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Arctic Warming: Environmental, Human, and Security Implications

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ABSTRACT

Arctic warming has myriad implications for the Arctic environment, residents, and nations. Although definitive predictions are difficult, without question the scope and rapidity of change will test the adaptive capacities of the Arctic environment as well as its residents. Warming is affecting marine ecosystems and marine life, terrestrial ecosystems, and the animals and people who depend on them. Human impacts include effects on access to food and resources; health and wellbeing; and community cohesion, traditions, and culture. Increased shipping and resource activity create the need for additional maritime presence and security; better environmental and safety regulations; peaceful resolution of boundary disputes and jurisdictional issues; and increased homeland security, law enforcement, immigration, public health, and related activities. The response to many of these challenges must be international and cooperative, should involve indigenous voices, and can be accomplished within existing legal and institutional frameworks by strengthening institutions and developing legally binding measures in several specific areas such as the regulation of shipping, oil and gas activity, and fishing for the purposes of safety, security, and ecosystem protection.

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I. INTRODUCTION

Arctic warming in the Arctic is having and will continue to have myriad implications for the Arctic environment, residents, and nations. Changes may be both negative and positive. The complexity of interacting factors affecting the Arctic and the fact that much is still unknown about the operation of climate and environmental systems in the region make definitive predictions difficult. Without question, however, the rapid change brought about by warming will test the adaptive capacities of both the Arctic environment and its residents, communities, and nations. This Article contains a general description of the types of expected effects on the Arctic environment, the social and economic well-being of its people, and the security of Arctic nations.

II. ENVIRONMENTAL IMPLICATIONS

During the twentieth century, air temperatures over Arctic land areas increased by up to 5°C.[1] According to the Arctic Council's 2004 Arctic Climate Impact Assessment (ACIA),[2] during the twenty-first century, under a moderate emissions scenario, average annual temperatures in Alaska and western Canada are expected to rise by 3–5°C (5–9°F) over land and up to 7°C (13°F) over the oceans.[3] Winter temperatures are expected to rise even more: 4–7°C (7–13°F) over land and 7–10°C (13–18°F) over the oceans.[4] The more recent 2007 Intergovernmental Panel on Climate Change Fourth Assessment Report (IPCC Report) predicts an averaged warming in the Arctic of 2°C to about 9°C by the year 2100.[5] The increase in temperature will have significant effects on the oceans, sea ice, permafrost, forests, freshwater lakes and rivers, and flora and fauna in the region.[6]

Warming is more rapid and intense in the Arctic than in other areas of the globe due to unique conditions in the region. Melting snow and ice reduce reflectivity levels, causing more sunlight to be absorbed as heat and less sunlight to be reflected.[7] In addition, the thawing of the permafrost is likely to lead to additional greenhouse gas emissions.[8] These and other related factors, such as Arctic cloud feedback, not only create intensified warming in the Arctic region but also have implications for the global climate system.[9]

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1. Oleg A. Anisimov et al., *Polar Regions (Arctic and Antarctic), in* CLIMATE CHANGE 2007: IMPACTS, ADAPTATION AND VULNERABILITY. CONTRIBUTION OF WORKING GROUP II TO THE FOURTH ASSESSMENT REPORT OF THE IPCC 653, 656 (Martin Parry et al. eds., 2007), *available at* www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-chapter15.pdf.

2. SUSAN JOY HASSOL, IMPACTS OF A WARMING ARCTIC: ARCTIC CLIMATE IMPACT ASSESSMENT: HIGHLIGHTS 2 (2004), http://www.amap.no/acia/Highlights.pdf.

3. *Id.*

4. *Id.*

5. Anisimov et al., *supra* note 1, at 662.

6. *See id.* at 662–69 (discussing the effects of temperatures warming in the arctic, including the "projected changes in the ocean," the expected impact of thawing permafrost, the resultant impact on freshwater systems, and the "projected changes in biodiversity, vegetation zones, and productivity").

7. HASSOL, *supra* note 2, at 5.

8. Anisimov et al., *supra* note 1, at 661.

9. *See* Gunter Weller et al., *Summary and Synthesis of the ACIA, in* ARCTIC CLIMATE IMPACT ASSESSMENT 989, 994 (Carolyn Symon et al.eds., 2004), *available at* http://www.acia.uaf.edu/pages/scientific.html (noting that ice-albedo, snow-albedo and arctic cloud feedbacks affect the Arctic climate and influence global climate change by amplifying the melting of glaciers and ice sheets); *see also* Anisimov et al., *supra* note 1, at 661–62 (discussing how "regional direct impacts may have global implications through the following processes and feedbacks: [r]eflectivity of snow ice and vegetation;" "[r]etreat of glaciers and ice sheets, freshwater runoff, sea level and ocean circulation;" "Arctic terrestrial carbon flux;" "[m]igrating species;" "[m]ethane hydrates;" and "[s]outhern ocean carbon flux.").

Warming in the Arctic, however, is not uniform. According to the ACIA, observational data from the scientific record—supported by indigenous observations—indicate that some areas such as Alaska, western Canada, and Eurasia are warming more than others (e.g., eastern Canada, Greenland, and the northwest Atlantic).[10] Effects of warming also differ within regions according to the geography, ecology, and related circumstances of various areas.[11] To be most effective, therefore, responses must reflect the particular circumstances of each place.

A. *Melting Ice and Sea Level Rise*

Melting ice and freshwater flowing into polar oceans have a direct effect on sea levels. "Over the past 30 years, the annual average sea-ice extent has decreased by about 8%, or nearly one million-square kilometers, an area larger than all of Norway, Sweden, and Denmark (or Texas and Arizona) combined . . . ."[12] "Sea-ice extent in summer has declined more . . . than the annual average, with a loss of 15–20% of late-summer ice coverage."[13] Moreover, the melting trend is accelerating. "Additional declines of 10–50% in annual average sea-ice extent are projected by 2100," with summer sea ice projected to decline more than 50% by late this century and some models showing a complete disappearance of summer sea ice during this period.[14]

Global average sea level rise has been about eight centimeters (three inches) in the past twenty years—an amount that is projected to increase to 10–90 centimeters (four inches to three feet) during this century.[15] Models indicate that the Greenland ice sheet may eventually melt completely, resulting in a sea level rise of as much as twenty-three feet.[16] Scientists also note the possibility that changes in ocean chemistry caused by melting ice and increasing flow from Arctic freshwater systems into the oceans could eventually affect ocean conveyor systems, which convey warm water from the tropics northward and are critical to the stability of the Earth's climate.[17]

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10. Henry Huntington & Shari Fox, *The Changing Arctic: Indigenous Perspectives, in* ARCTIC CLIMATE IMPACT ASSESSMENT, *supra* note 9, at 61, 67.

11. *See* Weller et al., *supra* note 9, at 1003 ("Observations also indicate that the climate is presently changing quite differently in each of these [Arctic] regions, and even within them, especially where there are pronounced variations in terrain . . . .").

12. HASSOL, *supra* note 2, at 3.

13. *Id.*

14. *Id.*

15. *Id.* at 4.

16. *Id.*

17. *Id.* at 5; *see also*, Anisimov et al., *supra* note 1, at 664 ("The cumulative effect of these increasing freshwater supplies on the thermohaline circulation remains unclear but is a critical area of concern.").

These changes have a number of secondary effects. Perhaps the most direct is their effect on marine ecosystems. For example, warmer water and related runoff from land and rivers may alter ocean chemistry and ecology,[18] creating increased risk of infestations; affecting fish, marine mammals, and animals that are dependent on sea ice for feeding and daily activities; and potentially harming the people who depend on those marine life and animals for subsistence.[19] "As the sea ice edge moves farther north, the distribution of crustaceans . . . adapted for life at the sea ice edge and fish . . . that forage on them shifts accordingly," affecting predators that are dependent on sea ice for feeding and breeding.[20] Ringed seals, walruses, and polar bears, which use sea ice as feeding and resting platforms, and bowhead whales, which are dependent on sea ice organisms for food, are among those affected[21]; in fact, polar bears were designated as threatened under the Endangered Species Act in May 2008.[22]

While melting ice and related changes create significant stress for some marine species and their predators, the impacts on Arctic fisheries will be regionally specific—in some cases beneficial and in others detrimental.[23] As a general matter, warming is causing a change from Arctic to Subarctic conditions in the marine environment, as a pelagic-dominated marine ecosystem previously in the southeastern Bering Sea moves northward.[24] Some fishing communities may thus experience beneficial effects as increasing areas of open water bring to the Arctic more commercial fish stocks, such as cod and herring in the north Atlantic and walleye pollock in the Bering Sea.[25] On the other hand, some coldwater species, such as shrimp and king crab, may suffer habitat loss and become less plentiful.[26] In addition, the movement of fish stocks and other marine life into new areas will affect the interrelationships among components of ecosystems in new ways; for example, as salmon sharks move farther north into the Bering Sea, they may compete for resources with threatened marine mammals such as the Steller Sea Lion.[27] As a general matter, the complex interactions in food webs may generate secondary effects that are not always easy to predict.

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18. Anisimov et al., *supra* note 1, at 664–65.
19. *Id.* at 665–66.
20. *Id.* at 668.
21. *Id.* at 668–69.
22. Determination of Threatened Status for the Polar Bear, 73 Fed. Reg. 28,212, 28,212 (May 15, 2008) (to be codified at 50 C.F.R. § 17.11(h)).
23. Anisimov et al., *supra* note 1, at 655.
24. *Id.* at 659.
25. *Id.* at 669. These species already comprise about 70 % of total catch in these areas. *Id.*
26. *Id.*
27. Huntington & Fox, *supra* note 10, at 77.

In addition to its effects on the marine ecosystem, loss of sea ice also affects activities on land. In many areas, sea ice forms a barrier for the coast, protecting it from waves and surges.[28] When that barrier disappears, ocean activity can lead to severe erosion, sedimentation, and related damage to coastal communities and areas.[29] For example, the small island of Nelson Lagoon in the Pribilofs has for years battled effects of winter storms by building increasingly strong break walls along the shore.[30] The walls were designed to brace shore ice, which would in turn provide a buffer from winter storm wave action.[31] Because the sea ice buffer has been lost, however, the full force of waves now surges against the wall, leading to breaks in some sections that have caused harm to the village.[32] Vital infrastructure has also been disrupted: a storm in 2000 caused a breach in a pipeline carrying drinking water to the village.[33]

Furthermore, as has been widely reported and discussed, sea level rise over time will have devastating impacts on islands and low-lying coastal areas, including communities close to the sea.

B. *Changes in Weather and Precipitation*

Weather, in general, has become more variable and less predictable by traditional means.[34] For example, elders in Kotzebue, Alaska, have reported that weather may vary as much as 35°C from day to day without warning.[35] Precipitation has increased over the past century, although the trends are small (about 1% per decade), variable from area to area, and uncertain because of deficiencies in the precipitation measurement network and the difficulty of obtaining accurate measurements in windy polar areas.[36] Observations in some regions, such as the watershed of large Siberian rivers, do not show increases in precipitation.[37]

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28. *Id.* at 76.
29. Anisimov et al., *supra* note 1, at 672 (discussing how erosion has contributed "a significant proportion of regional sediment . . . to the marine environment" and damaged property causing relocation and abandonment or structures).
30. Huntington & Fox, *supra* note 10, at 76.
31. *Id.*
32. *Id.*
33. *Id.* at 77.
34. *Id.* at 82; CTR. FOR INT'L CLIMATE AND ENVTL. RESEARCH–OSLO, FACT SHEET 4: HOW WILL CLIMATE CHANGES AFFECT INDIGENOUS COMMUNITIES?, http://acia.cicero.uio.no/factsheets/4_indigenous_communities.pdf (last visited Oct. 3, 2009).
35. Huntington & Fox, *supra* note 10, at 74.
36. Anisimov et al., *supra* note 1, 657.
37. Weller et al., *supra* note 9, at 992.

C. *Thawing Permafrost*

Increased temperatures are causing thawing of the permafrost and undermining stable support for houses, buildings, and other infrastructure such as roads, airports, and pipelines.[38] Models indicate that by the mid-twenty-first century, the permafrost area in the Northern Hemisphere may decrease by as much as 20–35%.[39] Even today the effects are very real. For example, it was reported in 2007 that in Shishmaref, Alaska, a small Inuit village on the Chukchi Sea, thawing permafrost and sea erosion had produced the following effects: three houses had fallen into the sea; seven houses had been relocated; rising seawater had almost reached the airport runway; the fuel tank farm, which seven years prior had been 300 feet from the sea, was now only thirty-five feet from the water; seawater was within eight feet of the town dump, creating a risk of long-lasting pollution in the nearby marine environment if the dump were inundated; and advancing seawater had contaminated the village's drinking water supply.[40]

D. *Arctic Freshwater Systems*

Although some freshwater systems are entirely contained within the Arctic, others are fed by river and lake systems further south.[41] The Arctic also contains numerous still-water systems, ranging from large lakes to shallow tundra ponds.[42] Warming and the consequent changes in precipitation, permafrost, and forests significantly affect such freshwater systems and their resources.[43] While Arctic freshwater ecosystems have been able to adapt to climate variations in the past, the high magnitude and rapid rate of change over the next 100 years will probably exceed the ability of such ecosystems to adapt, leading to significant changes—some positive but most

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38. Permafrost is defined as "sub-surface earth materials that remain at or below 0°C continuously for two or more years." Anisimov et al., *supra* note 1, at 660. Thawing of the permafrost may also have a second effect that is not discussed here—"feedback to the global climate system through potential emission of greenhouse gases." *Id.* at 661.

39. *Id.* at 663.

40. CIEL, Climate Change and Arctic Impacts, http://www.ciel.org/Climate/Climate_Arctic.html#2 (last visited Oct. 3, 2009); *see also* Anisimov et al., *supra* note 1, at 672 ("[I]n Shishmaref . . . the combined effects of reduced sea ice, thawing permafrost, storm surges and waves have led to significant loss of property, and this has led to the relocation or abandonment of homes and other facilities.").

41. Anisimov et al., *supra* note 1, at 663.

42. *Id.* at 664.

43. *See id.* at 660, 664 (discussing the impact of climate variability and the related effects, i.e. "seasonal shifts in flow, ice cover, precipitation/evapotranspiration and inputs of sediment and nutrients," thawing permafrost, and changes in vegetation cover, on freshwater systems and their resources).

probably negative.[44] In some areas, such as Siberia, scientists have observed a pattern of lake disappearance.[45] In Nunavut in the Canadian Arctic, researchers have reported that water levels in Baker Lake are decreasing, blocking travel in some areas and rendering hunters unable to get to traditional caribou hunting grounds and camping areas.[46] Elders from the Yukon have also reported that lakes and streams are drying up or becoming choked with weeds, making the water undrinkable.[47]

Alterations in biodiversity and productivity relationships as well as changes in contaminant pathways are also affecting aquatic species such as freshwater fish.[48] Scientists predict that more southerly species will colonize Arctic areas, bringing new parasites and diseases to which Arctic species are not adapted, thereby increasing mortality.[49] The movements of "anadromous fish, which migrate up rivers from the sea to spawn in freshwater, will [also] shift as oceanic conditions and freshwater drainage patterns change."[50] Species such as Arctic char may experience population reductions due to reproductive failures, habitat changes, and predation from colonizing species.[51] The IPCC Report finds it unlikely that changes in freshwater systems will be "offset by increased opportunity for freshwater acquaculture resulting from warming."[52] Thus, conserving Arctic aquatic biodiversity and ensuring the sustainable use of Arctic freshwater species will present significant challenges for Arctic residents, resource managers, and policymakers.[53]

E. *Terrestrial Ecosystems: Forests and Farms*

According to the IPCC, the adaptive capacity of Arctic ecosystems will be limited because the extent of those systems is likely to be reduced by compression between the general northward expansion of forests and the current coastline, increased flooding of northern coastal wetlands as the sea level rises, and loss of habitat to land use.[54] Indeed, the IPCC found the evidence of recent vegetation change compelling: "[A]long the Arctic to sub-Arctic boundary, the tree line has moved about ten kilometers northwards," and forest has

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44. *Id.* at 663.
45. *Id.* at 664.
46. Huntington & Fox, *supra* note 10, at 83.
47. *Id.* at 77–78.
48. Anisimov et al., *supra* note 1, at 665.
49. *Id.*
50. *Id.*
51. *Id.*
52. *Id.* at 666.
53. *Id.*
54. *Id.* at 659.

displaced 2% of the tundra on Alaska's Seward Peninsula in the past fifty years.[55] While shrubs and "greenness" have increased in some places, such as on the North Slope of Alaska,[56] in other areas such as parts of the Russian European Arctic bog growth has caused tree death.[57] The changes in forest and tundra ecosystems caused by warming have led to insect outbreaks, increased incidence of forest fires, and infestations. For example, on the Kenai Peninsula in Alaska, an infestation of spruce bark beetles has caused approximately 2.3 million acres of tree mortality.[58] At the 2007 Intergovernmental Climate Change meeting in Bali, indigenous leaders from northern British Columbia highlighted a serious invasion by the Mountain Pine Beetle.[59] Spruce budworm has also reproduced further north, and autumn moth defoliation of mountain birch trees has occurred over wide areas.[60]

On the other hand, there is also evidence of changes in growing season duration, timing, and productivity.[61] Although patterns are variable, Arctic warming in some areas is creating possibilities for agriculture on lands where such possibilities did not exist previously.[62] In addition, greater access to fish, timber, and minerals is evident in some locations.[63]

F. *Flora and Fauna*

Many Arctic species are particularly vulnerable to warming because they are specialized and have adapted to Arctic conditions in ways that may make them poor competitors with species from more benign climates.[64] Others require specific conditions such as the existence of sea ice to survive.[65] Moreover, warming is not the only

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55. *Id.* at 666.

56. Martin Jeffries, Nat'l Sci. Found., Office of Polar Programs, Presentation to the Symposium: Impact of an Ice-Diminishing Arctic on Naval and Maritime Operations (July 10–12, 2007), www.star.nesdis.noaa.gov/star/documents/2007IceSymp/Jeffries.pdf (PowerPoint presentation).

57. Anisimov et al., *supra* note 1, at 666.

58. CIEL, *supra* note 40; *see also* Anisimov et al., *supra* note 1, at 667 (noting the Kenai Peninsula's loss of 10–20% of its forest tundra as a result of a spruce bark beetle outbreak in the 1990s).

59. Geoffrey York, *Indigenous People Describe Real Perils of Global Warming*, THE GLOBE AND MAIL (Ontario, Can.), Dec. 14, 2007, *available at* http://www.manystrongvoices.org/_res/site/file/Media%20coverage/Geoffrey%20York%20article%20Dec%2014-2007.pdf.

60. Anisimov et al., *supra* note 1, at 667.

61. *Id.* at 666.

62. *Id.* at 668.

63. Scott Borgerson, *Arctic Meltdown: The Economic and Security Implications of Global Warming*, FOREIGN AFFAIRS, Mar./Apr. 2008, at 1, *available at* http://foreignaffairs.org/20080301faessay87206-p0/scott-g-borgerson/arctic-meltdown.html.

64. Anisimov et al., *supra* note 1, at 658.

65. *Id.* at 658.

factor; many species are facing multiple, concurrent, human and climate-induced stresses.[66] "Loss of a keystone species could have cascading effects on entire ecosystems."[67]

Impacts include effects on plants and berries as well as on wildlife such as fox, birds, caribou, and reindeer.[68] For example, "[i]cing events during warmer winters that restrict access to frozen vegetation have impacted some reindeer/caribou populations and high-Arctic musk oxen populations."[69] New species that could not previously live in the Arctic environment will enter, and some such as the North American mink and certain southern plant species may become invasive.[70] Invasive species and parasites heretofore unknown in the Arctic will affect both flora and fauna.

III. HUMAN IMPLICATIONS

"The Arctic is now home to approximately 4 million residents."[71] Although the makeup of populations varies from area to area, migration into the Arctic in the twentieth century resulted in a reduction of the proportion of indigenous inhabitants to about 10% of the overall population by the early part of the twenty-first century.[72] Developments in the twentieth century also brought about various forms of social, cultural, and economic change. For example, "[i]ndigenous residents have, in most regions, been encouraged to settle in fixed communities . . . ."[73] Although many residents and communities still retain and maintain strong relationships with the land and sea, this settlement policy has had negative effects on subsistence activities.[74] "At the same time, Arctic residents have experienced an increase in access to treated water, sewage disposal, and health care facilities and services," as well as greater access to market food sources.[75] "In general, the Arctic has a young, rapidly growing population with higher birth rates than national averages, and rising but lower than national average life-expectancy."[76]

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66. *Id.*
67. *Id.* (citation omitted).
68. *See id.* at 666 (describing the impact of climate changes on Artic species and vegetation).
69. *Id.* (citation omitted).
70. *Id.* at 667.
71. *Id.* at 657 (citation omitted).
72. *Id.*
73. *Id.*
74. *Id.*
75. *Id.*
76. *Id.*

On average, one-third of the Arctic population lives in settlements with fewer than 5,000 inhabitants.[77] Arctic communities, particularly coastal indigenous communities with a subsistence way of life, are vulnerable to the effects of warming. This vulnerability flows from the close relationships of community residents to the land and their reliance on local environments for aspects of everyday life such as diet and economy.[78] The degree of "vulnerability and resilience of each group and community differ greatly from place to place and time to time."[79]

The Arctic people, whose ancestors have inhabited the region for thousands of years, are known to have an extremely high adaptive capacity and history; many residents and communities have already initiated changes in behaviors, such as shifting the times or locations of hunting or other activities.[80] Some aspects of adaptive capacity, however, have been constrained by (1) today's more settled lifestyle; (2) increased participation in wage-economy jobs, which reduces mobility as well as time on the land observing and developing the knowledge that strengthens adaptation; and (3) the current state of social, economic, and political changes in the region.[81] Furthermore, the nature and breadth of the current changes, the rapidity with which they are occurring, and the unpredictability of the effects will surely test the adaptive capacity of even the most creative and resilient populations.

Arctic indigenous communities, of course, are not monolithic.[82] Ancestry, history, language, families, and traditions vary from community to community and region to region—from the Saami in northern Europe to the Inupiat, Aleut, and Yupik, and others in Alaska; the Inuit, Inuvialuit, Dene, and Gwich'in, and others in Canada; the Kalaallit and Inughuit in Greenland; and the Chukchi, Nenet, Yakuts, and others in Russia.[83] Indigenous groups have distinct cultures, languages, traditions, and ways of interacting with their neighbors and environments, but they also have in common close connections to their surroundings, intimate understandings of their environments, complex relationships with governments and non-indigenous migrants to the Arctic, a way of life that mixes

77. *See id.* (stating that, on average, two-thirds of the Arctic population lives in communities with more than 5,000 inhabitants).

78. *Id.* at 661.

79. Huntington & Fox, *supra* note 10, at 92.

80. Anisimov et al., *supra* note 1, at 655.

81. *Id.* at 661.

82. Huntington & Fox, *supra* note 10, at 62.

83. This is only a partial list of the many indigenous communities in the Arctic. *See* Yvon Csonka & Peter Schweitzer, *Societies and Cultures: Change and Persistence*, *in* ARCTIC HUMAN DEVELOPMENT REPORT 45, 47, 53 (Niels Einarsson et al. eds., 2004) (provides a map, chart, and discussion of the various language families of Arctic indigenous populations).

modern and traditional activities, and a major stake in the future of the region.[84] "The impact of projected climate change on the diverse communities of the Arctic can only be understood in the context of the interconnected social, cultural, political and economic forces acting on them."[85] Moreover, the implications of warming for Arctic residents extend beyond the economy and social life to the culture and traditions of Arctic indigenous communities. In a submission to the United States Senate, the Inuit Circumpolar Conference publicly argued that climate change will lead to loss of culture and identity.[86] The discussion below highlights some of the ways in which Arctic residents—including indigenous peoples—are being affected by Arctic warming.

A. *Access to Food and Resources*

"Per capita consumption of wild foods by rural Alaskans is [approximately] 465 grams per day and consumption by urban Alaskans is 60 grams per day." [87] "The collective value of these foods in the state is estimated at approximately US$200 million/yr."[88] In Canada, Arctic communities consume between "106 grams per day and 440 grams per day of wild foods, accounting for 6–40% of total energy intake and 7–10% of household income in Nunavik and Nunavut."[89] "[R]esources [involved] include caribou/reindeer, moose, musk ox, migratory birds and their eggs, and plants and berries."[90] "Wood, sods, peat and coal are used locally as fuels . . . ."[91]

Arctic warming is endangering many Arctic aboriginal people's ability to hunt. Inuit leaders at the 2007 Bali Climate Change meeting described the effects on their villages.[92] They reported that fragile ice is threatening migration patterns—even the very existence—of some of the animals on which villages rely for food and endangering the hunters attempting to find those animals.[93] Shifting weather and severe, increasingly frequent storms further complicate the hunt.[94] According to Inuit leaders, it is now difficult to predict

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84. *See id.* at 64 (discussing pan-Arctic identity and the influence of information and communication technology).

85. Anisimov et al., *supra* note 1, at 671 (citation omitted).

86. *Id.* at 661 (citing *Impacts of Climate Change: Hearing Before the S. Comm. Commerce, Scir. & Tech., 107th Cong.* (2004), *available at* www.ciel.org/Publications/McCainHearingSpeech15Sept04.pdf) (testimony of Sheila Watt-Cloutier, Chair, Inuit Circumpolar Conference).

87. *Id.* at 668.

88. *Id.*

89. *Id.* (citation omitted).

90. *Id.*

91. *Id.*

92. York, *supra* note 59.

93. *Id.*

94. *Id.*

the movement of caribou.[95] Some Inuit have made changes to their hunting patterns, the times of the year in which they travel on land, and their collection of winter wood and other supplies.[96]

On the other hand, as noted above, warming is likely to increase the opportunity for expansion of agriculture and forestry. The extent of these effects is not yet known; nor is it clear whether and to what extent markets and infrastructure will exist to take advantage of agriculture and forestry opportunities.

B. *Health*

Arctic warming has numerous implications for human health. Direct effects flow from exposure to temperature extremes and weather events. For example, respiratory stress has been reported from extreme warm summer days, and effects such as frostbite and hypothermia are increasing due to weather unpredictability.[97] Increases in precipitation affect the frequency and magnitude of natural disasters such as avalanches and rock falls.[98] On the other hand, warming during the Arctic winter months may also reduce deaths from cardiovascular and respiratory conditions often associated with extreme winter cold.[99]

Indirect effects include the possibility of increased injuries, accidents, and diseases related to changing environmental conditions such as thinning and earlier breakup of ice and greater exposure to chemicals.[100] Illnesses transmitted to marine mammals, birds, and fish in changing waters and ecosystems may, in turn, be transmitted to humans, particularly through subsistence diets.[101] At the same time, to the extent that warming and other economic and social changes are leading to increased transition to market foods, scientists point out that market food diets have been associated with a rise in levels of cardiovascular diseases, diabetes, and obesity.[102] Improved agriculture, on the other hand, could make healthy foods more available. In view of the interactions of so many interconnected factors, it is difficult to predict with certainty how diets will change and to what extent health will be affected.

Warming also threatens community and public health infrastructures, particularly in low-lying Arctic communities. "Community water sources may be subject to salt-water intrusion and

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95. *Id.*
96. *Id.*
97. Anisimov et al., *supra* note 1, at 671.
98. *Id.*
99. *Id.*
100. *Id.*
101. *Id.*
102. *Id.*

bacterial contamination."[103] Waste contamination may also occur, as indicated in the Shishmaref example noted above.[104] On the other hand, in some areas water treatment efficiencies may also improve due to warmer water temperatures.[105]

C. *Community Cohesion, Traditions, and Culture*

While Arctic warming is only one of many factors transforming Arctic communities, its effects are very real. As noted above, physical changes such as shifts in resources and the stability of community infrastructure have led to the need for migration or relocation of community residents and the alteration of life patterns such as hunting and gathering of supplies. These physical changes challenge the relationships of individuals and communities to the local environments that have been the basis of their identity, culture, and well-being for centuries. At the same time, ongoing changes in economies and societies globally are creating pressures that threaten to erode traditional ways of living.

The loss of traditions caused by such pressures can, in turn, erode the culture of Arctic people and communities, leading to psychological distress and anxiety in some cases.[106] Describing the ways in which increasing weather variability and unpredictability have affected their elders, Inuit researchers from Nunavut in the Canadian Arctic note that because elders can no longer predict the weather they perceive themselves as losing their traditional advisory roles in their communities.[107] Discussing the effects of climate-driven changes on hunting, natural resources, and loss of traditional knowledge, the IPCC notes, "Together these shifts are turning previously well-adapted Arctic peoples into 'strangers in their own lands.'"[108] While Native cultures are adaptive and constantly changing, perhaps one of the most critical needs is to find methods of adaptation that preserve indigenous culture to the greatest degree possible in the face of rapid and extensive change.

D. *Importance of Indigenous Wisdom*

Arctic researchers and policymakers are increasingly recognizing the importance of indigenous voices in assessing changes in the Arctic

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103. *Id.* at 672.
104. *Id.*
105. *Id.*
106. *Id.*
107. Huntington & Fox, *supra* note 10, at 82.
108. Anisimov et al., *supra* note 1, at 668 (citing Fikret Berkes, *Epilogue: Making Sense of Arctic Environmental Change?*, *in* THE EARTH IS FASTER NOW: INDIGENOUS OBSERVATIONS OF ARCTIC ENVIRONMENTAL CHANGE, 335, 339 (Igor Krupnik & Dyanna Jolly eds., 2002)).

and in addressing adaptation. Indigenous residents bring an intimate understanding of natural phenomena and the interrelationships between nature and the human population, a deep understanding of community structure and other factors that affect adaptation, and a perspective that dates back many generations. As the IPCC Report notes, "The effectiveness of local adaptive strategies is uneven across the Arctic and there are large gaps in knowledge about why some communities do well, while others are more vulnerable to drivers of change, even when they share similar resources and ecological settlings."[109] Indigenous knowledge and wisdom can be critical to filling these gaps.[110]

E. *Case Study: Indigenous Perspectives from Kotzebue, Alaska*

Specificity of knowledge and a practical, balanced approach can be seen in the assessments of indigenous residents reported in a case study done by the residents of Kotzebue, Alaska, an Inupiaq community on the Baldwin Peninsula thirty miles above the Arctic Circle in North West Alaska.[111] Kotzebue residents described a wide variety of specific impacts of warming from 1950 to the present.

For hunters, in particular, weather has an important effect on daily activity. Residents reported that seasons are now less consistent, with more mid-winter fog and high temperatures in winter, but lower temperatures in summer months.[112] They also reported more extreme daily weather changes. "It is relatively common for the temperature to change from -35°C one day to 0°C the next or vice versa."[113] In November 1999 and 2001, Kotzebue experienced 100 times less than the average amount of rain recorded for that month over the last fifty years.[114] This type of unpredictability affects the life activities of the indigenous residents of Kotzebue far more than it would affect urban residents.[115] However, the hunters also reported that climate change was not necessarily bad. Due to lichen cycles and decreased competition from reindeer, among other factors, the area now has caribou that it did not have earlier in the twentieth century; moose also began to appear in the 1950s.[116] These types of changes have helped improve quality of life.

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109. *Id.* at 673.

110. *See* Huntington & Fox, *supra* note 10, at. 64–66 (discussing the meaning of the terms "indigenous knowledge" and "indigenous wisdom" and their relevance to Arctic assessment and policymaking).

111. *Id.* at 73–76.

112. *Id.* at 74.

113. *Id.*

114. *Id.*

115. *Id.*

116. *Id.* at 73.

The case study looks, in particular, at the impacts of late freeze-up. Residents reported that late freeze-up has led to better whitefish harvests, clamming, spotted seal hunting, access to caribou, and access to firewood. They also said, however, that late freeze-up has led to a shorter ice-fishing season, poor access to Kotzebue, greater danger to those living outside Kotzebue resulting from rough ice and thin ice conditions, and more erosion and flood problems.[117] The shorter ice fishing season was described as particularly difficult for the community because ice fishing is an important social activity that binds the community and gives the elders and young people the rare opportunity during the year to harvest traditional foods.[118]

Community members also discussed the effects of late freeze-up on marine and land animals. For the spotted seal, late freeze-up has meant better access to inshore waters and fish and improved haul-outs for rest, but it has also meant greater risk of being trapped too far from open water when the ice begins to thicken.[119] For caribou, it has contributed to slower movements and less likelihood of travelling long distances.[120] For red foxes, it has led to better feeding but has also increased competition with Arctic foxes.[121]

Because of the breadth and depth of their knowledge, the practicality of their approaches, and the fact that they are directly affected by the changes brought about by warming, it is important that indigenous inhabitants of the Arctic be a part of any research into the effects of warming as well as a part of policymaking for adaptation and mitigation. Both researchers and policymakers need to learn from indigenous perspectives.

IV. IMPLICATIONS FOR NATIONAL SECURITY

New security challenges for the United States and other Arctic nations will arise from increased access to Arctic waters, the effects of warming on Arctic infrastructure, including oil and gas infrastructure, and environmental changes and their effects on the stability of the Arctic environment and the well-being of its people. In addition, traditional security issues, such as missile defense and early warning, as well as nuclear deterrence, defense, and clean-up in the Arctic continue to exist.[122]

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117. *Id.* at 75.
118. *Id.* at 74.
119. *Id.* at 75.
120. *Id.*
121. *Id.* at 76.
122. *See* ROB HUEBERT, ARCTIC SECURITY: DIFFERENT THREATS AND DIFFERENT RESPONSES 3–5 (2004), http://www.nrf.is/Publications/The%20Resilient%20North/Plenary%204/3rd%20NRFPlenary%204PPHuebert.pdf (discussing the evolution of environmental and human security in the Arctic from the Cold War to present).

A. *Marine and Territorial Security*

Warming and melting sea ice will open Arctic waters to increased vessel traffic. While estimates vary, some projections suggest that by 2050, the Northern Sea Route, which follows the northern coastline of Russia, may have as many as 125 days per year with less than a 75% sea-ice cover, creating favorable conditions for navigation by ice-strengthened ships.[123] The Northwest Passage above Canada is also becoming less ice-bound.[124] Because the opening of Arctic shipping routes offers the possibility of significant decreases in time, distance, and cost from current routes through the Suez and Panama Canals, increasing interest is being generated among Asian exporting nations such as China, India, Japan, and South Korea.[125] Arctic sea routes may also be used for transport of oil and gas from the region. Increased traffic through the Arctic, however, will likely occur gradually over time as the ice recedes, appropriate ice-strengthened vessels are constructed, and insurance issues are resolved.

To date, Arctic waters have not been well charted or fully regulated for traffic, safety, and security. Increased traffic and activity in Arctic waters will create the need for better charting, improved marine traffic regulation, and increased monitoring of traffic in order to detect and stop hostile intrusions. The choke point leading from the Bering Sea into the Arctic is one area of concern for the United States, but other areas will need attention as well.

Oil and gas exploration and exploitation will grow as those activities become feasible in Arctic waters. According to a 2008 United States Geological Survey study, the Arctic may hold as much as 90 billion recoverable barrels of oil and nearly 2 trillion cubic feet of recoverable natural gas, based on current industry capabilities and practices—approximately 13% of the world's undiscovered oil, 30% of its undiscovered natural gas, and 20% of its undiscovered natural gas liquids.[126] New technology may make it possible to both drill in deep Arctic waters with drills that sit on the ocean floor and pipe the oil or gas into ice-breaker tankers or LNG tankers.[127] The laying of fiber-

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123. Anisimov et al., *supra* note 1, at 676; Anthony Russell, *Carpe Diem: Seizing Strategic Opportunity in the Artic*, 51 JOINT FORCES QUARTERLY 94, 96 (2008).

124. *Id.*

125. *See* Russell, *supra* note 123, at 96 (discussing benefits to Asian nations of a reliable arctic passage).

126. Press Release, U.S. Dep't of the Interior, U.S. Geological Survey, 90 Billion Barrels of Oil and 1,670 Trillion Cubic Feet of Natural Gas Assessed in the Arctic (July 23, 2008), *available at* http://www.usgs.gov/newsroom/article.asp?.ID=1980&from+iss_home.

127. *See* Robotics Trend Staff, *Energid Technologies to Control Innovative Drilling Robots for Seabed Rig*, ROBOTICS TRENDS, May 29, 2009, http://www.roboticstrends.com/service_robotics/article/energid_technologies_to_control_

optic cable between areas in the Arctic, such as Prudhoe Bay and Norway or Iceland, may also become possible.[128]

New access to and uses of Arctic waters will add urgency to the need to settle bilateral boundary disputes in the area, decide rights to areas of extended continental shelf in the Arctic, and address disputes about the status of certain waters. Boundary disputes have existed for years between the United States and Canada in the Beaufort Sea, Norway and Russia in the Barents Sea, and Canada and Denmark relating to Hans Island.[129] Disputes also exist with regard to navigational rights in the Northwest Passage and the Northern Sea Route.[130] Canada claims that the Northwest Passage comprises Canadian internal waters, subject to the full requirements of Canadian law, while the United States and other maritime powers take the position that these waters are subject to the transit passage regime applicable to straits used for international navigation under the law of the sea.[131] Similar concerns exist with regard to navigational rights through the Northern Sea Route.[132]

Rights to extended continental shelves beyond 200 miles are being dealt with through national submissions to the Commission on the Limits of the Continental Shelf under Article 76 of the Law of the Sea Convention. For parties to the Convention, Article 76 establishes a process, through the Commission, for coastal states to secure international recognition of the outer boundaries of their shelves where those shelves extend beyond 200 miles.[133] Russia and Norway have already made submissions to the Commission, and other Arctic nations are conducting the necessary geological and geophysical studies to make such submissions in the near future.[134] Although the

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innovative_drilling_robots_for_seabed_rig/ (describing a drilling rig that operates in arctic environments).

128. Rob Stapleton, *Trans-Arctic Shipping Nears Possibility as Ice Melts*, ALA. J. COM., Nov. 18, 2007, *available at* http://alaskajournal.com/stories/111807/hom_20071118015.shtml (reporting statement by Mead Treadwell, chair of the U.S. Arctic Research Commission, made at the Trade is Transportation seminar on November 7, 2007).

129. Central Intelligence Agency (CIA), The World Factbook, https://www.cia.gov/library/publications/the-world-factbook/fields/2070.html (last visited Oct. 3, 2009).

130. *Id.*

131. Doug Struck, *Dispute Over NW Passage Revived*, WASH. POST, Nov. 6, 2006, http://www.washingtonpost.com/wp-dyn/content/article/2006/11/05/AR2006110500286.html.

132. *See* CIA, The World Factbook, *supra* note 129.

133. U.N. Convention on the Law of the Sea art. 76, Dec. 10, 1982 1833 U.N.T.S. 397, *available at* http://www.un.org/Depts/los/convention_agreements/convention_overview_convention.htm. Under Article 76, the outer limits of the extended continental shelves established on the basis of the Commission's recommendations throughout this process become "final and binding" on all parties (156 nations and the European Union, at the current time).

134 Submissions to the Commission on the Limits of the Continental Shelf, http://www.un.org/Depts/los/clcs_new/commission_submissions.htm (last visited Oct. 3, 2009).

United States has enormous areas of extended continental shelf beyond 200 miles in the Arctic (and off of some portions of its Atlantic coastline as well), the United States is not yet party to the Convention.[135] In order to ensure that U.S. rights to its extended continental shelf are on the firmest legal footing, as well as for many other reasons, the United States should immediately become party to the Convention.[136]

Increased transportation, resource exploration and exploitation, and other uses of polar waters will also open newly active land borders for the United States and other Arctic nations. Issues related to homeland security (terrorism), law enforcement (drug smuggling and other activities), immigration (illegal entry), public health, and other environmental effects will arise as a result of new ports; the temporary influx of travelers; the more permanent influx of workers related to shipping, oil and gas activities, and tourism; and the concomitant need for shore-based support infrastructure.[137]

These elements of a more open Arctic will require the United States to increase maritime presence and security operations, including ensuring freedom of navigation and overflight in accordance with the rules applicable under the international law of the sea. The January 2009 National Security Presidential Directive on Arctic policy commits the U.S. government to "develop[ing] greater capabilities and capacity to protect the air, land, and sea borders in the Arctic region; increas[ing] Arctic maritime domain awareness in order to protect maritime commerce, critical infrastructure, and key

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135. Bellinger: The United States and the Law of the Sea Convention, http://ilreports.blogspot.com/2008/11/bellinger-United-States-and-law-of-sea.html (Nov. 6, 2008, 08:57 EST) (transcribing a speech made by John Bellinger, Legal Adviser to the U.S. Department of State at the University of California Berkley School of Law's Law of the Sea Institute on Nov. 3, 2008).

136. As the nation with the world's largest navy, an extensive coastline, a continental shelf with enormous oil and gas reserves, and substantial fishing and commercial shipping interests, it is clearly in the United States' national interest to join the Law of the Sea Convention. *See id.* (providing reasons why the U.S. should join the Law of the Sea Convention). Among the many reasons for joining is the fact that, as a non-party, the United States cannot take its seat at the table as decisions affecting the world's oceans are made. An example of particular relevance to the Arctic is that, as a non-party, the United States cannot nominate a U.S. expert to sit on the Commission on the Limits of the Continental Shelf to aid in consideration of the claims that are currently being presented by other Arctic states. *Id.*

137. *See* Directive on Arctic Region Policy, 45 WEEKLY COMP. PRES. DOC. 47, 48 (Jan. 9, 2009), *available at* http://www.gpoaccess.gov/wcomp/search.html (select "2009 Presidential Documents" then search "Directive on Arctic Region Policy"; then follow PDF link) (asserting that the United States has a fundamental interest in preventing vulnerability to terrorism in the Arctic region); OFFICE OF FIELD OPERATIONS, SECURING AMERICA'S BORDERS AT PORTS OF ENTRY (2006), *available at* http://www.cbp.gov/linkhandler/cgov/border_security/port_activities/securing_ports/entry_points.ctt/entry_points.pdf (discussing generally the security issues presented by ports of entry into the United States).

resources; preserv[ing] the global mobility of U.S. military and civilian vessels and aircraft throughout the Arctic; protect[ing] a sovereign U.S. maritime presence there; . . . [and] encouraging peaceful resolution of disputes in the region."[138]

Navy missions in an ice-free Arctic may include operations to ensure freedom of navigation; transit of forces; forward presence, intelligence, surveillance and reconnaissance; homeland defense; scientific exploration; protection of natural resources; maintenance and improvement of the capability to operate in the Arctic; and upholding allied commitments.[139] Coast Guard Arctic missions, which have traditionally included operations such as ice breaking, ice patrol, Loran, fisheries enforcement and marine mammal protection, Bering Sea patrols, and marine safety, will likely also be updated and expanded.[140] According to a NOAA expert, the areas needing most improvement in the Arctic are search and rescue, training in cold-climate procedures, communications (land-based and satellite-based), coastal land weather stations, satellite in-situ observations, and military readiness.[141] New multi-mission platforms, including new icebreakers and ice-strengthened vessels, will be needed for military, law enforcement, rescue, research, and environmental responses.

Expanded cooperative efforts will also be necessary to regulate marine traffic, ensure safety, provide for search and rescue, and protect the environment. Although some Arctic nations have traffic systems in place, cooperation will be necessary to achieve full and consistent coverage. Likewise, cooperation will be needed between and among entities such as the North American Ice Service (NAIS), the Canadian Ice Service (CIS), the International Ice Patrol, the International Arctic Buoy Program (IABP), the International Ice Charting Working Group (IICWG), and others.[142]

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138. Directive on Arctic Region Policy, *supra* note 137, at 49. The Russian Security Council also released an Arctic policy for Russia on March 31, 2009. That paper, entitled "The Fundamentals of Russian State Policy in the Arctic up to 2020 and Beyond," includes deployment of military, border and coast guard units, as well as increased cooperation with other countries in the fight against terrorism, drug trafficking, illegal immigration, and environmental protection. Mia Bennett, Russia Plans Military and Economic Development in Arctic, http://arctic.foreignpolicyblogs.com/2009/03/31/russian-development-plans-in-arctic/ (Mar. 31, 2009, 06:10 EST).

139. Elizabeth Chalecki, *Climate Change in the Arctic and its Implications for U.S. National Security*, 2 IDEAS JOURNAL: INT'L DEV., ENV'T & SUSTAINABILITY 1, 4 (Apr. 2007), *available at* http://fletcher.tufts.edu/ierp/ideas/pdfs/issue2/Chalecki_Arctic.pdf.

140. *See* U.S. Coast Guard, 17th Coast Guard District, The Emerging Arctic: A New Maritime Frontier (2008), http://www.uscg.mil/history/docs/ArcticOverview[1].pdf (PowerPoint presentation describing U.S. Coast Guard missions in the Arctic).

141. Richard W. Spinrad, From 2001 to 2007: What We Have Learned and What We Have Done (July 10, 2007), http://www.star.nesdis.noaa.gov/star/documents/2007IceSymp/Spinrad.pdf.

142. *See id.* at 4 (presentation discusses the importance of developing international science partnerships).

B. *Energy Security*

Warming also raises the related security issue of the continued viability and security of oil and gas infrastructure in the Arctic. Melting permafrost and related environmental effects are already creating vulnerabilities for roads, pipelines, and buildings needed to support oil and gas development and transportation of those resources out of the Arctic[143]—an effect that will be exacerbated as more buildings and structures carrying heat are built on the permafrost. Investments necessary to ensure the continued viability of critical energy infrastructure will need to be made in an environmentally sustainable manner and in a manner that ensures their security.

C. *Environmental and Human Security*

As noted above, warming will have direct effects on the environment and the health and well-being of Arctic residents. The slow pace of natural recovery in the Arctic makes it critical to address such effects as quickly as possible. In addition, the potential impacts of intensified Arctic warming on the Earth's oceans and climate in general make the need to address environmental change in the Arctic even more critical. In creating the Arctic Environmental Protection Strategy (AEPS) in the early 1990s to address concerns related to transboundary pollution, the international community recognized the importance of cooperative action to address Arctic environmental security.[144] The Arctic Council, the successor organization to the AEPS, maintains environmental protection and sustainable development as one of its primary mandates.[145]

Scientific research will be critical to environmental and human security as well as to meeting broader national interests in the Arctic. Promoting international scientific cooperation through the Arctic Council and other bodies is a key element of the recent United States Arctic Policy.[146]

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143. *See* Anisimov et al., supra note 1, at 665–76 (discussing the impact of climate change on resources and traditional economies).

144. *See* About the Arctic Council, http://arctic-council.org/article/about (last visited Oct. 3, 2009) [hereinafter Arctic Council] (discussing the history of the Arctic Council).

145. *Id.*

146. *Id.* at 50.

V. LEGAL AND INSTITUTIONAL ISSUES

Because the causes of the environmental, social, and security problems discussed in this Article cross international boundaries, efforts to respond to them must be international and cooperative. The final Part of this Article touches briefly on legal and institutional issues related to the Arctic. Much has been written about a "race for resources" and the "potential for conflict" in the Arctic, and some authors have argued that a new, comprehensive Arctic treaty is required.[147] This Part describes briefly the legal and institutional regime currently in place and takes the position that, while some new agreements and cooperative mechanisms covering specific issues will be needed, the current legal regime under the Law of the Sea Convention forms a viable framework within which to deal with the problems of a warmer and more open Arctic.

A. *Current Legal and Institutional Framework*

The Law of the Sea Convention sets forth the jurisdictional rules governing the world's oceans and provides an extensive legal framework for a host of issues relevant to the Arctic:[148]

- It sets forth the navigational rights and freedoms of commercial and military vessels and aircraft in maritime areas;[149]
- It addresses the sovereignty of coastal states throughout the world, including the Arctic coastal states, by setting forth the limits of the territorial sea and the rules applicable in ocean areas;[150]
- It addresses sovereign resource rights by setting forth the limits of the exclusive economic zone and the continental shelf and the rules governing those areas;[151]
- It provides the geological criteria relevant to the establishment of the outer limits of the continental shelf beyond 200 miles and sets forth a procedure for securing international recognition of those limits through the Commission on the Limits of the Continental Shelf—a critical

147. *See, e.g.*, Scott Borgerson, *supra* note 63, at 1 (arguing that due to global warming there is a need for an Arctic Treaty).

148. The Convention covers the Arctic and in fact contains a specific article, Article 234, on ice-covered areas. *See* Hans Corell, *Reflections on the Possibilities and Limitations of a Binding Legal Regime*, 37 ENVTL. POL'Y & L. 321, 321 (2007), *available at* http://www.havc.se/res/SelectedMaterial/20070604corellarcticlegalregenvpolicy1.pdf (arguing that the United Nations Convention on the Law of the Sea applies in the Arctic); Bellinger, *supra* note 135.

149. Bellinger, *supra* note 135.

150. *Id.*

151. *Id.*

matter as the Arctic coastal states seek to extend their respective outer continental shelves to the limits permissible under international law.[152] International law, as reflected in the Convention, also calls for peaceful resolution of disputes where the maritime claims of coastal states overlap. As noted above, several such disputes exist in the Arctic region;[153]

- Finally, the Convention sets forth rules regarding marine scientific research in the Arctic as well as "the respective rights and responsibilities among coastal states, flag states and port states regarding protection of the marine environment."[154]

In addition to the overall jurisdictional framework of the Law of the Sea Convention, other conventions and agreements cover specific issues. The International Maritime Organization (IMO) provides a legal structure for development of rules relating to maritime transportation.[155] The Stockholm Convention on Persistent Organic Pollutants (POPS Convention) regulates transboundary pollution from persistent organic pollutants, a significant problem in the Arctic.[156] The Convention on the International Trade in Endangered Species of Wild Fauna and Flora (CITES), the Convention on Long Range Transboundary Air Pollution and its protocols, the Montreal Protocol on Substances that Deplete the Ozone Layer, and other conventions provide further mechanisms for international decision making on issues important to the Arctic region.[157]

In 2008, representatives of the five Arctic coastal states met in Ilulissat, Greenland, where they issued a Declaration pledging cooperation on a broad range of issues and reaffirming their commitment to the existing international legal rules applicable to the Arctic.[158]

The Arctic Council plays a key role in research and policy recommendations concerning environmental protection and sustainable development in the Arctic. The Council, originally

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152. *Id.* As noted above, the United States should become party to the Convention so that it can ensure that its rights to continental shelf beyond 200 miles in the Arctic can be protected under that procedure.

153. CIA World Factbook, *supra* note 129.

154. Bellinger, *supra* note 135.

155. *See id.* (describing the role of the International Maritime Organization).

156. *See* Corell, *supra* note 148, at 322 (asserting that environmental issues such as threats to the ozone and emissions of greenhouse gases are the most important issues that need to be addressed in the Arctic and citing the POPS Convention as an example of a treaty governing that problem).

157. *See id.* at 321 (discussing that there is already a legal regime for the Arctic).

158. Arctic Ocean Conference, Ilulissat, Green., May 27–29, 2008, *Ilulissat Declaration*, paras. 1-3, *available at* www.oceanlaw.org/downloads/arctic/Ilulissat_Declaration.pdf [Ilulissat Declaration].

formed in 1991 as the Arctic Environmental Protection Strategy, is a high-level intergovernmental consultative forum consisting of (1) the eight nations with land territory above the Arctic Circle (the United States, Canada, Russia, Denmark for Greenland, Iceland, Sweden, Finland, and Norway); (2) Arctic indigenous representatives who hold permanent participant status; and (3) several other nations and international organizations as observers.[159] The breadth of the Council's reach can be seen in its sub-bodies, which include the Arctic Monitoring and Assessment Program (AMAP); Conservation of Arctic Flora and Fauna (CAFF); Emergency Prevention, Preparedness and Response (EPPR); Protection of the Arctic Marine Environment (PAME); Sustainable Development Working Group (SDWG, dealing with health, telemedicine, cultural tourism and transportation); and Arctic Climate Impact Assessment (ACIA).[160]

The Council's major project has been its evaluation and synthesis of knowledge on climate variability, climate change, and increased ultraviolet radiation, with discussion of consequences for environmental, human health, social, and economic impacts that led to, among other things, the Arctic Climate Impact Assessment (ACIA).[161] PAME is responsible for Offshore Oil and Gas Guidelines, the Arctic Marine Strategic Plan, and the Arctic Marine Shipping Assessment.[162] AMAP assesses the health and ecological risks associated with contamination from radioactive waste, heavy metals, persistent organic pollutants (POPs), and other contaminants; it has also issued an action plan for the control of land-based sources of Arctic marine pollution, among other activities.[163] EPPR has issued a Field Guide for Oil Spill Response in Arctic Waters, an Arctic Shoreline Clean-up Assessment Technique Manual, Guidelines for the Transfer of Refined Oil and Oil Products in Arctic Waters (with PAME), and a set of circumpolar maps of Resources at Risk from Oil Spills in the Arctic.[164] CAFF works for the conservation of

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159. Arctic Council, *supra* note 144.

160. *Id.*

161. *See* Weller et al., *supra* note 9, at 990 (summarizing the conclusions of the ACIA).

162. *See generally* ARCTIC COUNCIL, PROTECTION OF THE ARCTIC MARINE ENV'T, ARCTIC OFFSHORE OIL AND GAS GUIDELINES (2009), *available at* http://arctic-council.org/filearchive/Arctic%20Offhsore%20Oil%20and%20Gas%20Guidelines%202009.pdf; ARCTIC COUNCIL, PROTECTION OF THE ARCTIC MARINE ENV'T, ARCTIC MARINE SHIPPING ASSESSMENT 2009 REPORT (2009), *available at* http://web.arcticportal.org/en/pame/amsa-2009-report [hereinafter AMSE Report]; Arctic Council, Protection of the Arctic Marine Env't, *PAME Work Plan 2009–2011*, at 1 (2009), http://arctic-council.org/filearchive/ pame_work_plan_2009-2011.pdf (discussing objectives and actions of PAME).

163. Arctic Monitoring and Assessment Programme (AMAP), http://www.amap.no/ (last visited Oct. 3, 2009).

164. Emergency Prevention, Preparedness and Response (EPPR), http://eppr.arctic-council.org/ (lasted visited Oct. 3, 2009).

biodiversity in the Arctic by supporting an international network of protected areas and through other conservation practices.[165] Although the Arctic Council does not have the authority to make binding law or regulations, its recommendations may become binding through incorporation in other mechanisms.[166] The Arctic Council has an Indigenous Peoples Secretariat that compiles information and develops recommendations for the Council.[167]

Other cooperative and consultative bodies are also active. The Nordic Council includes several EU member states (Denmark, Finland, and Sweden), Norway, Iceland, and autonomous territories of Greenland (the Faroe Islands and Aland Islands).[168] The Barents Euro-Arctic Council provides a mechanism for cooperation in the Barents region.[169] This body, which is organized on two levels—one intergovernmental and the other interregional—includes a working group of Indigenous Peoples, and its major goal is sustainable development through closer contact and cooperation.[170] The Conference of Arctic Parliamentarians includes parliamentarians from the eight Arctic states and the European Parliament, permanent participants representing indigenous peoples, and other observers.[171] The Northern Forum links subnational and regional governments in the region.[172] The Inuit Circumpolar Conference, an international non-governmental organization representing approximately 150,000 Inuit from Alaska, Canada, Greenland, and Chukotka in Russia, works in the areas of environment and sustainable development, international development, human rights and communications, and cultural and social issues. It cooperates with the Saami Council, the Russian Association of Indigenous Peoples of the North (RAIPON), and other indigenous groups.[173] Many other bodies also exist. The Arctic Council and other institutional arrangements such as these—likely in strengthened form—will be important in dealing with the challenges of the twenty-first century.

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165. Conservation of Arctic Flora and Fauna (CAFF), http://caff.arcticportal.org/index.php?option=com_content&view=category&layout=blog&id=4&Itemid=18 (last visited Oct. 3, 2009).

166. *See* Lawson Brigham, *Arctic Shipping Scenarios and Coastal State Challenges*, 7 WMU J. MAR. AFF. 476, 483 (2008) (discussing the need for Arctic states to work within the IMO to develop a set of binding ship guidelines).

167. *See* Csonka & Schweitzer, *supra* note 83, at 57, 210 (providing examples of how they have collected information).

168. Norden, About Nordic Cooperation, http://www.norden.org/en/about-nordic-co-operation (last visited Oct. 3, 2009).

169. Csonka & Schweitzer, *supra* note 83, at 124.

170. *Id.* at 216.

171. Conference of Arctic Parliamentarians (CPAR), http://www.arcticparl.org/ (last visited Oct. 3, 2009).

172. Csonka & Schweitzer, *supra* note 83, at 211.

173. *Id.* at 182.

B. *Need for New Arrangements or Agreements*

In addition to the agreements, rules, and guidelines already in existence, the challenges created by warming call for further cooperative responses in specific areas. First, as maritime traffic and tourism increase, maritime safety and security must be strengthened. The recently released U.S. Arctic Policy statement notes that "safe, secure, and environmentally sound maritime commerce in the Arctic depends on infrastructure to support shipping activity, search and rescue capability, short and long-range aids to navigation, high-risk area vessel-traffic management, iceberg warnings and other sea ice information, effective shipping standards, and measures to protect the marine environment."[174] Search and rescue systems, other navigation aids, and systems for environmental response must be strengthened and coordinated, and it will likely be necessary for some rules that are now voluntary to be reconstituted in mandatory form.[175]

Opportunities and needs also exist for greater scientific cooperation on Arctic issues, both among the Arctic coastal states and with other interested countries. For example, "the United States has made significant investment in the infrastructure needed to collect environmental data in the Arctic, including the establishment of portions of an Arctic circumpolar observation network through a partnership among United States agencies, academic collaborators, and Arctic residents."[176] Achieving a cooperative, international Arctic Observing Network is now a key activity of the International Polar year.[177]

Finally, additional agreements and arrangements will be needed for the protection of marine resources and the marine environment with regard to uses such as oil and gas exploration and exploitation, shipping, and fishing. The Ministers at Ilulissat highlighted their "stewardship role" in protecting the Arctic Ocean's unique ecosystem.[178] As noted above, the Arctic Council enhanced the previous Arctic Off-Shore Oil and Gas Guidelines for adoption by Arctic ministers in April 2009.[179] The Arctic Marine Shipping Assessment made recommendations on additional rules and regulations related to shipping activity.[180] New agreements or arrangements will also be necessary to conserve fish stocks and protect ocean ecosystems as more fishing occurs in the area. The

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174. Directive on Arctic Region Policy, *supra* note 137, at 51.
175. *See id.* (discussing how to achieve effective search and rescue systems).
176. *Id.* § E.3.
177. Brigham, *supra* note 166, at 484.
178. Ilulissat Declaration, *supra* note 158, at para. 5.
179. ARCTIC OFFSHORE OIL AND GAS GUIDELINES, *supra* note 162, 7.
180. AMSE Report, *supra* note 162, at 6–7.

United States Congress recognized the need for international cooperation on fisheries when it passed Senate Joint Resolution 17 (now Public Law 110-243), which directs the United States to initiate international discussions for an agreement to manage migratory and transboundary fish stocks in the Arctic Ocean.[181] In addition, in February 2009, the North Pacific Management Council adopted a Fishery Management Plan that prohibits U.S. fishing in the area north of the Bering Strait and north of Alaska until regulations can be put in place to ensure sustainability.[182]

Based on scientific advice, policymakers need to move expeditiously to develop and implement legally binding measures for the regulation of oil and gas, shipping, and fishing activities in the Arctic. These measures may be put into place through existing mechanisms, such as the IMO, or through other appropriate agreements or arrangements. In view of the sensitivity and interconnectedness of all aspects of the Arctic marine environment, the variety of anticipated human impacts, and the fact that few legally binding arrangements now exist with regard to protection of these ocean areas, a significant opportunity and challenge exist to craft these arrangements based upon the expressed goal of ecosystem-based management.[183] At a minimum, each individual regime should incorporate ecosystem-based management principles and obligations. A more forward looking goal would be to attempt to integrate management across and among all these uses on an ecosystem basis through a unified regional ecosystem management agreement or a coordinated set of specific agreements.

IV. CONCLUSION

Arctic warming is having and will continue to have numerous effects on the Arctic environment, residents, and nations—effects that may be both negative and positive. Melting ice and sea level rise affect marine ecosystems, marine life, and the animals and people who depend on those resources for their survival; they are also causing erosion and related damage to coastal communities and areas. Thawing permafrost is impairing housing and infrastructure on land. Arctic freshwater systems, terrestrial ecosystems, and related flora and fauna are also changing. The human implications of

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181. Managing Migratory and Transboundary Fish Stocks in the Arctic Ocean, Pub.L. No. 110-243, 122 Stat. 1569 (2008).

182. *North Pacific Fishery Management Council Closes Arctic for Fishing*, CONVERANET, Feb. 9, 2009, http://www.converanet.com/agriculture/blog/north-pacific-fishery-management-council-closes-arctic-fishing.

183. *See, e.g.*, Directive on Arctic Region Policy, *supra* note 137, at 54 ("Pursue marine ecosystem-based management in the Arctic.").

these environmental changes include direct and indirect effects on access to food and resources; health and well-being; and community cohesion, traditions, and culture. The complexity of interacting factors involved, the regional variations within the Arctic, and the fact that much is still unknown about the operation of climate and environmental systems in the region make definitive specific predictions difficult. Without question, however, the scope and rapidity of change in the twenty-first century will test the adaptive capacities of the environment itself and of the Arctic residents and nations.

Increased transportation and resource access in the Arctic brought about by warming, as well as increased activity along national borders, will also create needs for additional maritime presence and security; improved environmental and safety regulation; peaceful resolution of boundary disputes and jurisdictional issues; and increased homeland security, law enforcement, immigration, public health, and related activities. Responses to many of these environmental, human, and security issues must be cooperative and international and should involve the voices of Arctic indigenous residents. Such responses can be accomplished within existing legal and institutional frameworks by further strengthening of institutions, but they will also necessarily involve the development of new legally binding agreements or arrangements for regulation of certain activities such as shipping, oil and gas exploration and exploitation, and fishing. In view of the numerous and substantial challenges facing the fragile Arctic environment, it will be incumbent on policymakers and negotiators to ensure that these new regulatory arrangements provide strong protections for Arctic ecosystems and the Arctic people.