PART I

IMPLICATIONS OF ARCTIC TRANSFORMATION FOR THE NORTH PACIFIC

2. Consequences of the Changes across the Arctic on World Order, the North Pacific Nations, and Regional and Global Governance

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Overview: The Arctic region and the Northern Hemisphere oceans and continental lands[1] are now experiencing some of the most rapid and severe changes in climate on Earth. Over the coming decades, climate change is expected to accelerate, contributing to major physical, ecological, social, and economic changes in the region, many of which have already been documented. Changes in Arctic climate will also affect the Pacific region north of the equator, as well as the rest of the world, through increased regional surface temperatures, changes in regional weather, and rising sea levels across the globe. Further, these changes are very likely to have consequences in multinational policy, national and international governance, and security issues affecting societies and human well-being across the Arctic and neighboring Northern Hemisphere nations.[2] Is this important? Former Secretary General of the United Nations Kofi Annan summarized its importance when he stated:

> *"The stakes are high. Climate change has profound implications for virtually all aspects of human well-being, from jobs and health to food security and peace within and among nations. Yet too often climate change is seen as an environmental problem when it should be part of the broader development and economic agenda. Until we acknowledge the all-encompassing nature of the threat, our response will fall short."*

On a global scale the IPCC, and more recently, peer-reviewed scientific publications, have concluded that:

- Warming of the climate system is unequivocal, as is now evident

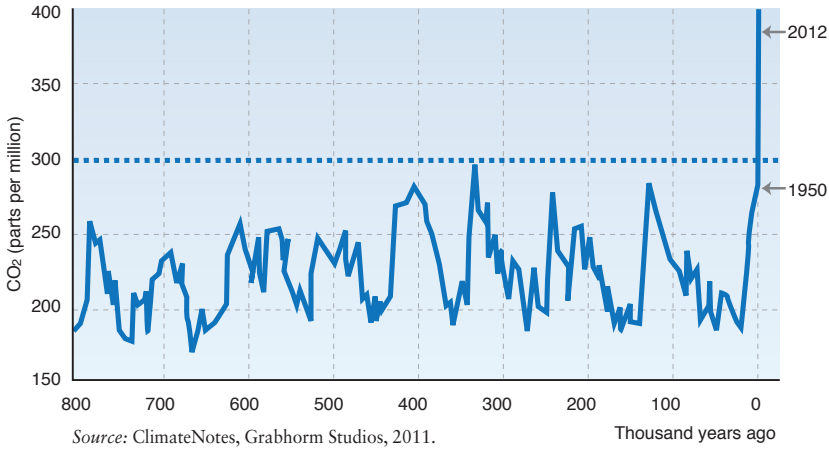
from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level,

- There is now higher confidence in projected patterns of warming and other regional-scale features, including changes in wind patterns, precipitation and some aspects of extreme weather and of ice, and
- Anthropogenic warming and sea level rise will continue for centuries due to the time scales associated with climate processes and feedbacks, even if greenhouse gas concentrations were to be stabilized.

Earth's climate is changing, with the global temperature now rising at a rate unprecedented in the experience of modern human society. While some historical changes in climate have resulted from natural causes and variations, the strength of the trends and the patterns of change that have emerged in recent decades indicate that human influences, resulting primarily from increased emissions of carbon dioxide and other greenhouse gases, have since about 1950 become the dominant factor.

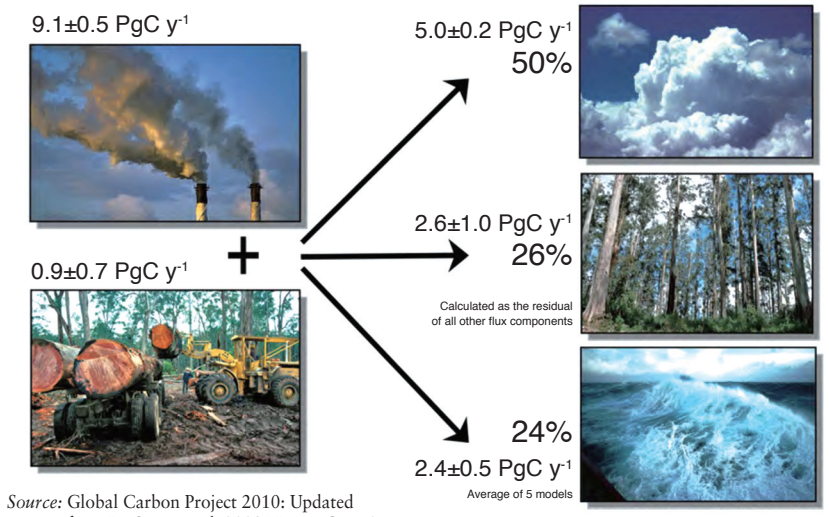
WHAT IS HAPPENING TO OUR CLIMATE AND WHY?

Earth's climate is indeed changing, with the global temperature now rising at rates unprecedented in the experience of modern human society. The strength of the trends and the patterns of change that have emerged in recent decades indicate that human influences, resulting primarily from increased carbon dioxide emissions from fossil fuels, deforestation of the tropical rain forests, and numerous other greenhouse gases, have now become the dominant factor. These climate changes are being experienced particularly intensely in the Arctic, where the average regional surface temperatures have risen at two to three times the rate of the rest of the world, particularly during the past several decades. Widespread melting of glaciers and sea ice and rapidly thawing permafrost provide further evidence of strong Arctic warming. These changes in the Arctic provide an early indication of the environmental and societal significance of global climate change. These climatic trends across the Arctic are projected to accelerate during the coming decades and beyond this century. These climatic changes are not limited only to the Arctic, as the climatic shift in the Arctic will influence regions far beyond, affecting global climate,



Source: ClimateNotes, Grabhorm Studios, 2011.

Figure 2.1 *The 800,000 year record of carbon dioxide*

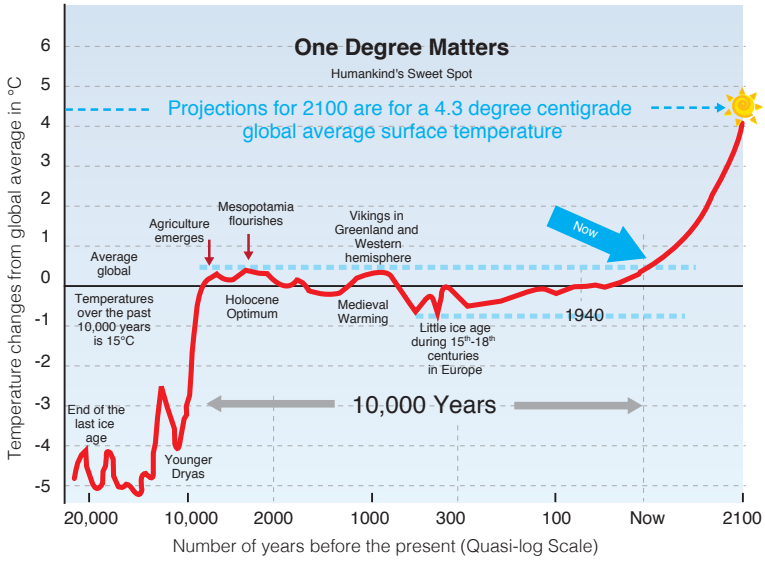


Source: Global Carbon Project 2010: Updated from Le Quere et al. 2009 Nature Geoscience.

Figure 2.2 *The global emission sources and sinks for anthropogenic carbon dioxide*

sea level, biodiversity, and many aspects of human social and economic systems. What follows are some of the scientific foundations for the issues that are likely to be derived from climate change and an ice-free Arctic region in the decades ahead.

Earth's climate is changing in ways unprecedented in human history,



Source: Adapted from "Climate Change and Human Health-Risk and Response" published by WHO in collaboration with UNEP and WMO 2003 and more recent data from IPCC 2007.

Figure 2.3 Humanity has developed during a 10,000 year period with a very stable climate

with global temperatures and impacts now rising at rates that exceed any in human history. The Fourth Intergovernmental Panel on Climate Change (IPCC) projected an anticipated global temperature range by 2100 of 1.1°C to 6.4°C, with a more than likely mean expected temperature of about 4°C (or over 7°C). As the data in the graphic indicates, humans have had over 10,000 years of remarkably stable climate, with less than one degree centigrade variability in temperature over that entire period of modern human history. Anthropologists and others studying the history of human development note that the stability of the Earth's climate has enabled humans to evolve to the richness of modern times. The Earth is entering into a new epoch, called the Anthropocene.[3] This geological epoch is unique in at least 800,000 years and quite possibly for millions of years.

While it is evident that changes in our climate historically have resulted from natural causes and variations – from Medieval Warming to the Little Ice Age – the scientific evidence is now unequivocal that during the past half-century, human influences on the climate system now exceed natural climatic variability. The scientific evidence is now unequivocal that climate change

is real, dangerous and immediate. The primary cause of this unparalleled human influence on our climate is the use of fossil fuels as the primary energy source, providing unequaled standards of living for many societies throughout the world. While at the same time, billions of people have not ever experienced these levels of societal well-being, fostering continued poverty, hunger, unacceptable levels of disease and inadequate capacity to deal with increased incidents of drought, floods and severe weather.

The foundation of this human influence on the climate system is simply the pervasive and unparalleled human uses of, and emissions from, fossil fuels that overwhelm the capacity of the greenhouse effect, which then increases global temperatures. While there are many greenhouse gases that form the protective greenhouse envelope around the planet, the primary greenhouse gas is carbon dioxide (CO_2), the concentration of which in the atmosphere is increasing dramatically because human-created emissions are accelerating. As depicted in Figure 2.2, about 90% of the CO_2 emissions are from the use of fossil fuels and the remaining 10% is largely the result of the clearing and burning of the tropical rainforest, such as in Brazil. Unfortunately, the capacity of both the oceans and plants in the terrestrial biosphere to absorb the CO_2 has decreased by about 5% over the past few decades, further increasing the concentration of CO_2 in the atmosphere,

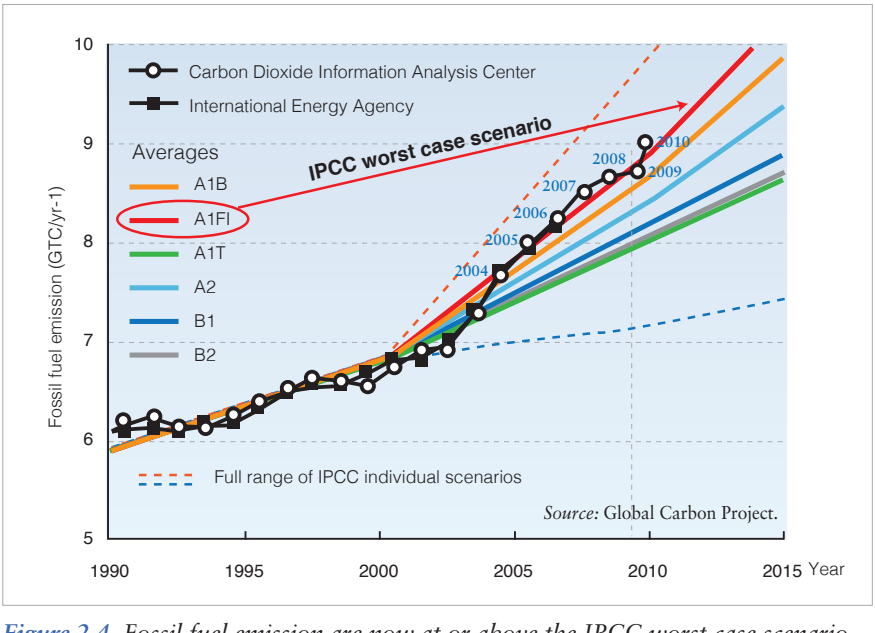


Figure 2.4 *Fossil fuel emission are now at or above the IPCC worst case scenario*

which further accelerates the warming of the global atmosphere. Figure 2.4, while seemingly complex, describes a troubling reality; even with international agreements under the United Nations Framework Convention on Climate Change (e.g., the Kyoto Protocol) seeking to curb the warming of the planet, global emissions of CO_2 have increased four times faster during 2000-2009 than in the previous decade and have exceeded the projected worst-case emission scenario projected by the IPCC in 2001 and depicted in Figure 2.4. If the observed rate of increase for the period 2000 to 2010 continues, the projected global temperatures will very likely exceed the temperatures projected by IPCC and be at or above 4°C by 2100. Further, if humans continue accelerating emissions of CO_2 and other greenhouse gases, the consequences for all humankind and the Earth's natural systems are likely to be devastating. This scientific finding is unfortunate, as this has been the period of implementation of the Kyoto Protocol, ratified by 184 parties, which set binding emissions reduction targets by 2012 for 37 industrialized countries and the European community.

The early warnings have been evident for decades and particularly intensely in the Arctic. The Arctic average temperature has risen at between two and three times the rate of the rest of the world in the past few decades and has been particularly evident during the past 15 or more years, as

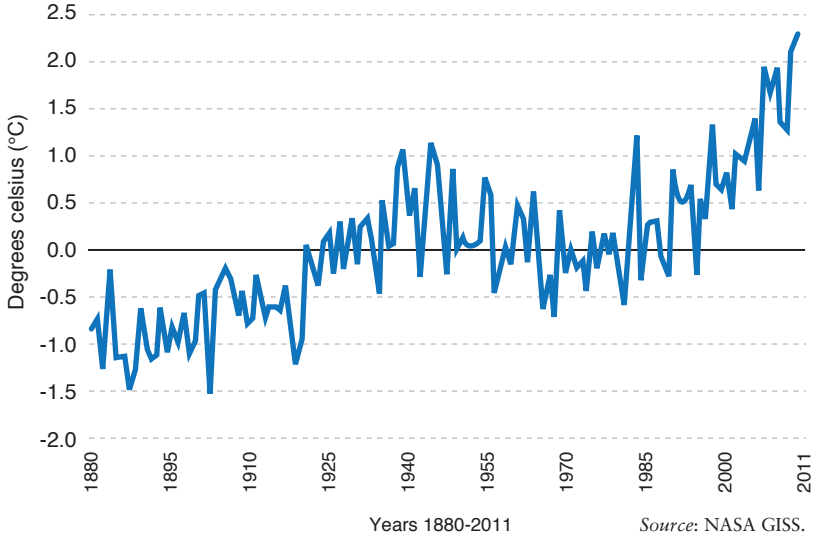


Figure 2.5 *Circumpolar surface mean temperature changes 1880 to 2011*

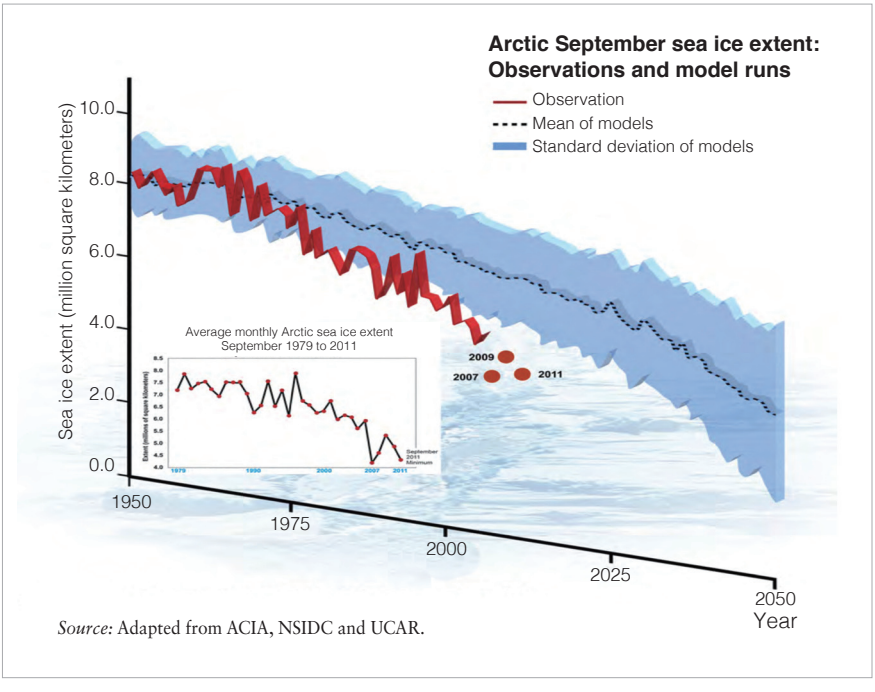


Figure 2.6 *Arctic sea ice minimum extent (September 1950 to 2011)*

depicted in Figure 2.5.

These increased Arctic temperatures have created widespread melting of glaciers, particularly the Greenland Ice Sheet, and dramatic decreases in both the surface area and thickness of the sea ice in the Arctic Ocean, as depicted in Figures 2.6 and 2.7. Figure 2.6 shows that climate models dramatically underestimate the rates of Arctic sea ice melting. Figure 2.7 shows the actual summer (September 2011) area of Arctic sea ice, which is about one half of what it was in 1980. While not depicted here, the sea ice thickness has similarly decreased by upwards of 25% to 40%, with a continued decline in overall Arctic basin sea ice volume. Current scientific research suggests that the Arctic Ocean will be increasingly ice free in summer, which opens seaways along both the Canadian and Russian coastal regions. A totally ice-free Arctic Ocean in the summer is likely to occur within a few decades, with increasingly longer periods, over the decades there after, of ice-free waters.

A further complication of substantial warming in the Arctic is the thawing of permafrost, shown in Figure 2.8, and the prospect therefore of the

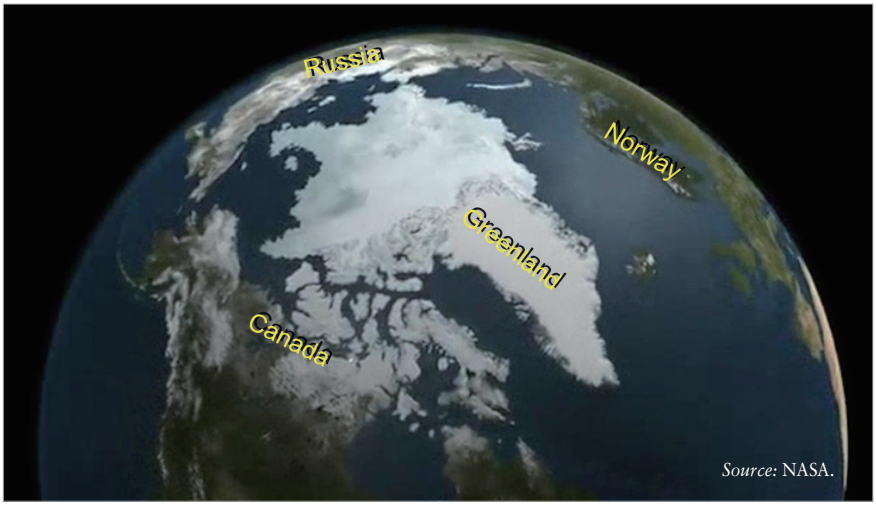


Figure 2.7 *Satellite imagery of 2011 minimum Arctic sea ice on September 19, 2011*

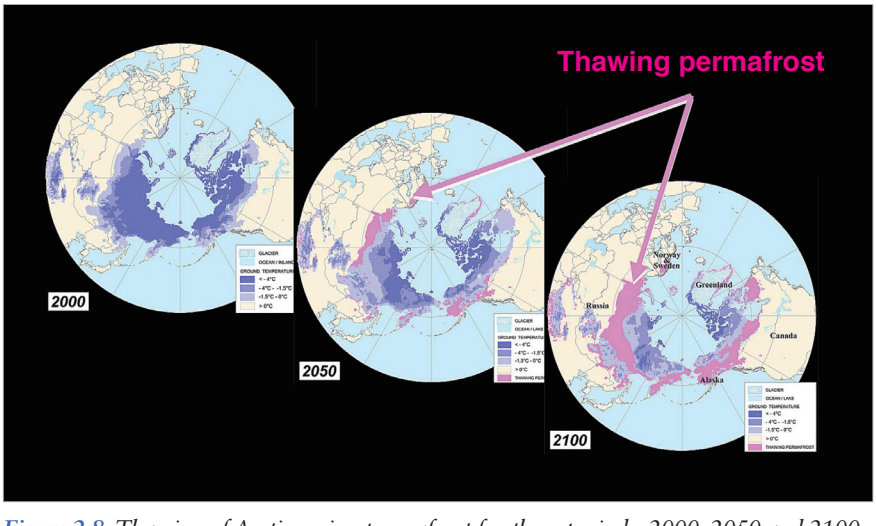


Figure 2.8 *Thawing of Arctic region permafrost for three periods: 2000, 2050 and 2100*

release of substantial amounts of methane (commonly known as the "natural gas" used throughout the world to heat homes, run appliances, and power industry). Methane is an extremely powerful greenhouse gas, 20 to 30 times more potent in effect than CO_2. The surface permafrost in the tundra regions of Alaska and Russia are already thawing, with projections for major areas to thaw over the coming decades as depicted in this graphic.

The prospect of such rising permafrost temperatures is further evidence

of a strong Arctic warming trend. These changes in the Arctic provide an early indication of the environmental and societal significance of global

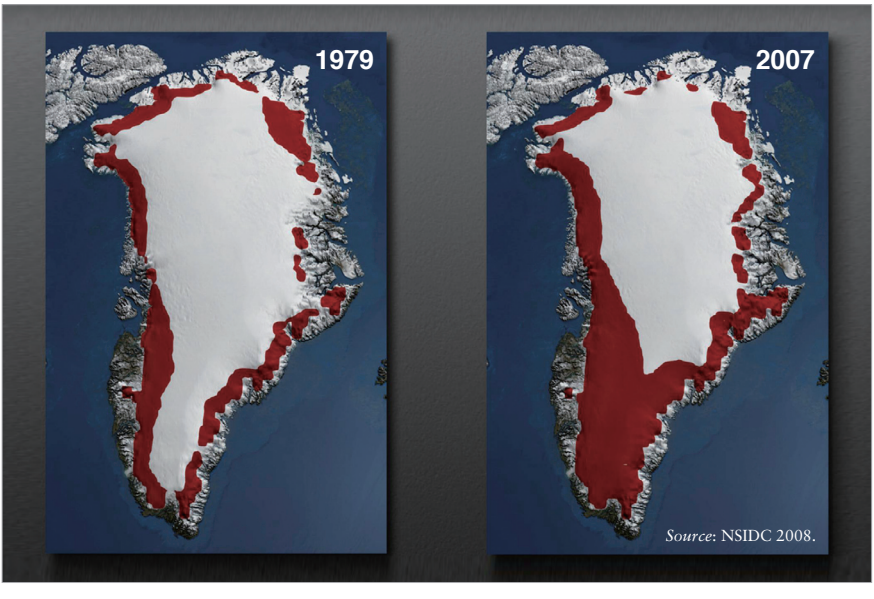


Figure 2.9 *Greenland regions of ice sheet melting from first satellite data in 1979 to 2007*

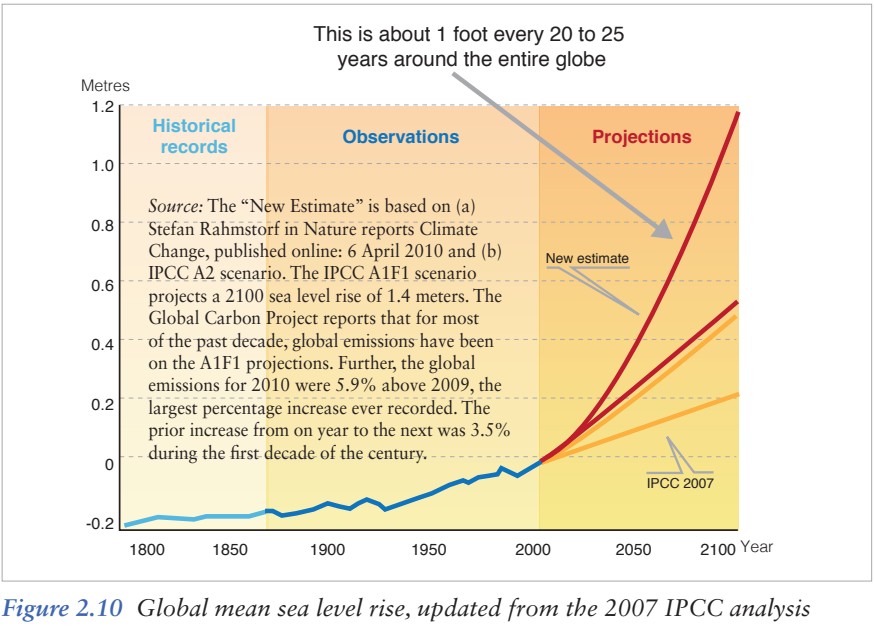


Figure 2.10 *Global mean sea level rise, updated from the 2007 IPCC analysis*

warming. These changes will reach far beyond the Arctic, affecting water and food availability, sea level rise, biodiversity, human health and many other aspects of human social and economic systems. An additional consequence of this early and accelerated warming in the Arctic is the melting of glaciers and the Greenland Ice Sheet. Whereas the melting of the Arctic sea ice does not add to sea level rise, the melting of land-fast glacial ice will directly contribute to sea level rise. The Greenland Ice Sheet is melting along its coastal regions (Figure 2.9) and is calving icebergs and small ice growlers from its internal ice sheet at accelerated rates, with the prospect of contributing to sea level rise of upwards of one meter (3.3 feet) or more by the end of this century. Some leading scientists are projecting about one foot of sea level rise every generation or so (Figure 2.10), which the IPCC projects is likely to displace tens to hundreds of millions of people in lowland areas and many small island states. Figures 2.11 and 2.15 depict the consequences of one meter or more sea level rise by 2100. There are highly variable regional changes in sea level rise (Figure 2.11) based on regional factors, such as regional seawater heating, regional currents, and regional wind patterns. This results in the conditions depicted in Figure 2.11, where the "small island nations" region of the Asian Pacific are likely

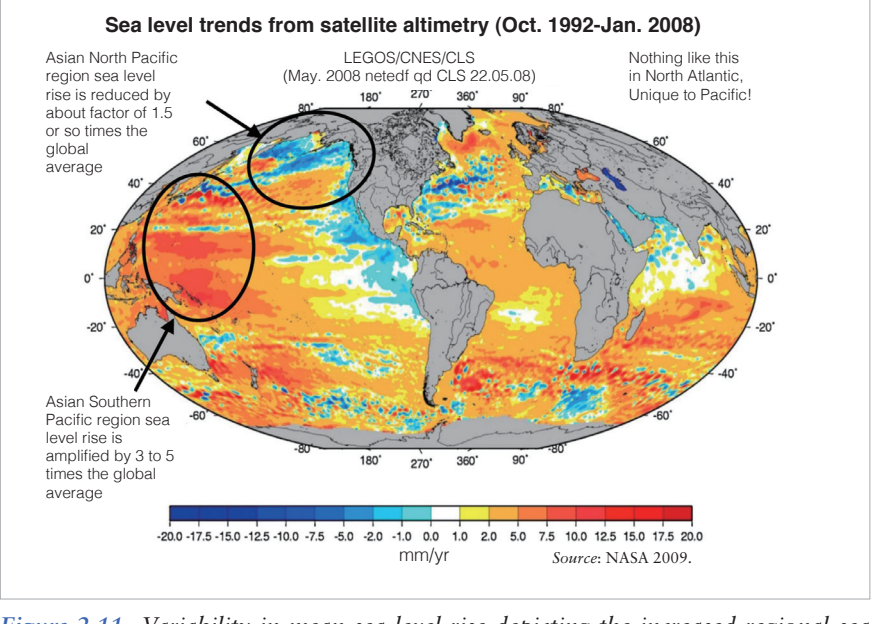


Figure 2.11 *Variability in mean sea level rise depicting the increased regional sea level rise for Western Pacific*

to experience regional sea level rise at rates three to five times the global average sea level rise. However, in the North Pacific region, the average regional sea level is likely to be reduced by a factor of 1.5 or more from the global average sea level rise.

It is important to note that climate change is taking place within a context of many other ongoing changes, including globalization, poverty and hunger, land use changes, rapid human population growth, and changes in cultural, governance, and economic conditions. It is now scientifically clear that the current levels and rates of climate change are already exceeding levels of stabilization of greenhouse gas concentrations in the atmosphere that will prevent dangerous anthropogenic interference with the climate system. In summary, we know these realities, all of which have direct and serious implications for the North Pacific Ocean region, with high scientific probability.[4]

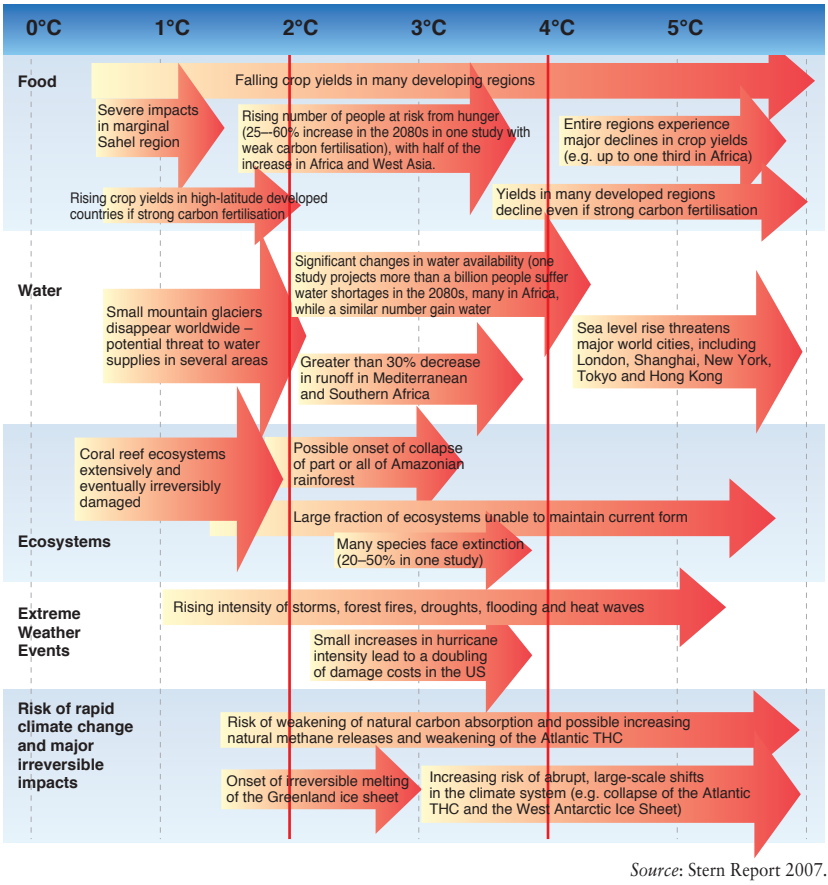
1. ***Sea Level Rise:*** The global sea level rose about 17 centimeters (6.7 inches) in the last century. The rate in the last decade, however, is nearly double that of the last century.
2. ***Global Temperature Rise:*** All three major global surface temperature reconstructions show that Earth has warmed since 1880. Most of this warming has occurred since the 1970s, with the 20 warmest years having occurred since 1981 and with all 10 of the warmest years occurring in the past 12 years. Even though the 2000s witnessed a solar output decline, resulting in an unusually deep solar minimum in 2008-2009, surface temperatures continue to increase.
3. ***Warming Oceans:*** The oceans have absorbed much of this increased heat, with the top 700 meters (about 2,300 feet) of ocean showing warming of 0.302 degrees Fahrenheit since 1969.
4. ***Shrinking Ice Sheets:*** The Greenland and Antarctic ice sheets have decreased in mass. Data from NASA's Gravity Recovery and Climate Experiment show Greenland's net lost was approximately 200 cubic kilometers (36 to 60 cubic miles) of ice per year between 2002 and 2006, while in the 2010 period it was double that loss. Antarctica had a net loss of about 152 cubic kilometers (36 cubic miles) of ice between 2002 and 2005.
5. ***Declining Arctic Sea Ice:*** Both the extent and thickness of Arctic sea ice has declined rapidly over the last several decades, at extent rates of about 10% to 12% per decade.

6. ***Glacial Retreat:*** Glaciers are retreating almost everywhere around the world (over 95%), including in the Alps, Himalayas, Andes, Rockies, Alaska and Africa.
7. ***Ocean Acidification:*** Since the beginning of the Industrial Revolution, the acidity of surface ocean waters has increased by about 30 percent. This increase is the result of humans emitting more carbon dioxide into the atmosphere and hence more being absorbed into the oceans and converted into carbonic acid. The amount of carbon dioxide absorbed by the upper layer of the oceans is increasing by about 2 billion tons per year.
8. ***Extreme Events:*** The number of record-high temperature events in the United States has been increasing, while the number of record-low temperature events has been decreasing, since 1950. The U.S. has also witnessed increasing numbers of intense rainfall events. Further, the energy in cyclonic storms (i.e., a hurricane in the Atlantic region, called a typhoon in the Pacific region) has increased by about 50% during the past several decades. While the total annual increases in precipitation (U.S.) since 1910 increased by less than 10%, observations for the same period indicate that extreme precipitation events (more than 2 inches in 24 hours) in the U.S. have increased by 20%-30%.[5]
9. ***Surging Greenhouse Gas Emissions:*** Global carbon dioxide emissions from fossil fuels in 2008 were nearly 40% higher than those in 1990. The rate of emissions for 2010 were 5.9% higher than the previous year, which is almost twice the highest rate ever recorded. Even if global emission rates are stabilized at present-day levels, just 20 more years of emissions would give a 25% probability that warming exceeds 2°C, even with zero emissions after 2030. Every year of delayed action increases the chances of exceeding 2°C warming.

WHAT ARE THE IMPLICATIONS OF THESE FINDINGS FOR HUMANKIND AND NATURAL SYSTEMS?

The scientific consensus is now unequivocal that climate change is real and the danger is immediate. The primary cause of this unparalleled

human influence on our climate is the use of fossil fuels as the primary energy source, providing unequaled standards of living for many societies throughout the world. When combined with the deforesting of our tropical rain forests, this will continue to change the climate for decades to come, hence warming the planet on long time scales. Further, several vulnerable elements in the climate system (e.g. continental ice sheets, the Amazon rain forest, West African monsoons and others) could be pushed towards abrupt or irreversible change if warming continues as business-as-usual throughout this century. These impacts from a changing climate are pervasive and potentially affect people on a global scale, from the most highly economically developed nations to those living in the "Bottom

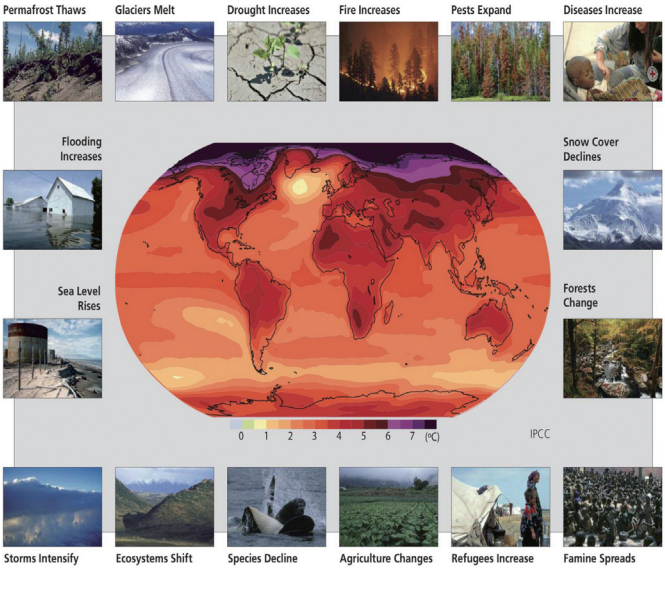


Source: Stern Report 2007.

Figure 2.12 *Consequences of global mean surface temperatures for critical impacted areas*

Billion."[6] Thus, waiting for higher levels of scientific certainty could mean that some tipping points will be crossed before they are recognized. These impacts are summarized in Figure 2.12, where the 2°C (3.6°F) and 4°C (7.2°F) lines depict the range within which projected emission rates will likely be towards the end of the 21st century (i.e., 2100). It is clear that the impacts affect global food supplies and security, water availability and security, the health of ecosystems and sustainability of vital life-supporting biodiversity, along with such issues as extreme weather events on regional scales and the risk of unpredictable and rapid climate change and major irreversible impacts affecting human well-being.

The Global Carbon Project (GCP)[7] documents global carbon emissions, atmospheric concentrations of global carbon, and other measures of the global carbon system in order to assist in the development of a comprehensive, policy-relevant understanding of the global carbon cycle, encompassing both natural and human dimensions and their interactions. Actual global emissions, as shown in Figure 2.4, have essentially followed the IPCC upper scenario projections (i.e., A1FI). Using peer-review



Source: ClimateNotes.

Figure 2.13 *Consequences of global mean surface temperatures as projected by IPCC 2007*

C-ROADS simulation[8] to project global mean surface temperatures based on the publicly available emission reduction proposal of the 194 UNFCCC nations, it is projected that the global mean surface temperature for 2100 will be 4.5°C, which is depicted in Figure 2.13 and shown graphically in the center of Figure 2.13. Such projections of climate change by 2100 are predicted to very likely affect virtually all aspects of society's activities, as suggested in Figure 2.13.

The Fourth IPCC Assessment[9] concluded in more detail than depicted in Figure 13 that the impacts are very likely (IPCC used "very likely" if the probability of occurrence is greater than 90%) to be severe and affect systems on decadal time scales, including, inter alia:

- ***Ecosystems:*** The resilience of many ecosystems is likely to be exceeded this century by an unprecedented combination of climate change, associated disturbances (e.g. flooding, drought, wildfires, insects, ocean acidification) and other global change drivers (e.g. land use change, pollution, fragmentation of natural systems, overexploitation of resources).
- ***Food:*** At lower latitudes, especially in seasonally dry and tropical regions, crop productivity is projected to decrease for even small local temperature increases (1 to 2°C), which would increase the risk of hunger.
- ***Coasts:*** Coasts are projected to be exposed to increasing risks, including coastal erosion, due to climate change and sea level rise. The effect will be exacerbated by increasing human-induced pressures on coastal areas.
- ***Industry, Communities and Society:*** The most vulnerable industries, settlements and societies are generally those in coastal and river flood plains, those whose economies are closely linked with climate-sensitive resources and those in areas prone to extreme weather events, especially where rapid urbanization is occurring.
- ***Human Health:*** The health status of millions of people is projected to be affected through, for example, increases in malnutrition; increased deaths, diseases and injury due to extreme weather events; increased burden of diarrhoeal diseases; increased frequency of cardio-respiratory diseases due to higher concentrations of ground-level ozone in urban areas related to climate change; and the altered spatial distribution of some infectious diseases.

- ***Water:*** Climate change is expected to exacerbate current stresses on water resources from population growth and economic and land-use changes, including urbanization. On a regional scale, mountain snow pack, glaciers and small ice caps play a crucial role in freshwater availability. Widespread mass losses from glaciers and reductions in snow cover over recent decades are projected to accelerate throughout the 21st century, reducing water availability, hydropower potential, and changing seasonality of flows in regions supplied by melt water from major mountain ranges (e.g. Hindu-Kush, Himalaya, Andes), where more than one-sixth of the world population currently lives.
- ***Extreme Weather Events:*** Altered frequencies and intensities of extreme weather, together with sea level rise, are expected to have mostly adverse effects on natural and human systems.

The Fourth Assessment IPCC further suggests these regional findings:

- ***Africa:*** By 2020, between 75 and 250 million of people are projected to be exposed to increased water stress due to climate change.
- ***Asia:*** By the 2050's, freshwater availability in Central, South, East and South-East Asia, particularly in large river basins, is projected to decrease.
- ***Australia and New Zealand:*** By 2020, significant loss of biodiversity is projected to occur in some ecologically rich sites, including the Great Barrier Reef and Queensland Wet Tropics.
- ***Europe:*** Climate change is expected to magnify regional differences in Europe's natural resources and assets. Negative impacts will include increased risk of inland flash floods and more frequent coastal flooding and increased erosion (due to storminess and sea level rise).
- ***Latin America:*** By mid-century, increases in temperature and associated decreases in soil water are projected to lead to gradual replacement of tropical forest by savanna in eastern Amazonia. Semiarid vegetation will tend to be replaced by arid-land vegetation.
- ***North America:*** Warming in western mountains is projected to cause decreased snow pack, more winter flooding and reduced summer flows, exacerbating competition for over-allocated water resources
- ***Polar Regions:*** The main projected biophysical effects are reductions in thickness and extent of glaciers, ice sheets and sea ice, and changes in natural ecosystems with detrimental effects on many organisms

including migratory birds, mammals and higher predators.

- ***Small Islands:*** Sea level rise is expected to exacerbate inundation, storm surges, erosion and other coastal hazards, thus threatening vital infrastructure, settlements and facilities that support the livelihood of island communities.

An acceleration of these climatic trends is projected to occur during the 21st century, due to ongoing increases in concentrations of greenhouse gases in the earth's atmosphere. These impacts will have particular significance for the North Pacific region and raises security issues for the peoples and nations of this region: (i.e., sea level rise and human health).

HUMAN HEALTH[10]

"Heat waves, droughts, wildfires, heavy downpours, floods, and other extreme weather events are projected to become more frequent and intense, with serious consequences for human health and well-being. The impacts of extreme weather events range from illness or death as a result of heat stress, injuries, drowning, air and water contamination, and mental health effects. Increased incidence of cardio-respiratory diseases caused by higher

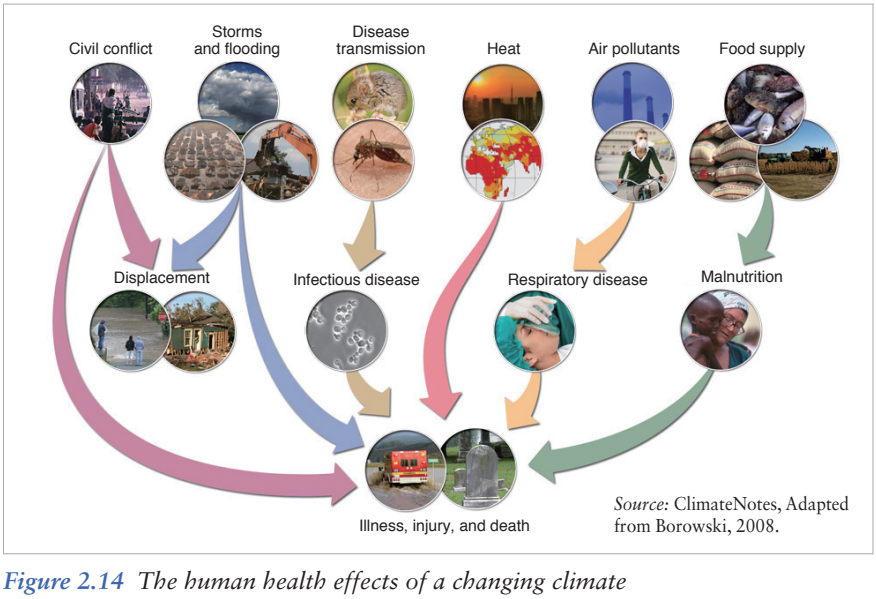


Figure 2.14 The human health effects of a changing climate

concentrations of ground-level ozone (smog) is projected. Ground-level ozone formation increases under the hot and stagnant conditions that are expected to increase in a warmer world. Breathing ozone results in short-term decreases in lung function and damages the cells lining the lungs. It increases the incidence of asthma-related hospital visits and premature deaths. Increased incidence of infectious diseases, such as those transmitted by insects and rodents, may become more common in regions where these diseases are not currently prevalent. Higher temperatures and changes in precipitation can alter the ranges and life cycles of disease-causing pathogens and the animals that carry them.

Impacts of climate change on food and water supplies are also expected to adversely affect human health, particularly in less-developed countries. About one-sixth of the human population is already undernourished, and climate change will further challenge food production. Hundreds of millions of people face water shortages that will worsen as temperatures rise. Regions most at risk include those already subject to drought. These impacts are shown in Figure 2.14.

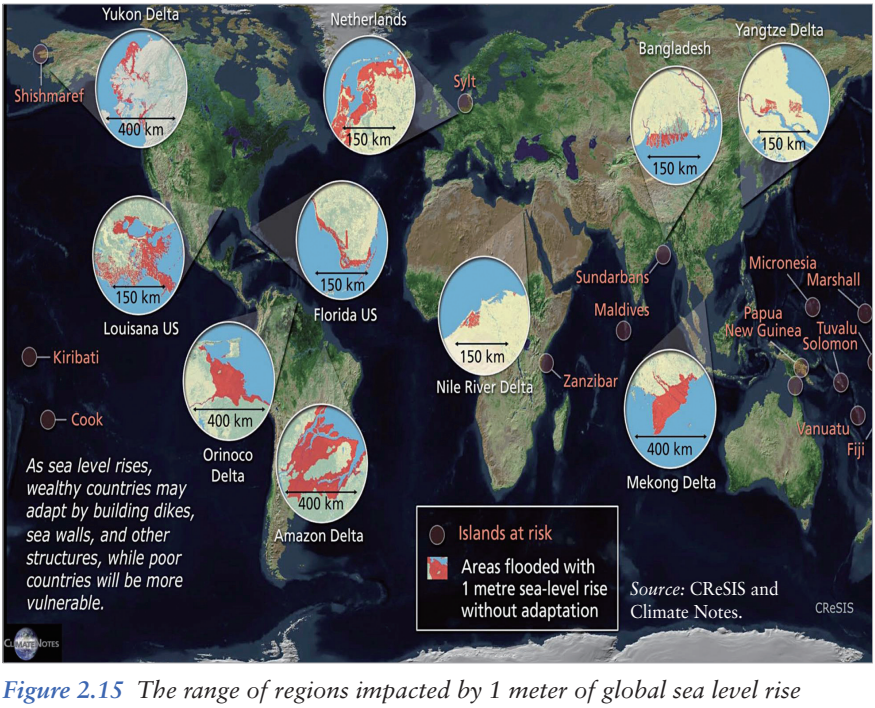


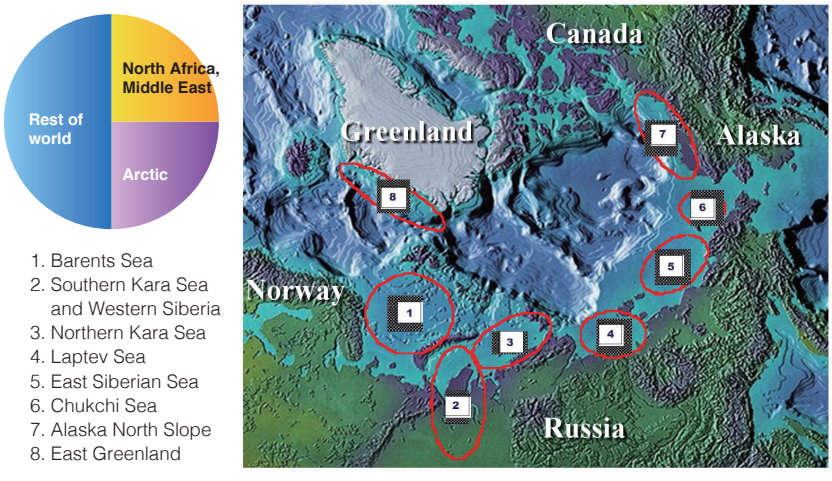
Figure 2.15 *The range of regions impacted by 1 meter of global sea level rise*

SEA LEVEL RISE AND COASTAL HAZARDS

Sea-level rise exposes coastlines to greater risks of flooding and erosion, and is expected to affect millions of additional people each year by late this century. Small islands, such as the Maldives, Asian mega-deltas such as in Bangladesh, low-lying coastlines in the United States along the Southeast and Gulf of Mexico coasts, and heavily populated coastal cities of Europe such as London and Venice are among the vulnerable locations. Some small island nations and major cities could disappear entirely from the face of the Earth. In addition to the loss of coastal land due to the gradual rise in sea level, there will also be increasing risks associated with storm surges. During such events, significant areas of land can be lost instantaneously. As populations are displaced from flooded coastal regions, such as the mega-deltas of Asia and Africa, large numbers of climate refugees will create significant potential for human suffering. Coastal wetlands, including salt marshes and mangroves, are very sensitive to sea level rise, and large fractions of these ecosystems are projected to be lost around the world. The largest losses are likely to be on the Atlantic and Gulf of Mexico coasts of the Americas, the northern Pacific oceanic barrier island and river deltas basins, the Mediterranean, the Baltic, and most importantly the small is lands of the oceanic Pacific basin. A graphical summary of these consequences is shown in Figure 2.15.

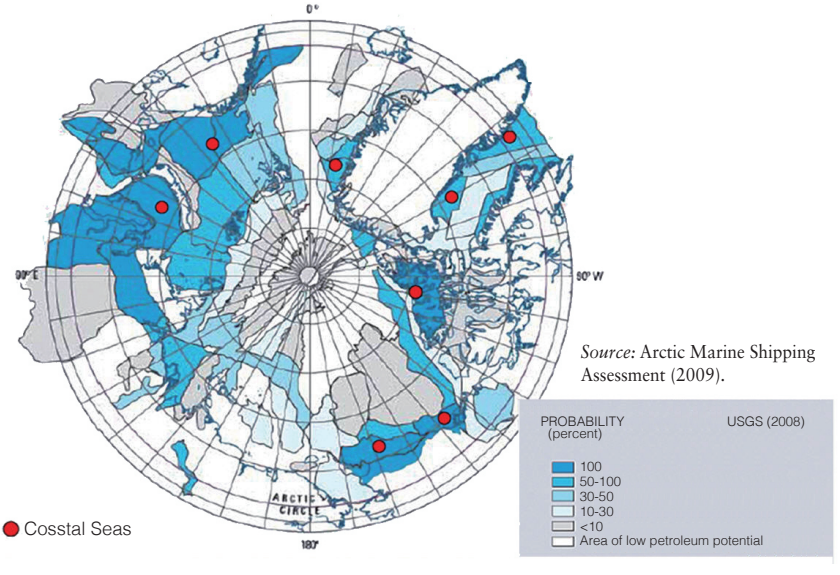
OPENING OF THE NORTHERN SEA ROUTE AND ITS IMPACTS ON THE PACIFIC REGION

The Arctic Marine Shipping Assessment (2009)[11], states that the Arctic is regarded as containing some of the last physically undisturbed marine spaces on Earth. The Arctic has also undergone extraordinary environmental and developmental changes early in the 21st century. Long known as a storehouse of untapped natural resources, high commodity prices and growing worldwide demand have in recent years poised the Arctic as a significant contributor to the global economy. Increasing regional and coastal marine transport to support the exploration and extraction of oil, gas and hard minerals, coupled with the increasing presence of the global marine tourism industry, have brought a complex set of users to the maritime Arctic. The potential impacts of these new marine



Source: USGS and US CIA 2009.

Figure 2.16 *The projection of locations of the world petroleum reserves reported by the U.S. Geological Survey and US CIA*



Source: Arctic Marine Shipping Assessment (2009).

Figure 2.17 *Probability of the presence of undiscovered oil and/or gas fields in the Arctic region*

uses - social, environmental, cultural and economic - are unknown, but will be significant for the Arctic's indigenous people and a marine environment

already undergoing significant changes due to climate change. Simultaneous with the globalization of the Arctic, marine access in the Arctic Ocean, driven by global climate change, has been changing in unprecedented ways. Arctic sea ice is undergoing an historic transformation - thinning, its extent reduced in all seasons, and substantial reductions in the area of multi-year ice in the central Arctic Ocean - which has significant implications for longer seasons of navigation and new access to previously difficult to reach coastal regions. The international scientific community has already taken advantage of these changes through pioneering voyages in the central Arctic Ocean. The same sea ice retreat also has important influences on the regional, Arctic marine ecosystems and future fisheries. Taken together, these changes present increased demands on the existing legal and regulatory structures that have the challenge of meeting the needs for enhanced marine safety and environmental protection in the face of increasing Arctic marine activity. Such challenges will require unprecedented levels of cooperation among the eight Arctic states and broad engagement with many non-Arctic stakeholders within the global maritime industry. The oil and gas resources appear to drive much of the interests in an Arctic Ocean that will be increasingly ice free in the summer in the coming decades. Assessments in recent years suggest that 25% or so of the world's petroleum (i.e., oil and gas) is located in the Arctic, as Figure 2.16 shows.

A more detailed assessment by the USGS in 2008 suggests these reserves are widely disturbed across the Arctic, the probabilities of which are shown in Figure 2.17.

Economically important marine-oriented resources, such a shard minerals, marine tourism, fisheries, oil and gas, shipping in the summer, and research expeditions can be seen, as this Arctic Marine Shipping Assessment report suggests. Marine shipping activities are very likely to increase over the coming decades as the sea ice reductions continue, as projected by IPCC, ACIA[12] and the SWIPA[13] study. Figures 2.18, 2.19 and 2.20 provide an early indication of the marine shipping traffic potential in the Bering Straits and across the Russian Arctic. The AMSA study notes that there is a long history of Arctic marine transport conducted primarily around the ice-free periphery of the Arctic Ocean. Year-round navigation has been maintained since 1978-79 in the ice-covered western regions of the Northern Sea Route (between the port of Dudinka on the Yenisei River and Murmansk). Previous Arctic marine transport studies for the Northern Sea Route, Canadian Arctic, Alaska's coastal seas and other regions have

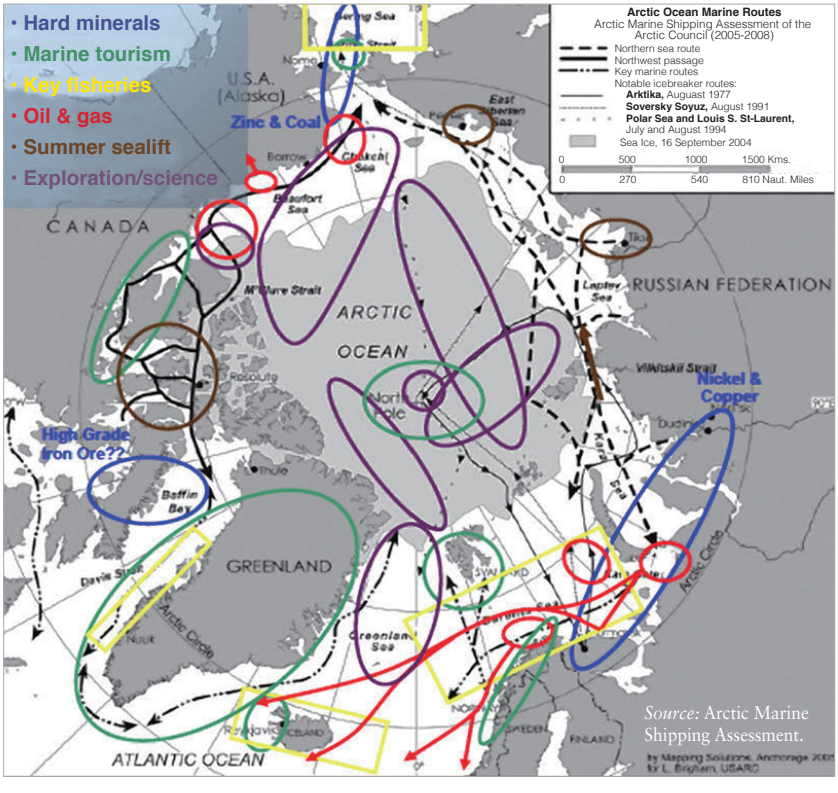


Figure 2.18 The projection of current marine related resources around the Arctic

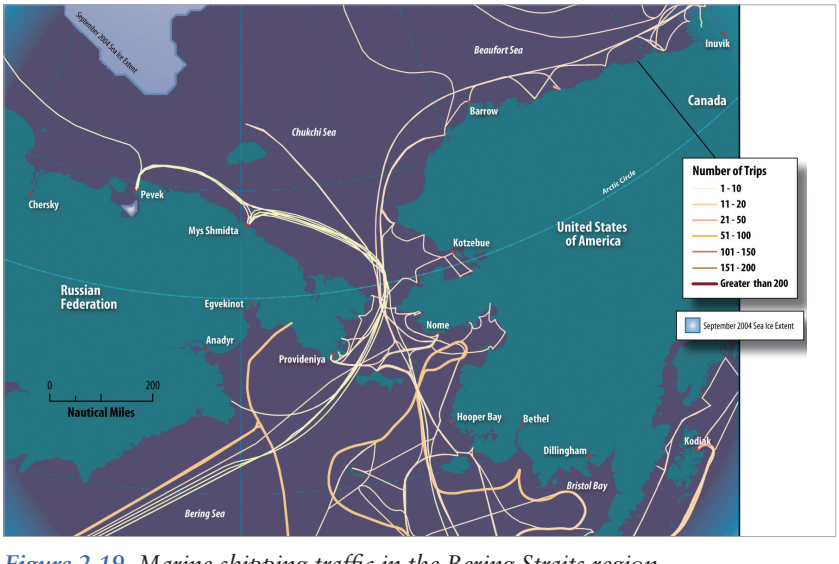


Figure 2.19 Marine shipping traffic in the Bering Straits region

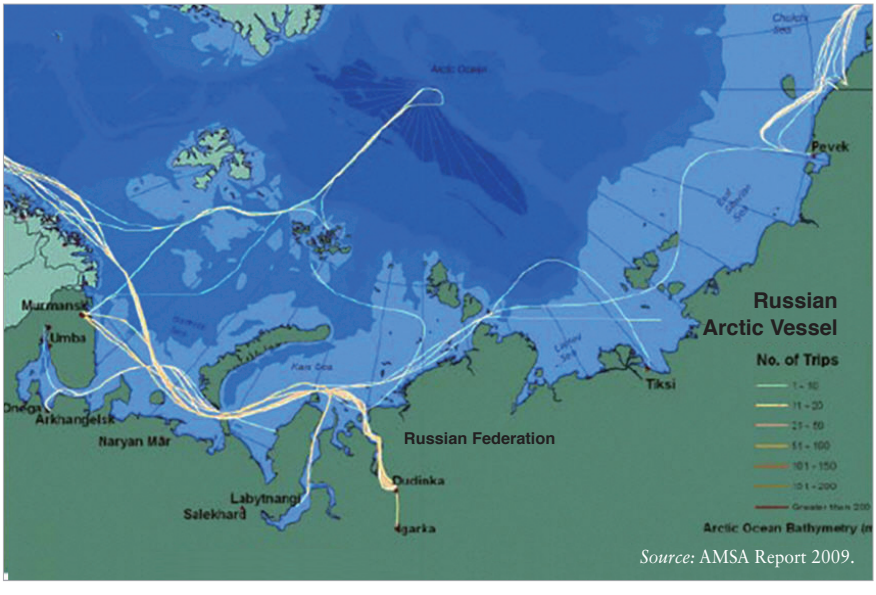


Figure 2.20 *Vessel traffic in the Russian Federal Arctic*

significant relevance to developing any future regulatory framework for the Arctic Ocean. Most of these past studies involved public-private partnerships and close international cooperation. While these Arctic Marine Shipping Assessment data are from 2004, recent data suggests that the trend towards increased marine shipping is continuing. Arctic Ocean ice is now predominated by one- or two-year ice, which is much thinner, thus making it much easier to access by icebreakers.

FISHERIES IN THE BERING SEA AND NORTH PACIFIC

The Arctic Climate Impact Assessment[14] reported that the continental shelves of the eastern and western Bering Sea together produce one of the world's largest and most productive fishing areas. They contain some of the largest populations of marine mammals, birds, crabs, and ground fish in the world. A quarter of the total global yield of fish came from here in the 1970s. The central Bering Sea contains a deep basin that separates the shelves on the Russian and American sides and falls partly outside the 200 nm EEZs of the two countries (See Figure 2.21).

Figure 2.21 *Economic zones between United States and the Russian Federation in the Bering Sea*

Prior to extended fishing zones, a complex set of bilateral and multilateral fisheries agreements was established for the area. These range from agreements on northern fur seal harvests and Canada/U.S. fisheries for Pacific salmon and Pacific halibut, to the multilateral International North Pacific Fisheries Convention for the development and use of scientific information for managing fisheries on the high seas. In the so-called "Donut Hole," a pocket of high seas area surrounded by U.S. and Russian EEZs, scientific research and commercial fishing are carried out in accordance with the Convention on the Conservation and Management of Pollock Resources in the Central Bering Sea by the two coastal states and Japan, Korea, Poland, and China. The North Pacific Science Organization and the North Pacific Anadromous Fish Commission were established to facilitate fisheries and ecosystem research in the North Pacific region, including the Bering Sea. Commercial fisheries in the Bering Sea are generally large-scale trawl fisheries for ground fish of which about 30% of the total catch is processed at sea and the rest delivered to shore-side processing plants in Russia and the

United States. The home ports for many of the Bering Sea vessels come from outside the Arctic region, reflecting the comparative advantage of supplies and services available in lower-cost regions. Small coastal communities have a strong complement of indigenous peoples with subsistence fishing interests. They depend on coastal species, especially salmon, herring, and halibut, but the overlap with commercial activities is generally small. Anadromous species extend far inland via the complex river systems and are critical resources for indigenous peoples. The chief indigenous involvement in the marine commercial sector is the Community Development Program in the Northeast Pacific, where 10% of total allowable catches are allocated to coastal communities and their chosen partners (Ginter, 1995). Because the eastern Bering Sea is within the EEZ of the United States, harvest levels of commercially important species of fish and invertebrates are regulated through federal laws. Management plans exist for the major target species that specify target fishing mortality levels calculated to maintain the long-term female spawning stock levels at 40% of the unfished equilibrium level for fully exploited species. In the western Bering Sea, within the Russian EEZ, fishery management is executed on the basis of an annual TAC established for all commercial stocks of fish, invertebrates, and marine mammals. Allowable catch is calculated as a percentage of the fishable stock. Percentages for individual stocks and species were based on early scientific studies and do not exhibit annual change. However, since 1997, these harvest percentages have been revised by government research institutes, using new modeling applications and adaptive management approaches. The recommended total allowable catches are approved by the special federal agency and issued as a governmental decree. There is a need for a comprehensive assessment of all living marine resources in the Bering Straits and Sea, the Chukchi Sea, the Eastern Siberian Sea and the Beaufort Sea. In this context, it is important to include coastal states and provinces, as they manage fisheries in state or provincial waters and coastal areas, which are very significant commercial and sport harvests. The Continental Shelf regions are depicted in Figure 2.22.

AN OVERVIEW OF THE CHANGES TO THE ARCTIC REGION AND ITS PEOPLES

- Substantial changes in climate and weather, with substantial changes in the oceans (e.g., acidification) and the biosphere (e.g., biodiversity

Source: Brian Van Pay, Office of Ocean and Polar Affairs, U.S. Department of State.

Figure 2.22 *A description in 2009 of the Arctic continental shelf regions as prepared by the U.S. Department of State*

losses affecting food supply and human well-being);

- Globalization, such as mixed economies and technological changes, which raises issues of human, economic and national security issues;
- New economic development opportunities and challenges, e.g., oil and gas reserves, economic minerals, fisheries, shipping and other commerce, etc.;
- Rapid cultural and social change;
- Challenging and heretofore unaddressed governance issues: boundary disputes, access to economic zones and extent of continent shelves, and legal regimes;
- High concentrations of contaminants such as PCBs and other POPs, mercury and other heavy metals; and

- Ozone depletion that leads to UV increases.

THOUGHTS ON CLIMATE CHANGE AFFECTS ON INDIGENOUS PEOPLES OF THE ARCTIC REGION

The resilience of the indigenous cultures of the Arctic (See Figure 2.24) has been remarkable; they have sustained their way of life for thousands of years. For these people, flexibility and innovation has long been the key to adapting and coping with climate and other environmental change. For example, the reindeer herding communities across Russia and northern Scandinavia have historically moved their homes (their tent-like lavvu[15]) with their herds to summer pastures, back to higher ground for the winter and back again. More recently, they have made permanent homes in the winter grounds and move into summer pastures with their lavvu, or even modest homes. Reindeer pastoralism, an ancient model that has sought and maintained a sustainable exploitation and management of northern terrestrial ecosystems, is based on generations of accumulated, conserved, and developed experience, and strategies for adaptation to the climatic and political/economic transformations that impact their culture. The research project EALÁT[16] focuses on understanding the adaptive capacity of reindeer pastoralism to climate variability and change and, in particular, on the integration of reindeer herders' knowledge in the study and analysis of their ability to adapt to environmental variability and change. For example, the EALÁT study has shown that with increasing climate temperature variations causing more "freeze-thaw-freeze" cycles that result in icing over forage plants, the presence of larger animals in the herd, such as those that have been sterilized, becomes an adaptation tool, a practice now more commonly used in reindeer husbandry as a tool for herd structure management. These sterilized males serve a special purpose in the herd regarding the icing issue because, due to their larger size, they are more able to easily break through ice layers in the snow, facilitating access to food for females and calves. In addition, the presence of these males has the effect of calming female reindeer and calves, making herds easier to control. Therefore, adjusting herd composition through male reindeer sterilization represents a critical strategy for adaptation to future climate change.

Empowering northern residents, particularly indigenous peoples, through self-government and self-determination arrangements, including

ownership and management of land and natural resources, is key to addressing the challenges of climate and other environmental and globalizations changes.[17] Increasingly, there are compelling reasons for the national governments of the arctic states to work toward supplying indigenous peoples with the powers, resources, information, and responsibilities they need to adapt to climate change.

As noted in the Arctic Climate Impact Assessment,[18] Their vulnerability, and hence the capacity to build resilience into their communities, will engage a number of cultural perspectives, and so the consequences of change will be perceived differently across cultures, age groups, economic sectors, etc. A reindeer herder will most likely define the vulnerability of their community differently than would an outsider assessing the same socioeconomic community. There may well be a range of different perspectives on what constitutes a vulnerable condition, and therefore it is essential to recognize and address these perspectives in carrying out solutions to these challenges. Evaluation of the exposure, sensitivity, and adaptive capacity of the human–environment system will require scientific and indigenous knowledge perspectives, observation, and participation of people who are part of the human-environment system. These local perspectives can help identify important locally oriented stresses, local human–environment challenges, and the outcomes they seek to obtain. They will inevitably identify changes in their cultural system, describe coping and adaptive capacities, monitor environmental and social phenomena, and articulate their perspectives and findings. An excellent analysis of the vulnerabilities of Arctic communities and societies is contained in the CAVIAR study,[19] the aim of which was to increase understanding of the vulnerability of Arctic communities to changing environmental conditions, including climate change, and to contribute to the development of adaptive strategies and policies. In partnership with local collaborators in over two dozen communities, researchers have documented the conditions and forces that contribute to vulnerabilities, identified adaptive strategies and attempted to assess the prospects for adaptation in the future.

The increasingly successful results of the Inuvialuit of the Canadian Beaufort Sea region in the face of climate change finds its roots in the Inuvialuit Final Agreement of 1984, a comprehensive native land claims agreement that recognizes rights of land ownership, co-operative management, protected areas, and economic development opportunities. The agreement evolved new governance mechanisms that, by contributing

to self-organization, help the Inuvialuit negotiate and manage the effects of change. While the agreement has profoundly important sectors, as Notzke and others have noted, there remains considerable unfinished work.[20]

For some arctic peoples, the political and management systems that could assess the impacts of climate change and allow local and regional governments to act on policy recommendations to deal with the consequences are already in place. Significant political changes since the 1970s have included land claims in Alaska and Canada and the formation of regional governments in Greenland and Nunavut. These political changes altered the ways that living and non-living resources are managed. A greater degree of local involvement in resource use management decisions has been introduced, including, in some cases, the actual transfer of decision-making authority to the local or regional level. Understanding land use and land cover issues is critically important, and is well addressed in a recent study[21] on "Eurasian Arctic Land Cover and Land Use in a Changing Climate," which studied the interactions of land-cover/land-use change with climate in a region of the Arctic where climate warming is most pronounced compared to other areas of the globe. The climate warming in the far north, and in the Arctic region of Northern Eurasia in particular, affects both the landscape and human activities, and hence human dimensions are an important aspect of the topic. Environmental pollution, together with climate warming, may produce irreversible damages to the current Arctic ecosystems. Regional land-atmosphere feedbacks may have large global importance. Remote sensing is a primary tool in studying the vast northern territories where in situ observations are sporadic. State-of-the-art methods of satellite remote sensing, combined with GIS and models, are used to tackle science questions and provide an outlook on current land-cover changes and potential scenarios for the future. The Continental Shelf regions are shown in Figure 2.22.

FRAMING THE GOVERNANCE ISSUES AFFECTING THE ARCTIC AND NORTH PACIFIC REGION

The territories encircling the Arctic Ocean belong to eight Arctic states. The three large federations, Russia, Canada and the U.S., are the first-, second- and fourth-largest stakeholders, respectively, in terms of Arctic lands.[22] The Russian quadrant, by far the largest, spans Eurasia to western North

America, roughly from meridian 32°04'35" E to meridian 168°58' 37" W. Given its vast territory, no initiatives regarding Arctic governance can succeed without due attention to Russia. The North American quadrant comprises northern Canada and the northern U.S. (Alaska), whereas the European quadrant includes Greenland, the Faroe Islands, Iceland, northern Norway, northern Sweden and northern Finland.[23] Sweden and Finland are considered Arctic states but have no coastlines on the Arctic Ocean.

The Arctic Ocean, the core of the region, is the smallest of the world's five oceans. Much of its economic activity comes from the exploitation of natural resources, including petroleum, natural gas, fish, and seals.[24] It covers an area of approximately 14 million square kilometers, or about 1.5 times the size of the U.S., with a maximum depth of 5,500 meters (18,040 feet). Though modest in capacity compared to the other oceans, this body of water has the widest continental shelf of all the oceans. The shelf is wide and shallow off Europe and Asia, all the way from the Barents Sea in the west to the Bering Strait. In some areas along this coast, the continental shelf extends a significant distance toward the North Pole. The corresponding continental shelves off Alaska, Canada and Greenland are significantly narrower. Norway, Russia, the U.S., Canada, Iceland, and Denmark (Greenland) all have an Arctic continental shelf. Arctic Russia embraces by far the largest area.[25]

The Ilulissat Declaration, adopted by the ministers of foreign affairs of Canada, Denmark, Norway, Russia, and the United States on May 28, 2008, reminds us that while there are pressing issues to address in this region, existing national and international legal frameworks already cover large parts of the Arctic region and address a range of issues. Thus, the declaration states, among other matters, that: *"By virtue of their sovereignty, sovereign rights and jurisdiction in large areas of the Arctic Ocean the five coastal states are in a unique position to address these possibilities and challenges...We remain committed to this legal framework and to the orderly settlement of any possible overlapping claims."*

Nonetheless, we are now witnessing an outpouring of ideas and proposals aimed at upgrading or supplementing the existing governance systems to address these issues (see the Arctic Governance Projects Compendium at: www.arcticgovernance.org/). There are hundreds of proposals, articles and governance suggestions from various official and stakeholder interests within Arctic states, as well as from non-Arctic states, scientists, political commentators, and representatives of nongovernmental

organizations, some of whom warn of competition and conflict for access to the Arctic's natural resources.

More recently, significant steps have been taken with innovative co-management regimes that allow for the sharing of responsibility for resource management between indigenous and other uses. A remarkable development in 2010 is the resolution of the so-called "disputed lands" between Norway and Russia. In a new spirit of collaboration and dispute resolution, on September 15 in Murmansk,[26] the Russian and Norwegian ministers of foreign affairs signed an agreement on the definition of their maritime border and concerning their cooperation on the Barents Sea and the Arctic Ocean. The agreement marked an end to a 40-year territorial dispute between the two countries. It also eased pressure in the region and has opened up the possibility of furthering the exploitation of an area potentially rich in natural resources. Furthermore, in a hallmark speech,[27] Russian Prime Minister Vladimir Putin stated on September 23, 2010 that *"While we are taking care of a steady and balanced development of the Russian North, we are working to strengthen our ties with our neighbors in our common Arctic home. And we think that preserving the Arctic as a zone of peace and cooperation is of the utmost importance. It is our conviction that the Arctic area should serve as a platform for uniting forces for genuine partnership in the economy, security, science, education and the preservation of the North's cultural heritage*."

The partnership and collaboration suggested by the Putin speech and the introduction of co-management has the potential to allow the nations of the Arctic region and indigenous peoples of the North to manage and regulate resource use in a way that incorporates indigenous views and traditional resource use systems. And it is within this new political and scientific environment of power sharing that indigenous communities, scientists, and policy makers can work together to find solutions to address the challenges and opportunities of globalization, climate change and other environmental challenges in the Arctic. Under these circumstances, there is a growing recognition that rapid change in the Arctic is producing new challenges to manage and regulate societies that live in these high northern regions. Whether these challenges may be met by adjusting existing frameworks,[28] or if they will require the development of new governance systems, remains to be seen. Nevertheless, it is already possible to identify a number of the central issues that are very likely to impact indigenous communities across the Arctic region and that will foster adaptation

strategies, as well as require further attention by governments, regional authorities, indigenous organizations and local entities:

- ***Access:*** As the Arctic sea ice recedes toward a more open ocean for months every year, issues of access and rights of passage through sea routes, including the Northern Sea Route (Russia) and the Northwest Passage (Canada), will be critical to not only the coastal nations of the Arctic, but to oil and gas development, trade and commercial sea routes for many other nations.
- ***Maritime claims and boundary issues:*** Currently, Denmark, Russia, and Canada are researching claims to the 1,220-mile underwater continental crust, the Lomonosov Ridge. The Lomonosov Ridge is five times the size of Britain, with twice the amount of oil of Saudi Arabia. The more open ocean is raising numerous issues involving claims to jurisdiction over areas beyond the territorial sea within the Arctic oceanic basin (including claims under the provisions of UNCLOS Art. 76 to continental shelves extending beyond the limits of Exclusive Economic Zones) and the resolution of offshore boundary disputes. (See Figure 2.23). It is within these benthic regions that analyses now underway will likely determine the range and scope of the continental shelves, and so the jurisdictions for economic zone protections for oil, gas and mineral exploration.
- ***Commercial shipping & oil and gas development:*** Issues regarding the development of effective codes of conduct for shipping under Arctic conditions and for the conduct of offshore oil and gas drilling and production.
- ***Arctic fisheries:*** Management of northward-moving commercial fisheries that takes into account the principles of ecosystem-based management and the rights of indigenous peoples.
- ***Land claims:*** Longstanding use and occupancy and the still unresolved claims of a number of indigenous peoples as they relate to the governance of human-environment interactions in the Arctic.
- ***Conservation of Arctic ecosystems:*** Protection of marine and terrestrial ecosystems in the Arctic under pressure from human actions as well as biophysical changes.
- ***Regional Governance:*** Multi-level governance and collaboration among regional, national, and international bodies in guiding northern development

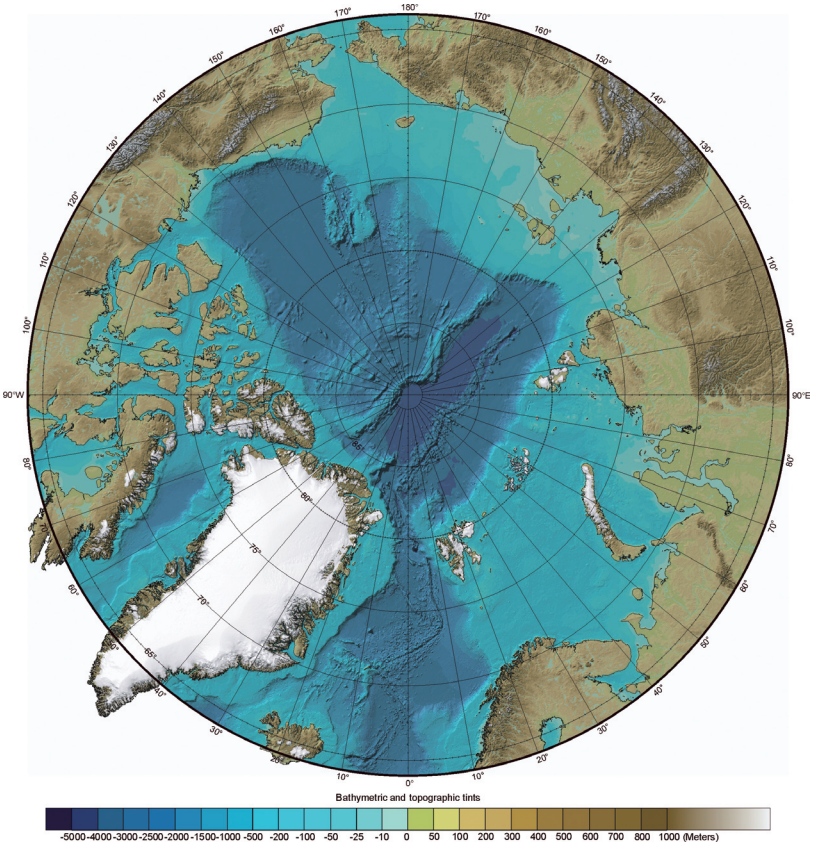
SUMMARY THOUGHTS

Six overarching issues are posited as likely to dominate geopolitical deliberations, and the development of adaptation strategies to cope with the rapid changes that are occurring across the Arctic region in the years to come. They are likely to be:

1. ***Human Security and Well-being:*** Strategies and implementation practices will be needed that protect and insure human security and well-being against the rapid changes induced by climate change, globalization and other facets of change. The challenges of increased storm intensities and increasingly longer and more frequent drought conditions projected by the IPCC, rising sea levels, major changes in land use and other scientific assessments, are likely to increase because of globalization patterns and/or climate change.[30]
2. ***Historic Claims and Rights of Indigenous Peoples:*** There are a host of issues about land rights and access by the historical claims of indigenous peoples across the Arctic who have lived and had unrestricted access to lands for thousands of years.
3. ***Challenges to Civil Infrastructures:*** The civil infrastructure within the region is being extended in ways that impact indigenous communities and their cultures. These civil infrastructures are being impacted, for example, by the thawing of permafrost and the loss of coastal ice that historically has protected lowlands across the Arctic,[31] all of which will likely require changes in domestic practices, policy and legal arrangements.
4. ***Access:*** Demands by many nations, local authorities, and indigenous and other residents of the North to address the need for legally protected access to vital lands and natural resources across the Arctic, which range from the pasture needs of reindeer herding cultures to fisheries and oil/gas resource development strategies.
5. ***Legal Challenges:*** Legal disputes within Arctic nations, among the Arctic countries and local cultures, and internationally among non-Arctic nations that perceive they have rights to access such resources as water, fossil fuels, food and arable land.
6. ***Patterns of Cultural and Human Behavior:*** The role of behavior, culture, and values should not be underestimated as key factors in addressing change, as the International Council for Science[32] found in

> an extensive study of the issues in harnessing the knowledge required to address the diverse realities of social life embedded in different cultural contexts. Culture and values define the goals of peoples and societies, frame their attitudes, and provide standards against which the behavior of individuals and societies can be judged. Social systems are characterized by their values, from which are derived norms, that is, concrete patterns of action that can include legal and moral norms, and a wide range of social norms. The change over time of prevailing norms and values is influenced by numerous forces, including social structures and power relations, and personal perceptions and identification processes. Understanding these across the Arctic region is likely to required reassessments of the role of local knowledge, scientific research strategies, and program implementation practices.

The landscape of these and other issues discussed in this paper will be profoundly impacted by the rapidly changing Arctic, which is populated by challenges outside the experience of humankind of 10,000 years of remarkable climatic stability, when the global mean temperatures did not exceed +/- 0.7°C. The world, and the Arctic, which is it leading indictor, are faced with the prospects of global mean surface temperatures significantly higher than this, with a projected global mean surface temperature of as much as 4.5°C by 2100 and global mean sea level rise of a meter or more. The Arctic is very likely to see much more dramatic increases in regional mean temperatures (i.e., up to or more than 10°C by 2100). Hence, the Arctic is very likely to dominate the geopolitical agenda of the eight Arctic nations and many non-Arctic countries for decades to come. There is an implication that developing solutions to the consequences and impacts from climate and environmental changes, and changes induced from patterns within globalization, are long-term, multi-decade issues. These present unprecedented challenges to humankind, its institutions of government, and to the cultures and socioeconomic foundations of societies of all kinds across the planet.



Note: This International Bathymetric Chart of the Arctic Ocean was produced by investigators representing the Intergovernmental Oceanographic Commission (IOC), the International Arctic Science Committee (IASC), the International Hydrographic Organization (IHO), the US Office of Naval Research (ONR), and the US National Geophysical Data Center (NGDC). Available at: (http://geology.com/world/arctic-ocean-map.shtml).

Figure 2.23 *A bathymetric chart of the Arctic Ocean basin*

Source: ACIA and Map by Clifford Grabhorn.
Note: This map of the people of the Arctic is from the 2004 and 2005 ACIA Reports.

Figure 2.24 *The locations in the Arctic region of the major indigenous peoples as organized within the Arctic Council*

Notes

1. The map of the Arctic is at the end of the paper. See the previous two pages.
2. This opening statement was adapted from material contained in the Arctic Climate Impact Assessment (ACIA), 2004. ACIA was an international project of the Arctic Council (www.arctic-council.org) and two of its Working Group (i.e., AMAP and CAFF) and the International Arctic Science Committee (http://iasc.arcticportal.org), to evaluate and synthesize knowledge on climate variability, climate change, and increased ultraviolet radiation and their consequences. The results of the assessment were released at the ACIA International Scientific Symposium held in Reykjavik, Iceland in November 2004 (www.acia.uaf.edu).
3. In 2000, Paul Crutzen, an eminent atmospheric chemist, realized he no longer believed he was living in the Holocene. He was living in some other age, one shaped primarily by people. Dr. Crutzen suggested this age be called the Anthropocene, "the recent age of man."
4. Reference for this summary (Much is taken from http://climate.nasa.gov/evidence/):

   IPCC Fourth Assessment Report, Summary for Policy Makers, p. 5.

   B. D. Santer et al., "A search for human influences on the thermal structure of the atmosphere," *Nature* vol. 382, July 4, 1996, 39-46.

   Gabriele C. Hegerl, "Detecting Greenhouse-Gas-Induced Climate Change with an Optimal Fingerprint Method," *Journal of Climate* vol. 9, October 1996, 2281-2306

   V. Ramaswamy et al., "Anthropogenic and Natural Influences in the Evolution of Lower Stratospheric Cooling," *Science* vol. 311 (February 24, 2006), 1138-1141.

   B. D. Santeret al., "Contributions of Anthropogenic and Natural Forcing to Recent Tropopause Height Changes," *Science* vol. 301 (July25, 2003), 479-483.

   In the 1860s, physicist John Tyndall recognized the Earth's natural greenhouse effect and suggested that slight changes in the atmospheric composition could bring about climatic variations. In 1896, a seminal paper by Swedish scientist Svante Arrhenius first speculated that changes in the levels of carbon dioxide in the atmosphere could substantially alter the surface temperature through the greenhouse effect.

   National Research Council (NRC), 2006. Surface Temperature Reconstructions for the Last 2,000 Years. National Academy Press, Washington, DC.

   Church, J.A. Church and N.J. White, 2006. "A 20th Century Acceleration in Global Sea Level Rise," *Geophysical Research Letters* 33, L01602, doi:10.1029/2005GL024826.

The global sea level estimate described in this work can also be downloaded from the CSIRO website.

http://www.ncdc.noaa.gov/oa/climate/research/ anomalies/index.html.

http://www.cru.uea.ac.uk/cru/data/temperature.

http://data.giss.nasa.gov/gistemp.

T.C. Peterson et al., "State of the Climate in 2008," *Special Supplement to the Bulletin of the American Meteorological Society* Vol. 90, No. 8, August 2009, pp. S17-S18.

I. Allison et.al., The Copenhagen Diagnosis: Updating the World on the Latest Climate Science, UNSW Climate Change Research Center, Sydney, Australia, 2009, p. 11.

http://www.giss.nasa.gov/research/news/20100121/.

http://science.nasa.gov/headlines/y2009/ 01apr_deepsolarminimum.htm.

Levitus, et al, "Global Ocean Heat Content 1955–2008 in Light of Recently Revealed Instrumentation Problems," *Geophysical Research Letters* Vol. 36, L07608 (2009).

L. Polyak et.al., "History of Sea Ice in the Arctic," in Past Climate Variability and Change in the Arctic and at High Latitudes, U.S. Geological Survey, Climate Change Science Program Synthesis and Assessment Product 1. 2, January 2009, Chapter 7.

R. Kwok and D. A. Rothrock, "Decline in Arctic Sea Ice Thickness from Submarine and ICESAT Records: 1958-2008," Geophysical Research Letters Vol. 36, paper No. L15501, 2009.

http://nsidc.org/sotc/sea_ice.html

National Snow and Ice Data Center

World Glacier Monitoring Service

http://lwf.ncdc.noaa.gov/extremes/cei.html

http://www.pmel.noaa.gov/co2/story/What+is+Ocean+Acidification%3F (Note: The pH of surface ocean waters has fallen by 0.1 pH units. Since the pH scale is logarithmic, this change represents approximately a 30 percent increase in acidity.)

http://www.pmel.noaa.gov/co2/story/Ocean+Acidification

C. L. Sabine et al., "The Oceanic Sink for Anthropogenic CO_2," *Science* Vol. 305 (16 July 2004), 367-371.

Copenhagen Diagnosis, p. 36.

5. http://www.ncdc.noaa.gov/ol/climate/severeweather/rainfall.html

6. The Bottom Billion: Why the Poorest Countries are Failing, and What Can Be Done About It by Paul Collier is a book worth reading. He argues that global poverty is actually falling quite rapidly for about 80 percent of the world. The real crisis lies in a group of about 50 failing states, the bottom billion, whose problems defy traditional approaches to alleviating poverty. Further, he contends that these 50 failed states pose the central challenge of the developing world in the 21st century. His analysis focuses on this group of small nations, largely unnoticed by the industrialized West, which are dropping further and further behind the majority of the world's people, and often falling into an absolute decline in living standards. He suggests that there is a struggle within each of these nations between reformers and corrupt leaders—and the corrupt are winning. He analyzes the causes of failure, pointing to a set of traps that snare these countries, including civil wars, a dependence on the extraction and export of natural resources, and bad governance. Standard solutions do not work against these traps, he notes; aid is often ineffective, and globalization can actually make matters worse, driving development to more stable nations. What the bottom billion need, he argues, is a bold new plan supported by the Group of Eight industrialized nations. If failed states are ever to be helped, the G8 will have to adopt preferential trade policies, new laws against corruption, new international charters, and even conduct carefully calibrated military interventions. Collier is the former director of research for the World Bank and current director of the Center for the Study of African Economies at Oxford University. In The Bottom Billion, he outlines strategies for solving one of the great humanitarian crises facing the world today.
7. www.globalcarbonproject.org/.
8. http://climateinteractive.org/scoreboard (more details about the assumptions and methods behind this analysis are available at www.climatescoreboard.org)
9. www.ipcc.ch/publications_and_data/publications_ipcc_fourth_assessment_report_synthesis_report.htm
10. This material is from a publication, Climate Notes, published by the Forum for Active Philanthropy(www.activephilanthropy.org) and prepared by a team composed of Susan Joy Hassol (www.climatecommunication.org/), Paul Grabhorn(Grabhorn Studios), Josh Weybright (Grabhorn Studios), Marta Darby (Climate Communications), Randy Udall (Climate Communications), Dr. Felicitas von Peter (Forum for Active Philanthropy) and Dr. Robert W. Corell.
11. www.pame.is/amsa/amsa-2009-report
12. The Arctic Climate Impact Assessment (ACIA) of 2004 and 2005 (www.acia.uaf.edu/)
13. The Snow, Water, Ice and Permafrost Assessment (SWIPA) of 2011 (www.amap.no/swipa/SWIPA%20Brochure%20Final.pdf)

14. ACIA Chapter 13, Fisheries and Aquaculture, Lead authors Hjáalmar Vilhjáalmsson, Alf Hakon Hoel.
15. http://lavvu.com/history.htm
16. http://icr.arcticportal.org/index.php?option=com_content&view=article&id=245&Itemid=86&lang=en
17. http://arcticgovernance.custompublish.com/index.php?find=self+governance
18. www.acia.uaf.edu/
19. www.waterstones.com/waterstonesweb/products/grete+k-+hovelsrud/barry+smit/community+adaptation+and+vulnerability+in+arctic+regions/8070725/
20. http://books.google.com/books?id=tWR7lYnQzokC&pg=PA160&lpg=PA160&dq=Inuvialuit+Final+Agreement+of+1984&source=bl&ots=8fTfFqWSqa&sig=GIMfC8qVSscJmjk-7q95xdRG4uQ&hl=en&ei=g-_JTJ7vGIOdlgeoqMjBAQ&sa=X&oi=book_result&ct=result&resnum=8&sqi=2&ved=0CDQQ6AEwBw#v=onepage&q=Inuvialuit%20Final%20Agreement%20of%201984&f=false and Aboriginal peoples and natural resources in Canada By Claudia Notzke at http://books.google.com/books?id=6VbIJTDlZIoC&printsec=frontcover&dq=and+Aboriginal+peoples+and+natural+resources+in+Canada+By+Claudia+Notzke&source=bl&ots=fwG_RIHJLB&sig=oWcnPhbWoRzN5w6TVNzwISgoZk8&hl=en&ei=SvHJTKPkE8aqlAfYtbHEAQ&sa=X&oi=book_result&ct=result&resnum=2&sqi=2&ved=0CBgQ6AEwAQ#v=onepage&q&f=false
21. www.springer.com/earth+sciences+and+geography/geography/book/978-90-481-9117-8 in the book: Eurasian Arctic Land Cover and Land Use in a Changing Climate. Gutman, Garik; Reissell, Anni (Eds.).
22. The total area of Greenland is 2,170,000 sq km (840,000 sq mi). Alaska has a total area of 1,717,854 sq km (663,267 sq mi).
23. More specifically, the land territories in the Arctic are generally considered to include Alaska; the northern territories of Canada (Northwest Territories, Yukon, Nunavut); northern Russia, including the Republics of Karelia and Komi, the Murmansk and Arkhangelsk Oblasts, the Yamalo-Nenets and Khanty-Mansi Autonomous Okrugs, the Taimyr and Evenkia former Autonomous Okrugs, the Republic of Sakha, the Magadan Oblast, and the Chukotka and Koryakia Autonomous Okrugs; Greenland; the Faroe Islands; Iceland; Arctic Norway (Finnmark, Troms, Nordland, Svalbard Archipelago and Jan Mayen), Arctic Sweden (Väasterbotten and Norrbotten) and Arctic Finland (Lapland and Oulu).
24. The Arctic Ocean includes Baffin Bay, Barents Sea, Beaufort Sea, Chukchi Sea, East Siberian Sea, Greenland Sea, Hudson Bay, Hudson Strait, Kara Sea, Laptev Sea and certain other waters. [source: https://www.cia.gov/library/publications/

the-world-factbook/geos/xq.html]

25. This Russian shelf area is estimated to contain 45–55 percent of the total volume of the undiscovered oil and gas resources in the Arctic. Russia and Norway have filed claims to portions of the Arctic seabed under the United Nations Convention on the Law of the Sea (UNCLOS). The Russian claim covers a vast area of 1,191,000 sq km (460,800 sq miles). Canada and Denmark are currently conducting research to support claims, whereas the U.S. has not yet ratified UNCLOS.
26. www.osw.waw.pl/en/publikacje/eastweek/2010-09-22/russia-and-norway-agree-maritime-border
27. http://icr.arcticportal.org/index.php?option=com_content&view=article&id=1746:full-text-of-putins-speech-a-closing-remarks-to-arctic-forum-in-moscow&catid=47:ealat-news-latest&Itemid=111&lang=en
28. The Arctic Governance Project Recommendations. See www.arcticgovernance.org/agp-report-and-action-agenda.156784.en.html
29. The routes from Asian markets to Europe make up about 45% of the current routes through the Suez Canal.
30. Storm severity and the depth of and duration of droughts are projected by the IPCC and numerous other scientific assessments to increase, creating challenges to human security and well-being.
31. For example: building supports and roadways have be damaged or lost by the thawing of permafrost, pipeline supports and integrity have been challenged, access to pastures by reindeer herders has been dramatically altered, and the forests, agricultural lands and ecosystems all have experienced impacts. Some coastal barrier islands in Alaska and Russia, with indigenous residents who have lived and thrived there for thousands of years, will be lost due to severe spring and fall storms that historically were protected by coastal sea ice that is now lost as the ice disappears earlier in the spring and re-freezes much later in the fall.
32. www.icsu.org/Gestion/img/ICSU_DOC_DOWNLOAD/584_DD_FILE_Consortium_Report.pdf

Commentary

Masahiro Akiyama

First, I would like to express my respect and gratitude to Professor Corell for his extremely well-prepared discussion paper.

I appreciate his explanations of climate change by demonstrating it with many charts, graphs and adducing evidence. I understand that the IPCC AR4 Report and many other scientific public actions have concluded there is warming of climate systems, with increases in air and ocean temperatures, melting of snow and ice, a rise in average sea level, and extreme weather.

While I am not a scientist myself, my understanding is that climate change is not due solely to such a simple mechanism as the increase or decrease in CO_2.

Nevertheless, based on results from the relevant Japanese studies, I am for the most part in agreement with Professor Corell's assessment of AR4 and the related views.

On the other hand, some experts insist that we will soon confront (in this century?) a Little Ice Age, although during the past half-century human influences on the climate system were realized. I have heard this opinion often in Russia. I cannot judge whether this is correct or not. I would appreciate it if you gave us reasons based on what they insist, and then make clear your scientific views against them as an introduction. It will help me further understand warming of the climate system.

I think the implications of Arctic transformation for the North Pacific include fishery issues, natural resource exploration, environment protection (sustainability) and marine transportation, such as the NSR.

1. With regard to fisheries, the eastern and western Bering Sea produce one of the world's largest and most productive fishing areas, as Professor Corell writes in the paper. There are many bi- and multilateral fisheries agreements established for the area. Many management plans, including TAC, exist and stakeholders maintain the frameworks.

   The Arctic transformation, in particular, factors related to climate change including changing of temperatures, current, and mechanism of oceans, will affect the North Pacific Sea, including the Bering Sea.

We are concerned if it would have a negative effect on fisheries there. At the same time, I am interested in the possibility of a productive fishing area emerging in half of the Arctic Ocean (the eastern region) toward the Bering Strait. We should study carefully, from a fishery-related perspective, the future of both seas, which are geographic neighbors, and which North Pacific countries are interested in.

2. Thanks to Professor Corell for providing useful information the current projection of Arctic marine-related resources. Countries in the North Pacific region are interested in the perspective of the exploitation and exploration of oil and gas and other natural resources in the eastern part of Arctic Ocean, while of course they are interested in the western part, and land areas, for finding feasible projects in the near future. Regarding projects in the eastern part of the Arctic Ocean, we are thinking of combining them with the opening of navigation on the NSR. As far as Arctic marine-related resources are concerned, transportation for the products should in the future be marine ones, and should be on a commercial basis, not as model test ones.

   On this point I would like to add that marine infrastructures and systems for natural resource exploration based on ships and sea-based facilities could reduce the total cost and environmental impact in polar areas where economic activities are seasonally concentrated. You can understand it well by noting that logging of the Taiga forests to construct land infrastructure related to resource exploitation has triggered the emergence of solifluction of the permafrost, the release of the powerful greenhouse gas methane, and various other pollution effects.

3. With regard to the implications of climate change for humankind and the natural system, Professor Corell says that the scientific consensus is now unequivocal that climate change is real, dangerous and immediate. I think sustainability is most important at this point. There are, however, many arguments in support of different definitions and interpretations of sustainability. If sustainability is the ability of future generations of mankind to inherit a healthy planet, and if the current environment of the planet is expected to exert a consistent influence over the next several centuries, then I believe we have already gone beyond the "tipping point." Seen from the time scale of our near descendants, it would be almost impossible

to restore the global environment to what it was in the early 20th century. This is clear if we see the changes in the Arctic region. The ecosystem, food, water, weather and irreversible impacts should be traced.

Assessment of the North Pacific region from this viewpoint can be appropriately conducted by following the traces in the case of the Arctic region. Regarding Japan's interests, we are observing and studying the situation in the region, including the western Bering Sea, Okhotsk Sea and the sea area close to Sakhalin Island and Hokkaido. Rises in sea and air temperatures, sea level rise, shrinking ice sheets and ocean acidification would all affect sustainability in the region.

At present, what is needed for securing sustainability is not brought up for full discussion. Instead, international society must survey, assess, share knowledge, draw up a roadmap and take action towards restoring the health of our planet.

4. Marine shipping in the Arctic Ocean has been maintained around the ice-free periphery of the ocean, as Professor Corell indicates. Northeast Asian countries are interested in the possibility of a Northern Sea Route in the Arctic Ocean becoming a commercial transport, as the northern route would make marine transport from East Asia to Europe much shorter than the current one, the southern route, saving time, money and CO_2 emissions, and freeing ships from pirate attacks. We have to carefully estimate the future ice melts and changing of ice conditions so that navigation in the Arctic Ocean can become dramatically much easier with icebreakers or, I would say, without them.

   Many issues must be addressed. As for shipping, the movement toward setting international standards for an ice navigator/ice certificate and navigation simulators is welcome. The important thing is that they should be processed in a transparent manner. In this regard, Russia should introduce a newly designed rule for navigation on the NSR as soon as possible if it needs a certain rule from the viewpoint of environment protection and safety of marine transport. Also, regarding search and rescue (SAR), while the clarification via convention of each country's area of responsibility should be applauded, there is the need for a clear roadmap to meet the necessary conditions for SAR, especially regarding systems, equipment improvement (icebreakers, airplanes), infrastructure,

operations, and so on. You can get a lot of relevant information in the International Northern Sea Route Programme (INSROP) study that was carried out by my foundation, the Ocean Policy Research Foundation, in the 1990s, which took six years: (http://www.sof.or.jp/en/activities/index6_1.php)

Followed by phase two, JANSLOP, in the 2000s: (http://www.sof.or.jp/en/activities/index6_2.php).

Another implication of the NSR on the North Pacific is the possible dramatic change of the global navigation network. You may understand it if you see that more than half of marine transport between East Asia and Europe, one of the world's main navigation routes, shifts from the southern sea route to the northern sea route. Japan, Korea, China and Taiwan now have a strong interest in the NSR from this viewpoint. I think Canada and the United States also have the same kind of interest related to the western sea route.

Finally, I would like to suggest that all the issues I have discussed are interconnected, and it is expected that solutions to Arctic problems will be found in an integrated manner. Other aspects we should take into account as relevant factors besides those I referred to include delimitation disputes, security, indigenous people, and human well-being.

And I do not believe it is alright that Arctic-related issues are simply engaged by the coastal states alone. All countries, particularly those relatively close to the polar region such as those in the North Pacific, should be involved in the Arctic transformation, because it is regarded as a global issue affecting the world.

From this point of view, ocean governance for the Arctic Sea must be an agenda to be focused on further, reviewing over the function of market mechanisms, patterns of human behavior, international collaboration, legal challenges, scientific surveys and studies as the basic infrastructure.

Commentary

James Seong-Cheol Kang

Dr. Robert Corell addressed the implications of Arctic transformation for the North Pacific region from the viewpoints of world order, the North Pacific nations, and regional and global governance. In particular, the paper discussed climate change and its implications for humankind and natural systems, the opening of the Northern Sea Route (NSR) due in large part to climate change and its implications for the North Pacific region, indigenous peoples in the Arctic region affected by climate change, and governance issues affecting the Arctic and North Pacific regions. After synthesizing key points of the paper, this commentary will examine climate change in Korea and the recent situation in the Arctic to provide further supporting information. Finally, some issues for discussion will be suggested.

KEY POINTS OF THE PAPER

Earth's climate is changing. Human influences on the climate system are exceeding natural climatic variability. Global impacts from climate change include melting of glaciers, thawing of permafrost, sea level rises, intensified storms, ocean acidification, forest changes, shifting ecosystems, and adverse effects on human health and well-being.

Some of these impacts are especially evident in the Arctic. Current scientific studies suggest that the Arctic Ocean will be increasingly ice free in summer, which opens seaways along both the Canadian and Russian coastal regions. A totally ice-free Arctic Ocean in summer is likely to occur within a few decades for increasingly longer periods. And over the decades thereafter, the Arctic Ocean could become ice-free waters.

The crises caused by climate change also present some opportunities. The opening of the NSR, due to the declining Arctic sea ice, could bring about significant advantages in logistics and natural resources development. If the NSR is taken, for example, from Busan, Korea to Rotterdam, Netherlands, 40% of the travel distance (about 7,400 km) is estimated to be reduced compared to the current route that goes through the Indian Ocean and Suez Canal, which is equivalent to a saving of 10 sailing days. More detailed analyses of the impacts of the NSR on North Pacific

transportation and logistics are presented in the two papers in Part II. Improved accessibility to the Arctic makes it easier to develop untapped natural resources (oil, gas, fisheries) in the area. Assessments in recent years suggest that 25% or so of the world's petroleum (i.e., oil and gas) is located in the Arctic. It has also been reported that the continental shelves of the eastern and western Bering Sea together constitute one of the world's largest and most productive fishing areas.

Arctic indigenous peoples have been resilient for thousands of years, maintaining their way of life. However, they are becoming increasingly vulnerable to the substantial changes in climate in recent decades. The opening of the NSR and subsequent developments in the Arctic region could exacerbate the negative impact on indigenous communities. Therefore the changes in the Arctic, if not unavoidable, should be adapted to and utilized in consideration of these indigenous peoples through an appropriate regional or global governance framework. The existing framework is the Arctic Council, established in 1996 by the Ottawa Declaration, with Canada, Denmark, Finland, Iceland, Norway, Russia, Sweden, and the United States being member states. The Arctic Council faces many issues and challenges related to climatic change in the Arctic and access to the NSR and natural resources in the region. Whether the Arctic Council can effectively address these issues and protect indigenous communities by reconciling their geopolitical interests remains to be seen.

CLIMATE CHANGE IN KOREA

In his paper, Corell described climate change from a global perspective.

I would like to add to his alarming information by providing some statistics on climate change in Korea in recent decades.

In Korea, the average surface temperature has increased by 1.7°C since 1912. The warming magnitude exceeds the global average. This has caused a nation-wide average increase in the frequency of extremely hot days and a decrease in the frequency of extremely cold days. The number of tropical nights (defined as days with a daily lowest temperature exceeding 25°C) during a 10-year period from 2000 to 2009 has increased by 0.6 days. In contrast, the number of frost days (defined as days with a daily lowest temperature below 0°C) has decreased by 5.6 days.

Winters became shorter by nearly a month in the 1990s compared to

the 1920s, whereas summers have lengthened. In the beginning half of the 20th century, the Han River, a major river in Korea that passes through the city of Seoul, was frozen for roughly three months in winter. But it has been completely ice free in some recent years. Sea surface temperatures around the Korean Peninsula have increased by approximately 0.93°C since 1968. The sea level has risen by 2.5 mm/year over the last three decades.

Annual precipitation has exhibited an increasing trend with distinct natural variability. For the period from 1996 to 2005, the average annual precipitation (1,485.7 mm) increased by 10% compared to the normal amount. The number of wet days has more or less decreased, while the number of heavy rainfall days has significantly increased. In particular, the number of days with daily precipitation exceeding 80 mm has increased from 20 (the normal figure) to 28 days in a year for the recent 10-year period. The heavy rainfall in Seoul and nearby areas over four days from July 26 to 29 this year is a striking and worrisome example. The amount of rainfall was 700 mm, which is half the average annual precipitation, resulting in 40 deaths from landslides.

Looking ahead, under the IPCC SRES A1B scenario, temperature in the late 21st century (2071-2100), as compared to that of the late 20th century (1971-2000), is expected to increase by 4°C throughout the Korean Peninsula. Precipitation in the late 21st century, as compared to that of the late 20th century, is projected to increase by 17%. The frequency and intensity of precipitation in Korea are anticipated to increase in the future.

RECENT SITUATION IN THE ARTIC

The Korean icebreaking research vessel "Araon" is exploring the Arctic at this moment. Reports from the vessel are surprising. Last year, sea ice in the Artic was first observed at a latitude of 69° north. However, it was not encountered until the vessel reached a latitude of 73° north this year, a 500 km retreat. The NSR became available in mid-September last year, but has opened more than a month earlier this year. This is because recent temperatures in the Arctic are 5°C~8°C higher than usual. The Arctic sea ice is melting at the fastest rate ever. On average, 93,000 km^2 of ice, almost the size of South Korea, disappeared daily in August this year. The amount of Artic sea ice decreased by 30% during a recent month (from 9,500,000 km^2 in early July, 2011 to 6,700,000 km^2 in late July).

As stated in Corell's paper, the IPCC and peer-reviewed scientific publications have concluded that warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level. The above information from the Arctic is a corroborating piece of evidence that climate change is indeed happening.

ISSUES FOR DISCUSSION

Curbing climate change and the opening and use of the NSR are conflicting matters: slowing down global warming would delay the opening of the NSR. The route is likely to be available soon unless the trajectory of climate change suddenly changes. So, use of the NSR needs to be approached from the perspective of adaptation to climate change. In this regard, among the important issues for deliberation are the following:

- The use of the NSR could exacerbate the melting of the Arctic sea ice. How do we strike a balance between using the Arctic region commercially and slowing down climate change in the Arctic?
- What would be the social responsibilities of the Arctic states and non-Arctic states in the North Pacific region, which could benefit from the opening of the NSR, regarding indigenous communities and parts of the world that could suffer from climate change in the Arctic?
- What is the political and environmental downside of utilizing the NSR and developing natural resources in the Arctic region?

References

Wikipedia, http://en.wikipedia.org/wiki/Arctic_Council

Han, Taek-Whan, Chung, Il-Ung, Lim, Dongsoon, Oh, Jin-Gyu, Lee, Myung-Kyoon, and Lee, Chang-Hee. 2011. *Green Growth: Climate Change*. Green Forum 2010, vol. 3, National Research Council for Economics, Humanities and Social Sciences.

MBC News, http://imnews.imbc.com/replay/nwdesk/article/2900896_5780.html

Commentary

Nancy D. Lewis

Aloha and welcome to the East-West Center. I am very pleased that the EWC is the host of this conference, Opening the Northern Sea Route and Dynamic Changes in North Pacific Logistics and Resource Security. I want to thank the Korea Transport Institute and the Korea Maritime Institute, as well as to EWC Senior Fellow Y.H. Kim, who has so ably served as the primary conference organizer.

I am honored to have been asked to comment on the opening address, "Consequences of the Changes across the Arctic on World Order, the North Pacific Nations, and Regional and Global Governance" by Dr. Robert Corell, former assistant director for Geosciences at the National Science Foundation, chair of the Arctic Climate Impact Assessment, and head of a New Initiative on Arctic Change Impact Assessment, about which I hope we learn more over the course of the next two days.

I am tempted to say that I am somewhat out of my depth, and that is not meant to be a climate change pun. My mother's family is from Alaska and I have visited, but as a scientist, I do not know a great deal about the Arctic. I have spent most of my academic career working in the small tropical island nations and states of the Pacific on issues related to health and the environment, and in the last decade, on how both are influenced by climate change. Time is limited and Dr. Corell's presentation was a truly outstanding introduction to the complex and interacting opportunities and challenges in the Arctic, including but not limited to climate change. He also addressed issues of governance and responsibility that face us as a global community with respect to the Arctic. I am going to yield most of my time to the other commentators in this session who have far more expertise than I do with Arctic issues.

There are parallels between the challenges of climate change for the indigenous peoples and environments of the Arctic and the challenges for the peoples and environments of tropical island states in the Pacific and elsewhere, although they are not exact mirror images of one another. One of the points that I want to make is that if we think only of the iconic images of marooned polar bears and sinking islands, or canaries in a coal mine, we deny the people of both the Arctic and the islands agency, and ignore the fact that they have been adapting to climate variability

and change for centuries, in some cases thousands of years (Barnett and Campbell 2010). Dr. Corell stressed that empowering northern residents is critical in addressing climate change and other environmental and global challenges in the Arctic, and the importance of co-management and engaging indigenous and traditional knowledge in addressing these issues. Frances Ulmer also underscored these thoughts in her written comments.

Issues of governance are addressed in this meeting at multiple levels. Preparing these brief remarks, I came across a paper written for a conference, the Indigenous Peoples' Global Summit on Climate Change, which was held in Anchorage in 2009, "Artic Governance: Traditional Knowledge of Arctic Indigenous Peoples from an International Policy Perspective" (Fenge and Funston 2009). I recommend the paper for those who are not familiar with the Arctic. Island states, individually and collectively, have been highly visible in climate change debates. This is in part due to their previously mentioned iconic status, but also because of their representation in the United Nations and in the UNFCCC. Some have suggested that islands have a "moral argument" with respect to climate change or that islands are the "conscience" of climate change, an ironically heavy burden given their very small contribution to greenhouse gas emissions. Although islands are highly visible in the debates, the lack of both human and financial resources to support large diplomatic missions or delegations, limits the real power that they have in climate politics (Barnett and Campbell 2010; Lewis 2011). The indigenous peoples of the Arctic have been given voice by their status as Permanent Participants in the Arctic Council. I defer to others to address the strength of this voice. I anticipate that Dr. Maynard will expand on the concerns and issues for indigenous Arctic peoples in her comments.

The term "climate or environmental refugee" is used with reference to both peoples of the Arctic and the island states. It is complicated and contested (Hartmann 2010). One argument is that it undermines the rights and status of political refugees. Maxine Burkett, head of the University of Hawaii Center for Island Climate Adaptation and Policy and a team member in the Pacific RISA project described below, noted that the fact that climate refugees have no legal status may be an additional reason to avoid using the term. Burkett goes on to argue that the international legal community lacks the will to address the legal implications of individuals and island communities who may be forced to abandon their islands. She also posed the question of whether the climate refugees are stateless persons

or landless citizens of a state that does not exist (Burkett 2011).

I want to mention one EWC activity that links us, to a small degree, to colleagues working with communities in the Arctic. The EWC hosts the Pacific RISA, or Regional Integrated Sciences and Assessments, one of 11 NOAA-supported RISA programs in the United States that strive to enhance communities' abilities to understand, plan for and respond to a changing climate through interdisciplinary research that builds partnerships with local, national and regional stakeholders. We have a particularly close relationship with another RISA, the Alaska Center for Climate Assessment and Policy, based at the University of Alaska, Fairbanks. Members of their team were in Hawaii for a meeting two weeks ago. Together, we have engaged in some preliminary efforts, linking indigenous communities in the Pacific and Alaska virtually. When I asked the ACCAP team what the issues they saw as most critical in the Arctic they stressed governance; indigenous use, including coastal erosion and coastal community relocation; safety (search and rescue); risks of oil spills; invasive species; tundra fires; marine and mammal protection; and air emissions.

The organizing theme for this conference is the changing Arctic climate and implications for sea routes, shipping and resource development. As we explored how best to organize the conference, it became clear that we needed to set the context for those discussions. This included outlining the myriad opportunities and challenges presented by the Arctic, the interests of the multiple stakeholders involved, and the need for multidisciplinary and international collaboration in addressing these issues. Bob Corell did a masterful job of setting this context.

Looking to another expert, I will close my remarks by quoting remarks by Dr. Jane Lubchenco (a marine scientist, Under Secretary of Commerce for Oceans and Atmosphere and Administrator of NOAA) in a keynote speech to the Arctic Symposium in June of this year (Lubchenco 2011) and present her six Guiding Principles, the first of which was also Dr. Ulmer's first suggested question for discussion. These principles can serve to frame our deliberations:

> *"…the loss of sea ice alone creates new opportunities, potential threats and new demands for information and services to evaluate trade-offs and ensure safety … and the loss of sea ice interacts with the plethora of other changes underway that influence Arctic ecosystems, communities and cultures. These changes affect not only the Arctic. They have global implications as*

well. More holistic approaches are needed if we are to achieve the multiple goals identified for the Arctic…."

SIX GUIDING PRINCIPLES

1. "When in doubt, err on the side of caution, especially when actions may trigger irreversible changes, ones affecting huge areas, or ones lasting for decades to centuries…"
2. "Adopt an ecosystem-based management approach that considers the interacting and collective diverse activities on the functioning of the Large Marine Ecosystems of the Arctic. This holistic approach recognizes that sectoral activities such as shipping, energy production, mining, fishing, tourism, defense, etc., affect one another and ecosystem functioning...If the goal is to use Arctic ecosystems without using them up, an integrated ecosystem approach is necessary."
3. "The people of the Arctic should have a strong voice in their future. At the same time decisions must recognize that many changes in the Arctic will have global ramifications."
4. "The challenges of operating and living safely in the rigorous and quickly changing Arctic environment require extra attention to safety, adequate communications, contingency plans and vigilance."
5. "Management and policy decisions should be firmly grounded in scientific information, with adequate attention to acquiring, disseminating and using the requisite data and information."
6. "Collaborations, openness and transparency are essential for effective expansion of the use of the Arctic."

I look forward to our discussions. Thank you.

References

Barnett, Jon and John Campbell. 2010. *Climate Change and Small Island States*. Washington, DC: Earthscan.

Burkett, Maxine. 2011. "In Search of Refuge: Pacific Islands, Climate-Induced Migration and the Legal Frontier." *AsiaPacific Issues* No. 98. Honolulu, HI: East-West Center.

Fenge, Terry and Bernard W. Funston. 2009. "Arctic Governance: Traditional Knowledge of Arctic Indigenous Peoples for an International Policy Perspective." *Indigenous Peoples' Global Summit on Climate Change*, Anchorage, Alaska, April 24, 2009.

Hartman, Betsy. 2010. "Rethinking Climate Refugees and Climate Conflict: Rhetoric, Reality and the Politics of Policy Discourse." *Journal of International Development* 22(2): 233-246.

Lewis, Nancy Davis. 2012. Is lands in a Sea of Change: Climate Change, Health and Human Security in Small Island States. In H.J.S. Fernando, Z. Klaić and J.L. McCulley, eds. *National Security and Human Health Implications of Climate Change* (pp. 13-24), NATO Science for Peace and Security Series C: Environmental Security. Dordrecht, the Netherlands: Springer.

Lubchenco, Jane. 2011. Keynote address to the June 2011 Arctic Symposium; 4th Symposium on the Impacts of an Ice-Diminishing Arctic on Naval and Maritime Operations, Washington, D.C. Organized by the US National Ice Center and the US Arctic Research Commission. Retrieved from http://www.noaanews.noaa.gov/stories2011/20110620_arcticice.html

Commentary

Nancy G. Maynard

INTRODUCTION

This paper addresses one aspect of the "Implications of Arctic Transformation for the North Pacific": the implications for the indigenous peoples of the region. How can we ensure that indigenous peoples will be part of and have a strong voice in the future of the Arctic, especially with the opening of the Northern Sea Route (NSR)? There is great concern by some that indigenous peoples will be pushed aside or even eliminated in the rush by Arctic and non-Arctic states and industries to exploit their resources. Indigenous peoples - the original native inhabitants of the region - are nested deeply in the center of the profound transformations taking place across the Arctic due to climate change, globalization, development, and now the opening of the NSR. The nature of the challenges facing indigenous peoples as a result of these changes is summarized in the

Conference Concept Note of the 2011 EWC/KOTI Conference as follows:

> *"…The shrinking of the Arctic's ice cap increases environmental fragility and threatens the traditional way of life for indigenous peoples. Climate change in the circumpolar region is already affecting indigenous peoples who consider the region to be their homeland. Arctic indigenous peoples are trying to protect their traditional ways of life from colonizers who seek to take advantage of new opportunities to exploit the region for oil, mineral, and forestry resources with adverse effects on their communities…"*

To fully appreciate the seriousness of the potential for major impacts by the coming transformation of the Arctic on indigenous peoples, it is important to understand the magnitude of existing stresses already impacting their communities and ways of life. To help establish a better understanding of these issues and encourage policymakers to include more indigenous peoples and their issues in related decision-making processes, this paper has provided background information, a few key questions, two examples of typical impacts on indigenous communities occurring today, and some possible solutions. The key questions are:

- Who are the "indigenous peoples?"
- What are the primary stresses on Arctic indigenous peoples?
- What are some possible solutions to improve involvement by indigenous peoples in the future of the Arctic?

WHO ARE THE "INDIGENOUS PEOPLES?"

"Indigenous peoples, or Native peoples (see map, Corell, 2013, this volume) have often been described as ethnic groups from particular regions or lands - often the original inhabitants - especially prior to the arrival of later and possibly dominating cultures (Galloway-McLean, 2010; Nakashima et al., 2011). As discussed by Nakashima et al. (2011), while there is no universally accepted definition of indigenous or native peoples, most include the following set of basic criteria:

- "maintenance of social and cultural traits that are distinct from those of mainstream or dominant society (which may include distinct

languages, production systems, social organization, political and legal systems, spirituality and worldviews, amongst other aspects);
- unique ties to ancestral territories and to the natural resources of these places;
- self-identification and recognition by others as being part of a distinct cultural group." (Nakashima, et al., 2011)

Worldwide, there are approximately 300-350 million indigenous individuals and 5,000 distinct peoples (McLean-Galloway, 2010). Indigenous peoples are approximately 5% of the world's population, manage 11% of the world's forest lands and occupy, own, or use 22% of the surface area of the land (McLean-Galloway, 2010). Although several countries in the Arctic do not identify indigenous peoples specifically, there are some estimates of numbers which suggest that the Arctic is home to approximately 375,000 indigenous peoples in five different countries (Bogoyavlenskiy and Siggner, 2004). The percentage of the populations of indigenous peoples in the Arctic range from 3-4% in Russia to 80% in Greenland (Galloway-McLean, 2010). Bogoyavlenskiy and Siggner (2004) list the following indigenous groups in Arctic countries: the Saami, who inhabit circumpolar areas of Norway, Sweden and Finland; the Inuit in Greenland; American Indians and Alaskan Natives in the United States; North American Indian, Inuit, and Metis in Canada; and the Saami, Nenets, Khanty, Sel'kup, Enets, Nganasan, Dolgan, Evenk, Even, Yukagir, Chukchi, Chuvan and Eskimo/Inuit-Yupik in Russia. They also list the following distribution of estimated population numbers in the Arctic regions by country: USA, 110,000; Canada, 66,000 Denmark, Greenland, 50,000; Norway, Sweden, and Finland, 50,000; and Russia, 90,000 (data from 2002 census). A detailed map of the locations of indigenous groups may be found in Corell, 2013, this volume. Settlements range from small, nomadic villages that follow a traditional lifestyle to larger industrialized cities (Galloway-McLean, 2010).

Indigenous peoples are considered especially vulnerable to climate change and development in the Arctic because of their strong relationship with the natural resources and environment for their cultural, social, and physical well-being (Ford and Furgal, 2009; Parkinson, 2009). In addition, over many years, indigenous peoples across the world have tended to maintain cultural and political separation from surrounding mainstream governments and systems, and therefore there has often developed a political domination by

those surrounding nation states (Galloway-McLean, 2010; Nakashima et al., 2011). Significant concern about the historic injustices that have occurred has resulted in the United Nations issuing a "Declaration on the Rights of Indigenous Peoples" to protect the rights of indigenous peoples and their culture, language, health, identity, employment, natural resources, and education (United Nations, 2008). Thus, it is important to take into account the consequences to, as well as the role of, Arctic indigenous peoples in the coming "Transformation of the Arctic."

WHAT ARE THE PRIMARY STRESSES ON ARCTIC INDIGENOUS PEOPLES?

To underscore the seriousness of the additional potential impacts to indigenous peoples resulting from opening of the NSR, this paper presents information about some of the stresses already affecting indigenous peoples from climate and development changes in the context of several of the categories of the 4th IPCC Assessment (ecosystems, food, human health, water and extreme weather). An overall summary of some of the existing stresses in these categories on indigenous peoples has been summarized as follows:

> *"…Resident indigenous populations of the Arctic are uniquely vulnerable to climate change because of their close relationship with, and dependence on, the land, sea and natural resources for their cultural, social, economic and physical well-being. Climate change will affect sustainable development of these communities through its impact on the sanitation and water infrastructure, food supply, transportation infrastructures and the prevalence of infectious diseases. Without addressing these basic public health needs, Arctic communities are not sustainable….*
>
> *(Parkinson, 2009)*

Ecosystems

For many indigenous communities, hunting, fishing, and herding are central to the culture and well-being of the community – maintaining a strong connection to the environment – as well as nutritionally for the ability to supply nutritional traditional foods such as seals, marine mammals,

reindeer/caribou, and fish for family and community (Huntington et al., 1998; Poppel, 2006). As changing sea ice conditions and warming oceans in turn change the distribution of the fish, seabirds, marine mammals, and other animals that are harvested by Arctic peoples, the availability of a predictable food supply is being threatened (Nuttal et al., 2005; Ford and Furgal, 2009). These factors are being exacerbated by the accompanying decrease in predictability of weather patterns along with low water levels and timing of snow, ice, and storms, which also influence the potential for successful hunting, fishing, herding, and access to food, as well as increasing the possibility of accidents (Nuttal et al., 2005; Ford and Furgal, 2009).

Food

Food security is a crucial factor for the survival of indigenous peoples, and currently many Arctic people are concerned about how they will adapt to impacts on their food supplies caused by climate change and development, as well as resultant changes in their diets (Ford and Berrang-Ford, 2009). For example, Inuit communities are trying to adjust the timing of their travels by land, sea, and ice due to changes in thawing and freeze-up of the ice for safety, as well as animal location changes due to changes in the environment (McLean-Galloway, 2010; Gearheard et al., 2006). Compounding these issues are impacts on traditional food preservation methods like the drying of meat, fish, fermentation, and storage in ice cellars – all of which are being affected by warming temperatures and thus reducing available food for communities (Parkinson and Evengard, 2009; Virginia and Yalowitz, 2011). Globalization influences in some communities are causing a loss of knowledge in younger generations on how to preserve traditional foods, again forcing families to rely on more expensive and less healthy Western foods, which in turn is increasing health issues normally associated with processed food such as diabetes, cardiovascular diseases, dental problems, and obesity (Berrang-Ford et al., 2011; Virginia and Yalowitz, 2011).

Extreme Weather

There are many impacts of climate change-related extreme weather on the indigenous peoples – who characteristically hunt, fish, and herd out in the Arctic environment - including potential for increasingly unpredictable

extreme weather events and storms, which can cause risks to travel and activities related to subsistence food gathering, risk of becoming trapped away from home communities, or risks to very isolated rural villages (Ford and Furgal, 2009; Brubaker et al., 2011; Berner et al., 2005). Other direct impacts include physical and mental injuries, disease, and even mortality from rapid changes in weather that can cause problems such as blizzards, avalanches, and premature ice melt (Berner et al., 2005; Ford and Pearce, 2010). In addition, loss of land-fast ice and increased open water are also causing less-predictable sea ice and fog conditions, which can create dangerous coastal travel conditions (Nuttal et al., 2005).

Human Health

Climate change is only one of the factors determining vulnerability or health status in indigenous communities, as the impacts vary among the widely diverse communities (ranging from small, remote settlements to large industrial cities), but it is a factor that can complicate other stresses (Anisimov et al., 2007; Revich, 2008; Brubaker et al., 2011). In addition to impacts from extreme weather, climate-related potential health impacts include temperature- and weather-related injuries or stress (frostbite, hypothermia, injury, accidents), UV-B radiation (immune suppression, cataracts, skin cancer), and cardiomyopathy associated with low temperatures and/or stress (Berner et al., 2005; Revich, 2008; Ford and Furgal, 2009; Parkinson and Evengard, 2009; Abryutina, 2009). Examples of other climate-related health issues are possible increases in new plant and animal species, infectious diseases, and zoonotic diseases (Revich, 2008; Parkinson, 2009; Brubaker et al., 2011). It is also important to consider background conditions that are already operating in the region, and although perhaps subtle in appearance, they are profound in impact. These factors include additional stressors such as the presence of serious levels of contaminants (e.g., POPs or persistent organic pollutants, radioactivity, and heavy metals such as mercury) (AMAP, 2009; AMAP, 2011). Studies by AMAP have documented significant health hazards to Arctic residents from the long-range transport of these contaminants to the Arctic from both local and distant industrialized sources, as well as their accumulation in plants and animals, with serious effects on the central nervous system, immune system, and cardiovascular system (UNEP/AMAP, 2011; Abryutina, 2009). This is an especially important threat

to indigenous peoples because the contaminants are biomagnified up the food chain to traditional subsistence foods (UNEP/AMAP, 2011). Climate impact studies also show that as indigenous peoples are losing the ability to practice their traditions and cultures and provide food for their families and communities, there are related increases in psychological distress and anxiety, accompanied by such issues as domestic violence and high suicide rates (Portier et al, 2010; Coyle and Susteren, 2011).

Water

The effects of climate change are starting to threaten drinking water and infrastructure in communities – especially in low-lying coastal towns (e.g., Shishmaref, Newtok, and Kivalina) and areas of thawing permafrost where not only are buildings crumbling, but also water sources are being impacted through increased river and coastal erosion and flooding, saltwater intrusion, loss of reservoirs, bacterial contamination, and sewage contamination (Anisimov et al., 2007; Parkinson et al. 2008; Virginia and Yalowitz, 2011). Disease incidence from contact with human waste can increase with flooding and infrastructure damage and limited availability of safe water for drinking, cooking and hygiene, and these conditions can result in increased rates of respiratory infections, skin conditions, pneumonia, and other diseases (Berner et al., 2005 Parkinson and Evengard, 2009).

TWO EXAMPLES OF CURRENT IMPACTS ON INDIGENOUS PEOPLES IN EURASIA

Example #1 Oil and gas development in Northern Russia: impacts and solutions

The purpose of this example is to help demonstrate the impact that extensive oil and gas development can have on local reindeer populations and associated indigenous peoples, as well as an example of a possible adaptation strategy through the sharing of knowledge among indigenous reindeer herders and Norwegian, Russian, and NASA scientists. The Yamal-Nenets Autonomous Okrug (YNAO) is one of the largest reindeer husbandry regions in the North, where traditional family reindeer herding has remained. However, very aggressive development of the Yamal oil

and gas fields has also been taking place, and is expected to dramatically increase. In recent years, industrial development has begun to collide with major reindeer herding areas, and local reindeer herders are already experiencing negative impacts such as loss of traditional migration routes and campsites to pipelines, roads, buildings, and pollution (Degteva, 2006; Mathiesen et al., 2010; Oskal et al., 2010; Maynard et al., 2011). A collaboration among members of an EALAT team from the International Centre for Reindeer Husbandry, St. Petersburg State University, Nenets indigenous reindeer herders, and NASA has co-produced maps and images that could be used to find alternate routes and for planning purposes with industry and the government regarding development of new oil and gas fields, to assure that access to migration routes will be sustained (Degteva, 2006; Mathieson et al., 2010; Oskal et al., 2010; Bongo et al., 2011; Maynard et al., 2011a,b).

Example #2 Impacts of large-scale mining infrastructure development in Russia on local reindeer populations and the indigenous peoples who depend upon them

The purpose of this example is to help demonstrate the type of impact that large-scale mining (increased gold mining and related development) can have on local reindeer populations and the indigenous people who depend on them. Nizhniy Kuranakh is one of the main gold mining regions in Russia. Up to 80% of the town's workforce has been employed at the open-cut gold mine since mining began as the town's leading industry in 1932. The area, however, is also used by Evenki reindeer herders who have historically migrated for thousands of years through the region from their nearby village, Khatystyr, to reach seasonal pastures (Pogodaev, personal communication). The growth in major infrastructure from the mining operations in the area is now blocking seasonal migration of large herds of reindeer and the Evenki herders through the entire area (Pogodaev, personal communication; Mathiesen et al., 2010). The Russian government and industry are currently planning to do massive development in the area. Pressures on now-fragmented pasturelands left available to reindeer and associated indigenous communities in Russia are expected to increase as a direct result of increased gold mining, other development, and accompanying pollution in the region (Pogodaev, personal communication; Maynard et al., 2011a). It is suggested that one solution to mitigate against total disruption of the herd migration by infrastructure could be

the increased use of remote sensing studies, combined with the knowledge and expertise of indigenous people as well as other Russian colleagues, making it possible to find alternate migration routes for the herders using collaborative maps and space-based observations (Degteva, 2006; Pogodaev, personal communication; Mathiesen et al., 2010; Maynard et al., 2011a, b).

WHAT ARE SOME POSSIBLE SOLUTIONS TO IMPROVE INVOLVEMENT BY INDIGENOUS PEOPLES IN THE FUTURE OF THE ARCTIC?

"Indigenuity" is a term coined by Dr. Dan Wildcat of Haskell Indian Nations University in Lawrence, Kansas, U.S., a leader in Native American studies in climate change, to describe some possible solutions or strategies in which indigenous knowledge in any location is combined with ingenuity to create even smarter solutions, especially for indigenous peoples (Wildcat, 2009).

Below are a number of examples of potential solutions compiled by the EALAT Yamal team when considering future strategies and adaptations for the Yamal reindeer herders as they try to deal with rapidly increasing oil and gas development and climate changes taking place across their traditional migration routes. Although the solutions in this case were prepared to address issues of local indigenous reindeer herders, it is suggested that many of the solutions could apply in general to cooperative arrangements among all indigenous peoples and states or parties as they increase their activities in the Arctic in the coming years (Degteva, 2006; Mathiesen et al., 2010; Oskal et al., 2010; Maynard et al., 2011a,b).

- Establish meaningful agreements between indigenous reindeer herders and oil and gas industries and governments to ensure "adaptive access" to historical pasturelands and migration routes so they can coexist in changing climates
- Create strong partnerships between the reindeer herding community and industry and government
- Create mechanisms for clear and ongoing communications between reindeer herders and oil and gas industry and governments for co-managing land use
- Ensure that indigenous knowledge and peoples are included in

decision-making that impacts the herding community
- Ensure that industry, governments and reindeer herders work together to help preserve the language, culture, and well-being of indigenous peoples
- Utilize all best available data for decision-making and predictions: indigenous knowledge, science, remote sensing, technologies, weather, etc.
- Collaborate and co-produce data and solutions
- Utilize the EALAT Observation and Monitoring Network for Reindeer Pastoralism at the International Center for Reindeer Husbandry to ensure strong input of indigenous knowledge for decision-making and predictions
- Create assessments and adaptation strategies to address impacts of climate change, development, pollution, and loss/changes in pasturelands on indigenous reindeer herder communities
- Expand and enhance educational opportunities in reindeer herders communities as well as industry and government employees out on Arctic lands

References

Abryutina, L. 2009. "Indigenous Peoples of the Russian North: Social and Climate Change." *Climate Change and Arctic Sustainable Development: Scientific, Social, Cultural and Educational Challenges*. UNESCO. 164-173.

Albrecht, G., G. Sartore, L. Connor, N. Higginbotham, S. Freeman, B. Kelly, H. Stain, A. Tonna, and G. Pollard, "2007: Solastalgia: the distress caused by environmental change." *Australasian Psychiatry* 15. S95-S98.

AMAP. 2010. *AMAP Assessment 2009: Radioactivity in the Arctic*. Arctic Monitoring and Assessment Programme (AMAP) Oslo, Norway. Xii and 92 pp.

AMAP, 2011. *Arctic Pollution 2011*. Arctic Monitoring and Assessment Programme (AMAP). Oslo, Norway. Vi and 38 pp.

Anisimov, O.A., Vaughan, D.C., Callaghan, R.V., Furgal, C., Marchant, H., Prowse, T.D., Vilhjalmsson, H., and Walsh, J.E. 2007. *Polar Regions (Arctic and Antarctic) Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press. 653-685.

Barber, D.C., Lukovich, J.V. Keogak, J., Baryluk, S., Fortier, L. and Henry, G. 2008. "The Changing Climate of the Arctic." *Arctic* (Coastal Zone Canada Special Issue) Vol. 61, suppl. 1. 7-26.

Berner, J., Furgal, C., Bjeerregaard, P., Bradley, M., Curtis, T., De Fabo, E., Juhani, H., Keating, W., Kvernmo, S. Nayha, S., Rintamaki, H. Warren, J. 2005. "Human Health." *ACIA Science Report*. Cambridge University Press. 863-906.

Berrang-Ford, L., J.D. Ford, and J. Paterson. 2011. "Are we adapting to climate change?" *Global Environmental Change* 21(1): 25-33.

Bogoyavlenskiy, D. and Siggner, A. 2004. "Arctic Demography." *AHDR (Arctic Human Development Report)*. Akureyri: Stefansson Arctic Institute. 27-42.

Bongo, M. P., A. Degteva, I. M. G. Eira, I. Hanssen-Bauer, A. Ivanoff, O. H. Magga, S. D. Mathiesen, N. G. Maynard, A. Oskal, M. Pogodaev, M. N. Sara, D. V. Schuler, E. I. Turi, and R. W. Corell. 2011. "Eurasian Reindeer Herding, Traditional Knowledge and Adaptation to Climate Change." In: UNESCO. Indigenous Peoples and Climate Change: Vulnerability, Adaptation and Traditional Knowledge. Report of workshop on Indigenous Peoples, Marginalized Populations and Climate Change: Vulnerability, Adaptation and Traditional Knowledge, Mexico City, Mexico. UNESCO: Paris. 1-17.

Brubaker, M., J. Berner, R. Chavan, and J. Warren. 2011. Climate change and health effects in Northwest Alaska. *Global Health Action* 4, 10.3402/gha.v4i0.8445.

Corell, R. 2013. Implications of Arctic Transformation for the North Pacific: Consequences of the Changes across the Arctic on World Order, the North Pacific Nations and Regional and Global Governance. This volume.

Coyle, K.J. and Susteren, L.V. 2011. The Psychological Effects of Global Warming on the United States: its Stresses, Traumas, and Societal Costs. Publication of the National Wildlife Federation Climate Education Program. 43 pp.

Degteva, A. 2006. Oil industry and reindeer herding: the problems of implementing indigenous rights in the Nenets Autonomous Okrug, Russia. Thesis. Master of Philosophy in Indigenous Studies. University of Tromsø. Tromsø, Norway. 24 pp.

Ford, J.D. and L. Berrang-Ford, 2009. "Food Security in Igloolik, Nunavut: an Exploratory Study." *Polar Record* 45(03): 225.

Ford, J. and C. Furgal. 2009. "Foreword to the Special Issue: Climate Change Impacts, Adaptation and Vulnerability in the Arctic." *Polar Research* 28(1): 1-9.

Ford, J.D. and T. Pearce. 2010. "What We Know, Do Not Know, and Need to Know about Climate Change Vulnerability in the Western Canadian Arctic: A Systematic Literature Review." *Environmental Research Letters* 5(1), 014008.

Galloway-McLean, K. 2010. *Advance Guard, Climate Change Impacts, Adaptation, Mitigation, and Indigenous Peoples – A Compendium of Case Studies*. UN

University. Darwin, Australia. 124 pp.

Gearheard, S., W. Matumeak, I. Angutikjuaq, J. Maslanik, H.P. Huntington, J. Leavitt, D.M. Kagak, G. Tigullaraq, and R.G. Barry. 2006. "It's not that simple": A collaborative comparison of sea ice environments, their uses, observed changes, and adaptations in Barrow, Alaska, USA, and Clyde River, Nunavut, Canada. *Ambio* 35(4): 203-211.

Gearheard, S., C. Aporta, G. Aipellee, and K. O'Keefe. 2011. "The Igliniit Project: Inuit Hunters Document Life on the Trail to Map and Monitor Arctic Change." *Canadian Geographer / Le Gégraphe Canadien* 55(1): 42-55.

Huntington, H.P., Mosli, J.M. and Shustov, V.B. 1998. "Peoples of the Arctic: Characteristics of Human Populations Relevant to Pollution Issues." AMAP assessment report: Arctic pollution issues. Oslo: Arctic Monitoring and Assessment Programme. 141-182.

Larsen, J. and Huskey, L. 2009. Material Well-being in the Arctic. Chapter 3 in ASI (Arctic Social Indicators) NORD. Copenhagen: Nordic Council of Ministers. 47-66.

Mathiesen, S.D., N.G. Maynard, A. Oskal, I.M.G. Eira, A. Degteva, M. Pogodaev, A. Ivanoff. 2010. "Defining Adaptation Strategies and Resiliency of Reindeer Herding Communities to Climate and Development Changes in the Eurasian Arctic." *IPY Oslo Science Conference 2010*. June 8-12, 2010. Oslo. Norway.

Maynard, N.G., A. Degteva, A. Oskal, I.M.G. Eira, A. Ivanoff, M. Pogodaev, and S. Mathiesen. 2011a. "IPY EALAT Project: Indigenous Traditional Knowledge & Science Working Together for Adaptation Strategies." Presentation at the UN University Workshop on Indigenous Peoples, Marginal Populations and Climate Change: Vulnerability, Adaptation and Traditional Knowledge, Mexico City, Mexico. July 19-21, 2011.

Maynard, N.G., A. Oskal, J.M. Turi, S.D. Mathiesen, I.M.G. Eira, B. Yurchak, V. Etylin, and J. Gebelein. 2011b. *Impacts of Arctic Climate and Land Use Changes on Reindeer Pastoralism: Indigenous Knowledge and Remote Sensing*. In: Gutman, G. and Reissell, A. (Eds.). Eurasian Arctic Land Cover and Land use in a Changing Climate. 177-205.

Nakashima, D.J., Galloway McLean, K., Thulstrup, H.D., Ramos Castillo, A. and Rubis, J.T. 2011. Indigenous Knowledge, Marginalized Peoples and Climate Change: Foundations for Assessment and Adaptation. Technical Report prepared for the Intergovernmental Panel on Climate Change – Working Group II. UNESCO/UNU: Paris/Darwin. 82 pp.

Nuttal, M, F. Berkes, B.C. Forbes, G. Kofinas, T. Vlassova and G. Wenzel. 2005. *Hunting, Herding, Fishing and Gathering: Indigenous Peoples and Renewable Resource Use in the Arctic*: In: Arctic Climate Impact Assessment. Cambridge:

Cambridge University Press. 649-690.

Oskal, A. 2008. Old Livelihoods in New Weather: Arctic Indigenous Reindeer Herders Face the Challenges of Climate Change. In: Development Outreach, World Bank Institute Special Paper. World Bank. 22-25.

Oskal, A., N. Maynard, A. Degteva, S. Mathiesen, M. Pogodaev, and A. Ivanoff. 2010. "Oil and Gas Development in Reindeer Pastures in Northern Eurasia: Impacts and Solutions." *2010 State of the Arctic Conference IPY*. March 16-19, 2010. Miami, Florida.

Parkinson, A.J., M.G. Bruce, and T. Zulz. 2008. International Circumpolar Surveillance, an Arctic Network for the Surveillance of Infectious Diseases. 14(1).

Parkinson, A.J. 2009. Sustainable Development, Climate Change and Human Health in the Arctic. UNESCO: Climate Change and Arctic Sustainable Development: Scientific, Social, Cultural and Educational Challenges. 156-163.

Parkinson, A. and B. Evengård. 2009. "Climate Change, Its Impact on Health in the Arctic and the Public Health Response to Threats of Emerging Infectious Diseases." *Global Health Action* 2(0).

Pogodaev, M. Personal communication.

Poppel, B. 2006. Interdependency of subsistence and market economies in the Arctic. In: Solveig Glomsrod and Iulie Aslaksen (Eds). The Economy of the North. Statkstisk Sentralbyra/Statistics Norway. Pp. 65-80.

Portier, C.J., T.K. Thigpen, S.R. Carter, C.H. Dilworth, A.E. Grambsch, J. Gohlke, J. Hess, S.N. Howard, G. Luber, J.T. Lutz, T. Maslak, N. Prudent, M. Radtke, J.P. Rosenthal, T. Rowles, P.A. Sandifer, J. Scheraga, P.J. Schramm, D. Strickman, J.M. Trtanj, and P. Whung, 2010. *A Human Health Perspective On Climate Change: A Report Outlining the Research Needs on the Human Health Effects of Climate Change*. Research Triangle Park, NC: Environmental Health Perspectives/National Institute of Environmental Health Sciences. 1-72.

United Nations. 2008. *United Nations Declaration on the Rights of Indigenous Peoples*. United Nations. 07-58681. 18 pp.

Virginia, R.S. and K.S. Yalowitz (Editors). 2011. "A New Paradigm for Arctic Health: Challenges and Responses to Rapid Climate, Environmental, and Social Change." Workshop Report for May 23-25, 2011, Dickey Center for International Understanding, and the University of the Arctic Institute for Applied Circumpolar Policy, Dartmouth College, Hanover, N.H.

West, J. and G.K. Hovelsrud. 2010. "Cross-Scale Adaptation Challenges in the Coastal Fisheries: Findings from Lebesby, Northern Norway." *Arctic* 63(3).

Wildcat, D. 2009. *Red Alert! Saving the Planet with Indigenous Knowledge*. Fulcrum Publishing. 143 pp.

Commentary

Frances Ulmer

Dr. Robert Corell has summarized the current state of arctic climate science and the results of numerous research projects, including the Arctic Climate Impact Assessment. The paper includes a discussion of the historical records and observations of climate change, the differences in the regional rates of change, and the probable consequences, including sea level rise, coastal erosion, ocean acidification, extreme storms, changing weather and drought. My comments will focus on the impacts and implications of these changes.

The nature of change is change

There is nothing new about changing patterns of climate, species evolution and adaptation. Change is the only constant on Earth. I was reminded of this recently during a visit to the University of Alaska Fairbanks Museum, viewing the bones of dinosaurs and mastodons that previously roamed Alaska's plains. What is different now is the rate of change and the extreme pressure that the rapid rate of change puts on species and ecosystems to adapt quickly or become extinct (as many are becoming). There is an excellent discussion by Professor Lee Kump in the July 2011 *Scientific American* describing the extraordinary rate of current warming by comparing recent changes to the Paleo-Eocene Thermal Maximum, 56 million years ago. Warming periods that come on suddenly are much harder on life than more gradual changes. This is particularly true for northern species that cannot move further north, unlike many more temperate flora and fauna that can migrate to higher latitudes or greater altitudes as temperatures warm. Ice dependent species like polar bears are particularly vulnerable.

It is important to remember that the four million people who live in the Arctic rely on the natural systems that are being dramatically stressed by these rapid changes. Subsistence hunting, fishing and gathering provide the majority of calories consumed by indigenous people of the North. Those activities provide the cultural foundation of people and are essential to preserve the social, economic and physical health of their communities. Walrus, seals, whales, bears, waterfowl, fish, berries, and many other

subsistence foods and materials derived from them are jeopardized by the sea ice retreat and warmer conditions. From the perspective of the people whose ancestors have lived in this region for thousands of years, this is a catastrophic change. Human health concerns are related to the health and availability of these species, which are threatened by a number of things, including the presence of persistent organic pollutants, the bioaccumulation of toxic substances, and the influence of invasive species. As noted in the paper, health concerns are widespread, not only in the Arctic, but are particularly significant where people are tightly connected to the land through subsistence harvests.

Coastal erosion is another significant threat to local people. In Alaska, over thirty villages have been identified as vulnerable and are in various stages of assessing response options from building retaining walls to moving the entire community. Increased coastal erosion has been attributed to a number of factors, including higher sea level, later onset of ocean freeze up, thawing permafrost, and stronger storms. A significant contribution to the erosion has been the retreat of sea ice and the longer season of open water adjoining coastal communities. Sea ice normally freezes up against the coastline in fall and the ice acts like a giant blanket on the ocean. This blanket reduces the open water fetch over which winds whip up large waves that erode the coastline. Without this protection, communities like Shishmaref (one of the communities that are being relocated) have lost houses and essential infrastructure to the sea. The significant social and economic costs of this trend are rarely acknowledged because our political system has been unable to make much progress in either mitigating or financing the adaptation required by climate change impacts. States and nations face large financial burdens from thawing permafrost (replacing buildings that have crumbled due to unstable foundations, rebuilding roads and airports that have buckled and cracked), and from coastal erosion. How can these expenses be factored into the analysis of mitigation and adaptation?

SHIPPING AND NAVIGATION

The potential for increased ship traffic in the Arctic is very real for a variety of reasons. In addition to less ice, economics make the area more attractive: interest in natural resources, oil and gas, fisheries, tourism, research and

security. There are several important issues to discuss under the heading of "shipping." We should start by differentiating among three different types of ship traffic: *intra-Arctic, destinational and trans-Arctic (transit)*. So far, most of the increase in ship activity is intra-Arctic(from one place in the Arctic to another) and *destinational* (from outside the Arctic coming to deliver something, pick up something or visit the area and return). Very few ships have been *trans-Arctic (transit)* traffic (from somewhere outside the Arctic to somewhere else outside the Arctic...just passing through because of a shorter route). At a recent conference called "The Arctic Imperative" in Girdwood, Alaska, representatives of the marine container shipping industry offered the opinion that arctic transit shipping is unlikely to expand in the near future in either the Northern Sea Route or the Northwest Passage (even less likely due to shallower depths and more ice) due to the following: at least for the foreseeable future, other routes like the Panama Canal will remain dominant because of convenience, predictability, depths, infrastructure, connectivity to rail and the realities of the Arctic. By contrast, destinational shipping is on the rise in the Arctic.

In order to navigate safely in the Arctic, mariners must plan for ice, cold, wind, weather, aids to navigation, marine communications, marine charting, etc. Even during summer months, the term "ice free" is relative, as icebergs are possible and challenging. We cannot dismiss as a minor inconvenience the nearly total absence of essential infrastructure to support shipping, tourism, and all other commercial, recreational, or governmental activity in the Pacific-sector Arctic Ocean. Ports, docks, refueling stations, communications, search and rescue and ports of refuge are functionally difficult and expensive to provide. In Alaska, the Coast Guard station closest to Barrow (the largest community on the North Slope) is in Kodiak, a thousand miles away. The challenges of providing essential infrastructure in remote areas of Alaska are legion, including shallow waters, few protected areas, small villages, few roads, a variety of ice conditions, including winter ice pileups that can reach several stories high, darkness, extreme cold and hurricane-force windstorms.

Another important building block for safe navigation is the Polar Code, which is being revised by the International Maritime Organization (IMO). The code now operates as a guideline for mariners, but many believe it must become mandatory. Given the unique conditions in the Arctic, most people agree that special rules should apply for ships and navigators in this region. It is important to train and educate those who will pilot ships about

navigating in ice conditions, and assure pilot house competency through the "Standards of Training, Certification and Watch keeping" process. Bathymetric mapping and charting in the Arctic Ocean are not sufficient and will require the collaboration of many entities and governments to make navigation safer. Another piece of the safety puzzle is domain awareness; it is essential to know the locations of ships, particularly in areas with few recognizable features, long periods of darkness, intense storms, inadequate communication coverage and incomplete mapping. Who will assure the international integration of information and continual improvement of these systems?

The state of search and rescue is problematic throughout the Arctic. A public safety official in Iceland told several of us visiting in Reykjavik in June that their best strategy for assuring the safety of tourists on large tour ships (which are coming to Iceland in increasing numbers) is to require the ships to travel in pairs. If one has an accident, the other can assist. This is similar to what actually happened in the Antarctic when the "M/V Explorer" hit an iceberg and sank. Fortunately, another cruise ship was close enough to rescue all of the passengers. The Canadian Coast Guard recently announced a significant investment in new ships and other assets to improve their response capacity. The Arctic Council adopted a SAR agreement at the last Ministerial in Nuuk, Greenland. Progress is being made, but the realities of this region demand a much larger commitment by the Arctic nations if they are going to be prepared for future accidents. For additional discussion of these challenges and recommendations, please see the Arctic Marine Shipping Assessment, prepared for and adopted by the Arctic Council in 2009: http://www.pame.is/images/stories/AMSA_Status_on_Implementation_of_the_AMSA_2009_Report_Recomendations-May_2011.pdf

FISHERIES IN THE REGION

Commercial fishing in the Bering Sea, North Pacific and Arctic Ocean is difficult to summarize, due to the wide variety of species, gear types, catching and processing technologies, regulatory regimes, jurisdictions, laws and international treaties. We should first distinguish between coastal areas where state and national fishing regimes and regulations are in place, and areas beyond the Exclusive Economic Zone (EEZ) and Extended

Continental Shelf (ECS) where there may be international agreements, as in the North Pacific, or may not be covered at all, such as in the Central Arctic Ocean. We must also clarify that the eastern and western arctic waters are different, with extensive fisheries in the east (Barents Sea) and no commercial fishing in the west. The Chukchi and the Beaufort Seas have subsistence fishing, but the North Pacific Fisheries Management Council (NPFMC) adopted a Fisheries Management Plan for the region in 2007 that prohibits commercial fishing. NPFMC recognized the lack of available information about species abundance in the area. If regulators don't know what is there, it is hard for them to manage resources sustainably.

In June, a group of scientists knowledgeable about North Pacific stocks and concerned about the state of scientific knowledge about the Arctic Ocean gathered in Anchorage to discuss next steps. It is clear that there is both interest in and commitment to improve the observing and understanding of fish abundance, prey/predator species relationships, survival, migration patterns, and other data needed for sustainable management of fishing. What is missing? Sufficient financial support for the research that needs to be done, and inadequate mechanisms to coordinate and collaborate among the nations' fish experts. There are a number of successful efforts that have developed in the North Pacific, including the BASIS program undertaken by the North Pacific Anadromous Fish Commission and the North Pacific Research Board's research programs like BEST-BSIERP, among others. The Alaska Ocean Observing System is another example of a program that helps integrate available information for a variety of uses. The challenge is to take examples like these to another level of effectiveness for areas that have had less active research, and make the information available to both private and public sector managers and decision makers.

A number of organizations have suggested international agreement to extend a moratorium on commercial fishing to all of the Arctic Ocean beyond national jurisdictions (or including them, where no current fishery exists). This is an important topic for the Arctic Eight to consider before access to the area becomes any easier. Even exploratory fishing can become a problem, as that would begin to establish catch history that could later be used to leverage permits to harvest prematurely. Given the need for more information about how the Arctic Ocean ecosystems work, additional observing networks, synthesis research programs and international cooperation must be undertaken if new commercial fisheries are to be

established.

CHANGES IN THE ARCTIC REGION THAT IMPACT LOCAL PEOPLE

Empowering northern residents is an important topic in this paper, given the presence of indigenous people with long records of living on and off the waters and land in the Arctic. The traditional uses must be respected, and in many places they are legally protected in some way. The Canadian Inuvialuit Agreement of 1984 is mentioned, but there is no discussion of the significant Alaska Native Claims Settlement Act of 1971, which in many ways was the "trailblazing agreement" for many land claims.

ANCSA provided for a significant grant of land, money and self-determination for Alaska natives; 44 million acres and a billion dollars were part of a settlement that was facilitated by the government's desire to construct the Trans-Alaskan Pipeline to carry North Slope crude to the Port of Valdez. In an effort to resolve what otherwise would have been long and protracted litigation over the land rights for the 900-mile pipeline route, the United States government found it possible to grant long overdue rights. The creation of regional and village corporations as the vehicles for managing the lands and the resources was unique in U.S. history. It has become a model elsewhere, attractive as a mechanism for empowering indigenous people through both land ownership and economic development. The corporations have an obligation to use and develop their lands to provide economic development opportunities for their shareholders, and as a result, several are actively engaged in tourism, timber harvesting, mining, and oil and gas support industries. An interesting provision of ANCSA requires the revenues from natural resource extraction to be shared with all of the ANCSA Corporations. The ANCSA Corporations have developed into a powerful force in Alaska's economy.

Complex factors (including the urbanization of Alaska Natives, which is consistent with the trend in other northern societies) have changed the predominantly village life of many Alaska Natives into a mix of cash-based economies with subsistence-based foods and culture. In spite of the economic development initiatives, subsistence foods are still essential to the majority of the region's peoples, and there is growing concern about changing climate conditions putting those foods at risk. The complexity of

this changing social and economic situation in arctic communities is not unique to Alaska, as was demonstrated over a decade ago in the landmark social science research project called the Survey of Living Conditions in the Arctic (SLICA)[1]. This international social science research project provided insight into the complexity of modern society and traditional culture in Arctic communities.

Consistently across the Arctic, the major determinant of the quality of life of indigenous people is the relationship to the land and waters of the region, and the traditional food gathering practices that were part of the culture. For more information see: http://www.iser.uaa.alaska.edu/Publications/researchsumm/SLiCA_07.pdf

SCIENTIFIC RESEARCH

Scientific research and exploration are significant activities in the Arctic. They need to be considered as governments attempt to adopt appropriate policies in the Arctic. If you look at current users of the Arctic Ocean, the research/explorer community is a major user, in addition to subsistence hunters, navy ships and submarines, occasional tour ships and supply ships for coastal areas. For decades, the research/explorer community has helped the rest of the world understand why the Arctic is mysterious, challenging and valuable to the world.

Research in the Arctic is expensive, difficult and dangerous. Trips are long, and the area is extremely remote. With various amounts and types of ice, special ships are required. Many research trips are international collaborations, a trend that should be encouraged and supported. Additional ice-capable vessels are being constructed (by China, Russia, and Canada) or refurbished (by the U.S.). New and old technologies (remote sensing, GIS, balloons, buoys, unmanned aircraft, etc.) are being creatively deployed to obtain as much information about the region as can be afforded. The research sector is essential to add to our understanding of the Arctic and its unique ecosystems. Decisions by both the private and public sectors can be improved by scientific research in the region if done in timely and scale-appropriate ways. Investment by the nations of the world is needed in a variety of key areas, including essential infrastructure, such as ice-capable research vessels.

The U.S. Arctic Research Commission issues a biannual report

identifying goals and objectives for arctic research. The five areas identified are: 1) environmental change of the Arctic, Arctic Ocean and Bering Sea; 2) arctic human health; 3) civil infrastructure; 4) natural resources assessment and earth science; 5) indigenous languages, cultures and identities. For additional discussion of these priority areas, please visit www.arctic.gov.

Creating a zone of scientific cooperation in the Arctic has been suggested by several entities, including the recently released Aspen Institute's Commission on Arctic Climate Change Report. See www.aspeninstitute.org/ee. It recommends the development of an open architecture for data and information sharing, and an agreement on common standards. Evolving networks of scientists who can collaborate across international boundaries and share their expertise, similar to what has been done with National Ice Centers, would be useful. Sustaining Arctic Observing Networks (SAONS) are designed to observe and understand change and enable others to respond to change. Investment in such international networks is needed to link and interpret complex data sets, and to make the improved understanding of system change available to managers and local people living close to the land and water. Developing coastal management plans and marine spatial plans that integrate complex data sets and balance multiple uses of the resources should become a priority for the Arctic.

GOVERNANCE[2]

Contrary to popular media stories about the Arctic, stability is on the rise. The exaggerated version of Arctic states' conflicts (planting flags, adding submarines and icebreakers as acts of sovereign aggression, etc.) does not reflect the current reality of cooperation among the Arctic Eight. A few important examples are mentioned in the paper: the Arctic Council's approval of the Arctic Marine Shipping Assessment Report in April 2009, the Arctic Council's adoption of a joint Search and Rescue Agreement in Nuuk in May 2011, the recent resolution of the offshore boundary dispute between Russia and Norway, and joint projects by several working groups on issues like oil spill response.

Existing governance: Most of the Arctic Eight have issued comprehensive statements of arctic policy in recent years. Examples include Norway's High North Policy, Canada's Northern Strategy, Russia's Vision of the Arctic Future, the U.S. Navy's Arctic Roadmap and State Department's Arctic Policy,

and others. Some of these are statements of national pride in a region that has not attracted much attention previously; some are declarations of sovereignty and control; some are efforts to focus energy and financial commitment to policies and programs that have lacked sufficient support; and most are recognition of future potential for the region that may provide important resources and wealth. All of them appear to recognize that international cooperation is essential in the Arctic. Russian Prime Minister Vladimir Putin's language is reflective of this shared vision:"zone of peace and international cooperation," "arctic arrangements that can mutually benefit the countries of the region."

The United Nations Convention on the Law of the Seas (UNCLOS) provides a fundamental framework for boundaries and regulation of marine pollution and resolving a variety of disputes. The IMO is the appropriate UN agency for maritime safety and for changing voluntary guidelines into mandatory ones in a Polar Code. The International Seabed Authority has responsibility for licensing and permitting mineral development, and conducting research in the area beyond the ECS areas. Can any of these bodies provide sufficient guidance and/or control for safe cruise and tourist traffic, or oil and gas development? Should specific regulatory and governance regimes be negotiated and adopted by treaties for different uses of the Arctic, or should each nation simply impose its own rules, in spite of the international nature of much of the arctic development that is on the horizon? These and many other questions about governance are important and unanswered at this time. Many ideas have been offered, and the paper mentions a few. What are the drivers behind the discussion about enhanced governance and the desire to "fill in the blanks" about rights and responsibilities?

Access: Concerns have been expressed by both Arctic and non-Arctic states about four kinds of access: 1. Legal access to the waters and the subsurface lands and resources in and beyond the EEZs. 2. Physical access to the Arctic Ocean for a variety of uses, from tourism to shipping, made possible by retreating ice, but made difficult by the challenging arctic conditions. 3. Economic access to development opportunities like natural resource extraction, which is more difficult for investors when there is uncertainty about the rules and the realities of a frontier area. 4. Intellectual access to assure that scientists are able to move freely across national boundaries (since ecosystems do not recognize borders) and to develop a better understanding of how the natural systems of the Arctic function in

rapidly changing conditions.

Expansion of the Arctic Council: Since 1996, the Arctic Council (Canada, Russia, the U.S., and the five Nordic States) has dealt with a variety of issues and created several working groups to address key challenges. Indigenous groups serve as Permanent Participants in a way that is quite unique among international bodies, and Observers bring additional perspectives and resources to the table. However, non-Arctic states are interested in being recognized as Permanent Participants. As countries like China, Japan, Korea, India and the European Union move forward their arctic agendas, the pressure to include them will mount. The counter pressure comes from a concern that their addition as Permanent Participants would dilute the impact of the indigenous groups and people who live in the Arctic. Balancing these interests and opportunities will continue to provide engaging dialogue.

The question remains, however, about how much farther the Arctic Council can take cooperation, particularly in controversial areas like fishing, oil and gas development, security, and other uses where a more uniform regime of requirements and limitations might make sense, but might be difficult to negotiate. I believe it is essential that the countries of the region and the world engage in dialogue about how to chart the future of a region that is quite unique, both vulnerable and valuable.

QUESTIONS FOR THE PANEL

- Should the Precautionary Principle apply, at least to the Central Arctic Ocean, which is only now becoming accessible to humans?
- Should marine protected areas be established or biologically significant areas be designated?
- How do NGOs, multinational corporations, indigenous people, and political subdivisions participate in the decisions that are being made at the national level? Do they have any standing in resource claims conflicts?
- What is the appropriate balance between Arctic and non-Arctic states in decisions that impact the Arctic?
- Should the Arctic Council membership be expanded? Should it be empowered to do more than it currently does, in order to fill a perceived vacuum in international decision authority?

- How does a region of the planet that is remote, previously inaccessible, and that contains very few people successfully engage "outsiders" in meaningful dialogue about the future of the region and its impact on the world?

Notes

1. SLICA was funded by the Nordic Council of Ministers (NMR), the Greenland Home Rule Government, the Commission for Scientific Research in Greenland (KVUG), the Barents Secretariat, the Nordic Arctic Research Programme (NARP), the Danish Research Council for the Social Sciences (SSF), the Swedish Research Council for the Social Sciences, Ministry of the Interior – Dept. of Municipalities, Norway, the Joint Committee on Research Councils for Nordic Countries (NOSS), the Social Sciences and Humanities Research Council of Canada (SSHRC), the National Science Foundation (NSF), and Statistics Canada.
2. In 2013, the Arctic Council granted six nations observer status to the Arctic Council: India, Italy, Singapore, China and South Korea.