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The editorial correspondence should be addressed to the Editor, Science Diplomacy Review, Research and Information System for Developing Countries (RIS), Core IV-B, Fourth Floor, India Habitat Centre, Lodhi Road, New Delhi-110 003, India. Phone: +91-11-24682177-80, Fax: +91-11-24682173-74. Email: science.diplomacy@ris.org.in and dgoffice@ris.org.in.

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EDITORIAL

This issue comes out at a time when the US elections on 3rd November 2020 opened the door to a change of US Presidency. Given that the US is the global leader in science and technology, major impact in these fields can be expected including significant global consequences for science and diplomacy. This will have an immediate effect on the handling of the COVID-19 crisis, especially in the US where the number of cases have exceeded 20 million, and the US re-engagement with WHO could strengthen the pandemic response and overall global health security. US engagement with global efforts to combat climate change and re-joining the Paris accord would be widely welcomed. The science and technology community in the US and elsewhere has by and large welcomed the change brought about by the US voters and looks forward to greater science and evidence-based policy making and governance.

The science and technology relationship between the US, European Union (EU) and China, the three leading R&D spenders in the world, is going through a stressful period. China has embarked on a drive to strengthen its technological self-reliance, and is making increased efforts in critical basic and applied science sectors. This thrust has been endorsed recently by the Communist Party of China's (CPC) Central Committee and plans will be further developed at the next Party Congress in 2021. China has reacted to technology controls and restrictions being put in place in the US and the EU. China has been accused of clandestinely and illegally acquiring advanced technology, including through pressurising foreign enterprises doing business in China. These issues are likely to remain at the centre of China's relations with the US and EU, complicated by China's aggressive geopolitical stance.

Recently, India has seen some major policy reforms. The New Education Policy (NEP) 2020 has been announced, making major changes that could usher in major qualitative and quantitative improvements in STI human resources, including researchers. The new Science, Technology and Innovation Policy (STIP) 2020 is in the final stages of formulation and is expected to give a boost to STI and international collaboration. As a result, India's science diplomacy too will undergo changes.

In this issue, Valerino, González and Pastrana focus on the growing importance of Health, Science and Diplomacy especially in view of the current need to enhance international collaboration during and post-COVID19 situation and for tackling future health challenges. They base their study on the example of Cuba which has built considerable capacity in health sciences and is making this available globally during disasters and disease outbreaks. Cuban recent medical assistance to Italy during the recent COVID-19 pandemic has been applauded. Namdeo and Goveas analyse innovation diplomacy, by looking at examples of policies for fostering innovation in various countries and analysing in detail, India's efforts to develop its strengths in innovation through various policy measures and programmes. India's external linkages where innovation plays a key role as well as the challenges facing the country are outlined. Zulkifli examines the growing importance of water related issues, and in particular underlines the crucial role played by the Asia Pacific Centre for Ecohydrology (APCE). APCE has pioneered the development of the conceptual framework of ecohydrology and its applications at local, national, regional and international levels as part of science diplomacy. Water is a critical resource and international collaboration for optimum use is essential.

In the perspectives section, Das reviews UNESCO's recommendations on Open Science released in September 2020. He views it as a milestone and emphasises on strengthening open science ecosystems by clearly drawing the roles of science diplomacy. Indian traditional medicine system comprising Ayurveda, Yoga, Unani and Siddha and Homeopathy (AYUSH) has been gaining increasing prominence in global health, and its potential for playing important role in India's health diplomacy and foreign policy is analysed by Abha Arya. The article by Sharma, Varshney and Yarlagadda delves into the issues and challenges in increasing the participation of women in STEM and discusses various initiatives undertaken to encourage women scientists in STEMM. The progress in finalising EU's major research programme Horizon Europe for 2021-27 is discussed. The issue of non-member countries' participation is also examined in some detail.

The section focusing on institutions in science diplomacy reviews the activities of the American Association for the Advancement of Science to understand its role in the evolution and recognition of Science Diplomacy.

The report review section looks at the UNEP's recent report assessing the progress made during the UN Decade of Biodiversity, in protecting biodiversity. The rate of biodiversity loss is unprecedented and the pressures are intensifying. It underlines that according to the report, none of the 20 targets for 2020 have been met, and only six targets have been partially met. However, India's progress has been assessed in national reports, and is found to be satisfactory.

The book review section presents a review of 'Emerging Technologies for Economic Development' edited by Meissner et. al. The review begins with a conceptual discussion and highlights the cross-cutting importance of nanotechnology in a number of important domains, such as new materials, energy storage, electric vehicles, and biological systems. Some new security related issues have also arisen out of emerging technologies.

The last section of the issue provides syntheses of the Vaibhav Summit aimed towards engaging with the Indian diaspora in STEM, also taking into account the PRABHASS initiative. The making of the Science Technology and Innovation Policy 2020 is also discussed in some detail.

We thank our stakeholders for their diverse contributions and continuing support this journal.

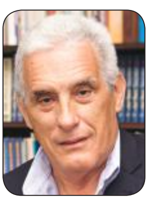
ARTICLE

Health, Science and Diplomacy: Necessity in Epidemic Times – A Cuban Perspective

Danev Ricardo Pérez Valerino*
Victoriano GustavoSierra González**
Sergio Jorge Pastrana***


Danev Ricardo Pérez Valerino


Victoriano Gustavo Sierra González


Sergio Jorge Pastrana

Introduction

"Millions of people die each year from preventable and treatable diseases, especially in poor countries. In many cases, cheap drugs can be produced on a large scale to save lives, but their sale prices prevent them from being bought by the people in need. Furthermore, there are many who die simply because there are no cures or vaccines because very few resources and research talent are devoted worldwide to treating the diseases of the poor" (Stiglitz, 2012)

In the present century, when social, economic and technological inequalities have increased mainly due to the global systemic crisis, Prof. Joseph E. Stiglitz, academic at Columbia University and a Nobel Laureate in Economics, warned about a situation that was hardly a priority for governments and international organisations during the previous century. Despite the scientific and technological progress achieved, uncertainties and challenges put the global health system at risk of collapse, and constitute a threat to the social balance and economic progress of countries, especially those with fewer resources. In an unpredictable way, natural disasters such as hurricanes, floods or earthquakes displace large groups of people from their homes, leaving them in a situation of high social and sanitary vulnerability.

* Head of International Relations, Finlay Vaccine Institute, OSDE BioCubaFarma. He holds a Masters' degree in International Relations.

** Science Advisor, BioCubaFarma. He is an Academic of Merit of the Academy of Sciences of Cuba.

*** Ambassador of Cuba in Barbados. He is the Executive Director of the Cuban Academy of Sciences and was the Foreign Secretary of the Academy.

Meanwhile, bioterrorism episodes such as the intentional spread of anthrax spores in the United States or the outbreaks of new or emerging diseases such as Ebola haemorrhagic fever in Congo, severe acute respiratory syndrome (SARS), Nile Fever, Antimicrobial resistance, food crises, variant Creutzfeldt-Jakob's disease in Europe or cases of bird flu can raise global alarm, regardless of the number of people affected or objective risks it represents for the world population. Some of these events have shown how the new technologies that support current progress are also a potential risk (OECD, 2003).

Modern means of transportation and communication have brought the world closer to the point of almost erasing its borders, allowing viruses and bacteria that cause these diseases to spread from one end of the planet to another within hours or days. In addition, information travels at an even greater speed, which allows us to experience crises that occur anywhere on the planet in real time. In this context, globalisation evolves quickly on different aspects of the international scene, making the need for trans-nationalisation and interdependence of the global system increasingly evident. As a result, the global conception of international relations becomes increasingly complex as a direct consequence of the appearance of new conflicts, scenarios and actors the world economy and politics.

The COVID-19 pandemic has been the latest call of attention to governments and international organisations. It has enhanced awareness of international collaborations through scientific development as the best possible way to face the complex current scenario of the planet, hit by millions of confirmed cases and more than 800 thousand deaths until August 2020. Today, Science Diplomacy, as well as Health Diplomacy, are tools that must be promoted globally in order to face the current situation. Hence, the importance of clearly understanding the concepts that define both, the possibilities for their academic and structural development, as well as their employment by some countries are immense. This article delves into the example of Cuba.

Science and Health Diplomacy in the Contemporary International Relations

For the last two decades, a political system has developed in the world that modifies exchanges between states and determines other aspects of human development. It directly influences the complex relationship between global health situation, trade, economy, and international relations and particularly impacts international cooperation through scientific development. With the commotion generated by the accelerated international spread of COVID-19, political systems have been forced, for the most part, to recognise scientific procedures and research as essential elements for making political decisions to face the epidemic. Facing a virus that does not distinguish between political ideologies, levels of social development, religions or social cultures, it has become urgent to promote collaboration and scientific exchange at the political level in most nations. Several voices including the UN Secretary General and several prominent world leaders[1,2,3,4] have openly expressed their views in the international political arena. In these circumstances, disciplines such as Science and Health Diplomacy are gaining space internationally. They play a key role in studying and understanding the dynamics of governments, global organisations and their regional political impact in facing health crises such as COVID-19.

During the last decade, these connections between scientific and technological development and foreign policy have received strong academic boost from think-tanks and universities. They have been implemented in government strategies mainly by developed countries in Europe (France, Spain, Germany, Italy and Switzerland), North America (United States and Canada) as well as Asian nations such as China, Japan and India. To a lesser extent, in Latin American and African countries some specific programmes or actions of Science Diplomacy have been created, mainly managed by developed countries as strategies of "soft power" based on scientific advances used to strengthen political ties and economic activities with developing countries.

It could be considered that, in theory, to carry out a political strategy based on Science and Health Diplomacy, a nation must have a recognised and respected diplomatic corps, as well as policies that support, on one hand, scientific-technological development in various branches of science and its corresponding applications and, on the other hand, health policies in favour of the majority of the population. However, based on the responses that some governments have implemented to face COVID-19 pandemic, it has been proven that this is not the general case.

Science Diplomacy & Role of Global Development Centers

Since early years of this century, there have been important negotiations conducted by international organisations such as the World Health Organization (WHO) that have placed it at the center of the new relationship between health and foreign policy. In this sense, we could mention the negotiations for the formulation and promulgation of a framework agreement for tobacco control, new regulatory mechanisms to manage health policies at global and regional level in coordination with local governments, as well as its support for the global strategy and Action Plan on Public Health, Innovation and Intellectual Property.

Another important step in this transformation was the Initiative on Global Health and Foreign Policy (GHFP) signed in March 2007 as the Oslo Declaration by the Ministers of Foreign Affairs of Brazil, France, Indonesia, Norway, Senegal, South Africa and Thailand. This initiative proposed among its objectives to promote a foreign policy in the signatory countries that envisaged health care and its problems as a priority issue beyond global crises and health emergencies. From the conceptual point of view, there are common as well as different criteria to characterize the terms Scientific Diplomacy and Health Diplomacy.

On one hand, Dr. Vaughan Turekian, former scientific advisor to the United States Department of State and International Director of the American Association for the Advancement of Science (AAAS), has published that according to his particular criteria Science Diplomacy does not have a "*quick definition*". He considers also that *while much of the scientific endeavour is driven by unplanned interactions, science diplomacy has a more strategic approach (…) is driven by institutions. Whether it be governments, universities, private sector and civil society, science diplomacy requires a link to an institutional arrangement* (Turekian, 2018).

For Daryl Copeland, Canadian diplomat and academic at the Canadian Institute for Global Affairs and the University of Montreal, Science Diplomacy is a "diplomatic technique through which knowledge of science and technology is freed from barriers and national and institutional instances, thus expanding its potential to directly address the global challenges of underdevelopment and insecurity" (Copeland, 2009).

In Europe, among different authors, we could mention the French academic and diplomat Pierre Bruno Ruffini, professor at the Faculty of International Affairs of the University of Le Havre, former diplomatic advisor for Science and Technology and author of the book "*Science and Diplomacy: a new dimension in International Relations*". He states that Science Diplomacy is a "*relevant, effective and potentially transformative tool that can play a key role in responding to some of the most elementary challenges faced by the international community, linking diplomacy with the most advanced scientific knowledge*" (Ruffini, 2017).

On the other hand, the Spanish researcher Marga Gual Soler, renowned activist and promoter of Science Diplomacy, with experience in case studies in the United States, Europe and Latin America, characterizes Science Diplomacy in her recent publications as "*a field of research, education and fast-growing practice dedicated to better understanding and strengthening the connections between science, technology and international affairs to address national and global challenges*" (Mauduit and Gual, 2020).

These authors have concentrated their analysis on the term Science Diplomacy in which they include branches such as Health Diplomacy, which for analysts such as the German specialist Dr. Ilona Kirckbush (Director of the Global Health Diplomacy Program of the Institute for Advanced Studies in Geneva and WHO Adviser) it "*tries to relate the negotiation process in which multiple actors with different degrees of political and economic relevance participate, and to shape and coordinate the global political environment for health*" (Kirckbursh, 2010).

The North American Professor Peter Hotez, an expert in the field of infectious diseases and vaccinology, with experience in health issues at a global level, characterised in 2014 a new hybrid between Science Diplomacy and Health Diplomacy that connects them based on the scientific strength that some countries and transnational companies have on the specific subject of vaccines. It is called Vaccine Diplomacy or Vaccine Scientific Diplomacy and has been gaining recognition from the effective use of these highly beneficial products, with scientific, innovative, and technological knowledge behind their development and commercialization, and most of all, their high efficiency in facing worldwide epidemics caused by bacteria and viruses (Hotez, 2014).

In the course of this century, these have been some of the conceptual basis for the creation of demanding academic and professional interrelation programmes focused on promotion and practical execution in the preparation of diplomatic and scientific experts to become advisers in science and health diplomacy. This strategy, initially conceived in developed countries, has now been also applied in developing countries.

Hence, there has been a step forward in the formative level of the think tanks at the Center for Strategic and International Studies through the Global Center for Health Policy in Washington DC, the Center for Global Health Security *Chatham House* in London, or the Graduate Institute of International Studies in Geneva, as well as in other institutions of similar academic relevance such as the Beijing Institute of Global Health, *Sergio Arouca* National School of Public Health in *Fiocruz* Institute, located in Rio de Janeiro, Brazil or the Research and Information System for Developing Countries Institute (RIS) in New Delhi, India.

This strategy is combined with health policies in a two-way bridge with foreign policies of the countries against the backdrop of international collaboration, compliance with the SDGs, application of scientific results in industry, economy and any additional aspect related to the equitable and sustainable development of nations.

A guideline for the implementation of these strategies can be found in the article *New Frontiers in Scientific Diplomacy*, published in 2010 by experts from AAAS and the English think tank Center for Scientific Policy, *The Royal Society*. They established three dimensions for science diplomacy:

- **Science in diplomacy:** seeks to generate foreign policy objectives with scientific advice.
- **Diplomacy for science:** from the theoretical and practical point of view is aimed at facilitating international cooperation for science.
- **Science for diplomacy:** its main objective is to use scientific cooperation to improve international relations between countries (The Royal Society, 2010).

Each of these dimensions has been addressed through case studies generated from circumstantial events that have occurred throughout history such as epidemics, conflicts and even natural disasters. Those circumstances generate regional, or in some cases global crises due to their negative effects, which have a powerful social, political or economic impact on several aspects of human life.

From the practical point of view, these three dimensions are the starting point of training courses, workshops, political analysis conferences and others, coordinated by AAAS in Washington. Similarly, in Europe, the S4D4C and InsSciDE both include networks of scientific institutions, universities, non-governmental organizations and think tanks with financial support granted by the European Union through the Horizon 2020 programme. We could also mention other academic centers such as the Barcelona Institute of International Studies (IBEI), the World Academy of Sciences (TWAS) in Trieste, the University of Bergen in Norway, SciencePo in Paris, among others.

In Asia, the most relevant actions have been carried out by Japan, China and India, three great scientific and diplomatic powers that with their own characteristics, have taken important steps in the introduction of these tools. In Japan, for example, the use of scientific results to attract investment has been successfully implemented; scientific advice has been promoted for the formulation of policies within the country as well as in collaborating countries. In addition, there has been strong support from the government to negotiate the participation of Japanese scientists in international research programmes.

Both China and India have managed to include the results obtained by their powerful scientific development in different branches of science in their foreign policy strategy. This is supported academically by universities, and government think tanks that promote the connection between them, as well as the identification of specific case studies linked to their social dynamics and development level.

There has been an evident increase in publications that address in each case the styles and peculiarities in order to finance, support and mostly promote both Science Diplomacy and Health Diplomacy at a global level through exchanges and contacts with international organizations, structures of power and world-renowned academic centers.

In a particular way, Vaccine Diplomacy in the current context has become a global event. According to the analysis appreciated in different online and written press reports strong negotiations between national coalitions and large biopharma companies with blatant internal contradictions are becoming more and more common.[5] In parallel the participation of an entity of governments and pharmaceutical companies, universities and military centers, states within states, in a race against time where high investments are combined by public or private financing sources.[6]

In this global scenario, a phenomenon known as "vaccine nationalism" has generated a kind of competition in great global powers to measure the power of their scientific capacities and to invest all the necessary resources to find a vaccine that will fight SARS-COV-2 virus. This position linked to anticipate the accumulation of doses of possible vaccines, not yet registered, for their citizens, is not wise or positive. Due to the high degree of dispersion of the epidemic as a result of globalisation, it would be impossible to stop it from spreading.[7] Science and health diplomacy are the alternatives to face this scenario.

Science, Technology, Healthcare & Cuba's Diplomacy

Historical Overview

Science and technology in Cuba are constantly evolving. Specifically, the biopharmaceutical industry is currently one of the priorities for the Caribbean island. The growing scientific-technological gap between rich and poor nations, in a world that is globalising rapidly, evidenced the need to develop a solid scientific project that would allow increase recognition of the achievements made by the Revolution in social health, welfare, etc. Today, after the impulse and support that Fidel Castro provided for its development, it has established its own model of science and innovation that has obtained results recognised by the international community (Martínez *et al.*, 2020).

After a few decades of fruitful development, this sector has become one of the most important for the Cuban economic strategy. About thirty institutions are included in the BioCubaFarma Business Group, with more than 20 thousand outstanding experts. Among its main goals, there is the contribution to the social development of the country, particularly in the areas of health and agriculture. In parallel, it has devoted efforts to achieve the necessary competitiveness to consolidate itself as one of the sectors that generate important sources of incomes for the country through the export of its products registered in several countries as well as through collaboration agreements with scientific and academic entities from all continents. This industry has grown through collaborative health programmes implemented since the 60s of the last century to send medical brigades and health experts to nations all over the world that have treated millions of patients and saved countless numbers of lives.

With the new century, these programmes increased their spectrum of collaboration by receiving the support of international organisations such as WHO/PAHO, UNICEF, UNDP, NGOs, as well as governments of developing countries with a high deficit of health personnel to face epidemic situations or natural disasters. With the support of Cuban personnel, resources have been invested for the additional creation of academic institutions for training doctors and health staff. The best-known examples are "*Barrio Adentro*" Programme and "*Milagros*" Operation, replicated in several nations, as well as the "*Henry Reeve*" Medical Brigade.

A key role in this dynamic has been the interrelation between the Cuban health authorities and their diplomatic personnel, which is highly recognised in international forums. Cuban diplomacy, following the approaches based on its traditional international solidarity and its solid principles, has worked relentlessly to support the scientific development achieved. Hence, it is accurate to state that there is a strong interrelation between Cuban foreign policy and its scientific development, specifically in the field of the biopharmaceutical industry, with vaccines and innovative products, as well as collaboration in the field of health and medical assistance.

Until now, several positive examples could be mentioned of the functional dynamics between the diplomatic corps, the scientific strength provided by the biopharmaceutical industry and the human resources in the health field trained the island, functioning as a unique force in response to crises occurring at the regional or global level.

In other words, the development of the biopharmaceutical industry has had an explicit impact in the diplomatic sphere, through the internationalisation of health products and medical collaboration and the various possibilities this has generated. It has directly influenced Cuban foreign policy especially during the last two decades. The cardinal principle of Cuban foreign policy, the consequent practice of internationalism and solidarity with other nations, has strengthened scientific and health diplomacy, with its own characteristics. International collaboration and negotiation of multilateral agreements promote the improvement of sanitary conditions in developing countries, through human resources and high impact biopharmaceutical products.

COVID-19 and Cuba's Approach

In the current pandemic scenario, Cuban science and health diplomacy has been useful to deal with the SARS-CoV-2 virus in African, Latin American, Asian

Table 1: Examples of joint actions including medical collaboration, the biopharmaceutical industry and Cuban diplomacy in the 21st century

DATE	COUNTRY (ies)	ACTION
2001-2002.	Uruguay + Meningitis epidemic outbreak	More than 1,250,000 doses of the Cuban VA-MENGOC-BC® vaccine were sent by the Cuban government. In discussions of health authorities with parliamentary representatives and the population they recognised, without a doubt, the effectiveness of the product developed in Cuba to fight this disease. Cuban government decided to donate the vaccines, discounting the cost of the vaccines from a debt of the Island with this South American nation.
2005-2006.	Pakistán Earthquake	There was a call for international aid after this natural disaster. Cuba sent more than 2,400 doctors, paramedical staff and tons of nationally manufactured medical equipment and medicines on 36 transport flights, establishing 32 field hospitals and two health camps in the affected area. From October 2005 to January 24, 2006, Cuban medical staff gave 601369 medical consultations, 5925 surgeries including 2819 major surgeries and gave medical care in 44 different locations in the area affected by the earthquake.
2006	Indonesia/ Sri Lanka Earthquake+ Tsunami	Cuba sent two medical brigades to these countries with 24 and 25 doctors respectively and more than 12 tons of different healthcare materials to each country.
2007-2012.	Sub-Saharan Africa Vaccine shortage in the area known as "meningitis belt" in Africa.	As a response to a call for international help from the WHO due to the low availability of vaccines to face meningitis epidemics in Sub-Saharan Africa, a fast-track agreement is reached between Cuban and Brazilian scientific entities. With the support of both governments, their respective regulatory authorities and under the guidance of international organizations such as WHO, PAHO and UNICEF they carried out joint productions of millions of doses of vaccines to immunize the countries affected by this disease. In some of these countries, Cuban medical brigades supported local authorities and experts from WHO and UNICEF in the immunization process. This was recognized as the first example of South-South collaboration in the biopharmaceutical industry globally.

Table 1 continued...

Table 1 continued...

2010-2011.	Haiti Earthquake+ Cholera outbreak	More than a thousand Cuban healthcare staff worked together with officials from PAHO and other nations such as Brazil and Venezuela in confronting the impact generated by the earthquake and the epidemic outbreak of cholera.
2014-2015.	Sierra Leone/ Guinea/ Liberia Ebola Outbreak	A Cuban medical brigade of more than 200 healthcare practitioners spent around six months working in Sierra Leona, Liberia and Guinea in response to the call of the United Nations Secretary General, Ban Ki-Moon, and the World Health Organization, to confront the virus. In those three West African countries, the most affected by the disease, Cuban healthcare workforce played a leading role not only in the cure of Ebola, but also in its prevention, as it was pointed out later by local authorities and international organizations. At the 140th Meeting of the WHO Executive Council, the Public Health Prize in Memory of Dr. Lee Jong-wook was unanimously awarded to the Henry Reeve Brigade of Cuban medical workforce in emergency situations.
2017.	Peru/Mexico	To face natural disasters caused by heavy rains and earthquakes, medical brigades were sent with tons of medicines and medical equipment to assist the victims, in close coordination with local and national authorities and in cooperation with health staff from international organizations.
2020	Around 40 nations	Cuban health cooperation in times of COVID19 pandemic has been extended to some 40 nations on all continents, sending brigades of medical staff to many countries all over the world that have requested Cuban medical assistance in the fight against the disease caused by the new coronavirus. The results achieved have generated an international solidarity movement, promoting the inclusion of the Cuban medical brigades among the proposals for the Nobel Peace Prize.

and European countries. This had also been previously acknowledged when facing the Ebola and the influenza A (H1N1) epidemics, as well as natural disasters that affected various nations. Those were examples of coordination between Cuban scientific and diplomatic personnel, who worked directly with local authorities and international organisations to respond effectively to human and material consequences. During this period fighting the pandemic, Cuba has promoted strong protocols to face COVID-19 in his own territory and shared it with more than 40 countries sending medical brigades and science specialists.

Local strategy has been based on a relevant role played by science and technology, organically linked to government management, all of them in function of offering a social, scientific, political and health response capable of facing the challenge that the pandemic has posed. Under this perspective, the strategy has combined three main factors:

Presence of a solid health care system, from primary to tertiary level;

A biopharmaceutical industry developed at national level that has managed to provide national drugs and develop also vaccine candidates currently in the clinical studies phase, as well as; and

A strong connection between civil society organisations that has made it possible to direct the indications and considerations from science conducted by health authorities and the central government.

Through Point 1, a group of prevention measures were implemented from the initial months of the pandemic and have been consolidated during it. For example, the use of drugs that increases the capabilities of the immune system including Prevengho-Vir (homeopathic formulation) and Biomodulin T, the mandatory use of masks on public roads, physical isolation and hand washing, as its central actions.

Direct confrontation has been based on the search for people at risk through massive investigation in the population going house to house; applying the tests to detect the virus in at-risk and silent populations; isolation, treatment of patients confirmed, their contacts, suspicious persons and travellers arriving in the country.

The pharmacological treatments classified in different therapeutic protocols, according to the situation of the person, include more than 20 Cuban products. New biotechnological drugs are used such as Jusvinza (peptide that has been shown to increase the frequency of regulatory T cells (Tregs) and the suppressive capacity of CD4+ effector T cells. In addition, it induces a reduction in pro-inflammatory cytokines, TNF, IL-17 and IFN alpha), others already known such as IFN 2b and interferon gamma, erythropoietin, Surfacen, hyperimmune plasma, oseltamivir and azithromycin. These are the result of the work of Cuban scientific research institutions such as the National Center for Biopreparations, the Center for Genetic Engineering and Biotechnology, the Center for Molecular Immunology, the National Center for Scientific Research and the Center for Research and Development of Medicines and the pharmaceutical industry with its central organization BioCubaFarma.

All joined by the government leadership and the Ministry of Public Health in function of having the best and most effective treatments against COVID-19. In this sense, the first confirmed case in the country was diagnosed on March 11th and as of November 13th, a total of 7,541 patients diagnosed with the disease have accumulated; 443 (5.8 per cent) confirmed cases, 441 (99.5 per cent) with stable clinical evolution. In addition, 131 deaths have been reported (1.74 per cent Mortality rate), and 6,965 recovered patients (92.3 per cent) have been accumulated. These results show a control of the situation by the authorities which strategy and protocols have been shared, as already mentioned, by the medical and scientific brigades that have worked in more than 40 nations in Europe, Africa, Latin America and Asia.

In addition, scientific community has been working on research projects for vaccine candidates in which the country has a long experience and research will continue to find, among all, the best drugs to combat this pandemic. Two vaccine candidates, Sovereign-01 and Sovereign-02 developed by a joint collaboration led by Finlay Vaccine Institute, Center of Molecular Immunology and the Synthetic Laboratory of Havana´s University, are in Phase 1/2 Clinical trials in humans with excellent perspectives.[8]

In case Cuban vaccine candidate proves safe and effective, it would become available for purchase in the region through PAHO (Americas regional office of the World Health Organization (WHO).[9] In addition would be taken into account by COVAX (ground-breaking global collaboration to accelerate the development, production, and equitable access to COVID-19 tests, treatments, and vaccines) co-led by GAVI, the Coalition for Epidemic Preparedness Innovations (CEPI) and WHO.

From the preceding discussion, it needs to be underlined that the Cuban experience could be conceptualised as a Science and Health Diplomacy *characterized by strategically enhancing the scientific and technical results as well as the health policies achieved during the last half century. This is key element for promoting and developing international collaboration and increasing diplomatic relations with countries and international organizations, following the principles that define the Cuban political process.*

Conclusions

Considering the difficult circumstances of international relations in recent years due to the different epidemics such as influenza, Ebola and now COVID19, except for some cases related to political or economic interests, there are general coincidences in the great importance of raising collaboration in the international scientific community. With the support of political decision-makers at a global level, the scientific community promotes alternatives such as those mentioned above, that provide other solutions to the current difficult situation the world is experiencing.

Science and health diplomacy implemented under the principles of multilateral collaboration, technical support, adequate financing, supported by solid and verifiable results, conducted by trained personnel at a scientific and diplomatic level, is a great option that must be developed with joint support and political will, according to the intrinsic characteristics of each nation.

Given the structural and development differences between developed countries and those with fewer resources, it is not possible to implement collaboration mechanisms in a "one size fits all" manner. We cannot equate all cooperation as the mere transfer of funds from one rich country to another poorer country. Countries of all levels of development can share expertise, knowledge and services in many different ways. There are different ways to promote investments and scientific and technological capacities at each local site to face epidemics and natural disasters that can be practical in different conditions to promote development in such a way that do not differentiate national societies and human beings by political ideology, wealth, religion, gender or race.

The results obtained by the Cuban scientific and medical international cooperation shows that, regardless of any previously considered pre-requisite for international cooperation, it is possible and desirable to achieve a symbiosis between diplomacy, science and health in North-South and South-South cooperation among most countries of the world, which can provide solutions to emerging challenges to global social and economic development.

Acknowledgements

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Endnotes

1 Guterres, A. 2020. "This is the moment for Science and Solidarity". *United Nations*. April 14, 2020. Retrieved from https://www.un.org/en/un-coronavirus-communications-team/time-science-and-solidarity.

2 Tedros, A.G. 2020. "WHO is fully committed to serving all people and all countries through science, solutions and solidarity". *World Health Organisation*. November 09, 2020. Retreived from https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-world-health-assembly---9-november-2020.

3 Dr. Angela Merkel (German Chancellor): "Germany will cooperate with the WHO, an institution that has a "key role" in this challenge (…) this pandemic will only be overcome by acting at the international and multilateral levels".

4 Mr Miguel Díaz-Canel (President of Cuba): "it is only possible to face the pandemic locally with full involvement of science and national technology, organically linked to government management, in order to offer an efficient social, scientific, political and health response (…) it is key to unify scientific knowledge and international cooperation and solidarity to obtain positive results and improve the global health situation".

5 Mainly, very critical press reports have been identified with the actions of some large biopharmaceutical companies with strong ties in political spheres. See, "Pharmaceutical industry looking to avoid lawsuits in Covid vaccine race", *Euronews*, September 03, 2020. Retrieved from https://www.euronews.com/2020/09/03/pharmaceutical-industry-looking-to-avoid-lawsuits-in-covid-vaccine-race; Trump's Vaccine Chief Has Vast Ties to Drug Industry, Posing Possible Conflicts. *New York Times*, May 20, 2020. Retrieved from https://www.nytimes.com/2020/05/20/health/coronavirus-vaccine-czar.html.

6 Several vaccine candidates developed in countries like Russia or China have had direct funding from government funds and the support of the army forces for the effective advancement of clinical research.

7 WHO leaders' position on this issue has been manifested from the statements of the Director General Dr. Tedros Adhanom Ghebreyesus who has declared: "It is natural that countries want to protect their own citizens first but if and when we have an effective vaccine, we must also use it effectively. And the best way to do that is

to vaccinate some people in all countries rather than all people in some countries (...) vaccine nationalism will prolong the pandemic, not shorten it". See, "WHO chief warns against COVID-19 vaccine nationalism". *CGTN*. October 26, 2020. Retrieved from https://news.cgtn.com/news/2020-10-26/WHO-chief-warns-against-COVID-19-vaccine-nationalism--UTD8hxtXeE/index.html.

8 See more on Marsh, S. 2020. "Cuba leads race for Latin American coronavirus vaccine". Reuters. November 12, 2020. Retrieved from https://www.reuters.com/article/us-health-coronavirus-vaccine-cuba-focus/cuba-leads-race-for-latin-american-coronavirus-vaccine-idUSKBN27S1OX.

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Indian Innovation Diplomacy: Choices, Challenges and Way Ahead

Suryesh K. Namdeo*
Jenice Jean Goveas**

Suryesh K. Namdeo

Jenice Jean Goveas

Innovation - A buzz word in India

'Promotion of innovation' received new vigour in India with the outgoing decade (2010-2020) declared as the decade of Innovation and the Science Technology and Innovation (STI) Policy 2013 as its highlight. The Atal Innovation Mission (2016) focussed on nurturing innovation right from school education through hands-on experience in emerging technologies including 3D printing, internet of things (IoT), miniaturised electronics and robotics.[1] AGNIi - Accelerating Growth of New India's Innovations, an Initiative for tech commercialisation; 'Startup India'; 'Stand Up India' that finances Scheduled Castes/Scheduled tribes and women entrepreneurs; National Innovation Foundation are a few of the many initiatives that have contributed to India's thriving innovation ecosystem.[2] Enabling regulations like the insolvency and bankruptcy code and liberalised foreign direct investment (FDI), labour code and import-export regimes have paved the path for accelerated increase in innovations, R&D expenditure, patents, FDI, start-ups and unicorns in the past few years.[3,4,5] The current pandemic necessitated several new med-tech innovations to mitigate its effects on public health and the economy.

Proactive programmes and policy interventions with consistent focus on innovation have borne fruit with significant improvement in global rankings particularly

* Programme Officer for DST Science, Technology and Innovation Policy Fellowship Programme. He works at the DST Center for Policy Research, IISc., Bangalore.

** Postdoctoral Fellow at the DST-Centre for Policy Research, IISc., Bangalore and is hosted at the Office of the Principal Scientific Adviser to the Government of India.

in the Global Innovation Index (GII) where India climbed from the 81st position in 2015 to an impressive 48 in 2020.[6] The ease of doing business saw India scaling to 63 in 2019 from 134 in 2015.[7] This progress is backed by trained human resource and robust R&D infrastructure through national institutes and labs including Indian Institute of Science, Indian Institutes of Technology, Indian Institutes of Science Education and Research, Tata Institute of Fundamental Research and National Institutes of Technology, along with laboratories of Council of Scientific and Industrial Research (CSIR), Indian Council of Medical Research, Indian Council of Agricultural Research, Defence Research and Development Organisation, Bhabha Atomic Research Centre and several state and private universities that are involved in cutting edge research across sectors. Further, the industrial R&D expenditure has been increasing in absolute terms but still remains low as a fraction of the total R&D expenditure when compared to other countries.[8]

India's innovation ecosystem is continuously evolving internationally through strong linkages with countries of both global North and South.[9] However, there is a need to further align our domestic innovation policies with our foreign policy initiatives to leverage their complementary strengths for achieving national development goals while supplementing diplomatic efforts to forge stronger ties with our international partners. This would bolster our efforts to attract more Foreign Direct Investment (FDI) and aid in internationalisation of the national innovation ecosystem. Such joint and synergistic efforts that harness diplomacy and innovation to achieve national or international goals come under the ambit of 'innovation diplomacy'.[10]

Innovation Diplomacy: History, Concept and International Practices

In the 1930s, Joseph Schumpeter was among the first to place innovation at the heart of the economy as the driving force of growth. Gerhard Mensh, in 1979, analysed innovation as the key factor in overcoming economic depressions. It was only in the late 20th century that the term 'innovation diplomacy' gained traction when it was used for projection of soft power to create a positive image for public and industries.[11] Innovation diplomacy can be used as a tool for promotion of trade and partnerships, building bridges between research and business, scaling up innovative solutions to global problems and collaborations to influence intellectual property regimes.[12]

Innovation diplomacy lies at the intersection of innovation and foreign policy. It is comprehensively defined by the São Paulo Framework as 'the component of national and subnational strategies that employ diplomatic tools and processes to enhance innovation capabilities, including research and development (R&D), technological entrepreneurship, innovation ecosystems, high technology production and trade, risk funding and qualified human capital'.[13] It comprises the spectrum of engagements that promote mutual cooperation, leveraging technology and innovation capacity. It supports the global dynamism of the economy by making it possible to forge necessary alliances to overcome antagonistic forces to tackle major challenges such as climate change, pandemics, etc. However, it also has more competitive dimensions with nations often having conflicting stands on the intellectual property rights (IPR) issues and competing with each other for attracting more FDI.[13]

Innovation diplomacy rapidly developed via networks, centres and hubs to internationalise nationally oriented innovation systems through unique programs and models that include innovation diplomats and non-governmental channels.[14] Many of these are prototypes with integrative setups that amalgamate science diplomacy with innovation diplomacy, gluing together several objectives and missions at the nexus of science, technology, economics and foreign policy. This is further elaborated below taking examples of some well-established innovation diplomacy practices around the world.

Switzerland

Being consistently ranked as the most innovative country in the GII, Switzerland was one of the earliest to focus on innovation diplomacy. Its first science attaché was posted to the US, as early as 1958, primarily to observe and report developments and potential use of nuclear technology by the US. Today it leads in innovation diplomacy through well targeted and orchestrated instruments by the Swiss State Secretariat for Education, Research and Innovation and the Federal Department of Foreign Affairs in partnership with private industry. They aim to further its foreign policy and scientific objectives by building networks, scouting for innovative developments, promoting Swiss products and technologies in the areas of agriculture, artificial intelligence, drones, entrepreneurship, health & life science, ICT, neuroscience, space research, vocational education, robotics.[15]

Swissnex, a public-private partnership venture, acts as the Swiss global science and innovation diplomacy network, through five knowledge outposts at Boston, San Francisco, Shanghai, Bengaluru, and Rio de Janeiro with several connected offices and science counsellors being located in other tech and innovation hubs. Its extensive network of contacts at universities, research institutions, and companies in the host regions is made available to interested Swiss institutions and individuals. Scientific and cultural activities for new bilateral cooperation programmes in science, education, art and innovation are also organised. It has successfully supported international expansions of several Swiss start-ups creating new avenues for foreign investment in R&D.

United Kingdom

In 2000, the British Foreign and Commonwealth Office was among the first to set up the Science and Innovation Network (SIN) headed by the ministry's Chief Scientific Adviser, to internationalise the UK's scientific interests connecting scientists and businesses nationally and overseas with a wide web of offices in 40 countries and territories. SIN's notion of innovation is defined by scientific excellence rather than industrial leadership and has clearly defined goals of strengthening the UK's foreign policy through science and innovation, connecting innovative UK industries and scientific expertise with international opportunities, supporting international development goals and matching UK expertise to international need. It has brokered several deals between UK's industries, universities and those in other countries including a 3-million-pound innovation challenge fund in India.[16]

Singapore

Singapore launched the Global Innovation Alliance in 2019 to strengthen its connection to major innovation hubs around the world for exchange of ideas and knowledge to promote innovation and local entrepreneurship.[17] It is a joint initiative between two government agencies, Enterprise Singapore and Singapore Economic Development Board. This network currently spans 13 innovation hubs in 10 countries, and it supports Singaporean start-ups in venturing abroad and international start-ups in scaling up in Asia using Singapore as a launch pad.

Germany

Always ranked as one of the most innovative countries, Germany accelerated its innovation internationalisation strategy since 2009, setting up German Centres of Research and Innovation (DWIHs) in New York, Tokyo, Moscow, New Delhi, and São Paulo. The Federal Foreign Office closely collaborates with the alliance of German science organisations that include the Alexander von Humboldt Foundation, German Academic Exchange Service (DAAD), German Research Foundation (DFG), Fraunhofer-Gesellschaft, Helmholtz Association, German Rectors' Conference (HRK), Max-Planck-Gesellschaft and the Association of German Chambers of Industry and Commerce (DIHK).[18] It provides a platform for German innovators to showcase their research and build a local network while also regularly organising international events and conferences with a significant social media presence.

Israel

Israel has been actively promoting its brand as the 'Startup Nation' with the Innovation, Entrepreneurship and Technology department of its Ministry of Foreign Affairs playing a key role. It trains diplomats heading for overseas assignments in the areas of technology and innovation to better represent Israeli interests.[19] Israel Innovation Authority, the primary facilitator of innovations in the country has extensive linkages and partnerships internationally. It creates and facilitates avenues for bilateral and multinational cooperation through joint networking events, innovation programmes and seed funds with government, industry and academic partners overseas.

Denmark

The Innovation Centre Denmark (ICD) was established in 2006 in the Silicon Valley followed by Shanghai, Munich, India, Brazil, South Korea and Israel. ICDs are managed by the Danish Ministry for Foreign Affairs (UM) and the Ministry of Higher Education and Science (UFM) that provides the bulk of public funding. ICD enables Danish stakeholders to tap into new global markets through export and growth-oriented S&T policies, Innovation-driven projects and services in the fields of Agriculture, Arctic, emerging technologies, Education, Entrepreneurship, FinTech, Health, Space, Engineering, etc.[20]

Brazil

Brazil's efforts for collaboration were evident right from the mid-20th century when the National Council for Scientific and Technological Development (CNPq), Coordination for the Improvement of Higher Education Personnel (CAPES), Pure and Applied Mathematics Institution (IMPA), National Commission for Nuclear Energy (CNEN) and the Technological

Institute of Aeronautics (ITA) were created by partnering internationally. They focus on strengthening and internationalisation of the National Innovation System, creating skilled jobs, increasing competitiveness and projecting Brazil as a key player in the global production chains. The 'Innovation Room' coordinates R&D and innovation projects of major companies in Brazil[21]. Brazil has been actively engaged in the EU Research and Innovation Framework Programme, Horizon 2020 and its successor, Horizon Europe, starting in 2021.

India's Innovation Diplomacy Engagements

Although the term innovation diplomacy has not been explicitly used in India's STI engagements, several steps have been taken to intensify bilateral and multilateral cooperation in innovation, making it an important agenda point in diplomatic engagements. Initiatives like BRICS STI framework, setting up of country desks at Invest India, launching of the GII in India in 2019, etc reflect the seriousness with which the Indian government is pursuing innovation diplomacy. Additionally, joint centres were set-up to promote STI cooperation with France (Indo-French Centre for the Promotion of Advanced Research - IFCPAR/CEFIPRA); Germany (Indo-German Science and Technology Centre -IGSTC); and the US (Indo-US Science and Technology Forum - IUSSTF). Despite the absence of a comprehensive innovation diplomacy strategy, India has made efforts in this direction some of which are elaborated in the following passages.

Initiatives by the Science and Technology Ministries

The International Cooperation division of the Department of Science and Technology (DST) is at the helm of India's STI cooperation.[22] It has been engaged in negotiating, concluding and implementing STI agreements between India and other countries in partnership with stakeholders including the MEA, academic institutes and industry bodies. It has facilitated over 80 bilateral STI agreements, multilateral engagements with the EU, ASEAN, BRICS, G-20, India-Brazil-South Africa (IBSA), Bay of Bengal Initiative for Multi-sectoral Technical and Economic Co-operation (BIMSTEC) etc. and collaborations with international organisations including United Nations Economic Scientific and Cultural Organisation (UNESCO), The World Academy of Sciences (TWAS), United Nations Commission on Science and Technology for Development, and the Organisation for Economic Cooperation and Development (OECD). It also administers dedicated funds and fellowships for R&D and innovation partnering with Australia, UK, Portugal, Hungary, South Korea and Israel. Similarly, the Office of the Principal Scientific Advisor to the Government of India (O/o PSA), Ministry of Electronics & Information Technology (MeitY), Department of Biotechnology (DBT) and the Department of Scientific and Industrial Research (DSIR) have their respective Divisions that initiate and coordinate international STI cooperation activities, fellowships, funds and joint programmes. Such institutional agreements act as building blocks that shape India's Innovation diplomacy efforts.

Initiatives by the Ministry of External Affairs (MEA)

India's Innovation diplomacy efforts have progressed through multiple modes that include formal government initiatives through the MEA which leads Indian diplomatic engagements through bilateral, multilateral and regional collaborations. Indian Technical and Economic Cooperation (ITEC) programme of the MEA has been the primary driver of India's development partnerships with the countries of the global south.[23] It involves various capacity building programmes in the areas of science, engineering, innovation and entrepreneurship. It has helped India build linkages with the innovation ecosystems of several developing countries. ITEC along with SCAAP (Special Commonwealth African Assistance Programme) engages 161 countries in Asia, Africa, East Europe, Latin America, the Caribbean as well as Pacific and Small Island countries through dialogue, shares India's development experience and provides development assistance.

A new division named *New and Emerging Strategic Technologies* (NEST) has been set up as the nodal point in India's foreign ministry for matters related to new and emerging technologies. Its mandate involves exchange of views with foreign governments and coordination with domestic ministries and departments on various aspects of policy and governance of emerging technologies fields. It aims to assess foreign policy and international legal implications of emerging technology and technology-based resources and involve in negotiations to safeguard Indian interests at multilateral fora. A major focus on innovations in the emerging and futuristic technologies are inevitably going to be part of its activities and initiatives.

Bilateral and Multilateral Partnerships

India's collaborative efforts that help in connecting innovation ecosystems of different countries at bilateral and multilateral fora are discussed below.

India-Russia Joint Technology Assessment and Accelerated Commercialization Programme was launched as a joint initiative of the DST, Foundation for Assistance to Small Innovative Enterprise (FASIE) of the Russian Federation and the Federation of Indian Chambers of Commerce and Industry (FICCI). Its vision is to foster R&D collaboration and technology transfer/ adaptation by science and technology led small and medium size businesses, start-ups and enterprises for mutually inclusive socio-economic impact development. This programme provides funding, capacity building, mentoring, technology transfer and networking support to the participants.[24]

US-India Science and Technology Endowment Fund to support and foster joint applied R&D to generate public good through the commercialisation of technology developed through sustained partnerships between U.S. and Indian researchers and entrepreneurs and its activities are implemented through the India-US Science and Technology Forum. There are several other partnerships involving Indian and American entities. The 'India Innovation Growth Programme 2.0' is a tripartite initiative of the DST, Lockheed Martin and Tata Trusts to provide mentoring and handholding assistance to innovations coming from diverse sectors. Further, the Defence Technology and Trade Initiative with the US is helping India strengthen its defence industrial base through supporting the latest of innovations in defence technology.

India-Israel Industrial R&D and Technology Innovation Fund (I4F) was launched with focus on promoting innovations in the key sectors of water, healthcare, agriculture, energy and ICT. With a total value of $40 million, this joint fund is viewed as a masterstroke in innovation diplomacy wherein each country invests $4 million annually for five years. This programme is implemented by GITA in India and Israel Innovation Authority in Israel.

India and Brazil have a 'Joint Commission on Science and Technology' that regularly meets to discuss the issues related to STI cooperation. Both countries recently adopted the action plan to strengthen the strategic partnership that includes furthering cooperation in STI, especially in emerging technologies. Sharing of best practices and undertaking joint research of mutual interest as identified in the 'Programme of Cooperation in Science and Technology' for 2020-2023.[25] Further, a joint commission was earlier set up on Science and Technology. In order to encourage the implementation of new technologies in the agriculture sector, the 'India-Brazil Agritech Cross-Incubation Programme' commenced with focus on exchange of innovative start-ups.

India-US-Israel initiative on digital leadership and innovation is a result of people-to-people collaboration with special efforts from the Indian diaspora in the US and Israel. It aims to facilitate 'open, interoperable, reliable and secure' access to emerging technological innovations starting with 5G and other digital communication networks.

BRICS STI Framework Programme and Implementation Plan for BRICS Multilateral research and Innovation projects was adopted in 2016 to support excellent research on priority areas which can best be addressed by a multinational approach. This initiative provides structure for cooperation among the researchers and institutions in the consortium which consist of partners from at least three of the BRICS countries. Most recent of activities under this programme is the 'Response to COVID-19 pandemic coordinated call for BRICS multilateral projects 2020' to jointly develop and scale technologies, tools, vaccines, drugs and epidemiological strategies for prevention and mitigation of pandemic spread.

Engagements through Regional Groupings

India-EU Innovation Partnership is an initiative to connect the innovation and start-up ecosystems of Europe and India by supporting networking activities between start-up incubators and accelerators from India and the EU. The EU's Horizon Europe (2021-27) project also invites Indian Universities and Research institutions to participate with EU counterparts in several research activities. During the recent India-EU summit the 'India-European Union Agreement on Scientific and Technological Cooperation' was renewed for the next five years with a strong emphasis on innovation cooperation by promoting networking between EU and Indian innovators, start-ups, incubators and accelerators, through setting up joint platforms and engaging in joint training and exchanges.[26]

ASEAN-India Innovation Platform (AIIP) functions under the ASEAN-India Technology Development Fund (AISTDF) to facilitate development, transfer and innovate low-cost technologies. Its major objectives are to have an extensive database of innovative products, technologies and intellectual properties in India and ASEAN while also creating a platform for their access. It further aims to create networking among industries and professionals to share ideas, experiences, problems faced and their solutions.

Global Innovation and Technology Alliance (GITA), a 'not-for-profit' public private partnership (PPP) venture promoted jointly by the Technology Development Board, DST and Confederation of Indian Industry (CII) to catalyse India as a key innovator and provider of technologies internationally. It functions by mapping the technology gaps, undertaking expert evaluation of technologies available across the globe, facilitating national and international techno-strategic collaborative partnerships appropriate for Indian economy and providing soft funding for technology development, acquisition, and deployment. It has launched bilateral programmes and joint industrial R&D funds with Canada, Finland, Israel, Italy, Republic of Korea, Spain, Sweden, UK and the EU with focus on various strategic and emerging sectors that are key to the upcoming Industrial Revolution 4.0. GITA thereby is a prime example of the role of PPPs with NGOs and industry led bodies in facilitating innovation diplomacy.

Analysing the innovation diplomacy frameworks:

As discussed earlier, there are different models of innovation diplomacy that are practiced globally. The **'Swiss model'** is based on a relatively independent entity (Swissnex) that works on public private partnership mode in collaboration with academic institutions and supported by a network of science and innovation counsellors. The **'German model'** enables science and innovation organisations to take a lead in building partnerships and networks for driving innovation. The **'British model'** relies on the vast network of science counsellors as part of the foreign ministry and connected to the chief scientific advisor mechanism practiced in British polity. The **'Israeli model'** focuses on training its existing diplomats in matters of technology and innovation in synergy with the domestic activities of Israel Innovation Authority. Lastly, the **'Singapore model'** is based on activating a global alliance for innovation by placing innovation representatives at the world's top innovation hubs, coordinated by a government empowered innovation authority and not the foreign ministry.

Despite several initiatives, India seems to have a weak structured framework and lacks a formal strategy for innovation diplomacy. This is partly due to uncoordinated efforts by various government agencies and paucity of strong linkages between international cooperation and national innovation ecosystems unlike the Swiss, German and Israeli models. Further, the involvement of industry and academia is episodic rather than part of a synergistic long-term strategy. MEA plays a secondary role while the science departments take the lead. This is sometimes problematic as the officials of science departments are not always experts in the nuances of diplomacy and the career diplomats now increasingly encounter technology and innovation issues in their routine work. Moreover, India currently has only four science counsellors posted in Indian missions that too with limited responsibilities. Taken together, these points indicate that a lot needs to be done to promote India as a hub for research and innovation.

Innovation can act as an important tool in achieving the sustainable development goals (SDGs) and promoting South-South cooperation. However, despite its focus on building development partnerships in the global south, India has been relatively less successful in forging innovation-based linkages for SDGs with these countries. The lack of a policy document and strategy roadmap that identifies and categorises the strengths of the national innovation ecosystem creates a gap in its fortification through international partnerships.[27]

Harnessing Innovation Diplomacy:

The 'problem-solving' nature of innovation in terms of social and economic issues makes it a potential force for sealing diplomatic ties among nations.[20] However, it has to be harnessed with the correct choice of policy instruments which address systemic bottlenecks like inadequate skills, lack of coordination and demand uncertainty that hinder the generation and diffusion of innovation at various stages. A holistic approach to formulate a comprehensive, evidence-based, action-oriented and inclusive strategy document on innovation diplomacy based on consultation with stakeholders in academia, industry, state and local governments, science and innovation departments and the MEA is the need of the hour. This could be achieved through a nodal body that facilitates consultations with relevant stakeholders and formulate a strategy document.

Single empowered facilitating agency: There often exists a lack of synergy between science and innovation departments or agencies including DST, DBT, CSIR, the O/o PSA, NITI Aayog and MeitY with the MEA that causes duplication of efforts and wastage of resources. A single empowered facilitating agency aptly represented by all relevant stakeholders including ministries, public research organizations, business, and NGOs could be formed. This agency could initiate, negotiate, implement and manage international agreements and programmes that address global challenges and national priorities through bilateral and multilateral ties.

Capacity and infrastructure development: India's innovation diplomacy initiatives have to be supported by a dedicated cadre of professional innovation experts and innovation diplomats with presence in more countries, especially in innovation hubs around the world. India needs to design a customised model for Indian requirements and context. One such model could be establishing the offices of GITA or Invest India in international technology and innovation hubs in coordination with the MEA and science and innovation departments. Training career diplomats in the nuances of technology and innovation and conversely training science and innovation experts in foreign policy and diplomacy prior to international assignments would inculcate synergy and the ability to work in tandem. Think tanks, industry bodies and academic institutions could be leveraged for such programmes. Greater participation of industrial bodies such as FICCI, CII, The Associated Chambers of Commerce and Industry of India (Assocham) and The National Association of Software and Service Companies (Nasscom) in international engagements can promote innovation-based partnerships.

Bilateral collaboration: There is a need to expand the scope and speed of science and innovation cooperation with India's strategic partners including Israel, Russia, UK, Japan, Singapore, South Africa, Australia, Canada, Brazil and South Korea by setting up joint STI centres on the lines of IUSSTF (US), IFCPAR (France) and IGSTC (Germany). Such centres could act as the hubs for facilitating the exchange of trained professionals, sharing resources, connecting R&D institutions and conducting joint programmes.

Leverage the diaspora: India's innovation diplomacy strategy should tap the potential of the diaspora that has been highly successful abroad particularly in the STEMM and management fields through their expertise, network and finances.[28] The recently conducted 'Vaibhav Summit' is an excellent example of extending outreach to highly qualified and enterprising diaspora. More such initiatives connecting the diaspora with the Indian start-ups, R&D centres and intellectual property framework should be conducted at national and state levels. Diaspora should be informed about the opportunities and recent advances related to innovation in India and their involvement must be promoted with the right incentives.

Innovation Diplomacy - A Tool for South-South Cooperation: Bilateral and multilateral partnerships with countries in South-East Asia, Africa and Latin America could help nurture strong ties while achieving national development and geopolitical objectives. For this, directed efforts on building strong innovation linkages with IBSA, BIMSTEC, the African Union and Mercosur should be made in addition to the bilateral efforts. Here, the existing ITEC mechanism could be complemented by facilitating greater involvement of Indian industry and academic bodies.

Inclusive and Bottom-up approach: Innovation needs to be bottom-up and address grassroots problems while being complemented by effective foreign policies that address challenges pertaining to the constantly evolving global landscape with populist and nationalist movements gaining strength across the globe. Often R&D and innovation activities are not only unevenly distributed between nations, but also within them. Several states have been active in attracting FDI to boost their local innovation ecosystems.[29] A mechanism is needed to better link the national and sub-national level efforts and maximise equitable FDI in innovation across states while leveraging their individual strengths. Such efforts would complement the initiatives of the central government.

Adopt global best practices: India should take steps to compile, study and analyse global best practices for strengthening its innovation ecosystem. In addition to studying various national efforts, the relevant reports of international bodies such as UNESCO and OECD should be analysed as they act as resource repositories for innovation policy practices. The engagement with these bodies should be upgraded and necessary steps should be taken to adopt the best practices on innovation as recommended by them with necessary changes.

Conclusion

Innovation diplomacy and technology cooperation play a great role in building bridges between countries. It creates new avenues for north-south and south-south cooperation as part of the diplomatic toolkit for forging ties among nations. India should enhance its international engagements to further create opportunities enabling scientists and innovators to work together on global concerns. These concerns include the spread of the pandemic, availability of vaccines and med-tech devices, energy security, environmental protection and disaster management. There is huge potential especially in the area of global tech governance in emerging technologies like artificial intelligence, blockchain, robotics and information communication technologies. Further, innovation and technology diplomacy could enable joint formulation of the rules of engagements with global tech giants like Google, Apple, Amazon and Facebook in international settings.

In the near future, innovation diplomacy may become increasingly complex and challenging for innovators, policymakers and diplomats due to the rise in protectionist sentiments and competitive spirits among nations as well as the rapid pace of technological advancements. A clear innovation diplomacy roadmap and framework would help an emerging economy like India to tackle such challenges while protecting national interests. The Indian government needs to give greater emphasis to technology and innovation in its foreign policy agenda to enhance the image of new India, attract foreign talent and investors, and increase trade through better connectivity. The recent developments like the upcoming Science, Technology and Innovation Policy 2020 and the NEST division of MEA can leverage S&T led innovation for socio-economic development through increased international engagements. Such steps could augment India's domestic capabilities, bolster the economy and help create an '*Atmanirbhar Bharat*'.

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ARTICLE

Rural Eco-Hydrological Issues in Indonesia

Muhammad Yunus Zulkifli*

Muhammad Yunus Zulkifli

Introduction

The current water problem has adversely affected the global ecosystem in which one of the indications is the diminishing biodiversity in the waters, as stated by the World Health Organization concerning water, health and ecosystem linkages. This clearly shows that the conventional approach to water resource management in all its settings is not enough to overcome the global water crisis. Many regions in Indonesia experience water shortages, especially deep ground water. With different regional typologies, water problems are not the same. Some parts of Indonesia experience low rainfall, such as Eastern Indonesia. So, the main obstacle is the quantity of water. Conversely, Western Indonesia experiences higher rainfall yet, it faces biggest obstacle in water quality. Even though the water in most big cities is abundant, the quality is still concerning.

Urban communities consume groundwater, even deep groundwater, which is actually illegal. The water used by local water companies in big cities shows that water quality is declining, because people and industries pollute water sources such as rivers. So far, the river has become a place for garbage and waste because of the low awareness of the community to protect the environment. This problem often leads to the emergence of water-related diseases, for example diarrhea. On the other hand, rural communities experience other water problems like, floods and droughts. At present, there are two challenges faced

* He is with the Centre for Development, Education and Training (Pusbindiklat LIPI), Jakarta, Indonesia.

in relation to water security, namely, how to reduce the risk of flooding and how to increase water supply for the community, industry and agriculture.

The COVID-19 pandemic hit the world including Indonesia and has greatly affected the ability and efforts of the Indonesian government to guarantee national water security. This is due to the connection between water and other sectors, such as food. An example is the threat of a food crisis which impacts on water security as one of its supporting sectors. If the results of food production cannot be marketed due to disruption in the trade system chain, it will be like a blockage that disrupts the smooth running of water supply for food production. Intensive coordination and consolidation of stakeholders, the government and the community regarding the fulfilment of basic needs in the water sector must continue according to the corridor of the target of Sustainable Development Goals (SDGs) on target two: ensure the availability and management of sustainable clean water and sanitation for all, so that the availability of intake nutrition, support for drinking water, and healthy sanitation are guaranteed and will determine the building of immunity as a major component of community survival.

The Asia Pacific Centre for Ecohydrology (APCE) as a UNESCO Category II Centre (C2C) is a centre for the embodiment of the science diplomacy at the Indonesian Institute of Sciences (LIPI) related to ecohydrological issues (environment and water) in the Asia Pacific region. APCE concerns water resources problems in Indonesia representing conditions in Asia Pacific, so that they can be resolved together with other countries. This truly matters because issues of water resources must become a mutual concern. The existence of APCE is in line with LIPI's role as a national focal point in the Intergovernmental Hydrological Programme (IHP), one of the international organisations under UNESCO, and relevant to UNESCO's main mission in improving science, education and culture. APCE has achieved high visibility in international community including the Asia Pacific Region as a reference for other UNESCO C2Cs, as well as a strategic position as the Chairman of UNESCO Regional Steering Committee (RSC) for the Asia Pacific region. APCE in this regard represents Asia Pacific in the UNESCO IHP Phase IX discussion team. Therefore, its position gives many opportunities to speak at UNESCO sessions.

APCE should stand in a position to coordinate its roles in science diplomacy by three determining components: scientific research, capacity building and networking. In the context of scientific research along with the dynamics of water problems in various regions of Indonesia, even in the current COVID-19 pandemic, APCE elaborated ecohydrological issues encompassing problems around water, humans and the surrounding environment. Subsequently, APCE tried to implement ecohydrology as an integrated water resource management system for a solution. It means that the novelty of the concept of ecohydrology lies in the fusion of four principles (ecology, hydrology, ecotechnology, and culture) while still relying on the community for water resource management with an approach based on local wisdom of the community. Therefore, APCE also becomes a catalyst for implementing ecohydrology to various institutions in order to enhance ecosystem services and sustainable water resources. This is in accordance with its contribution to the implementation of Goal Six of the Sustainable Development Goals (SDGs): ensuring access to water and sanitation for all. This paper brings up rural ecohydrological issues in Indonesia by ecohydrology as an integrated science applied by APCE.

Research Methodology

This paper attempts a literature review to explore the concept of ecohydrology in accordance with the conditions of water resource problems in Indonesia and present a case study of the implementation of ecohydrological approach by APCE.

Findings and Discussion

Conceptualisation of Eco-Hydrology

The nightmare of running out of clean water (as happened in Cape Town previously) can occur in other cities in the world. The causes are varied, ranging from population growth, which is compounded by wasteful lifestyles, water pollution, to climate change. The public has not yet realised that the amount of clean water on earth is actually limited. That is, there is no increase in the amount of water, but water only cycles from the atmosphere and back to earth. The hydrological cycle consists of condensation, precipitation, evaporation, and transpiration. Then, how much clean water actually exists in Indonesia? Based on the United Nations data, Indonesia contributes 21 per cent of the total clean water in Asia Pacific. Based on the data from the National Socio-Economic Survey (Susenas) of the Central Statistics Agency (BPS), only 65.05 per cent of households have access to improved drinking water sources in Indonesia in 2012. Increased access occurs annually to 72.04 per cent in 2017.

Water management in big cities of urban countries such as Japan and South Korea can be relatively applied in Indonesia, although the compatibility must be seen further due to cultural differences and social norms. In Indonesia, the management of water irrigation in Bali, namely *Subak* is now becoming obsolete due to land conversion or a paradigm shift. For this reason, a new approach is needed as a solution that is an ecohydrological approach that not only focuses on technical issues, but also on broad issues through sustainable water resource policies in order to manage water resources and biodiversity into one unit. Ecohydrology is an integrative science with a new paradigm that seeks to find solutions to problems around water, humans and the surrounding environment. The ecohydrology approach at the same time invites the community to protect the wet area ecosystem by planting plants to absorb pollutants and waste, so that the water is maintained in its quality.

One true formulation of the concept of ecohydrology is to avoid the confusion of terms (Rodriguez-Iturbe, 2000; Naiman et al., 2007). The concept of ecohydrology through scientific approaches always considers the interaction of abiotic and biotic aspects, which can be further formulated as follows:

Principle one: hydrological aspects, concerning the abiotic structure of the river system, the dynamics of the hydrological process, and the specific spatial-temporal impacts resulting from human intervention.

Principle two: ecological cohesiveness, involving inter-relationship between ecosystem components that shows the potential and capacity of ecosystems to produce environmental products and services.

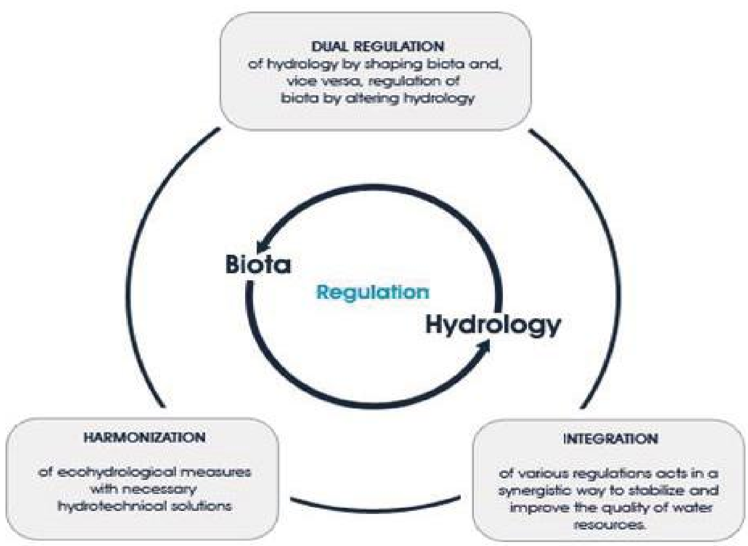
Principle three: ecotechnology, which involves the use of information and knowledge on abiotic and biotic aspects (from principle one and principle two) for the development of new ecological biotechnology and hydrological system solutions that can increase the capacity of ecosystems to produce environmental products and services.

The harmonious interaction of hydrology-biota in an engineering to increase the capacity of the ecosystem is known as the dual-regulation theory of ecohydrology.

APCE and Eco-Hydrological Issues

APCE's position to coordinate its roles in science diplomacy is by three determining components: scientific research, networking, and capacity building. The scientific research component in this regard goes along with the application of ecohydrology that APCE has implemented by the use of plants or vegetation in overcoming environmental problems, for example the return of the *Saguling* Reservoir ecosystem in West Bandung Regency and the impact on the water quality of the *Citarum* River. One way to improve the reservoir is through ecohydrological techniques. Contaminated reservoir water is cleaned through the use of plants such as grass or water hyacinth planted along the reservoir flow. As a result, the level of water cleanliness increases, and cleaning costs are cheaper. The concept of ecohydrology brings together various aspects including ecology, hydrology, ecotechnology, and culture. The purpose of unification in various aspects of the concept of ecohydrology is to present the best quality of water resources for the community.

Figure 1: Scheme of dual-regulation theory of ecohydrology



Source: https://bebasbanjir2025.files.wordpress.com/2011/11/1.jpg

The ecohydrological demonstration site of *Saguling* in West Bandung Regency also became a place of practice and construction to introduce the concept of the first multifunctional hydrology, so that its benefits as learning and lessons can be felt directly by the community. The developed concept of *Saguling*, in addition to monitoring and improving water quality, provided pilot ponds that can be used for fish and can be combined either to manage water resources or to be utilised by the community economically. This is because in every place the community is involved to start caring for the environment and shows that ecohydrology is beneficial to the community.

In an integrated water resource management effort, the concept of ecohydrology includes basic ecological information that has potential for conservation of water resources, application of appropriate technology as well as protection of local environment based on community participation. The latest application of the concept of ecohydrology is to reduce the impact of the dry season. The application of this concept and technology has been carried out in several regions of Indonesia, such as Kalimantan Island, Bangka Island, Mojokerto in East Java, and Grokgak in Bali, which resulted in significant reduction in the impact of drought. Aside from West Bandung Regency, APCE has also developed ecohydrological demo sites in Ciamis Regency and North East Regency of NTT, ecohydrology research in peat areas in Banyuasin District, and application of ecohydrological approach and peatland conservation in Central Kalimantan.

The basic thrust of ecohydrology is on managing water resources and biodiversity in unity. In the concept of ecohydrology, the provision of clean water is carried out by utilising the ecosystem contained in the environment. This does not only apply in mountainous or rural areas that are relatively richer in ecosystems, but also in urban areas that are more vulnerable to clean water crisis problems. One example of the utilisation of aquatic ecosystems is managing the wastewater that flows through a wet area ecosystem (wetline) with pollution-absorbing plants, so that the water becomes clean after leaving the ecosystem. Professor Maciej Zalewski, the inventor of the concept of ecohydrology as well as the Director of the Center for Ecohydrology of the European Region, suggested that the use of the concept of ecohydrology in providing clean water could reduce costs significantly, although the efficiency could vary. We incur 10 times higher costs to bring clean water through technology, compared to using the concept of ecohydrology.

The involvement of the community based on local wisdom can be a solution to the clean water problems that are often faced in a number of areas. The community has the ability to provide clean water by using social capital in the form of mutual cooperation, for example the provision of water by conserving certain ecosystems with traditional values that still exist in some indigenous groups. Traditional concepts in several ethnic groups in the country such as the prohibited forest, the prohibited pool, *sirahcai* (springs) and various other concepts, have been around for a long time in the community. These values are able to fuse in people's daily lives. Therefore, rural and urban communities are able to use their social capital for the collection and distribution of clean water, so that this complement government efforts but can be implemented through community independent efforts.

Regarding water quality regulation, we refer to water eligibility standards set by the government, one of which are parts of the Regulation of the Indonesian Minister of Health or Permenkes 492 of 2010 concerning Drinking Water Quality Requirements. However, with the frequent differences in the standards of water worthiness between communities and researchers, education on a cultural basis remains an alternative solution that can be done.

APCE located in the Cibinong Science Centre, Bogor, West Java is expected to be the frontline in deepening, sharpening and developing ecohydrological-based management concepts that benefit the community and the life around them. Components in ecohydrology have their respective roles. The principle of ecology is to increase the absorption capacity of ecosystems. Meanwhile, the hydrological principle becomes the framework for the process of water mass quantification. Ecotechnological principles are related to the use of ecosystem properties, namely as a tool for water management. The principle of culture is to enhance the dynamic relationship between hydrological, social and ecological systems. The community is actually able to create their own source of clean water. One form of village community initiative is the making of water reservoirs as a form of rural mutual cooperation. The existence of water storage tanks reflects the strong spirit of mutual cooperation and the process of regulating clean water management by the community.

Nonetheless, cooperation and positive responses from local governments are still needed to jointly manage and maintain clean water together. Education is important for the community to take the initiative to create good water management such as managing village forests, and the amount of clean water in the soil, and making fishes in water sources, and water reservoirs in villages. Education regarding the importance of clean water is needed to be taught from an early age. APCE in this case has sought to teach the importance of maintaining water resources and understanding to use water wisely to students. When season at its peak in August or September, the government should anticipate the effects of the drought. One step is to aggressively educate the public to start creating an appropriate water management system, especially for farmers to recharge so that national food conditions are not affected adversely. The Qoryah Toyyibah Farmers Association (SPPQT) headquartered in Kalibening Village; Salatiga of Central Java has successfully proven it by having made 930 infiltration wells in the water catchment area for Senjoyo water sources only in 2015.

Meanwhile, the application of the concept and technology has now been carried out in a number of regions in Indonesia and is expected to be continuously applied in a sustainable manner. The sustainable principle embedded in this regard is about the availability of water affordable for the community with well-maintained quality and quantity in urban or rural areas. With this concept, the water produced will be safe and secure for the health of the people who consume it. The availability of clean water can reduce water borne diseases and stunting, improve the health and economy of the community. One of the applications of ecohydrological technology is to reduce the impact of the dry season in Indonesia. With ecohydrology, the annual problem of the dry season that engulfs various regions is expected to be solved periodically.

The development of the concept of ecohydrology can be seen from information and knowledge and comes to wisdom in solving problems (Zalewski 2010). Many scientists and researchers have developed concepts to answer the challenges of hydrological problems of water resources, all as a result of research, so that a number of terms and concepts related to water resource management need to be clarified as identified in five interrelated concepts: Integrated Water Resources Management (IWRM), Hydroecology, Ecohydrology, Ecohydraulics and Environmental Flows (Naiman et al., 2007). Ecohydrological research is associated with other sciences such as environmental economics, social culture, gender, health, food, energy, and climate.

The networking component out of APCE's roles in science diplomacy is supremely relevant to international cooperation that greatly assists in the development of ecohydrological research capacity with mutually reinforcing and beneficial interactions for the development of science and technology in Indonesia. This can be very much possible with the presence of APCE (Hehanussa and Haryani 2011). Furthermore, systematic efforts to develop research infrastructure and ecohydrological research resources must be initiated immediately by involving all existing stakeholders, both in research institutions and at universities. APCE has begun with research training and workshops for researchers and lecturers in collaboration with the Ministry of National Education as its role in science diplomacy for capacity building component.

Countries in the Asia Pacific region are currently facing problems with the availability and low access to clean water. The same thing is experienced by Indonesia. Recently, there have been several regions in Indonesia with clean water crisis due to long drought along September and October this year, as happened in Bogor Regency and Kuningan Regency of West Java, Kaliori Village in Karanganyar District of Central Java, and Sikka Regency of NTT. Consequently, the concept of ecohydrology for the availability of sustainable clean water is applicable as APCE has successfully implemented.

Rural areas are estimated to need about 60 liters of water per day per person, and in urban areas it takes an average of 110 liters of water per day per person. Meanwhile, in metropolitan areas water needs reach 150 liters per day per person. The difference in water demand in rural and urban areas reflects a lifestyle related to water. To meet the needs of consumable water, the government has carried out a series of efforts in various sectors. The total population of Indonesia in the first semester of 2020 as of June 30 was 268,583,016 with 0.77 per cent increase this year based on the data of the Indonesian Ministry of Home Affairs. The population growth, diverse geographical conditions and varying degrees of ease of accessibility have affected the issue of water availability. Apart from the government concern to provide it, various community initiatives in providing water need to be seen and community participation also needs to be responded by the government.

Conclusion and Recommendations

APCE has contributed immensely to the implementation of Goal 6 of the SDGs in ensuring access to water and sanitation for all, and is in a position to coordinate its roles in science diplomacy by three determining components viz., scientific research, networking and capacity building with certain contributions: the application of ecohydrology by the use of plants or vegetation in overcoming environmental problems, international cooperation in the development of ecohydrological research capacity, research training and workshops for researchers and lecturers in collaboration with the Ministry of National Education. This should help the government to ensure sustainable water accessibility and availability regardless of any constraints of population growth, diverse geographical conditions, and so on. The government should positively respond to community initiatives in providing water as well as community participation in this regard.

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PERSPECTIVE

UNESCO Recommendation on Open Science: An Upcoming Milestone in Global Science

Anup Kumar Das*

Anup Kumar Das

In association with International Council for Science (ISC) and other intergovernmental and international organizations, UNESCO was engaged in extensive global and regional consultations on open science during 2019-20 and recently released the first draft of the *UNESCO Recommendation on Open Science* (UROS) on 30th September 2020 based on the inputs received from an online global survey, open science partnership, and online consultative meetings.[1] UNESCO had engaged ISC and its sub-organ CODATA (Committee on Data of the International Science Council) to prepare the UROS, as CODATA is experienced in promoting and building open science platforms across the world alongside their member institutions and national chapters. Many of the national science academies worldwide are institutional members of ISC, including the Indian National Science Academy (INSA) and Indian Council of Social Science Research (ICSSR).

ISC has become a trusted partner in promoting international science programmes of UNESCO for many years. ISC and CODATA were also involved in open access declarations that shaped global open science and open access movements. UNESCO launched the Global Open Access Portal (GOAP) in November 2011, aiming at presenting a top-level view of open access to scientific information. UNESCO and ISSN International Centre jointly launched the Directory of Open Access Scholarly Resources (ROAD) in December 2013, aiming at

* He is with the Centre for Studies in Science Policy, School of Social Sciences, Jawaharlal Nehru University New Delhi.

providing free access to ISSN bibliographic records that describe open access scholarly resources, namely, journals, monographic series, conference proceedings, academic repositories, and scholarly blogs.

UNESCO submitted the draft Recommendation to its 193 Member States for wider consultations and further enrichment. The final version of this Recommendation sets to become an international standard-setting instrument on open science. It is scheduled to be adopted by UNESCO's Members States at the 40th session of UNESCO's General Conference in November 2021.[2] While the member countries would commit the open science ecosystem in the respective countries, we will also observe a surge of the South-South and North-South collaborations in the proliferation of open science infrastructure and avenues across the world. We may recall the Responsible Research and Innovation (RRI) Framework, where open science plays a vital role in inculcating openness in the research and innovation (R&I) ecosystems. Similarly, we also see the emergence of FAIR Data Principles in recent times to make data Findable, Accessible, Interoperable, and Reusable, more particularly the scientific data and public-sector data. Thus, UROS sets to become a comprehensive standard-setting instrument for the countries to implement open science at the national, regional, and provincial levels.

For the global consultations on open science, UNESCO forged a Global Open Science Partnership that comprises the international scientific organisations, scientific academies, international and regional research institutes, university associations, libraries, open science publishing coalitions, data organizations and repositories, United Nations agencies, UNESCO Chairs and Centres, research funders, citizen science and science for society initiatives, and member states' organisations. This partnership also ensures an adequate representation from the triple helix model of innovation, i.e., academia (the universities), industry, and government, fostering economic and social development.

Globally open science movement has gained momentum since the launching of the preprint repository Arxiv.org in 1991, the signing of the global declaration Budapest Open Access Initiative (BOAI) in 2002, besides many others. Existing regional Open Science platforms, including the African Open Science Platform (Africanopenscience.org.za), European Open Science Cloud (EOSC) (Eosc-portal.eu), and European Open Science Policy Platform (Openscience.eu), take significant interests in the development of this UNESCO Recommendation and its implementation in the member countries.

In India, we also see the proliferation of open access platforms in higher education and research institutions since the initiation of BOAI in 2002. The first such initiative was ePrints@IISc launched by the Indian Institute of Science, Bengaluru (IISc), in September 2002. It became India's first interoperable, open-access institutional repository. As of 5th November 2020, the number of open access repositories recorded from India is 129 as per the Registry of Open Access Repositories (ROAR) and 96 as per the Directory of Open Access Repositories (OpenDOAR). Similarly, as of 5th November 2020, the number of open access journals and other OA scholarly resources regularly published from India is 2933, as on the

ROAD database. In comparison, the number of ISSN records for periodicals found is 23272. This denotes about 12.6 per cent of periodicals bearing ISSN are open access in nature. There could be some more periodicals that did not mention their open access characteristics to the ROAD database.

On 15th September 2020, an Asia-Pacific Online Regional Consultation towards a global consultation on open science was held. In this meeting, the speakers shared the lessons learnt and stakeholders' experiences in developing and implementing Open Science strategies, policies, and other initiatives in Asia and the Pacific, taking cognizance of the key challenges and required infrastructures for Open Science. The speakers also deliberated suggestions on overcoming the challenges and areas for international collaboration and networking to advance Open Science globally. Key inputs derived from this and other regional consultations shaped the first draft of the *UROS* document. UNESCO held a series of online and face to face consultations to support an open debate on Open Science awareness, understanding, and policy development to feed into the UROS. In this context, a series of regional and thematic consultations were organised, such as for the African region on 12th December 2019, for Western European and North American States on 23rd July 2020, for the Arab States on 24th August, for Asian and Pacific on 15th September, for Latin-American and the Caribbean States on 23rd September, and for the Eastern European States on 24th September 2020. Additionally, a Roundtable Discussion on Open Science in the English and Dutch-speaking Caribbean, a Consultation on Open Science in Africa, and a Consultation with the Global Young Academy were held in 2020. ISC Regional Office for Asia and the Pacific also organised an Open Science Forum for Asia and the Pacific on 13th February 2020 in Malaysia.

UNESCO organised an online global consultation on open science, where a number of scientists, academic publishers, science policymakers, science diplomats, and the persons with experience and interest in Open Science participated in the online survey that was designed to collect inputs for the development of the UROS. The online survey was available between February and June 2020 in English, French, and Spanish languages.

The draft UROS document defines the term 'Open Science' that refers to an umbrella concept that combines various movements and practices in scientific processes. The draft UROS further identifies the key elements in open science that include open access to scholarly resources, open data, open-source software, open hardware, open science infrastructures, open evaluation, open notebooks, open educational resources, open engagement of societal actors, citizen science, open labs, openness to diversity of knowledge, openness to indigenous knowledge systems, and openness to all scholarly knowledge and inquiry.[3]

The core values and principles of 'Open Science', as mentioned in draft UROS, include the collective benefit, equity and fairness, quality and integrity, diversity, and inclusiveness. The aspects of Access, Equity, and Inclusion (AEI) in Science, Technology, and Innovation (STI), as promoted by the Indian STI researchers, are taken care of in the draft UROS.

The draft UROS endorses the following key areas of action to be undertaken by each of the member countries include promoting a common understanding of Open Science; developing an enabling policy environment for Open Science; investing in Open Science infrastructures, services and capacity building for Open Science; transforming scientific culture and aligning incentives for Open Science; promoting innovative approaches for Open Science at different stages of the scientific process; and promoting international cooperation on Open Science. The draft *UROS* also enlists who will be the key stakeholders that include researchers, leaders at research institutions, educators, information scientists, software developers, coders, creatives, innovators, engineers, legal scholars, legislators, magistrates, civil servants, publishers, editors, leaders of professional societies, technical staff members, research funders, policy makers, societal actors, communities, users, and the public at large. Although omitted in the first draft of UROS, the revised draft should recognize the science diplomats as key stakeholders.

Conclusion

As the world faces a global pandemic of COVID-19, an international open science movement is also getting stronger. Much scientific research and clinical studies related to COVID-19 and coronaviruses are published and made available in open access mode with Creative Commons licenses. The global communities of biomedical researchers and clinical practitioners can now use and reuse the documented knowledge and resources, which are now widely and freely available. Concurrently, the major international and intergovernmental agencies have been promoting the biomedical and clinical data sharing practices that comply with the FAIR data principles to make biomedical and clinical data findable, accessible, interoperable, and reusable. In this direction, the Research Data Alliance (RDA), a global body of open research data practitioners and institutions, released "RDA COVID-19 Recommendations and Guidelines" in May 2020.[4]

Open research data is a critical element of the open science landscape. India is a significant contributor and consumer of open access and open research data resources, besides other essential open science elements. India's open science advocacy group, Open Access India, launched the Delhi Declaration on Open Access 2018 to strengthen the public and institutional policies for a better open science landscape.[5] This Declaration would be of great value for formulating open science mandates in India's upcoming Science, Technology, and Innovation Policy 2020 (STIP2020). Now, the draft UROS will be further debated and ratified at the national and institutional level in each member country of UNESCO, including in India, while the member countries and other stakeholders can suggest any further improvements in the provisions. Once approved and adopted in the 40th session of UNESCO's General Conference, Open Science will take a giant leap for humanity, and we will see a proliferation of open science ecosystems across the world. India's upcoming STIP-2020 should note the provisions and critical areas of action for making the national policy aligned to the global consensus. However, the revised draft UROS should be refined to include the clearer roles of science diplomacy and science diplomats in strengthening the open science ecosystems across the world.

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PERSPECTIVE

AYUSH and Its Significance in Health Diplomacy

Abha Arya*

Abha Arya

Introduction

Health diplomacy is a growing field and has a significant impact on the foreign policy (Kickbusch, 2011). Health and foreign policy complement each other in aspects of human security and social justice. Moreover, Kickbusch (2011) observes that health issues are crossing boundaries and different countries contribute and launch their global health initiatives in order to improve global health and wellness. For instance, the G8 countries launched the Muskoka Initiative to curb maternal mortality rate in low- and middle-income countries. During the ongoing COVID-19 pandemic, India has played an important role in supporting its neighbouring countries and other countries of the Global South. One of the examples is the issuance of INR 600 million 'to supply aid in the form of drugs, testing kits and other medical assistance to Myanmar, Latin American and Caribbean (LAC) states, and 12 countries in the African continent'.[1]

India, popularly known as the 'pharmacy of the world' is also home to one of the largest traditional and indigenous medicinal knowledge systems. The robust knowledge of traditional medicinal heritage can play a significant role in establishing India's image as a preventive healthcare leader in the world. The article discusses health diplomacy and India's contribution in the domain through Ayurveda, Yoga and Naturopathy, Unani, Siddhi and Homeopathy (AYUSH) playing a crucial part in leading health promotion and prevention

* Assistant Professor, Public Health Programme, Symbiosis Institute of Health Sciences, Symbiosis International (Deemed) University, Pune. She holds a Ph.D. in Science Policy from Centre for Studies in Science Policy, School of Social Sciences, Jawaharlal Nehru University, New Delhi.

activities, and establishing a way forward in expanding its relevance at the global platforms. Moreover, Ayurveda medicinal system dates back to 5000 BC (Garodia et al., 2007; Mishra, 2004) whereas some of the authors also believe that it is 2000 years old (Basham, 1988; Benner, 2005; Smith and Wujastyk, 2008). The concept of Ayurveda focuses both on health prevention and curative treatment. "*Swasthasya Swasthyarakshanam*" means maintaining and promoting the health (Vyas, 2015). These notions have been carried forward to the present day by the AYUSH system of medicine. This paper tries to explore the possibilities for AYUSH in the field of Health Diplomacy and also reviews ongoing diplomatic decisions taken in India on health-related issues, specifically related to AYUSH.

Health Diplomacy and Science Diplomacy

This section intends to discuss both the terms, health diplomacy and science diplomacy, and tries to understand the connection between the two fields. The theory of science diplomacy is explored to understand the health diplomacy in a better way.

Health Diplomacy

Health diplomacy which is also known as Global Health Diplomacy is "the practice by which governments and non-state actors attempt to coordinate global policy solutions to improve Global Health".[2] Various multilevel and multi-actor negotiations processes take place in diplomacy which shapes the environment of global policy for health (Kickbusch, Silberschmidt & Buss, 2007). Developing Global Health diplomacy as a foreign policy tool requires multilateral diplomatic cooperation to tackle the trans-boundary issues.

India's participation in Global Health Diplomacy started when numerous global health initiatives originated under the WHO. In the beginning, India was at the receiving end of the funds and services of the global health initiatives. For instance, the US President's Emergency Plan for AIDS Relief mentioned that in 2005, 108 countries received funds and India one of them.[3] Similarly, the Global Fund to Fight AIDS, Tuberculosis and Malaria had helped India in curbing diseases. However, later in 2019 India contributed US$22 million to the global fund of for three years.[4] With emerging health problems which started affecting the security and economic aspects of the country, India joined the path of Global Health diplomacy and one of its examples is the Pan-Africa Telemedicine and Education Network (Singh, 2017). India started developing public health training and education programmes to ensure comprehensive health security within and across its boundaries. India's growth in health IT and pharmaceutical manufacturing has tremendously benefitted the South-South public health cooperation. Thus, India can play an important role in the global health assistance as well. Moreover, the significance of health diplomacy, beyond health security and public health can be better understood if we look into its connection with science diplomacy.

Relationship between Health Diplomacy and Science Diplomacy

According to the symposium report of the Swiss Academy of Medical Sciences (2013), "science diplomacy and health diplomacy can be viewed as fields that are distinct, but overlapping in a number of ways".[5] The report further mentions that both science and health diplomacy have foreign policy as an integral part, and they forge bilateral and multilateral relationships between different actors and sectors leading to a balance in health and non-health activities. The Geneva symposium also explores the opportunity to discuss the rising scope of Global Health diplomacy in various areas. Similar to the increasing role of science diplomacy that goes beyond the 'international cooperation', the role of health diplomacy extends the function of health cooperation.[6] Also, health diplomacy can be understood as science in diplomacy as it tackles cross-border issues like public health, social justice, food security, etc. Science can be used as an evidence to impact diplomatic decisions and in this case, it revolves around the field of health.

India's Role in Health Diplomacy

India's role in maintaining and engaging global health diplomacy can be examined well before the time of COVID-19 pandemic. For example, for SARS, Ebola and Nipah, India has developed a detailed foreign policy to ensure health security of the population within the border. Singh (2017) observed that global health diplomacy has proven to be fruitful in creating global platform for political engagement. In March 2020, India agreed to supply medical aid, food supplies and medicines to other countries in the wake of the COVID-19 outbreak. The SAARC countries established the COVID-19 Fund with India as a major contributor to help in the times of crisis.[7] India is also providing Rapid Response Teams to countries like Kuwait to fight COVID-19.[8] The country has become a world leader in producing generic drugs and it has distributed HIV related drugs at a lower cost, maintaining its image as the 'pharmacy of the world'. During the COVID19 crisis, India played a key role in supplying hydroxychloroquine to various countries including USA. India's support to the Global Alliance for Vaccines and Immunization (GAVI) has been important for immunisation and its universal coverage. These are a few instances, where India has engaged in diplomatic ties and impacted world politics. Recently, India has given priority to the neighbouring countries like Bangladesh and Mayanmar with "Neighbourhood First" and "Act East Policy" in manufacturing of COVID-19 vaccines, and there has also been active cooperation between India and Mexico for the management of COVID-19 outbreak.[9] India is a country of various knowledge systems like the rich traditional and indigenous medicinal systems of the country and thriving tribal medicinal system like bonesetter practitioner of Nagaland, tribal healers using ethnomedicine like Kattahaalla (*Agave cantula*) in Wayanad district (Thomas *et al.*, 2014), folk healers of Malabar, etc. The development of AYUSH and its contribution in science as well as healthcare services are enormous. This is increasingly being recognised at the global platforms.

AYUSH Role in Health Diplomacy

Significance of AYUSH is well mentioned in the Bhore Committee (1946) especially its role in catering to the demands of healthcare services for a larger population. The Committee also stated that alternative medicinal systems like Ayurveda practitioners, should be integrated with the Primary Health Centers (PHCs) for inclusive healthcare delivery services. AYUSH can play a pivotal role in building the understanding of holistic health of an individual as well as community. Moreover, AYUSH ministry has come up with "AYUSH Health Promotion Product" in the wake of COVID19 pandemic.[10]. Therefore, preventive measures of AYUSH have been taken ahead by the health promotion component including, immunity boosting food habits, eating food supplements like Chyawanprash, practicing Yoga for beneficial outcome in "prevention and treatment of lifestyle-related diseases" (Dwivedi and Tyagi, 2016), etc.

Parallelly, AYUSH's internationalisation has focused on the Indian diaspora (especially, settled in SAARC countries) and for that an independent guideline for quality, safety standards and evidence-based efficacy has been built (Patwardhan, 2010). For international cooperation, the AYUSH Ministry has collaborated with the WHO Regional Office for South-East Asia and worked for the evolution of the Delhi Declaration on Traditional Medicine for the South-East Asian Countries of 2014. Similarly, AYUSH Ministry has set-up Information Cells in different countries like Cuba, Mauritius, etc. to spread information on AYUSH systems.[11] Furthermore, a WHO Global Centre for Traditional Medicine will be set up in the country to support and strengthen the WHO Traditional Medicine Strategy, 2014-2023.[12]

During the ongoing COVID-19 pandemic, the AYUSH Ministry has taken lead in enhancing the preventive measures in order to fight the SARS-COV-2 through the Guidelines for Ayurvedic/Siddha/Unani/Yoga Practitioners for COVID19[13] and Immunity Booster Measures for Self-Care.[14] One of the best examples of health diplomacy is Yoga Diplomacy which is being seen as a soft power of India.[15] A rich and vast knowledge sector like AYUSH has a lot to share in the international market, which can make direct and indirect impact on the foreign policy. Yoga and Ayurveda diplomacy has been used in public diplomacy. Despite the in-depth knowledge of AYUSH it has not been exploited fully in health diplomacy. There are various other aspects as well on which the state can work on. Figure 1 below demonstrates the effort to explore the possibilities of AYUSH in various spheres. It showcases the way forward for strengthening health diplomacy and internationalisation of AYUSH through student exchange programmes. The efforts may also include learning foreign traditional medicinal systems, leading to the development of traditional and indigenous medicinal systems in Global South, enhancing evidence-based research for AYUSH, extending health promotion and prevention measures for community (domestic and international), etc. The possibilities for exploring its various aspects are as follows:

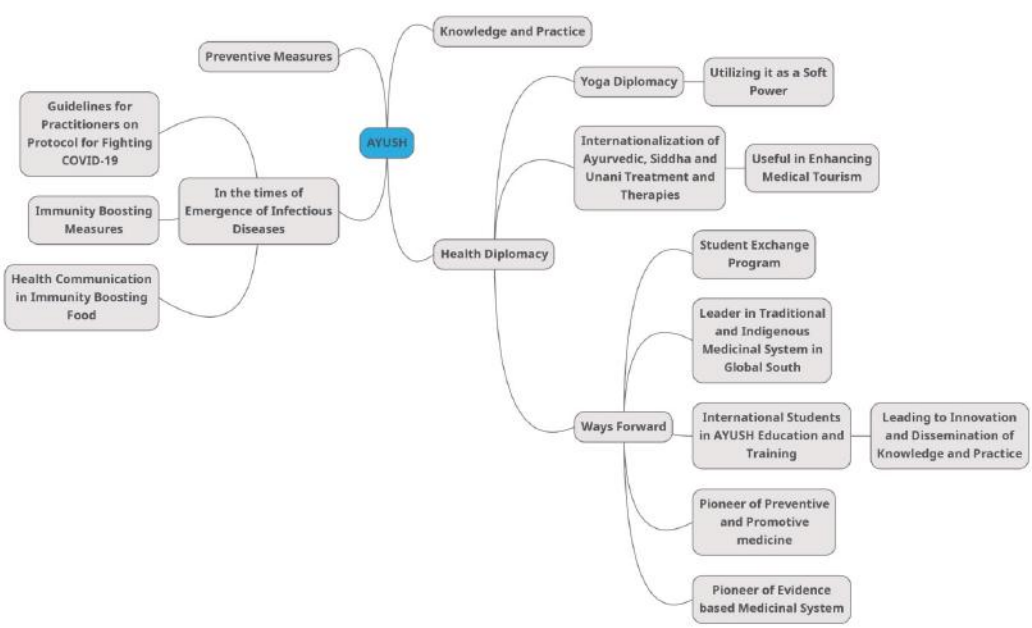
- Increasing demand of Ayurvedic treatment in medical tourism has been observed and it is estimated to grow by Rs 9 million by 2020.[16] This includes the increasing number of customers for Ayurvedic therapies and treatment. Certain famous therapies like arthritis treatment should be backed by evidence and disseminated to the public.

- Dissemination of knowledge is important because it will facilitate students to grow, translate and transform the knowledge through educational and student exchange programmes. Engaging young students in knowledge systems can stimulate innovation.
- The student exchange programme will also give us an opportunity to understand different cultures and their TCAM (Traditional, Complementary and Alternative Medicine) which can be fostered in collaborations with different countries like Sri Lanka and African countries like Kenya. India can become a leader in this transformation where countries can showcase their alternative medicinal systems. This is crucial for South-South collaborations/ cooperation. Traditional knowledge is a public good, it can help develop community trust, create and coordinate response, improve access and create an atmosphere for engagement, while ensuring harmony with regional cultures.[17]

Conclusion

The paper discusses health diplomacy and its conceptual overlapping with science diplomacy. It has evident links with the sub-concept of science diplomacy, i.e. science in diplomacy. Health and its related branches are seen working hand in hand with foreign policy to influence

Figure. 1: Mind-Map on the Relationship between AYUSH and Health Diplomacy



Source: Prepared by Author using Mindomo Apps various countries. India has significantly improved its position in the world politics through science diplomacy. The present paper discussed the pattern in which India has persuasively showcased its efficiency to contribute to global efforts for various health issues and the present endeavours to put Yoga diplomacy as a soft power in the international platforms. While doing so, we have also seen how India has strategically placed its medicinal system, pharmaceutical capabilities and knowledge bases in the domain of public diplomacy and improved its position in the global market. The paper at the end also discusses the way forward for AYUSH to establish itself in the heath diplomacy internationally. This discourse needs to be elaborated and required further discussion.

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PERSPECTIVE

Gender Perspective in Science Diplomacy

Jyoti Sharma*
Sanjeev Kumar Varshney**
Prasad KDV Yarlagadda***

Jyoti Sharma

Sanjeev Kumar Varshney

Prasad KDV Yarlagadda

The importance of gender equality and women empowerment has become a global objective and one of the Sustainable Development Goals (SDGs) in the 2030 agenda of the United Nations. Science, Technology, Engineering, and Mathematics (STEM) are considered vital for economic and social development, where the under-representation of women is obvious.[1] The United Nations Educational, Scientific and Cultural Organization (UNESCO) has acknowledged that the under-representation of women in STEM results in a loss of talent, innovation, and full participation in the growth that ultimately reduces the development of each country.[2]

Women researchers are leading several cutting-edge research projects and are part of remarkable discoveries. However, their representation is curtailed at higher or leadership positions. Despite 50 per cent enrolment at the graduation level, only 30 per cent of the world's researchers are women. Women share 3 per cent in Nobel Prizes for science, share a poor percentage of academic awards, and only 11-15 per cent are working at leadership positions throughout the world.[2] These figures underline the need for gender parity in various international collaborative formats. The fact sheet, released in June 2018 by the UNESCO Institute for Statistics

* Senior Scientist*, International Cooperation Division (ICD), Department of Science and Technology, Ministry of Science and Technology, Govt. of India.

* Head & Advisor, International Cooperation Division (ICD), Department of Science and Technology, Ministry of Science and Technology, Govt. of India.

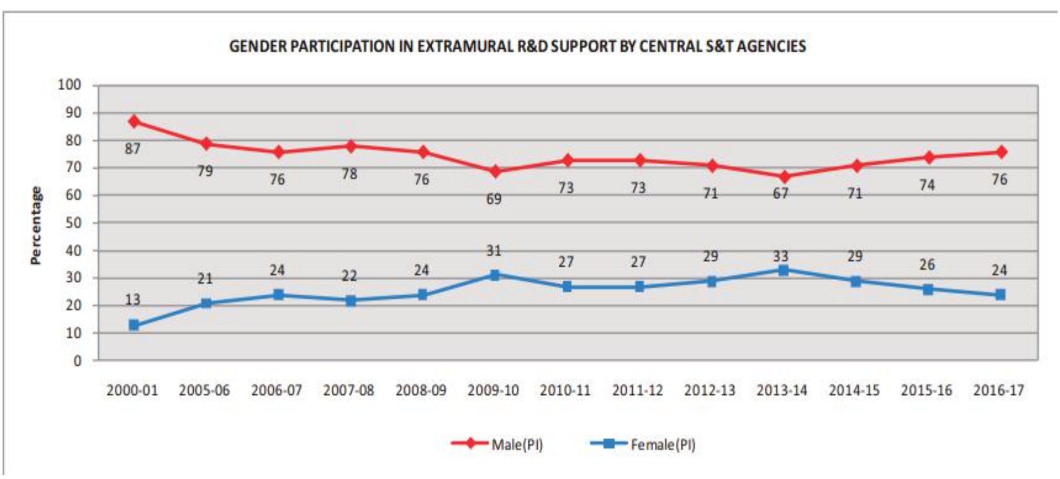
*** Professor of Smart Systems, Science and Engineering Faculty, Queensland University of Technology, Australia.

(UIS) revealed that the regional averages for the share of female researchers (based on available data only) for 2015 are 28.8 per cent for World; 39.8 per cent for Arab States; 39.5 per cent for Central and Eastern Europe; 48.1 per cent for Central Asia; 23.4 per cent for East Asia and the Pacific; 45.4 per cent for Latin America and the Caribbean; 32.3 per cent for North America and Western Europe; 18.5 per cent for South and West Asia; and 31.3 per cent for Sub-Saharan Africa.[3] This percentage further decreases in the areas of hard sciences like physical science, ICT, and engineering.[4]

According to the most recent estimates for the selected OECD (the Organisation for Economic Co-operation and Development) countries such as Belgium, Italy, Finland, Sweden, Spain, Norway, United Kingdom, Russia, and Poland, women representation is more balanced. Several other countries like Turkey and Singapore are also balanced as women are representing between 30 to 46 percent of the total researchers, though Japan and South Korea have a significant gender imbalance among researchers with a women percentage of 15 and 19 respectively.[5] Male dominate one-third medium and high technological jobs in other parts of the world.

India is ranked 112 out of 153 countries (Education attainment) in the 2020 Global Gender Gap Report.[6] Women were at or near parity among undergraduate degree earners in science (50.1 per cent) and IT and computer (47.7 per cent) but, remain under-represented in engineering and technology (31.9 per cent) in 2015–2016. As per research and development statistics, released by the Department of Science and Technology (DST), there were only 56,747 (16.6 per cent) women out of total manpower i.e., 3.42 lakh, employed in research and development till April 1, 2018. Though women's participation in extramural R&D projects has increased significantly to 24 per cent in 2016-17 from 13 per cent in 2000-01 due to various initiatives undertaken by the government in the science and technology (S&T) sector illustrated in Figure 1.[7]

Figure 1: Gender Participation in Extramural R&D Support by Central S&T Agency



Source: NSTMIS, Department of Science & Technology, Government of India

Data drawn from records available in public domains and online sources show that representation of women in scientific positions has increased but, women are clustered in certain disciplines and still excluded from core disciplines of natural sciences and leadership positions. Approximate 3 per cent share in the prestigious awards like the Shanti Swarup Bhatnagar award and 5-8 per cent as fellows from all three Indian science academies support this statement. Even though women comprised approximately 50 per cent of the share in the medical field, there is only one women director in the history of one of the prominent medical institutes of India i.e., All India Institute of Medical Sciences (AIIMS).[8]

Apart from societal, cultural, motherhood responsibilities, and institutional factors, the stereotyped nature of society, unconscious bias, pay differences, lack of role models, and certain restrictive constellations of family responsibilities are a few universal factors that limit women's participation in STEM.[9] There is a need for a multi-faceted approach from society, policymakers, and the government to repair the leaky pipeline and create an enabling environment. An effective government policy, affordable and quality childcare, family support, training in soft skills and negotiation skills, and introduction of role models and mentors may support to address the cause of the leaky pipeline.[9]

Science Diplomacy is playing an essential role in international cooperation to achieve SDGs and combat global challenges.[10,11] Apart from the successful models of vaccine diplomacy, space diplomacy, climate change, and mega projects like European Organisation for Nuclear Research (CERN), Facility for Antiproton and Ion Research (FAIR), International Thermonuclear Experimental Reactor (ITER)[12], Laser Interferometer Gravitational-Wave Observatory (LIGO), Square Kilometre Array (SKA) and Thirty Meter Telescope, science diplomacy is also playing a significant role in addressing gender issues. Most of the countries like Australia, Brazil, Japan, Korea, the UK, and the USA understand that gender parity could be achieved with set targets in prescribed timeline with international cooperation and sharing of the best practices. In this paper, we discuss various international programmes already in place and contributing to enhancing the participation of women in STEM and the role of science diplomacy in achieving gender parity.

International Platforms: Women in STEM

UNESCO: Supporting Women Scientists

UNESCO is committed to promoting gender equality in science and technology and supporting networks of women scientists in various scientific domains and regions, such as the African Women in Mathematics Association (AWMA), African Association of Women in Geosciences and the International Network of Women Engineers and Scientists (INWES). More than 4000 women researchers from across the world are connecting through the Organisation for Women in Science for the Developing World (OWSD) branch of UNESCO's Natural Sciences Sector, founded in 1987 and based at the office of The World Academy of Sciences (TWAS) in Trieste, Italy.[13] It provides training in cutting-edge research areas, career development and networking opportunities for women scientists at different stages of their careers. OWSD also connects them with mentors and role-models.[14] UNESCO is also promoting and encouraging international and regional cooperation to support women in science through knowledge sharing and collaborative work. The UNITWIN/UNESCO Chairs Programmes aim to empower women in science and technology in Argentina, Egypt, Pakistan, Sudan, and Togo.[13]

STEM and Gender Advancement (SAGA)

The STEM and Gender Advancement (SAGA) project is a global UNESCO project launched in 2015 to offer governments and policymakers a variety of tools to reduce the current global gender gap in science, technology, and innovation (STI) fields.[15] Through this objective, the SAGA project will contribute to increasing the visibility, participation, and recognition of women's contributions in STEM. The project focuses on four main activities: (i) develop a methodology and tools to support policymakers worldwide in setting up, implementing, and monitoring gender equality in STI policies; (ii) conduct training workshops in pilot countries to reinforce capacities; (iii) collect STI gender-related policies and instruments and sex-disaggregated data, and (iv) advocate on the importance of improving STI gender-related policies and instruments and collecting sex-disaggregated data.

Few studies have revealed that women in STEM are less paid for a similar work as compared to their male colleagues, and do not progress as far as men in their careers.[3] However, there is very little data at the international or even at country-level showing the extent of these disparities. Through SAGA, the UNESCO Institute of Statistics (UIS) has been working with partners in countries and regional organisations, to develop a toolkit that includes methodologies, indicators, and frameworks to produce more precise data and make better use of existing information.

L'Oréal-UNESCO For Women in Science International Award

The L'Oréal-UNESCO For Women in Science International Awards was constituted in 1998 to recognise and support eminent women researchers throughout the world.[16] The nominated women scientists, actively involved in scientific research, in any field of the Physical Sciences, Mathematics, or Computer Science should be recognised for their scientific excellence by the international scientific community. Out of 112 honoured laureates to date, 3 have won Nobel Prizes for science. Through its 54 regional and national programmes, the L'Oréal Foundation and UNESCO support 250 talented young women researchers every year during their thesis or post-doctoral studies.

Homeward Bound

The inception of Homeward Bound was in 2014 to train 1000 women with STEM background in leadership skills to lead the world within the next ten years.[17] This programme connects the influential women in STEMM and ensures that there is greater diversity at the global leadership table.

The Leadership programme aims to

provide participants' leadership mind-set and style and the impact this has on their ability to act as a leader in the world. The program has four core development components, or 'Streams': leadership, strategy, visibility, and science that are delivered during a 12-month programme, with online content and collaborative learning (11 months), and face-to-face on the ground in Ushuaia, Argentina (pre-voyage) and on-board a ship voyaging to Antarctica.

Research grants support early-career women scientists in the developing world

The OWSD with the partner countries aims to empower women researchers throughout the developing world in STEM. The two donors, IDRC and the Swedish International Development Agency (Sida) agreed to pool resources to provide a comprehensive career development programme for women scientists from 66 of the world's least developed and scientifically lagging countries (STLCs).[13] The Sida funded programme aims to enable women from STLCs to leave their home countries and travel to better-equipped laboratories and departments in other developing countries to complete their Ph.D. training in internationally competitive standards. The other programme supports their research in their home countries with international standards.

Gender Programmes in India

The Government of India had adopted the 'National Policy for Empowerment of Women' in 2001 to empower women and eliminate all forms of discrimination against women. The gender issue was taken up critically from the 6th Five Year plan (1980-85) when the government started a scheme, 'Science and Technology for Women' (S&T for Women) through the Department of Science and Technology (DST). This scheme mainly focused on the development of technologies for the improvement of the life and status of women. Subsequently, S&T policy 2003 was released during the FYP (2002-2007) which ensured full and equal participation of women in science. During 12th FYP (2012-2017), all women-centric schemes were revalidated, revitalised and consolidated under the umbrella of Knowledge Involvement in Research Advancement through Nurturing (KIRAN) to give women a strong foothold into the scientific profession, help them re-enter into the mainstream, and provide a Launchpad for further forays into the field of science and technology.[9] The Women Scientist Scheme (WOS), Consolidation of University Research for Innovation and Excellence in Women (CURIE), Vigyan Jyoti, Mobility, and Indo-U.S. Fellowship for Women in STEMM are mechanisms to empower women researchers at different stages of their lives (Figure 2).

The Department of Biotechnology also launched a Biotechnology Career Advancement and Re-orientation Program (BioCARe) in January 2011 for the career development of women scientists. The scheme is open for women researchers who are employed or unemployed or are desirous of coming back to the mainstream after a break by getting their first grant as the Principal Investigator.[18]

The Science and Engineering Research Board (SERB), an autonomous institution of the DST, recently launched a scheme called Promoting Opportunities for Women in Exploratory Research (POWER) to bridge gender disparity in the field of Science and Technology. This fellowship will include a SERB – Power Fellowship and a SERB – Power Research Grants for women scientists.[19]

Indo-U.S. Fellowship for Women in STEMM (WISTEMM)

The Department of Science and Technology (DST), Government of India and Indo-U.S. Science & Technology Forum (IUSSTF) have jointly implemented the "Indo-U.S. Fellowship for Women in STEMM (WISTEMM)" *(Science, Technology, Engineering, Mathematics, and Medicine)* program to provide opportunities to Indian Women Scientists, Engineers & Technologists to undertake international collaborative research in premier institutions in the U.S.A. to enhance their research capacities and capabilities.[20] The Programme is envisaged to provide an opportunity to bright Indian women students and scientists to gain exposure and access to world-class research facilities in U.S. academia and labs in different frontline areas of Science, Technology, Engineering, Mathematics, and Medicine (STEMM). Any Indian woman who is currently pursuing a Ph.D. degree in Basic Sciences, Engineering, or Technology including Agricultural and Medical Sciences on a full-time basis at any recognised academic institution/R&D institute/ university in India is eligible to apply for 3-6 months.

International Training Programme on Leadership and Career Development

The DST with the IUSSTF and CoACh International, USA conducted two weeks of international training programmes on 'Leadership and Career Development' to 'train the trainer' in 2014 and 2015.[9] During these training programmes, more than 200 mid-career women scientists were trained in soft skills. The focus of the programme was to provide training in career-building topics that are not covered in traditional science curricula. The women scientists were trained on topics such as effective negotiation skills, successful leadership methods, communicating science effectively, working in a team environment, consensus building, establishing a strong in-person and internet presence, and publishing in respected journals, grant writing, and the job search.

The DST is committed to empowering women scientists and is already implementing various gender supportive programmes. The programmes implementing under 'KIRAN' empowering women researchers through different modes of support system. More than 2200 women scientists are already benefitted from the 'Women Scientists Scheme' (WoS A, WoS b &WoC) during the last five years[21]. Women Scientist Scheme is meant to bring back those women scientists in the mainstream of the workforce who had a break in their career due to motherhood and social responsibilities. In continuation of this, another landmark programme, named as, 'Mobility Scheme' has been launched to address the relocation issue of women scientists working in a regular position in Government Organizations.[9] Recently formulating 'VigyanJyoti' programme of DST is designed and implemented for schoolgirls to inculcate the scientific temperament and introducing them with the role models.[22]

Science Diplomacy in 'Women in Science'

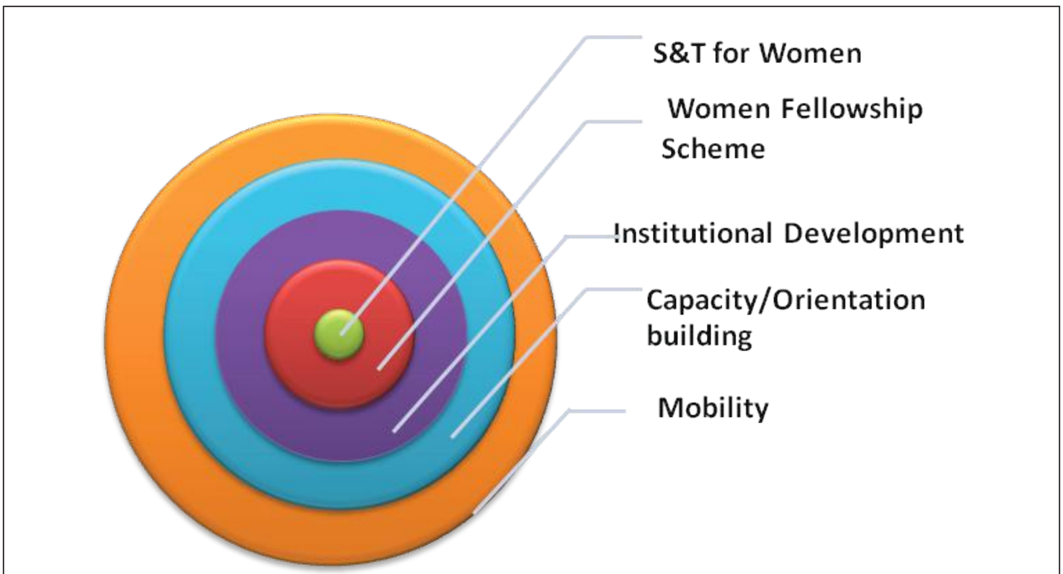
Most of the international reports revealed that women researchers are facing similar kinds of barriers despite their cultural and geographical locations.[4] The lower representation of women from most of the countries indicates an urgent need for international collaboration in this area. The common targets of SDGs persuade the use of science diplomacy to achieve gender parity in STEM. Lessons may be learned from the Muslim dominating countries like Jordan, Malaysia, and Tunisia where 50 percent of women are working in engineering and technical professions.[4] However, many nations have already initiated actions and are sharing successful models to promote and support women researchers. The Athena SWAN Charter is a successful model of science diplomacy and international collaboration in this direction.

Athena SWAN Charter

The Athena SWAN Charter was established in 2005 with ten founder members in the United Kingdom (UK) to empower women's advancement and leadership and has been subsequently implemented in three more countries i.e., Ireland, Australia, and India.[23] The grand success in terms of recording the positive impact of this programme in the UK encouraged policymakers and diplomats to opt for the programme in other countries. The Charter's reach has grown to 170 UK and Ireland members, and 812 awardee institutions and departments. Over 400 applications are made per year for the award, highlight the success and impact of this programme.

In 2015, a tailored Athena SWAN programme was launched in Ireland as a cross-sector initiative supported by the Higher Education Authority (HEA). To date, 11 institutions and 26 departments

Figure 2: Different components of KIRAN Scheme



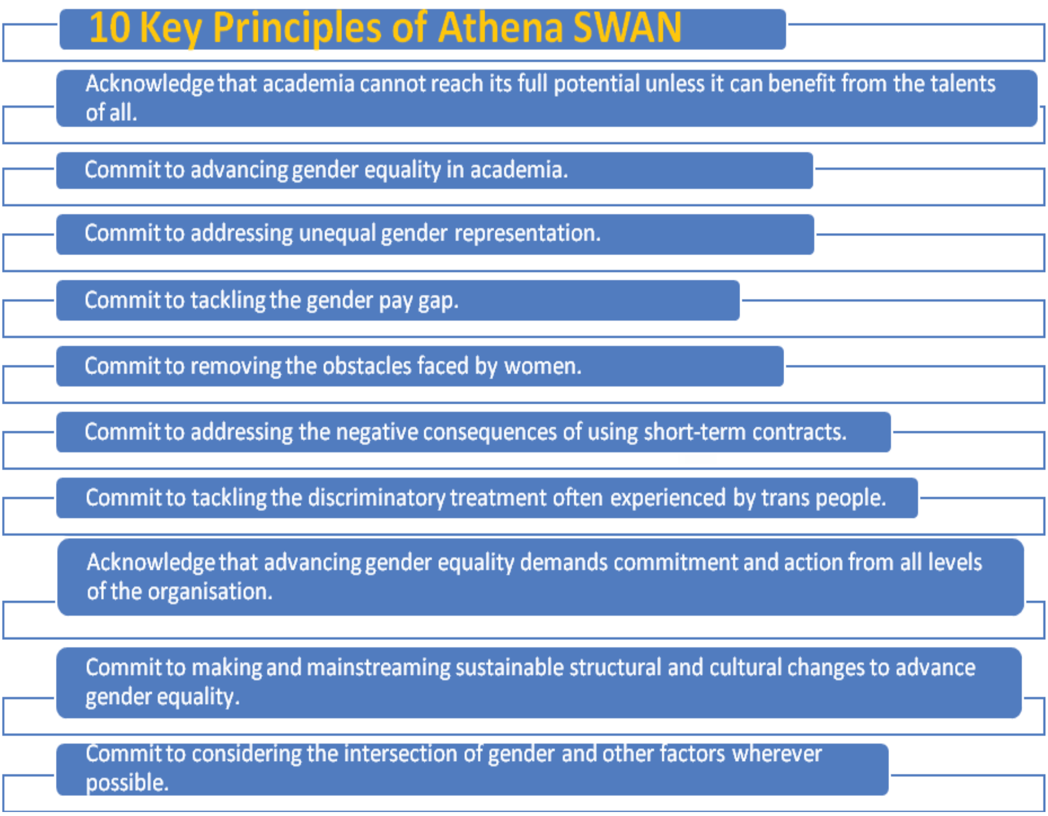
Source: NSTMIS, Department of Science & Technology, Government of India.

have successfully achieved Bronze awards, and Ireland authorities recommended establishing it permanently.[23]

The programme was also adopted in Australia in the same year and implemented through the Australian Academy of Science (AAS) and the Australian Academy of Technology and Engineering (ATSE) to oversee the pilot programme.[23] To date, a total of thirty-three (33) out of 38 universities, plus a higher education research institution (representing approximately 87 per cent of Australian universities), a higher education research institute, six out of fifty of Australia's medical research institutes (representing approximately 12 per cent of Australian MRIs) and five (5) out of approximately 12 publicly funded science research agencies (representing 40 per cent of these agencies) became part of the Science in Australia Gender Equity (SAGE) pilot programme and committed to the ten principles of the Athena SWAN Charter.[24]

Recently, the Indian government also opted for such a programme and named it 'Gender Advancement for Transforming Institutions (GATI)' for the implementation in Indian institutions.[25] The DST with the British Council will pilot it in an estimated 20 Indian higher education institutes, research laboratories, and academies to build capacities as laid out in the Athena SWAN framework.

Figure 3: Ten key principles of Athena SWAN Charter



Source: Jyoti Sharma and Prasad KDV Yarlagadda. 2020. narureasia.com. doi:10.1038/nindia.2020.41

GATI is an accreditation model and invites Indian research/ academic institutions for self-assessment and adopting the ten principles of the Athena SWAN Charter (Figure 3). This will make them responsible and committed to creating SMART (Specific, Measurable, Achievable, Relevant, and Time-bound) action plans for systemic and cultural transformation. The institutions will assess, accredit, and recognize through certification and awards. The British Council will facilitate the collaboration between the participated institutions under GATI with Athena SWAN accredited universities and research institutions in the UK. The global linkages and sharing of the best models will help to work towards reaching the global best practice for gender equality.

Conclusion

The exclusion of women from the science arena in terms of their presence in the decision-making structures is evident in numerous studies. The loss of so many women scientists impact the nation's scientific performance and productivity. Most of the countries are facing similar societal, cultural, and institutional factors that are impediments to women in STEM. There is an imperative need to address barriers to gender equity to retain the brightest minds in the workforce to overcome a broad range of challenges related to health, education, sustainability and food security. There is an urgent need for skilled human resource that needs much discussion and research in the context of building leadership qualities among women scientists. Each country observed that ongoing national programmes and policies are not enough to address the under-representation of women scientists at a higher level or retain them in their mid-level careers due to various societal and cultural differences. It is also important to share the successful programmes and policies to gather universal data, showcasing role-models at the global level, developing vast networking, understand the psychology of women from different geographical areas, and address their common challenges.

The governments of different nations are using diplomatic channels to address this issue. International programmes like L'Oréal, UNESCO, OWSD, Homebound are working at a global level to fulfil the need of women scientists. However, there is a critical need for replicating a successful model of one country to another part of the world. Science diplomacy in gender programmes would help in reducing the wastage of human resources, time, and skills. The replication of the Athena SWAN Charter in Australia, India, and Ireland is a step forward in this direction. There is progress in terms of gender equality, but it is slow, and we have a long way to go to achieve full equality, which may be a century.

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PERSPECTIVE

European Union's Horizon Europe Moves Ahead

Bhaskar Balakrishnan*

Bhaskar Balakrishnan

Horizon Europe (HE) is the European Union's (EU) next major research and technology development programme covering the period 2021-2027. It comes as a successor to the Horizon 2020 Programme (2014-2020), which itself was preceded by seven earlier Framework Programmes (FP1 to FP7), during the period 1984-2013. The budget for the framework programmes has grown steadily from EUR 3.8 billion (for FP1) to EUR 77 billion for Horizon 2020. There has been delay in finalising Horizon Europe, on account of the Brexit process and the COVID-19 pandemic. By way of comparison, Gross Domestic Expenditure on R&D (GERD) stood at EUR 318 billion in the EU-28 in 2017 alone, more than four times the entire budget for six years for Horizon 2020. EU's R&D expenditure has stayed at around 2 per cent of GDP since 2013, as against the 3 per cent R&D intensity target for 2020.

The EU is also increasingly lagging behind other advanced economies, such as the United States, Japan and South Korea in R&D intensity. While in 2000 the EU accounted for 25 per cent of global R&D expenditure, this share had fallen to 20 per cent by 2015. China, with an R&D intensity of 2.13 per cent in 2017 accounted for 21 per cent of global R&D expenditure in 2015, rising from a share of only 5 per cent in 2003. In terms of total expenditure on R&D[1], the EU comes second globally with EUR 318 billion (2017), following the US (EUR 453 billion, 2015), and ahead of China (EUR 203 billion, 2015), and

* Science Diplomacy Fellow, RIS and Former Ambassador of India. He holds a Ph.D. in Theoretical and Mathematical Physics from State University of New York, Stony Brook.

Japan (EUR 130 billion, 2015). The R&D intensities among the EU members varies considerably, ranging from a high of 3.33 per cent in Sweden to a low of 0.5 per cent for Romania. Sweden, Austria, Denmark, and Germany were above 3 per cent of GDP, 16 countries were in the range of 1 to 3 per cent of GDP. Eight Member States recorded a R&D intensity below 1 per cent. For the EU-28 as a whole the R&D intensity improved from 1.776 per cent in 2007 to 2.07 per cent in 2017. Horizon 2020 and its successor Horizon Europe could help to narrow these differences through stronger intra-EU R&D collaboration and capacity building.

Budget and Contours of Horizon Europe

The European Commission had made the original proposal for EUR 94 billion in April 2019. However, the withdrawal of the UK (Brexit) and negotiations with the European Parliament and member states resulted in a substantial reduction to EUR 85.5 billion as on 29 September 2020.[2] The budget includes EUR 2.4 billion for EURATOM, the EU's nuclear research programme, and EUR 3.6 billion in Invest-EU, an umbrella investment fund. The budget also depends on agreement being reached on the EUs overall long-term budget, which is in the final stages of negotiations. At the time of writing this, the German presidency of the European Union is trying to find a solution to the problem of veto by Hungary and Poland of the 2021-2027 budget, which consists of a 1 trillion EUR EU budget and an additional EUR 750 billion recovery package. Hungary and Poland are objecting to the money to be made conditional on respecting the rule of law.

With 7 per cent of the world's population, Europe accounts for 20 per cent of global R&D investment and produces 33 per cent of all high-quality scientific publications and holds a world leading position in industrial sectors such as pharmaceuticals, chemicals, mechanical engineering and fashion. EU funding has allowed researchers to work across countries and scientific disciplines to make Europe a world-class leader in research and innovation. Horizon Europe has three pillars (with percent of budget) - (1) Excellent Science (25.8 per cent), (2) Global Challenges and European Industrial Competitiveness (52.7 per cent) and (3) European Innovation (13.5 per cent). Widening participation and strengthening the European Research Area (2.1 per cent) is a cross cutting theme, while EURATOM gets 2.4 per cent and Invest-EU 3.5 per cent.

Horizon Europe will incorporate research and innovation missions to increase the effectiveness of funding by pursuing clearly defined targets. Five mission areas have been identified under Horizon Europe - (1) Adaptation to climate change including societal transformation, (2) Cancer, (3) Climate-neutral and smart cities, (4) Healthy oceans, seas, coastal and inland waters, and (5) Soil health and food. Several of these are also important for India, making it possible for Indian researchers to collaborate. However, given the serious nature of the COVID-19 pandemic, it is likely that research will also target future pandemics and responses, though a separate EU mechanism for this may well emerge. In response to differing national responses and a perceived lack of coordination in dealing with the COVID-19 situation, the European Commission is urging countries to grant more legal power to the EU and create a "Health Union" to manage future crises. Several of these mission areas are related to the UN 2030 Agenda and the SDGs, such as climate change adaptation (SDG 13), cancer (SDG 3), climate neutral and smart cities (SDG 11), healthy oceans, seas coastal and inland waters (SDG 14), etc. Therefore, the potential exists for forging wider partnerships with the global South which can be exploited, especially through access to relevant technological advances.

Horizon Europe will support European partnerships with EU countries, the private sector, foundations and other stakeholders. The processes for Horizon Europe have been simplified, including, (1) stable legal framework with simplified rules and procedures, (2) digital administration, (3) fair, transparent and objective evaluation of proposals, (4) data reporting, dissemination and exploitation for value creation, and (5) outreach, guidance and support to participants. There had been complaints regarding the excessive red tape in the FP7, so some simplification was made in Horizon 2020 and this is being extended further.

Impact of Brexit

Although the UK has technically already left the EU, the future UK-EU relationship is uncertain, and there is no clarity about whether the UK's science sector will be able to access Horizon Europe. In the transition period, under the Withdrawal Agreement, the UK scientific community was able to continue to participate in Horizon 2020. The UK-EU negotiations have stalled over the EU's proposed financial calculation for the UK. The EU is proposing that the UK contribute around GBP15.2 billion to Horizon Europe in a "one-way" deal. If the UK was to receive more in funding than GBP 15.2 billion, the UK government would have to repay the difference to the EU, but if the UK were to receive less it would not be entitled to get back the difference. The UK would need to win 16 per cent of funding from the programme to break-even while at present the UK wins only 12.7 per cent of funding, which would leave a substantial GBP 3 billion deficit. Therefore, flexibility is called for in the financial arrangements, as it is not possible to predict in advance, the total funding that would be obtained by researchers from a particular country.

US Position on Taking Part in Horizon Europe

The Trump administration has called for more reciprocity in Horizon Europe participation, and wants more say over how its money is spent. Currently US participants can take part and pay for themselves in cooperative projects. The EU has suggested US participation in Horizon Europe as an associated country as part of the current drive to widen participation beyond the EU's neighbours. The US assessment is that terms of the Seventh Framework Programme and Horizon 2020 have hindered, rather than fostered, full partnerships. Associated countries are expected to contribute to the Horizon Europe budget at levels that are no less than the amount that they receive from the programme, which means funding is not an incentive to associate. Association also does not give any oversight role for the international partner over the funds that they provide the European Commission. In addition, association in Horizon Europe allows the European Commission, unilaterally, to exclude associated third countries from elements of the programme. Europe benefits from US public research investment - for example, 15 per cent of the US National Science Foundation grants alone involve European partners. But US research institutions are only involved in about 1 per cent of Horizon 2020 projects. The US has called for reinvigorating international cooperation under Horizon Europe and provide a compelling case for association.

Third Country Participation in Horizon Europe

Participation of third countries associated to the Programme is covered under Article 12 of the regulations adopted on 29 September 2020. These state that the Programme shall be open to (a) European Free Trade Association (EFTA) members which are members of the European Economic Area (EEA), (b) acceding countries, candidate countries and potential candidates, (c) countries covered by the European Neighbourhood Policy, and (d) third countries and territories that fulfil all of the following criteria: (i) a good capacity in science, technology and innovation; (ii) commitment to a rules-based open market economy, including fair and equitable dealing with intellectual property rights, backed by democratic institutions; and (iii) active promotion of policies to improve the economic and social well-being of citizens.

Association of third countries under point (d) above shall be covered in a specific agreement which - (1) ensures a fair balance as regards the contributions and benefits of the third country participating in the Union programmes; (2) lays down the conditions of participation in the programmes, including the calculation of financial contributions to individual programmes and their administrative costs in accordance with the Financial Regulation; (3) does not confer to the third country a decisional power in respect of the programme; and (4) guarantees the rights of the EU to ensure sound financial management and to protect its financial interests. The scope of association of each third country to the Programme shall take into account the objective of driving economic growth in the EU through innovation. Accordingly, parts of the programme may be excluded from an association agreement for a specific country. The association agreement shall, as far as possible, provide for the reciprocal participation of legal entities established in the Union in equivalent programmes of associated countries in accordance with the conditions laid down therein.

Currently, 16 countries, including Switzerland, Israel, Iceland and Tunisia, are associated to the existing R&D programme, Horizon 2020. That allows their researchers to compete for EU funding on the same footing as EU researchers, on condition that their governments make a payment, based on the size of their gross domestic product, into a central EU money pool to help pay for the programme. There is interest in participation in Horizon Europe from non-EU member states, which now includes the U.K. Australia, Canada, Japan, New Zealand, Singapore and South Korea have expressed interest in associate membership of the Horizon Europe programme. Exploratory talks with interested countries will start shortly. The association process with non-EU countries needs to be completed by the autumn of 2021, which is the deadline for the first round of Horizon Europe funding calls. Undoubtedly participation by third countries will strengthen Horizon Europe and will be in the interest of both sides, provided win-win mutually beneficial arrangements can be worked out. At the same time, Horizon Europe budget is small compared to national R&D budgets of EU members, so third countries, may well seek separate bilateral cooperation arrangements for STI cooperation, especially with the countries with the largest R&D budgets.

Endnotes

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American Association for the Advancement of Science – Center for Science Diplomacy

Sneha Sinha*

Sneha Sinha

The foundation of the Royal Society, London (1660) and Asiatic Society of Bengal (1784) preceded the formation of numerous scientific societies/associations across the world during the nineteenth century. The German society, *Deutscher Naturforscher Versammlung* (1821) provided a model for similar societies across Europe and United Kingdom, including the British Association for the Advancement of Science (BAAS) in 1831.[1] The American Association for the Advancement of Science (AAAS) was founded in 1848. It played a critical role in mitigating geographical and academic isolation of scientific workers and shaping a discernible voluntary scientific community in the United States. AAAS fostered to the growth of various disciplinary societies and enabled both 'diffusion' and 'advancement' of science. The Association became the central space for scientific debates. AAAS's prestige is evident in its membership, public approval, international recognition and attention given by the state and federal governments to its recommendations.[2] AAAS pioneered various programmes in growth and issues of science, science education, social relations and social responsibility of science, science communication, science policy, etc.

Though science diplomacy was practised earlier, the term dates back to US foreign policy initiatives, aimed to re-establish US soft power and restore its reputation after 2003 Iraq invasion, which was detrimental to its image

* Research Associate, RIS. She holds a Ph.D. in Science Policy from Centre for Studies in Science Policy, Jawaharlal Nehru University, New Delhi.

in the world.[3] Since then, it evolved as a field of study and policy considerations.[4] As the term lacked theoretical grounding, it largely benefited from the emerging discourse by practitioners.[5] The formation of AAAS - Center for Science Diplomacy in 2008 is viewed as significant, substantive step towards its development.[6] AAAS's diversity allows it to engage with a global scientific community, build coalitions with other scientific organisations, non-governmental organisations and international governments, and use science to bridge the political differences for the benefit of global society. Following the foundation of the Center, AAAS conference on science diplomacy was first of its kind, which brought together various stakeholders.[7] Various efforts towards conceptual framing of science diplomacy, building on science and technology relationships with policy-making were initiated.[8]

As most twenty-first century challenges had scientific dimensions, efforts were made to create a new role for science in international policymaking and diplomacy.[9] In 2009, Royal Society and AAAS co-hosted a meeting, which was attended by 200 delegates across twenty countries in Asia, Europe, Africa, Middle-East and North and South America. Its landmark report *New Frontiers of Science Diplomacy* gave three-dimensional conceptual framework and definition for science diplomacy.[10] Report's theoretical approach and practical examples was the basis of the first trainings to expose early career scientists to the concept, history and practice of science diplomacy.[11] It is the most 'influential declaration and classification of the Anglo-American position and became the central point of reference for subsequent official statements and publications'.[12] However, researchers and practitioners of science diplomacy are working towards broadening its definitions and theoretical understanding, beyond those set by the report.

Despite some efforts at universities, majority of science diplomacy training programmes were conducted by international scientific organisations like AAAS, The World Academy of Sciences (TWAS) and the International Network of Government Science Advice (INGSA). AAAS's Center aims to build academic tools and resources to support science diplomats and ensure necessary training and resources to work at the intersection of science and international relations and address global challenges. It was the first organisation to offer dedicated summer-training course in science diplomacy in partnership with TWAS to expose scientists, policymakers, diplomats and other professionals from the Global South to the impact of S&T on international policies, and how diplomats can harness S&T to advance national and global goals in 2014. AAAS-TWAS Summer Course on Science Diplomacy has trained 200 emerging leaders from 50 countries over the years. The course exposes participants to important S&T, environment and health-related contemporary international policy issues. It provides understanding of the roles of international organisations, governments and private sector in S&T based issues, and how diverse governance structures are developed to address the needs and involvement of diverse stakeholders. AAAS, TWAS, Academy of Science of South Africa (ASSAf), and TWAS's Regional Office for Sub-Saharan Africa (TWAS-ROSSA) held a week-long course for regional training workshop for young Sub-Saharan African participants at science-diplomacy interface and in international policymaking in 2018.

The Science Diplomacy and Leadership Workshop combines academic lectures, field visits, professional development workshops, networking opportunities and leadership training. At the annual meeting in Boston in 2017, Science Diplomacy Education Network (SciDipEd) was launched. It is a platform to bring together educators and students interested in science diplomacy education in the United States and across the world, to advance intellectual and practical understanding of science diplomacy and support its expansion in formal and informal settings. More recent programmes, such as the AAAS Science Diplomacy & Leadership Workshop have emphasised on knowledge transfer, skill development, building networks, and designing national or regional science diplomacy strategies. Though these courses have been very successful and popular, but participation is often restricted to specific disciplinary and geographic audiences.[13],[14] To meet the growing demand, AAAS launched its first science diplomacy online course in 2017. It describes and utilises frameworks for understanding science diplomacy and traces its evolution in modern history through cases studies and interviews with top practitioners.

The Center for Science Diplomacy plays a critical role in developing conceptual framework for training and practical application of science diplomacy through strengthening its community, building capacity and advancing education and research.[15] Its foundation and subsequent creation of 'Science & Diplomacy' in 2012 as the first journal in the field were significant step in advancement of science diplomacy.[16],[17] So, far twenty-five issues of the journal have been published. Science and Diplomacy publishes perspectives and articles by science and diplomacy practitioners and thinkers from U.S., and international perspectives in science, providing a forum for advancing research and serving as a resource for stakeholders.[18] The Center serves as a global platform for bringing together stakeholders in science diplomacy. It has hosted numerous conferences, giving shape to a nascent community around various aspects of science diplomacy. It has instituted an Award for recognising outstanding contributions in furthering science diplomacy, presented at AAAS annual session. The Center has participated in numerous high-level conferences and launched science diplomacy roundtable sessions for showcasing application of science diplomacy in contemporary international topics/dialogue.[19]

Within an year of its inception, it began leading and facilitating scientific engagements with countries with which US shared challenging diplomatic relations to explore possibilities of scientific cooperation.[20] Apart from the Center and its activities under its science diplomacy programme, AAAS's Office of International and Security Affairs manages its international institutional relationships, supports internationalisation and its goals of providing leadership in science cooperation, science diplomacy and science, technology and security policy.[21] AAAS partnered with US Department of State, National Academy of Sciences and National Academy of Engineering and initiated Networks of Diasporas in

Engineering and Science (NODES) through engagement events and round-table discussions during its annual session.[22]

Numerous institutions in science diplomacy have emerged over the years, including the expert networks like Foreign Ministries' Science and Technology Advisors Network (FMSTAN), International Network of Government Scientific Advisors (INGSA), academic centers, university departments, research projects, consortiums, NGOSs, research programmes, think-tanks. However, most of these remain restricted to the United States, Europe, besides few initiatives in the Global South. AAAS continues to be an important institution and plays an important role in capacity building, forging networks and fostering the growth of a community in science diplomacy. It can provide a model for the institutions for shaping their science diplomacy programmes to advance education and research in science diplomacy. Linkages can be fostered and joint capacity building conferences, workshops, summer-schools, roundtable discussions can be organsised in collaboration with AAAS and other institutions in science diplomacy for furthering theoretical and practical application of science diplomacy in the context of specific countries or regional setting.

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REPORT REVIEW

Global Biodiversity Outlook 5

Report by UNEP CBD on Appraisal of 10 Years of Strategic Plan for Biodiversity (2011-2020) and Aichi Biodiversity Targets

Amit Kumar*

Amit Kumar

The Context

Ten years ago, during the tenth meeting of the Conference of the Parties (COP), held during 18-29 October 2010, in Nagoya, Aichi Prefecture, Japan, Convention on Biological Diversity (CBD) parties adopted a revised and updated Strategic Plan for Biodiversity, including the Aichi Biodiversity Targets for the period 2011-2020. It was themed as "Living in Harmony with Nature" with the purpose of inspiring wider action towards supporting biodiversity over the next decade by all countries and stakeholders. The UN General Assembly also declared 2011-2020 as the United Nations Decade on Biodiversity.

The vision of the Strategic Plan was that "By 2050, biodiversity is valued, conserved, restored and wisely used, maintaining ecosystem services, sustaining a healthy planet and delivering benefits essential for all people" and the mission was to "take effective and urgent action to halt the loss of biodiversity in order to ensure that by 2020 ecosystems are resilient and continue to provide essential services, thereby securing planet's variety of life, and contributing to human well-being and poverty eradication. To ensure this, pressures on biodiversity are reduced, ecosystems are restored, biological resources are sustainably used and benefits arising out of utilisation

* Research Associate, RIS.

of genetic resources are shared in a fair and equitable manner; adequate financial resources are provided, capacities are enhanced, biodiversity issues and values mainstreamed, appropriate policies are effectively implemented, and decision-making is based on sound science and the precautionary approach" (UNEP, 2010).

The following five Strategic Goals were stated in the Plan:

A: Address the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society

B: Reduce the direct pressures on biodiversity and promote sustainable use

C: To improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity

D: Enhance the benefits to all from biodiversity and ecosystem services

E: Enhance implementation through participatory planning, knowledge management and capacity building.

Within these five goals, 20 targets were also mentioned, known as Aichi Biodiversity Targets. These include:

Within Strategic Goal A:

- **Target 1:** By 2020, at the latest, people are aware of the values of biodiversity and the steps they can take to conserve and use it sustainably.
- **Target 2:** By 2020, at the latest, biodiversity values have been integrated into national and local development and poverty reduction strategies and planning processes and are being incorporated into national accounting, as appropriate, and reporting systems.
- **Target 3:** By 2020, at the latest, incentives, including subsidies, harmful to biodiversity are eliminated, phased out or reformed in order to minimise or avoid negative impacts, and positive incentives for the conservation and sustainable use of biodiversity are developed and applied, consistent and in harmony with the Convention and other relevant international obligations, taking into account national socio-economic conditions.
- **Target 4:** By 2020, at the latest, Governments, business and stakeholders at all levels have taken steps to achieve or have implemented plans for sustainable production and consumption and have kept the impacts of use of natural resources well within safe ecological limits.

Within Strategic Goal B:

- **Target 5:** By 2020, the rate of loss of all-natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced.
- **Target 6:** By 2020 all fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem-based approaches, so that overfishing is avoided, recovery plans and measures are in place for all depleted species, fisheries have no significant adverse impacts on threatened species and vulnerable ecosystems and the impacts of fisheries on stocks, species and ecosystems are within safe ecological limits.
- **Target 7**: By 2020 areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity.

- **Target 8:** By 2020, pollution, including from excess nutrients, has been brought to levels that are not detrimental to ecosystem function and biodiversity.
- **Target 9:** By 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment.
- **Target 10:** By 2015, the multiple anthropogenic pressures on coral reefs, and other vulnerable ecosystems impacted by climate change or ocean acidification are minimized, so as to maintain their integrity and functioning.
- Within Strategic Goal C:
- **Target 11:** By 2020, at least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes.
- **Target 12:** By 2020 the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained.
- **Target 13:** By 2020, the genetic diversity of cultivated plants and farmed and domesticated animals and of wild relatives, including other socio-economically as well as culturally valuable species, is maintained, and strategies have been developed and implemented for minimising genetic erosion and safeguarding their genetic diversity.
- Within Strategic Goal D:
- **Target 14**: By 2020, ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods and well-being, are restored and safeguarded, taking into account the needs of women, indigenous and local communities, and the poor and vulnerable.
- **Target 15:** By 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including restoration of at least 15 per cent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification.
- **Target 16:** By 2015, the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization is in force and operational, consistent with national legislation.

Within Strategic Goal E:

- **Target 17:** By 2015 each Party has developed, adopted as a policy instrument, and has commenced implementing an effective, participatory and updated national biodiversity strategy and action plan.
- **Target 18**: By 2020, the traditional knowledge, innovations and practices of indigenous and local communities relevant for the conservation and sustainable use of biodiversity, and their customary use of biological resources,

are respected, subject to national legislation and relevant international obligations, and fully integrated and reflected in the implementation of the Convention with the full and effective participation of indigenous and local communities, at all relevant levels.

- **Target 19**: By 2020, knowledge, the science base and technologies relating to biodiversity, its values, functioning, status and trends, and the consequences of its loss, are improved, widely shared and transferred, and applied.
- **Target 20:** By 2020, at the latest, the mobilisation of financial resources for effectively implementing the Strategic Plan for Biodiversity 2011-2020 from all sources, and in accordance with the consolidated and agreed process in the Strategy for Resource Mobilisation, should increase substantially from the current levels. This target will be subject to changes contingent to resource needs assessments to be developed and reported by Parties.

Global Biodiversity Outlook 5 Report: Salient Findings

At the tenth and final year of the Plan period, the UN CBD, in its recently launched report titled "Global Biodiversity Outlook 5" (GBO-5), has found that none of the targets have been fully met and only six out of the 20 targets are deemed to have been "partially" achieved. By "partially" achieved, GBO-5 referred to the targets, where at least one distinct element has been met (UNEP, 2020).

Overall, this report provides a grim scenario where it highlights that the rate of biodiversity loss is unprecedented in human history and the pressures are intensifying. As the earth's living systems, as a whole are getting compromised, and as exploitation of nature is going on in unsustainable ways, we are increasingly undermining our own wellbeing, security and prosperity. The COVID-19 pandemic has in a way demonstrated the importance of the synergetic relationship between human and nature.

The six "partially" achieved targets are as follows:

- **Target 9:** By 2020, invasive alien species and pathways are identified and prioritised, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment.
- *Progress Summary (as stated in the Report):* Good progress has been made during the past decade on identifying and prioritising invasive alien species in terms of the risk they present, as well as in the feasibility of managing them.
- **Target 11:** By 2020, at least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures and integrated into the wider landscapes and seascapes.
- *Progress Summary (as stated in the Report):* The proportion of the planet's land and oceans designated as protected areas is likely to reach the targets for 2020 and may be exceeded when other effective area-based conservation measures and future national commitments are taken into account.

- **Target 16:** By 2015, the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilisation is in force and operational, consistent with national legislation.
- *Progress Summary (as stated in the Report):* The Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization entered into force on 12 October 2014. As of July 2020, 126 Parties to the CBD have ratified the Protocol and 87 of them have put in place national Access and Benefit Sharing (ABS) measures, as well as establishing competent national authorities. The Protocol can be considered operational.
- **Target 17:** By 2015 each Party has developed, adopted as a policy instrument, and has commenced implementing an effective, participatory and updated national biodiversity strategy and action plan.
- *Progress Summary (as stated in the Report):* By the December 2015 deadline established in this target, 69 Parties had submitted an NBSAP prepared, revised or updated after the adoption of the Strategic Plan. An additional 101 Parties have since submitted their NBSAP, so that by July 2020, 170 Parties had developed NBSAPs in line with the Strategic Plan. This represents 85 per cent of the Parties to the Convention. However, the extent to which these NBSAPs have been adopted as policy instruments and are being implemented in an effective and participatory manner is variable.
- **Target 19**: By 2020, knowledge, the science base and technologies relating to biodiversity, its values, functioning, status and trends, and the consequences of its loss, are improved, widely shared and transferred, and applied.
- *Progress Summary (as stated in the Report):* Significant progress has been made since 2010 in the generation, sharing and assessment of knowledge and data on biodiversity, with big-data aggregation, advances in modelling and artificial intelligence opening up new opportunities for improved understanding of the biosphere. However, major imbalances remain in the location and taxonomic focus of studies and monitoring. Information gaps remain in the consequences of biodiversity loss for people and the application of biodiversity knowledge in decision making is limited.
- **Target 20:** By 2020, at the latest, the mobilisation of financial resources for effectively implementing the Strategic Plan for Biodiversity 2011-2020 from all sources, and in accordance with the consolidated and agreed process in the Strategy for Resource Mobilisation, should increase substantially from the current levels. This target will be subject to changes contingent to resource needs assessments to be developed and reported by Parties.
- *Progress Summary (as stated in the Report):* There have been increases in domestic resources for biodiversity in some countries, with resources remaining broadly constant for others over the past decade. Financial resources available for biodiversity through international flows and official development assistance have roughly doubled.

In addition to the six "partially" achieved targets, the GBO5 also highlighted the following targets, which have shown particular progress in the past decade:

- **Target 2:** Almost 100 countries have incorporated biodiversity values into national accounting systems.
- **Target 5:** The rate of deforestation has fallen globally by about a third compared to the previous decade.
- **Target 6:** Where good fisheries management policies have been introduced, involving stock assessments, catch limits, and enforcement, the abundance of marine fish stocks has been maintained or rebuilt.
- **Target 12:** Recent conservation actions have reduced the number of extinctions through a range of measures, including protected areas, hunting restrictions, the control of invasive alien species, ex situ conservation and re-introduction. Without such actions, extinctions of birds and mammals in the past decade would likely have been two to four times higher.

Assessment of Progress in India

In India, all 20 Aichi targets have been comprehensively incorporated in 12 National Biodiversity Targets (NBTs). Based on the latest 6th National Report for

Table 1: Indian National Biodiversity Targets and their Assessment

NBT No.	Target	Assessment
1.	By 2020, a significant proportion of the population especially the youth, is aware of the values of biodiversity and the steps they can take to conserve and use it sustainably.	On track to achieve target.
2.	By 2020, values of biodiversity are integrated in national and state planning processes, development programmes and poverty alleviation.	On track to achieve target.
3.	Strategies for reducing rate of degradation, fragmentation and loss of all-natural habitats are finalised and actions put in place by 2020 for environmental amelioration and human well-being.	On track to achieve target.
4.	By 2020, invasive alien species and pathways are identified and strategies to manage them developed so that population of prioritised invasive alien species are managed.	Progress towards target, but at an insufficient rate.
5.	By 2020, measures are adopted for Sustainable Management of Agriculture, Forestry and Fisheries.	On track to achieve target.

Table 1 continued...

Table 1 continued...

6.	Ecologically representative areas on land and in inland waters, as well as coastal and marine zones, especially those of particular importance for species, biodiversity and ecosystem services, are conserved effectively and equitably, on the basis of protected area designation and management and other area-based conservation measures and are integrated into the wider landscapes and seascapes, covering over 20 percent of the geographic area of the country, by 2020.	On track to exceed target.
7.	By 2020, genetic diversity of cultivated plants, farm livestock, and their wild relatives including other socio-economically as well as culturally valuable species, is maintained, and strategies have been developed and implemented for minimising genetic erosion and safeguarding their genetic diversity.	On track to achieve target.
8.	By 2020, ecosystem services especially those relating to water, human health, livelihoods and well-being are enumerated and measures to safeguard them are identified taking into account the needs of women and local communities particularly the poor and vulnerable section.	On track to achieve target.
9.	By 2015, Access to Genetic Resources (GRs) and the Fair and Equitable Sharing of Benefits Arising from their Utilisation as per the Nagoya Protocol are operational, consistent with national legislation	Achieved.
10.	By 2020, an effective participatory and updated national biodiversity plan is made operational at different levels of governance.	Achieved.
11.	By 2020, national initiatives using communities' traditional knowledge relating to biodiversity are strengthened, with the view to protecting this knowledge in accordance with national legislations and international obligations.	On track to achieve target.
12.	By 2020, opportunities to increase the availability of financial human and technical resources to facilitate effective implementation of the Strategic Plan for Biodiversity 2011-2020 and the national targets are identified and the Strategy for Resource Mobilization is adopted.	Progress towards target, but at an insufficient rate.

Source: ***Compiled by Author based on 6th Indian National Report for the CBD.***

the CBD (UNEP, 2018) submitted by India, the assessment of progress against each NBT is given in Table 1.

From the above assessment, it can be easily inferred that India's performance has been quite satisfactory in achieving almost all the Aichi Targets. Except in two NBTs (4 and 12), the progress is on track to achieve all other targets by 2020. In fact, two NBTs (9 and 10) have already been achieved, while in one NBT (6), the progress is expected to exceed the target.

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Emerging Technologies for Economic Development

Authors: Meissner, D., Gokhberg, L., & Saritas, O. (Eds.). (2019).

Publisher: Springer International Publishing.

Kapil Patil*

Kapil Patil

Over the past decade, emerging technologies have become a subject of much academic as well as policy discussions and initiatives. While the academic discourse has sought to deliberate on what qualifies a given technology as "emergent" (see Rotolo et al. 2015), the policy initiatives have mainly focussed on extracting potential strategic, economic and societal value from what has already 'emerged' or is likely to 'emerge' technologically. At the industry level, the technologies which are in the early life-cycle stages with proven applications are of immense significance due to their growing market potential. Whereas for policymakers, the new technologies serve as the means to address a variety of complex societal challenges and to usher in desired socio-economic transformations in the society.

Notwithstanding their general or special purpose applications, the 'technological emergence', is widely characterised as an 'uncertain' process involving various unforeseen risks and challenges. The uncertainties present in the development and diffusion of innovations are well-known in the literature. According to Nathan Rosenberg, a renowned economist, the history of successful innovations is fraught with widespread failure of "social imaginations" in anticipating their future socio-economic impacts. Although Rosenberg remained skeptical about the ability to overcome ex-ante uncertainties connected with uses of new technologies, the eagerness to exploit new market opportunities has historically driven investments in their development and commercialisation (Rosenberg, 1986; Lall, 1992).

Investigations into dynamics of emerging and new-generation technologies can nevertheless be useful to understand potential risks and uncertainties which may inform crucial policy decisions. Such investigations would

* Research Associate, RIS. He holds Ph.D. in Science Policy from Centre for Studies in Science Policy, Jawaharlal Nehru University, New Delhi.

be particularly valuable when setting policy priorities at the nations or corporate level to harness emerging technologies by taking into account broader societal, environmental factors for informing crucial R&D and investment-related decisions. Consequently, technology forecasting and assessment methods have come to be widely adopted in advance industrialised countries for availing economic and transformational impacts of new technologies. The book under review titled, 'Emerging Technologies for Economic Development' makes an important contribution in this direction by examining various applications of emerging technologies through foresight and technology assessment tools.

The book provides a well-rounded perspective on various technical and prospective applications of emerging technologies and their impact on economic development. More importantly, it describes market opportunities for applications of emerging technologies through methodological approaches like 'foresight analysis', 'technology assessment' and 'integrated road mapping', etc. These methodological approaches are novel and enable taking into account the 'interdisciplinary' character of new technologies and map their evolution in a fast-paced technology environment. Following the introductory chapter, four substantive sections of the book examine technological emergence in leading industrial areas namely, 'materials & manufacturing', 'energy & transport', 'living systems & environment', and 'security'. The industrial areas are highly relevant in terms of their growing value as well as their role in supporting global sustainable development goals.

The individual chapters under each of this field present different scenarios for technological 'emergence' based on global and national macroeconomic trends and also present integrated roadmaps for further development of these technologies. The section on 'materials and manufacturing' includes chapters on applications of nanotechnology for industries like light-emitting diodes (LEDs), petroleum refining and carbon fibre materials. The foresight analysis of carbon fibre materials shows that the sector offers strong economic prospects from new products applications of carbon fibres. It also reveals that innovation in carbon fibres are likely to be more incremental than witnessing any radical technological breakthroughs, which reduces fundamental uncertainty regarding its applications and also making the market more general-purpose from its niche customer base.

A chapter by Roud, Sokolov and Meissner shows promising applications of nanotechnology for enhancing energy efficiency in high-tech industries like light-emitting diodes (LEDs) and innovative lighting solutions and shows high priority accorded by countries like Canada, USA, Japan, China, and European countries for developing products through nano-scale components. According to Meissner and Rudnik, nanotechnology has promising applications in the development of catalysts used in oil refining processes. Based on the integrated technology roadmap, authors underline that Russia has strong potential to emerge as an international technology development hub for the development of catalysts and to gain competitiveness in segments of petroleum industry supply-chains.

The chapters under the second section, i.e., 'energy and transport domains' discuss the emerging developments in renewable energy technologies, fuel cell electric vehicles (FCEVs) as well as in aircraft and shipping industries. A chapter by Ermolenko and Proskuryakova maps Russia's overall technical potential for substituting fossil fuels with clean energy sources and calls for boosting investments in renewable sector for substituting fossil fuel with clean energy sources. Following that, a chapter by Sokolov, Saritas, and Meissner finds that growing concerns over global warming and climate change is driving investments and policy support for the fuel cell electric vehicle (FCEV) industry. Based on the extant industrial dynamics, the chapter examines emerging technological trends in FCEVs and argues that strengthening technological capabilities to develop consumer-friendly products is critical to capture the market and gain a competitive advantage in the domain of FCEV. In a similar vein, a chapter on aircraft and shipbuilding industries outlines innovation priorities for developing future sustainable transportation technologies.

In the third section, 'living systems and environment' are the main topics of discussion. The chapter by Saritas and Vishnevski maps future nanotechnology-based solutions for water treatment and to increase the efficiency of traditional water purification processes. The authors present three important scenarios for the development of nanotechnology applications and argue for launching 'mission-mode' projects to develop large-scale water treatment and purification systems based on advances in nanotechnology. Similarly, in the area of food and agriculture, the chapter by Gokhberg et al., conducts comprehensive landscape mapping of the industry by combining traditional foresight analysis with big data.

The analysis reveals some of the emerging technological directions in agriculture and food (A&F) industry, where technology development through relevant STI policy interventions can bring valuable gains. The last chapter in this section by Saritas focuses on role emerging technologies in human enhancement. Currently, many emerging technologies are bringing about revolutionary changes in the working environment, and the impact of such technologies remain far from established. The chapter thus calls for conducting economic, social, and ethical investigations to assess the advantages and disadvantages of such technologies.

The last section of the book focuses on emerging technologies in the domain of security, a critical area of national and international policymaking. A chapter by Hauptman focuses on the so-called 'dark side' of various new technologies that are seen through instances or threats of widespread privacy or security breaches. Drawing on the analysis of two emerging technology projects from Europe, the author shows that 'dark-sides' can be potentially exploited by criminals or terrorists and adequate cybersecurity protection in emerging digital technologies are crucial availing long-term economic benefit from such innovations. The research has important ramifications for mapping security threats from emerging technologies and to safeguard vital security interests.

The chapter by Andrew James takes this analysis further by reflecting on changing conceptions of security in the aftermath of 9/11 terrorist attacks. Among the emerging meta trends on technological change in defence, the author argues that dual-use technologies have become the dominant feature of defence technology paradigm and that the defence agencies will play only a "declining" role as a sponsor and lead user of advanced technologies in the future. Lastly, the chapter on applications of Internet of Things (IoT) in the military by Burmaoglu, Saritas and Yalcin points to numerous opportunities and challenges of advancements in ICTs in defence. While the IoT has opened-up several operational advantages for the military, the increasing number of connections render military systems equally vulnerable to cybersecurity breaches. The study thus opens an important debate on technology 'choices' for IoT-based applications in defence and security domain.

All in all, the book presents a comprehensive picture of risks and opportunities associated with new technologies and presents an insightful discussion on the implications of new technologies for regional economic development. In the case of technological emergence and convergence, policymakers frequently confront the "investment in one region and impact in another" dilemma, which makes it challenging to justify public policy support for new developing new technologies. The book offers an important policy prescription, in this regard, including rethink and redesign of STI policy interventions to balance technological emergence with regional development.

The analysis is particularly relevant for latecomer countries where technological milieu is frequently characterised by a range of time, resource, and budgetary constraints, giving rise to extremely challenging conditions of technology development or adaptation. Although emerging technologies offer significant opportunities for LDC firms and governments, these countries frequently lack the necessary skills and competencies to undertake technology foresight from a wider socio-economic perspective. Such capacity deficits can be best overcome by forging institutional linkages under the framework of north-south or triangular cooperation. Similarly, science diplomacy can be an equally effective tool to undertake capacity building efforts through the exchange of experienced personnel and best practices between developed and developing countries.

The foresight training programmes offered in countries like Japan can also be useful for understanding advantages in regional value chains and to gain further advantages by harnessing emerging technologies. Such capabilities can go a long way in determining potential risks and opportunities associated with various emerging technologies, as shown in the book, but also to design STI policy interventions that are flexible in terms of outlining specifications and long-term technological deliverables. In sum, technology foresight and evaluations are valuable instruments for providing insights about critical technology areas and to bring coherence into STI policy mix in developing countries.

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Science Diplomacy Events

VAIBHAV (Vaishwik Bharatiya Vaigyanik) Summit

The global summit of overseas and resident Indian scientists and academicians was organised by a collaborative initiative of S&T and academic organisations of India from 2nd October to 31st October, 2020. The broad themes of the summit included, to bring Indian luminaries in academic institutes and R&D Organisations across the world, on a single platform to debate upon the collaboration mechanisms and methods to strengthen S&T base in India, with their counterparts working in India; to bring together varied experiences and proficiency of diverse academic cultures together to push forward the research outcomes; and to strengthen 'Aatma Nirbhar Bharat' initiative for High End Research in Science and Technology.

The summit was a month-long brainstorming of experts on the horizontals of each identified vertical. There were 18 broad areas (verticals) and several sub-verticals and deliberations on these verticals were held from 3rd Oct to 25th October, which were organized by the respective Champion Institutes (there were more than 70 champion institutes involved). These deliberations were aligned with national goals and priorities of research in India and its objective was to carve a path for future collaboration in the areas of interests. The discussions mainly focused on mechanisms for accomplishing various types of education, research and entrepreneurship aspects of the scientific tasks, generic policies and schemes for enabling the collaborations, specific areas of collaborations and alignment to global standards and best practices in the vertical research. Finally, the presentations by the Vertical Core Groups were made to the Advisory Committee chaired by Dr. V.K. Saraswat, Member, Niti Aayog and Prof. Vijay Raghavan, Principle Scientific Advisor to Government of India on the last three days of the summit.

PRABHASS (Pravasi Bharatiya Academic and Scientific Sampark)

Platform broadly encompasses the outcomes of VAIBHAV. The initiative aims to develop mechanisms for participation of Indian Diaspora working in top universities, R&D organizations across the world, to further enhance the knowledge-base of Indian Research and Academic Institutions. PRABHASS is being developed with collaborative effort of all major scientific ministers/departments and the Ministry of External Affairs of India. The Council of Scientific and Industrial Research (CSIR) initiated this effort to develop a database and a virtual platform to bring on board the global Indian S&T community to address the Indian societal challenges and problems. It has been linked to CSIR Societal Portal to capture common man's problem/ challenges listed therein.

This National Digital Platform will enable effective collaboration of Global Indian S&T Community for collectively promoting inclusive growth in India, strengthening Indian innovation ecosystem and contributing towards nation building. This platform is accessible to both Indian S&T experts and the Diaspora S&T experts and would enable the scientific Diaspora to collaborate with Indian scientists through discussion fora, R&D projects, trainings, webinars, fellowships, etc. and vice-versa to address the identified challenges and problems through S&T interventions.

The database provides information on Indian S&T landscape, R&D institutions, collaborative funding schemes, Diaspora specific schemes of Government of India, details of registered experts in India and abroad, modes of engagement, societal challenges/ solutions, collaborative R&D, lectures and webinars, trainings etc. Indian S&T experts in India and abroad are encouraged to register so that these experts can identify collaborative opportunities.

Making of Science Technology and Innovation Policy (STIP) 2020

The Office of the Principal Scientific Adviser to the Government of India and the Department of Science and Technology (DST) have jointly initiated a decentralized, bottom-up, and inclusive process for the formulation of a new national Science Technology and Innovation Policy (STIP) 2020. The process involves broad-based consultations with all stakeholders within and beyond the scientific ecosystem of the country which includes academia, industry, government, global partners, young scientists and technologists, civic bodies, and general public.

The process of formulating STIP 2020 is based on four interlinked tracks which reached out to around 40000 stakeholders for consultation in the policy formulation. Track I involves extensive public and expert consultation process through a dedicated platform for receiving inputs from the larger public and experts. Track II comprises expert-driven thematic consultations to feed informed recommendations based on scientific evidences into the policy process. Track III involves extensive consultations with ministries and states, for which nodal officers are being nominated in various states and in ministries, government departments and agencies for extensive intra-state and intra-department consultation. Lastly, track IV constitutes an apex level multi-stakeholder consultation at the national and global level which includes consultation with institutional leadership, industry bodies, global partners and inter-ministerial and inter-state consultations. Inputs from these wide-ranging consultations will finally lead to STIP 2020. A Secretariat with in-house policy knowledge and data support unit has been built with a cadre of DST-STI Policy fellows, set up at DST (Technology Bhavan) to coordinate the complete process and interplays between the four tracks.

The consultation processes on different tracks moved in parallel. The activities of Tracks I and II started off in May and June 2020. Track II started with a series of information sessions (26-30 May 2020) to the thematic group experts. The sessions were attended by around 130 members of the 21 thematic groups along with 25 Policy Research Fellows and scientists of DST and Office of PSA. The Track I was launched virtually on 12 June, 2020, by Professor K Vijay Raghavan, PSA to the Government of India and Professor Ashutosh Sharma, Secretary, DST. The Track II thematic group consultations took place in multiple rounds throughout the month of June, after which each thematic group submitted their recommendation to produce the pre-draft version of STIP 2020. The inputs obtained from Tracks I and III, and other sources were provided to the thematic groups at every stage so that they were considered in the drafting process. After incorporating all the inputs, a draft version 1 has been launched for larger public, expert, and apex-level multi stakeholder consultations and the post-draft consultations ran in parallel in all three tracks for about 30 days. Based on the feedback and consultation inputs the final draft version 2 has been formulated and has been put out for public feedback and comments on DST website on 31st December, 2020. After incorporating the feedback and necessary changes, the final draft version 3 will then be taken for cabinet and higher level approvals.

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CALL FOR PAPERS

SCIENCE DIPLOMACY REVIEW (SDR)
MARCH 2021 ISSUE
(Volume 3, No. 1)

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, 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 the forthcoming March 2021 SDR issue.

SDR is an open access journal published by 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 February 21, 2021 to **science.diplomacy@ris.org.in** with "SDR – March 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 percentages (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

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About FISD

As part of its ongoing research studies on Science &Technology and Innovation (STI), RIS together with the National Institute of Advanced Studies (NIAS), Bengaluru has endeavoured a major project for Science Diplomacy year, 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 for leveraging 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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Core IV-B, Fourth Floor, India Habitat Centre
Lodhi Road, New Delhi-110 003, India.
Ph. 91-11-24682177-80 Fax: 91-11-24682173-74-75
Email: dgoffice@ris.org.in Website: www.ris.org.in

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