By Lawson W. Brigham

# Thinking about the Arctic's Future: Scenarios for 2040

MIKE DUNN / NOAA CLIMATE PROGRAM OFFICE, NABOS 2006 EXPEDITION

**The warming of the Arctic could mean more circumpolar transportation and access for the rest of the world—but also an increased likelihood of overexploited natural resources and surges of environmental refugees.**

The Arctic is undergoing an extraordinary transformation early in the twenty-first century—a transformation that will have global impacts. Temperatures in the Arctic are rising at unprecedented rates and are likely to continue increasing throughout the century.

Significant environmental changes in the region include retreating sea ice, melting glaciers, thawing permafrost, increasing coastal erosion, and shifting vegetation zones. The Arctic Ocean could even be temporarily ice-free during summer 2040, predicts one recent study.

These changes have profound consequences for the indigenous people, for all Arctic species and ecosystems, and for any anticipated economic development. The Arctic is also understood to be a large storehouse of yet-untapped natural resources, a situation that is changing rapidly as exploration and development accelerate in places like the Russian Arctic.

The combination of these two major forces—intense climate change and increasing natural-resource development—can transform this once-remote area into a new region of importance to the global economy. To evaluate the potential impacts of such rapid changes, we turn to the scenario-development process, the creation of plausible futures to enhance a dialogue among a multitude of stakeholders and decision makers.

The key themes providing the framework for the four Arctic scenarios posed for 2040 include:

- **Global climate change,** which results in significant regional warming in each of the four scenarios.
- **Transportation systems,** especially increases in marine and air access.
- **Resource development**—for example, oil and gas, minerals, fisheries, freshwater, and forestry.
- **Indigenous Arctic peoples**—their economic status and the impacts of change on their well-being.
- **Regional environmental degradation** and environmental protection schemes.
- **The Arctic Council** and other cooperative arrangements of the Arctic states and those of the regional and local governments.
- **Overall geopolitical issues** facing the region, such as the Law of the Sea and boundary disputes.

## Scenario One: Globalized Frontier

In this first scenario, the Arctic in 2040 has become an integral component of the global economic system. Formerly a hinterland, the region

has rapidly been drawn into the globalization age. Abundant natural resources, a less-harsh climate, mostly sparse populations, and a geography permitting shorter global air and sea routes between North America and Eurasia have been critical factors influencing the Arctic's development.

The Arctic remains a bellwether for global environmental change, because the manifestations of global warming are amplified in the high latitudes. The Arctic's dramatic environmental changes include the shrinking and thinning of sea ice and significant thawing of permafrost in the Russian Arctic, Alaska, and northern regions of Canada. Arctic sea ice disappeared completely for a two-week period during summer 2040. Such climatic change has had profound and largely unfavorable consequences for a majority of the Arctic's indigenous peoples. Several coastal communities in Alaska and Canada have simply washed away.

The age of polar transportation has arrived, as the Arctic now offers greater access than at any other period in circumpolar history. The opening of Russian airspace over the Arctic early in the twenty-first century shortened flights between North America and Asia and have relieved congestion on trans-Pacific routes.

Greater marine access—earlier and longer navigation seasons—has been achieved throughout the Arctic Ocean, and commercial shipping has steadily increased in Hudson Bay, northwest Russia (Barents and Kara seas), and around coastal Alaska. Sensitive nuclear cargoes have been transported in summer across the Northern Sea Route between Europe and Japan, thereby avoiding traditional navigation straits and coastal waters where political opposition has been intense. The sum of these transportation activities has placed unprecedented environmental pressures on the entire Arctic.

KAREN FREY, UCLA / COURTESY OF NATIONAL SCIENCE FOUNDATION

**Siberian lakes shrink** as the Arctic permafrost beneath them melts.

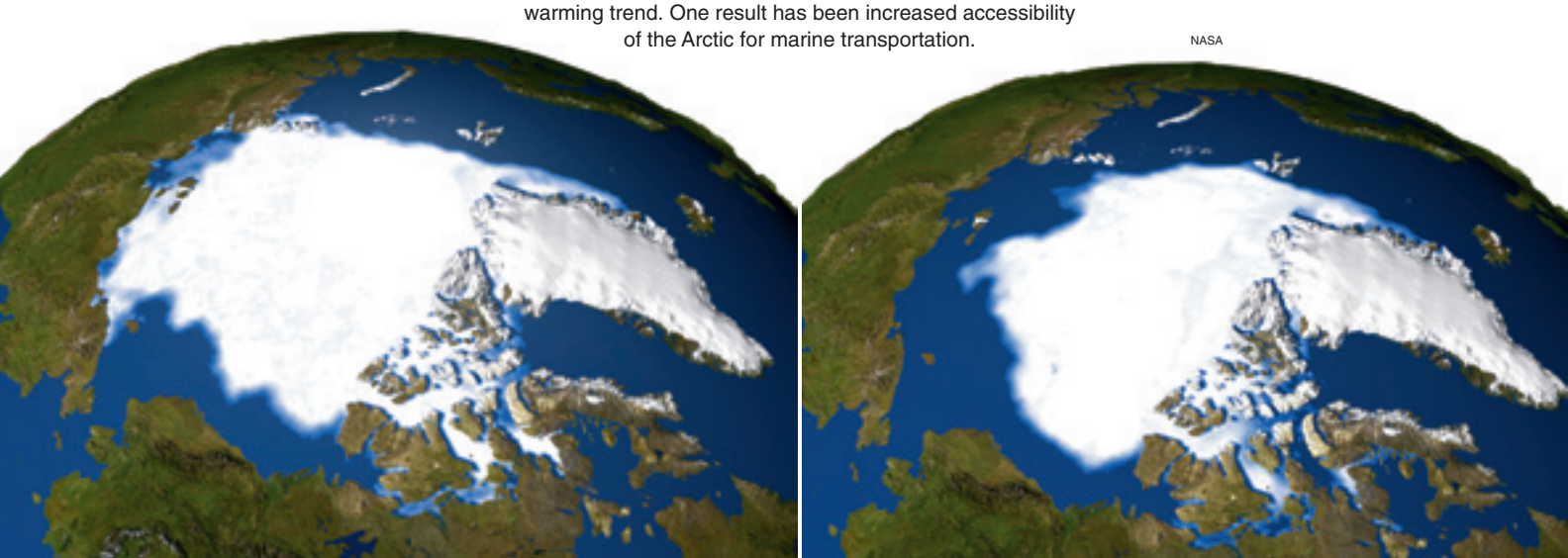
Rising global prices for oil and natural gas, as well as for key commodities such as nickel, copper, zinc, coal, and freshwater, have made Arctic natural resource exploitation economically viable. Oil and gas developments in western Siberia, including offshore in the Pechora and Kara seas, have been extensive.

The region's boreal forests, especially those in subarctic Russia, have experienced intense harvesting pressure. Since 2030, freshwater from the Canadian north has been transported by ship from Hudson Bay to warmer climates throughout the world. Tourism is flourishing, and everyone now has access by sea or air to the remotest Arctic regions.

Overfishing has plagued several Arctic seas since early in the twenty-first century. The fish stocks of the Bering and Barents seas have already been seriously depleted. The Greenland west coast fishery has been stabilized, but current fishery revenues are far too low to sustain the local communities. Thus, the Greenland Home Rule Government has pushed for increased tourism and further

**Satellite images showing minimum levels of Arctic sea ice** in the summers of 1979 (left) and 2005 demonstrate warming trend. One result has been increased accessibility of the Arctic for marine transportation.

NASA



AKER ARCTIC TECHNOLOGY INC., HELSINKI, FINLAND, WWW.AKERARCTIC.FI


**The *Arctic Express*** breaks through ice. The Arctic-going container ship was built by Finland's Aker Arctic Technology Inc. for the Russian mineral company MMC Norilsk Nickel Group. Both transportation and resource exploitation could increase in the future as climate change opens up the Arctic to increased development.

increased royalties by extending mineral rights to commercial firms for seabed tracts in Greenland's exclusive economic zone.

With growing industrial activity in the Arctic has come the specter of a major environmental disaster or emergency situation. Well-worn oil and gas pipelines in western Siberia and Alaska have experienced recurring, serious spills, and new pipelines have been built. No large marine spills have occurred, but serious ice damage to many ships operating in the Arctic has reawakened public interest in an enforceable Arctic marine environmental protection regime.

By 2020, five Arctic coastal states (Canada, Denmark [Greenland], Norway, Russia, and the United States) have asserted their sovereignty over resources of the seabed beyond 200 nautical miles. Only two small regions in the central Arctic Ocean remain under international jurisdiction.

Long-term sustainable development initiatives of the Arctic Council have come under considerable strain with the onslaught of recent Arctic industrialization. Environmental concerns that once fostered circumpolar cooperation have been superseded by economic and social interests, often driven by the private sector. Issues involving the freedom of navigation and commercial access throughout the Arctic Ocean remain highly contentious. The eight permanent member states of the Arctic Council have increasingly excluded outside participation in the Council's deliberations.

The protection, development, and governance of Svalbard have been a particularly vexing problem, as other nations (many outside the Svalbard Treaty) and several international consortiums believe they have a stake in the islands' potential resource exploitation. Russia continues to complicate the politics of Svalbard by not recognizing Norway's claim of a 200-nautical-mile exclusive economic zone around the islands.

## Scenario Two: Adaptive Frontier

In this scenario, the Arctic in 2040 is being drawn into the globalization era much more slowly than might be anticipated. However, there is substantial international cooperation and harmony among many actors and stakeholders, principally because the circumpolar nations realize they have significant environmental, social, and economic interests and responsibilities in the Arctic. The indigenous organizations around the Arctic have a much higher profile and significant influence over decisions related to regional environmental protection and economic development.

The Arctic continues as a key indicator of global climate change. Greenhouse gas emissions have remained relatively high, and the resulting impacts on the Arctic by 2040 are widespread and serious. Visible effects of decades of warming—on land and sea—are observed over large expanses of the Arctic.

A full-scale assault on Arctic oil and gas has not yet materialized. World prices have risen, but not enough for all regions of the Arctic to be competitive. New developments in the Caspian Sea, offshore Sakhalin Island, and in deep waters have generally met global energy demand. While northwest Russia and

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FRANCOIS LENOIR / REUTERS PHOTO ARCHIVE / NEWSCOM

**Russian man walks past a bust of Lenin in Svalbard.** Though the islands are governed by Norway, Svalbard is largely settled by Russians, who dispute Norway's claims of exclusive fishing rights.

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# Four Scenarios for the Arctic

In all four scenarios, the Arctic remains a bellwether of climate change, as global warming is amplified in the highest latitudes. In 2040, the Arctic Ocean could even be ice-free for a short period in summer. The Arctic's vast natural resources are experiencing unprecedented development.

Here is how other key issue areas fare in the four scenarios.

DAVID FORCUCCI / USCGC *HEALY*

| | Globalized Frontier | Adaptive Frontier |
|---|---|---|
| **Transportation** | Earlier and longer navigation seasons throughout Arctic Ocean increase commercial shipping. New polar air routes dramatically increase cargo and passenger loads. | Air and marine transportation has greatly expanded but under stricter international regulation for environmental protection and safety. |
| **Resource Development** | Rising prices globally for commodities increase exploitation of Arctic resources such as nickel, copper, coal, and freshwater, as well as oil and gas. Overfishing is serious problem. | "Assault" on Arctic resources has not materialized, constrained by international agreements such as strict harvesting quotas for fisheries. Sustainable development is widely embraced by most stakeholders. |
| **Well-Being of Indigenous Population** | While global warming has caused some coastal communities to wash away, commercial opportunities brighten prospects for Arctic indigenous workers, reversing exodus of Arctic workers following the collapse of the Soviet Union. | Indigenous organizations have a greater say in environmental and economic development decision making. Flourishing year-round tourism industry expands opportunities. |
| **Regional Environmental Protection** | Increased industrial activity puts the Arctic region as a whole at greater risk for major environmental catastrophe, such as spills and leaks from aging oil and gas pipelines. Ice damage to ships reawakens public interest in marine environmental protection. | Environmental protection as an imperative is widely held among all stakeholders, and emergency planning is proactive. The Arctic region has become a model for habitat protection. |
| **Regional Governance and Cooperation** | Economic interests related to industrialization have become more compelling—and contentious—and have put environmental issues on the back burner for the Arctic Council. | Private–public sponsorship aims to protect unique natural resources and to balance economic and environmental needs. |

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## Fortress Frontier

Marine and air access through the Arctic is tightly controlled and periodically suspended for foreign ships and aircraft, partly in retaliation against other non-Arctic states' actions elsewhere in the world. Cargo movement is disrupted.

Arctic states "jealously" guard natural resources to prevent uncontrolled access by global community; e.g., fishing rights to all but the Arctic states have been suspended.

Many indigenous peoples are displaced from their traditional homelands due to extreme environmental events. Though economically improved, life is unstable as illegal immigration becomes a major problem.

Sustainable development has largely disappeared as economic and security concerns take precedence.

The Arctic Council remains strong but focused on making the region more independent and exclusionary—a position largely unchallenged by the global community due to the Arctic's collective economic and military strength.

## Equitable Frontier

Transportation is a key Arctic industry, and a fivefold increase in regional marine commerce offsets a modest reduction in air freight on polar routes. Stringent regulation emphasizes environmental protection of key routes.

Sustainable practices benefit fishing, forestry, and reindeer herding, while oil production plummets. Clean freshwater from the Arctic has become a valuable global commodity.

Poverty among indigenous peoples has been reduced due to revenue sharing from industries such as tourism, transportation, and minerals extraction.

New areas are added to existing Arctic national parks, enhancing both the environment and the tourism industry.

The Arctic Council promotes a vision of social equity and environmental well-being; military presence is low, yet security is high because tensions among the Arctic states is virtually nonexistent.

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the Alaskan Arctic have witnessed expanded oil and gas development, the Canadian Arctic and offshore Barents Sea have experienced only minimal investment. European Union funding has helped Russia repair its Siberian pipeline infrastructure and fix its serious spill problems.

Transportation systems are more robust in the Arctic than ever before. Polar air routes are thriving, as in the Globalized Frontier scenario, but international accords have controlled aircraft emissions, limiting their impacts on the Arctic atmosphere.

Warming climates have fostered development of an aquaculture industry in Arctic coastal areas. Commercially viable fishing has continued in the Arctic marginal seas, and a total collapse of any single fishery has been averted using stringent harvesting quotas and other bilateral agreements.

Arctic tourism has flourished, and effective regulations have been issued by Nunavut, Svalbard, Iceland, and Greenland for managing the thousands of Arctic tourists who now travel north in all seasons.

The Arctic Council has proven to be a proactive forum resolving several disputes regarding Svalbard and effectively engaging Arctic indigenous peoples in all deliberations. Much has been accomplished, despite intense pressure from outside governments (who believe the United Nations should have a greater role in Arctic affairs) and from several nongovernmental organizations (who want much of the Arctic to be a wilderness area with a moratorium on further development).

Arctic contingency planning for environmental (man-made) and natural emergencies is advanced and well coordinated. Multinational response teams, jointly funded by private and public sources, have been established and operational exercises conducted in sea ice and permafrost.

Arctic Council and Northern Forum initiatives have also positioned the Arctic as a model region for habitat protection. Policies and funding mechanisms have been designed to

U.S. NAVY PHOTO BY PHOTOGRAPHER'S MATE SECOND CLASS STEVEN H. VANDERWERFF

**Scientists with U.S. Office of Naval Research** study Arctic Ocean currents and their potential effects on the Arctic ice pack.

GLENN WILLIAMS / NARWHAL TUSK RESEARCH, COURTESY OF NATIONAL SCIENCE FOUNDATION

**Arctic hunter in Alaska.** The future well-being of indigenous Arctic peoples and cultures may be affected by changes in the region's relationship with the rest of the world, suggests author Brigham.

support joint, private–public sponsorship of unique natural reserves. Despite significant transportation and resources development pressures, Arctic national parks have expanded modestly and been adapted to deal with increased tourism.

## Scenario Three: Fortress Frontier

Widespread resource exploitation and increased international tension exist throughout the Arctic in this scenario. The Arctic is viewed by much of the global community as a storehouse of natural riches that is being jealously guarded and developed by a handful of wealthy circumpolar nations. Preventing uncontrolled access to these vital resources, especially oil and natural gas, has become an obsession for all Arctic stakeholders. The Arctic is a part of the global economic system, but any linkage is orchestrated or dictated by the most powerful Arctic states.

The Arctic is undergoing extreme environmental stress as global warming continues unabated. Greenhouse gas emissions have been unleashed globally at unprecedented rates; the result has been massive permafrost thawing (and disappearance), rapid glacial retreat in Greenland and Canada, extensive coastal shore erosion, and a historic retreat of Arctic sea ice in all marginal seas and the central Arctic Ocean. Multiyear sea ice—that is, ice that survives the summer melt season—has disappeared, as no Arctic sea ice has been observed anywhere in the Arctic Ocean during September of the past two years.

Many Arctic indigenous populations have been displaced from their traditional homelands due to extreme environmental events. Although many people living in the Arctic have gained a measure of economic independence, their existence has nonetheless become unstable. For the first time in history, illegal immigration into many subarctic regions is a reality. Border law enforcement officials in the eight Arctic states acknowledge that their northern territories are very vulnerable to massive influxes of environmental refugees and economic migrants.

Air and marine transportation routes in the Arctic remain open to world fleets in 2040, but foreign aircraft and ship access has been periodically suspended. Russia has denied polar access to its airspace as retaliation against states' actions elsewhere in the world; global air cargo flows have been seriously disrupted without a polar network. Russia and Canada continue to tightly control marine access through the Northern Sea Route and Northwest Passage. Both countries have allowed non-Arctic class tankers to make open water transits for the export of oil and gas to world markets. This newfound flexibility in the navigation and environmental safety regulations has been applied when significant economic gain is anticipated from major exports.

World access to the Arctic region's resources is tightly controlled. Fishing rights have been suspended to all but the Arctic states: Japan, for example, has been excluded from fishing in the Bering Sea for the first time in 70 years and seeks redress. Since 2020, oil and gas exploration and production efforts have intensified in the Barents, Kara, and Canadian Beaufort seas. These new flows will meet increased U.S. and European demands as decreased imports are coming from the Middle East. Hard rock mineral production from mines in Arctic Canada and Greenland has also been rejuvenated. Technological advances have made offshore Arctic drilling safer and more efficient, and significant new drilling is being conducted off Alaska.

Svalbard has become a source of potential conflict over access to living and nonliving resources. A majority of states believe the 1920 Treaty of Spitsbergen is no longer operative. Norway, with assistance from the United States and Russia, has increased military forces in the region.

The Arctic Council remains, but it is an entirely different forum than originally envisioned. Any notion of sustainable development has disappeared, and environmental issues have taken a backseat to economic and security concerns. The United States and Russia, thought to be leaving the group in 2020, have found the Council useful in arguing

collective security, combating mass migration, and orchestrating the flow of exports from the Arctic consortium. The Council's avowed long-term strategy has been to make the circumpolar states less dependent on natural resources from outside the Arctic. Few in the global community have directly challenged this exclusionary strategy because of the collective economic and military strength of the United States, Canada, and Russia.

Arctic tourism continues to grow, since many other traditional tourist destinations are experiencing turmoil and a shortage of the necessities of life. The view is that the Arctic is a safe place with a more hospitable climate and with ready access to all the region's natural wonders. Tourism has become an economic boon to local communities, particularly those in Arctic Russia, and has alleviated some pressure on regional fisheries.

Early in the twenty-first century the five Arctic coastal states declared their sovereignty over resources of the Arctic seabed beyond 200 nautical miles to the edge of the continental shelf extensions. In 2030, the two small regions that remained within international jurisdiction were unilaterally placed by the Arctic Council under strict Arctic environmental protection measures, with marine access tightly controlled. Total dominance over the Arctic Ocean has thus been achieved by a handful of Arctic states—the epitome of fortress mentality!

## Assessing the Impacts of Arctic Climate Change

A major report on Arctic climate change was released in 2004 by the eight-nation Arctic Council. The report, *Impacts of a Warming Arctic: Arctic Climate Impact Assessment* (ACIA), captured global attention and wide media coverage, as it was the world's first comprehensive, regional review of the impacts of climate change.

Several hundred Arctic researchers worked for four years to produce this fully referenced and independently reviewed scientific evaluation of Arctic climate change and its impacts that affect not only the Arctic region, but the entire planet. Important to ACIA was the inclusion of special knowledge of the indigenous people throughout the Arctic.

Among the key findings of the report:

- Climate change intensely affects the Arctic, where the average temperature has risen at about twice the rate of the rest of the planet.
- The Arctic is experiencing widespread melting of glaciers and sea ice and rising temperatures of the permafrost (frozen ground). During the past 30 years, the annual sea ice extent has decreased by about 8%—nearly 385,100 square miles.
- Severe coastal erosion is being observed around the entire Arctic basin, and Arctic coastal communities are literally eroding into the sea.
- Arctic warming increases glacial melt and river runoff, adding freshwater to the oceans and potentially influencing global ocean circulation.
- Melting of the Arctic's highly reflective snow and sea ice uncovers darker land and ocean surfaces. This change perversely increases absorption of the sun's heat and further warms the Arctic and the planet.
- Reductions in Arctic sea ice will drastically shrink marine habitats for polar bears, ice seals, and some seabirds, potentially pushing some species toward extinction.
- Arctic warming is very likely to alter the release and uptake of greenhouse gases (such as methane and carbon dioxide) from Arctic soils and sediments. Boreal forests and arctic tundra contain some of the world's largest land-based stores of carbon.

More information about this compelling and historic study of the Arctic may be obtained from the Arctic Monitoring and Assessment Program, www.amap.no.

*—Lawson W. Brigham*

### Scenario Four: Equitable Frontier

In this scenario, the Arctic remains integrated with the global economic system in 2040, but the evolving international sustainability paradigm has altered the region's development strategy to one emphasizing gradualism. Resource exploitation such as fishing is a given (not an option) in much of the Arctic, but such commercial activities are being tempered by greater consideration of broad social and environmental concerns. Mutual respect and cooperation among the circumpolar nations are the norm. The Arctic governance system is viewed as a model for resolving complex sustainable development issues and regional disputes.

While the International Global Climate Treaty has resulted in sizable and continuing reductions in greenhouse gas emissions, these changes have had little immediate impact on the Arctic. Eight decades of unprecedented regional warming have taken their toll on the cryosphere. Thus, a comprehensive set of adaptive strategies has evolved to take into account such regional changes as thinner permafrost layers, an elevated sea level, and longer seasons of open water normally covered by Arctic sea ice. Transport user fees and other eco-taxes have funded the implementation of these strategies in cases where change has seriously impacted indigenous communities.

Transportation (air and sea) is a key Arctic industry that not only links the region with global trade, but also generates considerable revenues for the Arctic states. Since 2030, there has been a modest reduction in air freight on polar routes, and a fivefold increase in shipping around the Arctic basin. The extensive seven-month summer navigation season made possible by environmental changes has enabled the growth of international transits on the Northern Sea Route and Northwest Passage. This has enabled great

savings in ship time and fuel for select cargoes. Canada and Russia have maintained their stringent marine regulatory regimes that emphasize environmental protection.

Despite differences over freedom of navigation issues, the United States, Canada, and Russia have negotiated an agreement that allows ships a seamless voyage around Alaska and through the routes under a uniform set of operational procedures. Regional (multinational) disaster teams have been created under the Arctic Council to respond to maritime or other emergencies.

Boundary disputes in the Barents (between Norway and Russia) and Beaufort (between the United States and Canada) seas have been resolved. The Treaty of Spitsbergen (1920) has been reaffirmed by the International Court of Justice and its terms accepted by the global community. Fishing rights off Svalbard and in specific areas of the Barents and Bering seas have been allocated to a group of developing nations.

Social well-being and quality of life in the Arctic has been transformed: Poverty has been reduced thanks to revenue sharing from tourism, transport, and minerals extraction (fees mostly from transnational corporations), which has created sustainable incomes and helped develop affordable housing. By 2040, only a few pockets of poverty remain in the remotest regions of the Russian north.

The University of the Arctic, pioneered using the Internet in 2001, has brought quality education to within easy reach of all northern citizens. The Arctic Council has brokered an agreement among Canada, Russia, and the UN High Commission for Refugees to allow settlement of 30,000 environmental refugees in subarctic territories. Future Arctic relocation programs are being studied by a human rights team headed by the president of Iceland.

Arctic and subarctic fishing, forestry, and reindeer herding have been conducted using successful sustainable practices for nearly two decades. Reindeer herding has also benefited (and grown) as the warmer climate results in more robust and larger grazing lands. Oil production in the Arctic has plummeted, but natural gas continues to flow from western Siberia to Europe. The Barents Euro-Arctic Council, exhibiting regional solidarity, has funded environmental cleanup in much of the old oil–gas pipeline corridor through northwest Russia.

Clean freshwater has become a valuable global commodity due to its scarcity and chronic shortage in many regions of the world. How to distribute and market the vast quantities of freshwater from the Arctic and subarctic has been a consuming vision for many. Russia and Canada have developed plans for pipelines to carry water south from their northern territories. In several experimental voyages, tankers have carried water from ports in Greenland and Canada to the Middle East, Japan, and the Mediterranean.

A steady growth in Arctic tourism continues, prompting national and regional parliaments to establish additional wilderness lands and scientific (biodiversity) reserves and to add areas to existing Arctic national parks. To enhance environmental protections, the international Arctic Tourism Commission has developed access guidelines, established an Arctic surcharge or fee structure, and advocated a moratorium on wilderness adventures.

Although the Arctic is no utopia in the Equitable Frontier scenario, the Arctic Council can take much credit for fostering a vision and focus on social equity and environmental well-being. There is a low military presence in the region, and tension among the eight Arctic states is almost nonexistent. The Arctic Council has shown regional solidarity and foresight in engaging the rest of the planet on vexing problems such as refugees, transborder pollution, and access to living and nonliving resources by developing nations.

## Conclusion: Arctic Prospects

The above four scenarios offer a structure for thinking about the Arctic's future and its global impacts. There are also many intriguing wild-card issues that should be anticipated, such as:

- The continued enclosure of the Arctic Ocean seabed by the five Arctic coastal states (Canada, Denmark [Greenland], Norway, Russia, and the United States)—a trend that will surely drive regional geopolitics.
- Key boundary disputes between the Arctic states—between the United States and Canada, between Canada and Denmark, and between Russia and Norway—continue to be unresolved, vexing issues.
- Future ships voyaging into the Arctic Ocean could bring alien species in their ballast water and increase air emissions into the cooler surface atmosphere of the Arctic.
- A future "Global Climate Treaty" might slow climate warming, but by how much? It is plausible that the relentless loss of Arctic sea ice and glacial ice, observed during recent decades, might continue and possibly accelerate.

The Arctic is a complex but relatively small region of Planet Earth. Impacted heavily by global climate change and being viewed by many as a region of vast and now accessible natural resources, there can be little doubt that extraordinary change is coming to the entire region and its people. These four scenarios of the Arctic in 2040 are designed to be provocative but plausible. Hopefully, they will stimulate strategic thought and rational discussion about how the Arctic region should evolve throughout the twenty-first century. □

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The scenarios expressed in this article are the sole responsibility of the author and do not reflect the views of the Commission.

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