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EDITORIAL

Scientific collaboration serves as a vital diplomatic bridge during periods of global unrest. By transcending geopolitical boundaries, it prevents scientific isolationism and enables researchers worldwide to pool knowledge, data and expertise to address urgent, transboundary challenges such as pandemics, climate change, and biodiversity loss. When official political or state-to-state relations strain, science often remains one of the few shared universal languages through which dialogue can continue. History offers numerous examples of scientific cooperation political tensions, from the post-World War II reconstruction period to the Cold War, where sustained scientific engagement contributed to boarder diplomatic understanding. Scientific integrity is founded on shared empirical evidence, and independent research reinforces science as a global public good. Equally important, collaborative research brings together scientists from diverse cultural and political backgrounds, fostering trust, mutual respect, and a shared commitment to addressing challenges that no national can solve alone.

This issue of Science Diplomacy Review highlights the many ways in which science diplomacy can build bridges across geopolitical divides. It brings together research papers, perspectives, review that demonstrate how scientific cooperation contributes to addressing shared global challenges, including clean energy, waste management, nuclear science, Arctic research, as well as capacity building in science diplomacy. The issue includes a perspective and a book review which examines India's scientific partnerships with Germany and Taiwan, illustrating how bilateral cooperation can advance both national priorities and broader global objectives. Across these diverse contributions, a common theme emerges: science diplomacy remains a powerful instrument for dialogue, trust-building, and international cooperation.

The opening research paper examines the evolution of the Joint Institute for Nuclear Research (JINR), Dubna, as a pioneering model of multilateral science diplomacy. Moving beyond a historical narrative, the paper advances the theoretical understanding of international intergovernmental research organisations by demonstrating how they can simultaneously function as platforms, instruments, and actors of science diplomacy. It argues that JINR represents a distinctive "Dubna model" of science diplomacy centred on large-scale research infrastructure and illustrates how, even during periods of intense geopolitical rivalry, scientific institutions can sustain international collaboration and dialogue. The paper also draws important lessons for contemporary governance of emerging technologies, highlighting the continued relevance of such institutions in an increasingly fragmented geopolitical landscape. The second research paper examines the growing strategic importance of the Arctic in the context of climate change, evolving maritime routes, and emerging geopolitical interests. It analyses India's expanding scientific engagement in the region and argues that sustained scientific research and international cooperation will be central to India's Arctic policy and its contribution to global environmental governance.

The first perspective reviews more than five decades of Indo-German science and technology cooperation, highlighting how sustained institutional partnerships have evolved into a comprehensive framework encompassing research, innovation, industry, and capacity building. It argues that this long-standing partnership offers valuable lessons for addressing common global challenges through collaborative science and technology initiatives. The second perspective explores the challenge of managing solar photovoltaic (PV) waste in BRICS countries. While acknowledging the remarkable progress made in renewable energy deployment, it emphasizes that achieving a truly sustainable energy transition requires robust regulatory frameworks, technological innovation, and circular economy approaches for end-of-life PV management. The article calls for greater cooperation among BRICS nations in developing recycling technologies, harmonizing policies, and promoting the recovery of critical materials.

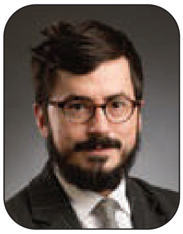
The report on the Asia–Europe Training on Science and Technology Diplomacy held in 2025 re-emphasises the growing importance of strengthening science diplomacy capacities through structured training and knowledge exchange, particularly at a time when technological competition and geopolitical tensions are reshaping international scientific cooperation. The issue concludes with a book review of Navigating India–Taiwan Relations in the Digital Age: Surveying the Theory and Practice of Science and Technology Diplomacy by Ramnath Reghunadhan. The review highlights the book's contribution to understanding how scientific collaboration and technological partnerships have emerged as important instruments of diplomacy between India and Taiwan, offering valuable insights into the evolving role of science and technology in contemporary international relations.

As in previous editions, we remain committed to advancing the Science Diplomacy Programme at RIS as a platform for generating research, fostering dialogue, and promoting informed policy discussions on the diverse dimensions of science diplomacy. We particularly encourage scholarship that demonstrates the role of science diplomacy in addressing global challenges and advancing sustainable development. We welcome your feedback and invite researchers, policymakers, diplomats, and practitioners to contribute to future issues of Science Diplomacy Review.

PAPER

Multilateral Science Diplomacy and the Founding of the Joint Institute for Nuclear Research: Architecting Bridges in Mirrored Spaces

Irek Suleymanov*



Irek Suleymanov

Introduction

The history of the Joint Institute for Nuclear Research (JINR) began on March 26, 1956, when 11 "people's democracies" signed an agreement in Moscow establishing this international scientific research organisation to ensure joint theoretical and experimental research in the field of nuclear physics. To succinctly characterise the time frame of JINR's development in the 1950s, it is appropriate to use the title of one of the books by the Institute's first director, Dmitry Blokhintsev, "The Birth of the Peaceful Atom," as well as the author's characterisation of the era, which "seemed unrealistic" for "those accustomed to the tense international situation of the post-war years" (Blokhintsev, 1977).

The design and construction of the edifice of the international system of "atoms for peace" took place in a situation not only of open confrontation between the ideological systems of the East and the West, but also of numerous "undercurrents". The stability of the emerging new world order required a well-thought-out system of supports, checks and balances. In architecture, the term "buttress" is used to denote additional support bearing the weight of the ceiling. It is entirely appropriate to consider the JINR phenomenon as a pragmatic science diplomacy solution, on the one hand supporting integration into the eclectically constructed edifice of international architecture of "atoms for peace", and on the other hand counteracting the cutting off of the USSR from international integration and supporting

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formation of a consolidated socialist scientific and technical space around itself.

The phenomenon of JINR is often considered as the most obvious example of "best practices" in the field of science diplomacy, often in application to modern times without special analysis in retrospect of the Institute's formation (Krynzhina et al., 2020); or in the general flow of the narrative "the atom unites" without a detailed analysis of the background and prerequisites of the integrative science diplomacy role of atomic science and technology during the Cold War (Vizgin, 2024; Gagarinsky, 2021).

The examination of the history of individual structural elements of the emerging architecture of the peaceful atom in the 1950s has often become the subject of research: IAEA (Emelianov, 1967; 1979; Timerbaev, 1999), Euratom (Lekarenko, 2009). Of considerable interest are studies that provide both a general perspective on the positioning of the USSR in the situation of European integration trends (Kalinichenko, 2017); the structure and dynamics of the USSR's perception of integration processes in Western Europe (Lipkin, 2016), and its particular cases, e.g. the USSR's reaction to the creation of Euratom (Todykov, 2023). Also relevant for research is a pool of works reflecting the contradictory realities of the formation of NATO, including from the perspective of the USSR's initial desire to participate in this organisation (Kochkin, 2009); as well as the preconditions for the creation of the Warsaw Pact (Lukyanov, 2006).

A study of the realities of the development of JINR in terms of the "Iron Curtain" was conducted by Roman Khandozhko (Khandozhko, 2019): the author, devoting attention to the evolution of JINR from a secret laboratory to a "showcase of socialism", considers the Institute as one of the centers in the complex mosaic of the "global Cold War".

Alexander Fursenko and Vitaly Afiani rightly note the role of JINR as a socialist alternative to CERN (Academy of Sciences, 2010). However, one must acknowledge the absence of studies that provide a comparative account of the plurality of key processes that unfolded in parallel in the formation of the international system of "atomic peace" and the role of JINR within it, in terms of science diplomacy. A review of the literature suggests a entrenched, straightforward and narrowly focused narrative justifying the idea of creating JINR as the USSR's response to the creation of the European Organization for Nuclear Research (CERN).

Geopolitical Background

Considering the emergence of JINR in a broader geopolitical and geostrategic context, it is important to note that international relations practices from the late 1940s to the mid-1950s shaped, at a precedent level, the Soviet Union's foreign policy tactics in response to Western powers' efforts to isolate the Soviet Union from multiple sectors, including through the use of science diplomacy. The most illustrative contextual case is the creation of the North Atlantic Treaty Organization (NATO) in 1949. It is deeply symbolic not only that the agreement entered into force on August 24, 1949, a few days before the successful test of the first Soviet atomic bomb, but also that it chronologically "rhymes" with the initiatives to establish CERN. Of no small importance is the experience of the USSR and the Eastern Bloc countries in creating, in the same year of 1949, their own specific organisation, which had a number of features characteristic of integration structures, such as the Council for Mutual Economic Assistance (Kalinichenko, 2017).

The USSR's remarkable successes not only in fundamental nuclear science but also in its applications served as a catalyst for decisive steps by the "Western world" to consolidate the disparate scientific resources in this field in post-war Western Europe. Dominique Pestre, examining the evolution of the idea of creating a European laboratory for nuclear research, notes that this initiative was also considered in terms of linking ideas of European unity with control over nuclear energy. Among the catalysts for the implementation of the idea of establishing CERN were the brain drain and the needs of Europe (Pestre, 1984), in particular the unique and therefore expensive nature of the required research infrastructure.

From this perspective, the pragmatics of the idea of establishing a European Nuclear Physics Centre is logical: in 1949, Louis de Broglie announced a proposal to establish a corresponding laboratory at the European Conference on Culture; and the American physicist Isidor Rabi called on UNESCO to support and encourage the establishment of regional research laboratories with the aim of expanding international scientific cooperation. Clearly, the scientists' words reflected not only the idea of pan-European solidarity among researchers, but also an understanding of the colossal pragmatics of such an integration of human and material resources. The frustration of former allies, especially the United States, regarding the potential risk of an uncontrolled scientific and technological breakthrough in Europe (primarily in terms of the "Atomic Project") should not be underestimated. It was precisely these initiatives, voiced by renowned scientists,[1] that are considered the starting points for the formation of CERN: 1951 UNESCO decided to create the European Council for Nuclear Research.

Declassified documents of the Central Committee of the CPSU indicate that the Soviet Union proceeded from the "organization of a laboratory" on the initiative of the United States, which "will widely use the results of this laboratory and European scientists for their own needs" (Academy of Sciences, 2010). At the same time, it is worth noting the somewhat contradictory narrative in the Western literature refuting the American "behind-the-scenes management" of the CERN project. In particular, Dominique Pestre writes, on the one hand, about the existence of several bilateral agreements between Western European countries and the United States and Great Britain, concluded in 1946-1949, while on the other hand, he tries to "disassociate" himself from the quite obvious leadership role of these countries in promoting the idea of a Western pro-American nuclear laboratory in Europe: the researcher's main argument is the allegedly existing diversity of parallel and independent initiatives of individual scientists with a similar focus (Pestre, 1984).

In September 1954, CERN's official life began: the corresponding multilateral agreement came into force. As is well known, the USSR officially proposed in the same year the creation of a collective security system in Europe, including the conclusion of a Pan-European Treaty on Collective Security in Europe and the possible accession of the USSR to NATO (Kochin, 2009): "guided by the immutable principles of its peaceful foreign policy and striving to reduce tensions in international relations, the Soviet Government expresses its readiness to consider, together with interested governments, the question of the USSR's participation in the North Atlantic Treaty." The Soviet government received a negative response, which became the starting point for the formation of an alternative integration platform, the Warsaw Pact was founded on June 14, 1955.

The Birth of a "Peaceful Atom" World Order

The crystallisation of the idea for the creation of JINR in the second half of the 1950s[2] occurred against the backdrop of the institutionalisation of the peaceful uses of atomic energy and the advancement of the ideology of banning atomic weapons. The USSR's vision of these issues (albeit in a greatly simplified form) boiled down to the position that the country's successes in testing atomic and hydrogen bombs and the destruction of the US nuclear weapons monopoly "created the material basis for their proposals to ban nuclear weapons" (Atomic Science, 1977). Complementary to this component, the USSR actively developed peaceful applications of atomic technology as a tangible alternative to atomic militarism: let us recall, first of all, the world's first nuclear power plant (1954), which had a Soviet "registration."

In this context, the process of forming the idea of creating the International Atomic Energy Agency (IAEA) is also relevant in terms of the preconditions for the establishment of JINR. The plan to create an international organisation for the peaceful uses of atomic energy was put forward by US President Dwight D. Eisenhower at the 470th plenary session of the UN General Assembly on December 8, 1953. Although the USSR supported the idea of limiting the nuclear arms race, it rightly saw in the US initiative to create the IAEA the risks of that country's dominance in the new organisation (as happened in other specialized UN organizations, for example, UNESCO, where, as Roland Timerbaev writes, the Americans "dominated undividedly" (Timerbaev, 1999). However, 1954, Soviet-American negotiations on the establishment of the IAEA began. Considering the "inconvenience" of the USSR as one of the founders, the US considered the option of creating the IAEA without Soviets.

Within the Soviet party and government leadership, there were different opinions on the advisability of dialogue with the Americans on the IAEA issue. However, the USSR Ministry of Foreign Affairs pragmatically assessed the risks of the country's non-participation in the new organisation, pointing out, among other things, that non-participation "could be used by American propaganda to attempt to portray the Soviet Union as an opponent of international cooperation in this area" (Timerbaev, 1999). In July 1955, the USSR decided to participate in multilateral negotiations on this issue, with openness to participation by any interested countries being at the top of the list of Soviet demands for the IAEA. Surviving negotiating directives from 1956 reflect the USSR's interest in participating in the IAEA, including in terms of affiliation, access to relevant information, and contacts with scientific and technical personnel in other countries (Timerbaev, 1999).

It is symbolic that a significant part of the negotiation process took place on the sidelines of the first International Conference on the Peaceful Uses of Atomic Energy in Geneva (1955), during the same period in which members of the Soviet delegation "probe" the possibility of the USSR's participation in CERN. This initiative became the starting point for the launch of the JINR project. It is also note worthy that in the same year and at the same venue, during the Geneva Conference of the Heads of Government of the Four Powers, the USSR delegation once again proposed for consideration the possible accession of the Soviet Union to NATO (Kochin, 2009).

The head of the American delegation at the IAEA negotiations was the aforementioned physicist Isidor Rabi, who had articulated the idea of creating CERN in 1949. The synchronicity of the two processes, namely, the formation of JINR and the IAEA became even more evident thereafter. On March 26, 1956, the Agreement on the Establishment of JINR was signed in Moscow, and on April 18 of the same year, the meeting to draft the IAEA Statute concluded in Washington. The final stage of the IAEA's formation, namely, the approval of the new organisation's statute from September 20 to October 23, 1956 took place in parallel with the Meeting of Plenipotentiary Representatives of the Governments of JINR Member States and the approval of the JINR statute on September 23, 1956.

Within a few years, JINR had become an instrument of science diplomacy and a symbol of the international influence of socialist bloc's international arena. For example, reports from the meetings of the first General Conferences of the IAEA are indicative: "representatives of 65 member countries […] took part in the work of the Conference, as well as representatives of various specialisded UN agencies and international scientific and technical organisations, including JINR and the European Organization for Nuclear Research" (Bershitsky 1959:80). The mention of the two organisations follows the dichotomous usage of the presentation of the entire text, compiled in the logic of parity: the USSR-USA dyad is organically complemented by a pair of multilateral "buttresses": JINR-CERN.

Birth of Siblings

In line with the UN General Assembly resolution, the International Conference on the Peaceful Uses of Atomic Energy was held in Geneva in August 1955 (Proceedings of the International Conference, 1957-58). Against this backdrop, the idea of a European laboratory for nuclear physics was put into practice: on June 29, 1953, the Convention establishing CERN was unanimously approved by representatives of eleven countries, and on September 29, 1954, following ratification, the European Organization for Nuclear Research was officially established.

Published archival documents and personal accounts allow us to conclude that the USSR seriously considered close cooperation with CERN as an initial and logical course of action, consistent with the broader "reunification" of scientific communities. This approach did not exclude the possibility of Soviet membership in this organisation. In particular, the leading member of the Soviet delegation to the Geneva Conference, Vasiliy Emelianov (USSR Academy of Sciences) recalled that at the 1955 conference, Academician Vladimir Veksler was instructed to visit CERN "to determine the possibility of cooperation between USSR scientists and this center" (Emelianov, 1979). A synonymous formulation of the question is also found in the declassified note of the First Deputy Minister of Medium Machine Building of the USSR Boris Vannikov dated November 4, 1955: "The question is, […] should the USSR seek admission to this laboratory?" (Academy of Sciences, 2010).

According to Vasily Emelianov, CERN's leadership announced that the organisation had suspended accepting new members for five years (Emelianov, 1967). This, he asserts, served as the impetus for members of the Soviet delegation to raise the issue of creating an institute in which scientists from socialist countries could collaborate on problems of modern physics (Emelianov, 1979): here, an obvious affinity with the NATO-Warsaw Pact case is evident.

Euratom

An additional parallel process, directly or indirectly interdependent with the development of the idea and the creation of JINR, was the formation of another specialised international organisation, the European Atomic Energy Community (Euratom), although the signing of the treaty establishing Euratom took place, one day short of exactly one year after the agreement establishing JINR on March 25, 1957. The founding fathers of Euratom envisioned the organization's focus not only on a single market for raw materials and equipment, but also on funding research and the development of relevant scientific centers. The USSR, adhering to the promising idea of pan-European unity, proposed in April 1956, at the 11th session of the UN Economic Commission for Europe, the creation of a pan-European organization for the peaceful uses of atomic energy within the UNECE. The Soviet initiative included the idea of creating specialized research institutes. In this context, the newly formed JINR, without an "anchor region" and integrated into a complex geography, looked advantageous.

Egor Todykov notes that, beginning in 1956, the Soviet Ministry of Foreign Affairs' policy was focused on uniting Europe under the auspices of nuclear cooperation (Todykov, 2023). At the same time, the USSR undoubtedly attempted to maintain a balance within the multifaceted system of checks and balances in Europe and the world, in particular, fearing that West Germany would be granted access to nuclear weapons (note in this regard the bilateral agreements with the GDR in the field of peaceful nuclear energy, and East Germany's membership in JINR, as a possible counterweight to these threats). The creation of Euratom predictably received a negative assessment from the Soviet side: concerns that the organization's activities would be subordinated to NATO interests, a deepening division in Europe, and an escalation of the general confrontation along the East-West axis.

The Ideal of Creative Cooperation

Paradoxically, despite the "destructive" position of Western countries, the USSR, from the very beginning, embedded in the genotype of JINR being created its orientation toward cooperation with CERN. This is confirmed by declassified documents of the Central Committee of the CPSU from 1955-1956, which "embed" the prospect of establishing cooperation with its European sibling: "As for the European laboratory, the necessary scientific contact with it can be maintained through the exchange of personnel and the exchange of achievements in the field of research, if the situation is favorable" (Academy of Science, 2010).

From the very first years of its existence, JINR articulated its openness to cooperation with specialized scientific communities not only in its member states but also in other countries. At the second meeting of the JINR Scientific Council in May 1957, Vice-Director Marian Danyszemphasized that the Institute's international cooperation should also be carried out with states "not participating in the Institute's work, through the broadest possible exchange of scientific information and mutual participation in scientific conferences and meetings" (Lebedev 1957:265).

It is significant that one of the motivations for the publication of the Agreement on the organization of JINR in the secret note of January 1956 noticed the fact of interest on the part of other countries, in particular Yugoslavia, India and Norway, in the creation of JINR (Academy of Science, 2010). In earlier documents, Yugoslavia and India, and other Asian countries (along with China and Korea) (Academy of Science, 2010) were included in the scope of potential members of JINR.

Linguist of Science Diplomacy: Joint vs. United?

The agreement establishing JINR will be prepared and signed in Russian. The Russian adjective "ob"yedinennyy" can be translated into English in at least two ways: "joint" or "united." Traces of this linguistic divergence are still visible to this day in the (historical) texts of publications of both the Institute itself (OIYaI) (Zinov et al., 1966), and the JINR member countries, for example, on the website of the Czech Technical University in Prague (Department of Physics FNSPE CTU, 2014), Poland (Poland in 1956, 1956)), the National Academy of Sciences of Azerbaijan (Azerbaijan National Academy of Science, 2015) or the Kim Il Sung University of North Korea ("JINRisalsocalledthe "UnitedInstituteofNuclearResearch"… ",(Nuclear Threat Initiative, 2023).

Apparently, when formulating the final name of the Institute, Nikita Khrushchev (the First Secretary of the Communist Party of the Soviet Union) could well have had in mind "United" in its UN sense, looking beyond the current context of creating a scientific organization ("in defiance" of Western competitors) and conceiving of the center being created within the UN framework. However, the official name of the Institute in English will still be "JointInstituteforNuclearResearch".

Strategy of Nuclear Science Diplomacy of the USSR

The USSR's science-diplomacy strategy in nuclear science sought, on the one hand, to strengthen its reputation as the undisputed leader in the nuclear field, maximise the potential of socialist bloc countries, for example, through scientific and technical transfer, and enhance the overall weight of the "Red Atom"in the competitive logic of the Cold War. In implementing this strategy, both multilateral and bilateral tactical tracks served as complementary approaches. Thus, the Soviet government's statement of January 15, 1955, on its readiness to transfer scientific and technical experience in the peaceful use of atomic energy within the framework of international cooperation fits within this logic. This was followed on January 18, 1955, by the decision "On Assistance to Foreign Countries in the Establishment of Nuclear Physics Research Centers": offers were made to the GDR, Poland, Romania, Czechoslovakia, and other socialist countries. Less than a year before the creation of JINR, in April 1955, the USSR signed agreements on assistance in the field of peaceful atomic energy with the GDR, Czechoslovakia, Romania, and others; in June with Bulgaria and Hungary, in 1956 with Egypt (Atomic Science, 1977). Vasily Emelianov notes that after the first Geneva Conference, the USSR concluded 34 agreements with 24 countries (Emelianov, 1979). It is clear that the scientific and technical competitive advantage of the USSR made it possible to convert it into the attraction of partnerships and cooperation not only in line with ideology, but also the pragmatics of real benefits for the participants of this cooperation.

JINR became the first multilateral collaboration between socialist countries in conducting research in fundamental physics (Atomic Science, 1977). Thus, JINR served as a kind of "umbrella platform" for the system of bilateral relations between the USSR and the Eastern Bloc countries in the field of atomic science: a methodological and ideological center for synchronising and coordinating the scientific and human resources potential of socialist countries. This cross-functional strategy made it possible to quickly elevate the scientific and technological potential of socialist countries in the field of peaceful atomic energy to the global scientific level.

JINR became the voice of fundamental nuclear science in the socialist bloc countries: for example, in the report of the first director of the Institute, Dmitry Blokhintsev, we encounter the following formulations: "over the past two years, there has not been a single significant international conference […] in which JINR scientists did not participate" (Atomic energy, 1961). At the same time, JINR became an object for demonstrating the achievements of "socialist science", a kind of scientific showcase for the countries of people's democracies. Thus, the recently created Institute was demonstrated to the participants (among the representatives of 27 countries were citizens of the USA, England, France, and Japan) of the International Seminar "Peaceful Uses of Atomic Energy and Youth" held in Moscow in August 1958 (International Seminar, 1958).

The idea of creating an international scientific center for socialist countries took shape in the context of the Cold War and the presence of the Iron Curtain. However, it is important to note that the perception of these concepts: their interpretation shifted from a black-and-white perception to the so-called "nylon curtain" mode (Khandozhko, 2019). In this extremely specifically configured and precisely sanctioned interaction, a special role was given to science, which was idealistically perceived as a depoliticised entity, devoid of any connection to national interests. Today, such a cosmopolitan reading of the concept of science diplomacy is often qualified by theorists and practitioners as so-called "naive" approaches: a kind of brotherhood of scientists united by values of a planetary scale. However, the USSR seriously considered international scientific cooperation, including in the categories of restoring scientific ties severed by World War II. For example, we encounter such a lexicology of cooperation in some official publications (Atomic Science, 1977). The statements of the official publication, "Atomic Science and Technology in the USSR," in the connotation of the JINR organisation, also fit into this style of "idealistic" interpretations of the concept of science diplomacy: "science has reached such a level of development that scientific problems can only be solved on the basis of creative cooperation and the unification of efforts of many countries" (Atomic Science, 1977).

The JINR Case: Advancing Science-Diplomacy Theory and Practice

This overview contributes to the theoretical framework for understanding international intergovernmental research organisations as a phenomenon of science diplomacy. Such organisations can function as a platform, an instrument, and an actor of science diplomacy, acquiring the authority of a "state of scientists" through their international legal personality. This autonomy endows them with particular potential for the bridge-building function commonly attributed to science diplomacy, as demonstrated by JINR during the Cold War.

From the perspective of science-diplomacy concept, the case of JINR's development enriches the repertoire of instrumental modalities. The Institute's history exemplifies the radical internationalisation of previously secret "megascience" facilities[3] and the de facto establishment of an international scientific program built upon an existing national research infrastructure, oriented toward explicit science diplomacy objectives. In this respect, JINR constituted an unconventional, asymmetrical alternative to the classical model of creating an international scientific organisation, exemplified by CERN in which a new institutional structure was established from scratch (quite literally in an open field) by a group of states within a single "anchor" region.

The JINR case also illustrates the fluctuating and ambivalent character of science-diplomacy nature, which combines tensions between global and national interests; cooperation and competition; the international character of science and the national affiliation of science diplomacy actors; and the ethical dilemma faced by scientists as diplomatic agents, loyal on the one hand to their state and on the other to the global scientific community.

In relation to JINR, it is appropriate to employ the concept of a "Dubna model" of multilateral science diplomacy centered on large-scale research infrastructure. This model is associated with features shaped by the historically secretive nature of constructing and operating such infrastructure: a specific location (often at a substantial distance from major metropolitan areas), a relatively closed social environment, integration of the scientific program into national scientific, technical, and organisational agendas, the availability of core scientific, engineering, and support personnel, and a reliance on permanent rather than rotating employment. The leading role of the host country as a comprehensive guarantor of the institute's functioning is also consistent with this model (Suleymanov, 2025).

From a "national" perspective on science diplomacy, the case shows how science-diplomacy instruments can support both utilitarian objectives, such as modernization of the national research system and the promotion of cross-border cooperation in fundamental science. The creation of the first international intergovernmental scientific research organisation among socialist countries established an important precedent for full-scale testing of a broad range of science diplomacy tools. For Soviet science diplomacy, the JINR case marked a departure from prevailing patterns associated with a reunification paradigm in international scientific and technical relations, and represented an entry into a "zone of advanced development": for the first time, the country sovereignly consolidated a new international platform under its own authority and on its own territory, rather than primarily seeking integration into existing organisations.

Amid current tectonic geopolitical shifts that have also affected science diplomacy, international intergovernmental organisations such as JINR have demonstrated relative stability and viability, maintaining their role as platforms for science diplomacy, as illustrated by the continuing collaboration between JINR and CERN (CERN, 2024). In a broader perspective, JINR was founded around a breakthrough field (nuclear physics) that is comparable, in contemporary terms of potential and sensitivity, to e.g. artificial intelligence. The experience of JINR's formation, in which previously secret fundamental knowledge became internationalised and more open, may prompt reflection on how to limit the potential negative impacts of emerging breakthrough research and associated technologies. Initiatives to establish international organisations in artificial intelligence (China's Diplomacy, 2025) may be moving in this direction; alternatively, states may continue to prioritise national interests before internationalising "new science" in the spirit of science diplomacy.

Conclusion

The "mirror room" situation, with a whole series of parallel and interconnected issues at the intersection of nuclear deterrence, disarmament, peaceful use of the atom, and nuclear science, is the reality in which the Soviet government quickly developed a science-diplomacy decision to create an international scientific center in the field of nuclear research, which would have far from a regional integration valence, but also a "benchmark" for the UN agenda.

The International Institute in Dubna is being created as a research center for people's democracies. An important characteristic of the founding countries' community was their ideological orientation (as is the case with CERN, "Western European countries" within the orbit of US influence). This is undoubtedly a characteristic and consistent with the realities of the Cold War evidence of the politicised nature of the initiation and development of both international research organisations.

The characterisation of the Soviet initial negotiating line is indicative: the aim of the Soviet proposals for accession and cooperation with CERN is, instead of creating scientific laboratories opposed to each other, which leads to duplication of research, limiting its transparency and hermeticity, to create a system of collective science in Europe, which leads to strengthening peace.

The science-diplomacy experience of the USSR in the 1950s in establishing JINR in the context of a multi-factor confrontation with Western powers is acquiring particular relevance in today's geopolitical realities, which demonstrate significant similarities with the situation of the Cold War.

JINR's experience has demonstrated the efficiency, and sustainability of the science diplomacy tools: the Institute celebrates 2026 its 70th anniversary, maintaining its international reach, competitiveness, and leadership in its field.

Endnotes

[1] Following the basic principle of science diplomacy that the scientist is its first among equal actors.

[2] Declassified documents of the Central Committee of the CPSU (Academy of Sciences, 2010) allow us to assert that the first documents with a proposal to create an "Eastern Laboratory of Nuclear Research" appeared in November 1955.

[3] The Soviet Union's in-kind contribution to the establishment of the JINR was the transfer to it of two formerly classified laboratories of the USSR Academy of Sciences in (future) Dubna: the Hydrotechnical Laboratory (a cover name that concealed a cutting-edge synchrocyclotron facility; it later became JINR's Laboratory of Nuclear Problems) and the Electrophysical Laboratory, where the synchrophasotron was being built (later JINR's Laboratory of High Energies).

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PAPER

From Peripheral to Pivotal: India`s Expanding Interests in the Arctic

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Introduction

Bridging India and the Circumpolar North

The Arctic often referred to as the 'Land of the midnight Sun' during the summer solstice[1] and the 'Realm of ceaseless twilight' during the winter solstice,[2] spans an area of 14.5 million square kilometres roughly equal to that of the Antarctic continent (Woods Hole Oceanographic Institution, n.d.).

The Arctic is endowed with vast reserves of minerals, latent depositories of hydrocarbons and a distinct population of its own acclimatised to the peculiar cold climate of the region. Unlike Antarctica, which prohibits mineral resource exploitation under the Antarctic Treaty System, the Arctic is recognised for its legal accessibility of minerals and hydrocarbons, in addition to being home to the native Indigenous populations adapted to the region's extreme climatic conditions. The word 'Arctic' has a Greek origin as the Greek seafarers were the first to discover it and called it the Arctic i.e. 'land under the constellation of the Great Bear'.[3] This boreal realm is a vast expanse of ice sheets spread over almost the entire length and breadth of the region, however, there exists some small habitable islands and continental extensions which serve as home to various indigenous population groups comprising the Inuits, Sami, Chukchi, Nenets, etc. The area above the Artic Circle (above 66° 34′ N) is surrounded by eight states - Russia, Finland, Sweden, Norway, Denmark, (Greenland), Iceland, Canada and the United States of America (USA) which have collectively come together to form the Arctic Council. The Arctic Council is a leading multilateral organisation dedicated

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to advance circumpolar cooperation,[4] underpinned by consensus-driven strategies. Alongside the membership of the eight states, the Council has also admitted non-Arctic States as observers, reflecting the increasing globalisation of Arctic governance. Inducted in 2013, as an observer satte in the Council, India has since sustained its scientific, diplomatic and policy engagement with the region.

In 1987, through the Murmansk Initiative of 1987, the incumbent Secretary-General of the Communist Party of the Soviet Union - Mikhail Gorbachev articulated an array of comprehensive foreign policy proposals addressing the Arctic region. This ushered in a paradigm shift, reimagining the Arctic region from a militarized theater to a "zone of peace" (Routledge Handbook of Arctic Security, 2020). Amidst the increasing global recognition of the strategic value of the region, underscored by its unearthed mineral wealth and untapped hydrocarbon deposits, the paper intends to discuss India's foray into the region following its induction as an observer in the Council. As stated in the World Meteorological Organization's, 'State of Global Climate in 2021' report, Indian coastal regions are witnessing a sea level surge that outstrips the global average rate, primarily attributed to Arctic amplification. Although the Arctic amplification makes a significant contribution to the formation of the global climate feedbacks and the atmospheric circulation, the effects of the Arctic amplification do not act as a single cause of climate variability; instead, they interact with the various other drivers of climate variability.

Figure 1: Map of Arctic Administrative Areas

Source: W. K. Dallmann, Norwegian Polar Institute. https://www.researchgate.net/figure/Arctic-administrative-areas-including-Nunavik-top-source-W-K-Dallmann-Norwegian_fig1_350488063

Additionally, climate change is impacting the globe disproportionately, with underrepresented regions, particularly the Global South, facing a more profound toll than their developed counterparts. According to the World Bank, climate change-induced effects may precipitate a substantial economic downturn, thereby pushing an additional 100 million people below the poverty line by 2030.[5] Other than its strategic and scientific importance, Arctic boats of a variety of delicate ecosystems due to its unique geographic and climatic conditions. The study of these systems provides India with a useful perspective in creating resilient cold-weather infrastructure and adaptive mechanisms that are applicable to the high-altitude and cryospheric areas of India (specifically, the Himalayas).

To facilitate a deeper understanding of the topic, the paper has been sectioned into five primary divisions. The first section briefs the causes and the underlying factors driving the need for India's increasing interest in the Arctic. It reasons out multiple factors addressing the need for India's increasing focus in the region substantiated through data and reports. The discussion addresses the critical question of 'Why' - emphasising the profound interlinkages between the environmental changes in the Arctic and the uncertainty shrouding India'sclimatic variability, progressively swayed by the Arctic shifts. The next section scutinizing the historical evolutions, shedding light on the maturation of India's Arctic policy throughout the years. It draws a comparison between India's preliminary engagements in the Arctic and the antecedents as well as the pivotal milestones in India's Arctic pursuits. The third section moves on to implore the geopolitical dimensions of India's Arctic manoeuvres exploring the strategic imperatives for non-Arctic countries like China and India to navigate the Arctic. Meanwhile the paper also tends to look at the diplomatic endeavours that India has pursued in the Arctic especially with its distinct bilateral relationshipswith Russia and Norway. The paper deliberately focuses on the two leading Arctic states given India's predominant scientific interactions in the region facilitated through these nations, while also exploring additional collaborations with these states. The fourth section is a 'discussion' exploring the challenges and opportunities for India's Arctic study, addressing how they might align with the future requirements of the country. The final section concludes with the synthesis of the principal insights of the study. It offers an in-depth analysis of key developments in the Arctic, concluding with a way forward and strategic recommendations for India's foreign policy as it realigns its focus towards the circumpolar nations.

India's Arctic Pivot

'Arctic as a region is unique in International security studies owing to it favouring cooperation over competition'.[6] This is what has come to be acknowledged as the "Arctic Exceptionalism" in the modern discourse. It is used to be seen as a sanctuary of calm and a realm of peaceful dialogue. However, the vested strategic and geopolitical interests in the region, are giving rise to a geopolitical contestation in the region by the stakeholders to preserve their interests.

India has shown its clear-cut pivot through its policy stance in 2022 'India's Arctic Policy : *Building a Partnership for Sustaineble Development*' which shows the importance that Arctic holds for India. This policy is the first structured initiative by the Government of India towards its Arctic engagement. It marks a decisive shift from a predominantly scientific engagement by India to a more integrated and strategic approach towards the region. Framed around six core pillars of India's engagement in the region including: strengthening India's 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; the policy looks at India's recognition of the Arctic beyond the region's scientific importance for the country.

Moreover, the impact of global warming, manifesting as the steady attrition of Arctic ice expanses, are facilitating easier passage through previously impassable routes. This, coupled with a proliferating interest in the Arctic's untapped natural riches and pivotal geopolitical importance, there is a marked surge in regional accessibility. Accordingly, non-Arctic states, including China and India are seeking to assist the conventional Arctic players to capitalize on the potential diminishment of transit distances, durations, and costs, in addition to strategic diversions from existing chokepoints including China's Malacca Dilemma. Therefore, in light of these developments, it is imperative to ascertain the catalysts behind India's burgeoning interest in the Arctic.

What Prompts the Arctic Surge ?

Himalayas as the Third Pole

India boasts the grandeur of the majestic Himalayas, the youngest fold mountain chain in the world, also the largest source of freshwater around the globe, outside the poles. For this reason, the Himalayas are frequently likened to as the third pole[7] of the planet. The crescent-shaped mountain chain exults in some of the highest mountain peaks found worldwide and spans almost five countries - India, Pakistan, Nepal, Bhutan and China. They form the northern frontier of the Indian subcontinent and thus, is indispensable for India in all dimensions be it economic, political, geostrategic or cultural spectrum. The third pole underpins the sustenance of approximately three billion lives living downstream of its rivers, which are crucial for irrigation and agricultural productivity in the area. Thus, India endeavours to achieve a robust presence across all the three poles of the world.

While the Arctic is not a high-altitude environment, yet both the Arctic and the Himalayas are regulated by the cryosphere processes and are extremely susceptible to the climate changes. Studies undertaken in the Arctic region can offer interesting information pertaining to the glacier processes, thawing of permafrost, atmospheric patterns and climate feedback processes that ought to be employed to understand climate-driven changes in the Himalayan region. Thus, the studying the Arctic in this regard would help in enhancing the modelling, prediction and adaptation strategies in the Himalayas.

Additionally, in its capacity as a signatory to the conservation of migratory species (CMS), India plans to partner with circumpolar states to advance research and conservation of Arctic biodiversity, particularly focusing on the surveillance and tracking of avian diseases and their developing transmission pathways. By engaging in research and surveillance of avian diseases and their transmission pathways in the Arctic, India can acquire profound insights into pathogen behaviour and migratory trends. India's Arctic engagement, thus, would help in addressing climate, ecological, and water-security challenges linked to the Himalayan region.

Monsoon Variability

Scientific consensus posits a direct correlation between the melting of Arctic sea ice and the incidence of extreme weather phenomena, notably intense precipitation events.Polar-tropical climate teleconnections are one of the least understood phenomenon. Given this, India's interest in this sector can help the researchers to understand the monsoon anomalies over a period of time. India's scientific ambitions transcend beyond conventional weather and climatic studies, to encompass less explored areas like atmospheric and space physics studies, including the study of extraordinary occurrences like the Aurora. This was made possible under the aegis of the Ministry of Earth Sciences (MoES), which in December 2023, launched India's maiden winter scientific expedition to the Arctic.

Antarctic Experience

Unlike Antarctica, which is deemed to be a separate continent and is governed by the Antarctic Treaty of 1959, the Arctic comes under various national jurisdictions. While Antarctica provides governance stability and openscientific access, the fragmented jurisdictions and geopolitical tensions in the Arctic do not allow independent research and must rely on the capabilities of remote access and satellite access.

The historic presence of India in Antarctica thus presupposes strategic applicability of Indian Arctic interests.The working experience acquired during the Antarctic research, especially related to extreme-environment logistics, satellite-based observation, and remote sensing offers a knowledge base that can be transferred to Arctic research. In this regard, the increasing space technology capacity of India is a key factor. In the contemporary landscape, India is at the forefront of cutting-edge space technology. India's national space agency, Indian Space Research Organisation (ISRO) stands as a paragon of scientific ingenuity and technological prowess in the 21st century. ISRO has become an important facilitator of polar studies because of its sophisticated satellite and earth observation systems, which play an important role in observing the changes in the cryosphere, biodiversity and climate-related changes in inaccessible territories.The technology thus gathered would be used to study the region along with the effects of climate change in Arctic, while also exploring flora and fauna. The role of ISRO is no longer being taught as being symbolic or a s a mere prestige act, but is now being realised as a practical answer to somepolar limitations especially with remote sensing and earth observation.

ISRO has a remote station in Antarctica known as the Antarctica Ground Station for Earth Observation Satellites (AGEOS). This pioneering enterprise commissioned to ISRO in 2013 is what can function as a prototype for ISRO to have a similar station in the Arctic. India also plans to deploy its Radar Imaging Satellite (RISAT) series of satellites for the study of the Arctic region along with the Indian Regional Navigation Satellite System (IRNSS) for assisting in the safety of maritime navigation in the region. In addition to that, India intends to leverage the NASA-ISRO Synthetic Aperture Radar (NISAR) mission in the Arctic to fortify the global oversight of natural resources and hazard mitigation.

Energy

One of the parameters of India's Arctic Policy includes its keen interest to support sustainable business development in the Arctic as mentioned by the Arctic Economic Council. Alaska (part of Arctic) holds the biggest concentration of undiscovered oil, which in total may range from 22 to around 256 billion barrels, with a mean of 90 billion.[8] Given its burgeoning populace and its rank as the fifth-largest economy worldwide, India confronts mounting energy needs. The country's share in universal core energy consumption is projected to increase two-fold by 2035.[9] The Arctic therefore, holds the promise for ameliorating India's future energy security concerns by providing diversified and cost-effective access to energy resources, such as hydrocarbons and critical minerals, and reduceover-dependency on limited resources and vulnerablesupply chains. Nevertheless, the 2022 Arctic Policy highlights that the country's approach to regional economic development is steered byUN Sustainable Development Goals. Arctic economy sustains on renewable (solar, wind, bioenergy, geothermal and ocean energy, sand hydroelectricity) and clean energy options, given its fragile ecosystem. India aims to cooperate with Arctic governments in order to reinforce alliances in the areas of non-living resource exploration and sustainable living.

Digitalisation

The growth of the Arctic economy depends on the process of digitalization around the world. Through the application of technology the world is becoming more and more integrated. In order to fulfill its potential, the digital economy depends on physical infrastructure that makes digital flows possible in the first place. Even with a warming rate of twice as fast as the rest of the planet, the Arctic is is still one of the coldest places on the Earth (Raspotnik & Steinicke, 2017). Additionally, the remaining energy needs can be fulfilled through renewable energy resources. The Arctic and sub-Arctic islands are already home to a number of data centres including Facebook's Lulea data center in northern Sweden.

Beyond digital and economic considerations, India's active involvement in the region holds vital importance given the region's potential repercussions on India's water security, sustainability and climatic patterns. India's involvement is crucial as it enables the country to proactively anticipate and mitigate the cascading effects of the region on the water security and climatic stability of India. As a result of prolonged scientific interactions, India will be able to produce high resolution climate information, enhance polar-tropical teleconnection theories, and enhance predictability of monsoon variability and severe weathers that have direct impacts on agriculture, and coastal structures as well as economic planning.

China's Expanding Footprint in the Arctic

China's growing presence in the Arctic is a valuable point of comparative and strategic discourse regarding how India engages with the Arctic, especially its accessibility, cooperation, and geopolitical limitations.

Chronology of India's Arctic Engagement

Arctic as a region has provided a long sequence of presenting innovative governance approaches to meet the concerns of governance.Historically, the region has been the testing groundsfordistinct governance strategies, characterised by cooperative multilateral institutions, scientific decision-making processes and formal inclusion of the Indigenous actors in regional governance practices.Climate change and globalisation have had the worst impacts on the Arctic region, making it the most rapidly transforming area globally. It has intensified resource extraction, tourism and intensified geopolitical competition in the Arctic, resulting in rapid environmental degradation and disrupting Indigenous livelihoods alreadytrying to survive fragile ecosystems.Another potential impact of these changes is the growing concern of non-Arctic states interested in the region to exploit the opportunities of the new shipping channels, oil and natural gas, access to minerals, fish stocks, and cruise tourism. This is the fact that it is strengthening the economic and geopolitical relations between the Arctic and the overall world system.

The Spitsbergen Treaty (commonly referred to as the Svalbard Treaty) was signed on February 9th, 1920 in Paris during the Peace conference at Versailles following the first World War. In this treaty, International diplomacy recognized Norwegian sovereignty (the Norwegian administration went in effect by 1925) and other principles relating to Svalbard, which established a distinctive legal regime limiting the exercise of sovereignty in the Arctic. Additionally, the Treaty laid down several important principles such as the demilitarisation of the territory, the environmental commitment and, the principle of non-discrimination

How has China Made Strides in the Region ?

In the past couple of years, China has turned its gaze towards the resource rich region of Arctic adopting the moniker of a near-Arctic state. One such strategic initiative by China is the development of the 'Polar Silk Road' (PSR) which would extend the Belt and Road Initiative (BRI) of China into the Arctic region. PSR aspires to forge a maritime corridor through the Arctic, connecting China with Europe via the Northern Sea Route (NSR). The Northern Sea Route provides China with a strategic maritime pathway to penetrate the European markets, circumventing its 'Malacca Dilemma,' while simultaneously facilitating the integration of Russian Arctic territories into the global economy (Agarwala, 2022). Maintaining cordial relations with China and India is a matter of political calculus for Russia - a balancing act. Additionally, China remains the most crucial ally for Russia, given India's closeness with USA in countering China especially after the 2020 border conflicts. In May 2024, Chinese President Xi Jinping and Russian President Vladimir Putin reaffirmed their "no limits" strategic partnership, as China committed economic assistance to Russia, particularly aimed to outmanoeuvre the sanctions led by the United States. Besides, Russia and China have synchronised their efforts in collaborative ventures to develop the 'Arctic Express' - a logistic initiative by Russia in partnership with China to develop a seamless shipping corridor across the Arctic Ocean via rail - bridging Europe and Asia, and converging with the Northern Sea Route.

(especially with regard to non-Norwegian states). Equal rights of entry, dwelling, fishing and mining, and other types of economic activity on the land and within the territorial waters were granted to all signatory states. Such equality between the Norwegian administrative powers and guaranteed economic and commercial rights in the Arctic is what renders the Treaty its lasting legal and policy value and makes Svalbard a rare case of a joint access in a sovereign context.

Nearly a decade ago, as India secured its position as an observer state in the Arctic Council at the Kiruna Ministerial Meeting in 2013, the then Foreign Secretary, Mr. Shyam Saran, proposed that emergent states like India and China should 'prioritise the Arctic on the international agenda'. The Arctic, once merely relevant, has now ascended in prominence . Not only the Arctic states, but non-Arctic states too, are redirecting their focus towards the new geopolitical hotbed.

Table 1 below showcases a comparative analysis of the twin engagements of India and China in the Arctic. China fares well with its technological prowess in the region highlighted by its multiple research stations and an early attempt to navigate the northern sea route. Besides, China is one of the few countries in the world to have its own PRV operational since 2018 known as the 'Snow Dragon 2' or MV Xuelong 2. However, the table shows that though lagging behind, India is making strides to enhance its engagements in the region.

India's foray into the Arctic began in early 2000s (specifically around 2007). During this time, India launched its pioneering scientific expedition in the Arctic focusing on the fields of Arctic microbiology, geology as well as atmospheric sciences. Nonetheless, India's interest in the poles gained momentum with its involvement in the Antarctic region in 1981 and the subsequent establishment

Table 1 : Comparative Analysis of India & China's Engagement in the Arctic

Engagements	India	China
Accession to Svalbard Treaty	1920	1925
Observer status in Arctic Council	1913	1913
Arctic Research Station	2008 - Himadri	2004 - Yellow River Station; 2018 - China Iceland Arctic Science Observatory
1st Arctic Expedition	2007	1999
Total Expeditions	2014	13
1st NSR Voyage	-	1912
1st Polar Research Vehicle	-	1999 - MV Xue Long

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1st Nordic Summit	2018	-
International Arctic Science Committee	2012	1996
Arctic Policy	2022	2018
Svalbard Integrated Arctic Earth Observing System	Associate Partner	Formal Partner

Source : Bisen, A. (2023)

of research stations in the southern continent of Antarctica. However, it was much later around the dawn of the 21st century, when India redirected its focus towards the Arctic.

The Ministry of Earth Sciences (MoES), as it is currently recognised, was created in 2006, evolving from its former identity as the Department of Ocean Development (DOD), directly under the charge of the Prime Minister of India. Subsequently, National Centre for Polar and Ocean Research (NCPOR), Goawhich was instituted in 1998 under the DOD, became an autonomous body of the MoES. Initially, the Centre was tasked with the study of the Antarctic region and the orchestration and execution of India's Antarctic Programme. However, with the establishment of India's Himadri station in the Arctic, the Centre has reoriented towards the Northern Hemisphere as well.

The fourth and the most recent International Polar Year (IPY - 2007-2008) rekindled India's interest towards the pole once again but this time it was an excursion to the Northern extremity. It gave India the opportunity to have a dichotomous framework in its polar study. In 2007, the Indian scientists began research activities at Ny-Alesund , an International research village governed by Norway. India's research was focused on studying the global linkages of climate change in the Arctic. This gave way to India's second Arctic expedition and led to the establishment of India's first permanent research station 'Himadri' at Ny-Alesund in 2008. It India the eleventh country to have a semi permanent research station inNy-Alesund. In 2012, India got elected to Council of the International Arctic Science Committee. India's induction into the Council of the International Arctic Science Committee in 2012, followed by its observer status in the Arctic Council in 2013, catalysed manifold opportunities for India in the region.

Hosting its indigenous seed bank in Chang La, Ladakh, it got a major endorsement upon affiliating with the Seed Bank at Norway. This represented a significant leap in bolstering its food security by becoming a part of the global initiative - the Svalbard Global Seed Vault (SGSV) on April 9, 2014. The Vault officially commissioned in February 2008, was designed with the intent to act as a 'Secure Repository' for the preservation rare seed materials.[10]

India is keen to examine the linkages between the climate in the Arctic and the Indian monsoon. To this end, it has established a series of observational facilities in the Arctic. In 2014, India deployed its its first ever multi-sensor mooring observatory deployed in the waters of Kongsfjorden, on the island of Spitsbergen in Svalbard. This underwater observatory signifies India's venture into Arctic exploration, employing an array of sensors, including fluorometers and dissolved oxygen sensors, to accumulate critical data. It aids in the deeper understanding of the interrelations between the Northern deep seas and the Arctic ice shelf, along with their impacts on the climate system of India. Venkatesan et al. (2016) has detailed that physical connection between large scale North Atlantic climate modes (i.e. Atlantic Multidecadal Oscillationand the North Atlantic Oscillation), and multi-decadal and inter-annual variability of the Indian summer monsoon processes, demonstrates the significance of sustained observations of the Arctic ocean. The observations made over one year found significant seasonal stratification, mixing of waters in winter, high variability of currents and biological reactions to freshwater, indicating the vulnerability of the fjord to the climate. Thereby, IndARC is an important landmark in the Indian Arctic research programme and highlights the usefulness of long-term moored observations to enhance the knowledge of the Arctic and monsoon relations and global climatic processes.[11] This initiative was succeeded by the establishment of the Gruvebadet Observatory, an atmospheric science facility that houses various observation networks in the Arctic region.

Schemes Under Ministry of Earth Sciences Focusing on Polar Research

PACER

Initiated in the developmental decade of 2010s, the Polar Science and Cryosphere Research (PACER) scheme is the integration of the Cryosphere and Climate, the Indian Arctic, Southern Ocean, and the Antarctic program. It has been initiated under NCPOR and has been granted approval for further continuation from 2021-2026. It comprises of six divisions out of which two link Indian scientific activities in the Arctic and building of polar research vessel (PRV). India's plan in the next 4-5 years is to get a PRV to facilitate its bases in the polar regions

O-SMART

The scheme previously named as O-STORMS (Ocean Services, Technology, Observations, Resources, Modelling and Science) scheme was renamed as Ocean – Services, Modelling, Application, Resources, and Technology (O-SMART) during 2019-20.[12] O-SMART's goal is to support ocean research as well as establish early weather systems. It help to understanding large-scale ocean circulation and climate teleconnections between the Arctic and the lower latitudes, such as the Indian monsoon system. The current decade (2021-2030) has been recognized by UN as the Decade of Ocean Science for Sustainable Development and the O-SMART scheme will assist in enhancing India's position in the international oceanographic research and technology advancement.

ACROSS

Atmosphere & Climate Research-Modelling Observing Systems & Services (ACROSS) scheme pertains to the atmospheric science programs of the MoES. Though the scheme does not focus on the Arctic region, it is expected that the many of the studies being initiated/ carried out under this Scheme could provide invaluable data and information of relevance to such areas of research as exploring the the teleconnections between the Arctic climate and the Indian monsoon. In addition, and perhaps equally important is the development of core competence in the country in atmospheric and climate research and modeling.

The graph here shows the latest data including the percentage of the total government expenditure on the above mentioned schemes. Henceforth, the table also highlights the year wise expenditure by the government on PACER, ACROSS and O-SMART from financial year 2015-16 to projected expenditure for 2024-25.

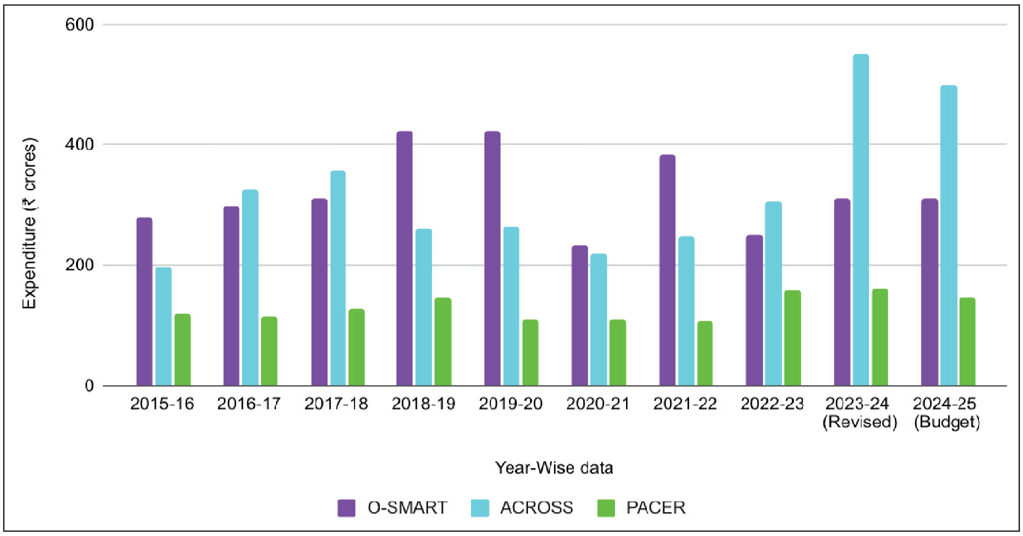
Table 2: Year-wise Expenditure Under MoES for Various Schemes

Expenditure (₹crores)										
Schemes	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24 (Revised)	2024-25 (Budget)
O-SMART	277.79	297.65	310.63	421.31	422.42	233.45	382.08	250.2	310	310
ACROSS	196.41	325.58	355.92	258.94	263.72	217.84	247	305.94	550	500
PACER	118.66	114.74	126.88	144.97	109.98	109.64	107.99	156.97	160	146
DOM	-	-	-	-	-	-	119.03 (launched)	56.03	450	600

Source : Authors' compilation based on reports from Ministry of Earth Sciences, Government of India.

As the data suggests, the government has been increasing the expenditure in these three schemes throughout the years. There is a consistent increase, except for a dip seen briefly in FY 2020-21, owing to the global pandemic. However, efforts are being made constantly, to expand India's research foray in the region. Recently, these three schemes were subsumed under the

Figure 2: Schemes Under Ministry of Earth Sciences Dedicated for Polar Research



Source : Authors' compilation based on reports from Ministry of Earth Sciences, Government of India.

'PRITHvi VIgyan' (PRITHVI) scheme of the Ministry of Earth Sciences. PRITHVI is a holistic scheme addressing all the five components of the earth system including the atmosphere, geosphere, cryosphere, biosphere and the hydrosphere. Examining these schemes helps in providing an empirical basis to assess the scale and continuity of India's research efforts in the Arctic. It enables one to see the pattern of programme design and funding trends more clearly as the years progress, whereas the expenditure growth analysis shows that the government has maintained its dedication to the program, even in the face of external shocks like the COVID-19 pandemic.

Through such schemes and initiatives, India is trying to set a foot in the Arctic. India's rising interests in the Arctic serves as the fillip for the country's science diplomacy. This can be seen vividly with its 2022 Arctic policy.

Discussion

Presently, eight sovereign states are already administering the Arctic through the Arctic council. According to Dr. Sulagna Chattopadhyay, Secretary General, LIGHTS and Convenor SaGAA, for India to secure a foothold in the Arctic as a non-Arctic state, it needs to articulate a policy blueprint delineating how India can prove to be instrumental to the Arctic nations and conversely, how it anticipates a reciprocal support - You help us, we help you.There exists a complementarity between the 1996 Ottawa Declaration on the establishment of the Arctic Council and the 2022 Arctic Policy of India. The declaration acknowledges the sovereignty and jurisdiction of the eight Arctic States over their respective territories and the surrounding seas as per the International law, and thus creates the Arctic Council as a high-level inter-governmental forum that would cooperate in common Arctic issues. The Arctic Policy of India, on the other hand, also acknowledges the primacy of the Arctic States and aims to engage in the process through scientific cooperation, environmental research, and multilateral governance mechanisms instead of making any territorial or jurisdictional claims.

India holds a pivotal importance in the Indian ocean trade, both economically as well as strategically. With the maritime traffic of the High North shifting to NSR, the Indian ocean would have to bear the brunt of an increased competition in maritime trade, necessitating a reevaluation of its geopolitical importance and economic value, while also rebalancing its stake in the maritime domain. In this sense, India could forge new alliances alongside strengthening the existing maritime frameworks like the Quad grouping. In alignment with the views expressed by Amb. Pankaj Saran, former Deputy National Security Advisor to the Government of India, the prospect of the Northern Sea Route (NSR) bridging Europe and Asia looms as an imminent possibility, which may precipitate profound implications for the utilisation of the Indian Ocean as a conduit for trade and commerce. This development would have a spillover effect on the traditional maritime routes in the Indian ocean including the chokepoints i.e. the strait of Malacca, the Strait of Hormuz as well as the Bab-el Mandab Strait. This would significantly alter the strategic importance that Indian Ocean holds in global shipping and trade logistics. The NSR offers a truncated and a direct passage linking Europe to Asia, effectively mitigating transit times and operational costs for shipping enterprises. Consequently, this modification could usher in a reconfiguration of worldwide trade circuits, impinging upon economies that hinge on the Indian Ocean for their maritime commerce.

Furthermore, ISRO could could consider establishingan advanced or an experimental setup like the Antarctica Ground Station for Earth Observation Satellites AGEOS in the Arctic, which could strengthen India's winter expeditions to the Arctic. It could transform the environmental monitoring of parameters like estimation of ice thickness, ocean currents as well as the wildlife habitats. India cancontribute to enhancing community resilience amongst the Indigenous people in the region, addressing challenges such as the permafrost thaw, logisticalconstraints pertaining to the inaccessible remote areas and extreme weather events-. This can be achieved through the creation of biological research facilities, ground-based measurements, and indigenous and local knowledge systems.

India has been progressively expanding its research footprint in polar regions. Polar years are significant periods designated for comprehensive scientific research in the Arctic and Antarctic. Each polar year involves focused international scientific collaboration and exploration. With its efforts, India can make headway to the next International Polar Year planned in 2032-33.

One of the focal points of India's arctic strategy is to apply for membership in the Arctic Economic Council and participate in its five working groups, which include the blue economy, maritime transportation, connectivity, investment and infrastructure, and responsible resource development.[13] A study says that Arctic will be free of ice in 'summer' by 2030. In the last 4 decades, we have lost most of the reflective ice in the Arctic. The third pole or as it is referred to as the pan-third pole along with the North and the South Pole - all go through the "Deep White" processes i.e. they're all extensively covered by snow and ice. The warming rate of the third pole is very similar to the North pole which is almost twice as fast as the global warming rate.

It is thus imperative for all of us to recognise, to cooperate and to know that it is after all one ecosystem irrespective of the boundaries that we have artificially created. The nature knows no boundaries. There lies vision that the architecture designed to suit the peaceful cooperation in the Arctic region is precisely the kind of architecture that the Himalayan region needs.

Conclusion

To sum up, India and the world are now focusing more on the Arctic owing to three reasons - availability of resources, worldwide impact of global warming in the Arctic, change in the global shipping corridor because of northern sea route. According to Dr. M Ravichandran, Secretary, Ministry of Earth Sciences, Government of India, it is imperative for us as a society to contribute to the efforts to enhance humankind's understanding of the Arctic region. Therefore, India needs to advance the study and the understanding of the Arctic. Rapid warming in the region has become a global phenomenon resulting in rising sea level and affecting Indian monsoons. This is disrupting to national development too, especially to the island countries which are on the verge of drowning, coming under the grip of the rising sea levels. Moreover, it will also hamper the development of maritime countries like India, where densely populated coastlines are increasingly exposed to cyclones and extreme weather events across the Arabian sea and the Bay of Bengal. While large cities are not immune, it is often in non-metropolitan and economically vulnerable coastal areas that the greatest effects can be felt, where the adaptive capacity and resilience to disaster are least established.

Hence, by leveraging its continued scientific expertise, sustainable development goals as well as diplomatic strategies, India is expanding its focus in the region. This persistent and multifaceted engagement makes India a key player in the Arctic's future as it comes more centrally into the world politics – it transforms India from a marginal figure in the Arctic politics to a key actor on the Arctic stage.

Endnotes

1 The summer solstice occurs at the moment the earth's tilt toward/from the sun is at a maximum.

2 Around December 21, the Northern Hemisphere tilts the farthest away from the Sun. This is called the northern winter solstice, and it is when we have the least amount of daylight of any time of the year.

3 https://worldoceanreview.com/en/wor-6/the-arctic-and-antarctic-natural-realms-at-the-poles/a-brief-history-of-the-polar-regions/#:~:text=The term "Arctic" comes from,constellation of the Great Bear".

4 https://arcticportal.org/arctic-governance/arctic-policies-database

5 https://www.usglc.org/blog/climate-change-and-the-developing-world-a-disproportionate-impact/#:~:text=Economic Development: The World Bank,people into poverty each year.

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11 Venkatesan et al.(2016), Indian moored observatory in the Arctic for long-term in situ data collection. The International Journal of Ocean and Climate Systems. 7(2):55-61

12 https://www.moes.gov.in/sites/default/files/2020-2021-Accounts-at-a-Glance.pdf

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PERSPECTIVE

Indo-German Science & Technology Cooperation: The Path to Success and Delivery

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Introduction

Indo-German cooperation in Science & Technology cooperation stands as a lighthouse of visionary diplomacy and long-standing partnership, successfully enlacing two of the world's most dynamic knowledge ecosystems, working together to address pressing global challenges that influences societal upbringing and well-being. Originating from the shared values of innovation, mutual trust, scientific excellence and sustainable progress, this collaboration has blossomed into a strong and resilient network linkage among eminent research institutions, cutting edge industries and brilliant scientific minds from both nations, fostering a sphere of innovation where ideas transcend geographical boundaries & disciplines, enabling the co-creation of pioneering technologies and groundbreaking discoveries. Such partnerships create a confluence of aspirations, and a purpose dedicated to reshaping a better future for humanity. Through this fusion of knowledge and invention, the Indo-German S&T cooperation continues to enlighten the pathways embodying the collaborative spirit and mutual commitment towards advancing scientific research, drive technological innovation, and propel industrial progression.

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Journey of Indo-German S&T Partnership

From the nascent dawn of India's post-colonial emergence, Germany emerged as a steadfast scientific and technological ally, beginning in the mid-1950s when Germany crystalised its technical and financial commitment for the establishment of the Indian Institute of Technology Madras (IIT Madras). Inaugurated in 1959 as the third milestone of engineering wisdom and beacon to the India's educational dream, IIT Madras stood not only as a triumph of shared goal but also as Germany's single international educational project, initiating a glorious chapter in a saga of bilateral scholarly exchange. A year later, The German Academic Exchange Service (DAAD) unfurled its first office at New Delhi, marking a seminal step in fostering academic and scientific ties. This was soon followed by a landmark agreement set forth between DAAD and the Council of Scientific and Industrial Research (CSIR), laying the foundation of bilateral scientific exchange for knowledge sharing. In the year of 1971, both the governments signed the Indo-German Agreement on the peaceful uses of Nuclear Energy & Space, signalling a deepening commitment to collaborative research in critical strategic domains.

The major achievement in bilateral cooperation in the field of science and technology was initiated under an Inter-governmental Agreement on "Cooperation in Scientific Research and Technological Development" signed in May 1974 under the nodal agency Department of Science & Technology (DST) from Indian side and Federal Ministry for Education and Research (Bundesministerium für Bildung und Forschung - BMBF) from German side for overall coordination and implementation, signifying a cornerstone of multidimensional S&T collaboration. This agreement paved the pathways for a series of S&T partnerships among several Indian and German organisations targeting relevant stakeholders including cooperation between Indian Council of Medical Research (ICMR) and Gesellschaft fur Strahlen- und Umweltforschun GmbH (GSF) in the fields of medicine and biology in 1976, Indian Space Research Organisation (ISRO) and Deutsches Zentrum für Luft- und Raumfahrt (DLR) in the field of space technology in 1974 and special arrangement between CSIR and DLR in aeronautical sciences in 1982. In the era of 90's, the cooperation got further strengthened by incarnating CSIR/ Fraunhofer-Gesellschaft (FhG) Letter of Intent (LoI) in 1994, establishment of Indo-German Apex Committee on S&T to coordinate the implementation of the cooperation through joint review of the activities and suggesting measures towards enhancement of cooperation among several nodal agencies in 1994 and launching of DST/DAAD project based research promotion program.

The dawn of the new millennium unveiled a cascade of milestones ushering prominent presence of many more bilateral cooperations in Indian R&D&I ecosystem. Starting from Department of Biotechnology (DBT)-BMBF Special Arrangement for Cooperation in Biotechnology in 2001, MOU between ICMR and Helmholtz Association for setting up of Indo German Science Centre for Infectious Diseases in 2006, agreement to establish the Indo-German Science & Technology Centre (IGSTC) in 2007, Indo-German Joint Declaration of Intent on Research Cooperation on Science for Sustainability and DST/Humboldt Foundation MOU on Frontiers of engineering (INDOGFOE) in 2008, establishment of Indo-German Science & Technology Centre (IGSTC) at New Delhi in 2010 and launching of Indo German Max Planck Centre on Computational Science at IIT Delhi in 2010 and so on – a testament to the ceaseless spirit of exploration.

50th year of Indo-German S&T Cooperation

In 2024, Indo-German S&T cooperation reached a historic milestone as it celebrated its Golden Jubilee—five decades of relentless pursuit of knowledge, innovation & excellence. The commemoration, jointly organized by DST & IGSTC, unfolded in New Delhi on October 24, 2024, bringing together distinguished dignitaries, scientists, industrialists and visionaries from both nations. The occasion successfully echoed the legacy and profound values of this decades-long partnership, enshrining ambition and courage to voyage together. It also created a platform to chart the future roadmap, reinforcing the spirit of collaboration which has shaped and will continue to guide this remarkable scientific alliance.

The event was inaugurated by Dr. Jitendra Singh, Union Minister of Science and Technology of India, alongside Ms. Bettina Stark-Watzinger, German Federal Minister of Education and Research. Both leaders expressed deep gratitude to the scientific communities of India and Germany, whose dedication has propelled this partnership into one of the most resonant and dynamic collaborations in the global research landscape. The event paid homage to fifty years of joint endeavours across an impressive spectrum of disciplines: from space technology to aeronautical sciences, medicine, and biology, as well as cutting-edge frontiers such as artificial intelligence, quantum technologies, waste management & sustainability and green hydrogen. Each initiative stood as a chronicle to the shared belief that science and technology could serve as bridges between nations and catalysts for human progress. The inaugural session of this remarkable event was highlighted by the felicitation of women researchers of IGSTC-WISER award, honouring outstanding contributions of women in science, along with the unveiling of the winning design for the "50 Years of Indo-German Partnership" logo competition. The inauguration of a science exhibition added vibrancy to the celebrations, offering a glimpse into the vast array of achievements and ongoing industry partnered projects under the collaboration. The event also witnessed the signing of an MOU between IGSTC and Bharat Petroleum Corporation Limited (BPCL) for advanced research in renewable energy, green hydrogen, carbon capture, and other transformative technologies – a pledge to green horizon and sustainable livelihood.

The golden jubilee celebration served as a vibrant platform for dialogue, interactive sessions and panel discussions featuring agencies such as DAAD, DFG, and Mega Science exploring the achievements of the past while mapping the pathways for future cooperation, underscoring the adaptability and foresight which keeps the Indo-German S&T cooperation at the forefront in the global research landscape. More than a celebration, the event rekindled the oath that Indo-German S&T partnership shall continue to sculpt the future of global research with steadfast commitment, seamless synergy and unwavering dedications.

Indo-German Science & Technology Centre (IGSTC)

Established in 2010 through an intergovernmental agreement between DST, Government of India and BMBF, Government of Germany, Indo-German Science & Technology Centre (IGSTC) was envisioned as a distinct bilateral platform to foster collaborative research, technology advancement and industrial innovation for the larger benefit of the society. IGSTC is mandated to promote Public-Private Partnerships (PPP) to nurture basic and applied cutting-edge research in frontier domains, capacity building, networking among early and mid-career researchers, institutions, and industries, thus redefining the landscape of partnership and technological cooperation through strategic programmes and initiatives targeting specific stakeholders. Unlike conventional funding agencies, IGSTC's vision transcends far beyond providing support to the research endeavours – it aims to culminate an inclusive and resilient ecosystem where scientific ingenuity seamlessly aligns with industrial aspirations, creating innovations with a profound societal impact.

The centre enkindles research areas of mutual priority such as sustainability, biotechnology, material science, artificial intelligence, advanced manufacturing, agritech – reflecting the ethos that S&T must not only push the boundaries but also work towards creating roadmaps for long term sustainable development. In addition, IGSTC is also committed to explore new avenues to connect more and more scientists, researchers and innovators to engage and create a common reservoir for knowledge sharing and achieving technological excellence. By leveraging the diplomatic channels through dedicated science counsellors of the embassy of both the nations as well as partnerships with sister organisations, the Centre has amplified awareness and widened access to opportunities, strengthening Indo-German collaboration across multiple dimensions. Over the years, IGSTC has emerged as a dynamic facilitator of more than just research collaborations—it has grown into a dynamic space where ideas steadily transform into innovations, concepts crystalises to a technology, and science becomes the universal language of long-standing partnership. Marking a new chapter, the Centre entered its second phase in 2016 through a joint declaration extending its mandate beyond 2022 with enhanced funding of eight million euros. Further strengthened by an additional five-year extension until 2027, IGSTC continues to stand as a stellar example of Indo-German scientific synergy, forging a future where research and innovation drive sustainable growth and value addition to the humanity.

Impact of IGSTC on strengthening Indo-German S&T Partnership

IGSTC has cultivated a comprehensive and an inclusive support ecosystem targeting researchers at various stages of their professional journey. The program portfolio is elegantly structured into three distinctive pillars. i.e., bilateral R&D&I projects, networking workshops and fellowships designed for capacity building and unlocking new pathways of collaborations.

In 2010, IGSTC introduced its flagship program "2+2 projects", stands out a hallmark program, inviting research proposals from a bilateral consortium (2+2 mode of partnership) to catalyse innovation centric industry driven R&D&I projects by synergising the strength of research/academic institution and public/private industry from India and Germany. The consortium exhibits the presence of minimum four partners comprising one academic/research and one industry from each country. Starting at Technology Readiness Level (TRL)~ 3, 2+2 projects aim to provide insights and exploitable industry relevant research outcomes leading to new technologies, products, processes, patents and/or services at the end of its three years duration. IGSTC announces the annual call for 2+2 projects on thematic areas considering the national level research priorities decided by Inter-Governmental Consultations. Since inception, IGSTC has supported 61 such innovative R&D&I projects on several thematic areas including Advanced & Additive manufacturing, ICT and embedded systems, Sustainable energy/environment, Water and wastewater technology, Sustainable production, Smart Cities, Waste to wealth, Bio-Medical technology, Sustainable packaging, Bioeconomy, Artificial Intelligence and this number is still increasing every year. More than 300 research institutions, academia and small/large scale industries got associated through this initiative across the wide demographic distribution in both India & Germany. Several projects out of these have generated tangible outcomes in terms of pilot plants or market ready technology and working prototype development. IGSTC also supports for additional two years as Phase-II for project showing promising results of having market potential to cover the gap between the research phase (TRL 5/6) and the pilot industrial implementation phase (TRL 7 to 9).

IGSTC Women Involvement in Science & Engineering Research (WISER) is yet another pioneering initiative specially crafted to build scientific capacity, retain and promote women researchers with no age barrier in India and Germany by utilising complementary expertise in science, technology, innovation and research partnerships. It also enhances the representation and progression of women researchers in STEM as well as create avenues for networking, interaction and long-term research collaboration. Through WISER, women scientists receive opportunities to visit the partnering country during the project tenure of three years. Designed as a catalyst for gender inclusivity in bilateral research collaborations, WISER provides a unique platform that enables talented women scientists and researchers to lead joint bilateral projects, bridging academic excellence with industrial relevance, thus, fostering a gender neutral diversity driven innovation ecosystem.

IGSTC Open Call for Indo-German Bilateral Workshops serves as a vibrant platform to ignite dialogues, nurture knowledge exchange and harvest enduring research networking between India & Germany. The support for organising the workshop acts as an incubator for ideas by bringing together expert researchers, eminent scientists, industry innovators, policymakers of both the nations for exploring frontier areas of STEM. By promoting cross disciplinary discussions and identifying complimentary expertise, the workshop creates a fertile ground for generating path- breaking ideas which could later transform into a successful 2+2 collaboration. The funding support for two to three-day workshop allows the students and early career researchers to gain exposure on recent progress and achievements in the topic while building long term network with leaders in the field, thus, establishing a robust foundation for their upcoming research careers.

IGSTC industrial fellowship is designed to encourage PhD students and postdoc researchers in S&T with an appreciable track record and aptitude for applied research and technology development. It offers a unique opportunity for these emerging innovators to dip dive themselves in the vibrant industrial ecosystem in Germany, accumulating invaluable hands-on experience and exposure to advanced technologies and industry practices. Through this cross-border mobility, IGSTC industrial fellowship intends to bridge the gap between lab-based innovation and industrial implementation, technology transfer and commercialisation. In addition, the programme creates avenues for capacity building in applied research by successfully establishing network with industries, thus shaping the new generation researchers who could translate scientific endeavours to address real-world challenges.

To ensure a balanced exchange of brilliant minds from both the countries, IGSTC launched the Paired Early Career Fellowship in Applied Research (PECFAR). Anchored in the spirit of bilateral collaboration, PECFAR creates a dynamic platform for cross fertilisation of ideas and scientific as well as cultural exchange by the early career researchers below 40 years of both India and Germany. The fellowship enables a pair of researchers to visit their host institution/industries to experience the work protocols, research methodologies and professional ethics affecting their future research trajectory. The networking through PECFAR thus strengthens long standing cooperations not only between researchers but also between partnering organisations of both nations.

Moreover, IGSTC Small Immediate Need Grants (SING) is being crafted to respond to emerging research and innovation opportunities in least turnaround time. Under SING initiatives, IGSTC supports proposals that require modest funding and has the potential to embark on good bilateral Indo-German collaboration. Targeting objective specific and time-sensitive approaches, SING acts as a catalysing agent for joint initiatives/ideas that have a scope to ignite and open avenues for long term connect/technology development/new areas of collaboration, joint activity towards innovation, rapid prototyping, technology demonstration or industrial R&D, proposals that have a high potential of involving industrial sectors or even for utilizing scientific events to share intellectual thoughts/ideas that can explore avenues for bilateral cooperation. By facilitating quick support in the focused objectives, IGSTC reinforces its commitment towards result-oriented bilateral cooperation to build a resilient S&T ecosystem.

In conclusion, Indo-German partnership in S&T cooperation has become a legendary example on how shared vision and scientific pursuit could achieve excellence and reshape the legacy of cooperation for the betterment of future and a sustainable world. Over decades, such an alliance has evolved from a small initiative to multi-dimensional collaboration engaging research, industry and government to address global needs. IGSTC, the latest feather in the crown has further strengthened this vision with its landmark programmes including 2+2 projects, women empowerment through WISER, several fellowships for knowledge exchange and also agile enabler like SING for innovators from early to mature stages. The successful celebration of Golden Jubilee celebration of Indo-German partnerships reaffirmed not just the achievement and success stories of the past, but it also paved a more comprehensive roadmap for the sustainable future with newer innovations and ready to use technological solutions.

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PERSPECTIVE

BRICS Nations: Beyond Solar Energy Leadership, Tackling Waste Management Challenges

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Introduction

In current times, the world is continuously changing and nations have to show economic, social, and institutional resilience to overcome global uncertainties, supply chain disruptions, health challenges, and climate risks.The BRICS ensure political and security cooperation, economic and financial cooperation, and people-to-people exchanges amongst its countries. Various global issues, i.e., terrorism, climate change, food and energy security, the international economic and financial situation, telecommunications, agriculture, labour and employment, international financial architecture, trade, and the WTO are the cornerstones of BRICS discussions. India is chairing the BRICS in 2026 whose guiding theme is "Building for Resilience, Innovation, Cooperation and Sustainability", reflecting a people-centric and humanity-first approach. It further aims to accelerate collective efforts toward climate action, green finance, energy transitions, and sustainable development aligned with national and global priorities.

BRICS and Solar Energy

The global installed solar PV capacity is projected to reach 4,500 GW by 2050 (IRENA, 2025) to ensure energy transition towards renewable energy. Among the highest cumulative deployment rates expected by 2050, China is set to lead with 1,731 GW, followed by India and the United States, each reaching 600 GW. Japan and Germany are projected to achieve 350 GW and 110 GW, respectively.[1]

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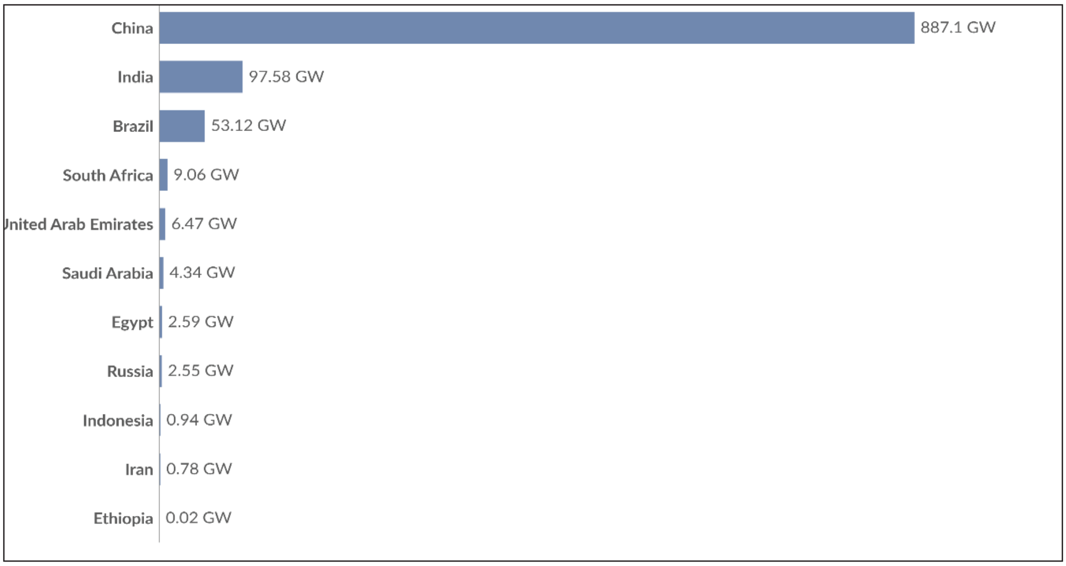
Global cumulative installed solar energy capacity in 2024 was 1866.31 GW and BRICS member nations account for 57 percent (1064.55 GW) of the total Installed Solar Energy Capacity, which includes solar photovoltaic and concentrated solar power. China is leading the solar capacity (887.1GW) with unmatched scale in manufacturing and deployment of Solar PV followed by India (97.58 GW), which is expanding its solar PV capacity continuously with conducive policies. Brazil is emerging as a leader in Latin America (53.12 GW) leveraging its abundant solar resources and strong distribution generation programs. BRICS nations hold a major share of solar PV, which is shaping the current energy transition and is going to play a pivotal role in achieving Net Zero targets.

The growing solar PV installations will also result in an increase in waste accumulation as Solar PV panels have a lifespan of around 18-25 years.[3] Accumulation of PV waste is shaped by several critical factors, including module service life, geographical distribution of past and future installations, and advancements in material composition within PV technology. Global PV waste is expected to increase from 43,500–250,000 metric tons (t) in 2016 to over 70 million tons by 2050.[4] Between 2025 and 2050, the United States is projected to generate 24.93 million tonnes of photovoltaic (PV) waste, while the European Union is expected to produce 36.23 million tonnes.[5] The field of waste management and end-of-life considerations for solar panels is gaining momentum (Oteng et al., 2021). BRICS nations with high solar energy installation along with their Solar PV waste management strategies and policies, have been analyzed in the section below:

Figure1: Cumulative Installed Solar Energy Capacity of BRICS member countries in GW (2024)



Source: IRENA (2025)[2]

China

China is projected to generate 134 million metric tons (Mt) of waste PV panels under the early loss scenario and 72 Mt under the regular loss scenario by 2050 (Song et al., 2023).In February 2009, the State Council introduced the Waste Electrical and Electronic Product Recycling Management Regulation, which came into effect in January 2011 (State Council of the People's Republic of China, 2011). This regulation mandates the collection and centralized recycling of e-waste through various mechanisms. Producers can handle collection and recycling independently or delegate these tasks to sellers, after-sales service providers, or e-waste recyclers, with disposal entrusted to qualified institutions. However, as of now, photovoltaic (PV) panels are not included in the regulation's waste electrical and electronic products processing directory.

India

Solar PV waste is projected to be up to 6.64 million tonnes due to the early loss scenario and 5.48 million tonnes due to the regular loss scenario. Whereas, in the ambitious scenario, the amount of waste estimated to be 10.30 million tonnes due to the early loss scenario and 8.51 million tonnes due to the regular loss scenario by the end of 2040 in India.[6] In India, solar waste is categorised as general electronic waste under the Ministry of Environment, Forest and Climate Change (MoEF&CC). However, solar PVs are not explicitly recognized as a distinct waste stream in the E-waste (Management and Handling) Rules, 2011 or the Municipal Solid Waste Management Rules (SWM), 2016. However, the E-Waste (Management) Rules, 2022, notified by the Ministry of Environment, Forest and Climate Change (MoEF&CC) on November 2, 2022, now include provisions for managing solar PV modules, panels, and cells.

Brazil

According to the National Energy Plan 2050 (PNE), Brazil will reach between 27 and 90 GW of installed PV generation capacity by 2050 (5 per cent–16 per cent of the total installed capacity in Brazil), depending on restrictions, for centralised generation alone, i.e., not considering residential or commercial installations (EPE, 2020b). Brazil could reach an installed capacity of 192 GW by 2040, leading to the generation of approximately 12.9 million tons of photovoltaic waste.

Brazil recently started regulating PV systems via National Electric Energy Agency (ANEEL) Normative Resolution 482 from April 17, 2012 (Brazil, 2012), which may explain the insignificant quantities of reported PV waste products. Likely, most manufacturers, importers, the public, and regulatory authorities lack immediate concern for this issue since the average lifespan of these systems is 25 years. In terms of regulation, Brazil has adopted an approach similar to the European Union's Directive 2012/19, by classifying PV systems under the broader category of electronic waste (e-waste) rather than creating a dedicated legal framework for PV waste. The country's current focus is on building recycling infrastructure and management systems to prepare for the significant waste streams expected in the coming decades.[7, 8]

South Africa

South Africa's demand for solar PV systems has surged, driving imports of solar modules to record levels. In 2023, imports reached US$947 million which shows a 213per cent increase compared to 2022. The country does not manufacture PV modules domestically, though a few local assemblers operate using imported components. There are no upstream producers of polysilicon, ingots, wafers, or solar cells. To support local assemblers, an import duty was introduced in 2024. By value, 90 per cent of South Africa's PV modules in 2023 came from China, which dominates global production with 80 per cent of PV modules manufactured across all stages.

Looking ahead, PV waste is expected to rise sharply. Estimates suggest cumulative PV waste could reach 8,500–80,000 tonnes by 2030, and between 750,000 and 1 million tonnes by 2050, depending on regular or early-loss scenarios.

South Africa is well positioned to address this challenge through its circular economy framework. The country has strong legislation guiding end-of-life (EOL) management, with e-waste regulations identified as a key driver. Since November 2021, producersincluding manufacturers, importers, distributors, and refurbishersmust participate in Extended Producer Responsibility (EPR) programmes via Producer Responsibility Organisations (PROs), under the National Environmental Management: Waste Act (2008).

Importantly, landfilling of e-waste, including PV modules, has been banned since 2021. E-waste is classified as hazardous, requiring treatment within 18 months of generation. Storage is restricted to 80 m^3 on-site, unless an environmental impact assessment and waste management licence are obtained.[9]

UAE

United Arab Emirates will face a sharp increase in solar panel waste over the next three decades. By 2030, waste volumes are projected to reach 3,000–9,000 tonnes, rising dramatically to 350,000–1,000,000 tonnes by 2050. This would represent about 1.3 per cent of global solar panel waste (IRENA & IEA-PVPS, 2016).

Saudi Arabia has taken a proactive stance by introducing its landmark Waste Management Law on 15 September 2021. The legislation regulates the handling, separation, transport, storage, import, and export of waste, and requires organizations to adopt safe disposal and recycling practices using environmentally friendly methods, as outlined in Articles 11, 14, 16, 18, and 19. The management of end-of-life (EOL) solar PV panels in Saudi Arabia is still in its early stages, but the government is actively developing new standards and building a comprehensive national e-waste management system. This reflects the country's growing commitment to renewable energy and its recognition of the challenges posed by PV waste.[10]

Conclusion

The accelerating accumulation of photovoltaic (PV) waste highlights the multifaceted challenges of achieving a truly sustainable energy transition that extends beyond the deployment of clean technologies to encompass responsible end-of-life management. Current research in this domain spans regulatory analysis, technological innovation, economic evaluation, and environmental sciences. Scholars are prioritising several objectives, including the examination of legislative frameworks such as the European Union's Waste Electrical and Electronic Equipment (WEEE) Directive and Extended Producer Responsibility (EPR) models; the advancement of recycling and repurposing technologies; the implementation of comprehensive lifecycle assessments to evaluate the environmental impacts of PV waste; and the development of forecasting models to anticipate future waste flows and their regional distribution.[11]

Countries such as the United States, Japan, the European Union, and Korea have initiated regulatory frameworks to address solar PV waste management. Nevertheless, the establishment of innovative economic pathways remains essential to strengthen the market viability of recovered materials. Such pathways not only underpin the transition toward a circular economy but also contribute to broader objectives of sustained economic growth and enhanced environmental stewardship. BRICS nations need to gear up to manage their Solar PV waste sustainably and the technology for recycling Solar PV waste should evolve and be shared with each other.

Enhancing PV recycling capacity and advancing technology are essential to meet the growing demand for solar energy and achieve the goal of high-value, low-cost recycling. To strengthen the economic viability of PV module recycling, it is also important to account for the value of recovered materials, particularly critical minerals. Moreover, it is noted that a significant gap exists in standardised recycling practices and regulatory policies, highlighting the urgent need for harmonised frameworks to ensure sustainable management of solar PV waste.[12]

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REPORT

Asia - Europe Training on Science and Technology Diplomacy: Strengthening Cross-Regional Cooperation in an Era of Technological Geopolitics

Radhika Trikha*

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Introduction

Science diplomacy has evolved dramatically over the past decades. During the Cold War, scientific collaboration often functioned as a quiet bridge between politically divided nations. Scientific exchanges and joint research initiatives provided neutral channels of communication even in times of tension.[1]

In Europe, science diplomacy gradually became institutionalised through supranational frameworks such as the European Union's research and innovation programmes. Europe positioned itself as a regulatory and normative leader, embedding ethics, human rights, and precautionary principles into technology governance. The European Union's Artificial Intelligence Act[2] is one such example illustrating how regulation itself can become an instrument of diplomatic influence.

Asia, by contrast, has experienced science diplomacy through the lens of rapid innovation, economic transformation, and technological scale. From digital public infrastructure models to climate adaptation technologies, many Asian countries have leveraged science as a development multiplier. Science diplomacy in Asia frequently emphasises capacity building, technology transfer, and South–South cooperation.

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What makes the Asia Europe dialogue particularly significant is the convergence of these two approaches: Europe's governance depth and Asia's deployment agility. The 2025 training programme captured this intersection powerfully. In this context, the Asia Europe Training and Youth Summit on Science and Technology Diplomacy 2025, organised by the Asia Europe Foundation (ASEF),[3] was designed to strengthen cross-regional dialogue and build capacity among emerging science diplomacy leaders. Conducted between 23 October and 4 December 2025, the programme combined conceptual instruction, policy analysis, simulation exercises, and collaborative workshops to equip participants with practical tools for navigating the science, policy and diplomacy interface. This report outlines the programme's structure and contributions, particularly from the perspective of institutional leadership in innovation ecosystems.

Conceptual Foundations: Science Diplomacy in Practice

Science diplomacy is commonly understood through three interrelated dimensions:[4]

1. **Science in Diplomacy:** Using scientific expertise to inform foreign policy decisions.
2. **Diplomacy for Science:** Facilitating international scientific collaboration.
3. **Science for Diplomacy:** Leveraging scientific cooperation to strengthen international relations.

The programme situated these frameworks within contemporary geopolitical realities, including technological competition, digital sovereignty debates, global climate commitments, and AI governance negotiations. Importantly, the training emphasised that science diplomacy today operates at multiple levels: multilateral institutions, bilateral partnerships, regional blocs, research consortia, and innovation ecosystems. This layered understanding aligns with the increasing institutionalisation of science policy in national innovation systems. The fragmentation of global order is visible in digital sovereignty debates, AI governance competition, and supply chain nationalism has heightened the stakes of science diplomacy.

Consider the following realities:

- Artificial intelligence is shaping public policy and security frameworks.
- Climate transitions require coordinated research, financing, and technology diffusion.
- Data governance decisions influence trade, privacy, and democratic resilience.
- Biosecurity and pandemic preparedness demand cross-border transparency.

None of these challenges can be addressed by a single nation.

Programme Structure and Pedagogical Design

The programme brought together 100+ participants from 41 countries, chosen from more than 2000 applicants. Science diplomacy cannot be confined to laboratories or foreign ministries alone. It thrives where research governance, innovation ecosystems, and diplomatic practice intersect. The programme was designed as a seven-week online interactive training, structured to provide engaging and practical learning experiences. Rather than traditional lectures, it featured webinars and hands-on workshops that emphasised skill-building, dialogue, and cross-regional collaboration. The programme featured speakers and contributors from leading global institutions,[5] including:

- UNESCO Mahatma Gandhi Institute of Education for Peace and Sustainable Development
- Chinese Academy of Sciences
- United Nations University
- Agency for Science, Technology and Research (A*STAR)
- German Aerospace Center (DLR)
- Department of Science and Technology (DOST Philippines)
- International Science Council
- Geneva Science and Diplomacy Anticipator (GESDA)
- The Arctic University of Norway
- Maria Curie-Skłodowska University
- United Kingdom Science and Technology Network

This cross-continental expertise provided comparative insights across governance systems, research infrastructures, and diplomatic models.

The Asia Europe Training 2025 adopted a blended and interactive format rather than a purely lecture-based model. Its key components included:

1. ***Expert Lectures and Policy Dialogues***

Sessions featured practitioners and scholars addressing:

- Global AI governance and regulatory frameworks
- Climate diplomacy and sustainability transitions
- Data governance and digital sovereignty
- Research security and technology transfer
- Innovation ecosystems and multilateral cooperation

These discussions were framed within Asia-Europe comparative perspectives, encouraging participants to examine regulatory convergence and divergence. For someone deeply involved in innovation ecosystems and technology commercialization, these simulations were transformative. They sharpened my understanding of how policy narratives influence negotiation outcomes.

2. ***Negotiation Simulations***

Participants engaged in structured simulations representing states negotiating technology-sharing agreements, data governance protocols, and collaborative research frameworks. These exercises revealed practical tensions between:

- Open science and strategic autonomy
- Intellectual property protection and knowledge diffusion
- National security and global cooperation

Such experiential learning sharpened diplomatic reasoning and policy framing skills.

3. ***Policy Laboratories***

Working groups developed policy briefs on emerging technology governance challenges. These exercises required:

- Evidence-based drafting
- Stakeholder mapping
- Risk assessment
- Implementation planning

The iterative feedback process strengthened analytical rigour and strategic communication. In collaborative teams, participants drafted policy briefs on AI governance cooperation, climate technology financing, and digital public infrastructure interoperability. The exercise reinforced that science diplomacy is not abstract, it is operational.

4. *Youth Summit Engagement*

The Youth Summit component broadened generational dialogue on equity, inclusion, and sustainable innovation governance. The inclusion of youth voices underscored the long-term dimensions of science diplomacy capacity building.

One of the most innovative aspects of the programme was ASEF's collaboration with Geneva Science and Diplomacy Anticipator (GESDA) to adapt the GESDA Quantum Diplomacy Game for an online setting, the first time this interactive foresight tool was facilitated virtually. The exercise simulated how quantum technologies could disrupt geopolitical balances and required participants to negotiate governance responses under uncertainty. It underscored a core principle: diplomacy must anticipate technological disruption before crises emerge. For leaders working in AI and cyber-physical systems, anticipatory diplomacy is not theoretical, it is operational foresight.

Thematic Scope and Relevance

The breadth of topics addressed during the programme reflected contemporary global priorities:

- Artificial Intelligence governance and ethics
- Climate change mitigation and green technology cooperation
- Cybersecurity and digital infrastructure resilience
- Open science and research collaboration
- Technology-driven development models
- Ethical deployment of emerging technologies

Particularly significant was the discussion on AI governance. As multiple jurisdictions develop regulatory models, including the European Union's AI Act[3] and emerging frameworks in Asia, the need for cross-regional dialogue is evident. The programme highlighted the risks of regulatory fragmentation and the importance of interoperable standards.

Institutional Impact

As an institutional representative of IIT Ropar Technology and Innovation Foundation (iHub AWaDH), operating under India's National Mission on Interdisciplinary Cyber-Physical Systems (NM-ICPS) of the Department of Science and Technology, Government of India, participation in the programme yielded several tangible professional advancements.

- Framing International Collaboration Strategically: The programme reinforced that international partnerships must align with national innovation priorities and global governance norms. Science diplomacy is not symbolic; it is structural.
- Governance Literacy in Emerging Technologies: Discussions on AI ethics, data governance,

anticipatory regulation, and cross-border research security provided a comparative understanding crucial for institutions operating in frontier technology domains.

- Cross-Cultural Competence: The deliberate focus on understanding personal and cultural lenses enriched negotiation sensitivity. Science diplomacy demands empathy as much as expertise.
- Building Asia–Europe Networks: The most enduring outcome may well be the network of 107 professionals across 41 countries. Such connections are the backbone of sustainable science diplomacy.

Asia Europe Synergy and Multilateral Implications

The Asia Europe framework created a platform for comparative learning:

- European participants contributed regulatory sophistication and institutionalised governance models.
- Asian participants offered deployment scale, innovation dynamism, and public digital infrastructure experiences.

The convergence of these perspectives highlighted opportunities for:

- Joint regulatory sandboxes
- Standard-setting collaboration
- Climate innovation funding partnerships
- Ethical AI dialogues

The programme demonstrated that science diplomacy must balance openness with strategic autonomy. The programe reaffirmed that science diplomacy is central to addressing global challenges such as Climate change, pandemic preparedness, AI governance, cybersecurity threats and sustainable development transitions. As technological advancements increasingly influence geopolitical alignments, the capacity to integrate scientific expertise into diplomatic processes becomes indispensable. For India, with its expanding digital ecosystem and global technology partnerships, science diplomacy offers a pathway to:

- Shape international norms
- Strengthen South–South cooperation
- Enhance multilateral engagement
- Promote responsible innovation

Conclusion

The Asia Europe Training and Youth Summit on Science and Technology Diplomacy 2025 represented a significant capacity-building initiative in an era defined by technological geopolitics. By integrating theory with practice, dialogue with simulation, and regional diversity with shared purpose, the programme strengthened participants' ability to operate at the intersection of science, technology, and diplomacy. For institutional leaders and science policy researchers, such engagements are not peripheral they are foundational to shaping responsible, collaborative, and globally informed innovation ecosystems. The programme concluded successfully, but its impact continues through the networks formed, the insights gained, and the commitments reinforced toward evidence-based and cooperative science governance.

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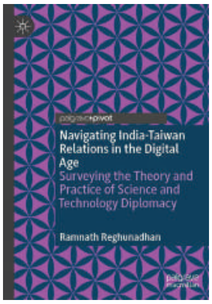
Navigating India-Taiwan Relations in the Digital Age: Surveying the Theory and Practice of Science and Technology Diplomacy



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In an era where digital technologies, scientific innovation and technological partnerships increasingly influence international relations, Navigating India-Taiwan Relations in the Digital Age: Surveying the Theory and Practice of Science and Technology Diplomacy by Ramnath Reghunadhan provides a timely and valuable contribution to the study of diplomacy and international relations. Published by Palgrave Macmillan, the book examines the growing relationship between India and Taiwan through the lens of Science and Technology (S&T) Diplomacy, highlighting how technological cooperation has emerged as an important part of foreign policy.

The book is particularly relevant at a time when countries are seeking new partnerships in critical sectors such as semiconductors, digital technologies, healthcare, renewable energy and telecommunications. By focusing on India and Taiwan - two countries whose relationship has expanded significantly in recent years, the author provides a new perspective on how science and technology can

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strengthen diplomatic engagement and contribute to mutual development.

One of the major strengths of the book is its ability to combine theoretical discussion with practical examples. Rather than treating diplomacy solely as a matter of political negotiations, Reghunadhan explains how scientific cooperation, technological innovation, research and knowledge exchange have become important tools for building international relationships.

The first chapter, Introduction, lays the foundation by introducing the concept of science and technology diplomacy and explaining its growing significance in international relations. The author outlines the objectives of the book and explains why India-Taiwan relations deserve closer attention. The chapter also highlights the broader geopolitical context shaping these relations, particularly the increasing importance of technology in shaping global power dynamics.

The second chapter, India-Taiwan Relations: Exploring Science and Technology Diplomacy as a Tool for Foreign Policy in the Twenty-first Century, explores the bilateral relations between India and Taiwan. The author explains how the relationship has gradually expanded beyond economic and trade interactions to include cooperation in science, technology, innovation, education and research. The chapter highlights the role of science and technology diplomacy as an effective foreign policy instrument. This discussion is particularly important because India and Taiwan do not maintain formal diplomatic relations, yet they continue to deepen engagement through practical cooperation in various sectors.

The third chapter, Science and Technology Diplomacy for India-Taiwan Relations in the Twenty-first Century: Case Studies, is among the most interesting sections of the book. Through a number of case studies, the author illustrates how scientific and technological cooperation functions in practice. The chapter discusses examples of collaboration in research, innovation, higher education, healthcare and technological development. These case studies help readers understand the benefits of bilateral cooperation and how science and technology can serve as a bridge between nations.

The fourth chapter, Taiwan's Role in the Global 5G Technology Landscape in the Indo-Pacific Region: Adoption, Competition and Diplomacy, focuses on Taiwan's growing importance in the global technology ecosystem. This chapter is particularly relevant given the increasing international competition surrounding advanced technologies and digital infrastructure. The author explains Taiwan's strengths in semiconductor manufacturing, electronics and 5G-related technologies. The discussion also explores how technological competition is reshaping regional geopolitics and influencing relationships among countries in the Indo-Pacific region. For India, which is actively seeking to strengthen its technological capabilities and reduce dependence on external sources for critical technologies, Taiwan emerges as a valuable partner.

The concluding chapter, Policy Recommendations, brings together the key findings and suggestions for strengthening India-Taiwan cooperation. Both sides can benefit from expanding collaboration in areas such as semiconductor, digital innovation, scientific research, education, renewable energy and healthcare. The recommendations are realistic and policy-oriented, reflecting the book's emphasis on practical engagement rather than purely theoretical debate. This chapter is especially of interest to policymakers and stakeholders seeking ways to deepen bilateral cooperation in the coming years.

Another notable aspect of the book is its discussion of health diplomacy and scientific collaboration in addressing common challenges. The experiences of the COVID-19 pandemic established the importance of international cooperation in public health, research and technology exchange. The author highlights how scientific partnerships can contribute not only to technological advancement but also to trust-building and stronger international relationships. This perspective broadens the understanding of diplomacy and shows how science can play a constructive role in addressing common global challenges.

Overall, Navigating India-Taiwan Relations in the Digital Age is a thoughtful, well-researched, and timely contribution to the growing literature on science and technology diplomacy. The book successfully highlights how scientific collaboration, technological partnerships and innovation-driven cooperation are becoming increasingly important in international relations. By explaining these developments through the case of India and Taiwan, Ramnath Reghunadhan provides valuable insights into the changing nature of diplomacy in the digital age.

The book will be of interest to readers engaged in international relations and science diplomacy, as well as policymakers, diplomats and researchers working on Indo-Pacific affairs. More importantly, it encourages readers to think beyond traditional diplomatic frameworks and to recognize the growing role of science and technology in shaping the future of international cooperation. As countries continue to navigate a rapidly changing technological landscape, the themes explored in this book are likely to become even more relevant in the years ahead.

Guidelines for Authors

1. Submissions should contain institutional affiliation and contact details of author(s), including email address, contact number, etc. Manuscripts should be prepared in MS-Word version, using double spacing. The text of manuscripts, particularly full length papers and essays may range between 4,000- 4,500 words. Whereas, book reviews/event report shall range between 1,000-15,00 words.

2. In-text referencing should be embedded in the anthropological style, for example '(Hirschman, 1961)' or '(Lakshman 1989:125)' (Note: Page numbers in the text are necessary only if the cited portion is a direct quote). Footnotes are required, as per the discussions in the paper/paper.

3. Use's' in '-ise' '-isation' words; e.g., 'civilise', 'organisation'. Use British spellings rather than American spellings. Thus, 'labour' not 'labor'. Use figures (rather than word) for quantities and exact measurements including per centages (2 per cent, 3 km, 36 years old, etc.). In general descriptions, numbers below 10 should be spelt out in words. Use fuller forms for numbers and dates— for example 1980-88, pp. 200-202 and pp. 178-84. Specific dates should be cited in the form June 2, 2004. Decades and centuries may be spelt out, for example 'the eighties', 'the twentieth century', etc.

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About FISD

As part of its ongoing research studies on Science &Technology and Innovation (STI), RIS together with the National Institute of Advanced Studies (NIAS), Bengaluru implemented a major project on Science Diplomacy, supported by the Department of Science and Technology. The programme was launched on 7 May 2018 at New Delhi. The Forum for Indian Science Diplomacy (FISD), under the RIS–NIAS Science Diplomacy Programme, envisages harnessing science diplomacy in areas of critical importance for national development and S&T cooperation.

The key objective of the FISD is to realise the potential of Science Diplomacy by various means, including Capacity building in science diplomacy, developing networks and Science diplomacy for strategic thinking. It aims to leverage the strengths and expertise of Indian Diaspora working in the field of S&T to help the nation meet its agenda in some select S&T sectors.

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