Science and Technology Prowess: India's Foreign Policy Options

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Science is the basic knowledge of nature, and technology is the practical application of such knowledge. On the other hand, innovation is the adaptation of knowledge for practical purposes. The primary objective of governance in any country is national security and the quality of life of the people. And these have to be understood in the broader sense. Science and Technology (S&T) plays a vital role in both these areas through economic and military power and has disruptive effects. Somebody else can put your business out of profit, displace jobs, etc. So, the state structures need to respond to S&T advances. So, STI policy and practice are very important and state and local governments must all play a role in it. STI takes place in a national ecosystem with many players. This ecosystem interacts with similar ones across the world. So, the paper looks into it in more detail later. S&T has moved from small to larger institutions, like Madame Curie in a lab in a garage, to larger institutions and large budgets like NASA, Exxon, etc. Governments and businesses have increased funding for S&T and built institutions and put policies in place. Now S&T knowledge originates from human brains engaged in private and public sector entities. Human resources are an essential component of S&T and knowledge in general. There is a disruptive effect of technology that can change the balance of power and economic activities within countries, which can increase the inequalities and job displacements and losses.

In pursuit of economic and military power, some countries try to control who can get their technology. One of the ways it is done is through IPR, patent protection, and other mechanisms, particularly for sensitive technologies - missiles, nuclear and biological and there are denial regimes like MTCR, NSG and so on. There are informal regimes like countries that may have export control on technology-rich products. Currently, the US is trying to put together a technology control regime that will deny Russia the opportunity to access any kind of semiconductor-related technology. So, because of these, people and countries try to acquire technology by both overt and covert means; overt means officially and legally - you pay for royalties and license fees; covert means technological espionage, which China has been accused of doing. And where you can't get technology, indigenous development of technology is resorted to. This happened to India in the space sector and nuclear programme. Iran is doing this in their nuclear programme. So, policymakers and civil society face challenges with technology always. And this will happen in the future as technology advances.

Understanding Science Diplomacy

Like economic diplomacy, military diplomacy, or cultural diplomacy, science diplomacy also exists which was formally defined by the Royal Society and AAAS in 2010. But it has been in existence long before. It implies the integration of science and technology considerations into diplomatic frameworks and policies. It has gained importance because of the increasing importance of science and technology in international relations. As mentioned, it contributes to economic power and military power. There is a growing importance of knowledge-based activities for competitiveness and economic benefits among countries. This is the orthodox definition of science diplomacy by AAAS and the Royal Society (UK): science in diplomacy, diplomacy for science and science for diplomacy. But then this is not the only definition, and for the purposes of developing countries, this definition needs to be expanded. For example, it does not discuss the role of the diaspora. This is just a matter of historical interest. We can move beyond this definition to broader definitions. Science in diplomacy means advice of scientists which goes into diplomacy and foreign policy. This initially started with nuclear weapons because the diplomats needed to be briefed on nuclear issues by scientists to negotiate various things but is now expanded to various areas of science and technology. Here advanced countries have been the leaders, they have been setting the agenda to address many global challenges and developing countries are more or less reactors and followers of this. And they have faced problems in dealing with some of these scientific negotiations. If one wants to succeed in international negotiations where science is involved, policymakers and negotiators must have a certain idea about the science underlying these issues. Scientists must communicate their work in an intelligible way to stakeholders, and the public, scientific and foreign policy communities have to work together.

Improving the scientific capacities of delegations from developing countries is very important, especially in issues like climate change, health, safeguarding biodiversity, etc. Sometimes, developing countries are just faced with a solution from the advanced countries and find themselves at a disadvantage in analysing and reacting to the implications.
Foreign policy has also changed a lot. These are some of the areas of science and technology that have come into foreign policy and diplomacy, starting from nuclear technology, which was the earliest and space, and chemical weapons. These were old issues. The new issues have started to come up, especially after World War II. A whole lot of them have come up. There are also some key issues involved, which affect the fate of nations.

There are multiple dimensions for science diplomacy: comprising science in diplomacy, diplomacy for science and science for diplomacy. Science in diplomacy explains how science can provide advice, inform, and support foreign policy objectives. Diplomacy for Science can facilitate science and technology development through cooperation and negotiations. Here we use diplomatic engagements to acquire scientific knowledge for participating in large-scale science projects like CERN and others. The primary objective is to use diplomatic tools to build up science and technology capacity in whatever way possible. We also use diplomatic means to make available the science and technology capability to other developing countries. This is the South-South cooperation aspect. We do this because sometimes, we can derive benefits from such cooperation with developing countries: access to raw materials, genetic resources, and concrete economic benefits. In the case of vaccines and health products, we can benefit from such cooperation. So that is why India should cooperate with developing countries even though we don't necessarily get scientific knowledge from them. We should work with them, and their support is also important when dealing with advanced countries on scientific issues like climate change. So, this is an important aspect also. Another factor is strengthening science and technology capacity through diplomacy, meaning strengthening the whole technology ecosystem where human resources are significant. Training and research partnerships involving foreign and Indian universities and utilising the science and technology capacity of the Indian diaspora are very big assets that few other countries have and hence should utilise. Retaining science and technology human resource is a challenge. Many of our top science and technology graduates are looking at careers abroad, which are now acquired naturally. They want the best opportunities for themselves, look at ecosystems worldwide, and whichever ecosystem offers them the best chance, they will try to migrate there. So, our whole ecosystem has to be competitive in this respect. If we can achieve this, we will not only retain scientists and technologists within our own ecosystem. We will also be able to attract scientists from other ecosystems to come and work within our country. China is a good example of this practice. They were able to improve the ecosystem to such an extent that they could attract global talent. Canada is also trying to attract global talent. The US is now realising that it is important, and they have now relaxed visa requirements for people to work after graduation in the US. They may even do more things. All countries are seeking to attract S&T talent because they have realised the value of human resources.

Some of the larger projects are important for gaining frontier science knowledge. CERN's Large Hadron Collider, ITER Fusion Energy Research, LIGO, TMT, SKA are projects in which India is participating. India has not participated in programs like the Human Genome Project and International Space Station- we stayed out, and today we realise the missed opportunity. India launched the International Solar Alliance and the International Centre for Genetic Engineering and Biotechnology (ICGEB) and has put a lot of resources into both of these initiatives. These projects require detailed international negotiations, and to finalise agreements, diplomats and scientists must work closely to put together these projects and participate in them. It offers India the opportunity to get cutting-edge science with very little investment. While these large projects will grow as scientific advances expand more and more, the cost of experiments becomes much higher, much more than what an individual country can afford, so countries are coming together to launch these large projects. So, projects can be of a single facility like the CERN, a big human network type like the Human Genome Project, LIGO, or the International Space Station, which includes seven countries, including Russia; Americans have put together an ambitious project called Artemis through which they aim to establish a station half-way between the Earth and the Moon, from there they will go the Moon and establish permanent settlements on it. With the discovery of water on the Moon, the availability of hydrogen fuel is there for further sending rockets to Planet Mars, which is the next objective, gravity force of the Moon is much less, so much easier to launch interplanetary missions from the Moon to Mars. So, we can foresee in the decades ahead permanent settlements springing up on the Moon and eventually on Mars; wherever water is available, things can be done as hydrogen and oxygen can be generated. So, these are all visions of what can happen. If you go out of space and into the oceans, you can see similar projects coming up.

For India and developing countries, development is a significant factor. We must develop our economies, and national ecosystems and we have a long way to go before we catch up with the advanced countries. The development dimension is crucial, and STI can play an important role in helping us to achieve the 17 SDGs, which are the defined development targets by the UN system. All countries are supposed to achieve this target by 2030. We are now in 2022, eight years ahead. There are many gaps, and COVID has not helped us in this process. So, there is a technology mechanism set up under the UN that is supposed to facilitate the transfer of technology for development to meet the SDGs. Unfortunately, this technology transfer mechanism has not delivered good results. We need to work outside that and find our ways of doing this. NITI Aayog in India is the coordinating agency for SDGs. The developing countries need to share their experiences of adapting S&T for development- what we call frugal innovation. For instance, a bicycle ambulance is a bicycle with a platform attached to it which can be used in the rural areas where the roads are not good to carry patients. So, there are hundreds of these kinds of frugal innovations which the advanced countries are not interested in because they do not need any, but for us, this kind of low-cost innovation is extremely important. This is where our universities and youngsters can be very, very productive. When it comes to diplomacy for science in developing countries, in India S&T development for tackling Indian development challenges will be much more relevant, and there are many useful opportunities for other developing countries, and they can benefit from us. We provide training capacity and institutional building activities, and MoEA has a hi-tech programme under which they fund these projects. The role of the Indian mission is critical in identifying what can be done in each country and leveraging the impact on relations with those countries.

The S&T ecosystem consists of several components - the government S&T departments, state and local agencies, research institutions, and the academic institutions which do teaching and research work- in the private and public sectors. Then there are funding agencies and mechanisms providing funds for R&D, and there are regulatory agencies. For example, medical research has to be regulated, as well as the use of GM in agriculture. Then there is the IPR system, the patent system, and the agencies that commercialise science and technology like the incubators and the business community. It is very important as they are the ones who convert the knowledge into economic products. Civil society is the consumers; it includes people who react to new developments in unexpected ways. For example, if they are not well-informed about genetically modified foods, the reaction can be negative. Similarly, if they are not well-informed about certain kinds of gene therapies, their responses may be negative, and this may cause problems for the scientists. So social activists and consumers are also very important.

Measuring Technological Prowess

When you talk about technology prowess, three or four indicators measure these. The first indicator is how much you spent on R&D as a fraction of GDP (as a percentage of GDP). That is called GRD and research intensity. We should compare India with countries of somewhat comparable size and capacity. So, for us, we should look at how we compare with countries like the US, China and the European Union because these are large countries and in a sense that the size and population compares well with India. There is a possibility of adding Russia as it is also a big country, though the population is lower. Here if one looks at the R&D spending, we are at 0.7 per cent of the GDP. This has not changed much; in 2021, it is also about the same. It is well behind countries like the US, which is a huge economy but still, 2.8 per cent of a much larger economy means there are at least four times or 16 times India's contribution to R&D. China's contribution is 2.1 per cent; Israel and Korea are the leaders- 4.3 per cent and 4.2 respectively. We are far below these competitor countries in spending on R&D. The second indicator is the number of researchers per million population. So here in India, there were about 218 in 2015, which is still quite below China- 1200, below Brazil, Russia and South Africa. We don't have figures for the US. Our number of researchers per million population is low. This has an important bearing because unless you have researchers, even if you want more money on R&D, that money will not be spent. The research workers working in universities and labs and who put forward projects are where the money has to be spent. If you don't have enough, you won't be able to utilise it. (Suppose we are giving three times the amount i.e., 2.1 per cent for R&D, unless you have the human resources and the brains to utilise this money, then it won't be utilised.). If you look at our budget of the Department of Science and Technology, you will find that the budget estimate is A, but the actual expenditure is offered below that, it reflects the fact that you don't have to come forward and use that money even at this low level.

The third indicator is how the expenditure on R&D is coming. Is it mostly from the government, or is there a balance between government and non-governmental sectors? So here in India, the spending is heavily coming from the government- 45 per cent; state governments' contribution to higher education is very low; public sector industries and others, including state governments, come to around 38 per cent. So, we need to increase the spending on R&D by other institutions. Eight major scientific agencies dominate the R&D spending of the central government. Higher education sector participation in GERD in India is quite low. Many universities lag in R&D because, in most universities, the primary objective is teaching. The university's managers or funders do not often consider research a higher priority. So, research takes second place. This needs to be addressed, and the New Education Policy 2020 and the new draft STI policy can make a difference. For example, Universities like Kerala University can improve their R&D and performance; for that, they can look at models like Weizmann Institute in Israel, which they call a research university only for post-graduates. They go to the extent of even having an IPR cell. And the IPR cell is not just sitting there passively; it is proactive. They involve themselves in discussions about all research projects being put forward for funding, suggesting things that are likely to lead to commercialising results. So, universities with even a little imagination in India can bring to the fore talent available within our country.

TABLE 1. India- Central Government- Main S&T related Departments

Sl No	***Main S&T related Departments***
1	Department of Atomic Energy
2	Department of Space
3	Ministry of Environment, Forests and Climate Change
4	Ministry of Earth Sciences
5	Ministry of Electronics and IT
6	Department of Science and Technology
7	Department of Scientific and Industrial Research
8	Department of Biotechnology
9	Ministry of Human Resources Development
10	Defence Research and Development
11	Department of Agricultural Research and Education
12	Department of Health Research
13	Ministry of New and Renewable Energy

Source: 2020-21 budget. Total budget - Rs 3,042, 230 crores

India's Engagement with Countries in Science and Technology

The Department of Science and Technology is the highest agency within the Government of India and is responsible for overall cooperation with other countries. So, they have bilateral agreements which are very similar. The agreements basically have cost-sharing of activities, sharing of any IPR which comes out of joint research and some facilitation clauses, and they have joint committees which review the implementation of the agreement. They have a programme of cooperation for one or two years at a time, with specific activities and projects, listing of partners, and a system for project approval and monitoring. This is the basic structure. DST has such agreements with 83 countries. Unfortunately, only 44 of these are active. In 39 agreements, nothing has happened, which is a big disappointment. There are consistent attempts to work with DST to see how these can be activated. This is not the whole story. Bilateral agreements in science and technology are also entered into by other agencies like the Department of Atomic Energy- they have agreements with 13 countries. The Department of Space has agreements with 36 countries- foreign entities and governments. So now we find that the overall coordination within the Government of India is lacking. DST does its things; so, do the DEA and DoS. Now, if one looks at MEITY- they also have agreements with foreign countries. So, this is a problem for our science diplomacy. How do we coordinate what different agencies in India are doing with other countries? When we are dealing with a country like China, for example, DST does not have any agreement. But they have an agreement with Taiwan. On the other hand, if you look at DoS, they have many agreements with China. If you are dealing with somebody like China, you need to have good coordination within your system. For that, firstly, you can explore synergies and ensure that you carry the same message forward.

Now let's look at our overseas network for science and technology cooperation. At present, we have 4 posts of science counsellors located in Washington, Moscow, Berlin and Tokyo. They are people whom DST selects on deputation for 3-year assignments. The process for the selection of these science counsellors is limited to government institutions, not private. So, what happens is that they issue calls for applications and get applications and then screen them. So, for a three-year term, they work as science counsellors. There is not much of a pre-assignment training programme about what they should be doing, how they should do it and so on. Usually, when they return to wherever they were deputed, there is no system of getting in touch with them or using their experience for future activities. So, this is something that we faced when we tried to organise a conference of science counsellors- past and present, and we found that the ministry concerned, DST, did not even have a proper list of those who had been science counsellors in various countries. We did some work, got hold and made a proper list, and held consultations with them. In addition to what comes out of DST, DAE has its scientific officers in Paris, Vienna and Moscow. ISRO has also got its people in Paris and Washington. DRDO has one in Washington. I think there is one more in London (not sure).

Again, many agencies are sending people abroad to work on S&T cooperation. This raises questions: can the science council or scientific officers not be sent abroad, and can he/she not work for the whole of India in promoting S&T cooperation rather than work for only his department? Even though her/his department is funding it, why he/she cannot work for the whole government S&T system? It is something like the MEA is funding officers abroad, but they do the work for the whole of India. They work for the Commerce Ministry, the Ministry of Culture, the whole government and even outside the government. So, this is the issue which needs to be addressed. Now where no scientific officers are posted abroad, the work for the rest of the countries is done from India. And mostly, it is event-driven, visits of prime ministers or presidents; when they prepare the agreement, they look at this, the idea emerges and consequently decide to sign this agreement; finally, during the visit, that is done. There are 39 cases where agreements were signed, and nothing has happened, so some of these fall into this category. In many other countries, S&T technology-related work is handled by IFS officers who are also doing economic, commercial work, education, and cultural-related work. And the initiative is largely left to the head of the mission. It depends on how much interest they take because there is not very little demand coming from New Delhi about what should be done in the S&T field.

Recently, PM has instructed that our missions abroad should work on three Ts: trade, technology, and tourism. And this message has been communicated by foreign secretary to Ambassadors all over the world. So, the emphasis on activating work on technology is welcome. When they say technology, there is a risk that they may be looking at countries from where we can get technology. We should not just look at that. We should have a broader vision. There is also no Science Attaché or Science officers in some important countries like China, Israel, the UK, Belgium, Korea etc. China is the number two world spender on R&D and is close to catching up and overtaking the US in science and technology. We do not have Science Attaché there, which raises the question of who keeps us informed about what China is doing in S&T and who is there to maintain contacts with Chinese S&T institutions. This is not to forget the fact that there are tensions with China; it is a country with which we have problems. But certainly, we should keep track of what the Chinese are doing and linkages within the S&T establishments of China. We have a much smaller network than countries like the US, France, Japan, the UK, Russia, etc. Therefore, we need to enhance our capability at the country level S&T either by having more science counsellors or by using our existing embassies and staff proactively. So, all these will hopefully come out of the new STIP policy at the draft stage. It will be announced at a suitable occasion very soon, and we look forward to it.

There are different models of how to carry out S&T diplomacy abroad, you have them in the embassies, but you could have an independent network like the UK. France also has departments in the embassies, and they follow a system similar to ours. The US has both types of systems- science officers as well as their own diplomats. Germany lets every agency in their country establish networks abroad. So, what you find in a country like India is that several German agencies are operating offices in India. And Russia has recently proposed an interesting idea of having a digital attache which is specialised in digital ICT cooperation in 16 countries. India is one of them that they are planning to have. All kinds of different types of networks are there, science ambassadors in Silicon Valley and some Scandinavian countries and so on.

Alternative Models for Science Attaché Networks in India

We can train our IFS officers to carry out SAs role together with economic work, with specific guidelines (the US model) and instructions from headquarters. We can have more posts for science counsellors. India has limitations in personnel and resources. Then we could set up joint agencies with countries. India has institutions several in France, and Germany; there is an Indo-France Cooperation Agency in S&T, along with Germany and the US. We can use specialists at home and specific research projects on particular topics like the US does. Or we can have a network of S&T cooperation with officers in various places- the UK, Switzerland and Netherlands- which will be very expensive for us, and no other private agency in India would afford this.

As far as what Indian diplomacy should do, we need to have full-time Science Attaches abroad. And we must have more of our officers being told to do science and technology work as part of their normal duties. They must be given guidelines, trained and given instructions like the Ministry of Commerce give to Commercial officers for commercial representatives. This comprises clear guidelines of what the commercial officers are expected to do. We have to follow a similar approach in the STI. Within India, many important ministries do not have scientific advisors. We have PM's Principal Scientific Adviser to the Government of India, Prof K Vijayaraghavan. But unlike the US and the UK, which have science officers or science advisors in many ministries, India does not have science advisors in some ministries like the Ministry of Environment, Climate change or higher education. This is something we need to look at. Then the objectives at the country and regional level have to be defined by Foreign Ministries in consultation with S&T institutions. What do you want to do in each country or region? They must be clear about that in consultation with your ecosystem and participants. Then officers and instructions to missions abroad must be given a briefing, periodic reporting system of what is happening in the target country STI and what are the new projects or new agreements they have signed with other countries, information about what is the latest technology coming out of the labs must be reported periodically to India. The next step would be building contacts with local S&T institutions, labs, heads of labs, and heads of research agencies, basically building contacts with the local S&T ecosystem, facilitating cooperation with home country institutions, and participating in large science projects. When these large science projects are at the discussions stage, we should get involved in the discussion, play our role in it, bring our own perspectives there and then engage in them early. Then stronger coordination of external engagement in STI within MEA, we need to have a more focused unit to deal with STI cooperation.

Science for Diplomacy

The whole approach of science for diplomacy is how science can be used to improve relations among countries. There are examples listed here. Scientists can help interact with each other, help build confidence and provide channels for communication. Scientific cooperation in dealing with common problems like health and the environment can strengthen relations with neighbouring countries. For example, in South Asia, challenges of air pollution, disease control, water management, and energy networks. These are all potential areas where cooperation among South countries including Pakistan can be promoted. So, it is similar to cultural and sports diplomacy. We have a lot of sports interaction and cultural interaction with our neighbouring countries. Science is a similar area we can exploit for dealing with common problems. These are examples of what happened in Science for Diplomacy in other countries to improve relations: Science Cooperation agreements between the US and the USSR, the US and China in the 1970s and 1980s, and the US and Cuba since 1997. The creation of new institutions like CERN (Geneva, with 20 states), ITER, and the International Space Station (ISS) with five space agencies are important initiatives within science for diplomacy. Other prominent examples are SESAME (located in Jordan with eight members including Israel and ME states and 17 observer states). Iran Nuclear Agreement (P5+1 and Iran) and Arctic Science Agreement, 2017 are also significant.

During the Covid period of two years, there were a lot of disruptions and loss of life. Nonetheless, there were many areas where India came to the forefront. In the WHO, India was on the executive board- chairperson of the executive board. So, we were engaged in the whole discussion about how to improve WHO's response to pandemics. Discussions on how to strengthen WHO's funding and the international health regulations were held. India has made a big contribution to the global supply of vaccines and internally administered vaccines to its population. We also worked in protective equipment, diagnostics, therapeutics, and international support when we had oxygen availability in our hospitals. We have launched with South Africa a proposal for temporary suspension of IPRs on Covid products. It has not been agreed upon, but it has brought the subject to discussion. India used ICT tools effectively for contract tracing and management- a very useful tool, and many have shown interest in that. The Covid has demonstrated the weakness of all countries' public health infrastructure and public health systems. The weaknesses have been starkly exposed. So, we need to work to improve our public health infrastructure to deal with future outbreaks.

Major Areas of Science Diplomacy

Nuclear technology is one area where we face diplomacy and foreign policy challenges. This is mainly because we wanted to have our own nuclear capacity- military as well as civil. India stood up to the pressures to join the unequal and unfair Non-Proliferation Treaty (NPT) and built our own Nuclear Civil Programme in the face of sanctions which now have been lifted, fortunately. We are now recognised as a responsible nuclear power outside the NPT. So, we will have to continue to work on nuclear issues at the global level because the very nature of our programme is such. In the case of climate change and energy, no solution is possible without India; so, the world cannot work out the solution because India's size of economic growth is such and similarly to China. The main challenge is how to maintain our economic development in the face of pressure to reduce Green House Gases (GHGs). Now we know that this is very unjust; advanced countries have had plenty of GHGs emitted for over 200 years and reached the development stage that they deny to the developing countries. So, we want to develop, but we need to minimise GHG emissions to the minimum extent for which we require technology and finance from other countries. There is some possibility of new technology, Carbon Capture Utilisation and Storage Technology. This negative emission technology will remove greenhouse gases from the atmosphere. There is a good possibility that commercial and viable solutions to this technology will emerge, which will relieve the pressure on the planet to reduce emissions. It does not mean that we should go on emitting. We should minimise emissions, but if we can remove some of the existing emissions, that will improve planetary health.

Climate change discussions have brought civil society and subnational entities involved. Because even when the US withdrew, California and New York, which are as big as several other countries, said they would follow the Paris Agreement. There is a concern that came out in Poland, a coal-producing country, about a just transition. What about countries that depend on coal and oil for their economy? Therefore, the transition must be fair. But how is it going to be fair? So, India is doing its share. We have targets for renewable energy, and we have announced the pecking of emission targets. But other countries also need to be pushed to do more. To mention some of the initiatives India has launched: International Centre for Genetic Engineering and Biotechnology located in New Delhi, which was established in 1983 under UNIDO, became an independent international NGO in 1994 and currently has 65 member states. But this has been plagued by a lack of support from developed and advanced countries like the US. They said they do not need an international mechanism for developing countries to access technology. They further push the developing countries to go to big pharmaceutical companies and others for technology. So, they stayed out of it and did not support it. This has brought weakness to it but continues to function and provide access to biotechnology for researchers from developing countries. International Solar Alliance, launched in 2015, has done so well so far. The Charter Amendment opened it up to all countries. Germany, Italy, and the US have agreed to join it, which is a huge achievement. China remains out of it but hopefully will join the ISA. It tries to mobilise all the resources for solar energy projects, and it partners with World Bank and other financial institutions, industry, etc. One of the projects which were recently approved by ISA was the project given to NTPC to develop 900 MW of solar power in Cuba. The financing comes from ISA, but the programme will be implemented by NTPC. So, there are benefits to us from this.

Another sector where India has a lot of stakes is the ICT sector. ICT has been recognised as one of the leading players, especially in the software industry and this is where India's human resources come to play. So, there are issues here. Who will govern cyberspace? Who will set the rules? Who will say this is a crime or not a crime? How will you proceed against people who violate cyber norms like terrorists, and cybercriminals? There is a new type of cyber warfare; command created by the US, unlike the conventional warfare where the Geneva convention was there which says you cannot attack civilian entities. In cyber warfare, we need to have some rules to say what is not allowed. For example, you cannot attack hospitals and services which will directly affect the civilian population including hospitals, and utilities. So, we need to work out some new regimes for this. So, these are all issues which are involved in cyberspace. Lifesciences have also become a significant point after it was discovered that DNA is the basis of life, can now change it, bring in elements of DNA from other species, transgenic artificial and synthetic genes. So, there is a host of issues coming out. Can you patent the gene as the gene is found in nature and no one invented it? Likewise, is it possible to patent Neem or Turmeric? These are some pertinent questions. It has a great potential impact on health, agriculture, environment and industry as well. However, concerns about how to handle the potentially harmful effects of biotechnology, especially by non-state actors have to be raised. Also, the pandemic of Covid has shown how a tiny virus can really bring even a big country like the US to its knees. This idea is certainly not lost on people who are bent on committing acts of terrorism against countries and they have understood it. Even with a garage-sized lab, you can modify viruses and genes and create new lives and forms. You can imagine what if a terrorist outfit with significant financial resources can manage to set up a lab and modify a pathogen, multiply and disperse it. So, we now need to look at the biological weapon convention, which has nothing on verification. We have to strengthen it to deal with such kinds of threats. Then there are ethical issues. You can modify through gene therapy, modify a human embryo, and have new technology for human reproduction, which raises many ethical issues that need to be handled. For example, can you go to a lab, say I want a child, and he/she should be 6 feet 5 inches tall. They do a genetic modification for that purpose. Should that be allowed? Somebody says they have thalassemia and want to make sure my children do not have it. Can you modify the embryo? That sounds more reasonable.

Seventy-one per cent of the Earth's surface is the oceans; life on earth originated from the oceans and came on to land. So, oceans are the mother of life. But we do not look at it like that. We dump everything in it; we fish and take whatever we want from it. We fight over and say that this part of the ocean is ours, we mine the seabed. We take out oil and gas and dump them in the sea. Tankers wash their tanks in the sea. Due to these activities apart from others, the oceans are in a bad state. We need to fix this. So, around India, there are two ocean spaces where we are supposed to be the leaders of the Arabian Sea and the Bay of Bengal, the two large marine ecosystems around us. Global Environment Facility (GEF) classifies them as high risk. These two high-risk marine ecosystems need to be handled by the Coastal states working together. At the same time, India has problems with Pakistan, which is also a coastal state with whom we have a problem in the Arabian Sea? So theoretically, unlike in other large marine ecosystems, say the Gulf of Guinea, where the countries concerned are working together, in the Arabian Sea, India, Pakistan and some of the Arabian countries have to deal with the problem. Bay of Bengal- India, Bangladesh and others have to work. Things are a little bit better there. But there is no machinery to deal with this, unlike some other ecosystems. The Indian Prime Minister remarked at the Indian Ocean Summit that India would join the 27 other countries pushing for more ambitious treaty negotiations. The UN Biodiversity beyond National Jurisdiction treaty. The treaty negotiations will start in March- it concerns 70 per cent of the Earth's surface. Public awareness of this is minimal; hardly anyone is writing or talking about it. It involves the livelihood of fishers, especially in coastal states like Kerala. Certainly, they'd have a high stake in this.

Then another important area is space. Now satellite platforms can be used for all kinds of purposes, militarisation of space is taking place, weaponisation of space, and now there is a negotiation going on about ASAT between three countries, and India is now the fourth country that tested ASAT. There is a large problem of space debris, especially in the Low Earth Orbit and there is a possibility of an accident at any time with a space station colliding with a big debris object. There are solutions which humankind wants to set up human habitats on the Moon and Mars. Here the main issue is concerning mineral extraction and its ownership rights. Theoretically, under the UN Convention, it belongs to the whole of humankind. However, under the Trump administration, the US said they would follow a finders-keepers policy; whoever finds something in outer space becomes the owner of the same. Therefore, we have problems ahead. Now we have hypersonic weapons which fly in the regime of 30 to 100 kilometres high. Now, outer space means conventionally beyond 100 kilometres and below that it should be the airspace of that country concerned. But conventional airspace agreements do not mention the zone between 30 and 100 km. This part around the earth is a grey area. We have to define the rules about that, and one needs permission to overfly. Even if there is a requirement, hypersonic weapons cannot be used. So consequently, those who have hypersonic weapons will argue for no regulations between the 30 and 100 km zone. So, this is an attractive new area which is coming up.

There are also numerous other issues. A fundamental question is how India engages with the diaspora, especially scientists and technology experts. India has a good reservoir of scientists and technology experts abroad. They create new knowledge and startups; creating prosperity in their host country. This diaspora can engage with India's ecosystem to be a potent asset. Whatever we do, the central, state and local universities and businesses must do their part to benefit from the Indian diaspora abroad. For this, India needs flexible policies which can allow these groups to engage in the development process without being physically available. For this, the processes need to be simplified and avoid bureaucratic delays. For example, if you want to bring someone as a visiting professor to a university, numerous procedures and steps are involved. All of these should be made as simple as possible. In this manner, institutions can provide opportunities for widened engagement with the Indian scientific diaspora. Secondly, there is a need to harness alumni connections, most of our alumni, for instance, a significant number of IIT alumni, are working abroad. They have a strong desire to help their mother institutions and their country. There are already some Indian government policies like the CSIR- Prabhas initiative and fellowships. The New Education Policy will now provide greater opportunities for the diaspora to work with Indian universities and Indian Universities to work together with foreign universities. The new STIP policy when announced will also provide new and similar opportunities.