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The Arctic at a Crossroads:
The Making of a New Frontier

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WILEY

The Arctic at a Crossroads

The Making of a New Frontier

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Foreword

The Arctic, once characterised by its geographical isolation, limited research, and icy conditions, was a region where extensive uninhabited areas were traversed by indigenous communities who adapted to the severe cold and sparse flora and fauna of the tundra. In recent decades, this landscape has undergone a significant transformation. Increased scientific research endeavours, the exploration and extraction of petroleum and mineral resources, the development of new shipping, communication, and logistics infrastructure, as well as intensified great power competition, have fostered the establishment of a multilateral framework, the Arctic Council, which will mark its 30th anniversary in 2026.

India is a tropical country with its southern extremities closer to the equator than its northern ones are to the Arctic Circle. However, decades of research on the most precious phenomena, the monsoon winds, and the most distinct geology to us, the Himalayas, have demonstrated that, geographical distances aside, what affects the Arctic also affects the Indian subcontinent. India is intimately connected with the Arctic.

India's vision for the Arctic, as an observer of the Arctic Council and as outlined in its 2022 National Arctic Policy, is founded on a trusteeship approach for sustainable development. The economic interests to be derived from the High North of planet Earth must be evaluated in light of global net-zero objectives, commitments to the Sustainable Development Goals, and India's international initiatives concerning clean energy, clean fuels, sustainable lifestyles, the safeguarding of traditional knowledge, and ecological conservation.

The Arctic at a Crossroads: The Making of a New Frontier convenes scholars, experts, and policymakers from around the globe who are aligned with these objectives. This compilation addresses pertinent issues, including climate action, science diplomacy, geopolitics, and emerging connectivity projects in the High North. The diversity of insights and intellectual contributions in this publication will significantly influence discussions and initiatives in and on the Arctic region.

Samir Saran
President, ORF

Editors' Note

The Arctic region is experiencing rapid change along multiple fronts: the opening of new maritime trade routes, the region's vulnerability to climate change and environmental degradation, its enormous natural resources, and the extractive industries vying for them, as well as, most importantly, its status as a new geopolitical theatre. Years before the High North became a crucial geopolitical and geoeconomic arena, geoscientists were the first to recognise that 'what happens in the Arctic does not stay in the Arctic'. This phenomenon, known to scientists as 'teleconnections,' is showcasing increasingly wide-scale ramifications, including in tropical and equatorial countries that previously had no stake in Arctic affairs. With the Arctic poised to experience a surge in economic activity, these teleconnections are likely to become the cornerstone of international relations.

The Arctic at a Crossroads: The Making of a New Frontier brings together scholars from various Arctic and non-Arctic countries to present realistic observations and their vision and recommendations for the region. Their expertise spans climate sciences, area studies, international relations, sustainable and

clean energy, ocean and maritime studies, and science and policy studies related to the polar regions.

A common understanding that emerges from the essays in this compendium is the equal role of Global North and South countries in ensuring that economic progress in the Arctic is carried out with stringent environmental and climate action measures, while protecting the welfare of native Arctic communities and their cultures. For that to happen, all possible mechanisms to promote and ensure international consensus must be put into motion. For comprehensive and holistic progress in the Arctic, there is now a need for the scientific exploration of environmental and climatic changes, for which Arctic science cooperation must be significantly enhanced. Similarly, economic activities cannot prevail without considering sustainable measures, such as using clean energy and fuels, pursuing net-zero policies, and preventing the pollution of permafrost, glaciers, lakes, the Arctic Ocean, and the region's air (primarily from greenhouse gases, black carbon, and other particulate matter). These factors must determine the evolution of geoeconomics and geopolitics in the Arctic.

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In her essay for 'The Arctic Alarm: Climate Signals from the North' section, Uma Bhatt notes that rapid environmental changes in the Arctic have far-reaching ramifications worldwide, affecting monsoon systems, leading to extreme precipitation events, and triggering climate change-induced security scenarios. She argues that India, a non-Arctic nation, needs to utilise its scientific and technological capabilities in the Arctic to assume a leadership role to shape Arctic policies that are essential for a safe and resilient future of the world.

Irina Strelnikova observes that international relations, particularly in the post-2022 era, have strained the scientific cooperation essential for the Arctic region. The resumption of dialogue between Russia and the West is imperative for continued Arctic scientific monitoring and to prevent gaps in understanding the potential long-term implications on the global climate. She also advocates for increased participation by Asian countries in Arctic science diplomacy, particularly in areas such as navigation safety and biodiversity conservation, which fall beyond the scope of the Arctic Council.

Next, Shailly Kedia and Abhilash Kolekar highlight the steps necessary for the sustained global governance of the Arctic region. They note that Arctic governance cannot be modelled on the principles of the Common Heritage of Mankind, as is the case with Antarctic governance. Littoral nations oppose a commons approach in favour of preserving their sovereignty. Nonetheless, a moratorium on commercial activities in the Central Arctic

Ocean must be maintained in some form beyond the current 16-year period. Furthermore, they emphasise the importance of integrating Arctic scientific data collected by climate action organisations and international meteorological and space agencies into policy and economic decision-making processes. Lastly, they highlight that the concept of nationally determined contributions is inherently state-centric and lacks provisions for transboundary impacts, a matter that warrants review as safeguarding the Arctic has increasingly become a global concern.

Kamrul Hossain emphasises the importance of the Earth's cryosphere, which plays a crucial role in regulating global surface temperatures. Any perturbations in the cryosphere, whether in the Arctic or Antarctic, will have an impact on cryospheres in the tropics. Hossain suggests that pursuing a unified examination of the global cryosphere is necessary to comprehend planetary-scale environmental feedback loops.

Zerin Osho presents a realistic scenario in which Arctic governance mechanisms struggle to keep pace with the accelerated impacts of climate change. These impacts will only heighten as melting Arctic ice unlocks access to vast mineral and petroleum resources. If the extraction remains unchecked due to unbridled ambitions for oceanic connectivity, the Arctic ecosystem is at risk of enormous degradation. To mitigate this grave scenario, Osho emphasises the need for the Asia-Arctic Five (India, China, Japan, South Korea, and Singapore) to assert their influence over the Arctic Council's engagements. Their neutral influence will alleviate tensions within the Council and refocus attention on global cooperation in this crucial region.

Next, in the opening essay for 'The Arctic Laboratory: Unlocking Opportunities of Science' section, Mikatekiso Kubayi notes that most scientific cooperation pursuits are driven by modern instruments established by countries that are signatories to the Antarctic Treaty. However, this approach does not account for the experiences and knowledge of the Arctic's indigenous communities. He suggests that although many countries in the Global South cannot invest vast monetary resources in expensive Arctic research infrastructure, mechanisms should be developed to include them in this collective global pursuit, as they are also vulnerable to the impacts of climate change.

Sulagna Chattopadhyay presents a historical account of how large swaths of the Arctic were once transferred from one country to another: from Russia to the US, from the US to the UK, and from the UK to Norway. The world's perception of the Arctic region is undergoing a similar transformation. She highlights the significance of the 'Scandinavian Code'—a set of distinct laws, codes of conduct, and ethics typical of the Scandinavian countries—which the Global South must become familiar with to gain access to the Arctic.

Amid growing commercial interests in the Arctic, Alexandra Middleton recommends that economic actors pursue science-informed business strategies based on evidence gathered through peer-reviewed mechanisms provided by international scientific bodies, and adopt science-based environmental, social, and governance frameworks that align with sustainable activities in the Arctic. Both these regulatory pursuits should be undertaken through a dedicated, multilateral platform that facilitates intersectional science-business collaboration.

Corine Wood-Donnelly highlights the importance of generating continuous temporal scientific datasets as governments worldwide strive to monitor both minute and broader changes occurring in the Arctic. She also notes the underwhelming role of social science and the humanities in Arctic studies and recommends that these be explored further amid the growing political, economic, and multidisciplinary dynamics emerging in the region.

Maria Lagutina's essay focuses on Russia's Arctic policy and the growing pivot towards Asia in the aftermath of 2022. As the largest Arctic littoral country, Russia has long invested in scientific infrastructure and pursued Arctic studies. She urges India and Russia to explore new avenues of Arctic science-business cooperation, with the intention that India establishes its presence in the Arctic in a significantly expanded form than what its Himadri Station currently offers.

In the next section, 'The Arctic Opportunity: New Business Pathways,' Nima Khorrami's essay explores China's multifaceted Arctic strategy that links resource extraction, maritime logistics, scientific research and dual-use technology development. China is the first Asian country south of the Arctic Circle to refer to itself as near-Arctic, and an influential operator in the Northern Sea Route (NSR), which highlights its ambition to shape the discourse, then the normative order of the Arctic, and further institutionalise its Arctic presence. However, China's Arctic ambitions are not without challenges, particularly Western sanctions and Russia's consternation about the skewed bilateral ties.

Pavel Gudev further elaborates on the significance of the NSR, its legal interpretations by the US and Russia, and how Russia, with the longest coastline among Arctic nations, differentiates between domestic maritime transport routes and international transit routes. Such legal interpretations require careful examination, considering national sensitivity, particularly as international maritime activities are expected to increase in Arctic waters.

Monty Khanna highlights completely novel areas of opportunity for India, leveraging its existing large workforce and expertise in the maritime, hospitality, and healthcare industries. With pleasant summers and habitats designed to withstand harsh winters,

the hospitality sector in the Arctic is expected to grow, driving demand for well-trained professionals. As the Arctic population increases due to the intensification of economic activities, well-trained medical and para-medical professionals will be needed to operate in these harsh geographies. Likewise, with more traffic passing through the NSR, seafarers will be in demand, especially those trained on icebreaker ships.

Chaitanya Giri and Sayantan Haldar discuss the significance of hydrogen and ammonia as fuels in efforts to decarbonise the diesel-based road and rail transportation in the Arctic region, which also contributes to black carbon emissions, a threat to the region's environment. Since most rail and road networks are built for the transportation of petroleum and mineral resources, decarbonisation of these networks using grey hydrogen fuel derived from natural gas, and turquoise hydrogen fuel derived from methane seepage should be promoted. Similarly, hydrogen, particularly in the form of ammonia, could serve as a clean fuel for ships operating in Arctic waters.

Sakiko Hataya writes about Japan's active and constructive role in Arctic affairs, including environmental matters, and the development of advanced mitigation technologies necessary for preventing and mitigating damages caused in this sensitive Arctic region. Notably, through its positive bilateral and multilateral contributions with Arctic Council member countries, Japan, a Council observer state, has highlighted the role non-members can play.

In her essay for the final section, 'Geopolitics in the Arctic: An Emerging Great Game,' Jennifer Spence emphasises the necessity for the mainstream media to look beyond existing narratives on Arctic affairs. There exists considerable potential for news coverage that underscores the leadership, resilience, and traditional knowledge of Arctic communities, as well as the complexities of Arctic governance, international collaboration, and science diplomacy.

Andreas Østhagen and Andreas Raspotnik present a unique security insight from Scandinavian countries. Although the Nordic countries continue to have their independent perspectives and priorities in the Arctic, the security equilibrium has now shifted since these countries have become NATO members, and as NATO and EU institutional collaboration has strengthened.

Elizabeth Buchanan discusses how the Arctic theatre, previously characterised as a conflict between the West and the Soviet Union, has now evolved into a confrontation between the 'West' and the 'rest'. Moscow's inclusion of Asian partners in its strategic initiatives is indicative of the 'Arctic Great Game'. The rivalry among great powers is expected to

accelerate resource extraction, increase pollution in the Arctic region, and potentially lead to the termination of the moratorium on fishing in the Central Arctic Ocean.

Next, Christopher Rossi highlights the origins of the Arctic Council, based on the premise of Arctic exceptionalism and its status as a 'zone of peace'. However, progress made by the Arctic Council on non-military conversations has come to a standstill since 2022. He delves into the identification of a new 'heartland', based on Halford Mackinder's construct, centred around Ukraine, while Russia assumes its heartland also consists of the Arctic. The Arctic, according to Rossi, has begun to appear as an arena of hybrid tension; however, he suggests that this is a distraction from the real game being played in Eastern Europe and the South China Sea.

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The Arctic, despite not being a global common, has the potential to transcend the rhetoric and theories of international relations. It constitutes a zone of constructive international cooperation that serves the interests of the global good. Conversely, it also functions as a domain of significant power competition. This compendium offers comprehensive insights into the prospective development of this cooperation, emphasising the roles played by non-Arctic actors as Arctic littoral nations endeavour to resolve their political and ideological differences. It is hoped that this compendium will aid foreign policy analysts, scientists, business entities, innovative startups, scholars, and policymakers in their efforts to advance constructive progress in the Arctic region. Furthermore, it recognises that progress in this region has teleconnections with the Global South, which stands to gain more from collaborative development than from escalating adversarial conflicts.

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The Arctic Alarm

Climate Signals from the North

Embracing the Interconnected World to Protect the Future

Uma Bhatt

Over the past four decades, scientists have confirmed that 'what happens in the Arctic does not stay in the Arctic' (1). Once considered a remote and static frozen region, the Arctic is now recognised as a dynamic system with profound global consequences. Amplified warming (2) has transformed it from a carbon sink into a source (3), while rapid sea ice loss (4) and increasingly frequent wildfires (5) are altering atmospheric circulation and accelerating greenhouse gas emissions. These changes have far-reaching impacts, reverberating beyond the polar regions to influence monsoon systems (6), extreme precipitation (7), and climate security for vulnerable nations in the Global South (8). At this pivotal moment, international cooperation is essential (9)—not only to protect the Arctic itself, but to safeguard Earth's environmental health and resilience.

Early Arctic Science: From Exploration to Coordination

The scientific study of the Arctic began with the daring expeditions of the late nineteenth and early twentieth centuries. Norwegian explorer, scientist, humanitarian and Nobel Peace

Prize laureate Fridtjof Nansen allowed his ship, the Fram (10), to drift across the Arctic Ocean from 1893 to 1896 and provided the first systematic observations of sea ice and ocean circulation in the central Arctic, forming the first points of the historical climate record. Nansen's observations of wind direction and sea ice drift, combined with the theoretical insights of Swedish oceanographer Vagn Walfrid Ekman, revolutionised oceanography by explaining wind-driven current dynamics (11).

Building on this foundation, the Soviet Union launched a series of drifting ice stations beginning in 1937 (North Pole-1 and successors) (12). These camps provided the first sustained, long-term meteorological and geophysical measurements in the central Arctic, demonstrating the value of systematic polar observations. Over time, individual and national efforts gave way to international coordination and cooperation. The first (1882-83) and second (1932-33) International Polar Years (IPY) pioneered multinational collaboration, and the International Geophysical Year (1957-58) established a model for modern cooperative science (13).

Disruptions: Politics and Science Entwined

Despite these advances, political developments have repeatedly disrupted Arctic science. The dissolution of the Soviet Union in 1991 abruptly ended the long tradition of Russian ice stations, with a 13-year gap before they were reestablished (14). Simultaneously, the number of Russian land-based observing stations declined sharply, resulting in significant blind spots in climate monitoring over the Eurasian Arctic.

More recently, the war in Ukraine has dealt another blow (15). US and European scientists have withdrawn from Russian field sites, including the well-instrumented Tiksi Observatory (16), a collaboration with the US National Oceanic and Atmospheric Administration, and Lena River Delta Samoylov monitoring station (17), a partnership with the Alfred Wegener Institute in Germany. These facilities, built through years of international collaboration, have provided critical insight into atmosphere-ice-land interactions. Their abandonment is more than a loss of infrastructure: it reflects the erosion of trust and dialogue between Western and Russian scientists, stalling progress on urgent questions of sea ice decline, wildfire risk, and permafrost change.

Modern Era: Integrated Campaigns and Modelling

Despite setbacks, the late twentieth and early twenty-first centuries ushered in unprecedented cooperation. The Surface Heat Budget of the Arctic Ocean (1997–98) (18) expedition, the first year-long modern drift by a research vessel, yielded coupled

atmosphere-ice-ocean datasets. The Fourth IPY (2007-09), involving more than 60 nations, expanded this cooperative spirit and set a standard for interdisciplinary research. The Multidisciplinary Drifting Observatory for the Study of Arctic Climate (2019-20) (19) became the most ambitious polar expedition ever undertaken, uniting hundreds of scientists and dozens of nations, who persevered during the COVID-19 pandemic.

Planning for the Fifth IPY (2032-2033) has already begun (20). At the same time, global climate modelling has matured into a pillar of Arctic science, with Russia, India, and other nations contributing to the Coupled Model Intercomparison Project (21). Together, these programmes underscore how far Arctic research has advanced—from isolated expeditions to a global enterprise synthesising observations, modelling, and policy-relevant knowledge.

The Arctic in a Global Climate System

The Arctic climate system does not operate in isolation. Amplified warming and sea ice loss are altering midlatitude circulation, influencing the jet stream, and driving more frequent extremes such as heatwaves, cold-air outbreaks, and droughts. Teleconnections extend even further: Arctic variability interacts with the El Niño-Southern Oscillation, shaping rainfall in the tropics.

For South Asia, the implications are profound. Recent studies suggest that Arctic change can influence the Indian summer monsoon, impacting rainfall that is crucial for food security and water management (22). Thus, Arctic change is not just a regional concern—it directly affects the livelihoods of billions in the Global South.

Given the Arctic's remoteness, satellite observations have become indispensable. Polar-orbiting platforms provide continuous, high-resolution monitoring of sea ice, snow, permafrost, and vegetation. Over the past four decades, satellites have revealed dramatic declines in summer sea ice, shifts in melt and freeze timing, and transformations in Arctic land cover.

Their importance has only grown as traditional ground-based networks have contracted. Political disruptions and cost-cutting measures have reduced the number of land stations in Russia, the US, and Canada, leaving satellites as the most reliable tools for consistent pan-Arctic coverage.

India has entered this global observing system, with the Indian Space Research Organisation (ISRO) partnering with the US's National Aeronautics and Space Administration (NASA) on the NISAR mission (NASA–ISRO Synthetic Aperture Radar) (23). Launched in

2025, NISAR delivers daily, sun-synchronous coverage, providing unprecedented detail on glacier dynamics, permafrost thaw, and ice sheet change. By contributing advanced Earth-observing capacity, India is positioning itself at the forefront of Arctic monitoring and strengthening the global scientific enterprise.

India's Role and Path Forward

India is already a recognised player in polar science, with longstanding programmes in Antarctica, active Himalayan research, and expanding Arctic activities. Initiatives such as the 2020 'Vaishvik Bharatiya Vaigyanik Summit' (24) sought to connect non-resident Indian scientists with their domestic counterparts, broadening research capacity. India is also investing in icebreaker development, ensuring infrastructure for future expeditions. Amid the enforced economic sanctions, Russia may need to contract India to build icebreakers (25). This contract will strengthen India's standing in shipbuilding, thereby enhancing the country's ability to navigate the Northern Sea Route and conduct scientific exploration of the polar regions. Combined with India's vast pool of Earth system scientists and data expertise, these investments make the country a valuable partner in international Arctic research.

Diplomatically, India's historic ties with Russia position it uniquely as a potential broker for sustaining scientific dialogue in an era of fractured geopolitics. As Western and Russian collaborations stall, India could help maintain communication channels essential for joint observation and modelling.

While much of the Arctic research enterprise has focused on documenting and understanding ongoing change, attention is increasingly turning toward interventions. Geoengineering proposals—from solar radiation management to regional albedo enhancement—are moving from theoretical debate toward small-scale experimentation. These measures carry the potential for profound and uneven consequences across the climate system. For the Arctic, interventions might slow ice loss locally but disrupt atmospheric circulation in ways that cascade into mid-latitude weather extremes and tropical rainfall variability (26).

Such unintended impacts will be especially consequential for South Asia, where even small shifts in the Indian summer monsoon can jeopardise food and water security for billions (27). This makes geoengineering not just a scientific issue, but a core policy concern for India and the Global South.

For these reasons, any future exploration of geoengineering must occur under robust international governance frameworks, rooted in transparency, cooperation, and equitable participation. India—through its growing leadership in polar science, advanced Earth observation programmes such as NISAR, and a long tradition of multilateral engagement—is well positioned to advocate for safeguards that protect vulnerable regions while ensuring that Arctic interventions do not compromise global resilience.

Conclusion: A Pivotal Moment for India and the World

Humankind stands at a pivotal moment in history. Human reliance on fossil fuels has driven the climate into an era of unprecedented extremes—floods, landslides, and disasters that know no borders. The Arctic, both a sentinel and a driver of this global change, serves as a reminder that local processes have profound planetary consequences.

For the world to respond effectively, nations must work together. With its scientific expertise, space capabilities, and diplomatic reach, India is well-positioned to play a leadership role in advancing Arctic science and sustaining cooperation. In doing so, India can help ensure that the Arctic's signals are not warnings ignored but pathways toward a safer, more resilient global future.

Uma Bhatt *is a Professor of Atmospheric Sciences at the University of Alaska Fairbanks, conducting research on climate variability with a focus on the Arctic and Alaska.*

Endnotes

(1) This phrase is widely cited in the press, with one of the earliest attributions to Howard Epstein of the University of Virginia, who was quoted during the US National Oceanic and Atmospheric Administration's annual Arctic Report Card briefing in 2013: "The Arctic is not like Vegas. What happens in the Arctic does not stay in the Arctic." The remark is a play on the well-known Las Vegas tourism slogan, "What happens in Vegas, stays in Vegas."

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The 'Global Arctic' and Climate Change: The Asia Factor

Irina Strelnikova

Although climate change in the Arctic is recognised as one of the most pressing issues in the region, its dynamics, irreversibility, and the reasons for its occurrence and intensification remain a subject of serious debate. The severity of the impact of global warming on the Arctic ecosystem and the potential risks of these threats spreading beyond the region are yet to be identified by scientists.

Some scholars proposed using a series of "indicators" to measure the dynamics of climate change (1). A different study built upon this premise to establish the following nine indicators to understand the dynamics of climate change in the Arctic between 1971 and 2017 (2):

(i) The annual **air temperature change** in the Arctic shows warming of 2.7°C. The temperature increased by 3.1°C from October to May and by 1.8°C from June to September. Later sea ice freezing and moisture advection in the region are the primary reasons for the increase in winter temperatures in the Arctic.

(ii) **Permafrost temperature** increased by 2.5°C. The melting of permafrost may alter water supplies in lakes and in the soil, thereby directly changing the processes of moisture exchange in the atmosphere. Increases in the average annual temperature of air, water and soil are clear indicators of melting permafrost.

(iii) The increase in **humidity** in the region is partly due to an increase in moisture advection at mid-latitudes. Increased humidity enlarges long-wave radiation, thereby contributing to increased warming. The rate of increase in Arctic humidity is estimated to be between 1.5 percent and 2 percent per decade.

(iv) Increased rainfall was detected in warm Arctic areas, while snowfall increased in colder regions.

(v) With increased average temperature and humidity, the Arctic is being **greened** and experiencing an increase in biomass from different vegetation. There is also strong evidence that summer warming causes an earlier and shorter flowering period for key plant species in interaction, including those involved in pollination.

(vi) Due to increased humidity and vegetation in the Arctic, there is an increase in the number of **fires** and the risk of fire during dry seasons.

(vii) The snow cover on land has decreased by more than 30 percent in spring. Due to the frequent thawing and precipitation in some Arctic regions, there is an increase in ice layer formation in the snow cover. Snow is a major factor in the functioning of the Arctic ecosystem, affecting surface energy balance, melting of permafrost, hydrology, plant phenology, and greenhouse gas exchange. More extended periods without snow will significantly impact the energy balance of the tundra, its ecosystem, and water circulation in the region.

(viii) There is also a predominance of the thinner **first sea ice**, which has replaced the thick and perennial ice, characterised by earlier melting. Its thickness and volume continue to decrease.

(ix) The regional balance of the **mass of glaciers** is also being reduced, both because of changes taking place and the acceleration of their development.

Although this study on climate change in the Arctic is detailed and pioneering, it does not answer the question of what (or who) is the primary cause of climate change in the region. Instead, it concludes that the Arctic ecological system is clearly deviating from its former

state, initiating a cycle of changes that will have consequences on the region and worldwide. Preventing these threats requires a collective response from the international community.

International relations in the Arctic region, traditionally defined within the terms of regional "exceptionalism" (3), have undergone significant change since the early 2010s. The 'Global Arctic' theoretical construction best defines the current state of affairs in the region (4,5). It differs from the traditional "Arctic exceptionalism" in two key ways: (a) environmental issues are perceived as a major regional threat, but are expected to be resolved through increasingly inclusive cooperation with various non-Arctic states; and (b) the increased involvement of non-regional states in the Arctic is due to the growing contradictions between the Arctic states and the region's growing instability, as well as the growing awareness that climate change in the Arctic is genuinely global in impact.

Asia's Deepening Ties

Climate change in the Arctic is a key concern for India, particularly given its impact on the vulnerable ecosystem of the Himalayan mountains, which house one of the largest reservoirs of water and ice outside the polar regions, thereby directly affecting the circulation of water in major Asian rivers, including the Mekong and Brahmaputra (6). In addition, the melting of permafrost and potential 'opening' of the Northern Sea Route are matters of concern for India's logistics enterprises, as the country is at the advantageous crossing of sea trade routes. Unpredictable changes in the Himalayas and rising sea levels are equally important for China, which is traditionally seen as the main Asian 'scientific actor' in the Arctic. China also has more significant economic and political interests in the region than India. As such, Beijing is seen as seeking to increase its influence in the region to prevent threats to its security and realise its economic interests through investment in the research, economy, logistics, and mining infrastructure of some Arctic states (7).

Japan, South Korea, and Singapore are also among the Asian countries affected by climate change in the Arctic. In general, these states are united by a common economic interest—participation in shipbuilding activities, which is also related to the supply of advanced information and technological products for ship technical equipment.

South Korea is concerned about the exclusivity of existing regional cooperation institutions and rising tensions in the Arctic. Seoul believes that further enhancing its role in the Arctic—as well as increasing stability in the region—requires resolving conflicts between Arctic states based on a single agreement. It believes that the parties interested in the Arctic should be involved in constructively developing this agreement (8).

Singapore, for its part, does not have a direct interest in the transformation of Arctic cooperation regimes; however, it is more actively engaged in global maritime security issues, potential mineral development in the Arctic, and the development of commercial maritime transport initiatives. Indeed, Singapore has sought to engage and enhance its role in matters related to marine and ocean security, including in the Arctic Ocean (9).

Japan, like China, is seeking to further its participation in Arctic "low politics" by developing its own initiatives and projects, as well as infrastructure and human capital, aimed at solving the common problems in the Arctic (10).

With specific reference to climate issues, most ideas emerging from the Asian countries interested in the Arctic imply a deeper participation in various international regimes and treaties aimed at combating climate change. Several treaties, conventions, and forums aimed at protecting Arctic biodiversity and mitigating the adverse effects of climate change are already in effect.

The Arctic Council is the most influential and vital international forum for the region. As a key institution of political cooperation and regional governance, its functional organisation is divided into three levels. The main "practical-oriented projects" related to transnational collaboration are at the level of working groups (the third level).

Although non-Arctic states with observer status can participate in the Council's activities, including working groups, their participation is limited by the Council's governing rules. Notably, amid the war in Ukraine, the Arctic Council has been 'frozen', although working group-level cooperation between Russia and its Western partners has resumed. Given this state of affairs, alternative avenues of transnational cooperation in the Arctic for climate change should also be considered (see Table 1).

Table 1: Treaties and Agreements in the Arctic

Documents	Year of signing	Objective of the document
I. Related to the safety of navigation, protection of seas, and fisheries		
The International Convention for the Regulation of Whaling	1946	To maintain the population of whales
The International Convention for the Prevention of Pollution from Ships (MARPOL)	1973	To minimise operational pollution from ships
UN Fish Stocks Convention	1995	To prevent illegal fishing, monitor fish populations

Documents	Year of signing	Objective of the document
The Agreement to prevent unregulated high seas fisheries in the Central Arctic Ocean	2018	To ensure sustainable fishing practices
The International Code for Polar Vessels (or Polar Code)	2014-2015	To improve the safety of navigation in the vulnerable ecosystems of polar regions
The UN Declaration on the Rights of Indigenous Peoples	2007	To establish minimum standards for the survival of indigenous peoples worldwide
II. Related to conservation of flora and fauna		
Convention on International Trade in Endangered Species (CITEC)	1973	To regulate global trade in wild-growing species
UN Convention on Biological Diversity (CBD)	1992	To ensure the conservation and sustainable use of biodiversity
Agreement on the Conservation of Polar Bears	1973	To protect polar bears and their natural habitat
III. Related to environmental protection		
The Convention on Long-range Transboundary Air Pollution	1979	To reduce transboundary air pollution
The Convention on Environmental Impact Assessment in a Transboundary Context (the Espoo Convention)	1991	To oblige states to inform each other of any activities or projects that may have a transboundary impact
The Kyoto Protocol	1997	To reduce carbon emissions and slow down global warming
The Paris Agreement	2016	To prevent the average global temperature from rising by more than 2°C annually by 2100

Source: Collated by the author from various sources

The Arctic is not as far for Asian states as previously claimed. China, India, Japan, South Korea, and Singapore participate in almost all the regimes listed in Table 1. Further deepening their participation in these regimes or joining them (11) is a crucial step towards increasing their role in addressing the Arctic's environmental challenges, both in terms of practical initiatives and in enhancing their standing in the region.

Partnering with Russia

Only China and India are major partners of Russia in the Arctic, and represent the most promising potential for cooperation (12). Meanwhile, Singapore, Japan, and South Korea currently support the Western sanctions regime against Moscow.

The most promising avenue of cooperation for Russia, China, and India in the Arctic is scientific research. This is primarily due to the traditional transnational cooperation in the Arctic region, which is limited mainly by the functional framework of 'low policy'—scientific and socio-cultural spheres of interaction—that do not concern the sovereignty and security of Arctic states, particularly Russia. Notably, the convergence of these three states in the Arctic is facilitated by the transformation of international relations, with Russia deprived of cooperation projects with European Arctic states and the interest of Asian countries in the region steadily and rapidly increasing for at least a decade. In addition, the shared interests of all three states contribute to the development of the research and cooperation domain, as do existing agreements within the framework of BRICS cooperation (13). Arctic research and climate issues are included in the BRICS cooperation agenda for science, technology, and innovation. Additionally, there is a separate BRICS Working Group on Ocean and Polar Science and Technology, which further enhances the potential for collaboration. Importantly, the other states of the original BRICS grouping, namely Brazil and South Africa, are also interested in ocean, climate, and polar research (14).

Conclusion

Climate change has been the main driver in shaping the economic, research, and strategic interests of Asian states in the Arctic region. The Arctic has become a truly 'global' region; its 'regional' problems have long since moved beyond the region, as an increasing number of states are seeking to contribute to resolving 'regional' problems, identify their interests in the Arctic, and establish their place in the regional governance structure. For Russia and the Asian states, their new relationship post-2022 is yet to be fully established, but doing so will require them to be more willing to respond to new challenges and rapid changes in the region.

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Climate Signals, Global Governance, and the Arctic

Shailly Kedia and Abhilash Kolekar

The Arctic is often described as the planet's early warning system for climate change, where impacts manifest earlier and with greater intensity than elsewhere. Over the past few decades, the region has warmed at more than twice the global average, a phenomenon known as Arctic amplification (1). This rapid warming has left a profound imprint on sea ice, permafrost, hydrology, and ecosystems, sending climate signals that resonate far beyond the polar north.

One of the clearest indicators of change is the retreat of Arctic sea ice. Since 1979, satellite data have shown dramatic declines in extent and thickness, with late-summer losses unprecedented in at least a millennium (2). Sea ice now thins and fractures more easily, reinforcing further loss. Permafrost, which stores nearly twice the carbon currently in the atmosphere, is also thawing. Even if warming is held below 2°C, about a quarter of near-surface permafrost is projected to thaw by 2100, with losses rising toward 70 percent under higher emissions (3). Such thaw releases greenhouse gases while destabilising Arctic landscapes and infrastructure.

At the same time, the hydrological cycle is intensifying. More precipitation now falls as rain, river discharge into the Arctic Ocean is increasing, and ice cover on lakes and rivers is declining (4). The Beaufort Gyre, the Northern Hemisphere's largest freshwater reservoir, has accumulated exceptional volumes in recent decades (5). A sudden release could disrupt salinity and density balances in the North Atlantic, undermining the Atlantic Meridional Overturning Circulation. The Arctic thus anchors the Global Ocean Conveyor Belt, the thermohaline circulation system that connects all oceans and stabilises global climate (6).

The region is also acidifying three to four times faster than other basins due to CO_2 uptake, warming, and freshening, threatening ecosystems and fisheries vital to global food security (7). Moreover, Arctic change influences atmospheric circulation, contributing episodically to midlatitude extremes (8). Recent research has identified the emergence of a new multidecadal climate oscillation in the Arctic Ocean, triggered by sea-ice decline below critical thresholds, with potential global teleconnections (9).

The Paradoxical Position of the Arctic

The Arctic occupies a paradoxical position in the contemporary global order: simultaneously a sentinel of planetary crisis and a theatre for geopolitical and economic ambition. As sea ice recedes, new shipping routes and resource frontiers have sparked heightened interest from Arctic states and major powers, who seek to consolidate their sovereignty through territorial claims and enhanced security presence (10). Yet such opportunistic narratives of development, particularly in relation to hydrocarbons, require critical interrogation.

The biophysical risks are profound. Thawing permafrost contains nearly twice the volume of greenhouse gases currently in the atmosphere and is releasing not only carbon and methane but also mercury into ecosystems and water systems (11,12). A warming Arctic also poses emergent biological threats, as melting permafrost in regions such as Siberia may reintroduce ancient pathogens, exemplified by anthrax outbreaks (13).

These processes, already destabilising Arctic livelihoods, reverberate globally through feedback to climate, health, and ecological systems (14). Moreover, the economic calculus of Arctic oil remains tenuous. Offshore projects require break-even prices exceeding $100 per barrel, in stark contrast to the lower-cost production of countries in the Middle East (15). While strategic management literature posits that technological innovation might improve viability, such advances are highly uncertain and contingent (16). From a governance perspective, the absence of an effective oil-spill response capacity renders further hydrocarbon expansion inconsistent with the principle of precaution (17).

The Central Arctic Ocean (CAO) epitomises the dilemma. Once insulated by multiyear ice, it is now increasingly open to industrial interests in fishing, shipping, and deep-sea mining, despite its critical role in regulating thermohaline circulation and stabilising hemispheric weather systems (18). The CAO needs to be understood as a locus where planetary stewardship, precautionary governance, and intergenerational justice must supersede short-term commercial opportunism (19).

The Global Commons Principle holds that vital spaces must be managed collectively rather than exploited under fragmented sovereignty. The Common Heritage of Mankind (CHM) asserts that such areas belong to all humanity and must serve present and future generations (20). Applied in the Antarctic Treaty System and the Law of the Sea, CHM demonstrates legal and practical viability (21). Its tenets of non-appropriation, peaceful use, equitable benefit-sharing, and intergenerational justice may be of relevance to the Arctic. Governance that is "flexible across issues and adaptable over time" can address the region's rapid transformations (22).

Global Climate Governance and the Arctic

The Arctic is not governed by a single treaty but through overlapping national, regional, and international frameworks. Its governance can be viewed across four components: land territories of Arctic states, governed by their national laws; regional cooperation mechanisms, primarily under the Arctic Council; sea territories within national jurisdiction, guided by the United Nations Convention on the Law of the Sea (UNCLOS); and the Arctic High Seas, which are governed by treated as part of the global commons. MARPOL and Polar Codes under the International Maritime Organization (IMO) may apply, but enforcement rests with the flag states.

The CAO remains one of the last highly vulnerable global commons that lacks an exclusive governing framework, unlike the High Seas Treaty (1958), the Antarctic Treaty (1959), the Outer Space Treaty (1967), and the Ozone Treaty (1987). The Antarctic Treaty System (ATS) sets a precedent for a potential Arctic Treaty due to similarities in their issue areas. Adopted in 1959, the Antarctic Treaty banned the establishment of military bases and weapons, designated the region for peaceful purposes and scientific research, and prohibited any country from claiming territorial sovereignty over the continent (23). In 1964, the Antarctic Treaty Consultative Meeting (ATCM) adopted the 'Agreed Measures for the Conservation of Antarctic Fauna and Flora' (24). The Protocol on Environmental Protection, which entered into force in 1998, marked a significant step forward by prohibiting mining activities in the region, except for scientific research (25). In 2004, the Secretariat was established in Buenos Aires to strengthen the system and coordinate the work of the ATCM (26).

Currently, the United Nations Framework Convention on Climate Change (UNFCCC) and the Convention on Biological Diversity (CBD) lack exclusive governance mechanisms focused on the Arctic. This gap can be addressed through reform measures such as establishing a dedicated body or mechanism to monitor, finance, and implement Arctic-specific policies on climate change and biodiversity conservation, while ensuring the active engagement of indigenous and local communities in the region.

Table 1 illustrates that Arctic governance is fragmented and sovereignty-driven, while Antarctic governance is unified under a treaty, offering stronger protections and oversight.

Table 1: Comparative Overview of Arctic and Antarctic Environmental Governance

Governance Aspect	Arctic	Antarctic
Legal Framework and Regime Type	Fragmented system combining UNCLOS, national legislation, and the Arctic Council (soft-law, non-binding arrangements). Sectoral agreements exist, but there is no overarching, binding treaty.	Comprehensive and binding Antarctic Treaty System (hard-law regime) with enforceable protocols such as the Madrid Protocol.
Actors and Stakeholders	Eight Arctic states, indigenous peoples (permanent participants in the Arctic Council), the scientific community, NGOs, and industry actors.	Treaty Consultative Parties (research-active states) and the scientific community; no indigenous or local populations.
Sovereignty and Territorial Claims	Active sovereignty and maritime claims; sovereignty remains central; boundaries often contested or fluid.	Sovereignty claims frozen under the Antarctic Treaty; no new claims allowed; Antarctica treated as an international commons.
Governance Mechanisms and Decision-Making	The Arctic Council operates by consensus; states retain sovereignty; enforcement is weak and largely dependent on national jurisdictions.	Consensus-based Antarctic Treaty System with institutional oversight, inspections, and stronger compliance mechanisms.

Governance Aspect	Arctic	Antarctic
Biodiversity Conservation	Managed via Arctic Council working groups, national/ regional laws, and integration of indigenous knowledge. No binding biodiversity treaty; higher terrestrial biodiversity with diverse tundra species and marine life.	Ecosystem-based conservation under ATS and CCAMLR; creation of marine protected areas; strict habitat and species protection; limited terrestrial biodiversity (mostly seabirds and marine mammals).
Pollution Control	Governed by national regulations, the Arctic Council's soft-law instruments, and IMO conventions (MARPOL, Polar Code). Ban on heavy fuel oil use in Arctic waters effective from mid-2024; enforcement rests on flag and coastal states.	Strong pollution regulation through the Madrid Protocol (ban on mining, strict waste controls); Antarctica designated as MARPOL special area; Polar Code mandates high standards; inspections ensure compliance; minimal human activity further reduces risks.
Climate Change Governance	No dedicated treaty; addressed through national climate policies aligned with UNFCCC/Paris Agreement. The Arctic Council facilitates research and adaptation strategies; rapid warming causes severe ecological and social impacts.	Addressed indirectly through ATS environmental protocols and global climate frameworks. Governance emphasises precaution and scientific monitoring.

Governance Aspect	Arctic	Antarctic
Energy Governance	Largely under national jurisdiction. Some states impose moratoria on offshore oil and gas (Canada, Greenland, US regions), but fossil fuel extraction continues in Russia, Norway, and the US. Growing renewable initiatives, but no supranational body.	Commercial resource extraction is banned under the Madrid Protocol. Energy use is restricted to research stations, relying on imported fuels or renewables.
Resource Governance	Controlled by national sovereignty. Cooperation occurs via sectoral arrangements, although non-binding. Fisheries are regulated through regional bodies and soft-law mechanisms; hydrocarbon projects continue in some areas.	Strong binding regime: Madrid Protocol bans mineral extraction, CCAMLR manages fisheries with an ecosystem approach; mandatory environmental impact assessments; international oversight ensures compliance.
Indigenous and Local Community Involvement	Indigenous peoples are recognised with permanent participant status in the Arctic Council.	No indigenous or resident communities.
Scientific Research and Collaboration	Important, but uneven across states. The Arctic Council encourages cooperation, but sovereignty often limits data sharing.	A foundational principle of the ATS: free access to research, open data exchange, and guaranteed international collaboration.
Global Commons Principles	Hybrid system: parts governed by state sovereignty, parts by international law (high seas); governance remains fragmented.	Strong commons ethos: Antarctica is treated as the common heritage of mankind.

Source: Authors' own

A key gap in global climate governance lies in the voluntary nature of nationally determined contributions (NDCs). While central to the Paris Agreement, they lack binding mechanisms for managing global commons. This is particularly inadequate for the Arctic, where safeguarding shared resources requires coordinated, legally binding governance beyond national pledges.

Unlike the Antarctic, the Arctic lacks an overarching international regulatory framework (27). Moreover, there is insufficient coordination among UN-related institutions such as UNCLOS, the UNFCCC, and the CBD in governing the region under a unified mechanism. The CAO can be regarded as a natural heritage of humankind, and changes in its ecology have global repercussions. Yet, its governance remains confined mainly to the Arctic states. The way forward requires a shift in the mindset of the global community towards assuming collective responsibility for Arctic governance, through the establishment of an Arctic treaty and by undertaking far-reaching reforms of the UN system.

The BBNJ Treaty, yet to enter into force, can enhance Arctic governance by establishing legally binding marine protected areas to safeguard vulnerable ecosystems. It mandates environmental impact assessments to mitigate impacts from activities such as shipping and mining (28). However, challenges include delays in ratification and geopolitical tensions among Arctic states.

Call for Action

The authors advocate the following three calls to action.

Institutionalise the Application of the Global Commons Approach and Precautionary Principle: Institutionalising principles such as the Common Heritage of Mankind and the precautionary principle is key for Arctic climate governance. Full Antarctic-style governance is unlikely, but selective measures are feasible, as shown by Canada's moratorium, Greenland's ban, and US lawsuits and federal action. The Central Arctic Ocean Ice Shield Moratorium could be explored as a measure of precautionary stewardship.

Strengthen Science Policy Interface: The Intergovernmental Panel on Climate Change report on oceans and the cryosphere, Arctic Monitoring and Assessment Programme assessments under the Arctic Council, and data from the US's National Oceanic and Atmospheric Administration and National Aeronautics and Space Administration, and international Arctic research stations provide vital knowledge. However, this science must be systematically integrated into policy and economic decision-making to ensure evidence-based governance, resilient adaptation strategies, and sustainable development in the Arctic.

Strengthen Global Climate Governance: As COP30 approaches, with countries submitting their third NDCs, current climate governance remains inadequate for accelerating Arctic change. NDCs are state-centric and lack provisions for transboundary impacts, while Arctic governance has limited authority. Strengthening global frameworks that integrate NDCs with cooperative approaches and establishing a dedicated Arctic mechanism are essential to safeguard planetary climate functions.

The climate signals from science are clear. What happens in the Arctic does not stay in the Arctic. Its role as planetary thermostat and oceanic connector underscores a pressing need for governance that transcends sovereignty. Safeguarding the Arctic is no longer just a regional matter but a global imperative.

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The Arctic Meltdown and the Third Pole Hindukush Himalaya: Interdependent Drivers of the Planetary Climate System

Kamrul Hossain

The effects of climate change on the Arctic and the melting cryosphere have reached a pivotal moment, with profound, interconnected global consequences. “What happens in the Arctic doesn't stay in the Arctic” (1), highlighting that changes in the Arctic impact not only the region itself but also have significant planetary implications. This is particularly true because changes in the Arctic accelerate the climate's impact (and consequences) globally, including regions with similar characteristics, such as those in the cryosphere, which contribute to regulating the global climate system. These changes carry risks associated with critical biodiversity and sensitive ecosystems, and could eventually threaten the triple planetary crisis: climate change, biodiversity loss, and pollution. The threats present multiple interconnected regional and global concerns related to the environment, socio-cultural community existence, and geopolitics. Against this background, this essay examines how global warming in the Arctic and the resulting cascading effects on other regions, particularly the Third Pole, the Hindukush Himalaya (HKH), play a critical role in climate-related interdependencies within global climate systems.

The Arctic Climatic Effect

The temperature rise in the Arctic is disproportionate, which, according to the Intergovernmental Panel on Climate Change, is four times faster than the global average (2). Consequently, the accelerated thawing of the Arctic cryosphere has emerged as the most pressing climate consequence, given its role in regulating the global climate system (3). The Arctic cryosphere contains permafrost, glaciers, snow cover, and ice sheets. Permafrost, a type of hard ice frozen underground for thousands of years, is thawing at an increasing rate. This permafrost typically holds massive amounts of methane and carbon dioxide, both potent greenhouse gases, which, if released every summer or even during warmer winters, may cause runaway greenhouse emissions (4). The glaciers in Greenland and other Arctic regions hold vast amounts of water in frozen form. Terrestrial snow cover in the Arctic fluctuates with a high degree of uncertainty and unpredictability from year to year. The ice sheet in the Arctic Ocean has reached unprecedented lows on an annual basis, resulting in a significant reduction in ice coverage. Projections indicate that the first ice-free day may occur as early as 2030 (5), and the entire Arctic Ocean is expected to be ice-free during the summer months by 2040 (6). The melting of glacial water, which is released into the oceans, contributes to two significant phenomena—global sea level rise and heat circulation through ocean currents.

The melting cryosphere poses significant consequences on a local, regional, and global scale. The escalating human activities in the Arctic, encompassing various land- and offshore-based activities such as mining, hydrocarbon extraction, and maritime shipping and transportation, exacerbate the impacts of climate change. The Arctic Ocean, once regarded as a stabiliser of the planet's climate, is now being recognised as a catalyst for accelerated climate change (7). Scientists warn that this acceleration could tip the climate system into a much more unstable state by affecting similar regions, such as the HKH (8). The acceleration of these processes has been shown to intensify cascading effects, resulting in interconnected global and planetary consequences. These include more frequent and severe extreme weather events, heightened threats to food and water security at both the regional and global scales, and significant social challenges—such as local and cross-border human displacement and mass migration—that jeopardise peace and security with far-reaching geopolitical implications from climate-sensitive human activities to the management of shared natural resources.

The Arctic Melt and Climate Interdependency with the HKH

The accelerated melting of the Arctic ice cap has led to a reduction in the region's capacity to regulate climate dynamics, thereby fostering an intricate climate interdependency with regions exhibiting similar characteristics. The HKH, often referred to as the Third Pole due to its extensive glaciers, experiences consequences similar to those in the Arctic. The region is distinguished by the presence of mountain ranges in the central and northern regions of South Asia, extending to the high-altitude Tibetan Plateau, which is home to notable mountain peaks, including Mount Everest. It is estimated that the region contains 100,000 sq km of glaciers (9), which contribute to the flow of Asia's major rivers, including the Ganges, Indus, Yangtze, and Mekong. The HKH, often referred to as Asia's water tower, is the source of fresh water supply for over a billion people, both for consumption and livelihood activities, such as agriculture (10). The substantial forests in the region play a pivotal role in the formation of snow during the winter season (11). Similar to the Arctic, the HKH faces disproportionate and faster temperature rise compared to the global average (12). The rapid melting of glaciers and ice cover in the region is causing significant changes to its ecosystems, affecting biodiversity and posing existential risks to local communities and downstream populations across countries. Water and food security are among the most pressing issues.

As such, both the Arctic and the HKH are two of the most critical and sensitive regions within the Earth's cryosphere, playing a vital role in regulating the global climate system. Although different in their distances, (geo)political and geographical contexts, they are deeply interlinked through the cryosphere connection with an effect on the planetary climate dynamics. Together, they form a powerful lens through which to understand and confront the complex, interconnected realities of a rapidly changing planet. The rising temperature in these regions does not have an isolated effect on each; instead, there are interconnected effects—the climate consequences in each region influence the other.

The interdependency between the Arctic and the HKH can be understood as follows: the thawing of the Arctic's cryosphere, including glaciers and ice sheets, and their release into the oceans disrupts ocean currents. The ocean currents distribute heat across the planet through ocean circulations. The alteration of ocean currents and the distribution of heat through ocean circulations contribute to changes in atmospheric circulation patterns. Atmospheric circulation influences weather patterns and climatic shifts, both locally and globally, resulting in extreme events such as floods, droughts, and changes in precipitation. The climatic shifts in the Arctic are linked to jet streams—the high-altitude winds that drive weather systems, which contribute to atmospheric air circulation from west to east (13). Jet stream disturbances over the Himalayas intensify monsoon

convection, causing cloudbursts and flash floods in the HKH region due to its steep topography. As a result, scientists have identified the repercussions of Arctic melting as having considerable ramifications for the South Asian monsoon (14). The consequences of these changes are far-reaching. Sudden runoff and heavier sediment loads flow into the Indus–Ganges–Brahmaputra River systems, bringing devastating floods, soil erosion, and widespread damage to farmland downstream (15). At the same time, the Tibetan Plateau plays a crucial role in driving the South Asian monsoon. When its heating patterns shift, the monsoon weakens or arrives late, disrupting water supplies and agricultural cycles that support nearly a quarter of the world's population (16). Added rainfall also increases the likelihood of disasters such as landslides and glacial lake outburst floods (GLOFs). Since 1833, the HKH region has recorded 697 GLOFs, with their frequency rising sharply in recent decades. These events have already claimed over 7,000 lives, and scientists warn that the risks could triple by the end of this century (17).

The climate interdependency of these regions furthermore complicates biodiversity conservation, including forestry preservation, which functions as a carbon sink. While the socio-cultural impacts of climate change and cryosphere melts are generally felt at the local level, the consequences extend globally. The Arctic and the HKH are home to diverse groups of local and Indigenous communities that possess a rich tradition of evidence-based ecological knowledge concerning the climate impacts on biodiversity and forestry management (18). The regions face critical challenges to cultural diversity and the maintenance of the identity of people and communities. These challenges are often linked to consequences caused by climate interdependency. For instance, climate-induced human and community displacement, as well as mass migration, have been demonstrated to contribute to the loss of community culture, traditional knowledge, way of life, and identity as distinct groups. Traditional indigenous knowledge is essential for Arctic economic activities because it provides a profound understanding of the environment, enabling sustainable resource use. Integrating this knowledge supports livelihoods and ensures long-term ecological balance.

Conclusion

The viability of a sustainable planetary existence, capable of hosting life on Earth, is contingent upon preserving the cryosphere as a critical component. The polar regions, including the Arctic and other regions in the cryosphere, play a pivotal role in regulating the Earth's surface temperature, thereby mitigating the adverse effects of climate change. Climate impacts are inherently interconnected, and the preservation of the cryosphere is equally interdependent. Consequently, global climate change and the cryosphere dynamics are also interconnected. As a result, it is imperative to examine the climate

interdependency in the Arctic and other regions of the cryosphere, including the HKH, in a unified manner. This underscores the necessity for a comprehensive examination of climate interdependency through a unified lens. This approach facilitates a comparative analysis of global climate system dynamics and vulnerabilities, thereby enhancing our comprehension of planetary-scale environmental feedback loops.

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Arctic Teleconnections: Why India Cannot Ignore the Far North

Zerin Osho

The Arctic, known as the Earth's "great white shield" (1), regulates the global climate through its albedo effect (2)—reflecting solar radiation to cool the planet and moderating weather extremes worldwide. Yet, the region is warming nearly four times faster than the global average (3). Such a rate of warming creates environmental stresses that could become so severe that large parts of the natural world will be unable to maintain their current state, leading to abrupt and irreversible changes (4). These scenarios are referred to as 'tipping points.' Five major systems are already at risk of crossing tipping points at the current 1.2°C level of global warming. At the current level, warm-water, low-latitude coral reefs are likely to have reached their tipping point; with increasing temperatures, the ice sheets of Greenland and West Antarctica, the North Atlantic Subpolar Gyre circulation, and parts of the boreal permafrost may soon follow (5). These cascading risks underscore the urgency of targeted policy interventions that not only slow Arctic warming but also safeguard global climate stability.

Rapid warming has transformed the Arctic tundra from a carbon sink to a carbon source (6). This shift is driven by the

permafrost carbon feedback (PCF) (7). Covering approximately 24 percent of the Northern Hemisphere (8), terrestrial permafrost contains up to 1,700 billion tons of carbon trapped in frozen biomass (9)—nearly twice as much as the entire atmospheric carbon pool, and over four times more than the cumulative anthropogenic emissions since the Industrial Revolution. With permafrost temperatures rising by 2-3°C since the 1970s (10), irreversible permafrost thawing can lead to the release of substantial amounts of carbon dioxide and methane, exacerbating climate feedback loops (11). These risks were highlighted in the first assessments by the Arctic Monitoring and Assessment Programme and the Intergovernmental Panel on Climate Change, which reported significant winter warming trends up to 2°C per decade since the 1970s (12). As warming continues, the region is experiencing cascading effects—Arctic precipitation has increased by between 2 percent and 10 percent, accompanied by a marked decline in snowfall (13). If these trends persist, the Arctic Ocean is expected to experience its first ice-free day before 2030 (14). As the melting ice opens new shipping lanes and resource frontiers, Arctic states and industries share a responsibility to align economic and policy frameworks with climate obligations, lest short-term gains drive tipping points with lasting global consequences.

Global Impacts of Arctic Ice Melt (15)

The ongoing melt of Arctic Sea ice is not an isolated phenomenon—it has far-reaching impacts beyond the poles. These effects occur through teleconnections—statistically significant and dynamically observable links between climate and weather patterns across distant regions of the globe, which describe how changes in one part of the climate system can influence weather patterns thousands of miles away, thereby affecting many tropical and equatorial nations (16).

A key mechanism through which Arctic Sea ice loss affects global weather is the jet stream—a high-altitude, fast-moving air current that typically flows from west to east (17). As Arctic temperatures rise at a much faster rate than in the tropics (18), the temperature gradient that drives the jet stream is weakening. This may cause the jet stream to slow down and become wavier or meandering (19). Such changes can lead to more extreme weather patterns in the mid-latitudes, resulting in prolonged heatwaves, droughts, or cold spells in densely populated regions of North America, Europe, and Asia (20). For example, the loss of sea ice in the Chukchi Sea has been linked to an increased frequency of heatwaves in California, causing aridification in the state (21).

Concurrently, as Arctic land ice melts, the Arctic Ocean receives an influx of fresh, relatively warm water with lower salinity and density, which affects the global deep-ocean heat transport system that distributes heat energy around the planet. This system,

known as Earth's thermohaline circulation, plays a significant role in regulating the Earth's climate (22). The Atlantic Meridional Overturning Circulation (AMOC), a major current that carries freshwater south from Arctic glaciers, has been observed to be slowing and weakening since 2008 (23), with Arctic ice melt accounting for approximately 75 percent of this decline (24). A potential collapse of the AMOC can have far-reaching consequences, including altered winds, temperatures, and precipitation patterns worldwide, as well as accelerated sea-level rise and increased hurricane activity along the eastern US and Europe (25).

Furthermore, a complete loss of Arctic land ice, particularly in Greenland (26), could raise global sea levels by up to seven metres (27), posing existential threats to coastal nations. For low-lying countries such as Singapore, (coastal) India, the Maldives, Sri Lanka, and Bangladesh, the rise presents socioeconomic and security challenges, compounding the risks of extreme precipitation and flooding events (28).

India's Teleconnection Science

India's climate is highly sensitive to global atmospheric and oceanic changes, particularly due to its dependence on the Indian Summer Monsoon Rainfall (ISMR) system, which occurs from June to September. With rainfed agriculture occupying about 51 percent of the country's net sown area and accounting for nearly 40 percent of the total food production (29), Indian summer monsoons are crucial for over 50 percent of the country's food yield (30).

The ISMR is a complex product of land-ocean-atmosphere interactions, driven by temperature gradients and seasonal wind reversals. Recent decades have witnessed an increasing variability in the intensity and distribution of the ISMR, influenced both by local climate forcings and remote teleconnections.

Indian scientific research has made notable strides in establishing linkages between Arctic climate change and monsoonal behaviour. Studies have demonstrated statistically significant correlations between Arctic Sea ice decline and variations in ISMR. In particular, the circumglobal teleconnection—a pattern of upper-level tropospheric circulation that extends across the Central Asian landmass—has emerged as a key driver of the Indian monsoons (31).

Furthermore, global warming-induced alterations in Arctic atmospheric and oceanic patterns have been linked to shifts in the mid-latitude jet streams, which in turn influence extreme weather events in South Asia, such as erratic rainfall and prolonged

dry spells (32). These changes have a direct impact on India's agricultural productivity, water security, and disaster resilience. Despite recent gains in productivity and steady growth, India's agriculture sector faces growing risks from Arctic melt, which is driving more frequent weather events and threatening the country's food security.

India has conducted strong scientific research on the links between Arctic Ice Melt and the Indian summer monsoon (33); however, its observer status in the Arctic Council limits its influence. The Arctic Council serves as a platform for coordinating on Arctic issues; however, India cannot vote or participate in key decision-making processes, thereby limiting its ability to shape strategies that may have direct consequences for its own climate and national interests.

Arctic Governance Frameworks and India's Participation

Arctic governance, which initially focused on environmental protection through cooperation among Arctic states and indigenous peoples (34), is now increasingly shaped by geopolitical and security considerations. Although the Arctic Council operates as a consensus-based body without legal enforcement mechanisms, it grants limited participatory authority to non-Arctic observer states, particularly Asian nations, despite their disproportionate climate vulnerabilities. The International Court of Justice recently emphasised that states have binding obligations to protect the climate system under the principle of common but differentiated responsibilities, explicitly rejecting the Global North's invocation of *lex specialis* (35), warranting a critical re-examination of the current governance frameworks within the Arctic. This strengthens the case for 'Asia-Arctic Five' (India, China, Japan, South Korea, and Singapore) (36) as observer states in the Arctic Council, to assert greater influence over the Arctic Council's engagements. Amplified climate advocacy by the observer states within the Arctic Council can help refocus attention on global cooperation to combat climate change by highlighting Arctic teleconnections, which will contribute to a more holistic mitigation strategy that reflects both Arctic and non-Arctic vulnerabilities.

Conclusion

Arctic governance mechanisms have failed to keep pace with the accelerating impacts of climate change. The existing framework remains rooted in territorial claims, largely overlooking the significance of teleconnections and the Arctic's critical role in regulating global weather patterns, as well as the far-reaching consequences for non-Arctic countries. Restoring focus on multilateral climate cooperation requires meaningful participation from a broader range of actors to ensure that global perspectives inform mitigation pathways.

Preventing the Arctic's accelerating melt requires an immediate focus on short-lived climate pollutants, such as methane and black carbon, whose mitigation can yield rapid climate benefits (37). Efforts by the Arctic Council's Expert Group on Black Carbon and Methane Monitoring have reduced black carbon and methane emissions notably by 20 percent (38) and 8 percent (39), respectively, focusing on fossil fuels, waste management (40,41), and diesel emissions. While these measures mark meaningful progress, they remain outpaced by the rapid loss of Arctic ice, particularly as black carbon emissions from the shipping sector continue to rise.

India's role in this discourse remains limited. The Arctic's teleconnections with South Asia, including monsoon disruptions, food insecurity, sea-level rise, and heightened economic and climatic vulnerability along maritime trade routes (such as the Northern Sea Route), pose challenges that India shares with other Global South observer states. By diplomatically communicating this evidence and engaging with the relevant stakeholders, India can strengthen its strategic position, enabling it to align with the Global South and establish its presence in the Arctic narrative based on science and evidence. Simultaneously, the Arctic ice melt is unlocking access to vast mineral resources; the global race for critical mineral security is adding to this urgency. As demand for critical minerals essential to the global energy transition grows, a stark irony emerges—efforts to combat climate change risk accelerating the degradation of one of the planet's most fragile ecosystems, the Arctic. With the Northern Sea Route reshaping global trade flows and countries racing to diversify supply chains and consolidate energy dominance, the Arctic is fast becoming a geopolitical and economic frontier. Without international policy interventions, these pressures threaten to turn these quasi-global commons into an arena of unchecked extraction, leaving the region more vulnerable than ever.

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The Arctic Laboratory

Unlocking Opportunities of Science

Development Through Science: The Arctic's Global Endowment

Mikatekiso Kubayi

The Arctic, renowned for its research, particularly in climate-related fields, has been one of the world's most discussed regions in recent months. This is particularly important amid the current US administration's disapproval of climate action (1), particularly multilateral efforts (2). Yet, it presides over one of the world's largest economies and is a member of the Arctic Council.

Established in 1996 as a forum for international cooperation by the eight Arctic states (Canada, the Kingdom of Denmark, Finland, Iceland, Norway, the Russian Federation, Sweden, and the US), the Arctic Council aims to promote exchanges between member countries and between their people on issues such as development and environmental protection (3). Notably, the Arctic Council's focus on sustainable development and international cooperation is crucial for advancing scientific research that supports sustainable development.

The Search for Development

The need for sustainable development (4) is not only well-documented but also widely understood by most, through the

lived experiences of both the haves and have-nots of development. Indeed, development is a multifaceted issue, encompassing social, economic, and political aspects. The scientific value of the Arctic is not immune to politics; "the importance of arctic scientific research to the political domain—both nationally and internationally—is a complex and multi-dimensional issue pervaded by divergent and contradictory views. An example of this is the nature of the relations between science and politics" (5).

The Arctic region (North) offers much to the world. The political and economic imperatives of involvement in the region are evolving, driven by the attraction of oil and gas, as well as other minerals that are now accessible with the receding ice. For regions like Africa, there is much to learn from the Arctic, particularly in terms of ongoing development and emerging techniques for environmental preservation amid rapid industrialisation. However, the Arctic is a challenging region to study, with limited African presence and fewer research stations than in Antarctica (South).

Antarctica currently has 70 research stations, belonging to countries that are signatories to the 1959 Antarctic Treaty (6), which governs research on the continent. Since its inception, the treaty has promoted international cooperation in scientific research for the benefit of human development. These stations conduct research for the advancement of the living standards of people and the protection of the environment, among other objectives, according to the United Nations (UN) definition: "Development is one of the main priorities of the United Nations. Development is a multidimensional undertaking to achieve a higher quality of life for all people. Economic development, social development, and environmental protection are interdependent and mutually reinforcing components of sustainable development" (7).

India, China, Japan, Peru, South Korea, and South Africa, among others, are some of the non-Arctic Council countries with research stations in Antarctica. Notably, the South African station is the only African research station in the region (8). Although research in the North and South Poles is invaluable, research expeditions to these regions are costly to organise, coupled with an inhospitable climate and environment for foreigners, and require expertise in numerous areas, both operational and research, which are not abundantly available on the African continent. This, along with the unstable floating ice sheets in the Arctic and Antarctica, explains why there is a limited African presence in these regions.

For countries seeking a scientific and technological advantage and power over competitors, the Arctic region is rich in 'cold rush' potential. The 'cold rush' is akin to the gold rush of the 1800s in Africa, where the attractive resource generated a surge of people to the area in search of wealth. Despite industrialisation in the region, which offers high potential financial rewards, albeit at the risk of significant environmental and social costs (9),

many still view the Arctic as a vast, white, frozen desert with polar bears and indigenous communities. The now receding sea ice highlights the realities of climate change as well as the geopolitical compulsions that prefer to have the ice recede to access the natural resource bounty that lies beneath. Still, for many, the benefits of scientific knowledge and the advancements from research conducted in this region will serve the purpose of environmental protection and general well-being.

In the 1980s, the Arctic was of great importance to the two superpowers of the Cold War era, the Soviet Union and the US, but for a far different reason than sustainable development. The Arctic was a strategic region for oil and gas exploration and extraction, as well as for military bases to protect trade routes and pipelines. It was the age of the Arctic (10), with the region becoming an arena for international cooperation and competition in environmental protection and fossil fuel extraction. The region has since experienced significant industrialisation (11), which "can be considered as the first 'Arctic boom' in post-Cold War geopolitics" (12). The Arctic Economic Council is actively promoting investment in this region (13). This, however, has come at a cost to the environment, with significant risk to global security and indigenous populations, who are dependent on the land and its resources. "Building on earlier Canadian staples theory [the spread effects or the impact of exporting on the local economy and society (14)], researchers have shown that, despite an intuitive belief that natural resource development will increase the wealth, and therefore the well-being of producing regions, a resource curse exists" (15).

Conclusion

The Arctic benefits significantly from the knowledge of its indigenous population, which has been passed down through generations (16). However, unlike the South Pole, there is a limited research presence in the Arctic due to the lack of a model for cooperation on research for sustainable development. Geopolitical interests in the region, along with the potential of rare earth minerals, continue to drive interest in the area, while research lags. The crowded investment space and the vast sums required for research in the Arctic effectively eliminate Africa and many countries in the Global South as research drivers. Still, despite the ongoing extractive activities, the region holds much potential for the collective global good. The Arctic's global research value should be stressed through a cooperation mechanism like the Antarctic Treaty or the expansion of the Ottawa Declaration (the founding document of the Arctic Circle). There is an opportunity for the region to evolve into an exemplar of human solidarity for scientific research and global development progress, and all interested countries must seize this opportunity.

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A Shifting Line of Arctic Abundance

Sulagna Chattopadhyay

In his third treatise, penned between the two Great Wars, French astronomer Pierre Duhem derisively mentions one Master Robertus Anglicus who taught at the University of Montpellier in the thirteenth century (1). Anglicus was deeply affronted by his Mediterranean peers ascertaining that frosty England was 'uninhabitable', his national pride brimming before his students, effusively claiming the island's "inexhaustible abundance, everything that mortals need.. rich in all kinds of metals". From an era of disregard and neglect, what England rose to become in the years that followed is a matter of common knowledge. The Arctic, too, is not far behind in its emergent bountiful transformation. The wintry history of the Arctic, a region that spans multiple national and international boundaries, is well-documented in the national archives of the High North states. However, its relevance for the Global South warrants greater definition.

The Arctic, a region of exquisite, undiscovered, and fragile ecosystems, holds prime value for science. Indeed, ferreting out the unimaginable connectedness of the global systems lights up pathways for invaluable South-North collaborations.

The implications of these global changes extend across a significant swath of the inhabited world, including many surf-drenched nations, as well as those struggling with population growth.

Weaving the Arctic-Tropic History

In the early 1900s, neither the French geographer Vidal de la Blanche (2) nor his student Lucien Febvre (3), who later rose to prominence as a historian, envisioned their idea of possibilism (4) being reshaped through the lens of a changing climate discourse. The ascendancy of human agency in shaping the environment and presenting newer possibilities has never been more marked than in the last five decades. Never has the global order faced such turmoil, the Poles standing testimony to unprecedented warming. While this may mean the practicability of High-North access, unleashing a watery grave for the Global South is also imminent. The Arctic ice melt from Greenland alone contributed to an equivalent of 274 ± 68 mm of global sea-level rise between 2000 and 2019 (5, 6) and between 1993 and 2023, global sea level rise has reportedly increased by 111 mm (7). Projections for the next three decades or so add over half a foot (169 mm) to the rise, seemingly obscure, but making the oceans nearer by an overall foot at best. Every cyclone, storm surge, coastal flood, and cyclical tide push the briny waters deeper, eating away at the Global South's precious and populated coastal lands. Without submission to egalitarianism, Semplenial views (8) may gain prominence, predisposing and further pauperising the Global South societies and states.

Crowning the Earth's farthest inhabited world is a fading ring of icy promontories that once engulfed a frigid ocean. The Arctic's future is unravelling, and weaving the Tropics into this historical tapestry is now an imperative.

The Arctic Awakening

Unlike the robust Antarctic operatives, the circumpolar north or the Arctic, more recently entered into a fragile understanding of shared governance. Set by science, the emergent environmental needs of the Arctic and its people in the 1980s provided a canvas upon which a common platform of governance was illustrated. More uniquely, the peoples of the High North— represented through the Arctic Athabaskan Council, the Aleut International Association, the Gwich'in Council International, the Inuit Circumpolar Council, the Russian Association of Indigenous Peoples of the North, and the Saami Council—fused by the agony of lost livelihoods, came together to add vibrancy to a mechanism that was to address multiple common concerns. What began as an Arctic Environmental Protection Strategy in June 1991 (Rovaniemi Declaration) was rolled out as the Arctic Council just five years later in 1996 (Ottawa Declaration) (9). The Arctic lands were represented

by nations that held sway over its icy terrain—Canada, the United States (US), Russia, Norway, Denmark (on behalf of Greenland), Finland, Sweden, and Iceland—intertwined in a fellowship that evidently worked.

Some years later, in 1998, the sagacious presence of nations such as Germany and England strengthened the Arctic's scientific adroitness and opened doors to observers. The Global South's foot in the Arctic Council's door, however, had to wait a decade and a half, with India finding itself at the table in 2013, rewarded for putting its Antarctic scientific legacy to the Svalbard test in the early 2000s. In October 2013, at the Arctic Council's Senior Arctic Officials Meeting held in Whitehorse, the capital of Canada's Yukon Territory, a historic first occurred. Admiral Nirmal Kumar Verma, India's then High Commissioner to Canada, the sole Indian flagbearer at the meeting, signed India's commitment to the High North, marking its entry into the Arctic Council. Since then, India's scientific expression, as manifested through its participation in over a dozen programmes (approximately half of which have been completed) out of the 123 projects of the Arctic Council, is representative of heightened Arctic needs (10).

The first set of scientific studies in the Arctic, focused on the loss of species and the monitoring of various fish, birds, and mammals. Consequent studies of pollutant and contaminant loads proved to be an essential pillar that bolstered conservation. That nearly a third of the studies conducted by the Arctic Circle's six working groups since its inception subscribe to such ideas is not surprising (11). What is surprising, however, is the rising number of studies related to shipping, heralding a shift and a flattering response to the surging opportunities of the High North (12). While the saltwater interplay and meeting and mating of oceanic creatures are a given, riding the surf faces fierce contestation. Fledgling shipping lines along the Arctic Ocean are perceived to hold value for many, strengthening and nurturing livelihoods. In contrast, for others, their probable divergence from established patterns of traffic elucidates exasperation. For India, the idea is still new. Explorations emanating from Indian scientific domains are focused on conservation and rest lightly on nuances of oceanic passage. More interestingly, the premise of Arctic-Tropic rivers in the sky (or teleconnections, as it is known in scientific circles) unleashing swashing waves of cloudbursts across the Himalayas (13) still seeks emphasis in the Arctic Council's science projects.

Shifting Fortunes

While waking up to Arctic expansionism, spotlighting the Stefanssonian (14) folly serves as a good starting point. The US Secretary of State William Seward's purchase of Alaska in 1867 proved prudent, and Benjamin Franklin's persuasive intervention in 1760 helped Britain relinquish Guadeloupe (15), a tiny tropical paradise, to France in favour of expansive swathes of cold Canada, a visionary move. A mere century ago, the Canadian Arctic

explorer Vilhjalmur Stefansson pleaded with the then-great powers of the world to hold on to the Spitsbergen archipelago and its fine coal-yielding islands. While the US turned away, handing over all its mining rights of the wintry islands to Great Britain, the British diplomats seemingly rewarded Norway, adding that "they did not see why anybody wanted these isolated, frozen islands, but if anybody did want them badly enough to ask for them, they didn't see why they shouldn't have them" (16). It is unclear if the United Kingdom still feels the same, although Spitsbergen now stands tall for different reasons. Svalbard, nestled in the southernmost part of the archipelago, is now an effervescent seat of environmental research, space science, and more, where numerous nations vie for a foothold. As Norway's presence in the global research community sparkles to prominence, American economist Ellsworth Huntington's considered judgement that "...the strain of life in the far north tends to eliminate the very type which is most likely to start some new idea and thereby cause progress..." (17) proves damningly incorrect. Around the same time, Norwegian scientist Fridtjof Nansen challenged the Arctic's marginality, turning what was once mystical into an object of scientific exploration (18). As Norway thrived, gaining nationhood in 1905, the northward shift of fortunes continued, with petroleum and natural gas topping the country's exports, followed closely by fishing, shipping, and hydropower (19).

Notwithstanding the northward shift of the line of abundance, nations respond variably to opportunities cast their way. A sprightly and unencumbered engagement with the cold north brings to the world an alternative, seeking to unseat interpretations of economic wealth and ushering in sustainability and simplicity, heralding a 'Scandinavian Code' (20). Within the region, strong neighbourly ties, institutional stoicism, and happy (21), low corruption (22), and free (23) and equal (24) societies become evangelism-worthy. The fact that the Scandinavian Code extends to the warm tropical lands, not only for partnerships in science but also for conflict mediation (25), is reason enough to believe that global models need reworking, keeping the well-being centrality in perspective.

The intellectual prowess and forward-thinking approach embodied in the Scandinavian Code provide nations of the Global South a blueprint for Arctic access. India's public, politicians, and diplomats are not widely conversant with the Arctic in a manner comparable to China or South Korea's High-North seats. India also does not have an Arctic ambassador to lend the country's sporadic presence (26, 27) at the Senior Arctic Officials (28) table any continuity. Still, the realisation that the line of abundance is migrating northwards, and that countries such as Norway, Iceland, Denmark, Sweden, and Finland are the key holders of that abundance, may provide an unfaltering bridge to the Global South's near absence in Arctic affairs.

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Integrating Science into Arctic Economic Development

Alexandra Middleton

The Arctic provides a unique natural laboratory that fosters international scientific collaboration. It offers a preview of our planet's future, given that it is warming at a rate four times faster than the rest of the world (1). In addition to its scientific importance, the Arctic serves as a strategic focal point for numerous nations pursuing new avenues for geopolitical dominance, trade routes, and the exploitation of natural resources, including critical minerals and marine biological resources such as fish stocks and aquaculture. This essay analyses existing and emerging avenues for scientific and economic cooperation in the Arctic, including both Arctic and non-Arctic states, and provides policy recommendations for integrating science into Arctic economic development.

Existing Scientific Cooperation Mechanisms

Arctic Council: A key mechanism for cooperation in the Arctic region, the Arctic Council serves as a high-level forum for promoting environmental protection and sustainable development. Established in 1996, the Council comprises Arctic

states, non-Arctic states, and Arctic Indigenous Peoples, operating primarily through consensus and employing soft law mechanisms through non-binding agreements (2). Its work is organised via six working groups (3). The Council acts as a facilitator rather than a binding decision-making body, which enables it to produce significant policy outputs and scientific assessments, thereby shaping Arctic governance (4). Non-Arctic nations participate as observers, allowing them to join discussions without the voting rights reserved for member states) (5). Observers include many European and Asian countries, including key global powers such as China and India and are involved in working groups and initiatives (6). Between 2013 and 2023, China and India participated in over 60 Arctic Council projects; China has steadily increased its participation in working groups, especially in the Protection of the Arctic Marine Environment, Conservation of Arctic Flora and Fauna, and Arctic Monitoring and Assessment Programme, while India's participation has varied over time and does not include Emergency Prevention, Preparedness and Response projects (7).

The 2018 Agreement on Enhancing International Arctic Scientific Cooperation by the Arctic Council aims to promote Arctic research by facilitating access to data, equipment, and research locations, while minimising administrative obstacles (8). Nevertheless, its implementation is hindered by national security limitations, persistent visa and customs issues, and geopolitical strains in the aftermath of the war in Ukraine, which have disrupted intergovernmental collaboration and stalled the Council's review procedures (9).

The Council's work can have an indirect impact on sustainable economic practices in the region, which must be incorporated into the business rules or legislation of each Arctic state. For instance, the Council's work on black carbon provides a non-binding, aspirational goal for a 20 percent reduction in black carbon emissions from 2013 levels by 2025, indirectly influencing key industries such as shipping, oil and gas flaring, and diesel transport, rather than directly mandating specific changes to their business practices (10).

International Arctic Science Committee: Founded in 1990 by the national scientific organisations of the eight Arctic states, the International Arctic Science Committee (IASC) serves as a key facilitator of scientific collaboration and coordination in the region. The IASC currently has 25 member countries, including India, with each country represented by national scientific bodies (such as research councils, academies of science, or polar research institutes) (11). In its 2023-2026 strategic plan (12), the IASC has emphasised the need to strengthen cooperation with the industry and business communities. However, its work has been disrupted by the war in Ukraine, much like other avenues of scientific cooperation in the region, as rising geopolitical tensions have limited possibilities for joint research efforts and challenged the Arctic's traditional image as a zone of low political tension (13,14).

Central Arctic Ocean Fisheries Agreement: The Agreement to Prevent Unregulated High Seas Fisheries in the Central Arctic Ocean (CAOFA), signed by 10 parties (Canada, China, Denmark, the European Union, Iceland, Japan, Norway, Russia, South Korea, and the US) in 2018, established a 16-year commercial fishing moratorium on Arctic high seas that began on 25 June 2021 (15). Despite geopolitical tensions, the agreement's Joint Program of Scientific Research and Monitoring operates as a model for international Arctic cooperation, demonstrating environmental stewardship that transcends political divisions. Scientific cooperation as part of this agreement can produce valuable scientific knowledge relevant to the future economic prospects of the Central Arctic Ocean.

Global Partners in Polar Science: Changes in the global cryosphere, including Earth's frozen areas (the Arctic, Antarctic, and high mountain regions), have far-reaching climate consequences, making polar science essential for guiding climate adaptation and flood control, particularly in vulnerable areas such as the Hindu Kush Himalayas. Operating under the United Nations (UN) framework, the Intergovernmental Panel on Climate Change plays a central role in global scientific cooperation by providing authoritative assessments, such as the 2019 Special Report on the Ocean and Cryosphere (16), that inform international climate policies and negotiations.

The UN has established a comprehensive framework for cryospheric sciences, declaring 2025 as the International Year of Glaciers' Preservation, 21 March to be celebrated as World Day for Glaciers, and proclaiming the Decade of Action for Cryosphere Sciences (2025-2034). The Decade invites the private sector to participate alongside scientists, governments, and other stakeholders to understand and address the impacts of a changing cryosphere (17). The outcomes of the decade of action will lead to the planning of the Fifth International Polar Year (IPY-5; 2032–2033) (18), an intensive, internationally coordinated scientific research campaign focusing on the Arctic and Antarctic regions, co-led by the International Science Council and World Meteorological Organization. Such unprecedented international initiatives promote organised transnational research cooperation, allowing for the systematic tracking of cryospheric changes and a holistic evaluation of their cascading effects on global sea level, hydrological cycles, and biogeochemical processes. These actions are intended to stimulate the scientific cooperation required to synthesise strong evidence-based knowledge informing international climate policy development and the creation of effective adaptation and mitigation measures (19).

Emerging Scientific Cooperation Mechanisms

Third Pole Dialogue: The Dialogue (also called the Himalaya/Third Pole Process) was officially launched in June 2022 by the Arctic Circle, in partnership with the United Arab

Emirates Ministry of Climate Change and Environment, to introduce the Arctic model of collaboration to the Third Pole. The first Inter-Polar Conference, held in 2023 in Nepal and jointly organised by the International Centre for Integrated Mountain Development and the Arctic Centre at the University of Lapland, was a step towards connecting the Arctic with the Third Pole.

BRICS Cooperation: Since 2022, Russia has been developing Arctic scientific cooperation with non-Western partners, including China and India (20). Furthermore, the BRICS collaboration framework has emerged as an avenue to enhance cooperation among non-Arctic states, particularly for Russia, as it seeks to navigate its geopolitical challenges while maintaining its interests in the Arctic (21). This shift indicates growing multilateral cooperation among Arctic and non-Arctic players, including joint efforts to mitigate issues such as environmental degradation and resource management (22).

Other Avenues of Cooperation

Economic cooperation in the Arctic is facilitated by the Arctic Economic Council (AEC), established in 2014 to foster dialogue between businesses, Indigenous partners, and governments. The organisation builds partnerships for the benefit of the region's people by leading policy advocacy, developing networks, and raising awareness of the Arctic (23). Among the AEC's key initiatives is promoting frameworks for responsible investment, such as the Arctic Investment Protocol (AIP) (24). Established in 2015 by the Global Agenda Council on the Arctic under the auspices of the World Economic Forum, the AIP was crafted with input from experts across academia, government, media, business, and indigenous organisations. It serves as a form of soft law, providing guidelines for sustainable investment and development in the Arctic (25). The AEC's publications provide strategic guidance on responsible investment, analyse key sustainable sectors, including the blue economy, and address critical infrastructure needs, such as broadband connectivity. Currently, the AEC comprises 34 members from nine countries, with no Indian representation. Consequently, Indian companies with strong ties to the Arctic should evaluate whether joining the AEC could offer them potential advantages.

Sustainability frameworks relevant for Arctic business development are relatively recent and limited, with only a few notable examples, such as the AIP, the Responsibility Standard for Arctic Zone of Russian Federation (2020), and the Circumpolar Inuit Protocols for Equitable and Ethical Engagement (2022), each offering voluntary guidance rather than enforceable standards and highlighting the need for more robust, inclusive, and business-oriented sustainability governance (26).

Data on economic and business development in the Arctic is fragmented, and there is no systematic platform for collecting such information. Examples of projects that address this gap are Business Index North (BIN) and the Economy of the North (ECONOR). The BIN project aims to establish a recurrent analytical tool to monitor and support sustainable business development across Arctic regions (27). It provides comparative cross-regional indicators on value creation, employment, investments, and innovation, with a focus on sectors such as shipping, energy, and digital infrastructure. The BIN integrates perspectives from companies, communities, and regional development conditions, offering data aligned with the UN Sustainable Development Goals to inform policy and investment decisions.

ECONOR is a circumpolar initiative endorsed by the Arctic Council's Sustainable Development Working Group (28). Its goal is to deliver a comprehensive overview of the Arctic economy, including traditional Indigenous production systems. ECONOR compiles macro-level indicators, such as GDP per capita, demographic dependency ratios, income levels, and education outcomes. The ECONOR reports address data gaps by harmonising statistics across national regimes and contribute to long-term assessments of sustainability and natural wealth management in the Arctic.

The most recent format of economic cooperation in the Arctic is the 2024 Arctic Circle Business Forum, which featured 90 speakers, including representatives from Greenland, India, the Faroe Islands, China's Special Envoy for Climate Change, and the CEO of COP28. The forum facilitated discussions on climate change and clean energy, Arctic investment, security and international relations, shipping and logistics, Indigenous rights, polar innovation and technology, and youth engagement in Arctic communities. Given the novelty of the Arctic Circle Business Forum format, it is premature to forecast specific outcomes. Nonetheless, the forum offers a strategic venue for fostering transdisciplinary networks and embedding scientific perspectives into emerging Arctic economic frameworks. Its emphasis on climate, innovation, and Indigenous engagement positions it as a potentially impactful arena for science diplomacy through business collaboration.

Recommendations

Building on the preceding analysis of institutional frameworks for science cooperation and emerging formats of Arctic economic cooperation, the following policy recommendations can bridge business-led initiatives with science diplomacy and sustainability imperatives.

- The future of Arctic economic cooperation should be driven by science-informed business strategies that are built using scientific evidence produced by the Arctic Council (such as the reduction of black carbon in the Arctic), IASC, and the UN.

- Corporations active in the Arctic should adopt science-based environmental, social, and governance (ESG) frameworks that go beyond compliance to incorporate climate accountability, stakeholder inclusivity, and adaptive governance mechanisms. The Arctic Economic Council has pioneered the Arctic Investment Protocol, while the Inuit Circumpolar Council (an organisation representing approximately 180,000 Inuit in Alaska, Canada, Greenland, and Chukotka, Russia) has developed the Circumpolar Inuit Protocols for Equitable and Ethical Engagement. These protocols should be used as a foundation for integrating sustainability norms into investment decisions and practices in the Arctic.

- Establish a dedicated multilateral platform at the intersection of science and business to encourage Arctic cooperation. Currently, these domains operate in silos, hindering integrated, evidence-based decision-making. The proposed platform, aligned with UN-led initiatives and designed with a long-term horizon in mind, should facilitate the co-production of knowledge, promote science-based ESG practices, and enhance strategic foresight for Arctic economic development. It must also prioritise systematic economic and business data collection across Arctic regions, addressing a critical gap in current knowledge infrastructure and contributing to the preparatory work for the IPY-5.

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Transforming the Laboratory: Making the Case for Systemic Arctic Regional Studies

Corine Wood-Donnelly

The Arctic has been understood as a metaphorical laboratory for 45 years. This depiction first surfaced at the cusp of a geopolitical and governance transition as the Cold War was entering its final stages, the critical economic potential of the region was emerging, and the legal framework for ocean territorial and exploitation rights was on the verge of being signed. At the time, the Arctic was described as 'the last frontier' and as a space with a need for an 'action agenda' (1). With the regional diplomacy that followed, culminating in the establishment of the Arctic Council and successive international agreements and practical collaborative arrangements (2), "The Age of the Arctic" (3) emerged, spanning three decades in a period often labelled 'Arctic exceptionalism' (4). With the Arctic region now experiencing a new geopolitical, economic, and security reality, alongside emerging understandings of decolonial ethics and posthuman futures, it is time for a new chapter of knowledge collaboration on and for the Arctic.

In recent times, the Arctic has emerged as a testing ground for practical cooperation, normative evolution and regional governance systems, facilitated through three parallel streams that enable bilateral and multilateral relationships. The first

stream encompasses the long-standing and persistent efforts by Indigenous citizens of the Arctic to gain a voice in Arctic decision-making (5). A second, near-simultaneous stream involves science cooperation to collect data sets on ice, atmosphere, permafrost, and earth sciences, among others, to understand the climatic and environmental conditions, changes, and their consequences for global systems and economic opportunities. The third stream is diplomacy, science diplomacy, and paradiplomacy, emerging from an interest in the region's economic development, facilitated by Arctic conferences (6), and corresponding to the evolution toward public, rather than confidential, Arctic policy documents.

Arctic geopolitics is now entering a new epoch, characterised by fractures in the collaboration between the Arctic states in public fora and subregional intergovernmental organisations (7). However, this has not yet resulted in a fracture in the 'regionality' of governance and bilateral cooperation on search and rescue, fisheries, and environmental pollution events, as well as cooperation on working groups in the Arctic Council (8). There are also disruptions in the collection and storage of scientific data due to changes in political preferences (9) and in response to the growing public distrust of science (10). While Arctic states, and others such as the European Union (11), have been generous with funding scientific studies in the region, this is heavily influenced by national interests (12), political priorities (13), and economic fortunes, which have recently been challenged by the costs of the COVID-19 pandemic and a shift towards defence spending.

Behind this change is the long legacy of spending on national interests in the Arctic, with science serving as a tool of statecraft. The most recent contributions can be characterised in three broad categories: ocean, atmospheric, and land sciences, which contribute to contemporary security and economic interests, including well-known activities such as sea mapping, cryosphere observations, and gas measurements. However, the legacies of Arctic science date back to imperial explorations, predating deliberate science funding programmes, and were funded by governments, monarchs, scientific societies, and private investors seeking both prestige and opportunity. The International Polar Years (IPY) (14) fostered international cooperation for the systematic acquisition of scientific knowledge in the Arctic. This was underpinned by strategic rationalities (such as mapping critical resource reserves), which eventually served as an accelerator for developing technological capabilities and enhancing environmental knowledge toward safety and security.

With Arctic science often paired with Antarctic science in the bid to understand the polar worlds, natural science has dominated knowledge production opportunities, research environments, and results. The outcome of this long-term pattern is that other critical knowledge dimensions are proportionally underdeveloped due to the lack of persistent strategic funding. Importantly, funding for open research in the social sciences, humanities, and indigenous knowledge is also limited. Amidst a shift in Arctic governance driven by

geopolitical realities, underpinned by security, economic, and demographic challenges in the North (and ultimately, concerns over sovereignty and legitimacy), Arctic regional studies must be prioritised.

Although there are notable scholars with deep expertise on the Arctic, pockets of institutional expertise exist in specific locations, and some networks are established within particular disciplines (such as law) or themes (such as justice). However, Arctic studies from a social sciences perspective suffer from a lack of concentrated expertise and knowledge building. This is because there have been overlapping 'waves' of Arctic social sciences and humanities (SSH) research, which can be crudely categorised into (i) research that predates the Arctic Council, mainly focussing on Arctic exploration or militarisation, (ii) Arctic legal and political research centred around emerging Arctic environmental governance, (iii) The economic opportunity and political optimistic period of Arctic institutionalism, (iv) Decolonisation and Indigenous self-determination, and, more recently (v) Geopolitical tensions and institutional strains. Amid these waves, many scholars have used the Arctic only as a context, often due to a failure to engage with the broader body of knowledge on the region. This has resulted in a shallow body of knowledge, which has caused Arctic SSH science to make only small advances through 'academic immaturity' (15).

Second, as a region with considerable dynamism, the Arctic is a catalytic arena, with numerous notable moments that have brought newcomers into the domain. This includes the placing of the Russian flag on the seabed at the North Pole (16), a US Geological Survey report of estimated reserves of Arctic oil and gas in the region (17), new maximum and minimum sea-ice limits reached (18), widening interest in Arctic Council observer status (19), changes to collaboration between the other Arctic states with Russia, and US President Donald Trump's interest in purchasing Greenland. These events result in widening interest in the region, far beyond academia.

Thirdly, despite this interest and activity, a solid understanding of Arctic issues, or 'Arctic literacy', is lacking for many. This results in a reproduction of the lack of nuance in communications related to the region, such that there is even a 'formula' for writing Arctic stories (20). This includes clickbait-worthy titles that feature words such as 'race,' 'scramble,' 'battle,' 'new cold war,' 'frozen conflicts,' or 'melting ice'. These sensationalist expressions have the effect of diminishing the complexity of Arctic political and social realities and conditions. Instead of making Arctic literacy accessible, they perpetuate the status quo knowledge of the region, particularly the core-to-periphery character of Arctic decision-making. While such communication can be excused when directed to the general public, an examination of cited resources in grey literature from think tanks indicates a prioritisation of journalism over science; this has resulted in diminishing the quality of

the knowledge that policy briefs or white papers provide to policymakers for decision-making (21).

Taken together, it seems apparent that what was described as ad hoc-ery, or the willingness to avoid whole-of-system approaches and solutions, in the Arctic nearly 50 years ago, remains today (22). In a region of global significance, the green transition, and future food security, the lack of global Arctic literacy is ultimately leading to poor policymaking and business decision-making. This is at least partially underpinned by the decline in funding for universities, which must deliver education as an efficient business plan, rather than as a knowledge-development training experience that leads to rich understandings and innovation potential among the youth. With SSH education and innovation challenged in this context, establishing courses dedicated to Arctic study is a luxury, especially given the lack of national and institutional investment in Arctic-specific SSH.

While the 'age of the Arctic' may have passed, the Arctic can certainly come of age as a domain of regional studies. This means (i) it is time to establish dedicated Arctic knowledge centres that integrate research and education (similar to regional studies centres funded by the US's CIA at the dawn of the Cold War), which can be part of the IPY 2032-33 international research collaboration framework or other national funding arrangements, such as centres of excellence and targeted educational funding; (ii) these Arctic knowledge centres, should in deliver systematic SSH knowledge that builds and expands on the decades of existing Arctic research, particularly to address social challenges in the north and in relation to global political and economic systems and needs, and (iii) ultimately, integrate and facilitate trans-, multi-, interdisciplinary and cross-domain knowledge on the Arctic, with the natural sciences and also with indigenous knowledge and local knowledges, to enable comprehensive and deep solutions for Arctic challenges.

It is time to amplify the opportunities of the Arctic laboratory by creating and capturing the benefits of cross-domain research with a new generation of Arctic SSH research through targeted funding. This will result in the strengthening and deepening of Arctic knowledge, training scholars to systematically leverage other knowledge domains, and educating a new generation of primary, secondary, and tertiary-level students in Arctic literacy. Without this, the next generation of scientists, decision-makers, and even ordinary citizens will perpetuate fragmented expertise, policy-research lag, and the democratic deficit, ultimately impacting the future security of the Arctic.

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Russia's Arctic Science Cooperation with Non-Arctic Countries: The Case of India

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Science occupies a central place in international Arctic cooperation and beyond (1). Almost all Arctic countries have identified science as a key area of bilateral and multilateral cooperation in their regional strategies. Today, observer countries in the Arctic Council also pay close attention to conducting scientific research and actively participate in various international Arctic science projects. For non-Arctic countries, participation in scientific research in the Arctic opens a window to the region, and, indeed, scientific diplomacy becomes the instrument for legitimising the presence of non-Arctic countries in the Arctic (2).

Russia and Asian Non-Arctic Countries' Scientific Cooperation in the Arctic

Today, scientific cooperation underpins the system of bilateral and multilateral relations between the Russian Federation (the largest Arctic power) and Asian non-Arctic countries, which have gained significant importance in Russia's Arctic policy in recent years. Due to geopolitical developments globally and regionally following the events of 2022, a clear 'turn to

the East' has emerged in Russia's Arctic policy (3), manifested in the intensification of bilateral cooperation, primarily with Asian countries such as China and India. Russia has prioritised scientific cooperation in its bilateral relations with China and India. Interaction with such a significant Arctic scientific power as Russia in this context seems important for non-Arctic countries, since Russia has not only the richest experience of scientific research in the Arctic, but also has a robust scientific research infrastructure (research and educational institutions, research vessels and icebreakers, polar stations, and highly qualified specialists in various fields). At the same time, Asian countries have little experience in scientific research in the Arctic, and are increasingly interested in studying the consequences of climate change in the region.

Russia's multilateral cooperation with Asian non-Arctic countries is conducted through several working groups of the Arctic Council. China, Japan, South Korea, and India are members of the Iceland-based International Arctic Science Committee and the Finland-headquartered University of the Arctic.

In recent years, Russia has been actively creating scientific and educational consortia with Asian non-Arctic countries. A promising platform for such engagement is the Northern Forum, a non-profit international organisation comprising several regional administrations from northern countries. South Korea's Gangwon region is currently a member of the Forum. The Northern Forum on Sustainable Development (NFSD) has been held annually since 2019, bringing together scientists, experts, politicians, and business leaders from various countries to discuss issues related to sustainable development in the Arctic. At the 2022 NFSD in Yakutsk (Russia), an agreement was signed to create the Russian-Asian Consortium for Arctic Research, which included "scientific and educational, research, professional, and other institutions of the Russian Federation and Asian countries" (4). The creation of this Consortium marks a continuation of Russia's 'turn to the East' policy in the Arctic; the Consortium is focused on expanding Russia's international relations with countries in East Asia in new geopolitical conditions. In recent years, the Northern Forum has been actively interacting with Chinese and Indian experts on Arctic issues, and several joint events have already been held. Mongolia and Indonesia have also shown interest in the organisation's activities.

The BRICS platform is another promising avenue for polar cooperation between Russia, China, and India. Since 2015, BRICS has included issues related to the joint use of the world's oceans and polar regions in its agenda. The grouping's polar activity appears to be underpinned by scientific cooperation, and further development is likely due to the specific areas of interaction among the participating countries, as well as the search for new scientific and educational formats of cooperation. This 'soft' approach allows

countries with different polar identities to cooperate (5). In 2018, a special BRICS Working Group on Polar and Ocean Science and Technology was established. The expansion of BRICS must be viewed as the expansion of the 'polar direction' itself, taking into account the three poles: the North, South, and the Himalayas. India, China, and the UAE have publicly announced the idea of 'Three Poles of Cold' on various platforms; Russia also supports this idea (6). This idea suggests that 'three poles'—the Arctic, the Antarctic, and the Tibetan Plateau—represent "a group because of the similar extreme cryosphere environments and their critical role in maintaining Earth's climate, hydrology, and ecosystem conditions" (7). From a diplomatic point of view, it suggests considering "how the positive experience of scientific and environmental co-operation gained in the Arctic and Antarctic can be applied to the Himalayas and Tibet in solving the existing bi- and multilateral problems in this region" (8).

Russia-India Scientific Cooperation in the Arctic

Today, India is demonstrating a growing interest in the Arctic as a subject of study for climate processes that affect the monsoon system of South Asia, as well as a promising area for technological collaboration with Arctic countries. Currently, cooperation between Russia and India in the Arctic is in its early stages, but there is considerable potential for interaction between the two countries. One promising area is scientific direction.

However, at this stage, Indian scientists' work in the Arctic is carried out mainly in collaboration with Norway in the Svalbard archipelago through the Himadri Arctic Research Station (since July 2008), the IndArc underwater multi-sensor moored laboratory (since 2014), and the Gruwebade laboratory (since 2016) (9). Meanwhile, Russia and India share common potential in Arctic scientific research. Three areas are the most promising: joint work on Arctic research stations; joint work on expanding the fleet of ice-class polar research vessels; and the creation of an international scientific and educational platform.

Other specific areas of cooperation can be:

- Conducting joint scientific research related to the study of the ecosystem of the Russian Arctic, as well as the climate and the impact of its changes on India;

- Joint biochemical studies of potentially pathogenic microorganisms that may be released because of melting permafrost and sea ice in the Arctic, and which may negatively impact the health and life of the local population, and flora and fauna;

- Cooperation in the space sector (India already has a satellite monitoring project with the US) – Joint project to form a space system that, firstly, will improve navigation along the Northern Sea Route, and, secondly, will speed up the collection of scientific data on the Arctic.

Compared to China, India remains significantly behind in its level of involvement in Arctic scientific cooperation with Russia; however, there is clearly sufficient potential for developing such cooperation. The two countries have recently made efforts in this direction.

In July 2024, the Antarctic Research Institute of Russia (AARI) and the National Centre for Polar and Ocean Research, an institution under India's Ministry of Earth Sciences, signed a memorandum of cooperation on scientific research and logistics in polar regions. The goal of the new collaboration will be to develop relations between the most prominent government organisations of the two countries, focusing on the polar natural environment and its variability, as well as providing mutual assistance in logistics matters, which is vital in harsh polar conditions. The parties also intend to exchange scientific data and conduct joint research programmes. In the future, an international team will be established for Arctic research on Russia's ice-resistant research vessel, the 'North Pole'. This will enable long-term interdisciplinary scientific research in the high latitudes of the North Pole (10).

The Russian Research Centre in Svalbard, which has been in operation since 2016, currently represents a consortium of 14 organisations from the Ministry of Natural Resources and Environment and the Ministry of Education and Science. AARI has been designated as the supporting organisation for the centre's work. Similar to this centre, plans are underway to create a platform for joint work among scientists from different countries, including India (11).

In March 2025, at a business and scientific forum ('Northern Forum-India: Uniting North and South for Sustainable Development') held in New Delhi, speakers from the two countries shared their experience of practical interaction and discussed promising areas of joint work in the future, particularly climate change (12). Following the meeting, several cooperation agreements were signed between organisations in both countries to implement joint Arctic projects in various fields.

An important area of cooperation is academic interaction, including the conduct of scientific seminars between think tanks and universities in both countries. Several meetings of this nature have been held in 2024 and 2025 (13, 14, 15).

Conclusion

The mutual interest of Russia and India in climate research, ecosystem studies, energy cooperation, logistics development, and monitoring systems indicates a progressive expansion of the scientific dimension of cooperation. A series of joint initiatives over the past two years shows that both countries perceive science not only as a tool for gaining knowledge, but also as a means of diplomacy and strategic partnership. If the current pace is maintained, scientific cooperation could become a key driver of broader bilateral relations in the Arctic.

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The Arctic Opportunity

New Business Pathways

Beyond Commerce: Unpacking China's Arctic Ambitions

Nima Khorrami

The Arctic is increasingly central to global economic, technological, and strategic calculations. Its resource wealth, shipping routes, and governance gaps offer opportunities for states to project influence, secure critical supplies, and shape emerging international norms. China's engagement in the region exemplifies this dynamic. Far from a peripheral observer, Beijing has cultivated a multifaceted strategy that links energy and mineral extraction, maritime logistics, scientific research, and dual-use technological capabilities. The underlying question is whether China's objectives are mainly commercial or part of a broader effort to secure long-term influence and fold the region into its global power projection. The evidence suggests the latter: Beijing's policy goes beyond resource access to include asserting normative authority, embedding itself in critical infrastructure, and cultivating strategic leverage through deepening partnership with Russia.

The Four Pillars of China's Arctic Strategy

China's Arctic strategy has evolved into a comprehensive framework that views the region less as a conventional periphery for infrastructure investment and more as a maritime

and governance space central to Beijing's global ambitions (1). Positioned under maritime governance and the ocean economy, the Arctic first appeared in the 14th Five-Year Plan in 2021 (2). This framing signals that China's interest lies in the Arctic's emerging governance architecture, its maritime potentials, and its transport corridors. Within the broader "total national security" concept, more specifically, the Arctic is treated as part of China's "overseas interests" and as a domain for "far seas protection" highlighting a strategy aimed at securing access, resources, and influence while minimising backlash from the Arctic states with regard to Beijing's regional ambitions (3).

At the political and legal level, China seeks to expand its "discourse power" by shaping the normative order of the Arctic (4). This is why Beijing consistently promotes globalised definitions of the region and emphasises the Law of the Sea, calling for the internationalisation of Arctic sea lanes. Its engagement with or participation in multinational arrangements such as the International Maritime Organization's Polar Code or Arctic Ocean fisheries agreement serves this purpose. More interestingly, the absence of an overarching Arctic treaty or a formalised governance model is seen as an opportunity that enables Beijing to influence emerging norms. Seen this way, China's Arctic-related multilateral engagements and initiatives constitute a deliberate attempt to legitimise and institutionalise its presence in the Arctic through law and governance rather than hard power (5).

This legal-political approach is further reinforced via economic and scientific initiatives. Economically, China has established a foothold in Russian Arctic energy projects, such as Yamal LNG and Arctic LNG-2, which serve dual purposes: diversifying China's energy supply and positioning natural gas as a transitional "green" fuel in support of Beijing's decarbonisation goals (6). At the same time, Chinese interest extends to critical minerals (7) and to the operationalisation of the Northern Sea Route (NSR) as a shorter and safer alternative to the Malacca Strait and Suez Canal (8,9). Through shipping companies like Newnew Shipping (10) and Haijie Shipping (11), China is steadily expanding container services along the NSR, aiming for year-round service by 2030.

Scientifically, China invests heavily in icebreakers and maritime technologies, seeking to provide navigation data and environmental intelligence. Most recently, it has deployed a flotilla of five icebreaking research vessels (12), marking the first time the country has operated more than three icebreakers simultaneously, while also advancing clean-energy cooperation with states such as Iceland and Denmark (13). The North Sea Navigation Support Center in Tianjin, moreover, has developed a high-resolution Arctic sea ice monitoring product to optimise navigation safety and inform maritime decision-making (14). Collectively, these initiatives position China as both a practical operator and a

normative influencer, capable of shaping shipping rules and standards while developing expertise in Arctic navigation.

The scientific dimension is also tied to Beijing's efforts to enhance its indigenous space capabilities, as well as its push for a greater stake in, and ownership of, digital infrastructure worldwide (15). Satellite connectivity, for instance, is critical for the operationalisation of automated mining (16) and navigation in remote Arctic zones (17), thereby binding China's industrial strategy to its space sector. Undersea cables, meanwhile, are emerging as another layer of influence (18). With 95 percent of international communications flowing through subsea systems (19), projects like Russia's Polar Express cable (20) are nothing short of a strategic endeavour where Chinese capital and technology could potentially play a role (21), especially since Moscow has banned any Western involvement in the execution of this project (22).

Finally, the security pillar underpins the entire framework. Chinese doctrine links Arctic activities to the protection of overseas interests, with the People's Liberation Army tasked to safeguard trade routes, energy flows, and scientific missions under the far-seas protection mandate (23). Initial steps, such as the China-Russia coast guard memorandum and participation in Russian Arctic exercises, signal a gradual, Russia-facilitated entry into Arctic security affairs (24). Moreover, incidents such as the involvement of Chinese-flagged vessels in cable damage (25) suggest Beijing's willingness to utilise its commercial presence in hybrid operations, either independently or in close cooperation with Moscow.

Taken together, these four pillars—political-legal, economic, scientific, and military—reveal China's priorities (26): securing access to resources and shipping routes, shaping the governance regime to legitimise its presence, embedding Arctic activity within its green transition narrative, and slowly expanding security capabilities. The strategy reflects Beijing's long-term view of the Arctic as both a strategic commanding height and a global commons that is crucial to its future prosperity and security.

Russia as the Critical Hinge: Implications and Constraints

It follows that China's Arctic strategy reflects a nuanced balancing act that combines pragmatism with ambition. Arctic LNG shipping, the deployment of ice-class vessels, and involvement in digital and under-sea infrastructure exemplify Beijing's ability to convert commercial engagement into a strategic advantage. Its partnership with Moscow, moreover, is central. Russia offers access to ports, nuclear-powered icebreakers, and regulatory flexibility, while China provides investment, technological expertise, and a vast market.

This relationship, however, is asymmetrical. Russia's vulnerabilities—exacerbated by sanctions and constrained shipyard capacity (27)—enhance China's leverage while deepening Russian dependence. The relationship is also, for the most part, one of necessity rather than choice. Moscow has been pushed to cooperate with Beijing in the Arctic due to Western sanctions (28), while China, categorised by the West as a strategic rival, has found Russia to be its only viable partner in the region.

Given this dynamic, China's Arctic strategy is not without constraints. On the one hand, Beijing must navigate Arctic states' concerns over sovereignty, the seasonal limitations of navigable routes, and the operational challenges posed by extreme conditions. On the other hand, its dependence on Russia for access to the region and on Western- or globally-sourced components for advanced satellites and AI-enabled maritime systems introduces risks, particularly under the influence of sanctions and export controls. Similarly, Beijing might find itself isolated in the region if the US can drive a wedge between China and Russia, although the prospect of this remains slim for the foreseeable future.

Still, China's Arctic engagement demonstrates a long-term vision that integrates resource acquisition, normative influence, infrastructure investment, and measured security presence. By embedding itself across economic, scientific, and governance networks, Beijing is not merely participating in Arctic development, but is also shaping the operational and regulatory environment in ways that enhance its global stature. Yet the strategy's success will depend on its ability to manage dependencies, sustain cooperative relations with Russia, and navigate the evolving geopolitical dynamics of a region where climate change, technological development, and great power competition converge.

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The Northern Sea Route: Prospects for Future Development and Russian Interests

Pavel Gudev

At the level of national legal doctrine regarding the Arctic Ocean, a fairly well-established view is that this maritime region is unique, which fundamentally distinguishes it from other maritime regions such as the Atlantic, Indian, and Pacific Oceans. This is due to its semi-enclosed nature, the characteristics of its continental shelf (large extent), special climatic conditions (presence of ice), and ecological vulnerability (the need for the priority protection of the marine environment).

The latter circumstance is used by certain countries in the region (Russia and Canada) that have the longest coastlines here and, therefore, extend their sovereignty, sovereign rights, and jurisdiction over vast maritime areas to introduce national measures to prevent marine pollution, which often go beyond the prescribed conventional norms, although they are based on the relevant provisions of the 1982 UN Convention on the Law of the Sea, in particular, Article 234 on ice-covered areas (also known as the 'Artic exception').

For instance, these features meant that in 2012, Russia introduced a permit system for commercial vessels on the Northern Sea

Route (NSR) under the law (1). The vessels are required to use pilotage and icebreaker services, depending on ice conditions. These measures are not discriminatory, as they apply to all ships without exception. Moreover, the Russian side views payment for these services not only as compensation for providing them, but also as financial support for developing infrastructure and ensuring navigational safety on the NSR (hydrographic and hydrometeorological services).

Then, in 2022, a federal law established a permit procedure for all foreign warships (2). However, they are required to obtain permission for passage through diplomatic channels only if they intend to pass through Russia's internal waters, which include the waters of the Russian Arctic straits of the Novosibirsk Islands (Sannikov and Laptev), and the Northern (Vilkitsky and Shokalsky) and Novaya Zemlya (Karskiye Vorota) archipelagos. The waters of these straits were traditionally considered by the Soviet Union to be internal, and are therefore under full sovereignty, where no other passage regime can exist except that of permission.

The primary opponent of the legal regime regulating shipping on the NSR, which was established at the national legislative level, is the US. The US and Russia agree that enhanced measures should be taken in the NSR to protect the fragile marine environment, and all Arctic countries can appeal to the provisions of Article 234. However, they insist that all national restrictions introduced must, at a minimum, be agreed upon within the framework of the International Maritime Organization, which is responsible for ensuring the safety of shipping (3).

The subject of Russian-American disagreements regarding the NSR primarily concerns another issue—the legal status of the Russian Arctic straits. The US disagrees with their legal classification as Russia's internal waters, insisting that these should be classified as straits used for international navigation under the 1982 Convention, to which the convention norm of transit passage should apply. The latter is extremely liberal in its approach: transit passage should not be impeded, it should not be suspended, and all civilian and military vessels are allowed to use it without exception.

Notably, the US did not contest the designation of these straits as internal waters in 1985. However, it did protest similar moves by the Soviet Union in other maritime areas (the Far East) at the diplomatic level (4). Most likely, this was because in 1985, Mikhail Gorbachev had just announced his policy of *Perestroika*, and there was a tacit understanding that the Soviet Arctic, for several reasons (including military-strategic ones), could not be internationalised.

The collapse of the Soviet Union, the entry into force of the 1982 Convention in 1994, and its ratification by Russia in 1997 led to it being considered the sole source of law applicable to this maritime region. The US's position in this matter is based on the principle that national legislation must subordinate itself to the 1982 Convention. Russia's classification of the NSR as a 'historically established transport artery' goes beyond the standards and provisions of modern international maritime law, according to the US position.

These contradictions could be resolved using the American-Canadian formula of 'agree to disagree,' which provides for the preservation of different legal approaches with a commitment on the part of the US to coordinate with Canada the passage of its ships and vessels through the internal waters of the Northwest Passage, and Canada's mutual commitment to facilitate such passages as much as possible and not to obstruct them. The opening of the Arctic to an increasing number of maritime users, in principle, means that regulation of various types of maritime activities should not be relaxed, but instead tightened. However, there is a significant obstacle on this path: the US and Canada are not just neighbours, but key allies, while the US speculatively considers Russia and China together as the two main threats to its security in the region.

For Russia, the development of the NSR is a strategic priority of the highest importance. However, the priorities for its development seem to be arranged in the wrong order. The NSR, as a historically established national transport route, is primarily essential for Russia itself. This includes ensuring the so-called "northern delivery", transportation in the interests of the Ministry of Defense in the context of western countries' policy of increased militarisation in the Arctic, transportation of construction materials and equipment for large oil and gas projects, and finally, the export of resources to foreign markets.

The potential of the NSR can be divided into two main components: domestic transit and international transit. Domestic transit refers to the transportation of goods within Russia, such as from Russian ports in the Far East to other Russian ports in the Barents or Baltic Seas. The Russian government has been clear about its plans for this type of transit for a long time, with fish and seafood being mentioned as one of the main cargo types. International transit, on the other hand, involves transporting goods from Southeast Asia to Europe via the NSR. While domestic transit is aimed at promoting economic development and balancing imbalances within Russia, international transit is purely a matter of business. The NSR will not compete with the Suez Canal in the near or medium term; the NSR currently transports only three million tons of cargo annually (out of a total volume of 38 million tons) (5), compared to the Suez Canal's estimated volume of over one billion tons.

Discussions on projects to create the so-called Greater NSR (from St. Petersburg to Vladivostok) are clearly aimed at implementing domestic transit within Russia. The Trans-Arctic Transport Corridor project (6) is developing domestic transit (St. Petersburg-Murmansk-Arkhangelsk-Vladivostok) and international transit (through connections with the North-South and East-West transport corridors). It is clear that the legal regime for navigation along the NSR route cannot in any way be applied to the maritime components of these transport routes. This is because it is primarily based on the provisions of Article 234 (ice-covered areas). It is important to note that the Barents Sea region is excluded from the NSR because it is often ice-free for most of the year.

However, the expansion of the NSR and the development of the intra-Russian transit are likely to be met with caution by the Baltic countries, especially those that control the Baltic Strait, Denmark and Sweden. The European Union is exerting enormous pressure on them to tighten the historically established shipping regime in the NSR, based on the provisions of the 1857 Copenhagen Treaty, with regard to Russia and the transportation of its energy resources. Other countries in the region are using environmental rhetoric to introduce preventive measures that go beyond the existing conventional regime and are aimed at combating the so-called 'shadow fleet'. Paradoxical as it may seem at first glance, the primary opponent of the erosion of the existing legal regime in the world's oceans, and in the Baltic region in particular, has always been the US, which advocates guaranteed freedom of navigation both in these straits and within the exclusive economic zones, as well as the right of innocent passage through territorial seas.

From Russia's perspective, the NSR should be regarded as a 'national treasure', a route primarily intended to revive the Russian economy and correct imbalances in regional development. It is also intended to ensure a reliable connection between the country's regions and facilitate the transportation of mineral and energy resources to international markets. In the long term, it could contribute to the development of international transit.

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India in the Arctic: Priorities for Deeper Engagement

Monty Khanna

Significant changes are underway in the Arctic. The most widely discussed is the steady warming of the region and the consequent melting of ice in the sea and on land. The effects of this will be profound, both positive and negative. While there may be a lack of unanimity among the scientific community on the pace of warming and its manifestations, there is a consensus on its trajectory—by the middle of this century (give or take a few decades), the Arctic will be ice-free in summer. This will fundamentally impact global shipping routes, while also making access to Arctic ports far easier and facilitating the harnessing of the region's vast resources. Facets of this change are already beginning to play out, as evidenced by the significant enhancement in shipping through the Northern Sea Route (NSR) (1) and Russia's earlier stated aim to make transit through this route perennial by the end of 2024, albeit with the assistance of icebreakers (2).

The second change is that apart from the United States, the other Arctic countries—Canada, the Kingdom of Denmark, Finland, Iceland, Norway, Russia, and Sweden—are facing a demographic decline. For instance, in Russia, the birth rate in

the first two months of 2025 plunged to a 200-year low (3). The enormous human cost of the protracted conflict with Ukraine will further exacerbate this demographic freefall in Russia. Thus, while warming will present opportunities associated with easier access, inadequate human resources will place constraints on Arctic nations in harnessing them.

The third issue is the gradual but persistent erosion of Arctic exceptionalism. Fundamental interlinkages between climate change, the economics of resource extraction, and connectivity have led to a gradual acceptance among Arctic countries that, despite their efforts, it will become increasingly difficult to maintain their dominant position on all regional issues. The conflict in Ukraine has exacerbated the situation by creating a deep divide between Russia and the rest, which has impacted consensus-building on major policy issues pertaining to the region. Russia's shepherding of China's growing presence in the Arctic, best exemplified by the joint rollout of China's Polar Silk Road in 2017 to complement the Maritime Silk Road under the overarching Belt and Road Initiative, and recent endeavours to expand cooperation in the Arctic to the security domain, is testimony to such fissures. Another telling example of this trend is the signing of the Central Arctic Ocean Fishing Agreement in Ilulissat, Greenland, in October 2018, which involved negotiations among China, South Korea, the Arctic, and European Union nations (4). Under such conditions, the Arctic Circle's restrictive rules related to collaboration among members and observers on research projects are not aligned with ground realities and should be amended.

The Way Forward: Recommendations

India had long viewed the Arctic as a distant, exotic, and detached region. However, given its enormous potential for enhancing connectivity, providing access to resources, and as a theatre of geopolitical contestation, India will be unwise not to remain invested there. In 2022, India released its Arctic policy (5), which outlines several focus areas, including strengthening scientific research and cooperation, climate and environmental protection, economic and human development, transportation and connectivity, governance and international cooperation, and national capacity building in the Arctic region.

While there are many initiatives under consideration and in different stages of implementation, three sectors can be prioritised:

- **Hospitality:** Countries in the Arctic are becoming increasingly popular tourist destinations. As access to newer destinations in the region improves, there will be significant potential to scale up the hospitality sector. The major constraint in doing so will be the difficulty in finding well-trained individuals to fulfil the demand in a highly human-resource-intensive industry. India is well-suited to meet this demand.

This will require India's hospitality industry to seize the opportunity to increase its footprint in the region. Potential candidates must receive appropriate cultural and language training, as well as competitive compensation packages. Indian hospitality firms can also consider initially adopting a franchise-based approach with properties manned primarily by locals. The Indian government could assist this process by encouraging Arctic states to promote overseas investment in this sector and reduce the compliance burden for migrants employed in the industry.

- **Healthcare:** The healthcare sector is facing increasing pressure due to the rise in longevity driven by ongoing advancements in medical science. The demands on healthcare are even greater in northern latitudes due to harsh living conditions, often associated with prolonged periods of darkness, leading to depression and other problems related to mental health. Patient care is another human-resource-intensive sector where India is well-positioned to excel. It will require an enabling regulatory framework that includes the mutual recognition of qualifications and the ability for such personnel to seek employment commensurate with their qualifications. The government will therefore play a significant role in this sector. Other issues related to cultural and language training will also need to be considered.

- **Shipping:** This is a 'sunrise sector' in the Arctic as the melting of ice will allow increased shipments through the NSR, the Northwest Passage, and the Transpolar Route. Even though ice melt will likely soon allow non-ice-class vessels to ply in the region, the vast majority of ships will continue to be ice-class, in compliance with the Polar Code and regulations promulgated by littoral states. India is among the top three providers of seafarers for the shipping industry (6). To maintain and build upon this dominance, all seafarers need to train for and attain ice-class certification. This will require training institutions to equip themselves with the skill set and approvals to impart such training.

While there are many other areas in which India could increase its footprint and engagement with the Arctic, actions focused on the hospitality, healthcare, and shipping sectors are simpler to execute and will also likely be more acceptable among the regional states. Engagement with the Arctic is not only an economic imperative but also a strategic one. As the region opens up, news rules will be written by the countries in the region, as well as those that have maintained a high degree of equity in Arctic affairs. It is, therefore, imperative for India to rapidly ramp up engagement, particularly in the hospitality, healthcare, and shipping sectors.

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Adopting Hydrogen-Based Connectivity to Meet the Arctic's Net-Zero Target

Chaitanya Giri and Sayantan Haldar

The Arctic Ocean littoral states are among the most economically endowed globally. The Arctic region has abundant deposits of minerals and petroleum, such as petroleum the North Slope in Alaska (1), the petroleum reserves, nickel, and cobalt deposits in the Canadian Arctic (2), rare-Earth deposits in Greenland (3), the petroleum offshore Norwegian Sea and North Sea, as well as scattered strategic mineral deposits along the entire coastline of Russia, and notably petroleum in the Yamal Peninsula (4). Natural resources have played a significant role in the economic prosperity of these countries.

Despite severe winters, sparse populations, and challenging terrain, extractive industries in the Arctic have established multimodal connectivity—oil and gas pipelines, road and rail-based transportation of petroleum and minerals—to densely populated southern regions and through maritime shipping routes (5). The Arctic region is among the most severely affected by climate change. Indeed, climate risks could adversely impact ongoing economic activities there and the associated supply and value chains (6). More critically, resource extraction, logistics, and connectivity within the Arctic Circle also impact the Arctic

climate, its sensitive environment, and the livelihoods of indigenous communities (7). Large-scale diesel consumption, used for heating, industrial processes, and transportation, results in significant emissions of black carbon (emerging from the incomplete burning of fossil fuels, biofuels, and biomass) and other particulate matter, adding to the degradation of the Arctic environment (8).

The Arctic countries face a dilemma between improving connectivity and maintaining sustainable economic practices. This can be alleviated through 'sustainable connectivity', particularly by adopting environmentally friendly fuels, such as hydrogen and ammonia.

Road and Rail Connectivity in the Arctic

The whole Arctic region is connected by an intricate network of highways and railways specifically designed to serve towns, cities, small settlements, remotely located research stations, and large economic installations. Russia is estimated to have around 99,000 km of public motor roads in the region (as of 2019) (9), while the US's Alaska has around 17,500 km of public motor roads (10). In contrast, most towns in Greenland are still unconnected by proper roads.

The northernmost point of Alaska's railway network is in the city of Fairbanks (11). Petroleum extracted on the North Slope is transported to the economic centres in the south via pipelines, particularly to the liquified natural gas (LNG) terminal in Nikiski, south of Anchorage (12), and to the underdeveloped port of Nome, located near the Bering Strait (13). Both ports primarily cater to East Asia, particularly South Korea, Japan, and Taiwan.

Canada is building all-weather roads to the ports of Churchill and Nelson, both located on Hudson Bay, with the intention of exporting natural gas to Europe (14). Russia's Norilsk Railway (15), operated by the nickel and palladium mining enterprise Nornickel, and the Gazprom-owned railway line linking the Bovanenkovo natural gas field in the Yamal Peninsula to the town of Obskaya (16), constitute significant routes that facilitate the transportation of northern resources to urban centres across Russia and Europe. Moreover, the Russian government is considering establishing a railway connection to the port of Sabetta on the eastern coast of the Yamal Peninsula, which has already been developed as an LNG terminal (17).

Road and rail connectivity is likely to expand as the US, Canada, and Russia increase their exports of natural resources. Consequently, there is significant potential for these countries to leverage their natural gas sectors to develop transportation infrastructure powered by cleaner gases, such as grey hydrogen and ammonia, thereby promoting

sustainable development across the Arctic Circle. Decarbonisation of transportation in the Arctic could significantly reduce the overall environmental impact, particularly when focused on reducing black carbon emissions from diesel engines.

Towards Sustainable Arctic Rail and Road Networks

Black carbon, or carbon soot, has a short atmospheric life, but is of immense consequence to the warming of the Arctic (18). The black carbon emissions of Arctic Circle nations constitute nearly 10 percent of the pollutant's worldwide anthropogenic emissions, but the black carbon contributions of these countries to their proximate Arctic warming are as high as 30 percent (19). Black carbon, which is particulate matter less than 2.5 microns in size, one of the sources of which is diesel engines, qualifies as a health hazard—a causal factor for respiratory and cardiovascular diseases (20)—to both indigenous communities and workers operating in the mining, petroleum extraction, logistics, and transportation industries in the Arctic.

The reduction of black carbon emissions is a primary concern for the Arctic Council (21), the UN Environment Programme's Climate & Clean Air Coalition initiative (22), and the Clean Arctic Alliance (23). In 2017, the Arctic Council expressed an aim of reducing black carbon emissions by between 25 percent and 33 percent relative to 2013 levels by 2025 (24). The goal is yet to be achieved. Nevertheless, the Council, the Coalition, and the Alliance may collectively decide to pursue the complete decarbonisation of onshore transportation within the Arctic Circle. In this context, the development of hydrogen fuel infrastructure and transportation systems in the Arctic countries is of paramount importance.

Arctic Council members can easily achieve the target of decarbonising their road and rail transportation. Most rail networks in the Arctic currently operate diesel locomotives, which hydrogen-powered locomotives can replace. Rail manufacturers from India, China, the US, Russia, and France have made significant progress in developing hydrogen-fuelled locomotives. In August 2025, the Indian Railways showcased the world's most powerful hydrogen-fuelled locomotive, which has freight applications (25). Hydrogen, along with electric vehicle recharging grids, could play a role in the decarbonisation of passenger and commercial motor vehicle emissions. Given that most Arctic countries are rich in natural gas and have vast lands and suitable geologies, they offer potential zones for storing captured carbon, making the utilisation of grey hydrogen and blue hydrogen viable. Cryogenic storage of hydrogen, combined with the use of more stable metal hydride storage (26), can resolve hydrogen storage safety-related concerns.

Potential Ammonia as Fuel-of-Preference in Arctic Waters

In April 2025, the International Maritime Organization (IMO) took a significant step towards establishing legally binding commitments for the achievement of net-zero emissions in shipping worldwide by 2050 (27). Known as the IMO Net-Zero Framework, the measures, formally adopted in October 2025, involve the introduction of new standards for clean fuels and the implementation of international pricing mechanisms for emissions, with these regulations set to take effect in 2027. Although the targets are designated for 2050, maritime vessels will increasingly be required to reduce the greenhouse gas intensity of the fuels they utilise, eventually transitioning to zero and net-zero fuel sources. These measures will be mandatory for ocean-going ships exceeding 5000 gross tonnage, which are responsible for emitting 85 percent of the total carbon dioxide emissions from global shipping (27). Ammonia, a hydrogen-rich chemical compound capable of serving as both a fuel for internal combustion engines and fuel-cell powered ships, is poised to become one of the preferred globally adopted net-zero fuels for the maritime industry.

Arctic Council members and observers can contribute by ensuring that all ships operating on routes within the Arctic Circle are among the first to adopt the IMO Net-Zero Framework. A dual strategy, combining a phased transition to ammonia for ships above 5000 tonnes with hydrogen fuel for smaller ships, should be considered.

Conclusion

The UN has given significant consideration to hydrogen as a crucial fuel for achieving the Sustainable Development Goals and as a step towards a low-carbon and sustainable future (28). While global initiatives are influenced by geopolitical and geoeconomic complexities, Arctic nations, under the leadership of the Arctic Council, can achieve net-zero emissions within their respective territories by adopting hydrogen and ammonia as fuels for internal combustion engines or fuel cell systems.

The Arctic Council, its members and observers, in collaboration with hydrogen- and ammonia-related industries and industry bodies, must outline plans to achieve this goal. Leading from the front, these nations will only then be able to encourage other nations, especially those disregarding or those who have exited the Paris Agreement, to accelerate their net-zero actions.

In the context of expanding the global hydrogen economy, it is essential that geographically bound multilateral organisations, such as the Arctic Council, formulate strategies for establishing hydrogen infrastructure, with a primary focus on global climate action objectives. Policies developed through the initiatives of the Arctic Council and their effective implementation, in conjunction with the region's transportation and extractive sectors, are crucial in reducing the projected levelised cost of hydrogen to below one US dollar per kilogram—an indispensable criterion for achieving global net-zero targets.

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Japan's Evolving Role in Arctic Governance, Science, and Sustainable Development

Sakiko Hataya

The rapid environmental changes occurring in the Arctic are amplified by the impacts of climate change, with the impacts likely to be felt worldwide. Japan, which has already played a leading role in addressing global environmental issues such as global warming and biodiversity loss (for example, in the formulation of the Kyoto Protocol and the Aichi Biodiversity Targets), has articulated an Arctic Policy that seeks to strengthen international cooperation, including with Asia-Pacific countries, while pursuing advanced mitigation and adaptation initiatives (1). Indeed, Japan is well-positioned to utilise its experience and expertise to make a significant contribution to addressing the global environmental issues arising from Arctic ecological change.

Japan has also been deeply involved in Arctic scientific research. At the Eighth Ministerial Meeting of the Arctic Council in 2013, Japan was granted observer status. Fundamentally, the role of observer states in the Arctic Council is "to observe" its work, contribute "primarily through engagement at the level of Working Groups, Task Forces, and/or Expert Groups", participate, if invited, in meetings and other activities, and "propose projects

through an Arctic State or a Permanent Participant" (2). Since then, it has contributed to Arctic science primarily by providing knowledge and data through the activities of the Arctic Council's working groups, as well as through bilateral and multilateral cooperation with Arctic states and other relevant countries.

Japan's Arctic Policy stipulates that it must "promote scientific and technical cooperation on the basis of bilateral scientific and technical cooperation agreements with interested states, including the Arctic states, in polar research and related fields (3)." An additional aspect of Japan's policy is to "participate actively in discussions of expanding the role of observers," and the country's participation in the negotiation process of the 'Agreement on Enhancing International Arctic Scientific Cooperation' (2017)— which aims "to enhance cooperation in Scientific Activities in order to increase effectiveness and efficiency in the development of scientific knowledge about the Arctic (4)"—demonstrates Japan's growing interest in pursuing this goal. Japan has particular expertise in collecting and observing scientific data, which will be crucial for the future of Arctic studies. Japan must participate actively in the development of international cooperation in Arctic science; Japanese scientists can engage in bilateral agreements with researchers from Arctic states.

Japan's commitment to Arctic science was further underscored in May 2021, when it, in partnership with Iceland, convened the Third Arctic Science Ministerial (ASM3) in Tokyo, marking the first time the meeting was held in Asia (5). Discussions and the concluding joint statement focused on promoting international cooperation in science and research to achieve a sustainable Arctic. Furthermore, the ASM3 produced a publicly-accessible visual database (6) of 434 research activities by theme and region, developed using Japan's Arctic Data Archive System as the platform. This resource illustrates the existing frameworks of cooperation, and also provides an overview of observational gaps and challenges, and should be used to establish enhanced observation systems.

Building upon these achievements, Japan has decided to construct a new Arctic research vessel, Mirai II, which is equipped with advanced icebreaking capabilities and world-class observation systems, making it suitable for use as an international research platform. The ship was launched in March 2025 and is scheduled for completion in the autumn of 2026. Through Mirai II, Japan aims to promote research activities that address the diverse challenges in the Arctic through international collaboration. In addition, the vessel is expected to contribute to the training of researchers, engineers, and other specialists. Moreover, Mirai II has been designed in an environmentally-friendly manner; it is the world's first research vessel to adopt a dual-fuel engine (marine fuel oil and liquefied natural gas), thereby reducing environmental impacts and improving fuel efficiency (7).

Japan's engagement in sustainable maritime innovation also extends to its potential role in Arctic shipping. Just as Singapore has become Asia's hub for the Suez Canal route, Japan—particularly Hokkaido—has the potential to serve as a hub for the Northern Sea Route. Vessels navigating from East Asia to the Northern Sea Route must proceed northward through either the Tsugaru Strait or the Soya Strait. In this context, Hokkaido represents the northernmost modern industrial region along these routes from East Asia toward the Arctic. The island is equipped with modern international ports, an international air transportation network, and a well-developed domestic land transportation system. Behind these ports lie urban centres that provide comprehensive infrastructure for transportation, commerce, healthcare, and accommodation. From the perspective of users of the Northern Sea Route originating in East Asia, including Japan, Hokkaido's geographical position—once considered a disadvantage as Japan's northern extremity—may now be viewed as a strategic advantage, serving as a gateway to the Arctic shipping lanes (8).

Maritime transport, which accounts for more than 80 percent of global trade volume, is the backbone of the world economy. Reducing emissions from vessels is thus expected to contribute significantly to improvements in global health and the environment, particularly benefiting populations residing in coastal areas. In 2018, Nippon Yusen Kaisha (NYK Line) launched a 10-billion-yen green bond, the world's first by a shipping company, to realise its roadmap for environmentally-friendly vessels and fund the research and development of LNG-fueled vessels, aimed at reducing sulfur dioxide emissions and improving exhaust gas cleaning systems (in keeping with the International Maritime Organization's regulations on sulfur content in marine fuels) (9,10). Furthermore, in May 2021, Kawasaki Heavy Industries developed the world's largest-capacity liquefied hydrogen carrier (with a single-tank capacity of approximately 40,000 sq m) and obtained basic approval for its cargo containment system with significant environmentally friendly characteristics to support the transition toward a hydrogen-powered society (11). If such large-capacity liquefied hydrogen carriers become operational, they could enable the supply of clean hydrogen even to remote regions via Arctic sea routes. In particular, the opening of the Northern Sea Route could reduce voyage distance and energy consumption for hydrogen shipments between Asia and Europe, thereby enhancing the economic and environmental feasibility of hydrogen-based supply chains in polar-adjacent logistics (12).

Taken together, these initiatives have significant implications for the Arctic. They demonstrate Japan's comprehensive approach—integrating science, policy, and technological innovation—to ensure that its contributions to Arctic governance and sustainability are both meaningful and forward-looking. As such, cooperation and joint analysis with Arctic states and other relevant countries will be crucial in advancing sustainable practices in this domain.

Japan has acted as a constructive and responsible stakeholder in the Arctic through its long-standing engagement in Arctic scientific research, its role as an observer in the Arctic Council, promoting international cooperation under the Agreement on Enhancing International Arctic Scientific Cooperation, its leadership in hosting the ASM3, and its continued investments in next-generation research infrastructure and clean maritime technologies. Looking ahead, Japan must further deepen its partnerships with both Arctic and non-Arctic states, enhance international understanding of Arctic climate change, and advance sustainable solutions for the Arctic, one of the world's most vulnerable regions.

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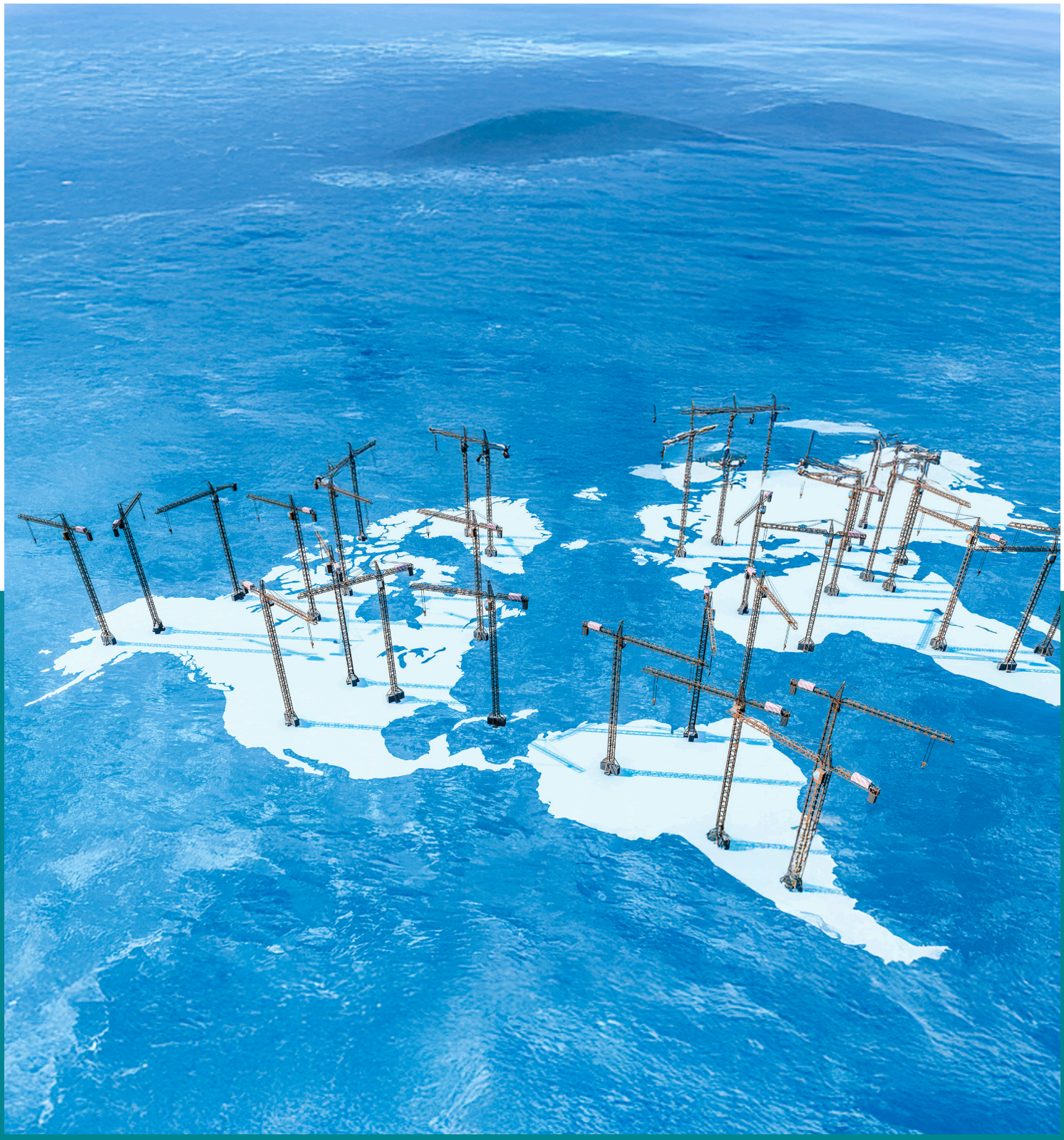

Geopolitics in the Arctic

An Emerging Great Game

All Eyes on the Arctic: A Look Beyond the Headlines

Jennifer Spence

The Arctic has often been portrayed by the mainstream media as a distant frontier—a realm of explorers, polar bears, and ice. In 2025, however, the region is starting to make headlines for quite different reasons. Media stories highlight naval expansions by the North Atlantic Treaty Organization (NATO), Russia's energy exports, and China's growing Arctic ambitions. The Arctic is portrayed as both a climate barometer and a new theatre of geopolitical tensions. The media reports on politicians making visits to Greenland, and US President Donald Trump and Russian President Vladimir Putin meeting in Alaska.

However, mainstream reporting tends to lean towards the sensational and often lacks facts and nuance. The promise of vast resources, revolutionary shipping lanes, and looming great power conflict may make for gripping reading, but more attention needs to be paid to balancing the hype with information about the region's sparse infrastructure, fragile ecosystems, and the lived realities of Northern peoples. To truly understand the Arctic requires moving beyond headlines toward a deeper, more nuanced analyses.

Current Arctic Headlines

Media interests in 2025 are coalescing around four key themes: military build-up, great power competition, economic opportunities, and climate change. Each of these is a real issue that deserves attention, but each also provides important examples of where more thoughtful research and reporting are critical to inform public opinion and shape policy.

Military Build-Up: Media coverage frequently depicts the Arctic as sliding into a new Cold War. Dramatic images of Russian submarines, refurbished bases, and NATO exercises are fuelling the perception of an escalating arms race. These portrayals may capture attention, but they rarely consider the drivers of these actions. For example, how might the perspective change if it is acknowledged that much of this activity is defensive? Russia's Arctic forces, while growing, serve a dual purpose: protecting vital military assets on the Kola Peninsula and also meeting civil infrastructure needs. Meanwhile, NATO states have been careful to emphasise that their actions are focused on defensive surveillance and protecting sovereignty. Framing these moves solely as militarisation overlooks the efforts of states to manage tensions and preserve stability (1).

Great Power Competition: Beyond Russia and NATO, the media increasingly focuses on China. Stories present Beijing's self-declared "near-Arctic state" identity and its Polar Silk Road initiative as evidence of its current interests in the region, despite this strategy being released in 2017. While Sino-Russian liquefied natural gas ventures and joint exercises in the Bering Strait certainly signal changing geopolitical dynamics in the Arctic, it is equally important to acknowledge that China's Polar Silk Road investments, while widely discussed, remain limited in scale and are increasingly being slowed by political and logistical barriers (2).

Furthermore, reporting on high-profile diplomatic events is reinforcing a sense of growing great power competition in the region. The Trump-Putin meeting in Alaska and visits by numerous political leaders to Greenland are widely covered as demonstrations of rivalry. Yet while such events generate spectacle, they can overstate the material significance of great power competition. Scholars caution that infrastructure gaps, seasonal access, and the importance of local politics place real limits on what external powers can achieve (3). The symbolism of presence often outweighs its practical impact.

A Last Economic Frontier: The Arctic is frequently portrayed as one of the world's final economic frontiers. Headlines highlight untapped oil, gas, and mineral reserves, alongside visions of transformational shipping routes. The Northern Sea Route (NSR) is presented as a 'new Suez Canal,' while Greenland is lauded as an untapped source for rare earths.

Media portrayals tend to dramatise opportunity while underplaying constraints, inflating expectations of an imminent Arctic boom.

In practice, these opportunities are far more constrained, and their feasibility remains questionable. The NSR remains hindered by environmental uncertainty and political risks (4). Mining projects face high costs, inadequate infrastructure, ecological risks, and pushback from local communities (5). The reality is that economic development in the region will likely be incremental and uneven.

Climate Crisis; Stories of Arctic climate change rely on striking visuals—starving polar bears, collapsing glaciers, and thinning sea ice. These images are effective in conveying urgency and highlighting the Arctic as the world's early warning system. The facts are sobering: the region is warming three to four times faster than the global average (6), and the consequences extend globally. Melting ice sheets accelerate sea-level rise; shifts in sea ice and ocean circulation affect weather extremes across the mid-latitudes; and thawing permafrost releases vast stores of carbon and methane, intensifying climate feedback loops (7). In this sense, the Arctic is not only a warning signal but an active driver of planetary change.

Yet the media's portrayal often oversimplifies. References to an "ice-free Arctic" rarely clarify that this refers to seasonal summer ice loss under certain emissions pathways (8). Furthermore, this coverage tends to focus on global consequences while underreporting local realities—eroding coastlines, collapsing infrastructure, and threats to food security. Crucially, these narratives overlook the agency of Arctic residents, who are leading adaptation efforts, advancing community-based monitoring, and shaping governance innovations.

What Should Make the Headlines

While sensational narratives dominate coverage, they risk obscuring the enduring reasons why the Arctic matters: the leadership of its peoples, its central role in climate adaptation, and its innovations in governance and science diplomacy.

Leadership and Resilience of Arctic Peoples: Nearly four million people live in the circumpolar North, including Indigenous Peoples with deep cultural and ecological ties to the region (9). For these communities, climate change is not a distant prospect but an immediate reality. Thawing permafrost destabilises homes and infrastructure, coastal erosion forces relocations, and changing wildlife patterns disrupt food systems and cultural continuity (10).

Yet these communities are not passive victims. Indigenous Peoples and local communities are leading adaptation and governance initiatives, ensuring that responses are rooted in local knowledge and priorities. Inuit-led programmes, for example, generate critical data for science while embedding community perspectives in decision-making. Similarly, Indigenous engagement protocols are strengthening the legitimacy and effectiveness of adaptation strategies (11). By centring the experiences and leadership of Arctic residents, the media can better reflect the resilience and innovation shaping the region's future.

Governance, Cooperation, and Science Diplomacy: The Arctic also demonstrates how governance can be innovative and cooperative, even in the face of geopolitical tension. The Arctic Council serves as a forum for collaboration, while agreements such as the Central Arctic Ocean Fisheries Agreement demonstrate how states can act collectively (12).

Science diplomacy has been especially powerful in the region. International research initiatives, such as the MOSAiC expedition, have built trust across borders while generating vital knowledge (13). Even in periods of political strain, scientific collaboration has continued, reinforcing the Arctic's reputation as a laboratory for cooperative governance (14). Indigenous-led monitoring adds further strength, ensuring that governance reflects both lived realities and scientific data. These practices offer valuable lessons for other regions and global governance more broadly: that precaution, collaboration, and science-driven decision-making can sustain cooperation even in contested spaces.

Conclusion

The Arctic's rising profile in the mainstream media reflects its global importance, but the media has a responsibility to recognise the crucial role it plays in shaping public opinion and influencing government policies. Now more than ever, what is needed is reporting that moves beyond spectacle toward an informed, nuanced, and respectful understanding of this vital region.

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Disclaimer: The *author used ChatGPT 5 to edit the essay and assist with adjusting the text to meet the word length requirements. All ideas and opinions expressed in the essay are fully hers.*

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Nordic Perspectives on Arctic Security

Andreas Østhagen and Andreas Raspotnik

In recent decades, the Arctic region has increasingly attracted global interest due to its climatic, economic, and political transformations. The Arctic's strategic relevance has been particularly accentuated amidst rising tensions with Russia, especially following its full-scale invasion of Ukraine in 2022. This attention has, in turn, amplified the roles of the Nordic countries—the Kingdom of Denmark (comprising Denmark, the Faroe Islands, and Greenland), Finland, Iceland, Norway, and Sweden—in regional security dynamics (1).

The accession of Finland and Sweden to NATO in 2023 and 2024, respectively, exemplifies the momentum towards deeper Nordic integration in security domains. This trajectory was further highlighted by United States (US) President Donald Trump's comments in January 2025 regarding control over Greenland, drawing international scrutiny to the island's strategic importance and the internal dynamics within the Kingdom of Denmark (2).

Diverse Nordic Perspectives on Security

The Nordic countries are often perceived as homogeneous entities due to shared historical narratives, advanced democratic institutions, and relatively small populations. Nevertheless, their approaches to security and the Arctic landscape reveal significant divergences. A critical fault line in these differences is their respective affiliations with NATO and the European Union (EU).

Traditionally, Iceland and Norway have abstained from EU membership, instead affirming NATO's role concerning Arctic affairs. In contrast, Finland and, to some extent, Sweden have proactively engaged with EU Arctic initiatives while maintaining a close yet not overly close relationship with NATO. The Kingdom of Denmark has straddled both entities, albeit its Arctic component, Greenland, exited the EU's antecedent, the European Economic Community, in 1985 (3).

During the Cold War, this dynamic led to the concept of a 'Nordic balance', wherein the Nordic countries maintained varied security stances vis-à-vis the Soviet Union and NATO, striving for a so-called regional equilibrium. The discourse around Arctic security notably underscores the disparities among the Nordic states. Although the focus has been collectively turning towards the Arctic over the past 20 years, the vigour and scope of engagement have been uneven. This is particularly evident when examining the Nordic countries' relationship with, and within, the EU and NATO.

The EU and NATO in the Arctic

The Arctic has traditionally been marginal in EU (hard/military) security discourse, despite the bloc undoubtedly being an active actor in the region, with multiple good reasons for pursuing its regional interests. The EU has a tangible presence in the region, both in terms of geography and legal competence, as well as its contributions to Arctic science. It also exercises influence through policies and regulations in determining access to its single market, as well as shaping its environmental footprint in the region (4).

Over the past two decades, the EU has sought to define its role in the Arctic largely through the lens of environmental protection, sustainable development, and scientific research. This framing has continued even as the region's security environment has deteriorated. The 2021 joint communication titled 'A stronger EU engagement for a peaceful, sustainable and prosperous Arctic'—the last update of the EU's Arctic policy—reiterates these themes and also prominently emphasises the EU's geopolitical role in the Arctic, yet makes limited inroads into hard security matters (5).

However, since October 2021, political developments have changed the Arctic context. Finland and Sweden's accession to NATO, Denmark's decision to abandon its EU defence opt-out, and Norway's recalibrated defence posture vis-à-vis Russia point to increasing convergence between Arctic and European security issues. The EU has, in turn, adopted stronger language around strategic autonomy and has begun to engage more robustly in areas such as maritime security and space-based situational awareness. This has also become evident in the EU-NATO relationship, a bond that has historically been characterised by a mix of institutional rivalry and operational complementarity.

NATO's attention to the Arctic—or more accurately, the High North (the European Arctic)—only truly manifested after 2014, and the change in relations with Russia after it annexed Crimea and initiated conflict in Ukraine. This change was driven primarily by a realisation of the need to reinstate Cold War-style capacities and activity monitoring in the North Atlantic and Barents Sea by the US, the United Kingdom, and other northern European NATO members, such as France and Germany (6).

With Finland and Sweden having joined the alliance, it is apparent that the defence alliance's focus and attention on northern European and Arctic security issues have increased and will likely continue to do so in the coming years. Trump's remarks about gaining control of Greenland have further pushed Arctic issues to the forefront in the Kingdom of Denmark and amongst European and NATO allies.

Traditionally, facilitating Nordic cooperation, notwithstanding shared cultural and historical trajectories, has encountered challenges due to divergent perspectives on Arctic and High North issues. Geopolitical orientations differ across the region; while Copenhagen (specifically Nuuk and Tórshavn) and Reykjavík tend to look westwards, Oslo's attention is drawn towards the north and the Barents Sea, and Stockholm and Helsinki focus more on southeast and the Baltic region.

Today, however, there is a realisation that security relations and military considerations vis-à-vis Russia in Northern Europe is a continuous domain, stretching from the Norwegian archipelago of Svalbard and the Barents Sea in the European Arctic, down along the 1540 km NATO (Norway/Finland)–Russia border, and into the Baltic Sea/Gulf of Finland, the Baltic countries, Poland and Ukraine.

Nordics Between NATO and the EU

At present, both organisations share 23 members—including Denmark, Finland and Sweden—and have articulated common values and overlapping goals, but they differ in

their mandates, structures, and capabilities. While NATO remains the central institution for territorial defence and hard security, the EU has concentrated its efforts on civilian, regulatory, and economic dimensions of security.

For the Nordics, this new setup offers several options to manoeuvre, particularly as the Arctic becomes increasingly entangled in global rivalries—between Russia, China, and the US:

- **The Kingdom of Denmark**, a complex entity in itself, has to navigate complex internal and external political dynamics amidst increased EU and NATO interest in the Arctic. While Denmark represents the entire Kingdom in NATO, Greenland and the Faroe Islands have distinct EU affiliations, requiring careful coordination to align their Arctic policies. This internal complexity challenges Denmark's ability to present a unified stance within both organisations, especially as Greenland seeks complete independence.

- **Finland's** Arctic policy has shifted significantly since Russia invaded Ukraine, with NATO accession prioritising national security and deterrence, especially in the Arctic. While NATO will lead defence efforts, Finland continues to value the EU as a key framework for foreign and security policy. As such, the country is balancing its defence priorities with a commitment to Arctic stability, while also managing its economic dependence on China for critical minerals.

- **Iceland** is more likely to engage with the EU on 'soft security' issues such as cybersecurity and climate change, while continuing to strengthen its participation in NATO. Despite Iceland's complex relationship with the EU, marked by its European Economic Area membership and ongoing EU scepticism, public opinion has shifted following the Ukraine invasion, with increasing support for closer EU cooperation on security matters. However, full EU membership remains questionable. Meanwhile, NATO's presence in Iceland has grown since the US base closure, reflecting a broader alignment of Iceland's security interests within NATO and the Arctic region.

- **Norway's** relationship with the EU has traditionally been ambivalent, especially in the Arctic, where it holds significant leverage in energy cooperation and regional development. As the EU's top gas supplier since 2023, Norway plays a key role in the EU's Arctic engagement; however, its primary focus on security remains with NATO, particularly in relation to Russia.

- **Sweden** is increasingly open to a stronger EU role in Arctic soft security, such as environmental and infrastructure issues, while maintaining NATO as its primary

security partner for defence. Sweden's strategy balances using EU resources for Arctic goals and NATO for direct security concerns, particularly in the Baltic. In the future, if US isolationism rises, Sweden may turn more to the EU for Arctic security, with NATO playing a secondary role.

Additionally, other EU member states have articulated their Arctic interests and share the commonality of being both EU and NATO members. As such, the dual challenges of internal fragmentation and external complexity will only continue to shape European options in the Arctic. Within the EU, member states diverge in their threat perceptions and approaches to both Russia and China. Externally, European states must navigate overlapping but distinct relationships with the EU and NATO, as well as global powers, all while maintaining their own coherence and credibility.

A New Nordic Balance?

The trends outlined above have led to heightened anticipation surrounding the potential outcomes of Nordic collaboration, also extending beyond defence strategies and into realms such as regional infrastructure, transnational economic cooperation, and research.

Given that all five Nordic countries are now NATO members, and with strengthened EU-NATO institutional collaboration, a coherent Nordic-led approach in the Arctic seems likely in the coming years. Establishing both political and operational Nordic Arctic unity could, in turn, foster a more cohesive European stance on Arctic security issues, from countering hybrid threats to bolstering joint research and investment initiatives.

The precepts of the Cold War-era 'Nordic balance' are thus less pertinent. The Nordics are no longer seen as balancing between global power blocs such as Russia, the US, or China. Instead, they align firmly with a Western and North Atlantic strategic doctrine in Arctic security. Despite these alignments, the distinct Arctic territories and security strategies of each Nordic state—shaped by NATO and EU dynamics—mean varied interests and priorities persist amongst the Nordics.

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The Indo-Asia-Pacific's Arctic Agenda

Elizabeth Buchanan

The Arctic was at a 'crossroads' more than a decade ago. Today, geopolitical forces have ushered in an era of enhanced strategic competition in the Arctic theatre, a region that no longer adheres to traditional geopolitical 'rules of the road'. Once a case of the 'West' versus the Soviet Union, the Arctic is now a frontier for the 'West' versus 'the rest'.

Seven of the eight Arctic rim nations identify as 'western' (Russia, of course, does not). These 'western' Arctic nations have worked to keep the region 'exceptional' and somewhat of a closed club. However, following the 2022 invasion of Ukraine, Russia's geopolitical isolation accelerated Moscow's shift to Asia (1). A key knock-on effect has indeed been the influx of Asian nations to the Arctic 'great game'. With the addition of India, states spanning the Indo-Asia-Pacific have cast their eyes north, unlocking pointed Arctic agendas.

The Asian Agendas

Countries spanning the Indo-Asia-Pacific, specifically China, India, Japan, and South Korea, have increasingly identified themselves

as Arctic stakeholders or, at the very least, as Arctic interested parties. Most have even developed pointed Arctic agendas that blend economic ambition and scientific pursuit in a way that somewhat obfuscates potentially more nefarious long-term strategies. The influx of Indo-Asia-Pacific nations in the Arctic not only has the potential to reshape the Arctic's governance (via the Arctic Council) but also amplifies strategic tensions far beyond the Arctic (2).

The engagement of Asian states in the Arctic 'great game' is legitimised by their past activity and adherence to the guardrails established by the Arctic Council. The Arctic Council is a key intergovernmental forum comprising the eight Arctic states (Canada, Denmark, Finland, Iceland, Norway, Russia, Sweden, and the US) that granted observer status to several non-Arctic (albeit Indo-Asia-Pacific) nations (3)—China, India, Japan, South Korea, and Singapore signed on early to the Arctic Council observer platform.

Asian economies are heavily reliant on global trade and energy imports, making the opening of the Arctic a long-term strategic interest for most. Arctic-rim nations continue to frame the Arctic as a zone of special interest, with many holding vast offshore territorial claims. However, the allure of the Arctic as a global transportation artery has well and truly internationalised the strategic theatre. For instance, the Northern Sea Route (NSR), hugging Russia's Arctic Zone, shortens the journey from Japan to Germany by about 40 percent compared to the traditional Suez Canal route linking Europe and Asia (4). Costs are reduced heavily, too.

China has emerged as the most assertive player among Asian nations, positioning itself as a 'near-Arctic state' despite its geographical distance from the Arctic. Beijing's Arctic agenda is multifaceted and encapsulated in its 2018 Arctic Strategy (5). Beijing's reference to "sustainable development" is illustrative of its long-term interest in unlocking the resource wealth of the Arctic Ocean High Seas. International law (the UN Convention on the Law of the Sea) affords Beijing such legitimate opportunities.

The simmering strategic economic goals for China in the Arctic relate to the development of a 'Polar Silk Road' (an extension of its Belt and Road Initiative), which seeks to integrate the Arctic into the global supply chains. China has invested heavily in Russian Arctic projects, such as the Yamal LNG plant, and is involved in numerous port development scoping projects. India is investing in the North-South Transportation Corridor, linking the Indian Ocean to Russia's Arctic Zone (6).

New Delhi's Arctic agenda is driven more so by climate and environmental concerns (7). Polar weather shifts influence monsoon patterns and, therefore, have an immense security

value to India's burgeoning agriculture sector. India joins China in operating research stations on Svalbard and making public commitments to enhancing BRICS Arctic research efforts (8). India seeks to diversify energy sources, eyeing Russian Arctic hydrocarbons and rare-earth minerals essential for a 'green' transition.

India has deepened ties with Russia, including training maritime personnel for polar navigation, seeking to bolster its access to the NSR for trade. India's Arctic push may also provide a future geopolitical edge: as a Quad member (alongside the US, Japan, and Australia), India could help offset the deepening Chinese influence in the Arctic.

Japan and South Korea, both maritime trading giants, share similar economic imperatives regarding the opening of the Arctic. Japan's Arctic policy, updated in 2025, prioritises scientific research, climate action, and upholding international law (9). South Korea is looking to reorient its shipping economy to utilise the NSR, and is offering its shipbuilding expertise for icebreakers and LNG transport solutions (10).

The Impact

The influx of Asian states to the Arctic, though driven by unilateral strategic interest, has ultimately linked the Arctic to the Indo-Asia-Pacific security architecture. Economically, the world should expect accelerated resource extraction (specifically for fisheries) in the Central Arctic Ocean. Geopolitically, there is likely to be an exacerbation of strategic competition in the Arctic, which will look significantly different from the Cold War-era experience. The Ukraine war has fractured Arctic cooperation, with Western states suspending engagement with Russia in the Arctic Council, enough to push Moscow into Beijing's arms (11). Large Asian nations have sidestepped Western sanctions and continued to do business with Russia in the Arctic.

Environmentally, increased Asian nation involvement (namely through shipping surges) raises concerns over Arctic pollution and biodiversity loss. Of course, this has also been a window of opportunity for rekindling multilateralism. The 2018 Central Arctic Ocean Fisheries Agreement (CAOFA) brought together Asian nations with Arctic-rim states to agree to sustainable norms in the Arctic (12). It is unclear whether the consensus on such a commitment will remain for the de facto protected area when the CAOFA comes up for reassessment in 2037.

Indo-Asia-Pacific tensions are likely to spill into the Arctic. In 2025, China applied immense strategic pressure to the US by deploying three icebreakers off the coast of Alaska, the US's Arctic frontier (13). Washington scrambled to get one of its two icebreakers to the

region. This underscored the gap in polar capability between Arctic nations, such as the US, and emerging Asian Arctic players.

Conclusion

The addition of Indo-Asia-Pacific states to the Arctic is underscoring that a global realignment is underway. Zones of special interest, like the Arctic, are no longer isolated from a rising China. The Arctic has internationalised. Indo-Asia-Pacific nations (namely India, Japan, and South Korea) pursue Arctic policies and plans that blend science and research with geopolitical foresight and military-strategic planning.

Gone are the days when the Arctic was managed by multilateral frameworks that efficiently operated in the interests of Arctic rim stakeholders. In its place is a fragmented collection of competing national agendas and interests, which for now appear to unify over a shared rejection of the 'West' and its traditional designs on a part of the world that no longer feels far away or 'frozen'. The future of the Arctic is already here, and it is contested, congested, and competitive. The Arctic is hosting a race, and the Indo-Asia-Pacific is about to take the lead.

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The Arctic Pivot: Hyperborean Spatial Politics Writ Large

Christopher R. Rossi

Scholarly treatments of the Arctic as an exceptional 'zone of peace', a zone removed from the forces of international politics, date back to Soviet leader Mikhail Gorbachev's 1987 Murmansk speech (1), in which he proposed a series of desecuritisation efforts to exempt the Arctic from competitive drivers of international affairs. Gorbachev called for cooperative engagements to utilise Kola Peninsula resources, promote scientific exchanges, create an Arctic Research Council, and commercialise the Northern Sea Route. Adumbrating the idea of an enlarged Arctic spatial realm, he also proposed restricting naval activity not only in the North, Norwegian, and Greenland Seas, but also in the Baltic Sea. Additionally, he proposed expanding discussions with sub-Arctic states (2), an initiative that, perhaps more than the circumpolar stewards recognised at that time, presaged the idea of a global Arctic (3).

Gorbachev's broad call for reframing the Arctic informed the 1991 Rovaniemi Ministerial Conference (4), facilitated the adoption of the 1991 Arctic Environmental Protection Strategy, and led to the creation of the 1996 Ottawa Declaration, which founded the Arctic Council as *the* high-level forum for cooperative engagement on Arctic issues (5).

If Gorbachev's idea of Arctic exceptionalism intended to create a *jus publicum arcticus*, its crowning achievement—the Arctic Council—expressly avoided discussion of military security issues, at least until the weight of Russia's invasion of Ukraine in 2022 became too much to bear for its Western-aligned members (6). The Arctic Council's five NATO-member states (joined by Finland and Sweden, which later acceded to the North Atlantic Treaty) suspended its Arctic tradition of cooperation and shunned almost all engagements with Russia. Excluding the Arctic's dominant stakeholder rendered the operation of a circumpolar forum, founded on the principle of consensus decision-making, functionally feeble (7).

As a result of Russia's aggression and the West's response, a geopolitical pivot to the Arctic now reframes the spatial understanding of security dynamics. A new Great Game of Mackinderian proportion and Spykmanean significance now unfolds in the High North (the geopolitical and geographical area generally associated with the area around and north of the Arctic Circle) (8).

Almost 200 years ago, the Great Game pitted rival British and Russian empires against each other for control of Central Asia. Today, the game churns to the High North. An insecure Russia, challenged by fraying threats to its imperial and Soviet-styled *Grobraum* (great space) animates this turn. An authoritarian alarm for NATO expansion feeds Russia's insecurity. Russia also casts a wary eye on China's Belt and Road Initiative, which forges technologically driven penetrations across, around, and atop its former influences in Central Asia (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan). This insecurity compounds to include the growing territorial temptations promoted by the receding Arctic ice. The prospect of global Arctic regions connecting Barentsburg to the Baltic, Kirkenes to Kyiv, Nome to Nuuk, and Reykjavik and Rotterdam to the Pacific Rim complicates Russia's calculus of security interests and challenges Russia's sense of place in the Arctic.

However, the real Great Game will have only derivative significance to the Arctic. Russia's commanding infrastructural and maritime presence in the Arctic will dominate over the near future, and nothing regarding the vicissitudes of war in Ukraine will alter Russia's strategic purpose or commitment to its "most survivable nuclear asset," Moscow's sea-based nuclear forces in the Kola Peninsula (9). The real Great Game is not in the Arctic. It is in Eastern Europe and the Baltic Sea. However, the regions are intimately connected.

In his mega-construction of geopolitics, Halford Mackinder's inner crescent amphibious states, alternatively conceived of as Nicholas J. Spykman's 'rimland bufferings' surrounding the Eurasian landmass (10), formed the basis of his 'Heartland Thesis'. The heartland of

this great landmass (or World-Island, in Mackinder's parlance) grew to include Eastern Europe and the Black and Baltic Seas (11). According to Mackinder:

Who rules East Europe commands the Heartland

Who rules the Heartland commands the World-Island

Who rules the World-Island commands the World

Control over this heartland citadel now centres on Ukraine. The war's Baltic perturbations have sucked Finland and Sweden into its vortex, immediately implicating the decades-long cooperative framework of Arctic exceptionalism and turning it into a murky idea marred by confrontation and contested influence among rimland states (NATO) and Russia.

Russia has always regarded the Arctic as part of its heartland. The puffery of Russian pronouncements framing the Arctic as a 'Russian Mecca' (12) or the Northern Sea Route as the next 'Suez Canal' (13) belies a deep psychological attachment to its Northern littoral coast and its inseverable connection to its interior. This association extends beyond the concentrated security studies framework formed from Atlantic-based and Eurocentric narratives from the Cold War to include broader storylines of ideology, culture, climate, and history (14). It involves Russia's historical penetration of the great river basins of the Arctic—the Ob, Yenisey, Lena, and Kolyma—to dominate the vast interiors of its Siberian steppe and to connect to the developmental ports of its vital cabotage system of resource extraction across the Northern Sea Route. Assimilating this route became the *sine qua non* for Russia's industrial development under Joseph Stalin, and it remains a focal project for reclaiming Russian spatial identity following the trauma of the Soviet collapse (15).

Russian nationalists now instrumentalise this identity as part of a Eurasianism project. This project fuels a Slavic Middle Kingdom sentiment, facilitating Russian President Vladimir Putin's screed against the West. It promotes a continental restoration of a nativist narrative that amalgamates Russian, Slavic, and Indo-European steppe peoples into a civilisation continuum. This continuum seeks to buttress Russian control over its increasingly unwieldy Central Asian rimland, now challenged by encroaching Chinese capital and emerging anxiety about vassal status with China in Russia's Far East. Russia's Eurasionist impulse must account for the complexities of its multinational ethnicities and its solution appears to construct a colossal sub-global cultural narrative connecting Hyperborean sentimentality with antiliberal Central Asian identity (16).

Putin forecasted his own pivot to Asia in 2013 (17), the year before invading Crimea. He did so to maintain a closer tab on China's activities in Northeast and Central Asia. This turn, described alternatively as a yoke around Russia's neck or as a vector of alliance, sums up the predicament of centuries of "geopolitical loneliness" (18). Russia's festering anxiety over its weakening sense of control over Central Asia, its predicament of its revanchist campaign in Ukraine, and its unease regarding a growing tributary relationship with China, which poorly attempts to cultivate Chinese investments at the expense of Chinese investors (19), mark the unreconciled tensions of an identity that previously regarded the Arctic as a placid backdrop to geopolitical tensions elsewhere. The decomposition of this attitude, facilitated by the merger of the Holocene and the Anthropocene, actively animates the Arctic as a geopolitical arena of hybrid tension. It provides a derivative and diversionary geospace meant to distract Western attention and divert Western resources from the real Great Game unfolding in Eastern Europe (and Taiwan).

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Endnotes

(1) Mikhail Gorbachev, "Speech in Murmansk at the Ceremonial Meeting on the Occasion of the Presentation of the Order of Lenin and the Gold Star to the City of Murmansk," October 1, 1987. Barentsinfo.org, www.barentsinfo.fi /docs/Gorbachev_speech.pdf.

(2) Gorbachev, Speech in Murmansk.

(3) Gunnar Rekvig and Matthias Finger, *GlobalArctic: The New Dynamics of Arctic Governance* (Palgrave Macmillan, 2025).

(4) "The Beginning of the Arctic Era," Arctic Finland, https://www.arcticfinland.fi/EN/Stories/Arctic-Era.

(5) Christopher R. Rossi, *The Arctic Großraum: Geopolitics and the High North* (Oxford, London, New York, New Delhi, Sydney: Hart Publishing, 2025), p. 71.

(6) Rossi, *The Arctic Großraum*, p. 72.

(7) "How We Work," Arctic Council https://arctic-council.org/explore/work/.

(8) The concept of the 'High North' is not synonymous with 'The Arctic'. It translates poorly and variously into English from the Norwegian term *nordområdene* (the northern areas). For more, see: Odd Gunnar Skagestad, *The 'High North': An Elastic Concept in Norwegian Arctic Policy* (Lysaker: Fridtjof Nansen Institute, 2010) pp.1-4.

(9) Steven E. Miller, "The Return of the Strategic Arctic," *Arctic Yearbook 2022* (2023), p. 1.

(10) Nicholas John Spykman, *The Geography of the Peace* (Helen R. Nicholl ed., intro. By Frederick Sherwood Dunn (Harcourt, Brace and Company: New York, 1944), pp. 40–41.

(11) Mackinder modified his 1904 thesis in view of the First World War, shifting the Heartland from Eurasia to include Eastern Europe and the Black and Baltic Seas. For more, see H.J. Mackinder, *Democratic Ideals and Reality: A Study in the Politics of Reconstruction* (London: Constable and Company LTD, 1919), pp. 139–41 (Quote: "The Heartland, for the purposes of strategical thinking, includes the Baltic Sea, the navigable Middle and Lower Danube, the Black Sea, Asia Minor, Armenia, Persia, Tibet, and Mongolia. Within it, therefore, were Brandenburg-Prussia, and Austria-Hungary, as well as Russia. … The Heartland is the region to which, under modern conditions, sea-power can be refused…").

(12) Dmitry Rogozin (@DRogozin), "The Arctic is Russian Mecca", X, April 20, 2015, https://x.com/drogozin/status/590025163166613504?lang=bg.

(13) Gleb Bryanski, "Prime Minister Vladimir Putin on Thursday Predicted Arctic Shipping Routes along Russia's Northern Coast Would Soon Rival the Suez Canal as a Quicker Trade Link From Russia to Asia," Government of the Russian Federation, 2011, http://archive.premier.gov.ru/eng/premier/press/world/5756/print/.

(14) Rossi, *The Arctic Großraum*, p.174.

(15) Rossi, *The Arctic Großraum*, pp. 121–22.

(16) V.D. Sukhorukov, Yu N. Gladkiy, and S.V. Kulik, "The Russian Arctic World as a 'Cultural Circle' and an Object of Development," IOP Conf. Series: Earth and Environmental Science 816 (2021): 1–8.

(17) Vladimir Putin, Presidential Address to the Federal Assembly, President of Russia, December 12, 2013, http://en.kremlin.ru/events/president/news/19825.

(18) Vladislav Surkov, "The Loneliness of the Half-Breed," *Russia in Global Affairs*, May 20, 2018, https://eng.globalaffairs.ru/articles/the-loneliness-of-the-half-breed/.

(19) Jack A. Jarmon and Alexander J. Motyl, "Russia: From China's Big Brother to Vassal," *Australian Institute of International Affairs* (June 17, 2024), https://www.internationalaffairs.org.au/australianoutlook/russia-from-chinas-big-brother-to-vassal/.