WORLD ECONOMIC FORUM

COMMITTED TO IMPROVING THE STATE OF THE WORLD

Global Agenda Councils

Demystifying the Arctic

Authored by the Members of the World Economic Forum Global Agenda Council on the Arctic
Davos-Klosters, Switzerland 22-25 January

January 2014

REF 140114

Contents

Executive Summary

To this day, the general public thinks of the Arctic in visions of unspoiled ocean and landscapes, expansive ice, clean water, unique species and aboriginal cultures – essentially, it reminds everyone that a true wilderness still exists. In addition to important natural resources, the Arctic provides inspiration by maintaining its irreplaceable cultures, a pristine environment, healthy ecosystem and ground-breaking collaborative governance models. As such, it is a global asset that should be maintained.

While largely true, this vision is not the complete picture. With a population of about 4 million people and an annual economy of roughly US$ 230 billion, the Arctic falls under the jurisdiction of eight modern countries with a long history of governance in the region. Development over the past decades has included major expansions of oil and gas activity since the 1960s. These and other facts are often surprising for people not familiar with the area, and indeed the Global Agenda Council on the Arctic has identified five particularly pervasive myths about the region that need correction (see Appendix). For example, the region's wealth of natural resources is *not* readily available for development, and the Arctic will *not* become immediately accessible even as summer sea ice continues to retreat in response to climate change. Moreover, the Arctic is *neither* a tense area with geopolitical disputes *nor* a likely flashpoint for the world's next military conflict.

On the contrary, the region is a powerful example of international collaboration; its countries largely conform to standard international treaties, confer regularly at regional forums such as the Arctic Council and use normal diplomatic channels to resolve differences. The widely publicized seafloor-sovereignty extensions now under way for the Arctic Ocean, for example, are science-based and not controversial, except possibly for the potential overlapping claims of several Arctic states at the North Pole. The parties involved are simply following the same United Nations (UN) procedure used to settle continental-shelf disputes around the globe. Some outstanding boundary and jurisdiction issues among the Arctic states have yet to create geopolitical friction at a level comparable to most

similar disputes in the world. Indeed, the Council's Members consider the region to be a leading example of international collaboration.

The Arctic is an emerging market in a well-governed but challenging environment, offering a host of major investment opportunities in the coming years as well as special risks. While its raw materials present many indisputable benefits, the potential negative global impacts of attempting to exploit those materials unsustainably are serious. This dichotomy may be the driving force of strong passions around Arctic matters in the public debate.

In this context, at least two important economic pressures will affect ongoing development in the region:

- **Natural resources**: Conventional hydrocarbons (natural gas, condensate and oil) and metals are critical and abundant natural resources in the Arctic. Several large projects with considerable potential for future development already exist, including the supply of one-fifth of the world's nickel from the Russian Arctic and one of the world's largest zinc mines located in the Alaskan Arctic. Other valuable resources include fish, high-value minerals (diamonds and rare earths) and fresh water.

- **Growing viability of seasonal shipping in Arctic waters:** Recent climate model projections reveal near-universal agreement that thinner, less-extensive sea ice will make Arctic waters more accessible in summer to lightly strengthened ships. While a highly seasonal phenomenon, this raises prospects for plausible new trans-Arctic shipping routes between the North Atlantic Ocean and Bering Strait, offering substantial savings compared to longer passages using either the Suez or Panama Canal. Such new lanes could possibly supplement existing global trade routes in summer, saving fuel and cutting logistics supply-chain time, with potential benefits for industries and consumers. Perhaps most significantly of all, new routes would increase the possibility of local "destinational" (bulk and cruise) marine activity, including resource development and extraction for global commodity markets. Cruise-ship tourism is a growing industry in the region.

While opportunities in the Arctic exist for both resource development and shipping, numerous important challenges must be addressed to ensure that any future plans unfold sustainably, so that the unique and vulnerable Arctic environment is maintained for future generations.

Challenge 1: The Arctic needs protection from environmental damage, resolution on certain global agreements, and new collaborative models to secure sustainable growth.

Primarily external factors – from world commodity prices to rising greenhouse gas emissions – drive long-term changes in the Arctic. Policy and business decisions made outside the region, at national and international levels, will be critical for future environmental, economic and social developments, such as progress in climate change negotiations. Strong disparities exist among national policies on economic development, aboriginal rights, climate change and environmental protection. Because the region is ecologically fragile, such inequalities heighten risks to all stakeholders, for example if strong protections against oil-spill risks are implemented in some but not all Arctic countries.

Challenge 2: The Arctic needs investment.

A critical deficiency and area of great strategic importance is the development of infrastructure projects and logistical hubs. Except for certain areas of Norway and the western Russian Federation, the region remains vastly underserved by transportation, port and other critical infrastructure. For further economic growth and overall development to occur, both public and private actors need to boost investment on necessary projects. Increasing the Arctic's attractiveness for investment can be pursued in many

ways, as in stable, transparent political governance and judicial systems, and a consistent, clearly defined regulatory regime. For many reasons, large industrial projects must often be "transborder", involving several Arctic states and even consumer countries. While currently lacking within the region, a framework to streamline such transborder collaboration would greatly facilitate investment.

Challenge 3: The Arctic needs measures to better ensure human and environmental safety in the face of increased shipping and offshore activity.

The extent of summer sea ice in the Arctic is decreasing sharply, raising the likelihood of increased traffic from moderately ice-strengthened vessels (e.g. those currently used in the Baltic Sea) and, potentially, from ordinary open-water ships on one of the world's most remote and dangerous oceans. Furthermore, for an ocean that is arguably the most pristine on earth, serious concerns exist about the safety of human life, property and the environment. In particular, the prospect of common open-water ships entering the Arctic Ocean, Northern Sea Route and Northwest Passage heightens the urgency to establish a comprehensive regulatory framework under the International Maritime Organization (IMO) to ensure that adequate vessel safety standards, navigation control systems, environmental protections and search-and-rescue capability are in place. The current lack of quality bathymetric information, navigation control and communication capacity must also be addressed.

Challenge 4: The Arctic needs science.

Natural resource development, sustainable economic growth, ecosystem protection and an understanding of the impacts of climate change in the Arctic all have one thing in common: a pressing need for more science. Despite intense global interest, the Arctic remains one of the world's least-studied environments. While a few areas have received a relatively high level of attention and funding (e.g. Arctic Alaska, the Greenland ice sheet, ocean-floor bathymetric mapping to support Article 76 claims of the UN Convention on the Law of the Sea [UNCLOS], the Barents Sea), the vast majority of Arctic landscapes, oceans and ecosystems, as well as the climate, have received little field study. The lack of basic scientific understanding and datasets now pose a challenge for both business and environmental interests. An urgent need exists among public and private actors for new scientific observations, including long-term monitoring and mapping programmes, improved computer modelling and development of new technologies, ranging from autonomous sampling platforms to satellite observing systems. Moreover, climate change in the Arctic affects climate elsewhere in the northern hemisphere, meaning that understanding the Arctic region will have a positive impact on managing the environment in non-Arctic areas.

The Global Agenda Council on the Arctic develops these four key challenges for sustainable Arctic development further in this report, and proposes opportunities that warrant greater attention and debate.

Challenge 1: The Arctic needs protection from environmental damage, resolution on certain global agreements, and new collaborative models to secure sustainable growth.

The Arctic's unique natural and cultural landscapes are vulnerable to a warming climate and greater human activity. Some influences have clearly negative effects, such as ecosystem changes due to climate change or increased risks from human activity such as oil spills. Others present new opportunities, like economic empowerment of local communities and provision of raw materials for developing markets. However, averting serious environmental problems in such a remote, harsh and fragile ecosystem requires conscientious environmental and cultural stewardship, with a strong emphasis on sustainable change. Laws, policies and business decisions made at national, regional and international levels will be critical for future developments in the Arctic.

Global climate change and the Arctic

Due to several well-understood feedback loops of environmental systems, the Arctic experiences amplified climate change compared with the rest of the world. The consequences, such as melting sea ice, visibly demonstrate how global climate change profoundly affects the region. In fact, climate change is triggering reductions in sea ice cover in the Northern Sea Route and Northwest Passage, which may open summertime shipping routes through the central Arctic Ocean by mid-century. More detrimentally, milder winters and thawing permafrost are making road construction on ice difficult and threatening already-built infrastructure on land. As the maritime and terrestrial environments change, both indigenous peoples and animal species across the Arctic are experiencing altered hunting

patterns. The ecological outcome of continued warming is difficult to predict, but will very likely pose challenges to some of the world's most iconic species. Also, the service and value provided by the ecosystem to society is altered but difficult to quantify.

Resolution of global, multilateral and bilateral agreements

The Arctic is not rife with geopolitical tension, but some issues still deserve resolution through diplomacy and international agreements. At the global level, meaningful international action is required to curb growth of the world's carbon emissions and to preserve Arctic ecosystems. Within the region, the UNCLOS treaty provides an orderly international process for adjudicating offshore seafloor sovereignty extensions, and that process is still ongoing; moreover, the United States (US) has not ratified UNCLOS, and some legal uncertainty surrounds the treaty's definition of ice-covered waters. The international status of the Northwest Passage through the Canadian Arctic archipelago, and a small disputed triangle (about 6,250 square miles) in the Beaufort Sea of overlapping claims between Canada and the US, remain unresolved. In addition, Greenland (Denmark) and Canada have competing claims over Hans Island in the Nares Strait. None of these situations will destabilize the region, but their resolution will further aid collaborative governance models in the region.

Protecting the Arctic in the face of development

The Russian Federation's strategy for its Arctic zone, signed earlier this year by President Vladimir Putin, has a clear agenda for increasing the development of northern regions. The theme of Canada's Arctic Council chairmanship is "development for the people of the North", with a focus on responsible Arctic resource development, safe Arctic shipping and sustainable circumpolar communities.[1] Greenland recently elected a prime minister who supports the advancement of northern development. Although the governments of the eight Arctic states all share an interest in advancing the development of their northern territories, they take divergent approaches that also vary at the local level. Since the Arctic region is relatively small and ecologically fragile, such divergences heighten the risks to all stakeholders if, for example, stronger regulation of offshore activities is implemented in some but not all Arctic states.

With increased activity, the need for better preparation for, response to and mitigation of environmental and public-safety threats will increase as well. As operations develop, best practices should be shared across the region; countries with Arctic stakes can facilitate this sharing by reinvigorating diplomatic attempts, through the Arctic Council and/or other bilateral and multinational means, to reconcile differences in national policies on economic development and environmental protection.

The challenge is finding the right balance between protecting the region and providing the appropriate tools to advance economic activity. While many factors make the Arctic a uniquely challenging environment, a crucial element for business is predictability. An accepted set of operating principles, adhered to by companies with Arctic operations across all sectors and promoted by national governments, may be a more achievable reality than formal, regionally agreed regulation. However, it is recognized that mandatory international regulations are being developed by the IMO for all vessels operating in the Arctic.

Regional and local operating principles should be established by evaluating and addressing several factors that include (1) the use of heavy fuel oil and the impact of black carbon from shipping and other emission-reducing measures; (2) the discharge of ballast water, garbage and pollutants; (3) routing measures and speed limitations; (4) particularly ecologically sensitive areas and places of refuge; and (5) emergency response capabilities. In addition, the database of the International Hydrographic Organization (IHO), with bathymetric, biometric and mapping information, could assist national governments and experts to better plan how the Arctic is used and to enhance safety for operations and the environment.

Opportunities for and protection of people in the Arctic

Four million people live in the Arctic. While climate change may offer some economic benefits in a region with relatively few opportunities for development, it also presents threats to cultural heritage and traditional subsistence lifestyles. In particular, it threatens lifestyles associated with the safe use of sea ice as a transportation platform or with the hunting of animals that have sea ice habitats (e.g. walrus, bearded seal, polar bear). At the same time, many Arctic communities seek more political autonomy in governing local affairs and greater economic participation in development by outside companies. Global companies and national governments need to ensure the inclusive growth of local communities, an objective currently legislated in a highly uneven way among northern-rim countries due to the differing status of land-claim settlements and subsurface mineral rights. This goes beyond revenue sharing to include respect for local decision-making platforms, economic aspirations and preservation of local languages and heritage. Community-based approaches are thus a critical part of development, in addition to environmental protection and safety, in order to secure sustainable change in the Arctic.

Challenge 2: The Arctic needs investment.

Growing international demand for natural resources, including hydrocarbons, metals and fish (all present in the Arctic), is a leading factor in the structure of global trade and industry. Consequently, infrastructure is a prerequisite for sustainable development. A related challenge is energy supply, which is often a bottleneck leading to high energy costs in the region.

Large infrastructure investments are capital-intensive and often require coordination or partnerships between public and private stakeholders at national or international levels. For many reasons, including geography, the seasons and markets, large Arctic industrial projects must often be transborder in scope, involving several Arctic states and even consumer countries. Adding to project cost and complexity, this makes investment decisions difficult. While currently lacking in the Arctic, a framework to streamline such transborder collaborations would greatly facilitate investment.

The need to expand Arctic infrastructure

While some Arctic areas, notably the Barents Sea, have a minimum level of infrastructure for their industries to operate functionally, a pressing need for physical infrastructure exists. This includes transportation (ports, harbours, roads, airports and railways), energy supply (power plants, pipelines and drilling platforms), telecommunications, buildings, water and waste management. Specialized transportation equipment is also a high priority, including icebreaking ships, airships, helicopters, planes, oil-spill remediation vessels and low-impact, land-based transportation. These types of infrastructure, currently lacking relative to anticipated needs, are important preconditions for sustainable Arctic development. Additionally, Arctic infrastructure inevitably requires greater levels of monitoring, management and maintenance than required in southern latitudes.

Facilitating cross-border cooperation and investment

High-level coordination is needed to ensure synergy between Arctic governments and stakeholders, and to develop collaborative plans for new infrastructure linking population centres, countries and proposed development projects. A good example of cross-border cooperation between private and public parties is the Barents 2020 Project undertaken by the Russian Federation and Norway; it focused on offshore oil and gas developments and protecting the people, environment and asset values of the Barents Sea area. As for environmental protection and sustainable development, the Arctic Council offers an effective, consensus-driven intergovernmental forum for promoting the common interests of its constituents in developing the Arctic in an economically and environmentally sustainable way.

Effective decision-making is also needed at the bilateral level. Such alignments provide a framework and platform for predictable decision-making, a necessary condition for successful projects and regional economic growth. During its Ministerial Meeting in Kiruna, Sweden in May 2013, the Arctic Council established a business roundtable for fostering intra-Arctic trade and attracting foreign investment. Non-Arctic states commonly express apprehension about a lack of investment safeguards or guarantees, and are thus dissuaded from making large investments. Establishing certain domestic mechanisms to address these concerns, together with reliable tax policies and regulations, would greatly ease capital inflows. Clear articulation of the procedures, requirements and timelines for project approval are especially crucial, as most businesses cannot afford drawn-out debates with ambiguous and unexpected outcomes.

An Arctic investment vehicle for sustainable development

Investment strategies of large institutional investors, such as pension funds and sovereign wealth funds, may have certain constraints – for example, they can only co-invest or invest in parallel with commercial banks or multilateral development banks. The resulting lack of Arctic investment could be overcome by establishing a cross-border financing institution, i.e. a Sustainable Arctic Investment Vehicle, designed much like (and possibly in cooperation with) one of the international development banks, for example the European Bank for Reconstruction and Development, the International Finance Corporation or the Nordic Investment Bank. This institution's mandate would be to finance projects around the Arctic region, including cross-border infrastructure investments. Along the same lines, dedicated Arctic funds could help mobilize private equity in close cooperation with the above institutions.

Improved communication and media relations

The Arctic is very different from other frontier markets due to its low population density. In addition, many Arctic communities see investing in industries that are invasive and/or potentially damaging to the environment (e.g. oil and gas, mining, shipping, commercial fishing) as disruptive to traditional culture and subsistence such as whaling, fishing and hunting. However, in many cases communities support development, provided it is done sustainably and offers clear economic returns. Such support is especially common in Alaska, Canada and Greenland, where land-claim settlements have been concluded. Other examples from communities like Hammerfest, Norway, show that industrial investments boost the local economy and enable northern inhabitants to thrive in an otherwise challenging environment. Increased prosperity, higher education levels and improved infrastructure are just some of the benefits making a real impact. This nuance is seldom recognized outside the Arctic states, and a common misperception is that all local (and especially indigenous) residents of the Arctic are oppressed and opposed to commercial development. More work is needed to communicate to the popular media and global audiences that balanced and integrated economic and environmental development is possible and, when done correctly, is supported by Arctic residents. In addition to portraying the real situation more accurately, such recognition would also bring attention to Arctic groups whose unsettled land claims are a detriment to their economies, autonomy and sense of identity.

Attracting permanent talent

The Arctic suffers from a lack of people and skills to realize large, complex industrial projects. In the long term, the region must become an attractive place to settle, and it will take time and require investments in liveable societies to attract families from outside. The expansion of data, telephone and satellite communications would contribute to both the industrial infrastructure and the attractiveness of the region, and help advance maritime safety and industrial development. Higher education is an essential part of well-being and for creating a value-added Arctic economy. The University of Alaska has three institutions of higher learning in the US state. The Northern (Arctic) Federal University in Archangel, and the universities in Tromsø, Bodø, Luleå and Rovaniemi of the Nordic countries, are other success stories. Many Norwegians were sceptical when the University of Tromsø opened in 1968, but it has since thrived, and most graduates stay in the region.

Challenge 3: The Arctic needs measures to better ensure human and environmental safety in the face of increased shipping and offshore activity.

Trends indicate that the thickness and areal extent of late-summer sea ice has declined sharply; it now covers about 40% less of the Arctic Ocean than during the late 1970s (September measurements). This steep reduction in sea ice has spawned abundant speculation about potential new shipping lanes for global trade, linking the Pacific and Atlantic Oceans through the Arctic, and offering significant savings over longer passages using either the Suez or Panama Canal. Nascent shipping activity has begun in the last two years along the Northern Sea Route, with 46 transits in 2012 and 71 in 2013 reported by the Northern Sea Route Information Office (some of the voyages between ports in the Russian Arctic).[2] The perception that sea ice is the sole obstruction to Arctic shipping is a myth, however, as numerous other factors influence the region's maritime activity. Key driving forces include the development of Arctic natural resources and linkage of the region to global commodity markets. Lack of quality bathymetric information, navigation control, communication capacity and search-and-rescue capacity are also important. And, to put the Northern Sea Route transit numbers into perspective, the Suez Canal accommodated 17,749 and 17,225 vessels in 2012 and 2013, respectively. Put simply, it seems unlikely that diminishing Arctic sea ice will revolutionize global shipping in the short to medium term.

Continued sea ice reduction, however, will in all likelihood tempt increasing numbers of ships to enter the Arctic's waters. The Arctic already experiences significant local destinational ship traffic related to community resupply and the oil and gas, mining and tourism industries. Destinational shipping will increase with greater marine access, longer seasonal navigation and new connections for Arctic natural resources to global markets. Model projections of current and future sea ice conditions show that even under the most conservative climate change scenarios, the technical ability of moderately ice-strengthened commercial vessels, like those currently used in the Baltic Sea, and ordinary open-water ships will expand in summer, with the former probably able to cross the central Arctic Ocean by the middle of this century. Such shorter summertime transits could burn less fuel and thus produce lower emissions, and

potentially create more efficient summertime supply chains that translate to lower costs for producers and lower prices for consumers. Furthermore, Arctic shipping routes could become more attractive not just versus alternative shipping lanes, but also when land routes are destabilized by thawing permafrost or winter ice-road seasons are shortened.

The Arctic – still a dangerous ocean

Despite climate change, many dangers remain. Arctic sea ice will refreeze in winter, creating unpredictable year-round floes and remnants perilous to common, open-water ships. Large seasonal and interannual variations in sea ice will challenge development of Arctic marine-transportation systems and create unpredictability for logistics supply chains. Small populations and low levels of economic development limit the amount and quality of physical infrastructure, navigational charts and the communications systems available. Shallow bathymetry and polar darkness will remain challenges regardless of diminishing sea ice.

All of this raises serious concerns for the safety of people, property and the environment linked to what is arguably the world's most remote, dangerous and ecologically fragile ocean. The prospect of common open-water ships (which comprise the vast majority of the world's fleet) entering the Arctic Ocean, Northern Sea Route and Northwest Passage heightens the urgency to ensure the safety of life at sea and the protection of the marine environment from fuel and oil spills, invasive species and other damages. Even with continued decrease in the thickness and extent of sea ice, the Arctic Ocean poses a unique set of challenges for companies and governments seeking to ensure safe and environmentally sustainable navigation in the region.

Working towards a mandatory Polar Code

To ensure adequate vessel safety standards, a mandatory and comprehensive regulatory framework, or Polar Code, from the IMO is an obvious, logical start. Currently being negotiated by the IMO to complement existing conventions, the Polar Code addresses security of life at sea, environmental protection and safe navigation of vessels. It would respond to the uncommon qualities of Arctic (and Antarctic) waters by creating better baseline operations that would translate into enhanced reliability and safety. Work on the Polar Code is ongoing; the goals are to have it ratified in 2015 and implemented in 2016. A focus should be on supporting the IMO's Working Group in completing its task, by securing support from the shipping industry and acceptance and implementation by the maritime states. To provide the most benefits, the Polar Code must ensure three critical requirements: (1) adequate ship structural standards for operation when in ice-covered waters; (2) special marine safety equipment for polar operations; and (3) international training standards and experienced ice navigators in the pilot house.

A mandatory Polar Code, ratified and implemented, would introduce a set of international standards for operators to abide by, and be a major step towards decreasing risk in one of the world's most demanding and unpredictable environments.

Improvements and harmonization in charting, regulations and communications

Apart from a mandatory IMO Polar Code, numerous other ways exist for countries, companies, international organizations and non-governmental organizations (NGOs) to support improved safety of life and the environment in the Arctic Ocean. The future of the Arctic's development depends heavily on the creation of safe, reliable transportation systems. The IHO, for example, is addressing hydrography and charting issues through the Arctic Regional Hydrographic Commission, a recently formed subgroup. This commission is working on several critical issues, including development of an Arctic Spatial Data Infrastructure, and drafting terms of reference and precautions for using navigation charts in polar waters. Making management systems more comprehensive, such as upgrading the quality of ship navigational aids and addressing the current lack of proper broadband communication infrastructure, will enable better ship-traffic control. These measures will require strategic investments by public-private partnerships in advance of increasing Arctic marine traffic.

Another area for improvement relates to regulatory differences for ships passing through coastal waters. The Governments of the Russian Federation and Norway are responsible for creating contingency plans to clean up any spills from ships passing through their waters, and both nations are already installing response depots along their coasts. In Alaska, shipping operators are responsible for containing, controlling and cleaning up any spill, although contingency plans are mandated by the US Government and the State of Alaska. Large differences in approaches exist between what is required from domestic operators and international shippers – situations not formally addressed by policy. Although a Polar Code will not deal with this need, the IMO may, through UNCLOS, require reciprocal port-state agreements that would implement better contingency planning than currently exists. Importantly, international shipping needs harmonized rules adopted by the IMO.

The role of the Arctic Council

For some time, the Arctic Council has recommended ways to make Arctic shipping safer – and it will continue to do so. Its Arctic Marine Shipping Assessment (AMSA), conducted in 2005-2009, established a large agenda for safe shipping. Apart from providing a comprehensive overview of Arctic marine use, AMSA also made 17 specific recommendations as a policy framework for Arctic states to pursue in protecting people and the marine environment. These recommendations were organized around three broad, interconnected themes, namely enhancing Arctic marine safety, protecting the region's people and environment, and building the Arctic marine infrastructure. The Arctic Council produced implementation status reports in 2011 and 2013, and a third is planned for 2015. Given the highly dynamic nature of Arctic shipping, the Arctic Council could consider refreshing the AMSA assessment with more recent findings to help update its recommendations and policies, as both physical and economic conditions continue to evolve rapidly in the region.

Challenge 4: The Arctic needs science.

Despite many historical expeditions and growing international interest in the region, the Arctic remains one of the world's least explored and least studied areas. In addition to known external impacts of global greenhouse gas emissions, pollutants and development pressures, strong natural feedback loops unique to the region flow back into local, regional and global environments. A two-way connection between Arctic and global greenhouse gas emissions, for example, could substantially and negatively impact the world's climate. Moreover, the Arctic Ocean exports low-salinity water to the global ocean thermohaline circulation via the Bering Strait and North Atlantic Ocean. Better understanding of these and other impacts can only be gained through heightened scientific study of the Arctic region, to assess current baseline conditions, set up long-term monitoring capacities and improve the ability to model future changes in the region and the world. Concerted increases in scientific activity are required, to be conducted across a spectrum of disciplines and over many years.

Different components of this huge scientific challenge are briefly outlined as follows:

Arctic Ocean geology and oceanography

The oceanic and continental crusts underlying the Arctic seas and continental margins are poorly mapped, and seafloor cores and geological sampling data are few in number. This lack of information presents major constraints to current understanding of the age and origin of the Arctic seafloor and its resources. Bathymetric mapping in particular requires substantial effort and is important to modelling ocean currents and their influence on climate, as well as the development of safe shipping lanes. Only an estimated 8-9% of the Arctic Ocean is charted to international navigation standards. Similarly, while the water column's chemistry and biodiversity provide ocean circulation and biological productivity information, as well as key signals of change, they rarely receive sampling surveys. Despite its small size, the Arctic Ocean collects about 10% of the world's freshwater river discharge, dominated especially by the major north-flowing rivers of the Russian Federation. These rivers transport large volumes of freshwater run-off and waterborne contaminants, but they and their associated coastal zones receive only light scientific study.

The shrinking Arctic cryosphere (sea ice, permafrost and glaciers)

The decreasing areal extent and thickness of its seasonal sea ice cover indicates that the Arctic is undergoing amplified climate warming at a faster rate than the global average. Satellite and ship observations of sea ice extent, thickness, drift, distribution and physical character are essential to understand these trends, as well as ocean-ice-atmosphere interactions, net primary productivity and ocean stratification. Improved long-term observations and modelling of sea ice processes and trends is needed for a wide range of topics, including marine ecosystem health, ocean acidification, climate feedbacks, planetary energy balance and marine accessibility. On land, permafrost soils thaw and trigger ground slumping and damage to buildings, pipelines and other built infrastructure, while potentially releasing vast quantities of carbon dioxide and methane greenhouse gases. The Greenland ice sheet's falling ice volumes and the abundant small glaciers of the Arctic are prime drivers of sea level rise. Better understanding and modelling of these phenomena require new satellite, field and instrument observations, together with basic theoretical research on ice-sheet sliding geophysics and permafrost stability.

Atmospheric science

The Arctic atmosphere influences weather systems not only locally but over the rest of the world. Adequate monitoring and forecasting of regional weather systems are crucial for both scientific and societal purposes, from tracking climate change trends to marine operations and search and rescue. Wind-transported contaminants are carried long distances into the Arctic, with known negative effects on ecosystems and public health, and enhancement of regional warming (e.g. from deposition of black carbon which reduces surface reflectivity). In addition, earlier onset of the spring thaw is increasing toxic load due to earlier release of deposited contaminants. To understand these problems, continuation and expansion of long-term meteorological records from existing and larger observation networks are essential, together with development of new, lower-cost technologies such as wireless instrument constellations, unmanned aerial vehicles and autonomous drifting platforms.

Arctic ecosystems

Additional life-science studies are needed for Arctic marine and terrestrial ecosystems, as well as public safety and health. Scientists have now confirmed that climate change is creating significant changes and threats to Arctic ecosystems, including shifts in the range of species, loss of wetlands, destruction of marine food webs and dangerous ice conditions. An urgent need exists to understand how climate change and development pressures impact Arctic species, on both a regional and global scale (e.g. migratory bird populations). The current and likely impacts of increased human activity in the region must also be examined, including disruptions to migration and/or breeding behaviour, and ecosystem sensitivity to oil spills. Such knowledge is imperative if attempts are made to develop Arctic resources in a responsible, sustainable manner.

Arctic natural resources

In addition to assessing environmental risk, much work is needed to map and quantify Arctic natural resource stocks. Basic research on the extent, viability and environmental sensitivity of the region's natural resources is lacking, particularly in the marine and offshore environment. Metals, hydrocarbons, fish and ecotourism are key opportunities for possible development, especially over the long term as global demand for these assets continues to rise. The extent and volume of offshore methane hydrate deposits are poorly mapped but known to be vast, representing both a potential long-term greenhouse gas threat and possible fossil fuel of the future. On land, more work is needed to assess the distribution and quality of valuable minerals, especially metals.

Applied science and engineering

Of the many opportunities for applied science and engineering, technological advances linked to mapping, remote data acquisition, energy production, safe shipping, search and rescue, sustainable fisheries and resource development are prime areas for growth. Particularly pressing is the need for new, innovative approaches for oil-spill response and remediation in ice-covered waters. Applied research in communications, transportation and logistics is critical to future activity in the Arctic. Fundamental scientific research will also aid these efforts, by obtaining key datasets and knowledge with cross-disciplinary, cross-sector, scientific, business and/or governmental relevance, and disseminating them to a global audience.

These components form just a partial listing of the many ways in which the Arctic needs science. Each of these component topics is deeply important to our understanding of both the region and the broader impacts and implications for the world. Baseline assessments of Arctic geology, oceanography, cryosphere, atmosphere, ecosystems and natural resources, together with development of new technologies, applied science and engineering, are urgently required. Such baseline studies will need substantial and cooperative commitments from governments, multinational companies, international organizations and NGOs, such as the International Arctic Science Committee, a non-governmental forum that includes scientific bodies from the Arctic states and thirteen non-Arctic states. Furthermore, the Arctic's need for science will not end there; indeed, the dramatic environmental and development changes now under way in the region make it a key laboratory for the planet. Sustained support of measurement programmes, model development, technology and the science communities will be crucial for understanding the rapidly transforming Arctic.

Appendix - Arctic Myths

The Global Agenda Council on the Arctic has highlighted five particularly pervasive myths about the region:

Myth No. 1: The Arctic is an uninhabited, unclaimed frontier with no regulation or governance.

Fact: With a population of 4 million people and an annual economy of roughly US$ 230 billion, the region is under the jurisdiction of eight countries (the Russian Federation, Finland, Norway, Sweden, Iceland, Greenland/Denmark, Canada and the US), with few territorial border disputes among them. Even offshore in the Arctic Ocean, most coastal waters fall within existing Exclusive Economic Zones, with further seafloor sovereignty extensions pending or likely under Article 76 of UNCLOS. In Canada, Greenland and the US, local control by aboriginal communities and regional business corporations can be substantial. In short, the Arctic is neither an unclaimed, contested region nor a closed military zone; it is governed under similar national structures and international frameworks to those in other areas of the world.

Myth No. 2: The region's wealth of natural resources is readily available for development.

Fact: Many technological, infrastructural, economic and environmental challenges impede natural resource development in the Arctic. Extracting resources is never a simple operation in polar environments, and resource development will require high levels of investment, including development of specialized technologies. The region is not homogenous with regard to development potential; strong distinctions exist between onshore and offshore environments, and between different regions and countries with regard to existing levels of infrastructure, population, environmental sensitivity and accessibility.

Myth No. 3: The Arctic will become immediately accessible as sea ice continues to disappear.

Fact: The opposite is true on land, owing to shorter winter ice-road seasons and destabilized ground due to thawing permafrost. Even in the Arctic Ocean, sea ice is not the sole obstacle to shipping and maritime structures such as drilling platforms. Other challenges include polar darkness, poor charts, lack of critical infrastructure and navigation control systems, low search-and-rescue capability, high insurance/escort costs and other non-climatic factors. The related myth that climate change will create an ice-free Arctic Ocean year-round is also false, as sea ice will always re-form during winter, and ice properties and coverage will vary greatly within the region.

Myth No. 4: The Arctic is tense with geopolitical disputes and is the next flashpoint for conflict.

Fact: The region is a powerful example of international collaboration, with the Arctic countries largely conforming to standard international treaties (e.g. UNCLOS), regional forums (e.g. the Arctic Council) and regular diplomatic channels to resolve their differences. The widely publicized sovereignty-extension petitions now under way for the Arctic Ocean seafloor, for example, are science-based and not particularly controversial, with the relevant parties following the same UN procedure used to settle other continental shelf disputes around the globe.

Myth No. 5: Climate changes in the Arctic are solely of local and regional importance.

Fact: The effects of global climate change felt by the Arctic have globally relevant repercussions, with numerous impacts flowing back to the rest of the world. These include faster sea level rise owing to greater ice loss from the Greenland ice sheet; altered weather patterns due to jet stream perturbation; altered planetary energy balance resulting from lower light-reflectivity of formerly snow- and ice-covered surfaces; increasing greenhouse gas emissions from thawing permafrost soils and methane hydrates; and the psychological loss of globally iconic species like the polar bear. Within the Arctic countries (especially Canada, the Russian Federation and the US), reduced winter-road access over frozen water and ground presents non-trivial socio-economic costs to Arctic populations, transportation networks and global commodity markets.

Members of the Global Agenda Council on the Arctic

Chair
Per-Ola Karlsson, Senior Vice-President, Booz & Company

Vice-Chair
Artem Volynets, Chief Executive Officer, Amur Capital Group

Vice-Chair
Gustaf Lind, Ambassador of Sweden for the Arctic

Lawson Brigham, Distinguished Professor of Geography and Arctic Policy, University of Alaska, Fairbanks

Cai Meijiang, Director, Safety and Technology Superintendent Division , China Ocean Shipping Group Co. (COSCO)

Michael Daly, Executive Vice-President, Exploration, BP

Vladimir V. Golitsyn, Judge, International Tribunal for the Law of the Sea

Guo Peiqing, Professor, Ocean University of China

Aleqa Hammond, Prime Minister of Greenland

Rúni M. Hansen, Vice-President, Statoil

Huang Huikang, Director-General, Department of Treaty and Law, Ministry of Foreign Affairs of the People's Republic of China

Amina C. Mohamed, Secretary of Foreign Affairs, Ministry of Foreign Affairs of Kenya

Laurence C. Smith, Professor and Chair, Department of Geography, University of California, Los Angeles (UCLA)

Mead Treadwell, Lieutenant Governor of Alaska

Felix H. Tschudi, Chairman of the Board and Owner, Tschudi Shipping Company

Jan-Gunnar Winther, Director, Norwegian Polar Institute

Council Manager
Ethan Huntington, Senior Associate, Global Agenda Councils, World Economic Forum

Forum Lead
Martina Gmur, Senior Director, Head of the Network of Global Agenda Councils, World Economic Forum

References

Arctic Council, April 2009. *Arctic Marine Shipping Assessment 2009 Report*, http://www.arctic.noaa.gov/detect/documents/AMSA_2009_Report_2nd_print.pdf.

Aspen Institute, 2011. *The Shared Future: A Report of the Aspen Institute Commission on Arctic Climate Change*, http://www.aspeninstitute.org/sites/default/files/content/docs/pubs/Aspen_Climate_Change_Report_2011.pdf.

Brigham, L. "Think Again: The Arctic". *Foreign Policy*, April 2011, http://www.foreignpolicy.com/articles/2010/08/16/think_again_the_arctic#sthash.oSwiql5i.dpbs.

Brigham, L. "Marine Protection in the Arctic Cannot Wait". *Nature*, October 2011, http://www.nature.com/news/2011/111012/full/478157a.html.

Commonwealth North, May 2009. *Why the Arctic Matters: America's Responsibilities as an Arctic Nation*, http://www.commonwealthnorth.org/documents_cwnorth/Why%20Arctic%20Matters%20Final%205-22-091.pdf.

Emmerson, C., Lahn, G. *Arctic Opening: Opportunity and Risk in the High North*, April 2012, http://www.chathamhouse.org/publications/papers/view/182839.

Hansen, R.M. "A Stepwise Approach to the Arctic". *Tvergastein: The Opening of the Arctic*, November 2012, http://issuu.com/tvergasteinjournal/docs/tvergastein_second_issue_web/35.

Smith, L.C., Stephenson, S.R. "New Trans-Arctic Shipping Routes Navigable by Midcentury". *Proceedings of the National Academy of Sciences of the United States of America (PNAS)*, March 2013, Vol. 110, No. 13, http://www.pnas.org/content/110/13/E1191.full.pdf+html.

White House, May 2013. *National Strategy for the Arctic Region*, http://www.whitehouse.gov/sites/default/files/docs/nat_arctic_strategy.pdf.

Endnotes

1 See http://www.international.gc.ca/arctic-arctique/chairmanship-presidence.aspx?lang=eng

2 See http://www.arctic-lio.com/

WORLD ECONOMIC FORUM

COMMITTED TO IMPROVING THE STATE OF THE WORLD

The World Economic Forum is an independent international organization committed to improving the state of the world by engaging business, political, academic and other leaders of society to shape global, regional and industry agendas.

Incorporated as a not-for-profit foundation in 1971 and headquartered in Geneva, Switzerland, the Forum is tied to no political, partisan or national interests.

World Economic Forum
91–93 route de la Capite
CH-1223 Cologny/Geneva
Switzerland

Tel.: +41 (0) 22 869 1212
Fax: +41 (0) 22 786 2744

contact@weforum.org
www.weforum.org