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EDITORIAL

This issue is being published at a time when the COVID-19 pandemic continues to rage, fuelled by the more infectious delta variant and other emerging variants such as kappa, lambda, iota, mu, and zeta. The vaccination rates in developing countries, especially in Africa, remain very low, compounded by lack of vaccine supplies and difficulties in administering the vaccines. Even in advanced countries such as the US, there is a substantial population that has not been vaccinated fully. The spread of the virus among a mixed group of vaccinated and unvaccinated persons poses a great risk to global health with the emergence of new variants that can resist existing vaccines. The requirement of a third booster vaccination shot being advocated in some advanced countries will further complicate the availability of vaccines for the unvaccinated. All this re-emphasizes the importance of basic measures such as masking, social distancing, testing, and hygiene while moving ahead more rapidly towards universal vaccination. The recent decision by India to ramp up vaccine production and resume exports is therefore most welcome.

The bright side has been the unprecedented and rapid application of science and technology and international collaboration in developing and producing vaccines, diagnostics, and therapeutics. Vaccine development, production, and deployment have taken place at an unprecedented speed that goes far beyond the present capability of regulatory systems led by the World Health Organization. The WHO has not been able to speed up processes even for emergency use authorizations for many vaccines in the pipeline, despite urgent global requirements, while national regulatory authorities have been more proactive. However, there is considerable avoidable confusion over the recognition of vaccination certificates for international travel, which needs to be cleared.

Another grand challenge facing us today is global climate change. The summer of 2021 has witnessed record heat waves across the planet causing forest fires that further degrade the green cover. While the average global temperature rise is 1.1 degrees C above pre-industrial times, the distribution of warming is also critical. The polar regions are warming at 2 to 4 times the average rate, melting away ice caps and permafrost, and thereby releasing methane, a potent greenhouse gas. The operation of positive feedback loops in the global climate system can lead to runaway effects and permanent changes. The Intergovernmental Panel on Climate Change (IPCC) report adopted recently on this topic has caused much alarm among civil society, which is likely to demand effective action by governments at the UN Climate Change Conference in Glasgow later this year. The S&T community must mobilize urgently to tackle renewable energy production and storage; carbon capture, use, and sequestration (CCUS), and create better global and regional climate modeling to predict and deal with climate changes. International S&T cooperation and science diplomacy are integral to tackling the ongoing COVID-19 and global climate change.

We are glad to present in this issue the article on the International Solar Alliance (ISA) initiative led by France and India, which has grown from its seeding into a sturdy tree with membership now opened up to all UN members. It meets both the needs of climate change mitigation, as well as depleting fossil fuel resources which are ultimately derived from the sun's energy. Both hydro and wind energy are also a manifestation of solar energy. The second article focuses on ocean change and the importance of water diplomacy. The author views water diplomacy as a subset of science diplomacy. The article underlines that science diplomacy can play a key role in tackling water use and preservation, and enable reaching agreements among nations in conflict.

In the perspectives section, we bring the article on the possibilities for science diplomacy in shaping international relations of smaller countries like Greece, which could be relevant to many other countries. The second perspective article shares insights on India's efforts in making available vaccines for COVID-19 for all. The last one eloquently argues for strengthening science diplomacy in Bangladesh, especially to achieve the SDGs. Much of this is relevant and applicable to other developing countries.

Under the events section, we present a review of a policy dialogue organized on the theme 'Opportunities, Challenges, and Policy Imperatives in COVID Era'. The issue also includes reviews of two books titled "Science and Diplomacy: Negotiating Essential Alliances" and "Midnight's Machines: A Political History of Technology in India". A report on Global Health Diplomacy by the Graduate Institute Geneva and Global Health Center is also reviewed. This is followed by a broad overview of the work of the International Institute for Applied Systems Analysis (IIASA). We also have a commentary piece on the experience and relevance of digital infrastructure developed in India for COVID-19 and the need for its further extension and deepening.

We hope our stakeholders will find the issue interesting and relevant. Your comments and suggestions on this issue and the Science Diplomacy Review are welcomed.

ARTICLE

Channeling the Sun: Ideas, Institutions and India's New Climate Diplomacy

Vyoma Jha*

Vyoma Jha

Introduction

On the first day of the 2015 Paris Climate Conference (COP-21), India and France jointly launched the International Solar Alliance (ISA) to boost solar energy for developing countries (UNFCCC, 2015a). An alliance of 120 countries came together to support the Paris Declaration based on a shared understanding that developing countries need technology, capacity building, and public finance to take solar energy to scale (UNFCCC, 2015b). A day before the launch, the Indian Prime Minister, Narendra Modi wrote an op-ed in the Financial Times urging the rich to take greater responsibility for climate change and reiterating that 'India will do its part for success in Paris' (Modi, 2015a). He went on to explain the decision to launch the ISA in these words:

> We are sharing our modest resources with the developing world, helping small island states and African nations with renewable energy. … We should meet our need for clean energy and healthy habitats in a spirit of partnership, not put nations on different sides. India will work with governments, laboratories, and industry to facilitate a natural transition to a clean energy era through affordable and accessible renewable energy.

The ISA was conceived by India as a coalition of 'solar rich' countries to address their energy needs and aims to provide a platform to collaborate on addressing the identified gaps

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in solar deployment (ISA, 2015). The 'solar rich' or prospective ISA member countries were identified as those located between the 'Tropic of Cancer' and the 'Tropic of Capricorn', i.e. countries geographically located for optimal absorption of the sun's rays. Crucially, most of these countries are developing countries with poor or no energy access, and the underlying motivation for the ISA stemmed from the lack of any specific international body to address the solar deployment needs of such countries.

By late 2016, a little less than a year after the initial announcement, the Ministry of External Affairs (MEA) of the Government of India – India's foreign ministry – opened the Framework Agreement on the establishment of the International Solar Alliance for ratification (hereinafter called the Framework Agreement). On 6 December 2017, the ISA formally entered into force and acquired the status of a treaty-based international organization. In a year that witnessed multilateral climate negotiations weakening – particularly with the withdrawal of the United States from the 2015 Paris Agreement, the end was marked by a new India-led treaty-based international organization becoming a legal entity. The ISA was the first instance of a treaty-making process being led by India, and it witnessed a rather quick ratification process. The dominance of India's foreign policy actors in the treaty-making process, in turn, allowed for innovation in the legal form and structure of the new international organization – wherein the institution uses the 'hard' legal infrastructure of a treaty while relying on the 'soft' social structure of participating actors for its future implementation (Jha, 2021).

This paper takes a closer look at the creation of the ISA within the broader context of science diplomacy that is the inclusion of science and technology into foreign policy. It argues that the creation of the ISA illustrates the integration of Indian climate and science diplomacy in two ways: first, diplomats galvanized entirely new geography of "sunshine states" – countries with a high potential for solar deployment based on their location– to shape a new international organization; and second, the ISA specifically aims to fill the technological and financial gaps in regions with the maximum potential but least resources for solar deployment. As a result, climate change considerations – in this case solar energy –became a point for consideration to further India's strategic interests of taking a leadership role on the global stage.

The changing face of solar energy in India and the world

India's leadership role in the creation and operationalization of the ISA stemmed from the vision of PM Modi, who since coming to power in mid-2014 brought the issue of climate change to the fore in a way previous governments had not. There was holistic thinking of domestic programmes with climate change connotations – in which solar got the most resonance with ramped-up targets.

The drivers for renewable energy in India continue to evolve: energy security in the 1980s after the oil shock, energy access in the post-liberalization India of the 1990s, and ultimately climate change and diplomatic implications of negotiation positions in the target-setting era of the 2010s (Chawla, 2018). Following the launch of the National Action Plan on Climate

Change, the National Solar Mission (NSM) was launched in January 2010. The NSM – India's flagship solar policy – aimed to create an enabling policy framework for the deployment of 22 Gigawatts (GW) of solar power by 2022 (IEA, 2021). Around this time, to encourage the development of a solar industry within the country, the government introduced a domestic content requirement (DCR) for solar projects funded through the NSM. These provisions, however, were the subject of a trade dispute between India and the U.S. at the World Trade Organization (WTO). Both the Panel and the Appellate Body ruled against India and held that these provisions violated global trade rules by imposing mandatory DCRs on solar power producers (Jha, 2017).

At the time of the Copenhagen climate talks, India started with a substantially blank slate on climate policy; by the Paris climate talks, India showcased an array of actions on both mitigation and adaptation, at the national and state levels (Dubash& Ghosh, 2019). In June 2015, under the leadership of Narendra Modi as Prime Minister, India set an ambitious domestic goal of achieving 175 GW of installed renewable energy capacity by 2022 (PIB, 2015). Of this, India's solar power capacity target was set at 100 GW by 2022, revised by five times its earlier goal of 22 GW of solar power by 2022. According to India's NDC submitted to the UNFCCC, 40 per cent of its total power capacity is expected to come from renewable sources by 2030 (UNFCCC, 2015c).

India has so far failed to generate a domestic solar manufacturing industry, and its industrial productivity in this sector remains far below that of the dominant player China (Shidore& Busby, 2019). With its ambitious high capacity installation targets, and in the aftermath of the WTO dispute against its solar policies, India has inadvertently chosen to become a consumer rather than a producer of new energy technologies. On the other hand, in pursuance of its clean energy ambition, China has squarely positioned itself as a producer and market leader of low-carbon energy technologies (Joshi & Powell, 2018). One of the biggest dilemmas facing India's solar programme is that 80 per cent of the solar panels are from China or Chinese-owned companies based elsewhere (Jai, 2018). An important aspect, then, of India's leadership on ISA is the inherent weakness (or lack thereof) of domestic manufacturing capacity in the solar space. India does not have China's manufacturing capacity for solar panels, and unlike China's 'Belt and Road Initiative', India is also limited in its ability to offer financial inducements to other countries to embrace solar power (Shidore& Busby, 2019).

However, with solar energy becoming significantly cheaper, it appeared ready to take center stage in global conversations around transitioning to clean energy sources. Technological advances and the falling cost of solar cells have made solar power competitive with other sources of power around the world. Any future developments in energy storage could further reduce solar power costs, making it an attractive option in various countries' energy baskets. India, today, ranks fifth in the world in total installed renewable energy power capacity after China, the US, Brazil, and Canada (IRENA, 2021). It also ranks fifth in total installed solar energy power capacity after China, the US, Japan, and Germany (IRENA, 2021). In November 2020, renewable

energy capacity in India was at 136 GW, almost 36 percent of India's total installed generation capacity. India aims to increase this to over 200 GW by 2022, which would exceed its 175 GW target stated under the NDC (Koundal, 2020). Therefore, the ISA was conceived as a "market-making" mechanism, which could drive the flow of finance and technology into 'solar rich' countries. The organization, to which 94 countries have signed up so far, will help aggregate different solar projects into larger tenders, allowing developers to benefit from economies of scale. It will also create an industry-funded insurance scheme to encourage banks to lend to what they might otherwise see as overly risky projects.

Three distinct factors are driving India's leadership on the ISA. First, India's large domestic markets and energy-related actions could drive down the prices for certain products, such as high-efficiency air conditioners, HFC free refrigerators, solar appliances, or electric vehicles. The low-cost solutions created for Indian markets could have distinct advantages for ISA member countries and be readily transferable to other developing country contexts in Africa, Southeast Asia, and Latin America. Second, the Indian model of scale-up solar, which includes creating an enabling environment for both utility-scale solar plants and off-grid distributed solar energy, could be an attractive idea to organize other countries (ISA, 2015). A third, all-important, factor is PM Modi's emphatic embrace of solar energy. As the Chief Minister of Gujarat, he was an early proponent of solar energy. The Gujarat government had launched its solar policy in 2009, well before the announcement of the NSM by the Centre in January 2010. The state of Gujarat aimed to install 500 MW of solar power by 2014. In April 2012, when the Charanka solar park – Asia's largest solar park – was inaugurated in Gujarat, the state had achieved an installed capacity of 605 MW ahead of the 2014 target date (DNA Correspondent, 2010). It was then, speaking at a programme dedicating the Charanka solar park to the nation, that he first expressed his vision for a new grouping of nations with high solar power potential:

> There are different League of Nations like OPEC and others. A league should be formed among the nations which get more sun rays. India should play a prominent role into the formation of such a league and step up its R&D to lead those nations (FWire, 2012).

This early idea to bring 'solar rich' nations together as a new bloc, ultimately took form as the ISA under Narendra Modi's leadership as Prime Minister. Leading up to the Paris climate talks, the Indian government solicited several big ideas from organizations working in the climate policy space, who suggested different templates for achieving solar energy-based cooperation. Around the same time, internal research within different ministries led to the finding that solar energy is a central element in the Official Development Assistance (ODA) provided by India to African countries, which proved to be a key factor signaling that an alliance conceived around solar energy could stand a chance as a multilateral effort (Jha, 2021). It also presented a clear market opportunity to tap into the economic potential for solar energy in energy-starved parts of the world. In addition, solar energy

markets in India looked primed to achieve economies of scale and contribute to domestic goals of energy access, job creation, and increased incomes – and it was this template that PM Modi wanted to extend to countries that had a potential but not the means to harness solar energy. A former Environment Secretary recalls that the world business community had started seeing India's ambitious renewable energy programme as a major economic opportunity that could transform the solar energy sector (Lavasa, 2019).

International Solar Alliance: The Climate Turn in India's economic diplomacy

In Paris, India's negotiating stance marked a complete departure from its previous outings at international climate negotiations. Modi had announced a domestic goal of 175 GW renewable energy by 2022. In addition, India jointly launched the International Solar Alliance with France on the first day of COP-21 and aggressively pushed for the expansion of its renewable energy programme. It also ratified the Paris Agreement to help bring it into force, despite concerns that it would insist on developed countries first fulfilling their pre-2020 commitments under the second phase of the Kyoto Protocol (Mohan, 2017). From being called 'obstructionist' (Mathur&Varughese, 2009) and 'difficult' (Vihma, 2011) in climate negotiations, India was being seen as playing a more constructive role in global climate policy (Mohan &Wihnert, 2019). India was lauded for playing a bigger role in Paris and transitioning into an 'agenda-setter' (Saran, 2015).

By 2015, the Modi government had brought in a larger shift in the Indian foreign policy agenda, especially as it wanted to be a leader in global governance and stake its claim among other major powers in global politics (Narlikar, 2017). India's engagement with climate change was material to its aspirations as a rising power (Dubash, 2019). It was important for India to not just be part of the solution but be *seen* to be part of the solution (Dubash, 2019). Therefore, India's diplomatic positioning at the Paris conference can be considered a paradigm shift as it 'provided India with an opportunity to showcase a new diplomatic configuration, reflective of the new reality in which it is a stakeholder both in the traditional developing world, the G77, and in the large economies, the G20' (Mathur, 2019).

This paper argues that the creation of the ISA illustrates India's entrepreneurial economic diplomacy. Empowered to strike deals by the new political leadership, India's diplomats and climate negotiators steered the course towards a new international organization. In establishing the ISA, India sought developing countries as its primary members and beneficiaries of a common solar future but also reached out to developed countries as partners to help achieve the ISA goals. Ultimately, the creation of the ISA reveals India's diplomatic success in capturing an issue-specific governance area (Ghosh, 2019), as well as straddling the G77 and G20 blocs in enabling the formation of a new intergovernmental organization (Mathur, 2019).

Under PM Modi, India's energy foreign policy has shifted focus from energy security to energy diplomacy. Earlier, India's energy foreign policy rested on the concept of energy security and on the need to find new and alternative sources of energy for India's domestic

needs. At the time, the core focus of India's energy security concerns was on nuclear power, and solar energy was one among the various other sources of clean energy. A former member of India's Planning Commission put it: 'Given the limited hydrocarbon resources of the country, even if there was no threat to climate change, it would be imperative that we develop solar technology for power' (Parikh, 2010). The initial objective for entering into decentralized power generation through solar and renewable energy was to help India meet its energy access problem. In the lead-up to the Copenhagen talks, there was a weaving of climate change concerns in India's energy security argument and a growing emphasis on renewable energy, and not merely nuclear power. With the launch of the NSM in January 2010, solar power assumed a central role in addressing India's twin challenges of energy security and climate action. In Dr. Manmohan Singh's words:

> The Sun has long been recognized as a primal source of all energy on earth. In an ancient civilization like India, the Sun has been worshipped as the God who bestows life and sustains it. The bounty of the Sun is truly inexhaustible, renewable, and free. It is to this source of energy that humankind must turn to meet the twin challenge of energy security and climate change (Singh, 2010).

Since PM Modi has come to power, there is a clear insertion of energy diplomacy in India's foreign policy. He highlights this new energy diplomacy in several speeches: in a 2015 address, he noted that energy diplomacy is the need of the hour in global relations, especially as Indian companies become more multinational (Modi, 2015b); in another 2016 speech, he noted that 'our proactive foreign policy and energy diplomacy is helping us to strengthen our ties with our neighboring countries' (Modi, 2016). One of the clear themes in Modi's early speeches is the effort to establish new partnerships through solar energy. He focused on building energy partnerships across different regional groups such as ASEAN (Modi, 2014a), SAARC (Modi, 2014b), and the East Asia Summit (Modi, 2014c).

Interestingly, the idea to bring South Asian countries together in efforts to tap renewable energy sources was first signaled by Prime Minister Singh in 2008: 'We should also pool our resources to tap renewable sources such as solar energy, hydropower, and wind energy, all of which South Asia has in abundance' (Singh, 2008). However, there is no subsequent mention of this idea or any related plans in Singh's speeches. The momentum around creating new energy partnerships through solar energy gained steam under Modi's leadership. In addition to highlighting the need to coalesce efforts around solar energy in different regional forums, the Modi government also partnered with countries in other ways, such as setting up solar projects in Mozambique (Modi, 2015c) and extending a line for credit for renewable energy development to Fiji (Modi, 2014d).

The first concrete suggestion about a new grouping of countries based on solar energy cooperation was outlined in Modi's interaction with African journalists before the 3rd India-Africa Forum Summit held in October 2015. He noted:

I think between India and Africa there is another aspect that links us with many countries in Africa and that is solar power from which many African countries are benefiting. I think this is going to become

a very strong community of nations and in the times to come the problem of climate change that the world is trying to counter and fight, we are going to be playing a very major role in mitigation and lessening the effects of climate change (Modi, 2015d).

He further added that the 'India-Africa economic partnership is not transactional' and 'rests in the belief of our shared destiny and the power of South-South cooperation in transforming the lives of our people.' Modi continued his focus on the renewed India-Africa energy partnership by highlighting two aspects: the need for energy access and the abundance of solar energy in the two regions. At the launch of the ISA, Modi said:

> We want to bring solar energy into our lives and homes, by making it cheaper, more reliable, and easier to connect to the grid. …There is already a revolution in solar energy. Technology is evolving, costs are coming down and grid connectivity is improving. It is making the dream of universal access to clean energy become more real (Modi, 2015e).

India's climate policy had operated within its overall foreign policy framework for over two decades, with the MEA playing a critical role in driving India's position and defining negotiating red-lines. Under the Modi government, too, the foreign ministry led the charge during the climate negotiations at Paris. This time, however, India's negotiating team in Paris led by S. Jaishankar – India's then foreign secretary – had a 'forward leaning' approach on climate change (Sengupta, 2020). The primary focus was the creation of a new global institution – ISA – which I argue became a deliberate instrument of India's foreign policy on climate change and energy. From a negotiating perspective, India was not only proactive in securing the final deal in Paris, but also very interested in creating this new institution to channelize finance and technology into solar deployment in the developing world.

It is argued that the creation of the ISA marks the first instance of the integration of Indian climate, science, and economic diplomacy. The motivation for the ISA was to bring developing countries together around a new issue area and recalibrate global rules of engagement. This was reinforced by the strong economic potential for solar deployment in the member countries of the new organization. One of the main instruments of India's development cooperation include Lines of Credit (LOCs) in India's neighbourhood, Africa, and increasingly to South East Asia, East and Central Asia, the Caribbean, Latin America, Pacific Island Countries, etc. The development partnership is a pillar of South-South cooperation, and the LOC mechanism is a major part of the initiative through which India assists developing countries by providing them with low-interest soft loans (GOI, 2019). A significant portion of GOI LOCs was in the solar energy sector, and the ISA presented an opportunity to turn the provision of 'club goods' into 'public goods'. By creating a new international organization for solar energy, the Indian government aimed to move this issue beyond South-South cooperation. At the ISA's Founding Conference, the Government of India announced nearly $1.4 billion worth of line of credit for solar energy projects (see Table 1). Further, by highlighting the market potential for solar deployment in ISA's 'solar rich' countries, the effort was to coalesce global finance and technologies in areas that need it the most and have tremendous potential for market growth.

Table 1: List of solar projects under GOI LOCs announced at ISA's Founding Conference

S. No.	Country	Proposed solar project	Estimated cost (Million USD)
1.	Bangladesh	Establishment of solar-based Base Stations in hard-to-reach areas for strengthening Tele-talk Network Coverage	30
2.	Bangladesh	Setting up of Mollahat 100 MW Solar PV power plant	150.26
3.	Benin	Electrification by photovoltaic solar system of 550 social community infrastructures (health centers, high schools, and hand-pumped boreholes) in Benin rural areas	21
4.	Burkina Faso	Solar-powered water stations for semi-urban water supply	36.50
5.	Chad	Establishment of a Solar PV module manufacturing plant at N'djamena	27.45
6.	Democratic Republic of Congo	Building of 15 MW Solar Photovoltaic Power Plant and Public Electricity Network at Karawa	58.94
7.	Democratic Republic of Congo	Building of 10 MW Lualaba's Provincial Solar Photovoltaic Power Plant and Public Electricity Network at Kolwezi	32.43
8.	Democratic Republic of Congo	Building of 15 MW Oriental Kasai's Provincial Solar Photovoltaic Power Plant and Public Electricity Network at Mbuji-Mayi	56.82
9.	Ghana	Solar-powered Street Lighting Project	34.80
10.	Ghana	Solar-powered mini-grids for island and forest zone communities	6.3
11.	Guinea	Solar Project for Supply of Electricity and Drinking Water for 7 Public Universities	14.40
12.	Guinea	Solar Project for Electrification and Refrigeration in 200 Health Infrastructures in Guinea	5.82
13.	Mali	50 MW Solar Power Plant in FANA, Mali	120
14.	Mali	Development of 2500 hectares to be irrigated through solar power	22
15.	Mali	Construction of 2 MW Solar Photovoltaic plants in Mopti	8
16.	Niger	Electrification of 250 villages through solar photovoltaic systems	38.2
17.	Nigeria	Solar PV Renewable Micro-Utility (REMU) in six political zones of Nigeria	8.36
18.	Nigeria	50 MW Solar Power Plant in Bauchi State in Nigeria	66.60
19.	Rwanda	30 MW (2 x15 MW) Solar power project with storage capacity for supplying power to the National Grid	90

20.	Rwanda	Solar Mini-Grids for 50 centralized off-grid areas, 200 Public institutions, and 200 Business centers	32
21.	Seychelles	Solar LED street lighting project in Mahe, Praslin, and La Digue	0.60
22.	Seychelles	Solar Rooftop PV Project for Government Buildings in Seychelles	3
23.	Seychelles	2 MW (1MWx2) Solar Power Plant with Battery Storage in Praslin and La Digue	4
24.	Sri Lanka	Development of 200,000 rooftop solar units for low-income families	50
25.	Sri Lanka	Establishment of rooftop solar units in hospitals, schools, colleges, and other government establishments	50
26.	Tanzania	Development of 150 MWp Solar PV Farm at Shinyanga Region, Kishapu District.	385
27.	Togo	Electrification of 350 villages through solar photovoltaic systems	40

Source: MEA (Government of India), 'List of solar projects under GOI-LOCs for the announcement at ISA Founding Conference', ISA Founding Conference (11 Mar. 2018), Retrieved from https://meacms.mea.gov.in/ISAFoundingConference.htm.

Conclusion

India's diplomats showcased a new kind of economic diplomacy at COP-21 in Paris: first, by creating a new global institution by leveraging its domestic renewable energy ambitions at an international level; and second, by reaching out to 'solar rich' developing countries with shared interests, as well as developed countries and other non-state actors with keen financial interests in these untapped 'solar rich' markets. This paper argues that this is the first time India used a legal tool to assert its power in the international sphere – the ISA being the first deliberate instrument of India's foreign policy on climate change. Until then, India's power was mostly seen in shaping alliances and negotiating blocs. This was the first time India asserted its power by creating a new international organization. Ultimately, the ISA was a diplomatic win for India, and demonstrated its leadership capability at the world stage by steering a new organization, bringing in ratifications, and setting up the infrastructure for a new organization.

India's solar story continues to move ahead at an incredible pace. In January 2020, the Economic Survey of India highlighted that India was on track to achieve its NDCs based on the significant leap in the renewable energy sector, with almost 83 GW being achieved out of the aimed target of 175 GW of renewable energy by 2022 (PTI, 2020). At the G20 Summit in November 2020, Modi reiterated that India is not only meeting Paris Agreement targets but will be exceeding them and promised 'a big step ahead by seeking to achieve 450 GW (of renewable energy) by 2030' (Modi, 2020). A recent report suggests that India is the only country on track among the

G20 nations to meet its climate change mitigation commitments (Mukhopadhyay, 2020). Despite the pandemic, many economic and industry leaders in India believe that the government is on track to meet the 175 GW target of installed renewable capacity by 2022, and could achieve the target of 450 GW by 2030 with timely policy interventions (Rana, 2021).

As a next step to the ISA, Modi in his 2020 Independence Day address spoke of a mega plan of 'One Sun, One World, One Grid' (OSOWOG), which is a transnational electricity grid supplying solar power across the globe. The idea was first floated by Modi in 2018 during the first assembly of the ISA. Several experts have cited this as part of India's answer to China's 'One Belt One Road' infrastructure initiative which entails investment in close to 70 countries. As per the draft plan prepared by the MNRE, OSOWOG will connect 140 countries through a common grid that will be used to transfer solar power. The plan is based on the mantra 'the sun never sets' and will be divided into three phases: the first phase will connect the Indian grid with the Middle East, South Asia, and South-East Asian grids to share solar and other renewable energy resources; the second phase will connect the first phase nations with the African pool of renewable sources; and finally the third phase will be the concluding step of global interconnection (Jai, 2020). Based on the geographies that OSOWOG targets, the ISA appears to be the first step in India dominating the global conversation around solar energy. By bringing wide-ranging countries and non-state actors on board the ISA, and in time demonstrating the gains from massive solar energy deployment in energy-poor regions of the world, India aims to expand its leadership role on the global public good – the sun.

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ARTICLE

Water Diplomacy: Science Diplomacy for Seeking Legal Solutions to Ocean Change

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Introduction

Science diplomacy (SD) is not a new concept in global or regional politics (US Government Printing Office, 1977). It was coined in a broader context of reinforcing the USA's diplomatic prowess, but also to spruce up the country's reputation marred by the US-led invasion of Iraq in 2003 (AAAS, 2015). Science diplomacy seeks to strengthen symbiosis between interests and motivations of two different communities yet working for similar global problems, namely scientists and foreign policy practitioners. There are many shades of contemporary diplomacy, where science diplomacy is only one of them. SD itself is composed of many different branches such as health diplomacy, cyber diplomacy, climate diplomacy, water diplomacy, etc. Scientific knowledge is needed more than ever before especially in the 21st century with complex challenges such as ocean change, sea-level rise, ocean governance, and access to potable water, etc. as covered in this paper.

The International Covenant on Economic, Social, and Cultural Rights (OHCHR) entitles everyone to sufficient, safe, acceptable, physically accessible, and affordable water for personal and domestic uses. In addition, on 28th July 2010, the United Nations General Assembly explicitly through Resolution 64/292 recognized human rights over water and sanitation and acknowledged that

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clean drinking water and sanitation are essential to the realization of all human rights (UN, 2010).

The governance of oceans in the face of ongoing changes marked by increasing human activities and climatic fluctuations requires urgent actions, which are not only political statements of generating goodwill but also creating legally binding frameworks (norms within the hard law mechanisms) with legally enforceable effects on international entities, states and other non-state actors (NSA), such as intergovernmental organizations (IGO) and other less formalized regional groupings. Global challenges including primary education, health care, food security, and access to water, are all connected to climate change. Those specific connections are the main themes, which researchers across the world make efforts to solve. Therefore, such a unique correlation between policymakers and researchers leads to the establishment of close cooperation and mutual dependence between them. Scientific knowledge is needed to get full, detailed information on how to solve problems or dilemmas in an efficient, effective, fast, and cheap mode. In turn, researchers do feel a form of obligation to help to solve global problems with their (our) scientific knowledge, through all the tools they are equipped with.

Water diplomacy as a Subset of Science Diplomacy

Science diplomacy is a new concept formally used in contemporary international politics and extensively used in American foreign policy since the soft power of science appeared to be more effective, useful, cheaper, and better to create a vision of the USA as a friendly and caring country for whom the world's fates were not indifferent. The country's reputation after the US-led invasion of Iraq was heavily affected (AAAS, 2015). Therefore, it can be assumed that SD is a result of an interaction between science and foreign policy. In such interactions, we might also observe the increasing role and relevance of science in global politics. The year 2009 witnessed a turning point in the history of science diplomacy, as this branch of science, being equally a source of both academic and political inspirations, started to be perceived as a new (rediscovered) tool of politics. This, in turn, has opened a field of discussion at the academic level, established varied scientific grants and scholarship, as well as first programs and courses of understanding, teaching, and using science diplomacy for various purposes.

The science diplomacy concept gained much currency through a path-breaking monograph, *New Frontiers in Science Diplomacy: Navigating the Changing Balance of Power* published by the two aforementioned institutions. We can find the definition of SD there as:

> Science diplomacy seeks to strengthen the symbiosis between the interests and motivations of the scientific and foreign policy communities. For the former, international cooperation is often driven by a desire to access the best people, research facilities, or new sources of funding. For the latter, science offers potentially useful networks and channels of communication that can be used to support wider policy goals. But it is important that scientific and diplomatic goals remain clearly defined to avoid the undue politicization of science (Royal Society, 2010).

The Intergovernmental Panel on Climate Change (IPCC) is considered to be one of the best-known examples of a science diplomacy (advice) mechanism at the international forum (IPCC, 2020). IPCC is the United Nation (UN)'s body for assessing the science related to climate change. This scientific panel was established in 1988 by the World Meteorological Organization (WMO, 2020) and the United Nations Environment Programme (UNEP, 2020). The panel's main aim is to provide the world with actual, unambiguous, and clear-to-master scientific views. This is indeed a breaking-through method of presenting highly complicated and detailed knowledge to non-scientists. But presenting such knowledge is one thing, while equally important is to make use of the gathered and analyzed information for the benefit of humankind. Here it is vital to underline that IPCC deals with the current state of climate change, and its potential environmental and socio-economic consequences. Thousands of scientists from all over the world, representing various disciplines, backgrounds and sharing different experiences both in science and very often in politics, contribute to these periodic assessments and review voluntarily, which is then used for global policy discussions.

SD is composed of different branches including water diplomacy. The preference in choosing methods, tools, and scopes (both territorial and social) depends on thematic and regional approaches, as well as the current need for results both coming from the political leaders and actual problems, or dilemmas analyzed by science. Global challenges such as basic education, health protection, food and nutrition security, water security, and accompanying aspects connected to the effects of climate change in the oceans have led to the establishment of close cooperation and mutual dependence between policymakers and scientists.

Water diplomacy became a relatively new field of interest in both international relations and building foreign policy strategy. The significance of water, potable as well water used for domestic needs and agriculture, has been increasing rapidly. Undoubtedly, water is a resource that is related to multifaceted issues, while it is predicted to become the trigger of 21st-century military conflicts. So-called "water conflicts" have been a serious and old form of military struggle between nations (Pacific Institute, 2019). Regrettably, we should expect them to increase in number due to the severe effects of climate change (Dehgham, 2020; Dabelko*et al.*, 2013). Water is the most influential factor related to food and nutrition, while the water quality, irrigation, scarcity of water can be defining pinpoints in the existence and survival of a community and its further generations.

Climate Change, Ocean Change and their Consequences on Global and Regional Fora

The maritime aspects of climate change are called 'ocean change'. Over the last few decades, the water became one of the most threatening aspects for inhabitants of the low-lying territories, islands, deltaic areas all over the globe (Siekiera, 2019). It is a potential and an already existing threat to people regardless of their civilization stage, gross domestic product, or development of their industry. In a variety of features that are linked to water, no one should be surprised that water diplomacy is

becoming a key field in science diplomacy, where politics and research are put together on an international table.

Humankind has always organized access to water underlining the geological, but very often also (geo) political importance. Due to industrialization, which has been harming the environment, scientists have become more interested in the water ecosystem. Diverse scientific disciplines such as hydrology, physics, ecology, social sciences, to mention a few, began to analyze various aspects of water supplement, distribution, and protection. Interdisciplinary approaches to water management affected the final drafting of the legal norms related to water. Examples of these include water dam constructions, polder (low-lying tract of land that forms an artificial hydrological entity, enclosed by embankments known as dikes) landscapes, river basins, lakes, coastal zone management. These are in the form of public or civil agreements, public tenders, foreign aids, or other formalized forms of cooperation. Water is a public good, while access to it is almost entirely governed by the state. Thus, administrative bodies are responsible for its maintenance and care. In addition, water management is a border-crossing concern, where two or more states have to jointly decide on mutual usage and protection of the source of potable water, as well as its handling in various branches of industry (S4D4C, 2020).

Water diplomacy is slowly taking a lead in the region as a political and legal tool. On 19th November 2018, the Council of the European Union (CEU, 2018) adopted the 'Water Convention'. The Convention, also known as the Helsinki Water Convention, was signed on 17th March 1992 and entered into force in 1996. The signatory countries include Albania, Austria, Azerbaijan, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Chad, Croatia, Czech Republic, Denmark, Estonia, European Union, Finland, France, Germany, Ghana, Greece, Guinea-Bissau, Hungary, Italy, Kazakhstan, Latvia, Liechtenstein, Lithuania, Luxembourg, Montenegro, Netherlands, North Macedonia, Norway, Poland, Portugal, Republic of Moldova, Romania, Russian Federation, Senegal, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkmenistan, Ukraine and Uzbekistan (UNTC, 2021). Its official name is the *Convention on the Protection and Use of Transboundary Watercourses and International Lakes* (UNECEF, 2018).

This international treaty not only underlines the link between water, security, and peace but also promotes universal accession to it and the implementation of the established norms. The Water Convention requires its signatories to prevent, control, and reduce the transboundary impact of water basins, as well as to use waters reasonably and equitably through sustainable management. Parties bordering the same transboundary waters were additionally obliged to strengthen cooperation by entering into precise bilateral agreements to establish dual, highly specialized bodies. From the public international law doctrine, the Convention should not be read as a replacement of an already existing and being in force bilateral or multilateral agreement. Instead, by the means of the universal authority enjoyed by the United Nations Economic Commission for Europe (one of five regional commissions of the United Nations, UNECE, 2020), this organization can effectively influence other states by offering them a guideline or "blueprint" for them to follow. Nonetheless, analyzing

this subject matter is so broad that indeed the Convention is just a beginning, "breaking through" form of establishing legal norms regarding water management. Thus, it cannot and will not solve all the problems experienced by its signatories. The Council of the European Union stated in its declaration in 2018 states:

> Water is a prerequisite for human survival and dignity and a fundamental basis for the resilience of both societies and the environment. Water is vital for human nutrition and health and essential for ecosystem management, agriculture, energy, and overall planetary security. The potential of water scarcity to affect peace and security, as water-related risks can have grave human and economic costs, all of which can have direct implications for the EU including through migration flows. The Council intends to enhance EU diplomatic engagement about water as a tool for peace, security, and stability and firmly condemns the use of water as a weapon of war. The Council also underlines the EU's commitment to promoting transboundary and integrated water management as well as effective water governance (CEU, 2018).

This statement indicates that water is understood by politicians and diplomats (not only in Europe) as either a tool for peace or a possible weapon and a cause of war.

There is finally an increased need for transboundary water cooperation by public institutions and private governance towards universal access to water and sanitation. The frequency of storms, floods has increased and severities of extreme weather events are one of the most obvious signs of climate change. Degrading effects of ocean change on life and the very existence of low-lying areas are slowly becoming part of the political agenda. The UN 2020 World Water Development Report (WWDR, 2020) has warned that climate change will have a severe impact on the quantity and quality of water resources. The report highlights that unsuitable water management tends to exacerbate the impacts of ocean change. Thus, the consequences of bad water management will very soon affect human health through diseases linked with food, while the amount and variety of parasites in water will most likely increase (Marques Ruiz, 2020).

The USA plays a leading role in the development of science diplomacy due to its strong and influential position in both academia and global politics. The vast majority of today's standards of science and diplomacy, science in diplomacy, and diplomacy in science can be traced to American initiatives. Nonetheless, the withdrawal of the USA and Israel from the United Nations Educational, Scientific and Cultural Organization (UNESCO) on January 1, 2019, was seen by many as a major setback to one of the crucial fora for science diplomacy. On the other hand, the UN itself wishes to be the leader in promoting water management and using water diplomacy, as a field of science diplomacy. After all, the third decade of the twenty-first century was announced as the ocean decade (UN Decade of Ocean Science for Sustainable Development, 2021-2030). Its motto is clear:

> The Decade will provide a 'Once in a lifetime opportunity for nations to work together to generate the global ocean science needed to support the sustainable development of our shared ocean (UN Decade of Ocean Science, 2019).

Here, the main body responsible for supporting global ocean science is the Intergovernmental Oceanographic Commission of UNESCO (IOC). This institution enables its 149 member states to work together to protect the health of the ocean by coordinating programs in ocean observations, hazard mitigation, tsunami warnings, marine spatial planning, and many more (UN Decade of Ocean Science, 2019).

However, ocean science accounts for only 0.04-4 percent of total research worldwide (GOSR, 2017). Water science and diplomacy are only at the first stage of their development. Finally, among many expected results at the local, regional and global levels, IOC hopes to enrich research and inspire scientists dealing with water science (ocean science). Scientists will most likely improve knowledge but also develop new technologies in alignment with sustainable management of oceans through multidisciplinary approaches, international demonstration, and appreciation of the value of their work to society (UN Decade of Ocean Science, 2019).

Potential Pathways to Water Diplomacy

It has been predicted, among others by the Organization for Security and Cooperation in Europe (OSCE, 2015) that future conflicts may break out because of a lack of access to raw materials including water. The combination of climate change and demographic growth will lead to exacerbating hydro-political issues whereas water conflicts are more likely to occur in areas that are already under water stress. The most vulnerable areas are around the Nile, Ganges-Brahmaputra, Indus, Tigris-Euphrates, and Colorado rivers (EU Science Hub, 2018). But water can also be a source of co-operation; jointly managing water can lead to improved relations among countries and communities, and enhance security, prosperity, more efficient use of water, and the protection of the environment (OSCE, 2015).

Water diplomacy is closely related to human security and safety. Therefore, the author introduces three key messages (being also a practical tool when doing research, writing political analysis, and decision-making) when using water diplomacy for the benefit of humankind. First, we have to recognize the potential of water as a source of future conflicts and part of securing stability and security under international law. Second, there is an urgent necessity to consider gender and indigenous perspectives in shaping water policy solutions. Finally, regional forms of developing international law tend to be more effective, efficient, and faster towards the pressing problem of ocean change.

Here are three corresponding examples portraying the current state of action when it comes to water diplomacy. The first example presenting the actual potential for armed conflict and therefore a threat to security and stability is the building of the largest dam in Africa, (Grand Ethiopian Renaissance Dam) on the Blue Nile by Ethiopia, Sudan, and Egypt are deeply concerned about the potential limitations of access to water as a political and humanitarian threat to their citizens. Often in opposition, Egypt and Sudan are now uniting behind a legally binding document on how the dam should be operated. The African Union, which is the most powerful regional organization, is mediating (Bearak and Raghaven, 2020).

The second example of insufficient water diplomacy related to gender and

indigenous perspective presents the negative perception of the Western countries willing to solve the problems of other nations by the Western methods and way of thinking. The Western nations, acting with goodwill however neglect at the same time the local communities' capabilities, legal, culture, and tradition. A well was built in an Afghanistani town by the American-led troops and other contractors. Such a project is understood by humanitarian aid organizations as "a typical project intended to win hearts and minds" (Boyd, 2011). A day after drilling it with a pompous inauguration with representatives of the local authorities and humanitarian workers, the well quickly was destroyed. By whom? Why? Well, by local women themselves, whose sole responsibility was to bring water to their families. Those women were not considered by either local authorities (males) or Western humanitarian non-governmental organizations (NGOs). Going to fetch water was the only chance for those women to spend some time outside of the home, to meet friends, to breathe during the already harsh times of conflict and the lack of stability with the state.

Lastly, the author's proposition as a legal solution to combat ocean change is that of the regional level and not waiting for the global arrangements. To realize a simple legislative instrument, one must bear in mind the process of ratifying the UN Conversion on the Law of the Sea (UNCLOS) (UN Oceans, 2018). The Convention, being the main source of this branch of international law, had been drafted after the Second World War. Back then any consequences of climate change including ocean change, shrinking islands, losing territory by states, and actual threats to humans and ecosystems were not foreseen. Therefore, modern lawyers say, the Convention is full of legal gaps while existing norms are inadequate for the twenty-first century's problems. The UNCLOS was signed in 1982 but it was not ratified until 12 years after. We must remember that access to water, and in this regard to the ocean, is being perceived as the common heritage of humankind (Taylor, 2018). Here it is worth underlining the usage of gender perspective which led to changing the previous phrase of oceans being the common heritage of mankind. The latter was adopted in 1970 by the United Nations General Assembly Resolution 2749 in its the Declaration of Principles Governing the Seabed and Ocean Floor (Holmila, 2007).

Still the USA, being the largest maritime power, has never ratified UNCLOS or implemented in its national legal system the norms of the UNCLOS. In addition, any amendments of the Convention in norms concerning sea level rise, acidification, losing some parts of the land and maritime territory, and thus threatening to human and state security, will be unlikely to gain unanimity. Different states present various interests, and they are indeed very clear in prioritizing their raison d'état. The International Law Commission report (ILC, 2020) presented the overall picture that most states are willing to uphold the status quo. Interestingly enough, this group represents the states being not affected by the ocean change consequences. Yet, we might observe the reliance on regional solutions and how it has been launched in the South Pacific. The Pacific Islands Forum (PIF, 2021) is the most influential regional organization in the region. Thus, it

has the actual but also the legal capacity to commit its members to a collective effort, including developing international law in the legal combat against ocean change. The Oceania states started to deposit data on their maritime boundaries by submission to the ILC to legally preserve existing territory delimitation, irrespective of the effects of sea-level rise.

Conclusion

To sum up, water diplomacy has become one of the key issues of global and regional politics in the twenty-first century. States all around the world, gathered in local groupings or global collaboration (mainly under the UN umbrella) are determined to strengthen their diplomatic engagements to integrate water management and protection of access to potable water. By strengthening the international system, mobilizing partners, both public and private, and combining science diplomacy methods in policy dialogue and development cooperation, states can promote peace and stability. The UN Decade of Ocean is the defining point in the history of water diplomacy, where political declaration, legally binding acts, new technologies, and advanced research in ocean science are all being employed for the benefit of the whole of humankind.

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The Role of Science and Technology on the International Relations of a Small Country: The case of Greece

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Setting the tone

Issues of science and technology (S&T) have been a prime focus for policy-makers and academics within the practice of international affairs. Focusing on countries with a global footprint (or even serving under respective governmental structures), their main objective has been to contextualize S&T within the conduct of a country's foreign affairs (Skolnikoff, 1993; Osiris, 2006). Given the implications of such issues on matters of knowledge, collaboration, entrepreneurial activities, the establishment of networks, and financial rewards, scholars and practitioners have seen the potential to project power to be exploited.

To be fair, great powers pursued international collaboration on such matters in the past because they revolved around national security topics and potentially catastrophic events such as nuclear proliferation, bioterrorism, weapons and missile defense, and other equally sensitive technological issues. A case in point here is the scientific collaboration between the US and USSR during the Cold War (Sher, 2019). These issues, in turn, were directly linked to real-life concerns such as security-related export control considerations, or the extent to which scientific collaboration between domestic and foreign scientists can be initiated/sustained unhindered,

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etc. (Evans and Valdivia, 2012; Weiss, 2005).

Lately, the second wave of interest in S&T in connection to foreign affairs has been on the rise. Dual in its approach, a) it seeks to frame S&T as a subfield of the scientific field of International Relations, and, thus, to imbue academic credence to an interdisciplinary domain *par excellence*. The creation of the 'Science, Technology, Art in International Relations' chartered section in the International Studies Association is a testament to this.[1] Secondly, the growing awareness that global environmental, health, educational, energy, and sustainable problems can be tackled through S&T and, in turn, the placement of the responsibility for the execution of policies at the national level (Mayer *et al.,* 2014a; Mayer *et al.,* 2014b) sets the framework conditions for the involvement of scholars and policy-makers. A case in point here is the Sustainable Development Goals as set by the UN. Universal in scope, they need to be addressed on the country level to be truly efficient.

Another example that highlights the dichotomy between the international versus domestic character of science collaboration is the case of USAID – an agency that seeks to extend medical and developmental aid towards a select list of countries and thus offers a humanitarian helping hand. This hand, though, is extended to those countries with which a minimum level of accordance on specific global issues has been achieved or to countries that the US establishment does not see eye to eye, yet, realize the opportunity for major geopolitical breakthroughs. Another case is the Chinese Belt and Road Initiative. At its greatest scale involving more than 120 nations, China's mega-plan for global infrastructure aims to transform the lives and work of tens of thousands of researchers by establishing science links (Nature, 2019). Neither of these endeavors is criticism-free. Too much resilience on cutting-edge information-technology infrastructure, e.g. 5G network, environmental concerns, and too much China-centered S&T priorities are some points of geopolitical friction with other global players that perceive the initiative in competitive terms. These examples indicate how deep science is embedded in the everyday foreign policy conduct of great power.

For all their worthiness, the existing literature missed the question of how small countries could incorporate S&T issues in their foreign relations. While a clear-cut definition of what stands as the archetype of a small state has not been achieved (Keohane, 1969; Neumann and Gstöhl, 2004), scholars have agreed that a ''small'' country should be considered in terms of population size and density, size of the economy, import and export demands, etc. Small, though, is by no means weak. Alliance building, veto power, and agenda-setting capability are mechanisms to project power for a small country (a case in point here is the institutionalization of the European Defence Agency, see Karampekios 2015).

Concerning science activities within the conduct of foreign affairs, most scholars, however, focused on the S&T workings of large countries.[2] This paper aims to address this gap by way of providing a viewpoint of such a small country - Greece. Taking a cue from the above considerations, the paper seeks to provide a real-life macro-image of actions

that can be taken to formulate the linkages between science and technology policy and their foreign relations.

A connection long overdue

S&T issues have not attracted the interest of Greek foreign policymakers. Traditionally, these issues were viewed as political issues of low importance due to several reasons. For example, they could not fit squarely with bilateral relations on this thorny corner of the Balkan Peninsula – relations that were more realistic than collaborative in principle. Moreover, such matters mature in periods that are more extended than the standard four-year electoral cycle. This presented a reality hard to accept for politicians who understood scientific collaborations as potential capitalization avenues to be exploited for electoral purposes.

Short-sighted approaches missed the high impact potential found in formulating international scientific networks that could be turned into, or, at least contribute to geopolitical alliances. Indeed, capitalizing upon this exact characteristic, i.e. regional (i.e. Balkan) leaders looking down upon science as a low priority theme, presents a window of opportunity for Greek policymakers to actively support their regional interests. This can be achieved by way of building long-lasting relations with their neighbours. This includes relations on topics that do not raise eyebrows, such as exchange programmes, science collaboration, technological partnerships, etc. However, this has not been the case so far.

This is paradoxical given Greece's strong science presence. For example, a systemic over-performance in competitive European collaborative projects – with an EU average of 11.9 per cent Greece has a 13.4 per cent success rate – (Commission, 2021) and an increasingly good bibliometric performance – for example, high activity and high impact science fields are (to name a few) particle physics, telecommunications, critical care medicine (National Documentation Centre, 2020). This means that existing science networks are there to be used for establishing long-standing relations. Indeed, these relations can be initiated on the grounds of science but they should not only be limited to that.

This omission seems even more paradoxical given Greece's highly educated diaspora individuals (Sachini*et al.*, 2020) occupying a disproportionately high number of academic and research positions in US Ivy League universities (Yuret, 2017). Masters in their fields, these individuals could be enlisted for the cause of establishing formal networks between Greece and the hosting country or with neighbouring countries that would welcome such high-profile mentors. Indeed, of late science diplomacy has been institutionalized as a term and practice in the state affairs of countries with a larger footprint whereby these countries actively seek to build bilateral technological and industrial alliances with countries of interest through high-profile individuals that can garner support for collaboration under the industry and academic standing.

This overdue 'bridge' between two distinct policy realms (foreign affairs and science) seems ripe for a variety of reasons. For example, it should be considered as part and parcel of an active, outward-oriented foreign policy that aims to construct common viewpoints and bank on knowledge creation. Also, and perhaps more importantly, because it is linked to

the country's overall economic progress. Keeping COVID-19 aside, the exploitation of science and its potential, including bilateral relations and technology transfer, are initiatives that can help reinstate Greece into a path of sustainable growth after a decade-long economic crisis. Further, this is consistent with several national development strategies and funding mechanisms that seek to capitalize on the knowledge, create networks, and incentivize technology transfer. Such strategies and mechanisms are the Recovery and Resilience Plan, the New Partnership Agreement, and the Research and Innovation Strategies for Smart Specialization.

Placing the building blocks

Placing the building blocks of a foreign-centered science and technology policy requires a multi-pronged approach that seeks to ''extract'' value out of this chain. One such avenue is bilateral science agreements. Currently, such agreements have been signed with four countries (China, Israel, Germany, and the US), yet the number and the scope of these collaborative arrangements should be increased, and countries that are of interest to Greece - not only scientific interest, should be included. A case in point here is India. A major Asian country with a huge science capacity stands as an obvious partner. Indeed, since 2007 an S&T agreement has been signed between the two countries, yet has remained largely inactive and unexploited ever since (Agreement between India and the Hellenic Republic, 2007). As of very recently, the two countries sought to re-boot their relations. The Indian Minister of Foreign Affairs met his counterpart in Athens and talked about of new prospects for consolidating and upgrading their relations. In addition to S&T-relevant endeavours, such as Greece becoming a member of the Indian initiative to promote solar energy, the "International Solar Alliance", the two spoke about larger, geopolitical alignment involving establishing military ties (eKathimerini, 2021).

Science partnerships mean little if an overall strategy connecting these cooperation agreements is not in place on behalf of the Greek Ministry of Foreign Affairs. In essence, S&T ought to be introduced as an upgraded and distinct foreign affairs domain. Science and technology policy, science and industrial diaspora, and technology transfer should be considered as potential subject fields in this new administrative function. These should be coupled with the job of formulating a relevant strategy as well as breaking down this strategy into to-do actions. Additionally, these topics should be introduced in the curriculum of the Greek Diplomatic Academy.

Related to this and as pointed above, science diplomacy has been on the rise (Labrianidis*et al.,* 2019).[3] Establishing bilateral relations to make use of scientific and technological potential and to strengthen ties between two countries have been institutionalized as a distinct state-led domain for countries such as the USA, France, Germany, Japan, and New Zealand seeking to enhance their partnering opportunities with the global best. Selecting a few capitals of the world with rich S&T activities (and, strong science and entrepreneurial diaspora) is an option for Greece to consider. The benefits accruing from this option are self-

evident: partnering with global players and tapping into first-class scientific knowledge is a valid science-centered collaboration approach that can turn into a technology transfer mechanism. An alternative avenue would be to establish an S&T-related network with countries that are not very S&T-competent, yet are located in the geographical vicinity and are central to Greece's foreign policy for several geopolitical reasons. It need not be only Greece learning something from them; it would be them learning something from Greece.

A parallel action would focus on promising early-stage civilian researchers. It could be researchers of young age with a promising future – in terms of publications and outreach potential, coming from a select list of countries – for example, those in the geographical vicinity of Greece. These individuals could be offered at least a fully paid semester to conduct research visits and, potentially, collaborate with Greek research centers and universities. This, in turn, could lead to the establishment of research partnerships, co-authoring opportunities as well as much-needed bonds of friendship with the next generation of senior researchers and policy-makers from these countries. Again, talking about individuals that will climb the social ladder, it is in the best interest of Greece to have them immersed in the domestic context and capitalize (in the future) upon then-formed research and technological networks. Existing EU financing schemes (e.g. Erasmus) can be used as blueprints. Yet, they should not constitute the only mechanism to initiate such visits. Enhancing one's own national interest through enabling bilateral science networks should be based on criteria that fit one's purpose.

In the case of military students, Greek defence academic institutions have a long experience in providing education for cadets from quite a few regional as well as more remote countries (from Balkan, Africa, and Armenia). Yet, formalized military networking extends only during the years of military schooling. From then on, these cadets return home and preservation of links with Greece rests entirely upon their predisposition. Some of them may probably reach the higher military echelons and/or are further employed in top industrial, technological, and policy positions. Therefore, maintaining formal links with Greece stands as a valid future-oriented approach that could open up the potential of establishing collaborative scientific, technological, and entrepreneurial arrangements. Closely affiliated is the newly found military Erasmus programme. Participation should be sought, not only because of securing much-needed research funds but as a stepping stone to formulate lasting Greek military partnerships with European countries of interest. Moreover, this should be embedded in the wider techno-industrial military strategy. Perhaps, similar steps can be taken with non-European countries, such as Israel and India through similar customized initiatives that focus on the exchange of military cadets and personnel.

The projecting force of the soft kind

Large countries have long ago realized the political force of S&T activities in terms of establishing common technological, industrial, and, indeed, political trajectories between countries. Yet, as of recently, the renewed emphasis on networks, knowledge creation, and technology transfer increased the importance of

international scientific collaboration among the available foreign policy tools and practices. These activities do not raise eyebrows as core military activities do, countries are increasingly steering towards this direction and are conceptualizing new policy themes, such as science diplomacy and people-to-people contacts, to increase their soft global footprint. It is exactly for the same reasons that Greece should go for it. Especially since its science capabilities are of high quality, in terms of both highly educated individuals and scientific output.

Endnotes

1 Science, Technology and Art in International Relations (STAIR) was chartered in 2014 based on the recognition that science and technology are at the core of global politics shaping much of the everyday reality of international security, statecraft, development, design of critical global infrastructures, approaches to social justice, and the practices of global governance (see https://www.isanet.org/ISA/Sections/STAIR) (accessed 09.08.2021). Creation of STAIR points to a wider consideration – that is the set of required skills and dexterities IR scholars and practitioners should possess. In other words, what is the level of technical and scientific expertise required of them?

2 A possible exception to the rule is Israel. A country that has worked extensively on issues of nuclear proliferation, bioterrorism, weapons and missile defence. These steps, however, were undertaken for the purposes of national security and deterrence.

3 Since 2017, ''Knowledge Bridges'' (https://www.knowledgebridges.gr/) has been seeking to connect Greeks, irrespective of the physical presence globally. Aspiring to create networks between highly educated and capable individuals and firms that can be turned into collaboration schemes, the initiative is founded on the notion of both physical and digital return to Greece.

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Insights from the Vaccine Development: Strengthening the Power of Health Diplomacy

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Introduction

From the beginning of this pandemic till now, the world has faced enormous challenges. The novel coronavirus (SARS-CoV-2) that originated in Wuhan, China around November 2019 quickly spread across the globe, causing the world's most severe pandemic in recent history (Mizumoto et al., 2020, and Sahu et al., 2020). As of 26 September 2021, over 230 million people have been infected with this virus and over 4.7 million people have lost their lives. To foster the development of COVID-19 vaccines, five acceleration factors, are important - the technology factor (based on technology, regulatory and R&D strategy factors), collaboration, strategic alliance financing, manufacturing scale-up, and supply strategies (Garcia *et al.*, 2021). The pandemic has also changed our outlook and has brought forth the humanitarian approach. We are now looking for solutions on a global level, whether it is about sharing medical equipment, or vaccine development and harnessing the power of diplomacy to tackle this global challenge.

COVID-19 has grown to a pandemic level, affecting over 180 countries in just three months of its start. From moderate, self-limiting illness to serious COVID-19 pneumonia, multi-organ deficiency, cytokine storm, and death, the disorder spans an entire clinical spectrum (Sahu*et al.*, 2020). Even now, the situation seems challenging with the emergence of new and more infective mutant strains. The magnitude of the damage to the

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economy has been great. It is important therefore to learn from the experience, and have framework/guidelines in place ahead of time (Sahu*et al.*, 2020). India has made a great effort and has practiced vaccine diplomacy, while keeping in view the needs of its citizens and ensuring the availability of COVID-19 vaccines within the country. China and Russia have also engaged in such diplomacy, whereas companies like Pfizer and Moderna are looking at it from the commercial angle.

Within few months into this pandemic, when the importance of vaccines was realized many countries initiated programs to develop COVID-19 vaccines. Indian researchers and industry also worked hard to develop a vaccine for COVID-19. India launched its COVID vaccination drive on 16th January 2021, and by now over 60 million people have been vaccinated with one or two doses. India is one of the world's largest vaccine-makers and an increasing number of countries have approached it for procuring two of the vaccines - Covaxin (jointly developed by Bharat Biotech, ICMR, and the National Institute of Virology), and Covishield (developed by the University of Oxford with AstraZeneca and manufactured by the Pune based Serum Institute of India). Three more candidate vaccines are under the final phases of clinical trials.

The vaccine distribution and deployment are making progress. Some initiatives like India's Vaccine Maitri offer a ray of hope for the worst-affected countries. Though advanced economies are administering vaccinations, majority of the low-income countries are yet to begin, potentially resulting in some parts of the world achieving herd immunity faster than others. To inoculate their populations, many advanced countries have pre-ordered more doses than needed.

Vaccine diplomacy is connected with humanitarian diplomacy as these initiatives are serving mankind and help them to survive through this pandemic. India is extending its hand to its immediate neighbors including Bangladesh, Maldives, Bhutan, Nepal, Myanmar and others, and this move will help India to increase its credibility as well as an image of a reliable vaccine supplier. Vaccine consignments carry a label "*SarveSantuNirmaya*" (may all will be free from disease), a Sanskrit verse showing our ancient traditions. This is a major step which shows India's capability of acting globally in the environment of self-sufficiency or a nationalistic approach.

India is considered to be the global hub in vaccine manufacturing and can manufacture millions of doses of the COVID-19 vaccines and many counties are relying on India's capacity. India has exported millions of indigenous vaccines to its immediate neighbours under the "Vaccine Maitri" (Vaccine friendship), (Prasanna&Varshney, 2021). This has been seen not only as a helping hand but indeed a diplomatic cum humanitarian step in the time of crisis. India has already pledged 1.1 billion vaccine doses to the World Health Organization's COVAX initiative, which would deliver COVID-19 vaccines to the poorest nations.

According to WHO by July 2021, at least seven separate vaccines have been rolled out in various countries. Vulnerable groups in all countries are being given priority. More than 200 additional vaccine candidates are being developed, with more than 60 of them moving forward into clinical trials.

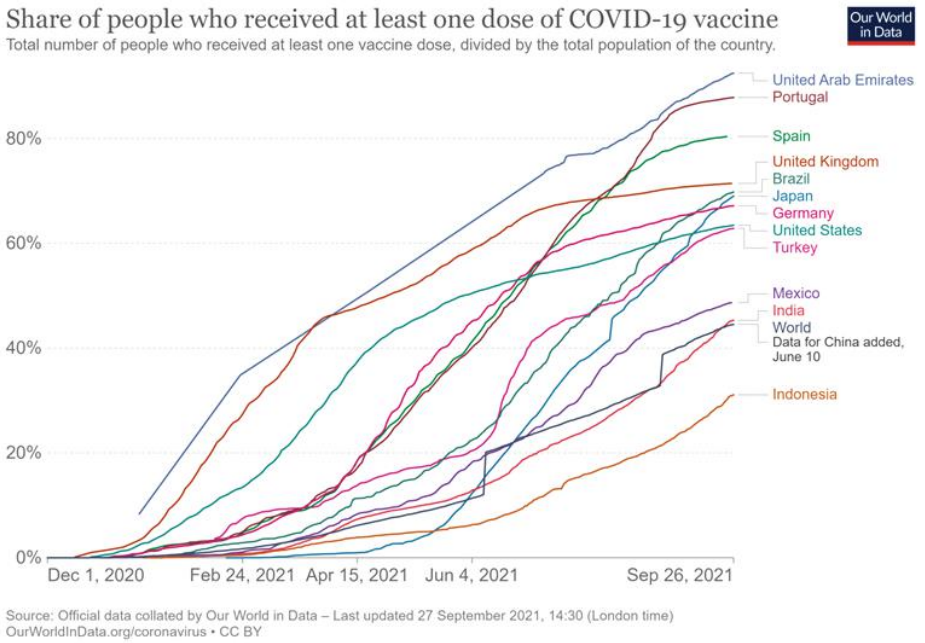
COVID-19 Vaccine R&D Status around the World

The production of polio vaccine and its implementation is a tremendous example showing how India's vaccine diplomacy has driven collaboration and coordination in times of crisis. Diplomatic efforts have also been put in place to counter various other diseases such as cholera, measles, hepatitis, Ebola, etc. A meaningful programme on vaccine research and development can open opportunities to potentially improve and strengthen foreign relations and promote peace, a form of science diplomacy.

In India, 12 vaccine candidates are in the pipeline to emerge as vaccines for the COVID-19 pandemic. Several countries are coming forward to collaborate in drug development.

COWIN

To attain universal vaccination, this platform (cowin.gov.in) was created as an open-source platform enabling nations to coordinate successful immunization with efficient monitoring. India has delivered over 855 million doses of COVID vaccinations through Cowin, including a record 25 million individuals in a single day recently. Furthermore, those who have been vaccinated can get certificates in digital form. The Prime Minister also emphasized the software's potential to be customized to meet the needs of interested countries. He expressed his hopes that guided by the 'One Earth, One Health' concept, mankind would be able to overcome the epidemic (Agriculture Infrastructure Fund, 2021). Given the scale and importance of vaccination, India chose to organize its immunization strategy entirely in digital format. This offers many



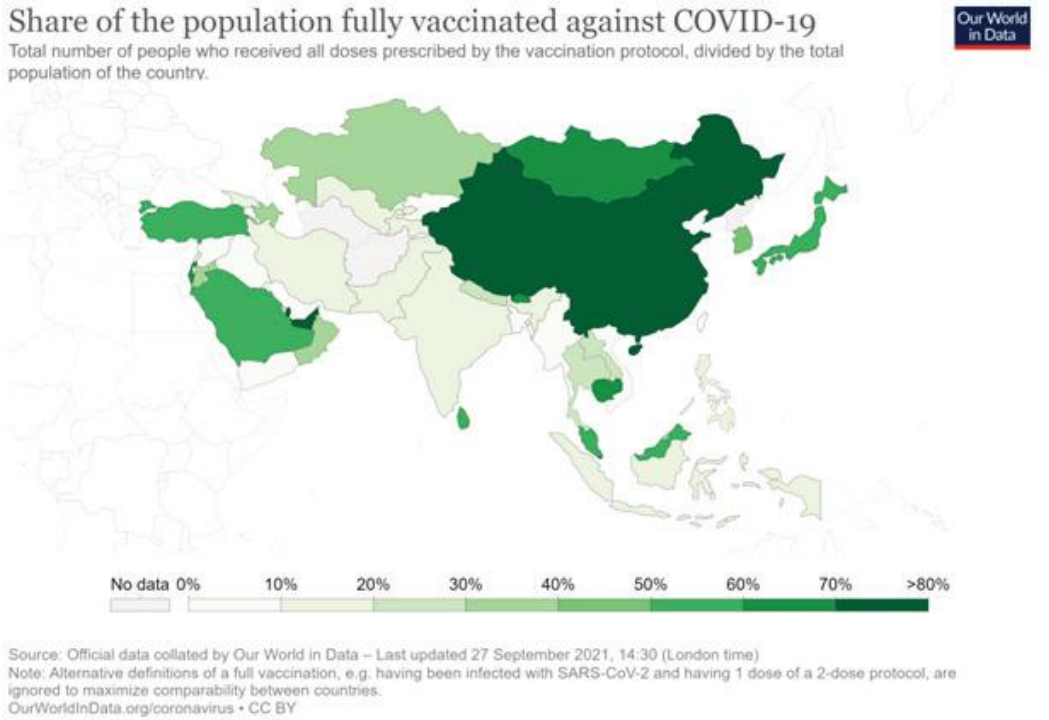
advantages to stakeholders. People may establish when, where, and by whom they were vaccinated with the assistance of safe, secure, and reliable evidence. The digital method also aids in tracking vaccine usage and reducing waste. Ms. Nirmala Sitharaman, the Finance Minister, has offered to share the Cowin platform for free with other countries, claiming that humanitarian needs outweigh economic gains. She presented India's excellent experience in combining technology with inclusive service delivery during the epidemic on the second day of the current G20 Finance Ministers and Central Bank Governors Meeting (Agriculture Infrastructure Fund, 2021).

Delta variant

B.1.617.2 (Delta) is a new worrisome variant of Sars CoV-2 that spreads extremely quickly and efficiently among people. The Delta version has been recorded in 135 countries. A variety of reasons are contributing to the growing propagation of the Sars Cov-2 virus across the world. The first is the emergence of dangerous mutants, such as the Delta variant. The second is that social mixing and mobility have grown; educational institutions have opened up, increasing interactions among individuals. The relaxation or improper use of public health and social measures is the third element. The world remains generally susceptible to infection by new variants (CDC, 2021).

India was the second-worst-affected country by COVID-19, and also the worst-affected during the COVID-19's second wave. However, India was rated 102 in genetic sequencing for SARS-CoV-2 in a Washington Post report released in April. The lack of infrastructure to do genomic research needs to be overcome to mitigate the pandemic (Kerkhove, 2021).

Figure 2: Fully vaccinated population in ASIA



COVID-19 Vaccine R&D endeavors in India

In the arena of vaccine development in this pandemic, India has demonstrated its remarkable presence and has showcased its potential. From the first dose of smallpox in 1802 to the coronavirus vaccine in 2021, centuries are witness to India's tremendous success. India has always shown its strength of vaccine development not only in COVID but also for several other deadly diseases and has established its presence as the largest vaccine manufacturer in the world. Vaccine R&D and processing were carried out by more than 30 Indian firms. Out of them, the seven candidate vaccines have received WHO clearance and are in different stages of production in India.

COVAXIN (BBV152 COVID-19 vaccine): (a whole-virion inactivated vaccine by Hyderabad-based company Bharat Biotech International Limited) was developed indigenously from the strain successfully isolated by ICMR's National Institute of Virology, Pune, Maharashtra (Bharat Biotech, 2020). Emergency use authorization (EUA) was granted in India by the regulatory authority of the Central Drugs Standard Control Organization (CDSCO). BBIL can manufacture 150 million doses per year. This vaccine has been supplied to Sri Lanka, Mongolia, Myanmar, Bahrain, Oman, the Philippines, Maldives, and Mauritius via government-to-government deals.

Covishield (AZD1222): Both *COVISHIELD*™ (manufactured by Serum Institute of India Pvt Ltd) and COVID-19 Vaccine AstraZeneca (manufactured by AstraZeneca) are ChAdOx1 nCoV-19. Vaccine platform is a replication-deficient adenoviral vectored vaccine.

ZyCoV-D: ZydusCadila's vaccine, ZyCoV-D, is being developed on a DNA vaccine platform or plasmid vector. Cadila worked with the Department of (DBT) on this project (DBT-BIRAC. 2021). The Drug Controller General of India (DCGI) has approved this Ahmedabad-based pharma company to begin Phase III clinical trials of its COVID-19 vaccine ZyCoV-D. This candidate has been supported by the National Biopharma Mission (NBM) of the Department of Biotechnology, Government of India (CDC, 2021).

Sputnik V: is a Recombinant adenovirus vaccine created by Gamaleya Institute in Russia is being manufactured in India by Dr Reddy's laboratory, Stelis biopharma, Gland Pharma, Virchow biotech, Hetero biopharma, and Panacea Biotech, with support from the Russian Direct Investment Fund (RDIF) (The Lancet, 2021).

Other vaccines include NVX-CoV2373 (Serum Institute of India/NovaVax UDSA), an RBD protein-based vaccine by (Biological E Ltd with Baylor College of Medicine/ Dynavax Technologies Corp USA) and the mRNA. The mRNA vaccine candidate HGCO19 (Gennova Biopharmaceuticals with HDT Biotech Corporation) (DBT-BIRAC. 2021). Some of the COVID vaccine candidates are nearing the end of clinical trials and should get approved for use soon. Pre-clinical trials are underway for over a dozen vaccines candidates.

ZydusCadila'sZyCoV-D: Two versions of this vaccine are being developed – first, the Measles viral strain vaccine and second the DNA vaccine. HGCO19- by *Gennova Biopharmaceuticals*, Ltd expects to launch the vaccine later in 2021, while protein-based vaccine by *Mynvax* is at the pre-clinical stage (Mukherjee, 2021).

An experimental COVID-19 vaccine is being developed by *Panacea Biotec*(with RefanaInc USA). A novel COVID-19 vaccine is being developed by Biological E Ltd., (with Baylor *College* of Medicine USA). A synthetic peptide vaccine is being developed by the *Translational Health Science and Technology Institute* (THSTI), A vaccine COVI-VAC is being developed by *Serum Institute of India*, (with Codagenix USA) (SIIPL, 2021). These are among the leading Indian vaccine manufacturers working on vaccine development for COVID-19.

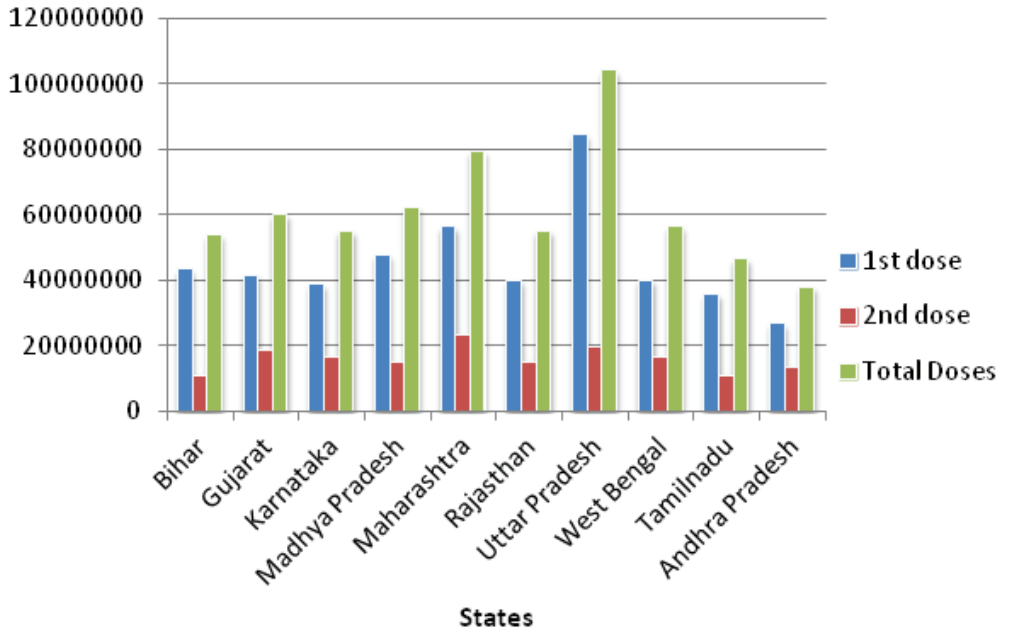
Global Capitalization for various COVID-19 vaccines

The development of a vaccine is a long process and so the financing which is involved in the development is critical. Millions of dollars have been spent on vaccines. The United States spent $4 billion on vaccine firms. This money has been distributed to six companies [Novavax (phase I), AstraZeneca (phase II), Pfizer (II&III), Moderna TX Inc (Phase III), Janssen Research & Development LLC (Phase I), Sanofi Pasteur & GSK, Merck & IAVI] with varying track records and, in many cases, on promising but untested technologies. India is set to vaccinate its population age group that is above 18 in its phase III vaccination drive which will cost about 0.36% of its GDP. The costs are met by the federal budget (0.12% of GDP), and state budgets is (0.24 percent of GDP).

Global Instruments aids easy access to COVID-19 vaccines

Various organizations have constantly been working on vaccine developments and supply. WHO introduced the ACT-Accelerator initiative, which is led by GAVI.GAVI - a global Alliance for Vaccines and immunization is a global health partnership of public and private sector

Figure 3: Total vaccinations in top 10 states in India as of 28 September 2021



organizations dedicated to "immunization for all"(Cruz et al., 2021; WHO, 2020). It was founded in 2000 to provide vaccines to children in the world's poorest countries with equal access to new and underused vaccines (Gordon, 2020). The COVAX initiative was launched by GAVI as a key component of the Access to COVID-19 Tools (ACT) Accelerator. COVAX is a global partnership aimed at accelerating the growth, manufacturing, and equal access to COVID-19 studies, treatments, and vaccines. GAVI, the Coalition for Epidemic Preparedness Innovations (CEPI), and WHO are leading COVAX in collaboration with developed and developing countries. COVAX aims to speed up the creation and production of COVID-19 vaccines while also ensuring equal and equitable access to all countries around the world.

Emerging Vaccine candidates in a developmental stage

More than 10 vaccines have been authorized for emergency use all over the world and among them, China and Russia are leaders in the COVID-19 vaccines. Russia has approved its three vaccines including Sputnik V, Epi Vac Corona, and Covivac. Similarly, four vaccines approved by China includes Coronavac, BBIBP-CorV, Convicidea, WIBP-CorV, and ZF2001 in collaboration with Uzbekistan. Apart from approved vaccines, several vaccines are in the pipeline to get approval and many of them are the result of the collaboration between global leaders. Vaccines including NVX-CoV2373 from Novavx, ZyCoV from ZydusCadila, Abdala (CIGB66) from Centre of Genetics Engineering and Biotechnology (Cuba), VIR-7831from Medicago/GSK; Dynavax, and VLA2001 from Valneva/UK National Institute for Health Research are in Phase 3 clinical trials.

Allocation and Pricing of COVID-19 vaccines

After vaccine development, manufacturers decide the price of doses, which should be affordable to reach the poorer groups. Pricing can have a significant impact on vaccine development and it can either encourage or hamper the public health efforts (Wankharand and Baruah, 2021). The Serum Institute of India in collaboration with Oxford University and AstraZeneca, had agreed to market the Covishield vaccine in India for less than Rs. 1,000 ($14) per dose. In the first two phases, where the federal government procured the vaccines, the cost was only Rs. 250 ($3.3) per dose in private hospitals while in Government hospitals, the vaccination was given free of cost.

However, Moderna Inc., a pharmaceutical company based in the United States, is expected to charge $50 to $60 per dose for its coronavirus vaccine. This price by Moderna would be appropriate only for the US and other high-income countries. The vaccine manufacturers including Pfizer, Moderna, and Merck & Co. want to benefit from their vaccinations, while Johnson &Johnson intends to price their vaccines on a not-for-profit basis.

Drugs made in India are less expensive and affordable particularly for low-income and emerging markets. The vaccines produced by Pfizer-BioNTech and Moderna, which are commonly used in the Global North, cost US$19 and US$32-37 per dose, respectively. Vaccines are cheaper in India, and vaccine

manufacturers are providing sufficient doses to the government at subsidized rates.

An important factor in the pricing of vaccines is the price paid for use of Intellectual Property (IP) and Technology (patents and royalties) used for vaccine manufacture. It is important to deal with IP barriers and facilitate technology transfer to expand the manufacturing base and increase availability as well. At the World Trade Organization (WTO), India and South Africa proposed waiving off specific provisions of the Trade-Related Aspects of Intellectual Property Rights (TRIPS) agreement (Khan and Dhama, 2021), especially to temporarily defer the IPR of SARS-CoV-2 vaccines, which will ensure equitable access to vaccines. Although the WHO Director-General and many countries supported the proposal, the United States, the United Kingdom, Canada, Norway, and the European Union opposed such a move (Gavi; DBT-BIRAC. 2021). The government should enlist the cooperation of various NGO or non-profit organizations across the world to make this process a success. In the absence of such an agreement, the recourse could be to negotiate temporary free access to technology with the patent holders, or compulsory licensing in the public interest. A similar situation had occurred in the past over the manufacture of retroviral for HIV by Indian companies.

Vaccine Maitri: India's Sanjeevani, building pillars of friendship harnessing vaccine science diplomacy

India has proven once again its belief in the slogan "Vasudhaiva Kutumbakam", the world is one family. India's "Vaccine Maitri" initiative in which India is gifting and exporting COVID-19 vaccines to 84 countries including neighbours has attracted attention (Mukherjee, 2021; SIIPL, 2021; Wankharand and Baruah, 2021). Under this initiative, India has already supplied vaccines to countries such as Bangladesh (3.3 million doses), Myanmar (1.7 million), Nepal (1.1 million), etc (Wankharand and Baruah, 2021; Khan and Dhama, 2021).This initiative has proved to be a major milestone to strengthen soft power and strengthen relations with other countries. India is widely known as the world's vaccine capital and provides the global community with approximately 60% of vaccines for several diseases such as DPT, measles, and BCG to fulfill global requirements (Khan and Dhama, 2021). Vaccine Maitri has been extremely successful and very well-liked by our partner countries across the world (Gavi; WHO, 2020). As the pace of vaccinations in India picked up, the export of vaccines was temporarily restricted to ensure domestic availability. However, by September 2021, the production of various types of vaccines has increased considerably, and India has announced that it will resume the supply of vaccines especially to needy countries, bilaterally as well as through multilateral initiatives. (India Today, 2021). This announcement has been welcomed by many countries.

Since the COVID-19 pandemic broke out last year, India has been supplying hydroxychloroquine to the United States and Europe, with a total of 150 countries receiving the drug. Apart from the United Kingdom, India has distributed 65 million vaccine doses to 93 countries in Asia, Latin America, and Africa. India in turn has received medical assistance from

countries such as the United States, France, the United Arab Emirates, Denmark, Singapore, Israel, and some EU nations, especially during the oxygen supply crisis.

Vaccine Nationalism: Obstacle to build diplomatic relations

Vaccine nationalism happens when a country procures vaccine doses for its people and prioritizes its domestic markets over needs of other countries (Wankharand & Baruah, 2021; Khan &Dhama, 2021). This happens through excessive pre-purchase arrangements between a government and vaccine manufacturers. Vaccine nationalism has happened in several other health emergencies, such as the 2009 H1N1 influenza pandemic and outbreaks of HIV/AIDS, smallpox, and polio. Vaccines were available to low-income countries only after high-income countries had obtained sufficient supplies (Sharma and Varshney, 2021). Vaccine nationalism may result in unfair COVID-19 vaccine distribution, costing the global economy up to $1.2 trillion a year in GDP terms (Marco Hafner, 2020). Even if certain countries are effective in immunizing their citizens against the virus, there would continue to be a major risk if the virus is not under control in all regions of the globe.

Vaccine nationalism is detrimental to fair vaccine access. Countries with less capital and bargaining power are further disadvantaged. Moreover, it denies people in the Global South to timely access essential public health services. When taken to the logical conclusion, it allocates vaccines to populations in wealthy nations which are marginally at-risk, over populations in emerging nations that are at greater risk. To prevent this, the World Health Organization and other international organizations have developed the COVID-19 Vaccines Global Access (COVAX) Facility.

COVAX is a global initiative coordinated by the World Health Organization (WHO), the Coalition for Epidemic Preparedness Innovations, (CEPI), and Gavi, the Vaccine Alliance, that accelerates and ensures the development, production and equitable access to COVID-19 vaccines (De, 2020). The goal of COVAX is to deliver two billion doses of safe, effective vaccines by the end of 2021 that have passed regulatory approval. The COVAX Facility will also maintain a buffer of doses for emergency and humanitarian use, including dealing with severe outbreaks before they spiral out of control. Finally, COVAX is the only truly global solution to the COVID-19 pandemic.

However, while it is good to protect and fulfill the demand of citizens, not supplying vaccines to other needy and lower-income countries is a negative policy for a country, and will hinder diplomatic relations. Solidarity has proven to be a weapon for fighting such crises in the past. Countries should look at the wider picture where they might be in a situation where they need this type of relief from other countries. There is a need to think about the present but also not neglect consequences in the future. Leaving large populations unvaccinated increases the risks of new mutant strains emerging which is a threat to all. The recent move in some countries to administer a third booster dose of vaccines to those already fully vaccinated will further aggravate the vaccine supply situation. For this reason, taking into account various factors, the WHO has advised against going in for third booster doses.

India's approach towards self-reliance/Atmanirbhar Bharat without hampering the international collaborations

Self-reliance tries to reduce the vulnerability of the country to international supply chains. In the case of India, it is not just about fulfilling its own needs but also playing an important global role in the fight against the lethal virus. India has given 60.4 million vaccine doses to 76 countries through various modalities, including grants in aid, donations, commercial supplies, and through the WHO-GAVI COVAX partnership, as of March 22, 2021. India has sent vaccines to countries in South Asia, Africa, South America, and the Caribbean, and will send more to Southeast Asia and the Pacific in the near future (Wankharand & Baruah, 2021).

The vaccines manufactured in India are better suited to countries with a weaker cold chain and infrastructure. Storage of Pfizer and Moderna vaccines require very low temperatures, while both Indian-made vaccines can be stored at temperatures ranging from 2 to 8 degrees Celsius temperatures (DBT-BIRAC. 2021; Mukherjee, 2021). India also has considerable capabilities and experience in mass immunization initiatives that it is willing to share. Moreover, in comparison to other foreign vaccines, the prices of Indian vaccines are much lower.

Progressive showcase commitments: accelerating vaccine development

There are tools for accelerating the production and availability of new vaccines in developed countries. If an effective vaccine is produced and requested by developing world governments, an AMC is a budgetary commitment to finance the future potential procurement of a currently inaccessible vaccine. The US government had entered into AMC agreements with several companies, including a $1.6 billion contract with Novavax to buy 100 million doses before clinical trials are finished, and a $1.95 billion deal with Pfizer and BioNTech to buy 100 million doses. Japan's government is in negotiations with Johnson &Johnson, a US healthcare conglomerate, to secure allocations of the upcoming COVID-19 vaccine. The British government has also agreed to buy 60 million doses of a new coronavirus vaccine from GlaxoSmithKline and Sanofi Pasteur.

"Oxygen Maitri": Global response towards oxygen shortage in India

The second wave hit India very hard in March 2021, due to the new delta strain and rise in covid cases, and people were dying due to the shortage of oxygen supply in hospitals (Hafner, M. et al. 2020; Awasthi, 2020; Prasanna and Varshney, 2021; Surie, 2021). While many countries came forward expressing solidarity and extending assistance, India identified several countries to procure high-capacity tankers/containers and oxygen gas cylinders.

To deal with the serious crisis over the oxygen shortage in India, assistance was received from many countries such as Singapore (Bagchi, 2021). The Indian Air Force airlifted four cryogenic oxygen tanks from Singapore. The government launched a multi-pronged strategy to increase oxygen production from overseas to avoid supply chain disturbances. India has struggled to cope with the sudden

increase in demand for oxygen, forcing hospitals to issue SOS messages on social media. With the downward trend in cases and the improved supply infrastructure for medical oxygen, the crisis has been overcome.

Battle against a single enemy: why not fight it together

The challenges like climate change, health crises or pandemics, global warming, etc affect the world. If challenges and problems are global, the strategies or remedies against the problem should also be global. Therefore, the world, as well as India, should focus on collaboration and collective solidarity (Bagchi, 2021; Prasanna and Varshney, 2021). In this spirit, India has offered to share its special IT platform Cowin for vaccination management with other countries.

Discussion

Vaccine development for a new and emerging disease is very important for saving lives and reducing health system burdens. No vaccine has 100% efficacy so vaccine manufacturers should look forward to achieving higher efficacy with minimal side effects and prepare for new variants of concerns that are more infective and lethal than the original virus. Companies should also follow ethical practices which will help to maintain and build trust among the population. The ethical aspects of the distribution of life-saving drugs and evaluating public health interventions to vulnerable groups have often been neglected. The factors like valuation of life linked to a particular country of origin, profit prioritization in clinical trials need to be regulated. The exploitation of vulnerable groups has resulted in vaccine hesitancy where vaccines and drugs caused adverse effects (Prasanna and Varshney, 2021). According to the World Health Organization, vaccination hesitancy refers to the delay in the acceptance or refusal of vaccines despite the availability of vaccine services (Prasanna and Varshney, 2021). It is influenced by factors such as complacency, convenience, and confidence (Binagwaho et al., 2021). This pandemic allows reversing unethical practices in global health (Prasanna and Varshney, 2021). While ensuring the ethical inclusion of vulnerable groups in vaccine development appropriate and additional safeguards should be provided for participant's well-being (Binagwaho et al., 2021). Consequently, there is a great need to ensure ethical conduct of research, decision making in clinical care, and public health policy making at every level. The pricing of vaccines is also a key concern and should not pose a heavy burden on the population.

Transparency plays an important role so that vaccine hesitancy does not become a barrier to the success of inoculation drives all over the world. (WHO, 2021; Gordon, 2020). Countries are under severe pressure to secure COVID-19 vaccines. Sometimes lack of transparency risks equitable access to vaccines, development, procurement, allocation, and distribution of vaccines leads to global threat (Transparency International, 2021). Governments must make it a condition for any funds given to GAVI that product cost details should be provided. GAVI must also be transparent about the Facility's construction and plans, including any deals reached with industry; all arrangements must be made public.

WHO, UNICEF, the World Bank and the Bill & Melinda Gates Foundation are

among its key partners. The main role of Gavi is to save children's lives and protect people's health by increasing access to immunization in poor countries. It contributes to achieving the United Nations' Millennium Development Goals by focusing on performance, outcomes, and results. Its partners provide funding for vaccines and intellectual resources for care advancement. They contribute, also, to strengthening the capacity of the health system to deliver immunization and other health services in a sustainable manner. At the World Health Assembly, GAVI is an observer. India is a GAVI recipient, therefore it will receive a share of the vaccinations from the COVAX facility.

Vaccines require storage at low temperatures during their distribution (Prasanna and Varshney, 2021). Therefore it is important to distribute these vaccines efficiently without making the vaccine ineffective (Awasthi, 2020). Cold chain technologies will assume an essential part in administering vaccines around the world. Administration, transporting vaccines, and distributing them from factories to cold storage facilities and especially to remote locations is still a challenging task (Hafner, M. et al. 2020). Reaching several places, with poor connectivity, where roads are not in good condition or too narrow in size is a matter of great concern. It may require vans and light commercial vehicles that can easily reach rural areas without any obstacles. Transportation in urban areas is less challenging but the supply of vaccines in remote areas is still in the limelight due to hurdles involved in this transportation process. India has planned some of the major steps to transport vaccines to the remotest part of the country (Shahidi and Rampal, 2020). In addition to being cheaper, the made-in India vaccines are more suitable for countries with weak cold chains and less infrastructure facilities (WHO, 2020). Indian-made vaccines can be stored at between 2 and 8 degrees Celsius refrigerator temperatures.

To address public health crises, global health diplomacy can serve as a connecting link between international collaboration, resource allocation, and mutual strategic trust for mutual benefit in the global context. Also to achieve sustainable and equitable development, diagnostic tools, treatments, and vaccinations should be made available to all persons, regardless of nationality or ethnicity. A step like this will act as a springboard for future global health efforts. Global vaccine security will be ensured by the development and large-scale manufacturing of immunogenic, safe, and cost-effective COVID-19 vaccines with strong global cooperation, leadership, and health diplomacy, as well as the implementation of effective public policies that ensure equitable access to all countries (The Lancet, 2021). This will undoubtedly assist in meeting the worldwide vaccination demand and combating the current pandemic, as well as open possibilities for accomplishing long-term health-promoting goals in the battle against future pandemics. India sets an example as an emerging Asian superpower in science and technology for supplying vaccines. A healthy and long-standing scientific cooperation is needed from various countries to tackle this type of pandemic (Javed and Chattu, 2020). Priority should be given for improving joint research collaborations and programmes in common areas of interest, as well as cultivating strategic relationships with resource-rich countries to provide solutions to global challenges

and to strengthen international cooperation during these unprecedented times.

However, to reap the benefits of these ongoing interdisciplinary concepts of diplomatic activities, the scientific research community, policymakers, and global stakeholders must commit to collective action and commitment for the global development, including supporting the GHD approach in advancing the United Nations Sustainable Development Goals (SDGs) (Kickbusch et al., 2007). In this context, the application and practice of global health diplomacy (GHD) becomes very critical. It enables multiple stakeholders to contribute to greater health needs of humanity and foster stronger Interdisciplinary approaches, promoting negotiations that shape and manage the global policy environment for health (AlKhaldi et al., 2021).

Science and technology Minister, Dr. Jitendra Singh recently emphasized the importance of R&D activities and ground-level collaboration (Singh, 2021). He said that India has huge resource material for research. It can offer the world exclusive preventive and therapeutic options, particularly because Indian phenotype and genotype are different from the rest of the world (Singh, 2021). "COVID-19 offers an appropriate opportunity for us to work on strategic research outcomes which are specifically India-centric, and can provide answers to many questions posed by the contemporary health scenario," he said.

The concepts of global health diplomacy, vaccine diplomacy, and fair research collaboration are the emerging powerful tools, which must be used for unifying the world and in building a safer and interconnected community. Universal health coverage (UHC) and sustainable development goals (SDGs) can only be achieved if the underlying root causes such as socioeconomic, gender and health inequities are appropriately addressed (AlKhaldi et al., 2021). National unity and global solidarity can strengthen GHD towards achieving considerable progress in global health. This process will strengthen our diplomatic relations and unleash the power of health diplomacy.

S&T Minister Dr. Singh said science and technology will determine the status and contours of the future global economy and India is poised to play a leading role in the comity of nations.

Cooperation in S&T by strengthening existing international connections, sharing best practices, and initiating new collaborations between governments and research institutions, exploring new research areas by initiating joint research projects in emerging sciences with potential for translating research into marketable applications of social relevance are need of the hour.

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Science Diplomacy for Scientific Advancement and Achievement of SDGs in Bangladesh

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Introduction

Bangladesh is one of the fastest-growing economies with a young population (almost half of the population under twenty-five years of age). The country has achieved the status of a lower-middle-income country in 2015 from a low-income country and is on track to leave the United Nations list of least developed countries in 2024. Since 2011, Bangladesh has had an annual growth rate of Gross Domestic Product (GDP) over 6.0 per cent and is now one of the fastest-growing economies in the world, thanks to high-yielding agriculture, readymade garment exports, remittances, and demographic dividend. On the other hand, Bangladesh is extremely vulnerable to climate change and suffers from environmental pollution, particularly air pollution and unemployment. Other major challenges that Bangladesh is facing today include ensuring food security, supplying clean water, controlling infectious diseases, addressing urbanization, building a green energy economy, and reducing biodiversity loss while creating employment for the youth population. Creating employment in any sector including tourism, agriculture, fisheries can impact biodiversity due to energy consumption and use of land and other natural resources (Rayment*et al.*, 2012). The COVID-19 pandemic has made all these challenges more

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intense and complicated. Overcoming all these challenges requires scientific research, innovation, and technological advancement.

Despite economic progress, the tertiary education and research sectors are not performing well. The culture and practice of research to develop products, processes and services have been largely missing in the country's tertiary education landscape, universities, and research organizations. As a result, Bangladesh was 137th among 160 countries in the ranking of patent filing for various countries in 2013. The result is the high (16 per cent) unemployment of tertiary-educated youth, higher than primary educated people (Rahman *et al.*, 2019). This undermines the country's competitiveness in the global knowledge economy and global knowledge index. Bangladesh Tertiary Education Sector Review report by the World Bank reported about Bangladeshi tertiary education and research sector (Rahman *et al.*, 2019). Achieving sustainable development goals is also challenging for the country, particularly in the context of the COVID-19 pandemic. The facts described in the World Bank report are evident in the classification of Bangladesh as a scientifically lagging country among four types of countries, scientifically advanced, proficient, developing, and lagging countries, as mentioned by The World Academy of Sciences (TWAS, 2021). Without scientific advancement, innovation, and technology development, Bangladesh cannot attain Sustainable Development Goals (SDGs) and have sustainable solutions to many of its problems. In the context of these realities, Science Diplomacy can help the country in making scientific advancements and achieving SDGs like the countries of the European Union and scientifically proficient neighbour, India. This paper discusses the present status of science diplomacy in Bangladesh, how science diplomacy can help achieve scientific advancement and SDGs, and what steps Bangladesh should take for effective science diplomacy.

Present status of Science Diplomacy in Bangladesh

Science Diplomacy is an almost unheard or hardly uttered term in the circle of the policymakers' and scientists' community of Bangladesh. There is no science diplomacy wing or initiative in the foreign ministry of Bangladesh. Nothing significant can be found about science diplomacy if we search the websites of the Ministry of Science and Technology of Bangladesh, Bangladesh Academy of Sciences (BAS), or the Foreign Ministry of Bangladesh. The National Young Academy of Bangladesh has just started a working group for promoting science diplomacy and improving the leadership of academics and researchers. This is the only initiative for science diplomacy till today. Due to the absence of the term science diplomacy in the above-mentioned sources, a recent review article of science diplomacy in the South Asia region could not mention any science diplomacy initiative from Bangladesh, though initiative and activities from few other countries were mentioned (Ahmed *et al.*, 2021).

Science Diplomacy tools in Bangladesh

On account of the lack of explicit Science Diplomacy activities and lack of a formal body for science diplomacy in any ministry

or organization of the country, Bangladeshi is devoid of all three types of science diplomacy tools.

Strategic tools

The literature review and internet search revealed that there is no strategic tool for Science Diplomacy, that is, there is no science diplomacy policy document in Bangladesh. Hence, it is obvious that Bangladesh has not set any goal in the realm of science diplomacy let alone devised any plan to achieve it.

Support tools

In Bangladesh, there is no science diplomacy forum. No university or institute in Bangladesh teaches students to become scientists with knowledge for operating in the science-policy interface. Hence, there are no training activities regarding science diplomacy and awareness-building activity geared towards scientists and/or diplomats. Consequently, professional scientists, researchers in any field are devoid of training in the policy process, introduction to science diplomacy, and capacity to deliver sound science advice. Thus, science diplomacy awareness among Bangladeshi academics, professional researchers, and (Natural and Social sciences) engineers tends to be very limited. Hence, there are hardly any human resources at different levels of the ministries who are trained or familiar with science diplomacy. However, there are few Bangladeshi diasporas with knowledge and expertise in Science Diplomacy working in developed countries.

Operational tools

Bilateral and umbrella Science and Technology agreements, S&T advisory boards, and S&T attaché or counsellor are the operational tools for science diplomacy. The Ministry of Foreign Affairs plays a key role in signing some science and technology cooperation agreements. However, this is done not as part of strategic science diplomacy, but as routine responsibility when any department of the government needs any treaty with another country in any scientific and technological matter.

a) Bilateral Science and Technology (S&T) cooperation agreements of Bangladesh

Bilateral Agreement on Science and Technology Cooperation (S&T agreement) is an operational tool for science diplomacy and belongs to diplomacy for science, the first core dimension of Science Diplomacy (Rüffin; Schreiterer, 2017). Such agreements are crucial for scientific advancement for scientifically lagging countries like Bangladesh. For these reasons, Bangladesh National Science and Technology Policy 2011 (MIST, 2011) has emphasized that "International collaboration (bilateral agreements and MOUs) in science & technology should be fully used for furthering national interest as an important component of foreign policy initiatives." However, Bangladesh is not fully using bilateral S&T agreements for national interest and as a component of foreign relationships. There are only a few bilateral S&T agreements. The theme of Science Diplomacy, Diplomacy (foreign ministry) for Science, however, is playing a limited role in Bangladesh.

b) S&T Agreements with India and other countries

Bangladesh signed its first bilateral agreement in science and technology with India in 1982 (Gupta *et al.*, 2004), and was the first South Asian country

to sign a bilateral 10 years' scientific cooperation agreement with the USA in 2003, which was renewed and is operational. Bangladesh has also renewed its bilateral science and technology agreement with India and has signed a nuclear power agreement with Russia (2015) and later India has joined this treaty. Here, Diplomacy for Science came into action. Russia is also training the nuclear plant's Bangladeshi staff on the use of its reactors for the generation of electricity and related research. Bangladesh expects the plant to go online by 2021, generating 10 percent of the country's electricity (WNN, 2015; WNN, 2017). Prominent national and regional newspapers report that space and information technology are the other two areas of cooperation between Bangladesh and India. In 2020, Bangladesh and India signed seven agreements with top priority in energy cooperation. Bangladesh has signed few S&T agreements, whereas its neighbour India has bilateral Science, Technology, and Innovation (STI) cooperation agreements with 83 countries (DST, 2021). Bangladesh should increase diplomatic effort to increase S&T cooperation with India, the only scientifically proficient country in South Asia, for scientific advancement. Senior scientists and policy influencers must also come forward to strengthen cooperation in every sector of science like that of clean energy. Scientifically developing Pakistan should also not be neglected in scientific collaboration. However, bilateral collaborations mostly focus on the training of S&T personnel, exchange of scientists, joint research, and development projects. Thus, bilateral agreements help develop research culture through infrastructures and human resource development, and attitude and mindset change. Ultimately these agreements also support science-based industries much needed for Bangladesh, which has a high unemployment rate of tertiary educated people.

c. Umbrella or framework agreements

Bangladesh also has scientific collaborations through regional, and multilateral agreements, through various agencies of the United Nations, such as the United Nations Educational, Scientific and Cultural Organization (UNESCO), United Nations Industrial Development Organization (UNIDO), United Nations Environmental Program (UNEP), International Labour Organization (ILO), World Health Organization (WHO), Food and Agriculture Organization (FAO), International atomic energy agency (IAEA) and the World Bank and South Asian Association Regional Cooperation (SAARC) (Gupta *et al.*, 2004). Diplomatic efforts, engagement of trained science diplomats, should be initiated to make those agreements effective for Bangladesh. Bangladesh should also focus on inking bilateral S & T agreements with other South Asian countries to solve common problems, such as biodiversity loss, climate change, environmental pollution, water scarcity and degradation, infectious disease control, and other challenges. Because these are common problems of the region and bi or multilateral agreements can easily be reached for a win-win future for all the countries and mitigate these common problems in the region. On the other hand, researching cooperation with other countries due to S&T agreements will provide access to additional expertise from other countries, sharing costs of research with partners of the agreement will save time and

money involving less human and other resources. As a result, knowledge, skills, and technology transfer to Bangladesh, in other words, the scientific advancement of Bangladesh will be faster at a lower cost. Effective international science, technology, and innovation agreements bring many benefits for all the signing parties. Such agreements exchange experiences, change funding patterns, increase access to research infrastructures, improve human resources, research reputation of the country, increase innovation and bring research excellence and ultimately build the S&T capacity of the country (Fikkers and Horvat, 2014). Hence signing S&T agreements with around 100 countries, like Indian (83) and Germany's (120) bilateral S&T agreements, should be the priority of the Science Diplomacy of Bangladesh (DST, 2021).

d. Science advisors at national, departmental, and embassy level

There is no national science and technology advisory board. Presently, the Prime Minister of Bangladesh has many advisers but none of them advises on science and Technology though one adviser has a portfolio of information and communication technology. There is no permanent national chief scientist or departmental science advisers' positions in Bangladesh like many other countries. Bangladesh has not appointed any S&T attaché.

Science diplomacy for fighting COVID-19 and Advancement in the Health sector

The world is in crisis over the availability of the vaccine for COVID-19 and the scenario is not different in Bangladesh. The scenario is rapidly changing and newspaper reports are the source of information for vaccine diplomacy and struggle. Initially, Bangladesh had only one source for COVID-19 Vaccine, The Serum Institute of India. Bangladesh got only 3.3 million vaccines from India before India stopped the export of vaccines when they faced the severe second wave of COVID-19 infection and death. Under such a situation, Bangladesh had to stop vaccination due to shortage of the vaccine and made all-out and aggressive diplomacy to get vaccines as donations or purchases from countries like the USA, UK, Japan, Australia, and Russia. With this vigorous effort, Bangladesh managed vaccines from Moderna and Sinovac for almost one million of its 160 million population. Despite its all-out effort, Bangladesh managed to vaccinate only 2.6 percent of its population over the last six months since it started vaccination (Hannah Ritchie, 2020). For the vaccination of the rest of around 150 million people, Bangladesh needs to continue vaccine diplomacy with the following focus.

The first focus of Bangladesh vaccine diplomacy must be to bring vaccines from different sources, and the second priority should be local manufacturing of vaccines developed in other countries. Bangladeshi pharmaceuticals can produce vaccines if the formula is given. Newspapers report that Bangladesh has already signed an agreement with Russia to produce their vaccine in Bangladesh. The third focus of vaccine diplomacy should be to help local COVID-19 candidate vaccine developer, Globe Biotech Company, in organizing all the necessary technical, logistical, regulatory, and financial support so that they can take their vaccine to people to protect them against COVID-19. The fourth

focus should be to make preparations to fight future pandemics. As there will be many more pandemics coming in the future (Cohen, 2020). To prepare best for all the future pandemics, Bangladesh needs to invest in scientists and science diplomats and to include them in the policy-making process. Bangladesh must appoint an advisory board for the health sector including experts in infectious and non-infectious diseases, vaccine manufacturing, and epidemiologists from home and abroad. With this Bangladesh should have immediate, short-term, and long-term plans to prepare for future pandemics.

Science Diplomacy (SD) for achieving SDG in Bangladesh

The seventeen SDGs are interrelated and interdependent; hardly any SDG can be achieved without achieving another. On the other hand, the use of existing technologies, developing new technologies or innovation is central to the implementation of Agenda 2030 and achieving SDGs (Saner, 2015). But, being a scientifically lagging country, it is difficult for Bangladesh to achieve the scientific innovation and technological development required to achieve SDGs alone. Collaboration with other countries and regional and multinational research organizations is crucial for developing new technologies and bringing in advanced technologies or transferring technologies. Hence, Bangladesh must bring technology diplomacy into play to minimize the technology gaps for achieving the SDGs.

Artificial Intelligence (AI) can play a crucial role in the achievement of SDGs. Vinuesa*et al.* (2020) found that AI could accelerate 134 targets while it may decelerate 59 targets. Thus, it has created both prospects and fears. However, to keep pace with the current advancement of AI around the world, the National Strategy for Artificial Intelligence Bangladesh (2019-2014) has been prepared (Desh. AI, 2019). To ameliorate the life of farmers, Bangladesh could use AI-assisted robotics, big data investigation, the Internet of Things (IoT), and genomics. Bangladesh must engage in science or technology diplomacy to make necessary AI-based techniques and technology available and utilized in the country.

Bangladesh needs to deal with the climate change issue seriously. Bangladesh has already embarked on climate change diplomacy and is an invitee to the Climate Change Summit by the UN and the USA. By involving climate scientists from home and abroad, Bangladesh should emphasize creating job opportunities, enhancing economic growth, and fostering innovative modes of production and consumption, not only for carbon-emissions reduction (Ollivier-Mrejen*et al.*, 2018).

Bangladesh was ranked 116th among 131 countries in Global Innovation Index (GII), 2020 released by World Intellectual Property Organization (WIPO) (Dutta, 2020), and was ranked 112th out of 138 countries in Global Knowledge Index, 2020 (Ghriss*et al.*, 2020). Without effective bilateral science and technology cooperation agreements, Bangladesh cannot make progress in innovation. So, vigorous diplomatic efforts are needed for scientific collaboration and cooperation (Diplomacy for Science). To keep the promise of adopting science, technology, and innovation strategies as integral elements of national sustainable development strategies, action must

be taken by Bangladesh to enhance knowledge sharing and collaboration (UNDESA, 2015).

Less developed countries like Bangladesh require the transfer of technology from highly developed industrialized countries. To make SDGs a sustainable reality every country needs new technology and sharing of technology among countries can be accomplished through S&T agreements when Diplomacy for Science (science diplomacy) is in action (Saner, 2015). To transfer and adopt advanced technology from developed countries, the Bangladesh Council of Scientific and Industrial Research (BCSIR) has established the Institute of Technology Transfer and Innovation (ITTI). Recently, ITTI introduced soil-less grass-vegetable farming (hydroponics) and Recirculating Aquaculture System (RAS) through technology transfer from other countries that created huge enthusiasm among farmers and entrepreneurs. Technology transfer between Bangladesh Agricultural Research Institute (BARI) and International Crops Research Institute for The Semi-Arid Tropics (ICRISAT) is one of the finest examples of Science Diplomacy. In association with ICRISAT, BARI has introduced a new variety of chickpea named BARI Chola-10 in Bangladesh which is heat tolerant, resistant to botrytis grey mold, and high yielding. This collaborative work contributes to SDG 2, 13, and 17 (ICRISAT, 2017). Bangladesh must speed up diplomacy for science for many such techniques and technology transfer and developing new technology in the country to create sustainable alliances with developing and developed countries to acquire advanced technologies to achieve SDGs.

Science Diplomacy for Bangladesh: The Way Forward

Science diplomacy should be initiated in Bangladesh without any further delay. The foreign policy of the country must integrate science diplomacy for collaboration in Science and technology with countries around the world, particularly with scientifically advanced countries.

Bangladesh should take the following steps to be benefitted from Science Diplomacy:

- Establish a Science Diplomacy wing in the Foreign Ministry of Bangladesh in consultation with the Ministry of Science and Technology, Bangladesh Academy of Sciences (BAS), and National Young Academy of Bangladesh (NYAB).
- Develop and deploy necessary science diplomacy tools- strategic, operational, and support tools for effective science diplomacy.
- An Independent science diplomacy forum should be established in the country by the national science academies for study and research on science diplomacy.
- Few universities should incorporate science Diplomacy in their curriculum.
- Diplomats, scientists, and academics should be trained in Science diplomacy.
- Governments and policymakers should encourage the young scientists of the country to engage in science diplomacy at organizational and national levels.
- Appointments of science attaché or consular: Government should appoint science *attachés* or Science counsellors in the diplomatic mission in, at least, scientifically advanced 10 countries, for the scientific collaboration and advancement of the country.

- Bangladesh must sign bilateral science & technology agreements with all countries with which it has a diplomatic relationship.
- Exchange of scientific materials: Diplomatic initiative must be taken for easy and quick exchange of scientific materials (samples, both biological and non-biological) with other countries.
- Quick and simple visa access: Diplomatic initiative must be taken to simplify and quicken visa processing for scientists to attend conferences or collaborate on projects.

Science Diplomacy is the call of time, particularly in the context of the COVID-19 pandemic. Bangladesh government, scientists, and scientific bodies must bring Science Diplomacy into play for the scientific advancement of the country, fighting present and future pandemics and achieving SDGs. Bangladeshi scientists' communities must engage in science diplomacy to build bridges with neighbouring and other countries through closer interactions between science and diplomacy and elevate the role of science in foreign policy to address national, regional, and global challenges.

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Opportunities, Challenges, and Policy Imperatives in the COVID-19 Era

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Introduction

The rapid spread of SARS-CoV-2 (COVID-19) in the initial months of the year 2020 caught the globe unaware and threw unprecedented challenges before the healthcare system. Since it was a new virus on which no prior knowledge existed, it posed a great challenge to all countries to stop its spread and to bring down the morbidity, mortality, and suffering it inflicted on a large part of the human population. The inadequate health infrastructure and unequal access to health systems also posed a serious challenge for treating those infected by COVID-19 and to prevent/control its further spread. The COVID-19 pandemic motivated strong research and development (R&D) efforts to discover/invent/make a vaccine/drug to prevent/cure SARS CoV2 infection.

Although popularly known as the pharmacy of the world, the pandemic has underlined India's large-scale dependence on China for raw materials required for drug manufacturing, including the Active Pharmaceutical Ingredients (APIs), and intermediaries. Substituting imports from China proved to be difficult for Indian industry. This situation had affected the country's ability to supply essential drugs at the peak of the pandemic. Inadequate supply of raw materials also posed a challenge for India to ensure rapid and

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timely production of vaccines during the pandemic. This is in sharp contrast to developed countries where the vaccine industry quickly leveraged available platform technologies, infrastructure, and resources to produce vaccines. Inadequate health care infrastructure and resources also put pressure on authorities to manage the COVID-19 infected population.

Policy dialogue: Reshaping the current information on vaccines

Given such concerns for India, the CSIR-NISTADS and CSIR-NISCAIR jointly organized a policy dialogue on the theme, "The COVID-19 Vaccine: From Self-Reliance to Global leadership, Opportunities, Challenges, and Policy Imperatives in COVID Era" on 1st March 2021. Held virtually, the dialogue deliberated upon spreading awareness on vaccine issues in the Indian context. This dialogue provided a platform for young students, researchers, scientists, and technocrats to exchange knowledge and ideas to encourage innovations for the betterment of society. Experts from various organizations, including the Department of Science & Technology (DST), CSIR-IGIB, CSIR-Headquarters, BIRAC, Office of the PSA, Govt. of India participated in this discourse.

Dr. Shekar C. Mande, DG-CSIR, Secretary DSIR, in his inaugural address highlighted major contributions of CSIR-India in combating the COVID-19 pandemic and achieving self-reliance and global leadership in certain S&T areas. He noted that the country was proud of the fact that the COVID-19 vaccine which was taken by the Indian prime minister had been developed by CSIR laboratories. Taking the session forward, Dr. Anurag Agarwal, Director, CSIR-IGIB, New Delhi, informed the gathering about the active participation of his institute in a series of serosurveys, genomic research, and developing diagnostic kits.

Emphasizing the need for data transparency, Dr. Shailja Gupta, Senior Advisor from the Office of Principal Scientific Advisor (PSA) noted that *'Prime Minister himself got vaccinated at AIIMS and it builds trust* and commended Indian industry for doing a wonderful job. Dr. Shirshendu Mukherjee, Mission Director, BIRAC, New Delhi, stated that BIRAC played a crucial role in international cooperation in vaccine development. Dr. S. K. Varshney, Advisor & Head, International Cooperation, Department of Science & Technology (DST), emphasized that India is a global hub for supplying medicines and vaccines to other neighbouring countries through vaccine diplomacy. Acknowledging the need for effective science communication during the pandemic, Dr. Geethavani Rayasam, Head of Science Communication and Dissemination Division, CSIR, New Delhi, highlighted the importance of science communication and public health awareness. She added that giving the right/reliable information is extremely important in times of health emergencies.

India seeks to achieve self-reliance to deal with the COVID-19 pandemic amidst intense global competition. Over the years, India's vaccine R&D efforts have resulted in achieving self-sufficiency in vaccine production to meet the country's universal immunization needs and to combat infectious diseases. This inherent strength has come in handy to meet the COVID-19 pandemic. Global

pooling of resources through CEPI also contributed to pushing R&D at greater speed against COVID-19. The Indian Government's investment in publicly funded organizations and private industry has been a major asset and enabled the development of indigenous vaccines. The collective efforts of all the scientific departments, policymakers, strategic partnerships of industry and academia, regulatory organization, and consistent government support have led to the successful development of the Indian vaccine in a short time and India could initiate mass vaccination from January 2021.

Way Forward

The policy discourse focused on various challenges and opportunities in vaccine development, its approval process for public use within a year, India's leadership role in global vaccine diplomacy, and also discussed a way forward.

A snapshot of COVID-19Vaccines: R&D efforts from India

The policy discourse was very timely as it was organized soon after India started to vaccinate its population with the COVID-19 vaccine in mid-Jan 2021. India could vaccinate its people with indigenously manufactured vaccines within a year after the pandemic began. Two domestic private companies manufactured vaccines against SARS CoV2, one company (Serum Institute of India, Pune) with a technology bought from AstraZeneca, a Swiss company, and another Company (Bharat Biotech International Ltd. Hyderabad) developed the vaccine through a public-private partnership with a strain identified by ICMR's National Institute of Virology. With its huge population (second largest in the World), it is not easy for India to vaccinate the whole population within a short time and enhancement of vaccine production capacities would also take time. India rightly adopted a public health strategy by first vaccinating healthcare workers, a vulnerable population above 50 years, and a population above 50 years with co-morbidities. With only two companies manufacturing COVID-19 vaccines, it would take a long time to vaccinate the entire population, therefore GOI planned to expand vaccination to other age groups in a phased manner as more COVID-19 vaccines would be made available by the GOI over time.

Government initiatives emphasizing the role of vaccine research

Simultaneously, the Government of India (GOI) was also trying to import or locally manufacture vaccines in collaboration with domestic companies with technologies transferred or bought from elsewhere to vaccinate its population. GOI gave a call to all the scientific and technological organizations in the country to do research and develop diagnostics, medicines, and vaccines at a faster pace. The strategy India adopted to combat the pandemic is the following. Adopt the slogan of 'Self-Reliance' to combat COVID-19 Pandemic, policy support to do R&D in public-funded organizations and private entities to develop and innovate in diagnostics, vaccines, and medicines at a faster pace, financial support for COVID-19 R&D, set-up various task forces to manage the pandemic efficiently at a faster pace, financial support and advance market commitments to the two domestic companies for the supply of vaccines, prioritizing vaccination strategies to

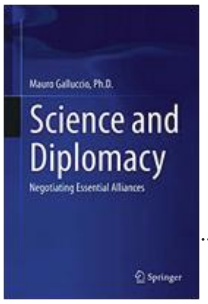
the vulnerable population first, and distribution/donation of COVID-19 vaccine doses to the neighbouring countries through goodwill gesture by adopting 'vaccine diplomacy'. This not only saved the wastage of vaccine doses but also helped the poor countries that needed the COVID-19 vaccine.

Significance of Policy Dialogue

Policy dialogue discourse constituted experts from the various fields, who were able to provide the right kind of impetus to policy perspectives to manage this pandemic. It included experts from epidemiology (the backbone for any evidence-based policy in disease management/health/vaccine), vaccine governance, an international collaboration (technology access, funding, and training of human resources), vaccine diplomacy, science communication, and awareness (very essential to satisfy the public appetite for authentic information).What was missing in this discourse were the inputs from regulatory authorities and the industry perspective. Though we invited eminent persons from DCGI, they could not participate as the DGCI office was very busy with the emergency approval processes. From Serum Institute of India, one of the executive directors who agreed to participate in the policy dialogue dropped at the last minute. This was the limitation where we missed first-hand information and the industry perspective on the opportunities, and challenges faced for making COVID-19 related vaccines and medicines available within a short period.

Vaccine development: Strengthening the future of vaccine policy

Overall the event was very fruitful as the enthusiastic audience/participants benefited from the insights this debate could provide are the following. The gaps in the knowledge on the epidemiology of SARS-CoV2 and ongoing research on its genomics; serosurvey studies, CSIR efforts in developing cost-effective COVID-19 related diagnostic kits, adjuvants, vaccines, testing purposeful drugs; how funding from BIRAC facilitated human resource development (HRD), infrastructure and international collaboration to enhance innovations in COVID-19 research; strengths of public & private sector and public-private partnerships in the development and manufacture of vaccines; the strategy of self-reliance; public awareness with authentic scientific information dissemination; means and ways of building public trust in vaccines; necessity for data transparency for building public trust were highlights of this debate. The take-home message is that simultaneous concerted efforts with the right kind of inputs and policy support can help to achieve the goal of self-reliance fruitfully.



Science and Diplomacy: Negotiating Essential Alliances

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Science diplomacy is considered a lynchpin in dealing with and overcoming the challenges of the COVID-19 pandemic, which is considered the 'most challenging crisis we have faced since the Second World War'. However, this has been hindered because of ignorance and 'uninformed' or 'disinformed' decisions by various international and national stakeholders in dealing with the crisis, which ought to transform and transition itself into 'informed decision-making' (Al Khaldi*et al.* 2021; Berkman 2020).

Informed decision-making involves "science with broad characterization to inform decisions with foreign policymaking" that enables institutionalization of infrastructure in international relations and helps "solve local-global challenges" (Berkman, 2020). The role and importance of science diplomacy are much greater as a bridge to narrow the gap in providing a coordinated and coherent strategy in dealing with the threats to the survival and existence of human civilization. In the aftermath of establishing the American Association for the Advancement of Science (AAAS) Center for Science Diplomacy in 2008, the priority towards science diplomacy as a prominent paradigm of engagement in international relations has risen exponentially (Berkman, 2019).

The focus on science diplomacy can act as a tool to overcome the issues and tension between various stakeholders, all of whom joined through "communication", "cooperation", and "interpersonal negotiation" to create alliances that are required in dealing with the emerging global challenges. This book

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edited by Mauro Galluccio deals with the (mis)perception in science diplomacy and issues in using "heuristic [incompetence and] shortcuts to simplify problems and to exercise control through limited consultations and conflict avoidance", particularly in the context of various phases and elements during the COVID-19 pandemic and related crisis.

The first two chapters emphasize the need to "restructure concepts, constructs, techniques, and strategies of public policy and diplomacy adapting them to this new era of global communication that shapes the public context… [of] the COVID-19 experience" (pp. 3-5). According to the book, an important facet of science diplomacy that needs to be improved is "interpersonal negotiating skill" to "manage evidence-informed policymaking process" to deal with the "cognitive biases and psychosocial mechanisms" creating a "continuous mutation". This creates gaps in understanding and issues about sound and effective policies and mechanisms in dealing with various interests and challenges like "public health, right to work, [and] economic factors".

The section elucidates how recent issues and challenges exacerbated due to the impact and implications of the COVID-19 pandemic and related crises. The dearth of sustainable "scientific advice" and "public info strategy" through evidence-informed policymaking was a huge hindering factor for the institutionalization of the "gold standard for crafting policy" (pp. 5-13). There are issues related to "global communication", including "blogosphere, journalistic and propagandistic websites, video transmission", and the scrutinization of (existing and emerging) policies as well as actions. Incidentally, there has been (at least a partial) alteration of "metacognitive functions", "adaptive decision-making", and mindsets "from a 'fixed' entity perspective to a 'growth' incremental perspective".

The second part of the book emphasizes "interpersonal negotiation" in science diplomacy and the need for joint engagement. An important aspect of chapter three is the contextualization and conceptualization of science and diplomacy, wherein the book quotes the definition by Nina Fedoroff as "the use of scientific collaborations among nations to address common problems and to build constructive international partnerships". Further, the history, methodological underpinnings, and paradigmatic shifts, as well as the use in the exercise of soft power, multilateralism, and mechanisms for improving cooperation and collaboration, were dealt with in detail. Chapter four discusses the aspects of history, development, and institutionalization of science diplomacy in the European Union (EU), particularly in institutionalizing values, safety, democracy, peace, and international security.

In chapter five, the focus and importance of evidence-informed policymaking has been summarized by the author in the quote taken from Daryl Copeland's article *Bridging the Chasm* (2015), which is that "policy without science is gambling" (p. 65). The chapter provides a brief history of evidence-based policymaking, its evolution in the EU and recommends the need to improve relational (i.e., contextual, structural, and cultural) facets between scientists and diplomats. It also entails the need to streamline processes, and the standardization procedures, including the development and use of "Theoretical, Empirical, Applicable, and Reliable Impact rating system (THEARI)" in the various scenarios.

Chapter six entails evidence-based medicine and clinical practices, climate change as well as its impact in the form of extreme hazards, the issues related to "incomplete and uncertain information", negotiations on the global level, and resilience and well-being among citizens. Finally, chapter seven summarizes and consolidates the use and implementation of evidence-informed policymaking, particularly in the EU.

The third part of the book focuses on the aspects of adaptive decision-making. Chapter eight deals with the challenges of bioterrorism, biosafety, environmental disasters, capacity development, risk, crisis assessment, management, communication, and resilience. Chapter nine outlines crisis management and risk assessment in the EU and related mechanisms of institutional frameworks. Chapter ten entails the responses and preparedness to biosafety and biosecurity, mainly in Europe. The focus is on increasing resilience, disaster risk reduction, and risk communication in the policy process and decision-making.

The fourth part deals with the theoretical frameworks and conceptualizations, particularly in the use and utilization of evidence-informed policymaking in various scenarios. Chapter eleven by Mauro Galluccio and Mattia Sanna provides a more empirical, quantitative, and cluster (categorization and) analysis of data from various sources. Incidentally, chapter twelve by Maria Lodovica and Laura Vivani examines various case studies like the EMPHASIS project and Horizon 2020, utilizing a multi-actor approach to provide *analytical* and *directive* decision-making, as well as suggestions to policymakers. Chapter thirteen by Robert L. Gallucci analyses the three misunderstandings of scientific negotiations that led to the first nuclear crisis in the Korean Peninsula. Meanwhile, chapter fourteen by Mauro Galluccio and Aaron Tim Beck delves deep into cognitive insights on utilizing interpersonal negotiation, which according to the author, needs to transition from *scientists versus diplomats* to (communication and negotiation between) *scientists and diplomats*.

The book lays the foundation for (non-)academic debate between scientists, diplomats, and policymakers across the world in a very extensive manner. More importantly, it contextualizes and outlines the threats, vulnerabilities, and related implications of science diplomacy in the world (especially in the EU) due to the challenges as well as divergences that have arisen recently. Concomitantly, the book emphasizes the need to increase, improve and (re-)institutionalize coordination, standardization, and interoperable functionality through interpersonal negotiation, reducing cognitive bias, increasing resilience, and improving risk management towards various challenges that have arisen and can potentially emerge in the near future.

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Midnight's Machines: A Political History of Technology in India

Author: Arun Mohan Sukumar

Gurgaon, Haryana: Penguin Random House India.

Saksham Kothari*

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India's scientific breakthroughs usually do not get the traction it deserves in public memory. In his well-meaning attempt to bridge this gap, Arun Mohan Sukumar's Midnight's Machines seeks to review the nation's post-independent technological lineage crisply through the lens of leaders and major events that have shaped the nation's destiny. It strives to create a concrete map for present leaders and future policymakers to deal with and learn from the past. The personality of the individual at the helm in crucial junctures of a nations' technological history is often tied up with their calculations of leveraging technology as a political instrument; the book shows that all ventures were neither wise nor all missed opportunities tactical errors. In this attempt, the author might also have inspired other writers to pen details regarding other scientific breakthroughs that shaped the political history of technology's role in India's development story (Pulakkat, 2021).

Sukumar proposes to describe India's technological leaps through four cycles akin to a pilgrim's journey: passing through the age of innocence to the age of doubt, the age of struggle and at last, the age of rediscovery. In between these broader outlooks, Sukumar discusses significant developments that influenced the thinking and policy-making processes in New Delhi. Through the erudite application of poetry and prose, Sukumar efficiently creates a thematic atmosphere for the readers on what may follow. "The Age of Innocence" begins with

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the vision of Malaviya and Visvesvaraya who advocated the adoption of pre-war German and Japanese technocratic models to shape the destiny of the nation on the verge of its Independence.

However, as the Chairman of the National Planning Committee, then Prime Minister Nehru's vision of a centrally planned economy and a thrust towards adoption of technology that could help strengthen the nation's economy and well-being vetoed other voices.

Poorly executed and rushed backing for the widespread acceptance of the solar cooker and mismanaged Community Development Scheme (1952) further distanced the common masses from what appeared to be sophisticated and grandiose claims of life-altering technology, removed from the needs of the common man (Sukumar, 2019). The technical and monetary assistance granted under the Colombo Plan (the 1950s) ushered a new age that the author terms as "the Age of Doubt." This was marked with large-scale industrialization projects undertaken during the Second Five Year Plan (1956-1961) and the genesis of indigenous space research, atomic and electronics industry. However, concerns over machine-led mass unemployment set the stage for the government's push for over-regulation and contributed to the rise of the 'appropriate technology' movement that embodied much of the popular mood towards the adoption of technology in the 1970s.

This was followed by the "The Age of Struggle" of the 1980s which was marked by India's reluctance to join the Human Genome Project, the difficulties that came up with manufacturing semiconductors locally, and the controversy surrounding the India-US Vaccine Action Programme. Still, this decade saw significant leaps in India's geo-spatial research endeavours with the establishment of the first Antarctic research base (*Dakshin Gangotri*) as well as the first flight of an Indian (Squadron Leader Rakesh Sharma) in space (1984). It also saw the launch of INSAT 1-A (1982) and the Integrated Guided Missile Development Program in subsequent years.

The thrust for digitally available, nationwide databases of various governmental records was pursued through the Computerized Rural Information Systems Project and NICNET, which in many ways was the precursor of the idea behind AADHAR. However, poor coordination among different departments, incurring higher costs, and lack of political consensus took much promise out of these well-intentioned programmes of the 1990s. The book also sheds light on the advent of cable television for the public and the tightrope India had to walk through those years; manoeuvring American sanctions post-Indian nuclear tests and the end of the Cold War. It emphasizes the Y2K issue that provided a breakthrough opportunity for the nation's burgeoning middle-income families in this "Age of Rediscovery."

It caused the boom for IT-related services such as Business Process Outsourcing whose ripple effects we see even today. The author chooses to pay a dedicated tribute to the contributions of Mokshagundam Visvesvaraya, Vikram Sarabhai, and Nandan Nilekani among the plethora of contributors to the nation's technological frontier. Since the book began by tracing Prime Minister Modi's technological ventures under the philosophy of Madan Mohan Malaviya's*swadeshi* vision, it ends with a

glimpse of PM Modi's promotion of digital technologies that may revolutionize the government's civic engagement and last-mile connectivity programmes such as the JAM (Jan Dhan-Aadhar-Mobile) Yojana. Thus, it leaves space for future historians to fill on the question of the path present and future leaders might carve between continuing the tradition of attempts at taming technology at will versus allowing unregulated terms of engagement between the ever-expanding digital domain and the civil society.

The book succinctly describes India's entire technological journey in mere 206 pages. In doing so, it feels like the narrative is hopping from one significant issue to another, with the tenuous link between issues. It does not adequately cover India's technological journey during the era of the coalition governments. Finally, even though the book keeps a score of India's atomic and space adventures it achieves this at the cost of the limited focus on other significant developments such as the Operation Flood (1970) and the Universal Immunisation Programme (1985). Bilateral and multilateral collaborative efforts of using technology to solve futuristic needs such as the construction of Metro rail networks in various parts of the country and the International Solar Alliance (2015) are also scarcely accounted for. One might also notice a lack of space given to other known stalwarts of India's technological journey such as P.C. Mahalanobis, C.V. Raman, and S.N. Bose among others in the book.

To his credit, Sukumar has ventured into uncharted waters amid a real scarcity of books that trace India's STEM development through a historical lens. Sukumar's open-source reportage and novel prose elevate the book as a valuable asset for policymakers as well as lay readers. The book lays the groundwork and provides valuable insights to present and future entrepreneurs, scientists, and technocrats of experiences from the past so that we can improve on our shortcomings. Its lasting legacy might be for future historians working to blend the interaction among science, politics, and institutional culture in India.

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A Guide to Global Health Diplomacy: Better Health - Improved Global Solidarity -More Equity

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Debanjana Dey*

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Even before the recent pandemic, the impact of global threats such as climate change, food insecurity, resurging infectious diseases, health inequality was recognized. However, global health diplomacy has lingered on the sidelines of foreign policy. The recent pandemic has yet again drawn attention to the importance of health not only for well-being but its contribution to economic growth and sustainable development. It has also emphasized that such a crisis cannot be dealt with within the boundaries of a nation or a region alone but needs global cooperation of state and non-state actors for containment and mitigation of the disease. Global health diplomacy is a multi-level and multi-stakeholder engagement that shapes and manages the global policy environment for health in both health and non-health forums (Kickbusch*et al*., 2007). Such diplomacy deals in particular with health issues and determinants that cross-national boundaries and needs to be tackled through global agreements.

Successful global health diplomacy requires a pragmatic approach informed by public health knowledge and science (evidence) with political and diplomatic underpinnings. The development of global health diplomacy or global health governance can be traced back to the mid-nineteenth century when many international regimes on public health were created, such as treaties to deal with infectious diseases which followed from a series of International Sanitary Conferences since 1851;

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treaties to control international trade in narcotic drugs and alcohol; laws governing transboundary air pollution, etc. (Fidler, 2001). These treaties constructed rules and institutions and served as a buffer against advancing health risks. Also, during this period, to further facilitate cooperation on infectious diseases, four international health organizations were established and one of them was the World Health Organization (WHO) - set up in 1948 as a norm-setting organization on international health. However, for decades, policymakers around the world treated health concerns as a secondary issue in development cooperation. But, towards the end of the twentieth century global cooperation on health and prioritizing global health in foreign affairs began to take shape. For example, in Oslo Ministerial Declaration (2007), foreign ministers from seven countries agreed to use health as a defining lens for foreign policy and development strategies.

The report 'A Guide to Global Health Diplomacy' under review has been brought out by Global Health Centre at the Graduate Institute of International Studies, Geneva. It focuses on the practical aspects of global health diplomacy as reflected by underlying values, approaches, and mechanisms of the same. The guide presents the fundamentals of global health diplomacy and elaborately explains how health negotiations take place at international organizations and in other multilateral agencies that aim to resolve global health challenges. It has specifically focused on the World Health Organization and global health negotiations in Geneva (Kickbusch*et al*. 2021). This guide can be used for teaching and training purposes on global health diplomacy.

Global Health as an Agenda

The report presents the changing role of diplomacy with globalization and liberalization and how the major shift in the orientation of diplomacy - from development to addressing 'common global goals together' has occurred. It highlights that the shift towards multi-stakeholder diplomacy has been crucial in the inclusion of global health as an agenda in foreign policy. The inclusive Sustainable Development Goal (SDG) negotiations, which put into place the focus on global challenges and the need for strong global partnerships to achieve the SDGs was a major leap in the direction of multi-stakeholder diplomacy. Also, the 'Global Action Plan for Healthy Lives and Well-being for All' launched in 2019 brings together 12 international organizations to promote collaboration and support countries in their efforts to achieve the health-related SDGs marks a new form of multilateralism. The report states that the new multilateralism with the involvement of different stakeholders, especially non-state actors in agenda-setting, negotiations, and collaboration in different forums has led to the recognition of 'global health' as an agenda to be discussed in major global and regional summits. A health-related agenda setting in negotiations at the United Nations depends on the convergence of the problem; the consideration of equity, human rights, and social justice; and the power considerations. The report listed the following criteria that can be used to determine if a specific problem could be covered by future global health governance: i) the problem should be of a global and growing magnitude; ii) transnational factors play a dominant role, and iii) the existing instruments have

proved inadequate to tackle the problem. The role of digital media in recent times has also been crucial to shape or persuade a particular agenda. For example, the "Hands off our medicine!" campaign in 2010 dissuaded a trade agreement between the EU and India which would have limited the production of generic drugs for the treatment of tuberculosis and other diseases.

Negotiating Health in Multilateral space

The report attempts to delineate the roles of international agencies for global health diplomacy in the multilateral space and highlight the power imbalances that influence negotiation outcomes. Despite the democratic voting principles in international organizations such as WHO, power imbalances between member states exist and they are shaped by geopolitics. For example, the long stand-off between the Soviet Union and the United States during the Cold War or competition between the US and China in recent times greatly influenced WHO's global health governance and health diplomacy. Also, unequal power relations exerted by wealthier nations providing a large sum of funds for the global health system; or by large philanthropic organizations; or by 'neocolonialism', where the International Monetary Fund and the World Bank impose strict criteria for loan agreements leading to austerity measures and a drastic reduction in health and social sector spending in debtor countries, can influence negotiation outcomes to their advantage and are detrimental to poorer countries. The diversity and inclusion of large numbers of stakeholders to international organizations have reinforced the legitimacy of these organizations to not only serve as a platform but also as an actor in itself for global governance and fair and just negotiations. The stakeholders include national sectors and agencies, development banks, civil societies, private industries, philanthropic organizations, academic institutions, professional associations, etc. Multi-stakeholder diplomacy encompasses a wide range of initiatives and institutions to promote global health cooperation. To put the institutions into practice, the World Health Assembly or other multilateral agencies adopt several hard (regulations and conventions) and soft (recommendations) instruments on specific agendas which carry significant normative and political weight to bring about a substantial impact on public health.

The report also underscores the importance of national global health strategy and regional diplomacy/ cooperation for proactive engagement in multilateral forums. A national strategy on global health based on 'information-sharing, capacity-building and internal negotiations' among diplomats, civil servants, and different ministries, not only sets the policy priorities for global health negotiations but also promotes inter-ministerial coordination for defining negotiation positions. 'Regional diplomacy strengthens national contributions to global health'. It fosters 'collective will and knowledge of States' to tackle shared health challenges at global forums. This has also shifted the traditional channels of association between developed and developing nations to an expanded network of a small group of countries. Broad alliances and diplomacy among the CARICOM countries to put non-

communicable diseases on the UN agenda or the BRICS nations acting as regional power brokers to take lead on certain health issues in global affairs are some of the examples of regional agreements which enabled agreeing on a common position with partnering countries on health-related issues in multilateral negotiations.

Global Health Diplomacy: Key features

The domain of global health diplomacy is not just negotiations; it is much more than that. It includes "building and maintaining of relationships, gathering information, the establishment of goodwill, and the use of health as soft power". The report highlights that effective global health diplomacy like any other diplomacy can be defined by three key elements – 'representation, communication and negotiation' and requires skilled diplomats with knowledge of different sectors especially foreign policy and public health.

Representation: Very few countries designate an ambassador for global health, but most of the high-income countries assign health attachés for diplomatic missions. However, health attachés or diplomats who diplomatic representations in Geneva often deal with issues other than health and participate less actively in health negotiations, unless the topics are essential to them/their country. The report highlights the critical role that health attachés can play for favourable outcomes in health negotiations. A competent diplomat would try to understand the complexity of global health issues, listen to debates and negotiations to comprehend the geopolitics and national interests behind any resolution or negotiation, and regularly study the operation of political groups and voting blocs in the UN context for effective global health diplomacy. Often national interests of the health ministers, representing their countries in the WHO governing bodies, and foreign policy interests of Member States lead to tension over the negotiation table. In such situations, the communication skills and personal contacts of health attachés can influence the day-to-day negotiations and achieve a favourable outcome.

Communication: An important aspect of health diplomacy is building relationships in Geneva and other negotiation hubs. Liaisoning with fellow diplomats from other missions in Geneva; communicating with the non-state actors (civil society, academic experts, scientists); informal interaction over side-events, coffee breaks, etc. for building alliances and network with like-minded delegations are all considered important for a favourable outcome in global negotiations. The report stresses the need for foreign affairs organizations to train diplomats 'with additional knowledge, skills, and abilities in health communication, analysis, and public health ethics so that they can promote global health more effectively.

Negotiation: "Global health is about delivering global public goods". The universal values underlying global health objectives are 'human dignity and rights, 'equity' and 'universal access'. However, on several occasions, countries find universal values to be at odds with their values and interests which lead to 'red lines' rather than value-based arguments. The report mentions a set of tactics for conflict resolution and identifying ways for integrative bargaining in global health diplomacy. Negotiations at the World

Health Assembly require member states' diplomats and experts to wear several hats. Understanding the rules and procedures of governing bodies; engaging and listening to the views of different global health actors (government, academia, local communities, civil society, private sector) at home enables a diplomat to familiarize with the issues at stake and gain tactical advantages over negotiation table and also to defend a coherent national position.

The report presents several examples of tackling global health challenges which involve negotiations in different forums combined with multi-stakeholders and emphasizes the importance of international organizations for global health diplomacy. During the recent pandemic, global cooperation for equitable access to the COVID-19 vaccine was impaired due to nationalistic and free-market-driven, competitive approaches taken by some countries within the ambit of intellectual property frameworks and the interests of national pharmaceutical companies. This raised important questions concerning vaccine access in low and middle-income countries. During such scuffling multilateral health governance, vaccine diplomacy initiatives such as the COVAX facility, which allows participating countries for the pooled purchase of vaccines, enabled vaccine supply to many developing countries. Ensuring equitable access to vaccines or medicine would require such initiatives of vaccine diplomacy and strong global governance. However, certain issues such as antimicrobial resistance, trade and health impacts, etc. which cut across different sectors need effective coordination of various ministries at the national level as well as at multilateral and inter-agency settings. As the report argues, health diplomats need to consider carefully the relevant actors, processes, and institutions that interface with health to set an agenda and negotiate at the global and multilateral forums. This calls for strengthening the interaction and coordination between health, foreign policy, and other sectors at the national level so that both health and foreign policy officials are aware of the importance of reinforcing their engagement in global discussions on health for 'better health, improved global solidarity, and more equity'.

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International Institute for Applied Systems Analysis (IIASA)

Sneha Sinha*

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Foundation of IIASA

In the middle of the Cold War, origins of International Institute for Applied Systems Analysis (IIASA) is an excellent example of using science cooperation to improve international relations between countries. IIASA emerged as a bridge between the East and the West and its very foundation highlights the role of science diplomacy. Its origins can be traced back to the American president Lyndon Johnson's speech in 1966, in which he called for a liaison between the Eastern and Western scientists.

> It was time that the scientists of the United States and the Soviet Union worked together on problems other than military and space matters, on problems that plagued all advanced societies, like energy, our oceans, the environment, health (Raiffa, 1992).

The National Security Action Memorandum (NSAM) 345 issued on April 22, 1966 on Nuclear Planning is viewed was one of the initiatives for "bridge building" between the Union for Soviet Socialist Republic (USSR) and the United States of America (USA) (McDonald, 1999). In his speech in 1966, said

> The President also wishes to have developed other forward-looking proposals that would increase the cohesion of NATO and the North Atlantic community. One kind of measures included constructive political, diplomatic and economic initiatives addressed to Eastern Europe and the Soviet Union (The White House, 1966).

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In response to the NSAM 345, an interagency group under the chairmanship of Dean Acheson submitted their final report with following comments on June 3, 1966

> An East-West Foundation or University might be established in one of the Eastern European countries or Austria. The purpose would be to provide Western instruction in subjects of acute practical importance to the Eastern Europeans, e.g. Agriculture, business administration and modern management techniques (McDonald, 1999).

The NSAM 352 specifically focused on 'bridge building' and noted that

> The President has instructed that in consultation with our Allies we actively develop areas of peaceful cooperation with the nations of Eastern Europe and the Soviet Union (The White House, 1966).

On October 7, 1966 at the National Conference of Editorial Writers, President Lyndon B. Johnson emphasized on quickening the progress in East-West relations 'to achieve a reconciliation with the East - a shift from the narrow concept of coexistence to the broader vision of peaceful engagement' (Johnson, 1966). He stressed on developing science and technology as a common resource, and clearly hinted at the role of scientific cooperation as an important bridge-building force (McDonald, 1999).

All these steps taken and supported by the political leadership particularly, President Johnson and Premier Kosygin prepared ground for the IIASA. These along with the success of the Glassboro Summit in 1967, followed by series of efforts and negotiations undertaken during this period culminated into the foundation of IIASA in 1972 (McDonald, 1999). Representatives from scientific institutions of 12 countries[1] including the Academy of Sciences, Union of Soviet Socialist Republics and the National Academy of Sciences signed the charter for the establishment of IIASA. Recognizing the role of science and technology and its application for the benefit of mankind, the Charter reinforced the belief that *international co-operation between national institutions would promote co-operation between nations and the economic and social progress of peoples.* The institution was established as an autonomous, multinational and non-governmental scientific institution, headquartered at Laxenburg, Austria. It sought to initiate and support research to find solutions to problems arising from science and technology development vis-à-vis systems analysis, cybernetics, operations research, and management techniques and ensure high standard scholarship and working towards peaceful purposes. The charter gives details about the general powers, membership, structure, etc. of the Institute (IIASA, 1972). Upon, establishment Howard Raiffa[2] became the first director of the Institute. During his tenure, he faced several challenges in building and setting-up the institution (Raiffa, 2002; Roger, 1997).

IIASA's Activities and Research Programmes

The inception of IIASA gave professional freedom, research opportunities and provided a platform for professionals of the East to interact with the West. Through its varied research programmes, it encouraged collaborations, international exposure, etc. It's founders had emphasized that the Institute's focus would be both research and training. However, during

the early years it focused on research and not training (McDonald, 1999). IIASA also faced several challenges pertaining to relations with National Member Organizations (NMOs) as well as issues of defections and spying. Ronald Reagan's administration halved the funding of the National Science Foundation's (NSF) for international programs for 1982 on account of other bilateral funding priorities, lack of reciprocity from the Soviet Union as well as poor-quality research. The U.S. government's withdrawal of support affected several other NMOs as well. As a result, the Royal Society formally withdrew on account of the U.S. government's withdrawal and a "lack of intellectual merit" in IIASA's research plan. The initiative to establish three international centers for cooperative research on global climate change during George Bush's presidency; intensified lobbying by the American Academy's U.S. Committee for IIASA and others, as well as diminishing security concerns in Washington led to renewed White House support. Other NMOs also supported U.S. interests in developing IIASA as an institute for global change. The NSF peer-reviewed all proposals for U.S. contributions since 1985. IIASA continued to be one of the international research institutions which performs interdisciplinary and international systems and policy analyses of global and universal issues. As a valuable international asset, it warrants strong international support to contribute towards informed resolution of international policy problems (Roger, 1997).

Currently, IIASA is funded by several organizations from member countries', along with grants, and donations from governments, international organizations, academia, businesses, and individuals (IIASA website). It has twenty-four NMOs[3] at present, which includes several S&T institutions, academies, scientific societies, national committees, research councils, government departments and ministries, etc., representing both the Global North and the South. The institution has undertaken several research programmes with member countries to tackle global challenges and sustainable development specific to each country (IIASA website). Over the years, IIASA has broadened its mandate and has undertaken several research programmes to develop and apply systems analysis for transformation towards sustainability. These include advancing Systems Analysis, Biodiversity and Natural Resources, Economic Frontiers, Energy, Climate and Environment, Population and Just Societies, Strategic and Large Scale Initiatives (IIASA website). The International Center for Climate Governance ranked IIASA second place in their annual global listing of top think tanks for climate change economics and policy. Several IIASA researchers/alumnus have received prestigious academic awards including the Nobel Prize, and have been elected as fellows of several academies of science across the world. They have been appointed as scientific advisors at the European Commission, UN Climate Action, UN SDGs Advisory Group, etc. (IIASA website). Its research has impacted science and policy both at local and global level, vis-a-vis issues of water, global temperature, biofuels, energy, pollution, land-use, greenhouse gases, natural disasters, etc. Apart from issues that are specific to Europe, there are efforts made by IIASA to partner with other countries like East Africa to

study the effect of regional economic development on its water resources. It provided Brazil with a clear, quantitative basis to its climate commitments, that would lead to a robust policy. The IIASA developed methods to improve integrated management and help policymakers design robust, sustainable policies, which fed into national policy in Ukraine. From 2011, Brazil and IIASA are working towards sustainable agriculture and land use strategy to reduce deforestation. Thirty papers were published on wide range of issues, like demography, renewable energy infrastructure, etc. with Egypt (IIASA website). Similarly, IIASA is undertaking collaborative research with other member countries on various issues of sustainable development. Its recent research largely focuses on sustainable developments and issues of food, water, pollution, environment, climate change, etc.

IIASA's science diplomacy initiatives

The term science diplomacy was coined only during the first decade of twenty-first century. However, IIASA's inception is an excellent example of science diplomacy and the institution has continued its efforts towards international S&T partnerships for issues like, sustainable development and climate change. In 2015, IIASA won the Science Diplomacy Award conferred by the Science Forum South Africa recognizing its contributions as an 'international partnership which has achieved excellence in global science'. The awards committee praised IIASA efforts in applying science to find solutions to global problems through applied systems analysis, thereby improving human wellbeing and protecting the environment. During the last decade and especially from 2016, IIASA has made concerted efforts in furthering science diplomacy. It regards science diplomacy as a key tool to foster S&T cooperation to support foreign policies and solve international problems. IIASA has contributed towards capacity building in science diplomacy through various programmes, workshops, lectures, etc. for diplomats and scientists. It hosted the 'International dialogue on integrating S&T advice into foreign ministries' in collaboration with the Fletcher School of Law and Diplomacy[4], the International Network of Government Science Advice (INGSA) and the Global Network of Science and Technology Advisors in Foreign Ministries (IIASA, 2016). IIASA has invited noted speakers to deliver lectures on science diplomacy. Sir Peter Gluckman, Chief Science Advisor to the Government of New Zealanddelivered lecture entitled "*Science Diplomacy – Looking Towards 2030* during IIASA's 45thAnniversary in November 2017 and emphasized on the growing utilitarian importance of science diplomacy (IIASA, 2017). Few months later, Professor Daryl Copeland gave a lecture on 'New Frontiers in Science Diplomacy' (IIASA, 2018). Apart from these lectures, IIASA also organized sessions on science diplomacy during the Annual Meeting of the American Association for the Advancement of Science (AAAS), in Austin in February 2018, which was attended by about 80 and 50 participants respectively. The discussion led to an agreement between IIASA, CERN and ICTP to launch a network of international research organizations engaged in science diplomacy (Muller, 2018). IIASA hosted meetings of the Foreign Ministries Science and Technology

Advisors Network (FMSTAN) and the Science Policy in Diplomacy and External Relations (SPIDER) network in Vienna and Laxenburg in November 2019, together with the Austrian Federal Ministry for Europe, Integration and Foreign Affairs, the Vienna School of International Studies (Diplomatische Akademie Wien), and the Natural History Museum (IIASA, 2019).

Recognizing the role of large scientific research infrastructures in science diplomacy, the IIASA founded the Big Research Infrastructures for Diplomacy and Global Engagement through Science (BRIDGES) in 2019 – an open and informal network of people who deal with science diplomacy and international relations in mega-science research infrastructures. Since, its inception it has held three meetings. The inaugural meeting was hosted at the Abdus Salam International Centre for Theoretical Physics (ICTP) in July 2019, which brought together representatives from ten international research organizations (IIASA, 2019). The second meeting was held in November 2019 focused on informed decision making for sustainable future (IIASA, 2019). The BRIDGES session at the ESOF2020 introduced the network to the wider science diplomacy community and discussed with the audience emergent relevant issues. The speakers were from IIASA, ICTP, EMBL, JRC and CERN (IIASA, 2020). Due to the ongoing COVID outbreak, the third BRIDGES meeting was held online with representatives from 12 big research infrastructures. During the roundtable presentations participants mapped their respective organizations' stakeholders, and discussed the scientific community willingness to actively engage in bridging policy, science, and diplomacy, along with the policies on open access to scientific knowledge (IIASA, 2020).

Conclusion

'IIASA is a child of "diplomacy for science", and is making efforts to promote science diplomacy and explore how science can help to build trust between nations, and support foreign policies' (Muller, 2018). Since, its inception, IIASA has developed networks with several S&T institutions, academies and associations of science, big research infrastructures and science diplomacy institutions across the world. However, its initiatives and networks in science diplomacy have largely remained restricted to the Global North. With a wide network of member countries' research organizations and the BRIDGES network of big research infrastructures, IIASA can play a key role in furthering theoretical and practical perspectives in science diplomacy. Its diverse research programmes with greater focus on sustainable development provide scope for collaboration in regional and global issues of climate change. Through its network of IIASA researchers, experience in research on issues concerning sustainability and wide network of S&T institutions can also play a critical role in advancing S&T cooperation to achieve the sustainable development goals. From a science diplomacy and science policy perspective, IIASA will play a more important role in the years to come, given the various challenges before us, and the critical role of STI in finding equitable and sustainable solutions.

Apart from the Global North, the Global South is also making efforts towards furthering international S&T cooperation and science diplomacy to deal with national, regional and global issues. India's

commitment towards strengthening international S&T partnerships, use of STI for SDGs and pro-active STI diplomacy provide ample scope for collaboration with institutions like the IIASA (MoST, 2020). Since 1970s, there already exists research collaborations between IIASA and India. The relationship got stronger after India became a national member of IIASA in 2007 through the Technology Information, Forecasting and Assessment Council (TIFAC). IIASA also has research collaborations with the National Institute of Hydrology (NIH) and The Energy and Resources Institute (TERI). Therefore, networks could be developed between IIASA and Indian intuitions, and scope for closer collaboration, capacity building and practical perspectives in science diplomacy can be explored.

Endnotes

[1] Other institutions include; The Committee for the International Institute for Applied Systems Analysis, Canada; The Committee for the International Institute for Applied Systems Analysis of the Czechoslovak Socialist Republic; The French Association for the Development of Systems Analysis, France; The Academy of Sciences of the German Democratic Republic; The Japan Committee for the International Institute for Applied Systems Analysis; The Max Planck Society for the Advancement of Sciences, Federal Republic of Germany; The National Centre for Cybernetics and Computer Techniques, People's Republic of Bulgaria; The National Research Council, Italy; The Polish Academy of Sciences, Poland; and The Royal Society of London, United Kingdom.

[2] He was a member of the U.S. team that negotiated IIASA and viewed its establishment as a confidence-building gesture and added that he learnt extremely during 1967-1972 about theory and practice of many-party negotiations with had extreme cultural differences.

[3] These include Austria, Brazil, China, Egypt, Finland, Germany, India, Germany, Israel, Iran, Indonesia, Japan, Jordan (Prospective Member), Korea, Malaysia (Observer), Mexico (Observer), Norway, Russia, Slovakia, Sweden, South Africa, Ukraine, USA, UK, Vietnam.

[4] See Sinha, S. 2020. Science Diplomacy Center, Fletcher School of Law and Diplomacy. *Science Diplomacy Review, Vol. 2(2), pp.* 59-66. Retrieved from http://www.fisd.in/sites/default/files/SDR%20July%202020-min.pdf.

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COMMENTARY

The Role of Digital Infrastructure in Post COVID-19 India

Neeraj Sinha* and Naman Agarwal**

Neeraj Sinha

Naman Agarwal

Background

The coronavirus outbreak has provided a new beginning for digital infrastructure development. Digital infrastructure has emerged as a significant necessity vis-à-vis traditional infrastructure such as buildings, roads, power and water supplies, etc. Using the cloud, big data and AI applications create room for industries to develop and build new business models that help citizens understand the severity of the pandemic and ensure preventive measures. The COVID-19 pandemic has provided a major impetus to the ever-expanding digital infrastructure. The article outlines the need for the digital revolution in India and the initiatives of the Indian Government so far. The article also touches upon various enabling opportunities for India, innovating and learning by doing, investing public funding to help finance research and development in critical areas.

Economies across the globe are charting ways to make their digital infrastructure, comprising physical resources necessary for the use of data, computerized devices, methods, systems, and processes, more resilient, agile and futuristic. The digital infrastructure has become indispensable for the functioning of a society and the quality of life of its citizens. All over the globe, countries have leveraged their digital infrastructure to proactively respond to the ongoing pandemic. Going forward, the resilience of a nation's digital infrastructure can be pivotal to successfully address adversities such as the COVID-19 pandemic. India, being one of the most populous countries in the world, is uniquely positioned in the global landscape and has the potential to become a leading digital force in the emerging world order.

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Nearly half a billion internet users in India, a host of indigenous digital services, platforms, applications, content, and solutions, are expected to transform India's digital ecosystem. India could potentially see a five-fold increase in economic value from digital transformation by 2025 representing an attractive opportunity for global and local businesses, start-ups, and innovators to invest in emerging technologies (like AI, blockchain, or drones) in ways that are customized to India's needs (PIB, 2019). Although there has been rapid adoption of frontier technologies such as artificial intelligence, blockchain, internet of things (IoT), the COVID-19 pandemic has put the digital infrastructure under immense pressure. It has led to an inevitable surge in the use of digital technologies due to the social distancing norms and nationwide lockdowns. People and organizations all over the world have had to adjust to new ways of work and life.

An increase in digitalization is leading firms and educational institutions to shift to work-from-home (WFH). Blockchain technology will become important and will entail research on design and regulations. Gig workers and the gig economy are likely to increase in scale, raising questions of work allocation, collaboration, motivation, and aspects of work overload and presenteeism. Workplace monitoring and technostress issues will become prominent with an increase in digital presence. Online fraud is likely to grow, along with research on managing security. The regulation of the internet, a key resource, will be crucial in the post-pandemic era. Digital money, too, with contact-free usage, assumes importance in crises and research will address their adoption, consequences, and mode. Aspects of surveillance and privacy gain importance with increased digital usage.

Digital Revolution: Need of the Hour

India's digital divide is narrowing fast as less affluent states and sections of society leapfrog to catch up with more affluent states. India can create up to $1 trillion of economic value from the digital economy by 2025 with half of the opportunity originating in new digital ecosystems that can spring up in diverse sectors of the economy. E-commerce platforms are expected to drive recovery of Consumer electronic products – mobile devices, smart TVs, LED lighting, etc. – faster, and having a robust manufacturing ecosystem is essential to adequately address the rise in indigenous demand. An immediate need is to develop local supply chain networks, and efforts in this direction could result in enhanced indigenous electronics manufacturing.

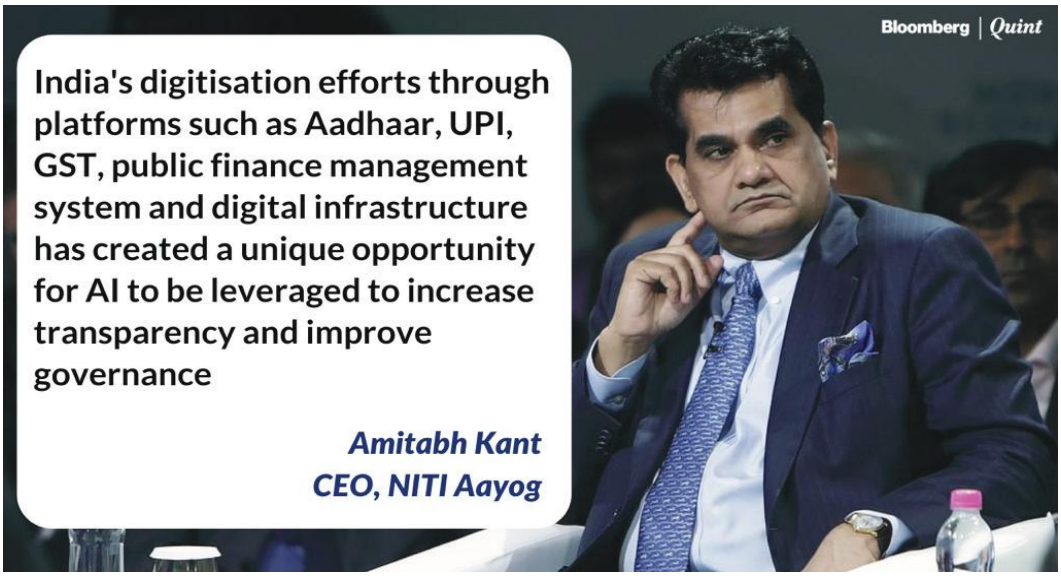
The industry should develop quarterly short-term strategies and calibrated decision-making to address disruptions caused due to the COVID-19 pandemic. The 'Atmanirbhar Bharat' policy could give a much-needed fillip to the country's disrupted business operations by promoting indigenous manufacturing, export competitiveness, import substitution of low-technology goods, and encouraging local produce at lower prices (Electronics B2B, 2020). It is the need of the hour to promote and create a framework for the development of robust digital infrastructure especially connectivity and wide access, which could facilitate the adoption of emerging technology areas such as 5G, IoT, artificial

intelligence, machine learning, drones, robotics, additive manufacturing, photonics, nanodevices, etc., and their applications in areas such as defence, agriculture, health, cybersecurity, smart cities, and automation, with special focus on solving real-life problems.

The global electronics market is estimated to be over US$ 2 trillion. Although India's share in global electronics manufacturing has grown from 1.3 percent in 2012 to 3 percent in 2018 (Invest India, 2020), it is still considered to be minuscule as compared to some other countries. The electronics industry is a crucial part of the digital ecosystem of a nation, the industry and the government must make concerted efforts in this domain. Semiconductors, being the building block of electronics, are central to the global electronics ecosystem. The absence of a state-of-the-art semiconductor fab in India has been a major capability constraint. Semiconductor manufacturing is a complex capital-intensive and R&D-intensive sector defined by rapid changes in technology - which require a sustained R&D and investment commitment. Semiconductors are not only at the heart of electronic products, but they also constitute a significant part of the total value of the final products.

The recent expression of interest for setting up or expanding existing semiconductor wafer/device fabrication (fab) facilities in India or acquisition of semiconductor fabs outside India by the Ministry of Electronics and Information Technology is a welcome step. It is believed that acquiring a second-hand fab of 28 nm could take care of a large part of India's current needs instead of going after the most modern fab (Financial Express, 2020). This will not cost more than US $500–700 million. In addition, a thrust on semiconductor fab manufacturing, including a Gallium Nitride (GaN) fab, with a milestone-based, time-bound approach, is also important.

Figure 1: Efforts of the Indian Government to promote digitalization



Initiatives of the Indian Government

India has set an ambitious target of building a $5 trillion economy by 2024. Global macroeconomic factors coupled with a cautious outlook and muted domestic consumption pose a serious challenge to achieving the ambition.

It is necessary to break the old paradigms of economic growth and development by harnessing technology-led innovation. The digital economy alone can support 60-65 million jobs in the future (Financial Express, 2019), fuelled, of course, by enabling government policies, support, and initiatives. Some of the major initiatives include:

The Digital India programme has had a tremendous impact on the national digital infrastructure. Under this programme, the government aims to provide high-speed internet connectivity across the length and breadth of the country. In addition, it also aims to expand and leverage the unique identity (Aadhar) as a mode to ensure digital identity, financial inclusion, benefit distribution, and easy access to the common services centers (CSCs). The network of 3.59 lakh CSCs with a presence in 2.3 lakh gram (village) panchayats has become a robust mechanism for the digital delivery of services. The CSCs are delivering 50 Central and more than 300 State services. In this process, the CSCs' have generated employment for more than 1.2 million persons in rural areas (Economic Times, 2019).

The Government has set up National Centres of Excellence (CoEs) at the Indian Institute of Technology (IIT) Bombay for technology solutions in internal security and at the IIT Kanpur for flexible electronics. The Centre of Excellence has also been set up in Bangalore in collaboration with the National Association of Software and Services Companies (NASSCOM) for the Internet of Things (IoT). These measures are also expected to bring in cutting-edge technologies (Ministry of Electronics & Information Technology, 2019).

The Modified Electronics Manufacturing Clusters (EMC 2.0) Scheme, notified in April 2020, aims to address gaps by providing support for the creation of world-class infrastructure along with common facilities and amenities, including Ready Built Factory (RBF) sheds/Plug and Play facilities for attracting major global electronics manufacturers, along with their supply chain to set up units in the country (Ministry of Electronics & Information Technology, 2021).

The Scheme for Promotion of Manufacturing of Electronic Components and Semiconductors (SPECS), April 2020, will help offset deficiencies in domestic manufacturing of electronic components and semiconductors and strengthen the electronics manufacturing ecosystem in the country (Ministry of Electronics & Information Technology, 2020).

The Production Linked Incentive Scheme (PLI) for Large Scale Electronics Manufacturing, April 2020, offers a production linked incentive to boost domestic manufacturing and attract large investments in mobile phone manufacturing and specified electronic components, including Assembly, Testing, Marking and Packaging (ATMP) units (Ministry of Electronics & Information Technology, 2021).

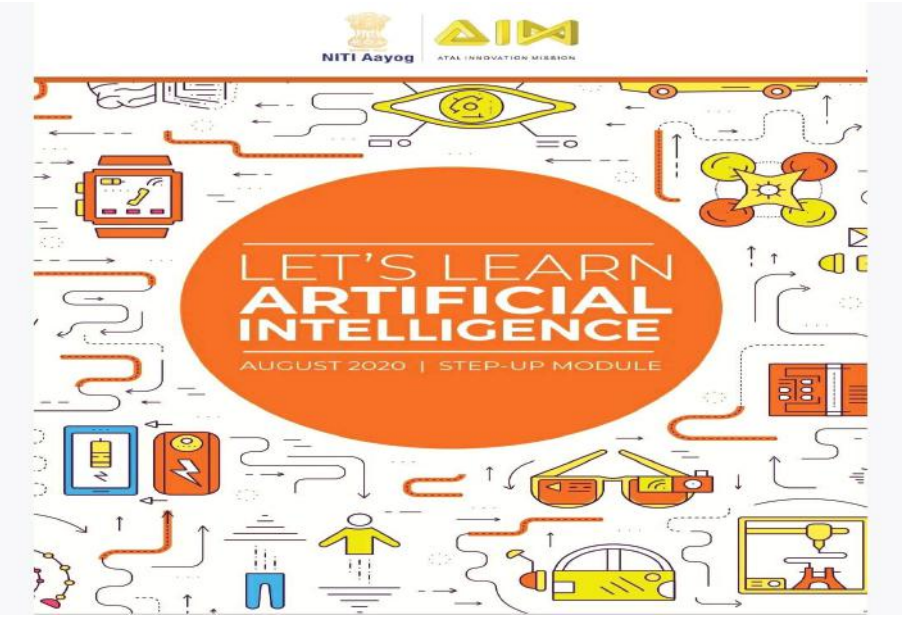
The National Policy on Electronics 2019 (NPE 2019), prepared after extensive stakeholder consultations,

aims at positioning India as a global hub for ESDM with a thrust on exports by encouraging and driving capabilities in the country for developing core components, including chipsets, and creating an enabling environment for the industry to compete globally (Ministry of Electronics & Information Technology, 2019).

The vibrant IT-BPM, telecom, e-commerce, electronics sectors, the explosion of new digital startups equipped with technologies such as virtual reality (VR), augmented reality (AR), Blockchain, Artificial Intelligence (AI), robotics, analytics, automation, cloud, cyber-security, mobile, and social media, could help to achieve close to $250 billion in gross value by 2025 (Financial Express, 2019). With the target of expanding its economy by 2024 to $5 trillion, India has made many efforts to become more digitalized. The Digital India Mission is envisioned to be created on digital security and trust. Building digital trust is a major effort for the whole society, business, and also for people using digital services.

There is a light at the end of the pandemic tunnel as many vaccines have been approved and vaccination has started in most of the countries of the world. India is running the largest vaccination campaign in the world, with over a billion people being vaccinated in record time. COVID-19 has, however, changed our world for good including the way we work, our healthcare, our jobs, our education, and the importance of digitization. When the world came to a standstill, services and products were adjusted using digital systems to allow continuity of business and life. Speaking at the CoWIN Global Conclave on 5 July 2021, where 142 countries were represented, Prime Minister Narendra Modi offered CoWIN to any countries free of charge and as open-source software. The software can

Figure 2: NITI Aayog launched a module to enable students to explore the fascinating world of AI.



be customized to any country according to local requirements. India had already made its COVID tracking and tracing app AarogyaSetu open source as soon as it was technically feasible. The CoWIN platform had enabled the inoculation of a large percentage of the world's population with ease, while simultaneously ensuring complete transparency.

Enabling opportunities for India

- India has been steadily rising in the Global Innovation Index (GII) rankings, and currently holds the 46thposition. With the 3rdlargest S&T manpower in the world (India Brand Equity Foundation, 2021), MNCs like Samsung, Bosch, Microsoft, CISCO, etc. have started leveraging India's capability.
- A young country with rising expectations: Working-age population (between 15 and 64 years) to touch 1 billion, surpassing China by 2030, 65 per cent of India's population is below the age of 35 (ASSOCHAM India, 2015).
- Employment Challenge: Need 12 million new jobs a year to absorb the growing working population; 50 million people need to be skilled each year, the current capacity of only 3 million (India Today, 2020).
- The growing middle class seeks new value propositions: By 2021, India will have about 900 million people constituting the 'emerging middle and middle-class segment, which will provide new opportunities.
- To win in this market, companies will need to deploy a shift in mindset to achieve new value propositions delivered through innovative business models.
- India's gross expenditure on R&D (GERD) increased from Rs 65,961.33 crore (US$ 14.07 billion) in 2011-12 to Rs 104,864.03 crore (US$ 16.27 billion) in 2016-17. However, it is only about 0.7 percent of GDP and is likely to grow further.
- Some successful countries have increased their ability to innovate, and invested in public funding to help finance research and development in critical areas, and involved all big and small, public, and private, rich, and poor.

Conclusion

A coalition of stakeholders (private and governmental) is supporting pharmaceutical enterprises with funding for the vaccine. To modernize, upgrade and update digital infrastructure and to tackle the ongoing and future pandemics, different financial models like public-private partnerships and consumption/outcome-based models need to be evolved to alleviate the financial crisis during the development phase. It is the right time for countries to fast-track construction of new digital infrastructure, such as IoT along with AI, in addition to the hastening of vital projects and major infrastructure construction which is included in countries' financial stimulus plans.

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FISD
Forum for Indian Science Diplomacy

CALL FOR PAPERS

SCIENCE DIPLOMACY REVIEW (SDR)

Editors: Prof. Sachin Chaturvedi, Amb. Dr. Bhaskar Balakrishnan and Dr. Krishna Ravi Srinivas

Science Diplomacy Review (SDR) a multidisciplinary, peer-reviewed international journal, is a forum for scholarship on theoretical and practical dimensions in science diplomacy. It seeks to discuss and engage with the developments, issues, perspectives and institutions in science diplomacy. We invite contributions on issues related to science diplomacy in the form of research articles, perspectives, essays, book reviews and review articles. We welcome manuscripts on history of science diplomacy and historical case studies in science diplomacy. The role and relevance of science diplomacy in understanding and mitigating the present COVID-19 outbreak as well as epidemics in future, SDGs, and issues of global 'commons' and other global challenges in the post-COVID world are also welcome. We encourage contributions from scientists, diplomats, policymakers, researchers, research scholars and representatives of civil society for forthcoming SDR issues.

Contributions are received, reviewed, and published on a rolling basis. We strive to get contributions reviewed, revised, and published as early as possible. All manuscripts are acknowledged on receiving them. We work closely with authors and reviewers to ensure that the turnaround time is reasonable. Prospective contributors can go through the issues available online to get an idea on types of contributions and themes/topics covered by SDR

SDR is an open access journal published by the Forum for Indian Science Diplomacy (FISD) based at Research and Information System for Developing Countries (RIS), New Delhi, India. RIS is an autonomous independent policy research think tank with the Ministry of External Affairs. The Science Diplomacy Programme funded by the Department of Science & Technology is being implemented by RIS.

Most challenges facing the world today including the present COVID-19 outbreak, climate change, environmental degradation are complex, interdependent and transnational. The Sustainable Development Goals (SDGs) which seek to address numerous global challenges also require a multilateral and internationally coordinated response. Science, Technology and Innovation (STI) lies at the core of these efforts. Finding relevant solutions to these challenges require leveraging STI through effective multilateral and global partnerships between scientists, policymakers and diplomats. Science diplomacy assumes a crucial role in achieving SDGs, and for development cooperation to address global concerns. It calls for international science cooperation, dialogues and engagements between various stakeholders and countries. Science diplomacy is increasingly adopted as a useful tool by many governmental and non-governmental organisations in both developed and developing countries. SDR has been launched as a journal, inter alia, to reflect upon and debate on the above-mentioned themes.

Categories: Submit manuscripts including, full length articles and essays (4,000 – 6000 words), perspective (2,500 - 4,000 words) or book reviews/report reviews/event reviews (1,000 - 1,500 words) by July 21, 2021 to **science.diplomacy@ris.org.in** with "SDR – September 2021 Issue" in the subject. We are open to considering longer articles as long as they are relevant to the overall objectives of SDR. Previous SDR Issues can be accessed on **http://www.fisd.in/science-diplomacy-review.**

G20: Call for Papers

G20 is gaining importance as a global platform for articulation of economic, social and development issues, opportunities, concerns and challenges that the world is confronting now. Over the years, G20 has witnessed a significant broadening of its agenda into several facets of development. India is going to assume G20 presidency in 2022 which would be important not only for the country but also for other developing countries for meeting the Sustainable Development Goals and achieving an inclusive society. India can leverage this opportunity to help identify G20 the suitable priority areas of development and contribute to its rise as an effective global platform.

In that spirit, Research and Information System for Developing Countries (RIS), a leading policy research institution based in New Delhi, has launched a publication called G20 Digest to generate informed debate and promote research and dissemination on G20 and related issues. This bi-monthly publication covers short articles of 3000 to 4000 words covering policy perspectives, reflections on past and current commitments and proposals on various topics and sectors of interest to G20 countries and its possible ramifications on world economy along with interviews of important personalities and news commentaries.

The Digest offers promising opportunities for academics, policy makers, diplomats and young scholars for greater outreach to the readers through different international networks that RIS and peer institutions in other G20 countries have developed over the years. The interested authors may find more information about the Digest and submission guidelines on the web link: **http://www.ris.org.in/journals-n-newsletters/G20-Digest.**

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 articles 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/article.

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.

Referencing Style: References cited in the manuscript and prepared as per the Harvard style of referencing and to be appended at the end of the manuscript. They must be typed in double space, and should be arranged in alphabetical order by the surname of the first author. In case more than one work by the same author(s) is cited, then arrange them chronologically by year of publication.

Invitation to Join Mailing List

Interested readers, who wish to receive the soft-copy version of Science Diplomacy Review (SDR), may kindly send details, along with institutional affiliation to science.diplomacy@ris.org.in. Also specify if hard-copy is desired.

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 is implementing 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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