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Science Diplomacy in the Cryosphere: Insights from the Arctic and the Third Pole

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Introduction

The growing interaction between science, technology and foreign policy has redefined modern diplomacy. With science increasingly shaping foreign affairs, science diplomacy has become a crucial element to foster cooperation amongst states. This article examines the evolution and practice of science diplomacy in two regions: the Arctic and the Hindu-Kush Himalaya (HKH). Both regions possess large ice reserves that regulate and shape conditions, both globally and regionally, while also providing essential ecosystem services, including water, food, and energy, sustaining billions of people, worldwide. Simultaneously, both regions are warming more than the global average; Arctic warming is four times higher than the global average (Tandon, 2022), while warming in the HKH region is double the global average (Gymatsho, 2023). While climate change affects both regions significantly, the responses to it differ in the regions. The Arctic is seen as a successful example of science diplomacy, with the formation of the Arctic Council and the Arctic Science Cooperation Agreement. On the other hand, the HKH has sporadic and fragmented scientific cooperation.

The paper examines the divergences in science diplomacy discourses between the two regions. It argues that, while science diplomacy has institutionalised regional cooperation and depoliticised climate action in the Arctic,it remains weak and fragmented in the HKH. The paper draws from the updated framework of AAAS to assess two functions of science diplomacy, science impacting diplomacy and diplomacy impacting science, while keeping the traditional triad of science diplomacy: science in diplomacy, science for diplomacy, and diplomacy for science. The results illustrate that the Arctic has a reinforcing loop of science diplomacy, whereas the HKH region has a broken loop of science diplomacy.

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Conceptualising Science Diplomacy

As a concept, science diplomacy was formally introduced by the Royal Society and the American Association for the Advancement of Science (AAAS) in 2010 through their work "New Frontiers in Science Diplomacy." Science diplomacy "seeks to strengthen the symbiosis between the interests and motivations of the scientific and foreign policy communities." It is defined as the interaction between science and international relations, and how this interaction achieves common goals. The report introduced the three dimensions of science diplomacy: science in diplomacy, science for diplomacy, and diplomacy for science (Royal Society & American Association for the Advancement of Science, 2010).

Science in diplomacy refers to the use of scientific advice to inform foreign policy objectives. Second dimension, diplomacy for science is the use of diplomatic tools to facilitate scientific cooperation between individual scientists at both the top-down and bottom-up levels. Third dimension, diplomacy for science refers to the use of scientific collaborations to improve international relations between countries. This includes track two diplomatic efforts that aim to inform track one but include non-governmental and informal actors that can facilitate cooperation (Royal Society & American Association for the Advancement of Science, 2010). However, this three-dimensional conceptualization of science diplomacy was criticized to be state-centric and benevolent, and lacking the capacity to address geopolitical disruptions that are different from the world order of 2010, when the world order seemed more peaceful (American Association for the Advancement of Science & Royal Society, 2025).

"… Arctic has a reinforcing loop of science diplomacy, whereas the HKH region has a broken loop of science diplomacy…"

Consequently, to address the critique, AAAS and the Royal Society have added a fourth dimension to science diplomacy, a two-fold framework: science impacting diplomacy and diplomacy impacting science, to ensure more flexibility and accommodate the possibilities of cooperation and conflict in the changing geopolitical landscape. Science impacting diplomacy recognises the role of science in informing diplomacy, especially in addressing global challenges, including pandemics, environmental, technological, and demographic issues that require attention, regardless of the

state of diplomatic relations between countries. Diplomacy impacting science refers to the use of diplomatic tools that can either enhance cooperation or limit it due to national security concerns with the shifting geopolitical landscape (American Association for the Advancement of Science & Royal Society, 2025). The revised model highlights that science and diplomacy are not two discrete functions but mutually reinforcing, either positively or negatively. This paper employs the updated concept as an analytical lens to explain the divergences in both regions.

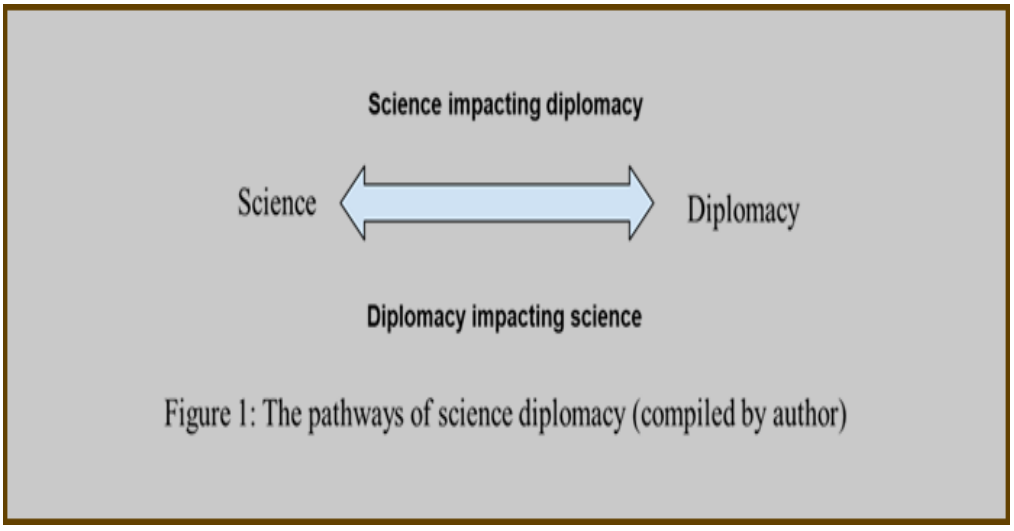

Figure 1: The pathways of science diplomacy (compiled by author)

The Arctic

The Arctic has been the epicenter for both geopolitics and scientific cooperation. Given the environmental risks, it witnesses, the region has highlighted environmental cooperation. Thus, it is studied as a successful example of how science shaped diplomacy in the region with both formal and informal modes of cooperation (Ruffin and Ruland, 2022).

Science impacting diplomacy

Science has been foundational to Arctic cooperation. The Arctic Environmental Protection Strategy (AEPS), with four working groups- The Arctic Monitoring and Assessment Program (AMAP), The Conservation of Arctic Flora and Fauna (CAFF), Emergency Prevention, Preparedness and Response (EPPR), and Protection of Arctic Marine Environment (PAME), culminated into the Arctic Council (Koivurova, 2012). The strongest groups, the Arctic Monitoring and Assessment Programme (AMAP) produced the Arctic Climate Impact Assessment (ACIA), which revealed that the region was warming twice than the global average, with irreversible impacts on ecosystems, livelihoods, and regional and global climate systems marked a critical juncture. These scientific assessments moved beyond the scientific circles to policy tables and ministerial discussions, and scientific findings were incorporated into the IPCC reports, placing them on the

global climate agenda through the Arctic Council.

Furthermore, indigenous knowledge strengthened this pathway with six permanent indigenous people organizations whose inputs were incorporated by ACIA, acting as a bridge between pure scientific findings and local knowledge. Indigenous knowledge further strengthens this pathway. The Arctic Council formally includes six Permanent Participant organisations representing Indigenous peoples, whose input is integral to assessments. By combining indigenous knowledge with Western scientific methods, Arctic assessments gain legitimacy and broaden. Thus, science has been the backbone of regions' evolving regional dynamics, structuring debates in regional and global policy landscapes. It has also, to some extent, depoliticised the region, bringing two rivals, Russia and the US, to cooperate on the region.

Diplomacy impacting science

Diplomacy, in turn, has strengthened scientific cooperation in the region. The Arctic Council has emphasized environmental protection and sustainable development has produced legally binding agreements. The first such agreement was the Agreement on cooperation on aeronautical and maritime search and rescue in the Arctic (2011), to undertake search and rescue operations for people, ships, and aircraft in distress in the region. It depoliticized the region in terms of enhancing preparedness and humanitarian assistance, irrespective of the national boundaries. Another suchagreement isthe Marine Oil Pollution Preparedness and Response Agreement (2013), aimed at preventing, preparing, and responding to marine oil pollution. Despite the rivalry between the US and Russia, the Agreement on Enhancing International Arctic Scientific Cooperation was signed in 2017 by the foreign ministers of the US, Russia, Canada, Norway, Denmark, Iceland, Finland, and Sweden. The agreement established a benchmark for scientific cooperation between the countries in the Arctic, even when diplomatic relations between them were unstable. It facilitates cooperation in marine, terrestrial, and atmospheric research in the region (Berkman et al, 2017).

These agreements have enabled the functioning of the Council even when geopolitical tensions arise, for instance, during Crimea (2014) and Ukraine (2022), the cooperation channels remained open. In 2023, the Council restarted working on climate monitoring and technical work without Russia (calling itself Arctic 7), highlighting that if institutionalised, diplomacy can shield scientific cooperation amid disruption. Thus, the Arctic is a region where science diplomacy

is not just discussed prescriptively but is institutionalised and legally codified.

The Hindu Kush Himalaya

The Hindu Kush Himalaya encompasses eight countries: India, Pakistan, China, Nepal, Bhutan, Afghanistan, Bangladesh, and Myanmar, sustaining billions of livelihoods through ecosystem services. The region is undertaking rapid transformation as it is warming more than the global average. While these environmental challenges are transboundary in nature, efforts to address them remain limited.

Science impacting diplomacy

The HKH region has a vast amount of scientific knowledge on the cryosphere and mountains, but it has not adequately influenced policymaking and diplomacy. The International Centre for Integrated Mountain Development (ICIMOD) serves as a regional knowledge hub, producing scientific assessments and knowledge, including the HKH Assessment Report (2019) that gave a particular insight into the state of cryosphere, water, energy, food, poverty, migration, biodiversity, and governance in the region. Similarly, the HIWISE report highlighted the loss of glacier mass, lack of knowledge on permafrost, impacts on water tables, and society seeking regional attention.

Yet unlike AMAP and ACIA in the Arctic, ICIMOD's findings have not been able to influence regional policy-making. Consequently, engagement remains technocratic with minimal involvement of political actors. National policies such as India's National Mission on Sustaining Himalayan Ecosystem recognise the Himalayan ecosystem and the need to preserve it, but often from a national and domestic lens, rather than adopting a regional lens. Bilateral efforts between countries exist, such as India and Nepal, along with China-Pakistan cooperation on glacier monitoring. However, these efforts are fragmented and predominantly donor-driven.

Diplomacy impacting science

In the HKH, diplomacy has often restricted scientific cooperation rather than enabling it. Water sharing agreements have existed, but have struggled to continue throughout. The Indus Water Treaty (IWT) is struggling to continue due to the need for updating it, and the hydrological data sharing agreements, like the India-China MoU on sharing data on the Brahmaputra waters, are often politicised and remain vulnerable to suspension. For instance, post the Doklam crisis in 2017, China restricted data sharing with India due to mistrust.

Scientific collaborations are restricted due to the securitization of the region, resulting in restrictions on visas, scientific exchange, cross-border mobility, and access to glaciers. Unlike the Arctic, which has a scientific cooperation treaty to enable scientific exchange and reduce restrictions on movement to facilitate permits and visas, HKH does not have these mechanisms. Consequently, Himalayan science depends on external actors and donor funding.

ICIMOD's intergovernmental mandate remains largely advisory, limiting its capacity to translate science into legal or diplomatic commitments. Thus, HKH is a region with a broken reinforcing loop of science impacting diplomacy and diplomacy impacting science, where it restricts and securitises, impeding cooperation, not enforcing it. This has led to a broken and fragmented science diplomacy landscape in the region, unlike the Arctic.

Conclusion

The comparative cases of the Arctic and the HKH reveal both potential and constraints of science diplomacy in the high mountains and the polar region. The institutionalised science in the Arctic shows how it can build trust and shape regional order, acting as a soft power even during the conflict-ridden world order. Whereas the HKH represents a fragmented science diplomacy often brokered by developmental agencies and not states officially. This contrast highlights the decisive role of regional institutions and mutual trust in transforming scientific cooperation into regional cooperation.

In many ways, the Arctic offers valuable lessons for the HKH in fostering regional cooperation through scientific and environmental efforts. Transparency in data sharing across borders and depoliticisation and desecuritisation of the environmental issues are crucial to foster cooperation amongst states. As the climate impacts continue to rise, cooperation will be imperative. Fostering scientific and epistemic networks across regions is essential for global and regional environmental cooperation, especially against the backdrop of an unstable world order.

About the author

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