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The rise and fall of science diplomacy in the Arctic: The "INTERACT" experience

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Abstract

At a time of increasing environmental changes and geopolitical tensions, the need for collaboration in the Arctic is greater than ever. Top-down initiatives such as the Arctic Council have contributed to important increased collaboration and science diplomacy. Similarly, bottom-up initiatives have also played a major role in establishing diplomacy among researchers with spin-offs at government levels. We track the rise of science diplomacy achieved by INTERACT. In 2021, this was a network of 90 research stations in 18 countries (including all Arctic nations). It aims to improve the wellness of Indigenous Peoples, other Arctic residents and the global community by facilitating environmental monitoring and research. It supports scientists from around the world and facilitates environmental monitoring for more than 150 international/global networks. INTERACT contributed to science diplomacy until spring 2022 when the invasion of Ukraine by Russia completely changed its pan-Arctic networking over a couple of months. This decrease in INTERACT science diplomacy was due entirely to external constraints related to the current geopolitical circumstances and poses a new reality for INTERACT and its important contributions to environmental monitoring and research in a region where changes have global implications.

Introduction

At a time of accelerating environmental changes and geopolitical tensions, the need for international collaboration is increasing. Today's ongoing environmental change is posing global challenges that single nations cannot solve themselves. State boundaries are defined by people and are highly permeable to disease (like the COVID-19 pandemic), environmental degradation, biodiversity loss, pollution and climate change (e.g. Thompson, 2018). Science diplomacy is an effective way of bringing countries together politically to mitigate these overarching challenges, as well as geopolitical problems, both to respond to emergencies as well as to implement sustainable future solutions. Science diplomacy refers to the effort to leverage the engagement and execution of science in support of broader objectives which is beyond science discovery. Although the term "science diplomacy" is a phenomenon of the 21st century (Turekian, 2018), it has been practised for many decades (and even centuries).

The need for science diplomacy has increased during the last decades, especially in areas with rapid environmental change. The Arctic is experiencing the most dramatic climate change on Earth (AMAP, 2021), with air temperatures that have risen nearly four times as much as the rest of the world, the local, regional and global impacts are huge (Rantanen et al., 2022). Local challenges include harmful effects of extreme climate on human health, on ecosystem services and on biodiversity (Evengård et al., 2021). Global challenges include increasing sea levels due to melting glaciers and the Greenland Ice Sheet (Beckmann & Winkelmann, 2023), increasing greenhouse gas emissions due to thawing permafrost (Harris et al., 2023; Romanovsky et al., 2017), changes in albedo due to shorter snow season (Callaghan et al., 2011) and changing vegetation resulting in more energy remaining in the system and hence additional warming of the Arctic (Mård et al., 2017) and potentially the rest of the world.

Increased collaboration in the Arctic has been stimulated and achieved through top-down initiatives such as the Arctic Council, which was founded in 1996. The Arctic Council is an intergovernmental forum promoting cooperation in the Arctic, which is one aspect of science diplomacy (Berkman, Kullerud, Pope, Vylegzhanin, & Young, 2017). Before the invasion of Ukraine, the eight Arctic countries, the permanent participants (representing the Indigenous Peoples of the Arctic), the working groups and the observers (including non-Arctic states, Intergovernmental and Inter-Parliamentary Organizations and Non-governmental Organizations) met regularly to provide means for promoting cooperation, coordination and interaction among the Arctic States. The Arctic Council's working groups produce assessments such as the Arctic Climate Impact Assessment of 2005 (ACIA, 2005), which have been very important in bringing Arctic issues to the global arena through policy recommendations and

international cooperation. The need for greater international cooperation in science on globally important issues contributed to the diplomacy among all the countries within the Arctic Council in making an agreement on enhancing international Arctic Scientific Cooperation, which was signed on 11 May 2017. The agreement aims to improve the use of existing infrastructures and to enhance the mobility of people (researchers, students), equipment and materials. In addition, the agreement promotes sharing of metadata and data and greater inclusion of traditional and local knowledge (Berkman et al., 2017).

This successful, top-down diplomacy changed in 2022. On the 3rd of March 2022, Canada, the Kingdom of Denmark, Finland, Iceland, Norway, Sweden and the United States condemned Russia's invasion of Ukraine and paused the work of the Arctic Council (US Department of State, 2022). Later in the same year, the Arctic Council's work was resumed, but in a condensed way and excluding Russia, which at this time was the Chair of the Arctic Council (Vylegzhanin, Young, & Berkman, 2021).

The International Arctic Science Committee (IASC) is another example of a top-down initiative in the Arctic that contributes to science diplomacy. IASC was founded in 1990 by representatives of national scientific organisations of the eight Arctic countries. It promotes and supports interdisciplinary research through its five working groups, which encourage and support science-led international programmes. This is achieved by offering opportunities for planning and coordination in order to foster a greater scientific understanding of the Arctic region and its role in the Earth system (Rachold, 2022).

Science diplomacy is most obvious when it is implemented through top-down initiatives. However, science diplomacy in the Arctic is seldom one-dimensional. Both the top-down and the bottom-up perspectives are important to influence policy (Rüffin & Rüland, 2022).

One important Arctic network that started off as a bottom-up initiative that practices science diplomacy is INTERACT (International Terrestrial Network for Research and Monitoring in the Arctic (eu-interact.org)). INTERACT seeks to improve the wellness of Indigenous Peoples and other Arctic residents and the global community by facilitating the environmental research of scientists from around the world and by operating environmental monitoring for more than 150 international/global networks ensuring that environmental information is included in policy making. A global analysis of ecological infrastructures (Loescher et al., 2022) shows a significant gap in northern and central Eurasia where INTERACT, working with the Siberian Environmental Change Network (SecNet; www.secnet.online/en), has established significant coverage for research and monitoring of ecosystems, climate, geosciences and social sciences (Figure 1).

This commentary paper tracks the rise of bottom-up science diplomacy in the Arctic seen through the eyes of INTERACT and describes the fall of this diplomacy under external constraints related to current geopolitical circumstances. We focus on INTERACT as a basically bottom-up network operating over 20 years and as the largest terrestrial infrastructure network in the Arctic.

The rise of science diplomacy in INTERACT

Science diplomacy can be described and categorised in many ways. The Royal Society (2010) identified three different types of science diplomacy; "Diplomacy for science," "Science for diplomacy and "Science in diplomacy." INTERACT contributes to all these three types of science diplomacy (Table 1). We have not applied the more complex typologies of science diplomacy as we are practitioners of science diplomacy and our success overall is based on functional simplicity.

Diplomacy for science

"Diplomacy for science" is defined as "*facilitating international science cooperation*" (The Royal Society, 2010, p 15).

- **Building a pan-Arctic network - from 9 to 90 Research Stations**

INTERACT is an inter-generational spin-off (Callaghan & Johansson, 2021) of the International Biological Programme (IBP) which coordinated large-scale ecological and environmental studies between 1964 and 1974 (Bliss, Heal, & Moore, 1981). IBP linked research sites and researchers throughout the tundra including participants from Canada, the United States, and western Soviet Union during the ongoing Cold War. Former participants of IBP met in 1998 to discuss making a transect ("SCANTRAN") of research stations in Scandinavia (Turunen, Hukkinen, Heal, Saelthun, & Holten, 1999), which would lay the ground for comparative environmental studies. This bottom-up idea was expanded to initiate a network of nine research stations around the North Atlantic called "SCANNET" in 2001 (Figure 1). SCANNET was established to facilitate research to understand impacts of global change on the lands of the North Atlantic Region and also to monitor changes in real time. The 4-year SCANNET project was funded under the EU's 5th Framework programme (Callaghan et al., 2004).

In 2004, the research stations in the network continued to work together and established a Memorandum of Understanding. New stations approached the network and joined, despite lack of funding. The three criteria for a research station to join the network were 1) that the station should be long-term and stable, 2) it should have multidisciplinary activities and 3) it should be able to host guest scientists at their own expense. In 2011, the network had grown to 33 stations in 12 countries which together applied for a grant within the EU's 7th Framework Programme. The application was successful and as the geographical scope had increased from Scandinavia to most of the Arctic, SCANNET had developed into "INTERACT." The overall aim of the network was to provide a geographically comprehensive and excellent infrastructure of terrestrial research stations throughout the Arctic and adjoining forest and alpine regions and to act as a one-stop-shop for environmental information on the terrestrial Arctic. In 2016, when the second phase of INTERACT was funded through the EU Horizon 2020 programme, the network had grown to 77 stations. When the third phase of INTERACT was funded in 2020 (also by the EU Horizon 2020 programme), the network had grown to 86, and at the beginning of 2022, the network consisted of 90 research stations from 18 countries. Together, the stations annually host more than 15,000 scientists, produce data for over 150 international networks (Figure 2), provide important bridges between the Arctic States and reach millions through outreach and education activities.

INTERACT is diverse and inclusive. It does not recognise any national or cultural boundaries and encompasses conventional science and Indigenous perspectives. Unlike centralised polar institutions in the South, INTERACT is widely distributed throughout the Arctic and neighbouring territories while the

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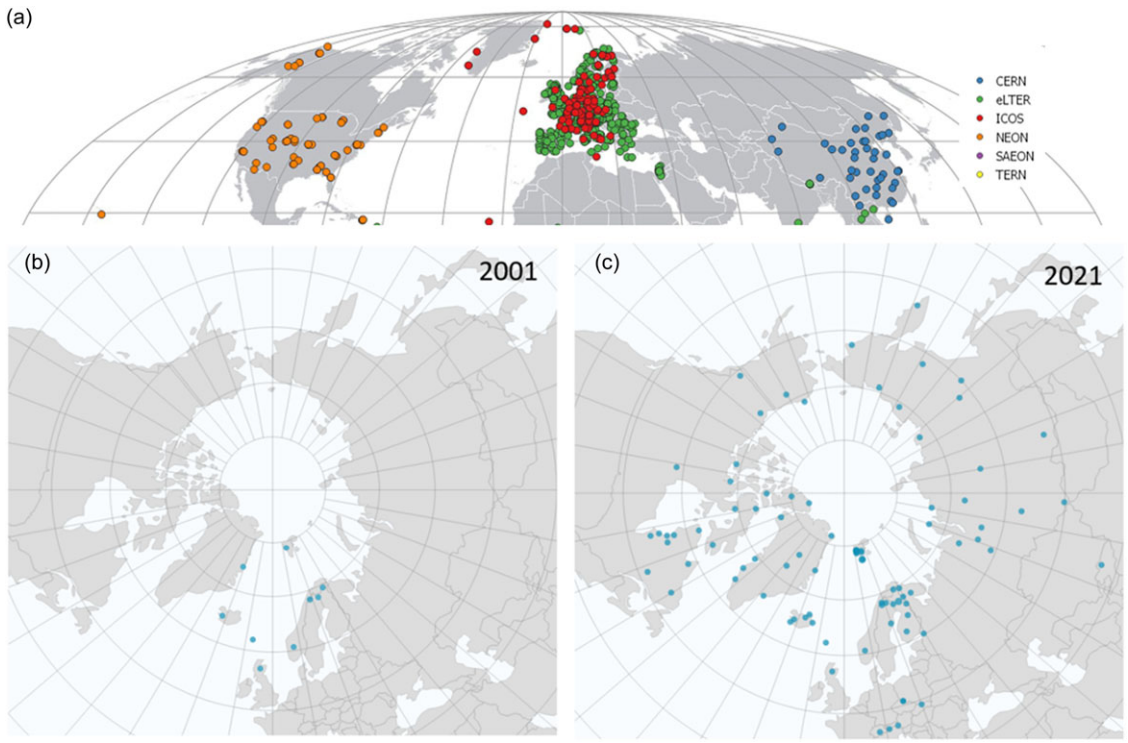

Figure 1. Research infrastructure networks in the Arctic. a) Northern Hemisphere distribution of Global Ecosystem Research Infrastructure sites showing a large gap in Russia and the Canadian Arctic (Loescher et al., 2022) b) INTERACT started as a network of 9 terrestrial research stations in 2001 c) 20 years later, the network had grown to include 90 research stations in all Arctic countries and in adjacent high-alpine areas, filling the gap identified by Loescher et al. (2022).

stations and their staff are often parts of the local communities. The current network of research stations has worked together for more than 20 years providing long-term, reliable and sustainable interaction, which is one of the criteria identified by Turekian (2018) essential for actors to be able to contribute to science diplomacy.

- **Making connections between networks and contributing to new networks**

INTERACT research stations contribute to more than 150 organisations and networks from global organisations such as the World Meteorological Organization (WMO) to thematic networks such as the Global Terrestrial Network on Permafrost (GTN-P) (Figure 2). In addition, to making these connections, INTERACT has also stimulated the formation of new, national networks. An example is the Siberian Environmental Change Network (SecNet; Callaghan & Shaduyko, 2019). SecNet is an open community of universities, research institutes and other organisations, teams and individuals that are united by a common goal to support sustainable development of the North, including the Arctic, by accumulating experience and knowledge on Siberian environments and society to understand and predict societally important changes so that negative anthropogenic consequences can be minimised. INTERACT – SecNet collaboration resulted in important East-West diplomacy for science and collaboration by bringing Russian research into global literature (Callaghan, Shaduyko, Kirpotin, & Gordov, 2021a) immediately before the Russian invasion of Ukraine and the deterioration of East-West diplomacy. At that time, the Russian Senior Arctic Official contributed a published Foreword to a study by SecNet (with contributions from INTERACT) stating the importance of international cooperation in the Arctic.

Science for diplomacy

Science for diplomacy is defined as "*using science cooperation to improve international relations between countries*" (The Royal Society, 2010, p15).

- **Opening up the Arctic to the rest of the world**

In 2011, INTERACT developed a transnational access scheme which allowed scientists to access excellent research infrastructures in countries other than their home country for their field research. This mobility scheme contributes to network-building, encourages partnership among the scientific community, friendships and understanding of different cultures including introductions to Indigenous and local people when appropriate. Scientists receive travel and accommodation costs covered by the EU funds for successfully evaluated projects to conduct excellent science.

In the first phase of INTERACT (2011-2016), the project provided transnational access from West Greenland, eastwards to East Siberia. At this point in time, the EU did not fund transnational access to North America. However, this was achieved through funding from the Centre for Northern Studies at Laval University and the Arctic Institute of North America for INTERACT transnational access in Canada and through the National Science Foundation in the United States for transnational access to Alaskan research stations. INTERACT could therefore provide unique pan-arctic transnational access to 24 research stations for researchers from all around the world.

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Table 1. INTERACT has contributed to three types of science diplomacy identified by The Royal Society (2010)

Type of Science Diplomacy	Definition (quotes from The Royal Society, 2010, p 15)	INTERACT example
Diplomacy for Science	*"Facilitating international science cooperation"*	• Building a pan-Arctic network - from 9 to 90 Research Stations • Making connections between networks and contributing to forming new networks
Science for diplomacy	*"Using science cooperation to improve international relations between countries"*	• Opening up the Arctic to the rest of the world through Transnational Access • Changing perceptions, and empowering future generations
Science in Diplomacy	*"Informing foreign policy objectives with scientific advice"*	• Contributing to Societal Challenges and Sustainable Development Goals • Contributing to global and regional assessments • Advising and working with national governments • From field experiments to International Law • Working with Indigenous Peoples and other Arctic residents • Planning future international Arctic research

From 2016, EU funds have covered also transnational access to North America thereby providing funding for pan-arctic transnational access from one funding source!

INTERACT's transnational access has continued and grown since 2016. At the start of INTERACT 3 in 2020, 52 research stations from 11 countries provided transnational access. So far, INTERACT has enabled more than 1,000 scientists from almost 50 countries (Figure 3) to carry out research in the Arctic and has hence contributed to ensuring a significant number of new international collaborations – as well as breaking science of international importance. Although we focus here on science diplomacy, largely an unexpected spin-off, it should be remembered that the main aim of INTERACT is environmental research and monitoring. Hundreds of publications have been published in highly-ranked journals (a list is available at https://eu-interact.org/publication/ta/).

There are two important indicators of the success of *Science for diplomacy*. Firstly, the transnational access pool of funding where individual partners pool unused funds so that others can maximise their awards when they have spare capacity is an important aspect of international sharing arising from trust. The transnational access funding pool indicates a spirit of cooperation and is not inspired by a spirit of competition which can be the case for other organisations (e.g. Ruffini, 2020). Secondly, several collaborations have arisen between local scientists at stations and foreign visitors supported by INTERACT funds.

- **Changing perceptions and empowering future generations**

Our future is the next generation. This generation will experience the major impacts of ongoing climate change, other global and Arctic challenges and geopolitical tensions caused by our generation. Organisations such as the Association of Polar Early Career Scientists, INTERACT and the University of the Arctic (UArctic) are investing in empowering new generations of scientists and policymakers to interact more efficiently than at present. For all generations to contribute to reducing climate change and other environmental impacts, fact-based perceptions are essential to understand the causes and implement solutions to the challenges.

To formulate general perceptions based on fact and to provide educational materials, INTERACT has produced two volumes of "Stories of Arctic Science." Here, projects mainly supported by INTERACT Transnational Access are presented, using popular science and various communication methods and channels to describe where the projects were carried out and why the work is important (INTERACT, 2015; 2020). The INTERACT outreach and educational materials are available in at least 63 countries. Many of the science stories are interdisciplinary or multidisciplinary. This recognises that complex environmental problems need input from many disciplines working together. The importance of bringing people from different disciplines together, e.g. science, art, and politics enhances "science for diplomacy."

Science in diplomacy

Science in diplomacy is defined as "*informing foreign policy objectives with scientific advice*" (The Royal Society, 2010, p 15).

- **Contributing to Societal Challenges and Sustainable Development Goals**

INTERACT is currently focusing on understanding and facilitating responses to six urgent societal challenges with local and global impacts (Table 2). The societal challenges (that INTERACT focuses on) were selected based on discussions with local communities, Indigenous Peoples, decision-makers, researchers, policy-making communities, reference to the EU Horizon 2020 societal challenges, United Nations sustainable development goals, the joint statement of Ministers from the second Arctic Science Ministerial meeting and the EU-PolarNet white papers (Vieira, Biebow, & Velázque, 2020). The selected societal challenges respond to six of the United Nations' Sustainable Development Goals (SDGs) that were adopted in 2015 by 193 countries. The SDGs have been highlighted as an important framework to connect science to global policy priorities which enhances the role of science diplomacy (Turekian, 2018).

- **Contributing to global and regional assessments**

The Intergovernmental Panel on Climate Change (IPCC) was established in 1988 to provide policymakers with regular scientific assessments of the current state of knowledge about climate change. The IPCC has proven to be extremely independent, and the Directors – Bert Bolin (a climate scientist from Sweden), Robert Watson (a British chemist) and Rajendra Pachauri (an Indian economist and engineer) – proved to be excellent diplomat scientists, as were many of the lead authors (Moomaw, 2018) resulting in IPCC contributing to science in diplomacy (Ruffini, 2018). INTERACT scientists have been involved in IPCC since the

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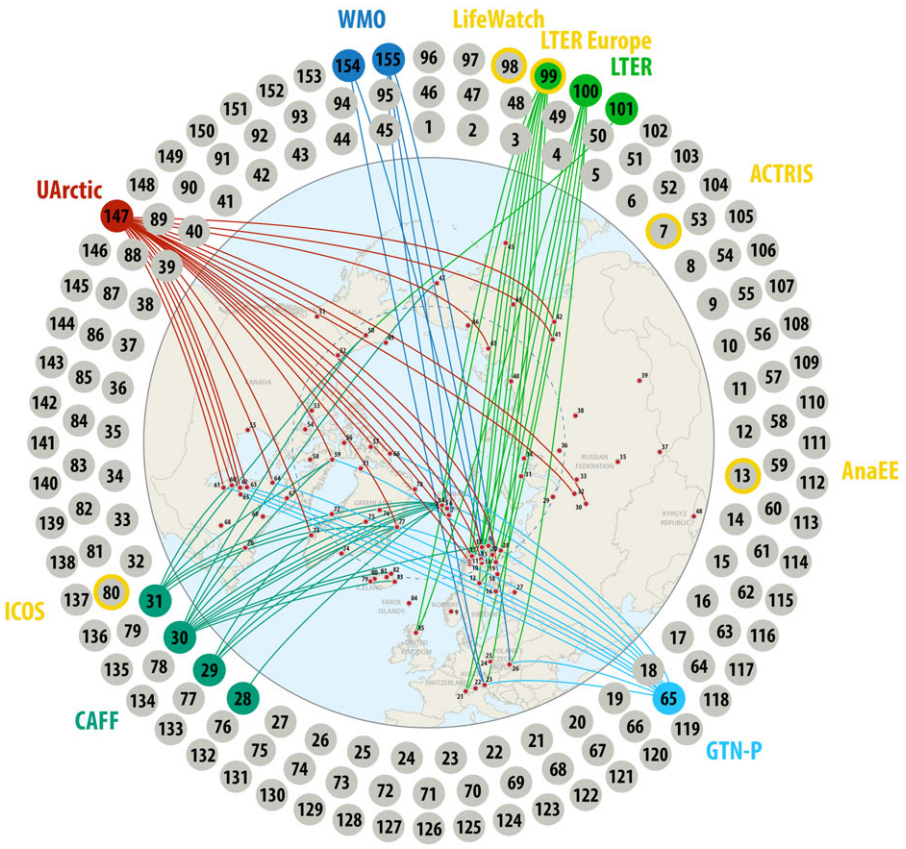

Figure 2. INTERACT serves more than 150 networks (circles with numbers surrounding the map). The figure gives an example of support for ecosystem networks (LTER Europe, LTER US and iLTER, nos 99-101), biodiversity and conservation networks (e.g. four expert groups of CAFF, nos 28-31), permafrost networks (e.g. GTN-P 65), education and Thematic Networks (UArctic, no 147), and the global meteorological network (WMO, nos. 154-155). INTERACT Stations contribute to five ESFRI (the European Strategy Forum on Research Infrastructures projects; yellow circles) (INTERACT, 2020).

first Assessment Report (AR1) (e.g. Melillo, Callaghan, Woodward, Salati, & Sinha, 1992) and INTERACT Stations have contributed with environmental data and research expertise to subsequent assessments carried out by the IPCC such as the Polar chapter in the 4th and 5th Assessment Reports; (Anisimov et al., 2007; Larsen et al., 2014).

The first regional climate assessment for the Arctic "The Arctic Climate Impact Assessment" was presented in 2005 (ACIA, 2005). Led by the Arctic Council's working group AMAP and IASC, INTERACT researchers played a fundamental role that continued in the follow up "Snow, Water, Ice and Permafrost in the Arctic" (AMAP, 2011; 2017) assessments. In these assessments, INTERACT researchers' "science in diplomacy" led to the inclusion of Indigenous knowledge and an Indigenous co-author.

Biodiversity loss is another global challenge. Although biodiversity in the Arctic is low (Callaghan et al., 2005), it is threatened by the accelerated rate of warming in the Arctic and the vulnerability of Arctic biodiversity to species invasions (CAFF, 2021). INTERACT facilitates research and monitoring of Arctic biodiversity in collaboration with the Arctic Council's working group "Conservation of Arctic Flora and Fauna." Results from this collaboration inform the global Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services process.

The UN Conference of Parties (COP) is an important arena for science in diplomacy. It was convened to prevent "dangerous" human interference with the climate system. It is the decision-making body of the United Nations Framework Convention on Climate Change which entered into force in 1994 (https://unfccc.int/process-and-meetings/what-is-the-united-nations-framework-convention-on-climate-change). Today, 197 countries have ratified the Convention and all States that are Parties to the Convention are represented at COP meetings. The COP meets every year unless the Parties decide otherwise. At the meetings, the Parties review the implementation of the Convention and any other legal instruments that the COP adopts and take decisions necessary to promote the effective implementation of the Convention, including institutional and administrative arrangements.

INTERACT has been invited to contribute to the UN COP by hosting Ambassador-level climate negotiators from the European COP team at an INTERACT station and demonstrating actual and predicted (through experiments) climate change impacts. INTERACT also demonstrated its science in diplomacy by presenting at COP meetings and their side events.

- **Advising and working with national governments**

INTERACT partners advise Governments of e.g. Finland, Sweden, the UK, Canada and Denmark. Some concrete examples are the development of the Canadian High Arctic Research Station that was built in Cambridge Bay in 2019. The Government of Canada approached INTERACT for advice and best practices from other INTERACT research stations. Another example is the role INTERACT plays in the UK All-Party Parliamentary Group for the Polar Regions with a main aim to inform Parliamentarians on all

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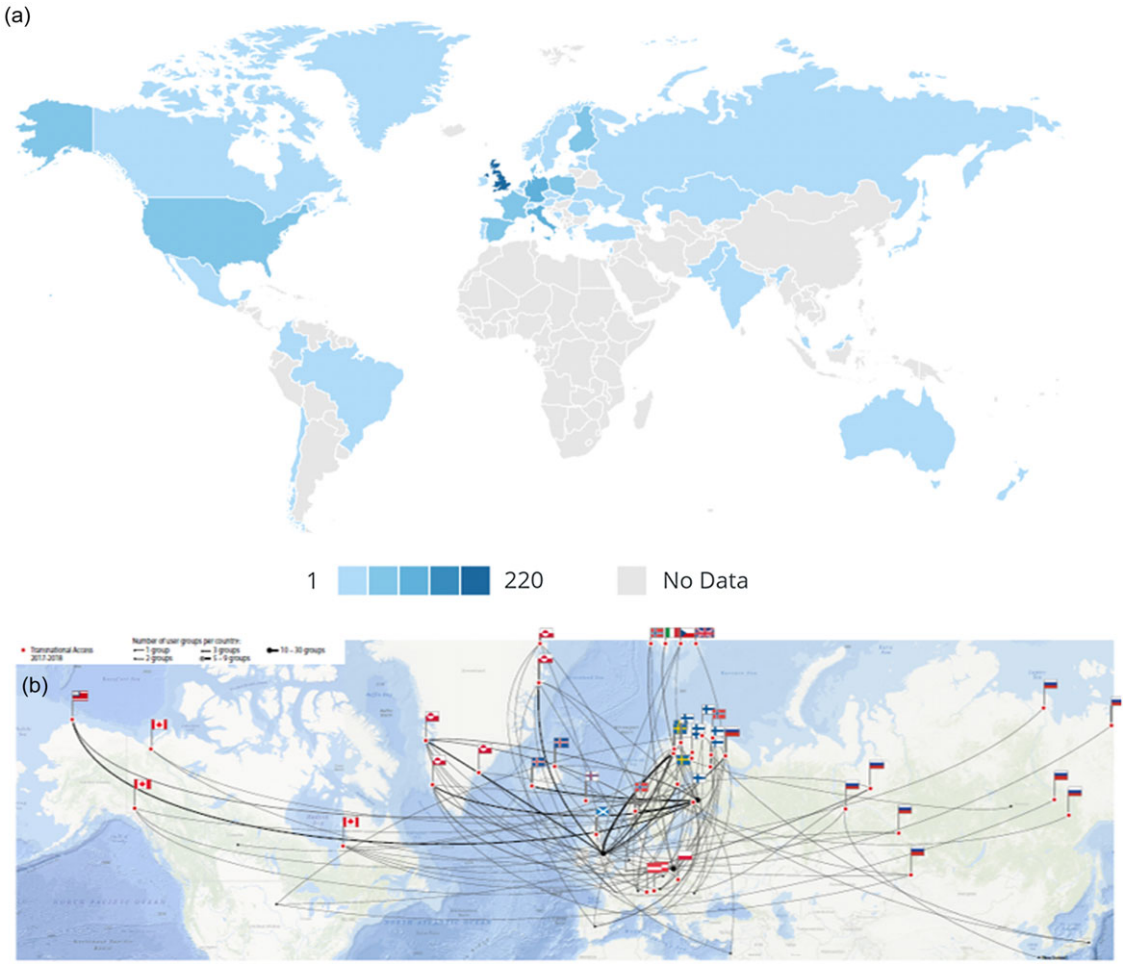

Figure 3. INTERACT has opened up the Arctic to scientists from all over the world through the transnational access (TA) scheme starting in 2011. a) TA Users from almost 50 countries have received TA Awards, the map shows the country of origin of the TA users. b) The lines denote project groups rather than individuals starting from their home institutions and travelling to an INTERACT research station denoted by a flag. Please note the comprehensive Arctic coverage, the east-west connections and the opening up of research stations in Russia denoting "science for diplomacy" before the Russian invasion of Ukraine.

matters relating to the Arctic and Antarctic regions. INTERACT has also been working with the Government of the Yamal-Nenets Region and the British Embassy in Moscow, which has co-funded several meetings involving INTERACT and SecNet partners to improve science contacts between East and West (Callaghan, Shaduyko, & Kirpotin, 2019a; Callaghan et al., 2019b). INTERACT was approached by the Czech Government to advise on future polar strategies for the country and was represented at a Czech-Russian diplomatic meeting in St Petersburg. In Russia, INTERACT has had high visibility including from Vice Chancellors of Universities (e.g. Lomonosov Moscow State University and Tomsk State University), Governors of provinces (such as the Yamalo-Nenets Autonomous Okrug) and various ambassadors and Ministers of the Dumas.

The importance of INTERACT's activities of "*science in diplomacy*" has been recognised by Royalty in Sweden and the UK, and Ambassadors of various countries including Canada, Russia, the USA, the Czech Republic, France and business leaders. Recognition includes support of applications by INTERACT to continue and invitations to high-level conferences. INTERACT was discussed by the European Parliament and an INTERACT station joined in major diplomacy based on its science when it hosted environment ministers and high officials from 28 countries and the European Commission in 2007. At this meeting, the INTERACT station presented its collaboration with Sámi reindeer herders to make them aware of climate change challenges on Indigenous livelihoods and wellbeing. This action of significant science in diplomacy ensured the politicians were made aware of the plight of the Indigenous people of the Arctic while the Indigenous communities greatly appreciated this important visibility and started a close, productive and lasting relationship with INTERACT.

- **From field experiments to International Law**

Inclusion in global and regional environmental assessments that have shaped intergovernmental policies has often been based on ground-breaking research at INTERACT research stations. Probably the world's first experiment to predict the impacts of stratospheric ozone depletion on a natural terrestrial ecosystem was performed at the Abisko Scientific Research Station (Johanson, Gehrke, Björn, Callaghan, & Sonesson, 1995) and the research was elevated to "*science in diplomacy*" as the team was included in the United Nations Environment Programme Panel on Stratospheric Ozone Depletion Effects that reported to the signatories of the Montreal Protocol and its Amendments.

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Table 2. INTERACT's contributions to addressing major societal challenges (SC) of local and global importance (including UN sustainable development goals - SDG). The SDGs have been highlighted as an important framework to connect science to global policy priorities which enhances the role of science diplomacy (Turekian, 2018)

Focal challenges				INTERACT's role	
UN SDG	Societal Challenge	Problems	So What?	The Solutions	Practical & Diplomatic Benefits
	SC1. Unpredictable Arctic – extreme weather events	The Arctic is experiencing unpredictable and hazardous extreme weather events and contributes to such events in mid-latitudes	Extreme weather events affect local ecosystem services which impact health and wellbeing for humans and wildlife in the Arctic and beyond	INTERACT improves monitoring of extreme weather events and their impacts on ecosystems and society while highlighting the need for improved forecasting	Using international expertise and local knowledge for better weather forecasts benefitting health and wellbeing. Improved detection of geographically wide-spread biodiversity changes.
	SC2. Connecting the Arctic: Transport and Communication	Data transfer and communication in remote Arctic regions. Regulation of science sample transport across national borders	Poor communications inhibit responses to health and safety emergencies. Stringent cross border regulations inhibit exchange of researchers and scientific samples	INTERACT identifies current barriers to communication and transport and helps to reduce these among stations and local and Indigenous communities and the outside world	Improved health, safety and wellbeing of local communities derived from international collaboration. Increased flow of researchers and samples across national borders from identification of existing barriers.
	SC3. Climate Action: Making data widely available	Discovering hidden data at research stations.	Old (incl. 19th Century) and currently inaccessible records at research stations hold information on environmental change	INTERACT discovers hidden data and use artificial intelligence and machine learning to interrogate data and ensure availability in appropriate repositories.	More long-term data available for national and international global climate models and greater understanding for sustainable development.
	SC4. Preparing for a future world: improving education and awareness at all societal levels	Lack of sufficient awareness and acknowledgement across society of the scope and impacts of global change and Arctic amplification, counter-productive perspectives of climate change and their drivers.	Insufficient public and political will to solve environmental problems and need for improved education for the next generation to act meaningfully	INTERACT develops outreach material to inform and influence the general public internationally. Also, it improves the development and delivery of educational resources at all levels and in more than 63 countries.	Better understanding among international society, changed attitudes, and increased preparedness of future generations encouraged to work together across borders
	SC5. Cleaner Arctic, cleaner world: documenting and reducing pollution	Unknown impacts of emerging pollutants	Emerging pollutants could affect health and food security for humans and wildlife inside and outside the Arctic and could contribute to ongoing global climate change	INTERACT identifies emerging pollutants and their impacts	Improved health and food quality for people and wildlife inside and outside the Arctic
	SC6. The Arctic Resort: increasing benefits and reducing impacts from developing Arctic tourism	Accelerating Arctic tourism could exert more pressure on very vulnerable ecosystems and communities	Harmful impacts need to be reduced and opportunities to Arctic communities need to be increased	INTERACT helps to educate tourists and tour operators and review existing tourism policies and regulations	Enhanced diplomacy between local communities and national/international tour operators and their clients leading to sympathetic and sustainable tourism, and improved wellbeing of communities and ecosystems

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- **Working with Indigenous Peoples and other Arctic residents**

INTERACT is working directly with Indigenous Peoples and other residents in the Arctic who are often underrepresented in political systems. Indigenous Peoples lead work on local adaptation and increasing tourism in the Arctic. INTERACT has also worked together with SecNET and held workshops in Siberia where local and Indigenous Peoples have met together with scientists and local government representatives to discuss local environmental problems and solutions for sustainable adaptation plans (Callaghan et al., 2019b). The recommendations resulting from the workshops have been used in negotiations between the Sámi community and national government. Also, INTERACT researchers use diplomacy to mediate with local government on behalf of Indigenous and local people in conflicts of interest such as in fishing and hunting (Callaghan et al., 2019b).

- **Planning future international Arctic research**

INTERACT has also played a role in the three International Conferences on Arctic Research Planning (ICARP) processes that were presented in Hanover NH (USA) in 1995, Copenhagen (Denmark) in 2005 and Toyama (Japan) in 2015 and were organised by IASC. The ICARP process was initiated in the early 1990s, as the end of the Cold War enabled regional cooperation in the Arctic between Western and Russian scientists interested in the circumpolar north. In addition, this was a time when research projects started to involve collaboration among larger groups of scientists and the Arctic was seen as a region subject to rapid environmental change. Hence the need for conducting coordinated observations in an effort to understand the behaviour of Arctic systems was identified (ICARP web site, 2023). ICARP I-III have identified and integrated many key topics and priorities for future Arctic Research and INTERACT stations have played important roles in implementing these priorities. Currently, the ICARP IV process is ongoing and INTERACT will contribute with suggestions on what role the terrestrial research infrastructures in the Arctic should play in the coming 10 years.

The fall of science diplomacy in INTERACT

Since the Russian invasion of Ukraine, geopolitical diplomacy has plummeted in the Arctic. This has affected major science initiatives such as the work of the Arctic Council but also bottom-up organisations such as INTERACT (Witze, 2022; Rees & Buntgen, 2024). The exclusion of Russian stations in INTERACT resulted from directives from the EU funders (and the inability to transfer funds through sanctions), directives from the operators of some of the stations and personal moral choices that varied among participants. Consequently, there were some major top-down and bottom-up constraints, but some individual bottom-up contacts remain between Russian and non-Russian stations and staff.

Diplomacy for science

Research stations have joined INTERACT at different times and the stations themselves have been formed at different times. A great asset of the INTERACT network is that the oldest have been operational for more than a century and new ones have formed as interest in the Arctic has grown. INTERACT was instrumental in developing two research stations in Siberia. Sadly, against this dynamic, the Russian invasion of Ukraine in February 2022 resulted in a paused collaboration between 21 Russian stations and INTERACT. Within a few months, INTERACT went from a pan-arctic network to a network covering only half of the Arctic land masses. Even if the work continues with all other Arctic countries, the implications of this pause are numerous and profound.

Science for diplomacy

At the environmental level, the majority of Indigenous Peoples in the Arctic live in Russia, the longest Arctic coastline (53% of the Arctic coast line), the largest boreal forest and the greatest Arctic land area are found in Russia. Changes there are dramatic and are affecting local people through changes in water supplies (e.g. Bogdanova et al., 2023) and food (e.g. Callaghan et al., 2021a), while carbon emissions from permafrost thaw (e.g. Schuur et al., 2022) and increasing forest and tundra fires (Kharuk et al., 2021) have the potential to drive geographically wider impacts. To predict future changes in the Arctic, we need environmental information from Russia. The pan-arctic transnational access that developed within INTERACT during the last decade has contributed to provide important environmental data from Russia. However, the transnational access scheme is greatly impacted by the paused collaboration with Russia. Overall, the number of research stations providing transnational access decreased from 52 to 39 and the geographical coverage was greatly reduced to cover half of the Arctic.

Before the Russia/Ukraine war, INTERACT brought environmental research by about 100 Russian researchers into the Western domain (Callaghan et al., 2021a) and similarly, it brought researchers from the West to the East. This is now much more difficult, despite publications showing the bias in the West of even previous research away from the Russian Arctic (Metcalfe et al., 2018; Virkkala, Abdi, Luoto, & Metcalfe, 2019; Callaghan, Cazzolla Gatti, & Phoenix, 2021b) and a study that shows that the observational power of the INTERACT network of research stations is greatly reduced by omitting data from Russian stations (López-Blanco et al., 2024).

Science in diplomacy

INTERACT continues to contribute to science in diplomacy in similar way as it has done during the last decades but representing the decreased geographical area. There are some concrete examples where the work/collaboration has stopped completely. The first is a community-based environmental monitoring programme on extreme weather events in Siberia. Another example is the work related to the Arctic Council's Agreement on Enhancing International Arctic Scientific Cooperation which was on a long pause as the Arctic Council work was on pause. INTERACT was supposed to play a major role to inform about the agreement and encourage the use of it among research stations in all Arctic countries.

In all three diplomacy types mentioned above, in the past, scientists have managed to collaborate despite political tensions. The current interactions between East and West within INTERACT are more challenging than those that existed during the International Biological Programme i.e. during the Cold War. During this period, research stations in the former Soviet Union contributed to data sharing. Workshops were held in both the West (Heal, 1971) and the former Soviet Union (Wielgolaski & Rosswall, 1972) and both regions were represented by researchers. Currently, most Western institutions cannot collaborate with state-owned Russian institutions because of constraints by funding agencies, employers or

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personal morality. This current isolation of East and West is greater than that during the Cold War and after the annexing of Crimea because the invasion of Ukraine is the largest European war since Second World War and has global ramifications. However, collaborations between colleagues continue in some cases. Such collaborations are regarded as bridges to continue communication for the time when, hopefully, normality will return.

Conclusions

Measuring the success of INTERACT's science diplomacy

There are both quantitative and qualitative criteria for success of INTERACT's science diplomacy. INTERACT in numbers shows the success of the three types of science diplomacy: 23 years of international cooperation, ca 550 research projects realised, ca 50 research stations providing transnational access, a peak of more than 90 research stations, contributions to more than 150 international and global networks, outreach to more than two million, educational resources in more than 60 countries. It is difficult to deconvolute and rank the success of INTERACT in the three different types of science diplomacies as they are all interconnected.

Enabling possible ways forward: a long-term sustainable network – the INTERACT non-profit association (INPA)

INTERACT has been a network-type structure that has allowed effective development of scientific cooperation and science diplomacy in the Arctic. To ensure the long-term sustainability of the network and to continue to contribute to all three levels of science diplomacy (The Royal Society, 2010), INTERACT developed the INTERACT non-profit association (INPA) in August 2020. This enables the network to contribute to other initiatives as one unit rather than as 65 partners (which was the number of partners at the outset of INTERACT 3). The purposes of INPA are to support the use and operational procedures of infrastructures in Arctic, sub-arctic, boreal and alpine regions, to support research and scientific development in the field of climate change and environment and to increase general awareness about these topics within the general public and among politicians and decision-makers.

Although INPA is maintaining as much diplomacy as possible, the greatest challenge is to rebuild "*Diplomacy for Science*" between East and West. On one hand, INTERACT and INPA regard themselves as "networks of friends" and bridges exist between friends in Russia and the West. However, instead of crossing these bridges to return to the former high level of science diplomacy, we are walking on a tight-rope fraught with repercussions on both sides. The next stage of crossing bridges to engage in science diplomacy is beyond the current possibilities of INPA. Hopefully, the future will allow the former high level of cooperation within INTERACT to be reestablished before too many irreversible changes have occurred to the Arctic's environment and the dynamics among international research and monitoring consortia.

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