Correspondence

Cold war lessons for Arctic diplomacy

Russia's threat to withdraw from the Arctic Council is a matter for global concern, with burning cold-war security issues becoming hot again. Since 1996, the council has been the high-level forum dealing with common Arctic issues through science and dialogue. But, as stipulated in its founding Ottawa Declaration, it "should not deal with matters related to military security".

This wisdom was abandoned nine days after the full-scale Russian invasion of Ukraine in February 2022, when the seven other Arctic Council states issued a joint statement "pausing participation in all meetings of the Council and its subsidiary bodies". This pause in dialogue is becoming permanent, undermining open science along with climate and other research in the Arctic. But more than that, the continuing lack of dialogue among allies and adversaries alike is the beginning of conflict.

Lessons from after the Second World War should be heeded now. The third International Polar Year (IPY), which became the International Geophysical Year (IGY) 1957–58, led directly to cooperation between the United States and Soviet Union in Antarctica as well as space throughout the cold war. The IGY facilitated the 1959 Antarctic Treaty, which became the first nuclear-arms agreement and template for the Arctic Council, with continuous cooperation among superpower adversaries. The fifth IPY, in 2032–33, offers a practical time horizon to reverse the deterioration of East–West relations, again with science diplomacy and common-interest building.

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Long COVID needs novel clinical trials

Diagnostic biomarkers and effective therapies are urgently needed for the millions of people living with long COVID. But the challenges of designing and conducting clinical trials mean that only large, well-funded academic centres can engage with the problem.

We propose an alternative approach, based on interactions between clinician–patient pairs and researchers. Before clinical trials, an online platform could enable the peer review of trial designs and plans for statistical analyses. After recruitment, the focus would shift to clinician- and patient-reported outcomes and biomarker read-outs, ideally from wearable technologies.

During treatment, a cloud-based system could be used to report adverse events and real-time biomarker read-outs, with general practitioners providing an untapped source of data. After treatment, the peer-review system could make data accessible to all relevant researchers.

We are confident that this 'grassroots' system would avoid long COVID problems that can plague clinical trials: low enrolment, late or missing trial reporting and faked or fatally flawed results.

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The authors declare competing interests; see go.nature.com/42rxxnk for details.

Europe must join forces to monitor its forests

Last November, the European Commission proposed a regulation to establish a coordinated monitoring framework for resilient forests using a combination of imagery from the European Union's Copernicus Earth-observation satellites and *in situ* data, mainly from national forest inventories. The proposal is based on the premise that forest monitoring in Europe is "fragmented and patchy", with no fully developed "consistent, transnational data-gathering approach".

This premise, however, is misleading. In 1986, the commission launched a coordinated forest monitoring scheme, which evolved in cooperation with the International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests (ICP Forests), which I currently chair. The programme now covers 37 European countries and has a comprehensive portfolio of harmonized, quality-assured methodologies, databases and governance.

Such infrastructures can provide essential data to explain changes in forest conditions and to understand processes, both key aspects when aiming to build resilient forests. At a time of increased signals of forest vulnerability, it would be a missed opportunity not to take advantage of all the available resources for the future European forest monitoring system.

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The author declares competing interests; see go.nature.com/49gphse for details.

Train taxonomists to save biodiversity

Species extinctions are speeding up worldwide. Biodiversity monitoring and assessment must underpin efforts to tackle this crisis (E. Tekwa *et al. Phil. Trans. R. Soc. B* **378**, 20220181; 2023). Yet expertise in taxonomy, the scientific basis for biodiversity research and management, has been in decline.

University credit hours in taxonomy that have been reallocated to fields such as molecular biology or biotechnology should be reinstated. Training in technologies such as digital and virtual-reality herbaria, wildlife camera traps and environmental-DNA analysis should be combined with schooling in empirical research practices. Community scientists and Indigenous people play an important part in conservation, and trained members of local groups could bolster volunteer efforts to monitor biodiversity.

Artificial intelligence can also help: trained on large taxonomic data sets, it could be used to recognize plant morphologies or animal audio recordings to aid species identification, for example. Such initiatives could fill gaps in expertise and help to achieve the United Nations Sustainable Development Goals for biodiversity conservation by 2030.

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World Bank speeds Africa's COVID vaccination

Thomas Bollyky and colleagues suggest ways in which the World Bank could accelerate vaccination in Africa (see *Nature* **603**, 788–792; 2022). Such initiatives are in fact already under way.

Last year, the World Bank teamed up with the African Union, the Africa Centres for Disease Control and Prevention (CDC) and others to support the Africa Vaccine Acquisition Trust to help countries swiftly purchase and deploy vaccines for up to 400 million people (see go.nature.com/37w8je). Moreover, the World Bank has supported the Africa CDC since 2017, to combat epidemics and advance public-health priorities. This support helped the Africa CDC to play a crucial part in tackling the COVID-19 pandemic from the outset.

The private-sector arm of the World Bank, the International Finance Corporation, has increased its activities in Africa. It is helping to fund early-stage development of local manufacturing projects for vaccines and personal protective equipment. It is also contributing to existing vaccine facilities to build up domestic capabilities. Further funding will cover logistics, transport, distribution and cold storage.

The pandemic will not end until everyone in every country has access to vaccines. The World Bank Group is committed to supporting developing countries throughout the pandemic and to helping them towards a resilient and inclusive recovery.

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One Health: evaluation framework launched

The 'One Health' approach aims to balance and optimize the health of people, animals and ecosystems in a sustainable way (see go.nature.com/3j7w8re). However, a dearth of evaluation tools is hampering application of this initiative in shaping policies and practice.

As members of the Global One Health Index team of 38 researchers and an expert advisory committee, we have developed a framework for assessing One Health performance in guiding policymaking in local settings. We used the index to assess the One Health approach of more than 200 countries and territories to zoonotic-disease control, food security, climate-change mitigation and antimicrobial resistance (see X.-X. Zhang *et al.* Preprint at https://doi.org/hq75; 2022).

As well as helping to advance general understanding of the determinants and functions of a One Health approach, the results will enable the formulation of a realistic plan for implementing the principles globally and for promoting capacity building where it is needed.

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Revitalize China's cotton industry

China is the world's largest producer of cotton, but productivity is stalling. We identify three crop-breeding factors that could help to counteract this trend.

China's cotton production is being limited by its yield-directed breeding strategies. These have narrowed the genetic background and resulted in a dearth of early-maturing, disease-resistant and high-quality traits in modern cotton cultivars. There is no effective genetic transformation platform for developing elite genotypes (X. Du *et al. Nature Genet.* **50**, 796–802; 2018), hindering attempts to tap into their genomic profiles — for example, to improve fibre quality (S. He *et al. Nature Genet.* **53**, 916–924; 2021). And technical barriers are curtailing haploid breeding, which bypasses the repeated crossing and backcrossing of conventional breeding.

Extensive screening of seed germplasm resources, coupled with molecular-marker-assisted breeding, would promote desirable traits in new cotton varieties that are suitable for mechanized production (L. Fang *et al. Nature Genet.* **49**, 1089–1098; 2017). In addition, establishing an efficient cotton-transformation platform and a haploid breeding system would accelerate the generation of pure inbred lines with multiple desired traits.

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Arctic science diplomacy maintains Russia co-operation

Leaders of international Arctic-research organizations and Arctic Indigenous peoples' organizations, from Arctic and non-Arctic states — including Russia — contributed to three webinars held in February and March. These dialogues continued despite Russia's invasion of Ukraine, conveying the importance of open science (see go.nature.com/3jkffpe) with both allies and adversaries for our shared survival as a globally interconnected civilization (see go.nature.com/3m9n1fq).

The webinar series was entitled Enhancing International Scientific Cooperation: Arctic Science and Technology Advice with Ministries (see go.nature.com/3jswed7). Funded by Japan's Ministry of Foreign Affairs, with logistic support from the United Nations Institute for Training and Research, it involved participants from 43 nations. After Russia's invasion, some representatives from European countries withdrew.

The discussions inspired international cooperation and common-interest building. Such informed decision-making operates across a continuum of urgencies, short- to long-term — from pandemic to climate timescales — for the sustainability of all (see go.nature.com/3rivds).

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POLICY FORUM

SCIENCE DIPLOMACY

The Arctic Science Agreement propels science diplomacy

Amid geopolitical tension, science aligns common interests

By **Paul Arthur Berkman,[1] Lars Kullerud,[2] Allen Pope,[3] Alexander N. Vylegzhanin,[4] Oran R. Young[5]**

Global geopolitics are fueling the renewal of East-West tensions, with deteriorating U.S.-Russia relations in the wake of conflicts in Ukraine and Syria, issues involving cyber-security, and broader concerns about expanding militarization. Against this backdrop, the Agreement on Enhancing International Arctic Scientific Cooperation, signed on 11 May 2017 by foreign ministers of the eight Arctic States, including the U.S. and Russia, as well as Greenland and the Faroe Islands, is a milestone. This "Arctic Science Agreement" is a strong signal reaffirming the global relevance of science as a tool of diplomacy, reflecting a common interest to promote scientific cooperation even when diplomatic channels among nations are unstable (*1*–*3*). It provides a framework for enhancing the efforts of scientists working on cutting-edge issues, but translating the general language of the agreement into enhanced action requires further attention, collaboration, and effort among diplomats and scientists to ensure its successful implementation. With the International Arctic Science Committee (IASC) convening the International Science Initiative in the Russian Arctic (ISIRA) at the Russian Academy of Sciences in Moscow next week, we highlight steps to advance science, its contributions to informed decision-making, and its role in maintaining the Arctic as a zone of peace and cooperation.

STRENGTHENING ARCTIC SCIENCE

Negotiated under the auspices of the Arctic Council through a process co-led by Russia and the United States, the agreement recognizes first "the importance of maintaining peace, stability, and constructive cooperation in the Arctic." This legally binding agreement aims to enhance scientific cooperation by "removing obstacles" (*4*) and by providing a basic road map and commitment to facilitate consistent access for marine, terrestrial, and atmospheric research on a pan-Arctic scale.

The agreement aims to improve use of existing infrastructures that were previously unavailable; enable new movement of researchers, students, equipment, and materials; promote sharing of data and metadata in ways that were not previously possible; and encourage holders of traditional and local knowledge to participate in scientific activities across territories (see the map). The science community, working through the organizations representing it in the Arctic Council, including IASC, the University of the Arctic (UArctic), and the International Arctic Social Sciences Association (IASSA), as well as through separate meetings of science ministers, already has identified substantive priorities for the next phase of Arctic research (*5*).

Concrete examples of improvements needed to achieve success with the agreement would be to (i) establish procedures to expedite the granting of visas and permits for accessing field sites; (ii) digitize historic and other data from hard-copy formats and create shared platforms for searching data located in a variety of repositories, including coordination with the Arctic Data Committee and Sustaining Arctic Observing Networks; (iii) use organizations mentioned in the agreement to set up and monitor research partnerships across borders; (iv) increase support for field and summer schools and related means for training the next generation of Arctic scientists; (v) promote well-formulated comparative studies designed to examine common issues at multiple locations across the Arctic; (vi) maximize the use of icebreakers and other forms of infrastructure for scientific purposes; and (vii) create innovative venues that integrate natural and social sciences along with indigenous knowledge to address common concerns.

Some of these measures will require action on the part of officials in foreign ministries; others can be handled best through organizations representing the science community. Each of the signatories can and should designate an official point of contact with a mandate to assist with the implementation of the agreement, monitor progress regarding efforts to remove obstacles, and make recommendations for the adoption of additional measures as needed.

Although the Arctic States are the signatories, the agreement emphasizes that these States "may continue to enhance and facilitate cooperation with non-Parties with regard to Arctic science." This holistic (international, interdisciplinary, and inclusive) science cooperation broadens the scope of the agreement beyond its defined area (see the map).

PROPELLING SCIENCE DIPLOMACY

The Arctic Science Agreement is the third legally binding instrument to emerge from the efforts of the Arctic States, following the search-and-rescue (*6*) and marine oil pollution preparedness and response (*7*) agreements. All have benefited from Russian and U.S. leadership of the negotiations (along

PHOTO: NASA/KATHRYN HANSEN

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Supplies are retrieved by crew from the U.S. Coast Guard Cutter Healy while in the Chukchi Sea, 12 July 2011. The Arctic Science Agreement can improve researchers' access to marine and terrestrial regions.

with Norway regarding marine oil pollution), but only the Arctic Science Agreement enhances the logistic capacity for cross-cutting knowledge discovery and application.

Historically, polar scientists have played important roles in building East-West cooperation as demonstrated at the height of the Cold War. The 1957–1958 International Geophysical Year stimulated cooperation leading to the 1959 Antarctic Treaty, with its membership based on "substantial research" to manage nearly 7% of Earth's area forever for "peaceful purposes only," becoming the first nuclear arms control agreement.

The Antarctic Treaty laid the groundwork for the 1967 treaty promoting the peaceful use of outer space. Derived from common interests of the United States and Russia, among other nations, these two international spaces (*8*) were used peacefully throughout the Cold War and remain insulated from global geopolitics as a result of science diplomacy [see the supplementary materials (SM)].

Drawing lessons from these regions and facing "burning security issues" involving nuclear weapons in the Arctic, Soviet President Mikhail Gorbachev observed in his 1987 Murmansk speech (*9*) that "scientific exploration of the Arctic is of immense importance for the whole of mankind." This speech triggered a stream of cooperative developments with science in the lead.

Recognizing the value of Antarctic Treaty linkages with the Scientific Committee on Antarctic Research, national academies of science moved quickly to establish IASC in 1990. Science-based public agencies took the lead in the 1991 formation of the Arctic Environmental Protection Strategy, which then became the first signed record of international governance among the eight Arctic States (see SM). This catalyzed the 1996 establishment of the Arctic Council (*10*) as a "high level forum" of the eight Arctic States and six indigenous peoples organizations with observers and six technical and science-based working groups, involving key Arctic stakeholders (see the map and SM). In parallel, the education community created the Circumpolar Universities Association in 1989. With the endorsement of the Arctic Council, the UArctic was born in 1998 (see the map).

Within and between nations, research and education together promote understanding of and resilience to external stresses and disturbances (*11*), applying methodologies of the natural and social sciences as well as indigenous knowledge to detect and interpret changes over time and space. For example, diminishing sea ice and increasing ship traffic in the Arctic Ocean highlight biophysical and socioeconomic changes that directly affect the security of Arctic residents facing risks today and across generations (*12*). Moreover, external stressors, which are planetary in scale, raise additional questions (see SM) about the future of the Arctic in our globally interconnected civilization (*5*).

Minimizing the risks of policy shifts, the agreement enhances the stability of research platforms across nations to interpret and disseminate previously inaccessible data, as well as generate continuous data to interpret marine, terrestrial, atmospheric, and human-centered changes on a pan-Arctic scale (see the map). Moreover, scientific investigation is being enhanced to facilitate research on land, extending from marine scientific research under the law of the sea, to which all Arctic States "remain committed" (*13*).

Resulting questions, information, and observations can be organized into data; analyzed to expose patterns, trends, and other insights; and become evidence that can underlie decisions (see SM) about built infrastructure and governance mechanisms. As an apex goal, informed decisions benefit from consideration of available options (without advocacy), which can be used or ignored by the decision-makers. In the

Arctic, this science-diplomacy process (see SM) is being enhanced by the agreement to address the "common Arctic issues," in particular, "sustainable development and environmental protection," established by the Arctic Council (*10*), balancing economic prosperity, environmental protection, and societal well-being. In this context, the Arctic Science Agreement emphasizes "the importance of using the best available knowledge for decision-making."

LOOKING FORWARD

Science, whether for basic or applied objectives, can promote cooperation and prevent conflict by engaging diverse stakeholders in dialogue. With stakeholder inclusion (see the map and SM) enhanced by the Arctic Science Agreement, holistic evidence and options become increasingly feasible for informed decision-making (see SM) to achieve Arctic sustainability across the 21st century, recognizing that children born today will be alive in the 22nd century. As the upcoming ISIRA Workshop demonstrates, the agreement is already generating opportunities to enhance pan-Arctic research that will become increasingly vital, complementing implementation of the 17 Sustainable Development Goals on a planetary scale.

Discussions foreseeing $1 trillion USD of investment in the Arctic over the next few decades (*14*) reveal global commercial opportunities extending across the 21st century (*15*), but with local risks that will swell without planning across generations. Warming of the Arctic (*16*), thermohaline changes in the ocean from melting ice sheets, decreasing albedo as sea ice disappears, and increasing methane emissions from thawing permafrost all have climate footprints with societal, environmental, and economic implications on a planetary scale (*16*).

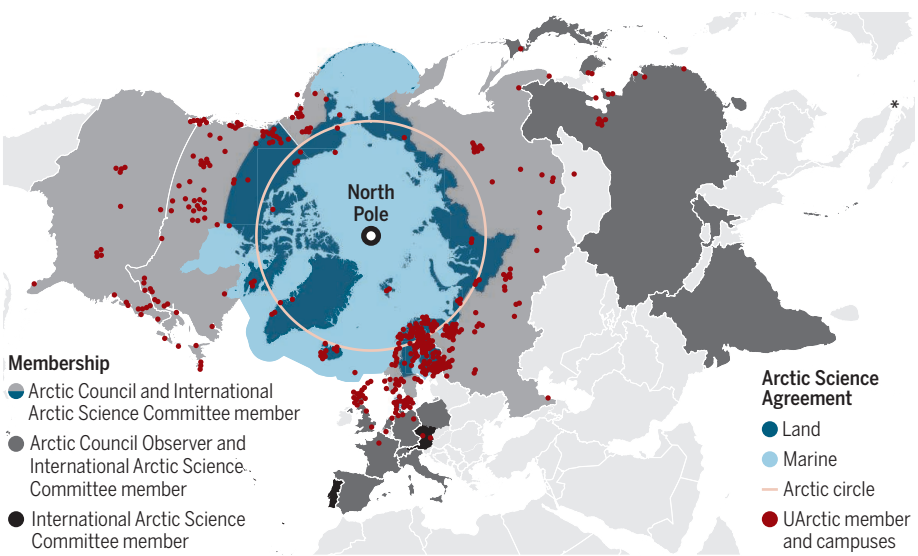
Effective implementation of the agreement will require its associated networks (including IASC, UArctic, IASSA, and partner organizations) to help strengthen research and education across borders (see the map). Considering the sovereign rights of Russia extending over nearly half the Arctic, research partnerships with Russian scientists are critical for Arctic science and diplomatic progress.

Researchers can and should invoke the Arctic Science Agreement as a research-facilitation tool to build partnerships, conduct fieldwork, access data, and begin to answer previously unanswerable scientific questions, especially with pan-Arctic dimensions. The pathway for the researcher could involve the international research and education networks mentioned above to interface with the diplomats, for example, through periodic meetings jointly convened with foreign ministries.

Ultimately, the process of science diplomacy (see SM) builds common interests among allies and adversaries alike across a continuum of urgencies, spanning security to sustainability time scales with efficiencies and synergies that transcend the geopolitics of today. These issues are being discussed among foreign ministries (*18*) and will be relevant to the continuing series of Arctic Science Ministerials (*19*). In the Arctic, as elsewhere, science diplomacy helps to balance national interests and common interests for the lasting benefit of all on Earth with hope and inspiration across generations. ■

Land and ocean areas covered by the Arctic Science Agreement

The map draws on information from the following sources: Extent of the Identified Geographic Area in Annex 1 to the Arctic Science Agreement, U.S. Department of State (2017); H. Ahlenius/Nordpil; IASC; UArctic; thematicmapping.org. The map is a stereoscopic equal distance projection (north-south). See Supplementary Materials for high-resolution map with bathymetry and topography.



*Singapore is an Arctic Council Observer State.

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SUPPLEMENTARY MATERIALS

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The New York Times

March 12, 2013

Preventing an Arctic Cold War

By PAUL ARTHUR BERKMAN

JUST a quarter-century ago, and for millenniums before that, the Arctic Ocean was covered year-round by ice, creating an impregnable wilderness that humans rarely negotiated. Today, as the effects of global warming are amplified in the high north, most of the ocean is open water during the summer and covered by ice only in the winter.

This unexpected transformation has radically altered the stakes for the Arctic, especially for the eight nations and indigenous peoples that surround it. But while there has been cooperation on extracting the region's oil, gas and mineral deposits, and exploiting its fisheries, there has been little effort to develop legal mechanisms to prevent or adjudicate conflict. The potential for such conflict is high, even though tensions are now low.

Several countries, along with corporations like ExxonMobil and Royal Dutch Shell, are preparing to exploit the region's enormous oil and natural gas reserves. New shipping routes will compete with the Panama and Suez Canals. Vast fisheries are being opened to commercial harvesting, without regulation. Coastal areas that are home to indigenous communities are eroding into the sea. China and the European Union are among non-Arctic governments rushing to assert their interests in the region. Some states have increased military personnel and equipment there.

The most fundamental challenge for the Arctic states is to promote cooperation and prevent conflict. Both are essential, but a forum for achieving those goals does not yet exist.

In 1996, eight countries — the United States, Russia, Canada, Norway, Finland, Sweden, Iceland and Denmark (which manages the foreign affairs and defense of Greenland) — and groups representing indigenous peoples established the Arctic Council to chart the region's future. So far, this high-level forum has identified sustainable development and environmental protection as "common Arctic issues." But another crucial concern — maintaining the peace — was shelved in the talks that led to the council's creation. The fear then, as now, was that peace implied demilitarization. It doesn't. But if these nations are still too timid to discuss peace in the region when tensions are low, how will they possibly cooperate to ease conflicts if they arise?

Since 2006, each of the Arctic nations has adopted its own security policy to safeguard its sovereign rights. What they must do now is compare their separate security policies, identify the ways in which those policies reinforce or conflict with one another, and then balance national interests with common interests.

How, for instance, will each nation position its military and police its territory? How will the Arctic states deal with China and other nations that have no formal jurisdictional claims but have strong interests in

exploiting Arctic resources? How will Arctic and non-Arctic states work together to manage those resources beyond national jurisdictions, on the high seas and in the deep sea? Without ratifying the Convention on the Law of the Sea, a 1982 treaty governing use of the world's oceans, how can the United States cooperate with other nations to resolve territorial disputes in the ocean?

NATO's top military commander, Adm. James G. Stavridis of the United States Navy, warned in 2010 of an "icy slope toward a zone of competition, or worse, a zone of conflict" if the world's leaders failed to ensure Arctic peace.

Whether it is through the Arctic Council or another entity, there needs to be a forum for discussing peace and stability, not just environmental and economic issues. We need "rules of the road" to take us safely into the Arctic's future.

President Vladimir V. Putin of Russia, whose economy is reliant on its rich deposits of oil and natural gas, clearly understands the benefits of a northern sea route and of the hydrocarbon deposits on his nation's continental shelf, and has emphasized the importance of peace and cooperation in the Arctic. So have leaders of other Arctic nations. But we have heard virtually nothing from President Obama, even as he has made the dangers of a warming earth a priority of his second term.

At an Arctic Council meeting in Tromso, Norway, last year, Hillary Rodham Clinton, then the secretary of state, said "the world increasingly looks to the North" but did not go much further. She called for "responsible management of resources" and efforts "to prevent and mitigate the effects of climate change."

As the head of an Arctic superpower and a Nobel laureate, Mr. Obama should convene an international meeting with President Putin and other leaders of Arctic nations to ensure that economic development at the top of the world is not only sustainable, but peaceful.

Paul Arthur Berkman, a biological oceanographer at the University of California, Santa Barbara, is the author of "Environmental Security in the Arctic Ocean: Promoting Co-operation and Preventing Conflict."

OPINION

International spaces promote peace

Lessons are still being learnt from the Antarctic Treaty, adopted 50 years ago this week. It set a visionary precedent for governing regions and resources beyond national jurisdictions, says **Paul Arthur Berkman**.

This year marks the 50th anniversary of a landmark treaty — the planet's first nuclear arms-control agreement, and the first institution to govern all human activities in a region beyond sovereign jurisdictions. Adopted in Washington DC on 1 December 1959, the Antarctic Treaty recognized that "it is in the interest of all mankind that Antarctica shall continue forever to be used exclusively for peaceful purposes and shall not become the scene or object of international discord".

During the 1960 ratification hearings of the Antarctic Treaty in the US Senate, polar scientist and explorer Laurence McKinley Gould testified that it was "a document unique in history that may take its place alongside the Magna Carta and other great symbols of man's quest for enlightenment and order". This comparison to England's legal charter of 1215, renowned worldwide as a seminal precedent for constitutional law and national democracy, may seem presumptuous. But it is fitting.

Nearly 75% of Earth's surface lies beyond national boundaries. International institutions governing such spaces are still in their infancy, having originated largely in the aftermath of the Second World War, when humankind was inexorably introduced to our global interdependence. Humankind is only gradually awakening to the shared responsibility for governing human activities in these international spaces and for managing the effects of global phenomena such as climate change. At this threshold in our civilization, the Antarctic Treaty offers a unique precedent.

Since 2000, with collaborators around the world, I have been planning an interdisciplinary and inclusive event to celebrate the first fifty years of the Antarctic Treaty. An open Antarctic Treaty Summit will be held from 30 November to 3 December 2009 at the Smithsonian Institution in Washington DC (www.atsummit50.aq). The summit will highlight lessons learned about science–policy interactions in international cooperation and governance. It also will introduce the Forever Declaration — a non-binding affirmation of the Antarctic Treaty legacy, open for signature on 1 December (on the above website) to anyone anywhere with hope for enduring peaceful uses of regions and resources beyond national jurisdictions.

CARLTON COLLEGE ARCHIVE

US embassador Herman Phleger signing the Antarctic Treaty on 1 December 1959. He later autographed this photo: "To Laurence Gould, without whom there would be no Antarctica Treaty".

> **"The Antarctic Treaty demonstrates the strength of science as a tool of diplomacy."**

The ice-covered continent of Antarctica is surrounded by oceans and is without indigenous human populations. It could easily have become an area for weapons testing and storage, or been divided up between nations interested in exploiting its resources. The first nation to claim territory in the Antarctic was Great Britain in 1908, followed by New Zealand, France, Australia, Norway, Chile and Argentina. Some claims overlapped. To avoid territorial conflicts and to preserve sovereignty rights, in 1948 the United States issued to the seven claimant nations a secret aide memoire with a draft agreement proposing an international status for the Antarctic area.

The draft focused on the global relevance of science and exploration, as well as on the importance of maintaining international peace and security in Antarctica. This antecedent of the Antarctic Treaty matured under the statesmanship of President Dwight D. Eisenhower, who entered office in 1953 envisioning "a day of freedom and of peace for all mankind".

During the cold-war period of the late 1940s and early 1950s, the United States and Soviet Union raced to create missiles that could deliver nuclear weapons across continents. Few bridges were being considered, much less built, between these superpowers. The treatment of Antarctica, at first, was no exception. At a US National Security Council meeting in June 1954, a territorial solution for the Antarctic was discussed that would "ensure maintenance of control by the United States and friendly powers and exclude our most probable enemies". Curiously, it was rocketry that would also herald cooperation in the Antarctic.

Science for peace

Meanwhile, the International Council of Scientific Unions (ICSU) had begun planning the International Geophysical Year (IGY) for 1957–58 to coordinate geophysical observations on a planetary scale. At their October 1954 meeting in Rome, the ICSU further recommended the development of satellites for the IGY, to advance upper-atmospheric research and provide unparalleled measurements of the Earth system.

Recognizing the inevitability of satellites and ballistic missiles, Eisenhower introduced his 'Open Skies' proposal in Geneva on 21 July 1955, whereby the United States and the Soviet Union would give each other a "complete blueprint of our military establishments" as part of a system of mutual aerial reconnaissance.

Eisenhower's hope was for "practical progress to lasting peace". But his proposal was rejected by the Soviet Union as an "espionage plot".

The following week, the White House disclosed its first space policy: the United States would launch small Earth-circling satellites during the IGY. Special efforts were made to ensure that this was seen as a peaceful project. The US Navy was chosen to conduct the satellite launch, even though the Army was technologically more advanced in rocketry. In fact, the Army Ballistic Missile Agency was specifically restrained by the White House from firing the fourth stage of the Jupiter-C rocket during a September 1956 test launch for fear of exacerbating the cold war. Instead, the freedom of space was preserved and perhaps because of this, the Soviet Union became the first into orbit with Sputnik in October 1957, followed three months later by the first US satellite.

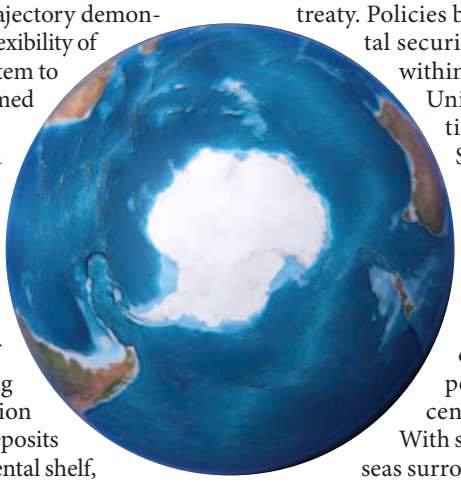
Eisenhower had failed to push through his Open Skies proposal, but there was another front on which he hoped to engage the Soviet Union in peace talks. Building on the momentum of scientific cooperation during the IGY, in May 1958, President Eisenhower invited the Soviet Union and the other ten nations involved with Antarctic research (the seven claimants, plus Belgium, Japan, and South Africa) to seek an effective means of ensuring that the "vast uninhabited wastes of Antarctic shall be used only for peaceful purposes". Over the next 18 months, 60 secret meetings were convened in the United States, culminating in the Conference on Antarctica between 15 October and 1 December 1959, when the Antarctic Treaty was signed.

The Antarctic Treaty is elegant in its simplicity. It has just 14 articles to govern the area south of latitude 60 ° S, covering nearly 10% of Earth's surface. Territorial issues were set aside. "Substantial research" activities became the criterion for nations to consult on "matters of common interest" (species conservation, open inspection, questions of jurisdiction, freedom of scientific investigation, scientific cooperation and peace) and to make decisions by consensus every one or two years. The Antarctic Treaty became the first nuclear-arms agreement, with the unrestricted inspection strategies that Eisenhower had envisioned for Open Skies. With the IGY, science had become a tool of diplomacy.

The first institution to govern a region beyond national boundaries, but without blanket governance, was the 1958 Convention on the High Seas, which formalized several long-standing concepts of international law, including the freedoms of navigation and fisheries as well as the prevention of piracy, pollution and slavery. It was the 1959 Antarctic Treaty, however, that first governed all activities in an international space, demonstrating how common interests could be used to overcome distrust. The Antarctic Treaty became the precedent for the 1968 and 1972 non-armament treaties for outer space and the deep sea, respectively.

Policy building

Once the Antarctic Treaty was in place, the signatories began to build specific policies concerning their common interests, starting with species conservation. With advice from the Scientific Committee on Antarctic Research (an ICSU body), the signatories agreed on measures for the conservation of Antarctic fauna and flora in 1964. A conservation convention for Antarctic seals was adopted in 1972. In 1980, the Convention on the Conservation of Antarctic Marine Living Resources introduced an ecosystem approach for the rational use of species living in the Southern Ocean — an area with global importance because of its extensive biomass. This policy trajectory demonstrates the success and flexibility of the Antarctic Treaty system to reach agreements informed by science.



PLANETARY VISIONS LTD/SPL

It was mineral resources that truly tested the resilience of the Antarctic Treaty consultative process. Following the 1973–74 oil embargo by the Organization of the Petroleum Exporting Countries and speculation about vast oil and gas deposits on the Antarctic continental shelf, new signatories to the Antarctic Treaty expanded exponentially over the next 15 years as nations asserted their interests in potential mineral exploitation. There was intense discussion during this period about how to regulate mineral resource activities, but these negotiations fell apart in the late 1980s. Soon after, the signatories signed the 1991 Protocol on Environmental Protection to the Antarctic Treaty, which prohibits any activity relating to mineral resources other than scientific research. Even for extremely divisive issues, the treaty process was capable of creating resolution.

As US secretary of state Hillary Clinton noted at the April 2009 Antarctic Treaty Consultative Meeting, "the genius of the Antarctic Treaty lies in its relevance today". The Antarctic Treaty model recognizes that solutions to trans-boundary or global issues must be processes involving cooperation, iteration and responsiveness to ever-changing circumstances. This lesson is particularly relevant to managing our changing climate, with perspectives and expectations beyond solutions forged at a single meeting. The challenge for governments and civil society is to envision a science-policy process that will operate over decades and centuries.

The Antarctic Treaty is especially relevant to the Arctic, where stakeholders have thus far avoided shared discussions about peace and security. Amplified climate warming in the polar regions is causing the Arctic Ocean to transition from a permanent ice cap to a seasonally ice-free sea: the most profound environmental state change on Earth. Risks of political, economic and cultural instability are inherent.

Before it becomes ice free and new commercial activities become entrenched, there is opportunity in the Arctic Ocean to establish a process of continuous policy development that explicitly promotes cooperation and prevents discord. This does not require a new treaty. Policies based on environmental security could be facilitated within the framework of the United Nations Convention on the Law of the Sea, in concert with the scientific advice of the Arctic Council and other institutions. An important outcome of this consultative process would be inspired climate adaptation policies with relevance centuries into the future. With statesmanship, the high seas surrounding the North Pole could become the next pole of peace.

The Antarctic Treaty demonstrates the strength of science as a tool of diplomacy, having facilitated peaceful cooperation between adversaries and allies at the height of the cold war. The future of our world requires leaders who can apply all such tools to balance national and common interests. Reflecting on the lasting legacy and lessons of the Antarctic Treaty during its first fifty years, 1 December deserves to be celebrated as a day of "peace for all mankind". ■

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See go.nature.com/xoiQkv for further reading.

SCIENCE AND GOVERNMENT

Governance and Environmental Change in the Arctic Ocean

Strategies are being sought that will promote international cooperation and reduce the risks of discord in the Arctic Ocean.

Paul Arthur Berkman[1,2]* and Oran R. Young[2]

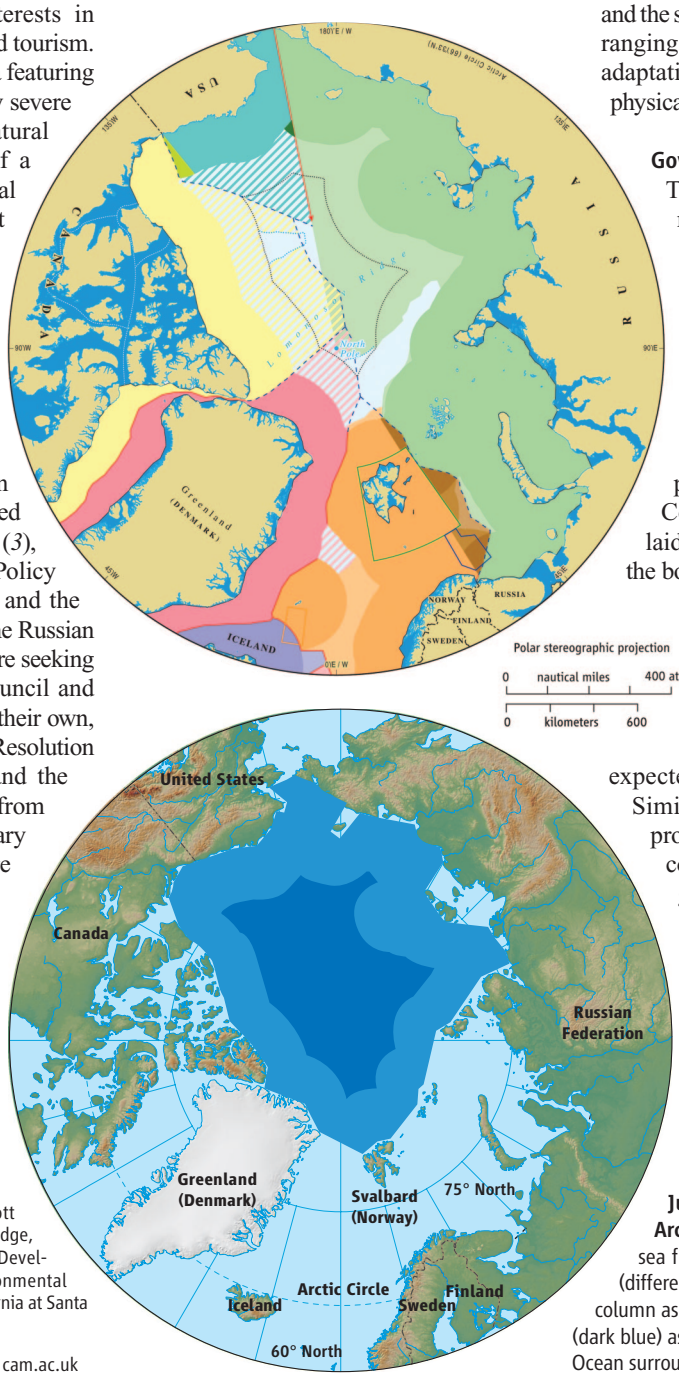
The Arctic Ocean is crossing an environmental threshold expected to transform it from a perpetually ice-covered region to a seasonally ice-free sea within the next few decades (*1*, *2*). This environmental change has awakened global interests in Arctic energy, fishing, shipping, and tourism. The Arctic could slide into a new era featuring jurisdictional conflicts, increasingly severe clashes over the extraction of natural resources, and the emergence of a new "great game" among the global powers. However, the environment provides a physical and a conceptual framework to link government interests in the Arctic Ocean, as well as a template for addressing transboundary security risks cooperatively.

The Arctic coastal states are collectively and individually reinforcing their sovereign rights and jurisdiction from their coastlines seaward, as stated in the May 2008 Ilulissat Declaration (*3*), the January 2009 Arctic Region Policy directive of the United States (*4*), and the March 2009 Arctic State Policy of the Russian Federation (*5*). Non-Arctic nations are seeking an enhanced role in the Arctic Council and asserting Arctic policy strategies of their own, as exemplified by the October 2008 Resolution of the European Parliament (*6*) and the November 2008 Communication from the European Commission (*7*). Military interests in the Arctic Ocean are mounting as reflected by the Canadian decision to purchase ice-breaking patrol vessels, the rebuilding of Russia's northern fleet, and the emerging interest in the Arctic on the part of the North Atlantic Treaty Organization.

At the same time, these developments present the international community with a historic opportunity to integrate science and diplomacy. As with the governance of other international spaces, such as Antarctica, science has a dual role: to interpret the dynamics of the Earth system (e.g., phenomena of stratospheric ozone depletion and climate change) and to carry out the monitoring, reporting, and verification needed to maintain trust in international cooperation. Success of science diplomacy in the Arctic will depend on knowledge-sharing and the steady generation of scientific findings ranging from climate feedbacks to human adaptations under conditions of rapid biophysical and socioeconomic change.

Governance Challenges

The Arctic Ocean is already subject to a number of governance systems (*8*). The 1982 United Nations Convention on the Law of the Sea (LOSC) applies to the entire Arctic Basin and is in force for all Arctic rim states except the United States, which accepts the relevant provisions of LOSC as customary international law. This governance system is playing a major role in the Arctic today. Coastal states are following the rules laid out in LOSC Article 76 to establish the boundaries of their jurisdiction over the seabed beyond the limits of the Exclusive Economic Zone (EEZ) (*9*). Russia and Norway have made submissions to the Commission on the Limits of the Continental Shelf; others are expected to follow suit (see figure, top). Similarly, the coastal states are using the provisions of LOSC Article 234 on ice-covered areas as a basis for regulatory guidelines applicable to Arctic shipping. Canada is extending the reach of its Arctic Waters Pollution Prevention Act. A number of related legal regimes, such as the 1973–78 Convention for the Prevention of Pollution from Ships and the 1995 United Nations Fish Stocks Agreement, are fully applicable to the Arctic.



Jurisdictional representations of the Arctic Ocean with boundaries based on (**top**) sea floor as a source of conflict among nations (different colors) (*17*) and (**bottom**) overlying water column as a source of cooperation, with the high seas (dark blue) as an international space in the central Arctic Ocean surrounded by EEZs (light blue) (*18*).

CREDITS: (TOP) INTERNATIONAL BOUNDARIES RESEARCH UNIT, UNIVERSITY OF DURHAM; (BOTTOM) ADAPTED FROM CANADIAN POLAR COMMISSION

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At the other end of the spectrum lies the intergovernmental forum of the Arctic Council (*10*, *11*). Although the council has no regulatory authority, it has achieved considerable success in generating policy-relevant knowledge about the Arctic and bringing Arctic issues to the attention of global forums, such as the negotiating committee that produced the 2001 Stockholm Convention on Persistent Organic Pollutants. The council's primary products have been scientific assessments, including the 1997 State of the Arctic Environment Report, 2004 Arctic Climate Impact Assessment, 2004 Arctic Human Development Report, and 2008 Arctic Oil and Gas Assessment. An Arctic Marine Shipping Assessment is scheduled for release during 2009, and science is likely to continue to play a key role in the conduct of similar assessments.

Intermediate regulatory arrangements are emerging. The International Maritime Organization adopted a set of voluntary "Guidelines for Ships Operating in Ice-Covered Arctic Waters" in 2002 (*12*). The scope of some regional fisheries management organizations (RFMOs) created pursuant to LOSC Article 118 (e.g., the Northeast Atlantic Fisheries Commission) is broad enough to cover parts of the Arctic Basin (*13*). The 1992 Convention for the Protection of the Marine Environment of the North-East Atlantic, which focuses on pollution, is applicable to a significant segment of the Arctic Ocean.

Further developments of this sort are needed, including a mandatory polar code covering all forms of shipping, an Arctic-wide agreement designed to control marine pollution, a system of RFMOs specifically applicable to large marine ecosystems located wholly or partially in the Arctic, and a regulatory regime for tourism along the lines of the International Association of Antarctic Tour Operators. Such arrangements should be in place before severe ecological damage occurs and conflicts of interest become intractable.

Yet these sectoral regimes cannot avoid the dangers of institutional fragmentation. They also cannot provide integrated governance for the Arctic Ocean treated as a large, complex, and highly dynamic socio-ecological system (*14*). Some relevant precedents for integration exist. The 1980 Convention on the Conservation of Antarctic Marine Living Resources, for example, is based squarely on the goal of ecosystem-based management (EBM). But there is a clear need for enhanced scientific understanding of both biophysical and socio-economic systems in the Arctic as a basis for applying EBM. An important step is to strengthen the International Arctic Science Committee to further facilitate cooperation in all aspects of Arctic research (*15*). We also need to carry forward the shared momentum of the 2007–09 International Polar Year to stimulate ongoing interdisciplinary research and analysis relevant to the practice of EBM in the Arctic.

One useful approach in developing effective governance for a rapidly changing Arctic may be to treat the central Arctic as an international space and to draw a clear distinction between the overlying water column and the sea floor. Ecologically and legally distinct from the sea floor, the overlying water column and sea surface of the central Arctic can remain an undisputed international area (see figure, page 339, bottom) in which the interests of Arctic and non-Arctic states alike play a role in the development of effective governance. This region involves the high seas, a sea zone universally accepted as beyond national jurisdictions. Focus on the high seas opens the door to treating the central Arctic as an international space subject to cooperative decision-making regarding a variety of issues (e.g., fishing and shipping) through regulatory arrangements articulated under the auspices of LOSC and customary international law.

Environmental Security

As the European Commission Communication points out, environmental changes are altering geostrategic dynamics of the Arctic, and these changes could have consequences for international stability (*7*). The resultant risk of political, economic, or cultural instability has become a matter of global security. However, an inclusive dialogue about security risks and responses relating to the Arctic Ocean has yet to emerge. The injunction in the 1996 Ottawa Declaration that the Arctic Council should not deal with matters related to military security (*11*) is a serious constraint on efforts to address security and to come to grips with transboundary challenges. This has not precluded ad hoc measures directed toward specific concerns, like mitigating the impacts of radioactive waste associated with decommissioned nuclear submarines (*16*). But it has truncated efforts to design a coherent and inclusive approach to Arctic Ocean governance that prevents international discord.

The success of the Antarctic Treaty, founded on scientific cooperation and denuclearization, offers inspiration, although differences between the polar regions rule out a similar treaty in the Arctic. Moreover, in the Arctic, the combination of national and common interests will expand the policy choices for governments to enhance their own security.

Harmonization of international law with national approaches is a difficult task, especially without detracting from the authority of the Arctic rim states over their coastal and continental shelf regions. Nonetheless, national implementation strategies lack the consistency needed to resolve transboundary issues in a dynamic natural system. Holistic integration of EBM and other maritime management strategies pertaining to the Arctic Ocean requires coordination that acknowledges the special role and responsibilities of the Arctic States and indigenous peoples organizations. Before sectoral activities accelerate with the diminished sea ice, the window of opportunity is open for all legitimate stakeholders to forever establish their common interests in the central Arctic Ocean as an international space dedicated to peaceful uses.

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