the habitat for many birds, reindeer/caribou, and other locally beneficial species, thereby adversely affecting local residents. Potential complications include projected increases in forest disturbances such as fires and insect outbreaks that could reduce expected benefits.

Climate change is taking place within the context of many other ongoing changes in the Arctic, including the observed increase in chemical contaminants entering the Arctic from other regions, overfishing, land use changes that result in habitat destruction and fragmentation, rapid growth in the human population, and cultural, governance, and economic changes. Impacts on the

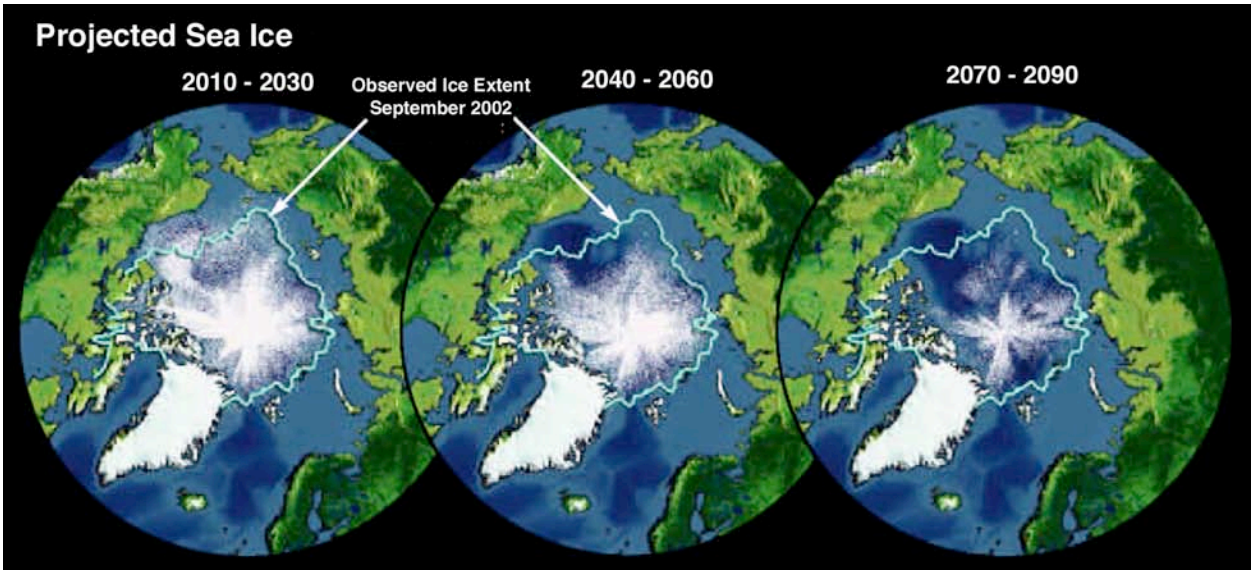
environment and society result not from climate change alone, but from the interplay of all of these changes.

One of the additional stresses in the Arctic that is addressed in this assessment results from increasing levels of ultraviolet radiation reaching the earth's surface due to stratospheric ozone depletion. As with many of the other stresses mentioned, there are important interactions between climate change and ozone depletion. The effects of climate change on the upper atmosphere make continued ozone depletion over the Arctic likely to persist for at least a few more decades. Thus, ultraviolet radiation levels in the Arctic are likely to remain elevated, and this will be most pronounced in the spring, when ecosystems are most sensitive to harmful ultraviolet radiation. The combination of climate change, excess ultraviolet radiation, and other stresses presents a range of potential problems for human health and well-being as well as risks to other arctic species and ecosystems.

To communicate the results contained in the 1200 page Scientific Report of this assessment, the more non-technical and plain language Overview Report we are discussing today, integrates the scientific aspects of the assessment through ten Key Findings. A more detailed listing of these ten Key Findings is contained in Attachment I at the end of this testimony, the essence of which is contained in this list of ten Key Findings:

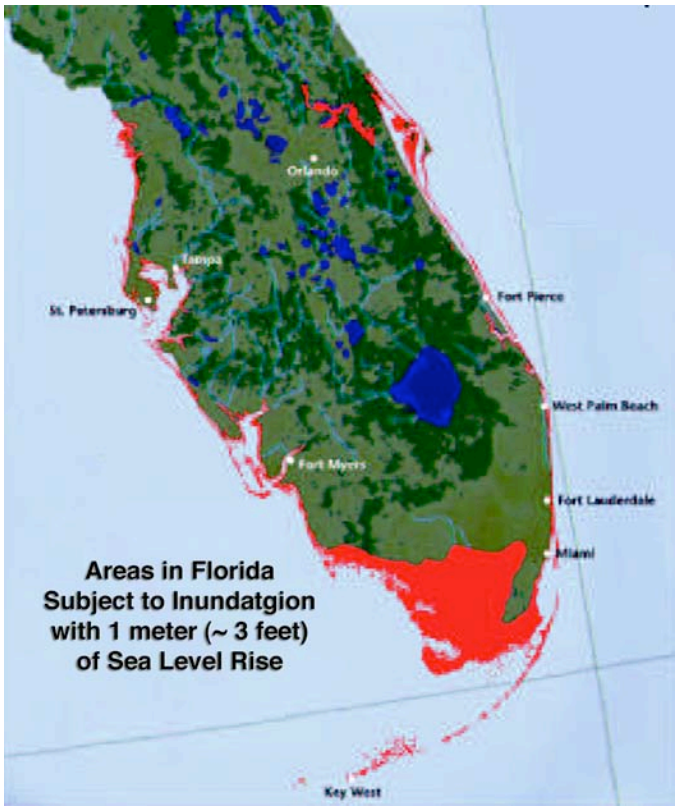
1. Arctic climate is now warming rapidly and much larger changes are projected,
2. Arctic warming and its consequences have worldwide implications Arctic vegetation zones are very likely to shift, causing wide-ranging impacts,
3. Animal species' diversity, ranges, and distribution will change Many coastal communities and facilities face increasing exposure to storms,
4. Reduced sea ice is very likely to increase marine transport and access to resources,
5. Thawing ground will disrupt transportation, buildings, and other infrastructure,
6. Indigenous communities are facing major economic and cultural impacts,
7. Elevated ultraviolet radiation levels will affect people, plants, and animals,
8. Multiple influences interact to cause impacts to people and ecosystems,
9. Elevated ultraviolet radiation levels will affect people, plants, and animals, and
10. Multiple influences interact to cause impacts to people and ecosystems.

We appreciate the opportunity to meet with the Committee and to outline some aspects of these ten Key Findings contained "*Impacts of a Warming Arctic*". This Overview Report details the major findings of the assessment. For example, the reductions in sea ice depicted on the next page is based on the analyses conducted in this assessment which show that September sea-ice extent, already declining markedly, is projected to decline even more rapidly in the future. The three images show the average of the projections from five climate models for three future time periods. As the century progresses, sea ice moves further and further from the coasts of arctic land masses, retreating to the central Arctic Ocean. Some models project the nearly complete loss of summer sea ice in this century.

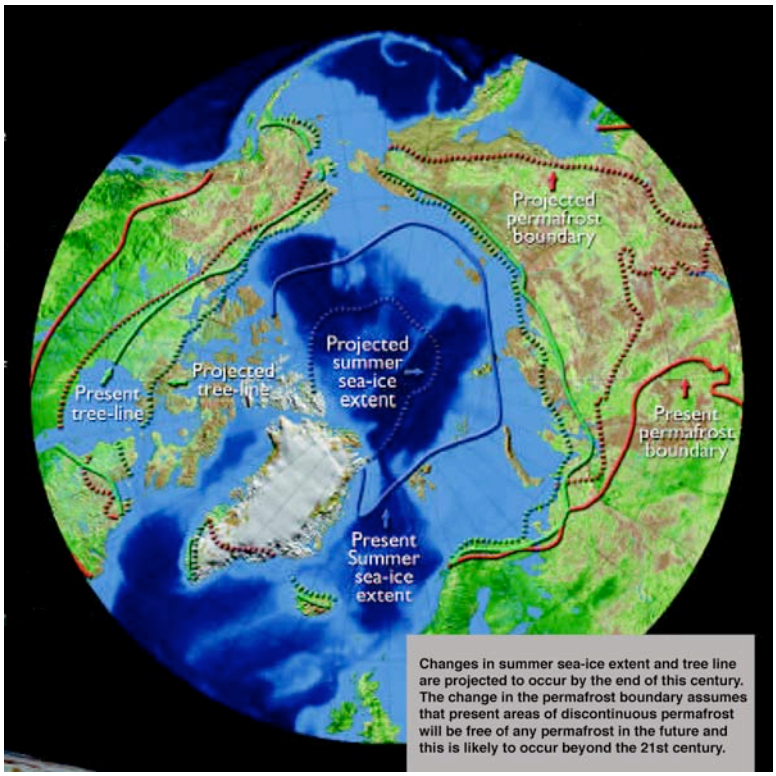


Further, sea level rise has the potential for significant impacts on societies and ecosystems around the world. Climate change causes sea level to rise by affecting both the density and the amount of water in the oceans. The primary factors contributing to this rise are thermal expansion due to ocean warming and melting of land-based ice that increases the total amount of water in the ocean. Global average sea level is projected by IPCC to rise 10 to 90 centimeters during this century, with the rate of rise accelerating as the century progresses. However, recent studies suggest the potential of up to 1 meter (~3 feet) by the end of the century.

This would have profound impacts for Florida as depicted in this graphic. Over the longer term, much larger increases in sea level are projected. Sea-level rise is expected to vary around the globe, with the largest increases projected to occur in the Arctic, in part due to the projected increase in freshwater input to the Arctic Ocean and the resulting decrease in salinity and thus density. Sea-level rise is projected to have serious implications for coastal communities and industries, islands, river deltas, harbors, and the large fraction of humanity living in coastal areas worldwide. Sea-level rise will increase the salinity of bays and estuaries. It will increase coastal erosion, especially where coastal lands are soft rather than rocky.



This summary graphic to the right projects some the major changes in both the landscape and the Arctic oceanic basin. As Larisa Avdeyeva of Lovozero, Russia has indicated "Nowadays snows melt earlier in the springtime. Lakes, rivers, and bogs freeze much later in the autumn. Reindeer herding becomes more difficult as the ice is weak and may give way… All sorts of unusual events have taken place. Nowadays the winters are much warmer than they used to be. Occasionally during winter time it rains. We never expected this; we could not be ready for this. It is very strange… The cycle of the yearly calendar has been disturbed greatly and this affects the reindeer herding negatively for sure." These changes observed by this elder in Russia are also consistent with and documented by the scientific analyses of this assessment and are projected to continue in the coming decades.



I'd like to conclude by noting that the impacts of climate change in the Arctic addressed in this assessment are largely caused from outside the region, and will reverberate back to the global community in a variety of ways. The scientific findings reported here can inform decisions about actions to reduce the risks of climate change. As the pace and extent of climate change and its impacts increase, it will become more and more important for people everywhere to become aware of the changes taking place in the Arctic, and to consider them in evaluating what actions should be taken to respond. The IPCC[4] concluded in 2001that *"There is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities".* The findings of this assessment are consistent with this perspective. Based on both our analyses and those of the IPCC, carbon dioxide concentrations in the atmosphere will remain elevated above historic levels for centuries, even if emissions were to cease immediately. Some continued warming is thus inevitable. However, the speed and amount of warming can be reduced if future emissions are limited sufficiently to stabilize the concentrations of greenhouse gases. The more than 30 scenarios developed by the IPCC assume a variety of different societal developments, resulting in various plausible levels of future emissions. Of these scenarios, the ACIA used a moderate IPCC scenario, B2, for all of its model simulations of future climate change in the Arctic, adding in some cases the A2 scenario to explore additional aspects of climate change across the circumpolar Arctic. None of these scenarios assume implementation of explicit policies to reduce greenhouse gas emissions. Thus, atmospheric concentrations do not

[4] Intergovernmental Panel on Climate Change (IPCC), 2001

level off in these scenarios, but rather continue to rise, resulting in significant increases in temperature and sea level and widespread changes in precipitation. The costs and difficulties of adapting to such increases are very likely to increase significantly over time.

If, on the other hand, society chooses to reduce emissions substantially, the induced changes in climate would be smaller and would happen more slowly. This would not eliminate all impacts, especially some of the irreversible impacts affecting particular species. However, it would allow ecosystems and human societies as a whole to adapt more readily, reducing overall impacts and costs. The impacts addressed in this assessment assume continued growth in greenhouse gas emissions. Although it will be very difficult to limit near-term consequences resulting from past emissions, many longer-term impacts could be reduced significantly by reducing global emissions over the course of this century. This assessment did not analyze strategies for achieving such reductions, which are the subject of efforts by other bodies.

Attachment I

Key Findings of the Arctic Climate Impact Assessment[5]:

1. **Arctic climate is now warming rapidly and much larger changes are projected.**
   - Annual average arctic temperature has increased at almost twice the rate as that of the rest of the world over the past few decades, with some variations across the region.
   - Additional evidence of arctic warming comes from widespread melting of glaciers and sea ice, and a shortening of the snow season.
   - Increasing global concentrations of carbon dioxide and other greenhouse gases due to human activities, primarily fossil fuel burning, are projected to contribute to additional arctic warming of about 4-7°C over the next 100 years.
   - Increasing precipitation, shorter and warmer winters, and substantial decreases in snow cover and ice cover are among the projected changes that are very likely to persist for centuries.
   - Unexpected and even larger shifts and fluctuations in climate are also possible.
2. **Arctic warming and its consequences have worldwide implications.**
   - Melting of highly reflective arctic snow and ice reveals darker land and ocean surfaces, increasing absorption of the sun's heat and further warming the planet.
   - Increases in glacial melt and river runoff add more freshwater to the ocean, raising global sea level and possibly slowing the ocean circulation that brings heat from the tropics to the poles, affecting global and regional climate.
   - Warming is very likely to alter the release and uptake of greenhouse gases from soils, vegetation, and coastal oceans.
   - Impacts of arctic climate change will have implications for biodiversity around the world because migratory species depend on breeding and feeding grounds in the Arctic.
3. **Arctic vegetation zones are very likely to shift, causing wide-ranging impacts.**
   - Treeline is expected to move northward and to higher elevations, with forests replacing a significant fraction of existing tundra, and tundra vegetation moving into polar deserts.
   - More-productive vegetation is likely to increase carbon uptake, although reduced reflectivity of the land surface is likely to outweigh this, causing further warming.
   - Disturbances such as insect outbreaks and forest fires are very likely to increase in frequency, severity, and duration, facilitating invasions by non-native species.
   - Where suitable soils are present, agriculture will have the potential to expand northward due to a longer and warmer growing season.
4. **Animal species' diversity, ranges, and distribution will change.**
   - Reductions in sea ice will drastically shrink marine habitat for polar bears, ice-inhabiting seals, and some seabirds, pushing some species toward extinction.

[5] 2004 "Impacts of a Warming Arctic", Arctic Climate Impact Assessment (www.acia.uaf.edu), Cambridge University Press (www.cambridge.org),

- Caribou/reindeer and other land animals are likely to be increasingly stressed as climate change alters their access to food sources, breeding grounds, and historic migration routes.
- Species ranges are projected to shift northward on both land and sea, bringing new species into the Arctic while severely limiting some species currently present.
- As new species move in, animal diseases that can be transmitted to humans, such as West Nile virus, are likely to pose increasing health risks.
- Some arctic marine fisheries, which are of global importance as well as providing major contributions to the region's economy, are likely to become more productive. Northern freshwater fisheries that are mainstays of local diets are likely to suffer.

5. Many coastal communities and facilities face increasing exposure to storms.

- Severe coastal erosion will be a growing problem as rising sea level and a reduction in sea ice allow higher waves and storm surges to reach the shore.
- Along some arctic coastlines, thawing permafrost weakens coastal lands, adding to their vulnerability.
- The risk of flooding in coastal wetlands is projected to increase, with impacts on society and natural ecosystems.
- In some cases, communities and industrial facilities in coastal zones are already threatened or being forced to relocate, while others face increasing risks and costs.

6. Reduced sea ice is very likely to increase marine transport and access to resources.

- The continuing reduction of sea ice is very likely to lengthen the navigation season and increase marine access to the Arctic's natural resources.
- Seasonal opening of the Northern Sea Route is likely to make trans-arctic shipping during summer feasible within several decades. Increasing ice movement in some channels of the Northwest Passage could initially make shipping more difficult.
- Reduced sea ice is likely to allow increased offshore extraction of oil and gas, although increasing ice movement could hinder some operations.
- Sovereignty, security, and safety issues, as well as social, cultural, and environmental concerns are likely to arise as marine access increases.

7. Thawing ground will disrupt transportation, buildings, and other infrastructure.

- Transportation and industry on land, including oil and gas extraction and forestry, will increasingly be disrupted by the shortening of the periods during which ice roads and tundra are frozen sufficiently to permit travel.
- As frozen ground thaws, many existing buildings, roads, pipelines, airports, and industrial facilities are likely to be destabilized, requiring substantial rebuilding, maintenance, and investment.
- Future development will require new design elements to account for ongoing warming that will add to construction and maintenance costs.
- Permafrost degradation will also impact natural ecosystems through collapsing of the ground surface, draining of lakes, wetland development, and toppling of trees in susceptible areas.

8. Indigenous communities are facing major economic and cultural impacts.

- Many Indigenous Peoples depend on hunting polar bear, walrus, seals, and caribou, herding reindeer, fishing, and gathering, not only for food and to support the local economy, but also as the basis for cultural and social identity.
- Changes in species' ranges and availability, access to these species, a perceived reduction in weather predictability, and travel safety in changing ice and weather conditions present serious challenges to human health and food security, and possibly even the survival of some cultures.
- Indigenous knowledge and observations provide an important source of information about climate change. This knowledge, consistent with complementary information from scientific research, indicates that substantial changes have already occurred.

9. Elevated ultraviolet radiation levels will affect people, plants, and animals.

- The stratospheric ozone layer over the Arctic is not expected to improve significantly for at least a few decades, largely due to the effect of greenhouse gases on stratospheric temperatures. Ultraviolet radiation (UV) in the Arctic is thus projected to remain elevated in the coming decades.
- As a result, the current generation of arctic young people is likely to receive a lifetime dose of UV that is about 30% higher than any prior generation. Increased UV is known to cause skin cancer, cataracts, and immune system disorders in humans.
- Elevated UV can disrupt photosynthesis in plants and have detrimental effects on the early life stages of fish and amphibians.
- Risks to some arctic ecosystems are likely as the largest increases in UV occur in spring, when sensitive species are most vulnerable, and warming-related declines in snow and ice cover increase exposure for living things normally protected by such cover.

10. Multiple influences interact to cause impacts to people and ecosystems.

- Changes in climate are occurring in the context of many other stresses including chemical pollution, overfishing, land use changes, habitat fragmentation, human population increases, and cultural and economic changes.
- These multiple stresses can combine to amplify impacts on human and ecosystem health and well-being. In many cases, the total impact is greater than the sum of its parts, such as the combined impacts of contaminants, excess ultraviolet radiation, and climatic warming.
- Unique circumstances in arctic sub-regions determine which are the most important stresses and how they interact.