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"Changing dynamics of Indian Foreign Policy – the Science and Technology Dimension"

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Thank you very much. It is really an honour to be here to speak to a distinguished academic community like the Central University of Punjab. This is part of the outreach program of the Ministry of External Affairs which is keen to interact with the youth of the country at the universities as well as in the schools. Our diplomats therefore give lectures on topics of current interest across the country. So I am very glad to be here as part of that programme.

Today I am going to talk about the Science and Technology part of India's foreign policy and in general .So let me start with some basic concepts. As some of you know science is the basic knowledge of nature and Technology is the practical application of that knowledge. This is sometimes not so clear. For example we knew that penicillin works against bacteria but not why. At each level of understanding new science opens up and there is new technology to be applied. Another concept is Governance. The goal of governance in any country is firstly national security and secondly a better quality of life for all its people. Now Science and Technology has a very strong impact not only on society but also on the international system. We can see many examples of this such as mobile phones and smartphones. In the international system countries which discover and use new science and technology gain an advantage - both economic and military. Because of this all governments must deal with science and technology in an appropriate manner.

Science research has moved away from small laboratories and individual researchers such as Madame Curie who worked alone in a garage sized lab processing one ton of pitchblende and extracting radium. Today, scientific research is a much larger scale operation involving large budgets, and many researches and facilities which might be spread across several countries..Governments have been funding Science and Technology research and building large facilities for this purpose and have put in place policies designed to stimulate and support scientific research .Science and Technology has a disruptive effect it can change the balance of power among States as well as increasing inequality within States. Persons who can take advantage of Science and Technology will prosper while those who cannot will be left behind..

In the pursuit of economic and military power countries try to control science and technology knowledge and prevent it from going to rivals. Various technology control regimes have come into being and there is a system of intellectual property rights which also controls access to technology and enables profits to be made from access to technology. There are cases of technology denial to certain countries and India itself has been a victim of denial of nuclear technology .In response, countries which are denied access to technology will seek to develop it indigenously or acquire it by open or covert means. Today the main issue between the US and China is about illegal and clandestine acquisition of technology. Denial of nuclear technology resulted in countries such as India, Iran, North Korea, making indigenous efforts to acquire this technology, or to acquire clandestinely as in the case of Pakistan. As new technology comes into the world policymakers and civil society will continue to face challenges.

Science diplomacy is a term which has been coined about 10 years ago. It is analogous to economic diplomacy, cultural diplomacy, or sports diplomacy. There have been efforts to define this concept - for example by the Royal Society of U.K. One popular way of looking at science diplomacy is to regard it as composed of three components - science in diplomacy, diplomacy for science, and science for diplomacy. Science in diplomacy means the scientific inputs going into diplomacy and foreign policy making. Diplomacy for science means making use of diplomacy to gain benefits in science and technology - bilaterally as well as multilaterally and globally. Science for diplomacy means using science and technology collaboration to bring countries which have differences together. Another way of looking at science diplomacy is based on intentions - advocacy, promotion, and influence. Another approach is based on geographical scope - domestic, transborder, and global. A good working definition for our purpose would be the integration of science and technology into the diplomatic and foreign policy framework. This concept recognises that science and technology are becoming increasingly important in international relations and also in determining global competitiveness, where the role of knowledge based industries is becoming increasingly critical.

Let us consider the first aspect - science in diplomacy. Increasingly, global challenges such as weapons of mass destruction, climate change, cyber security, human health, energy and environment, outer space, etc. all require scientific inputs in order to understand and deal with them. These challenges are trans-border and require application of Science and Technology in order to resolve them in addition to normal diplomatic efforts. This requires that science and technology experts must have a good dialogue with policymakers so that the latter are well informed about the scientific aspects of the global challenges and the former also appreciate the diplomatic challenges involved. Many advanced countries have long recognise this and have integrated science and technology experts into their policymaking bodies. The challenge is that policymakers must understand the basic science underlying global challenges and the scientific community must be able to explain in plain and simple terms the scientific issues involved. Therefore close co-ordination between the scientific community and policymakers is extremely important. Developing countries in particular face severe challenges in this respect and often their delegations are not well prepared at international conferences. This results in the advanced countries taking the initiative while developing countries are sometimes not prepared to defend their interests.

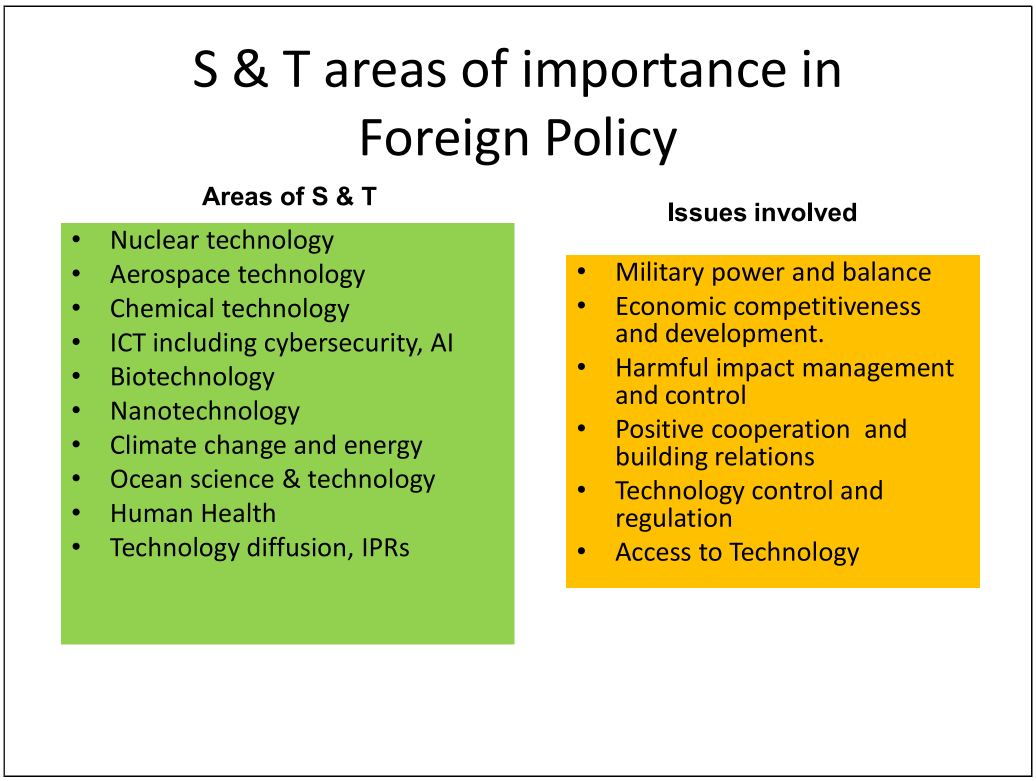

Figure 1

Figure 1 indicates the various subject areas in Science and technology which have arisen in international discussions and also the issues and interactions which are involved. Basically governments react late to the emergence of new technology usually only after some negative or harmful effects for example on employment, environment, etc. begin to appear. This happens long after the technology and knowledge has spread from the scientists into the economy and life of the country..

Diplomacy for science is quite similar in many respects to economic diplomacy where we try to expand our exports and increase inward investment. Diplomacy for science seeks to acquire science and technology knowledge to strengthen national economy and capacity and to participate more effectively in international discussions where science and technology are involved. External collaboration in science and technology especially with advanced countries and engaging in large International scientific projects therefore becomes important. Also using our own science and technology capacity and knowledge to support other developing countries and in general to achieve the sustainable development goals is also important.

Mega or large-scale International science projects are a good opportunity to participate in frontier scientific research with comparatively lower cost. Science research is increasingly becoming more expensive and beyond the means of individual countries, even the large economies like the US. International scientific collaboration is growing and more and more projects are coming up in this sector. India has participated in projects such as CERN, ITER, Thirty metre telescope , square kilometre array, and LIGO. We missed the opportunity to participate in the Human Genome Project and the International Space Station. Now that India has given manned space exploration some priority it is possible that we may participate in large-scale international projects involving manned space flight.

Some international projects where India has taken the initiative are the International solar Alliance (ISA) launched in 2015 with France as main partner, and the ICGEB which was launched in 1983 together with Italy. The ICGEB was intended to help developing countries to gain access to the newly emerging field of genetic engineering and biotechnology and to apply it to problems faced by them. The ISA is a global platform that seeks to bring together and mobilise technology and finance to implement solar energy ;projects in member states.

Large-scale international projects and activities in science and technology required detailed negotiations to reach agreement and implement them. Diplomats and scientists need to work closely together in this process. Significant benefits can accrue through participation in such projects. For example India's participation in CERN is on a win-win basis where India supply components and equipment, the value of which then finances Indian researchers who work at CERN. As we go deeper and deeper into the frontiers of science, the cost of doing research and setting up facilities becomes higher and higher. It may be beyond the ability of single country to finance this research. For example the US which had embarked on a large particle accelerator project in Texas had to abandon it because of the high cost after which CERN became the leading laboratory in this field. Now China is also trying to build a large accelerator by 2022 and it remains to be seen whether they will be able to build it. So in the future we expect more and more large scale international science projects which will be multinational in character. Such large projects could be of two types - a single large facility like CERN; or a network of a large number of institutions dispersed around the world as the case with LIGO. Even in the case of CERN, the data generated from experiments is shared through a world wide network (CERN had invented the world wide web) of collaborating Institutions across the world who carry out analysis and research on the data. I am sure that in the future, institutions like yours will be able to participate in such large scale international science projects by collaborating with research groups.

Another important area of diplomacy for science is the focus on development particularly sustainable development. Science and technology for development is critical .Development has to be seen in its widest context. The international community has agreed in 2015 upon a set of 17 Sustainable Development Goals (SDGs) which all countries have undertaken to achieve by 2030.To support this effort the UN and member states have established a Technology Facilitation Mechanism(TFM). This mechanism is intended to enable developing countries to access the technology which is required to achieve the SDGs. Given that the SDGs cover subjects which cut across several Ministries and also the States of the union in India, Niti Aayog has been designated as the nodal coordinating agency for implementing the SDGs. For developing countries it is very important to share the technology which they have used or developed for achieving the SDGs .So South South cooperation in this area is very important. Developing countries have come up with innovations which are very cost effective and relevant to their needs. For example a bicycle ambulance has been developed for rural areas to transport patients across rural roads. Such frugal innovation needs to be promoted and supported.

The SDGs were adopted in 2015 and today we are five years down the road. Every year a Sustainable Development Report is published which ranks the performance of countries according to the SDG targets. Figure 2 shows the performance and ranking of some countries in this respect. The top ranking has been secured by Denmark in 2019 while India's rank is 115. In Asia, Japan is ranked highest at 15. In South Asia, Maldives, Bhutan, and Sri Lanka have done quite well. In South Asia and in Sub-Saharan Africa performance in achieving SDG especially of the larger countries needs to be improved considerably.

SDG Performance Index and Global Ranking, 2019

Denmark	85.2	1	N Zealand	79.5	11	Iran	70.5	58
Sweden	85.0	2	Chile	75.6	31	Turkey	68.5	79
Finland	82.8	3	Thailand	73.0	40	Bhutan	67.6	84
France	81.5	4	Maldives	72.1	47	Saudi Arabia	64.8	98
Germany	81.1	6	Algeria	71.1	53	Indonesia	64.2	102
Norway	80.7	8	Vietnam	71.1	54	Nepal	63.9	103
UK	79.4	13	Russia	70.9	55	South Africa	61.5	113
Japan	78.9	15	Brazil	70.6	57	India	61.1	115
RO Korea	78.3	18	Mexico	68.5	78	Bangladesh	60.9	116
USA	74.5	35	Sri Lanka	65.8	93	Pakistan	55.6	150
China	73.2	39	Egypt	66.2	92	Afghanistan	49.6	153
Cuba	70.8	56	Myanmar	62.2	110	Nigeria	46.4	159

In South Asia, Sub Saharan Africa, countries with large populations are at the bottom of the rankings. China has improved its ranking considerably. [Source: http://www.sdgindex.org]

Figure 2

Science and Technology Solutions developed in India for tackling development challenges can be very useful for other developing countries because the conditions in many developing countries are similar to that found in India. In fact the development challenges which can be found anywhere are also present in India. So India has a huge repository of experience in tackling development challenges and in using science and technology which could be very useful for other developing countries. Therefore the Government of India has an Indian technical and economic cooperation programme (ITEC) through which India provides capacity building assistance and training tor personnel from other developing countries. Indian Missions abroad play a vital role in this programme.

Science and technology does not function in a vacuum. It is part of the larger ecosystem of the country .Human resources or brain power is the most important element of this ecosystem. The other elements of the ecosystem include academic and research institutions, funding agencies, IPR and ,commercializing agencies, regulatory frameworks, business and civil society. In many developing countries the S and T ecosystem has deficits especially in terms of capacity of academic and research Institutions and funding for research. This results in the so-called brain drain or migration of skilled science and technology personnel to advanced countries with more favourable ecosystems. The diasporas from developing countries contain substantial science and technology personnel working in advanced countries whose involvement in strengthening the capacity of the home country could be beneficial. Many countries have developed innovative programs to attract their diaspora science and technology personnel to engage with their home country. India has a very large diaspora with large numbers of science and technology personnel working in the advanced countries and this constitutes an important resource.

Retaining highly skilled science and technology personnel is also a challenge. In a competitive world, policies need to be flexible, realistic, and responsive to the particular needs of skilled science and technology workers. Adequate facilities, infrastructure and funding is also important. There is a global competition for attracting the best science and technology talent and academic and research Institutions must face this challenge. India has very good science and technology graduates coming out of institutions but because they do not find enough opportunities to work within the country they leave the profession or migrate to a country which has a better ecosystem. Apart from the US which attracts a lot of foreign science and technology talent, other countries such as Canada, European Union and China are also seeking to attract foreign science and technology talent.

Commercialization of research outputs is particularly important. For this reason many Universities and research institutions have associated business incubators and mechanism to facilitate start-ups. In India academic research Institutions do produce high quality S and T talent .However the lack of sufficient capacity with research institutions and limited funding of research, as well as the limited development of commercializing agencies is a weakness. As a result of these deficits in our ecosystem India faces the problem of the so called brain drain where the best of a S&T talent migrates to advanced countries in search of better opportunities. India therefore has to strengthen and build sufficient capacity in its S & T ecosystem so that S & T talent can find adequate opportunities with to work in India.

Figure 3 presents some data on India's S & T ecosystem. Gross expenditure on R and D (GERD) is around 0.7 % of GDP which is well below many other countries. UNESCO has suggested a benchmark of 2% of GDP for GERD. This is what we should aim at. The number of researchers per million of population in our case is fairly low. The share of the private sector and academic institutions in research and development expenditure is around 40% which is quite low compared with some of the advanced countries where it is around

60%. Unfortunately many of our academic Institutions and Universities, though producing high quality S&T talent do not have sufficient R&D activity. This will need to be corrected in future.

India S & T ecosystem data

- India's total spending on R & D was 0.7 % of GDP (2016-17), much below that in major nations such as the US (2.8), China (2.1), Israel (4.3) and Korea (4.2).
- The number of researchers per million population in India was 218 in 2015 , well below that of China (1200), Brazil (884), Russia (3000), and South Africa (473).
- Gross Expenditure on R&D (GERD) - Central Government 45.1%, State Governments 7.4%, Higher Education 3.9% and Public Sector Industries 5.5%, Private Sector Industries contributing 38.1%.
- The R & D spending of central government agencies is dominated by 8 major scientific agencies.
- Higher Education Sector participation in GERD by India is quite low. Many Universities lag in R&D.

Figure 3

The R&D expenditure in the government sector in India (see Figure 4) is dominated by 8 science departments. The biggest share of expenditure is by three departments DAE, DOS, and DRDO which undertake both civilian and defence related research and development. There are 5 other science departments whose expenditure is relatively lower. There are also a number of other Ministries which are not regarded as scientific Ministries but which do play important role in R and D. This is a rough picture of the government sector R & D activity.

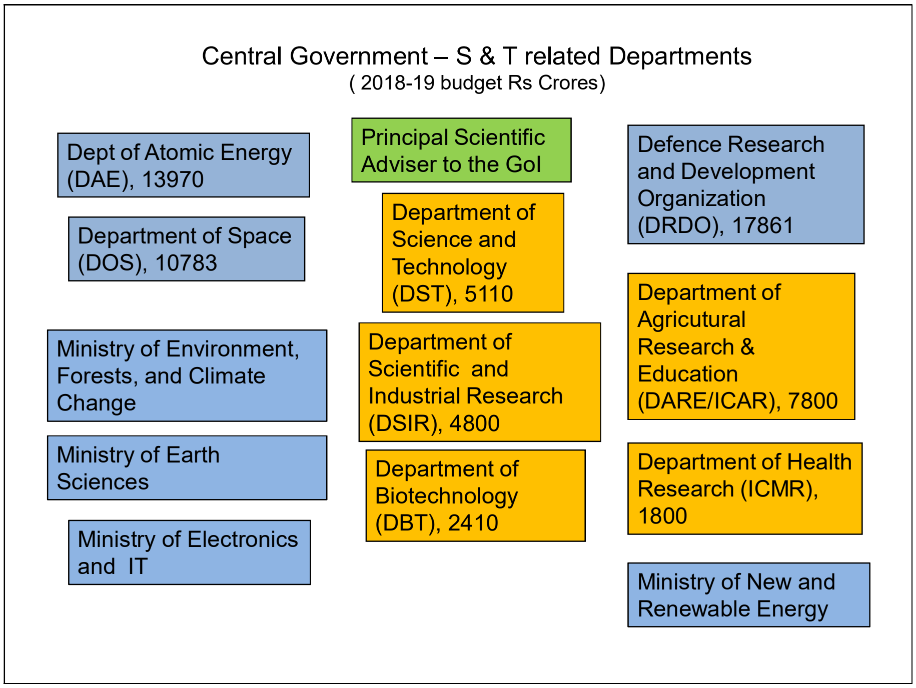

Figure 4

It is interesting to look at the large research centres which are being setup in talent rich countries like Israel and India by multinationals such as GE, Microsoft etc. and to examine how they interact with the host economy. Figure 5 depicts this in a simplified form. An advanced economy with a sophisticated ecosystem develops linkages with ecosystems of countries such as India and Israel in order to benefit from the human S & T talent present within the latter. There are basically two modes of interaction. The first involves the recruitment of S&T talent from the less advanced country to work in R&D institutions in the more advanced country. This mode is important where the physical proximity to R&D facilities and infrastructure in the advanced country is essential. The second mode involves the setting up of research centres in the less advanced country where talented S&T professionals can be hired to work and generate knowledge. This mode is more cost effective where large R and D physical facilities are not required, for example in software and information technology products. In both these modes the fruits of R&D are largely captured by the advanced economy through their institutions and enterprises. They are able to exploit the generated knowledge and commercialize it in the larger and global markets. A small part of the benefits of this of these modes of R&D activity may be shared with the less advanced economy. We must regard this as a normal and inevitable phenomenon but be aware of its consequences and negotiate the best outcomes possible.

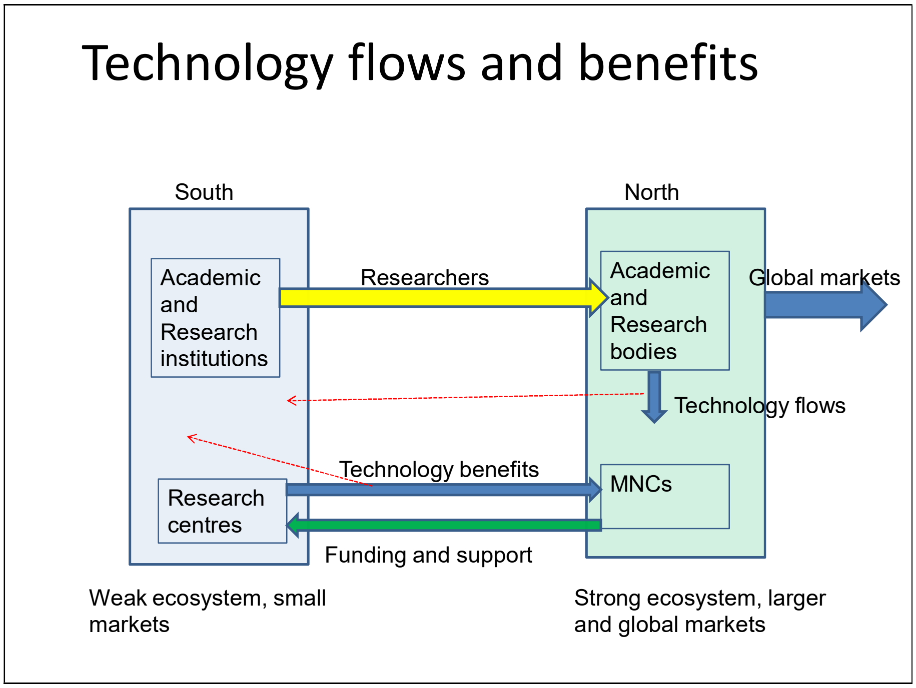

Figure 5

Let us examine our bilateral cooperation in Science and Technology with various countries. India's bilateral S&T agreements are fairly simple in structure. They are based on cost sharing, joint implementation, agreed programme of cooperation activities, and periodic review meetings. The DST has such agreements with over 80 countries. Out of these 44 agreements are considered to be active. The DAE and DOS also have bilateral agreements with various countries. Better coordination of external engagement of various science departments could prove to be beneficial.

Our present network for science diplomacy is small. We have science counselors located in our missions in Russia, USA, Germany, and Japan. In addition there are some personnel from DAE, DOS, and DRDO in a few missions. In all the other countries S&T cooperation work is handled from India The work tends to be episodic and mostly event driven. We need to have capacity for handling S&T cooperation in our missions in several important countries. This can be achieved by training our diplomats to handle S&T cooperation activities. The networks operated by other countries for science diplomacy are quite diverse. The UK has an independent science innovation network which has personnel located in 30 countries. The US gives its career diplomats training in Science and Technology cooperation work and stations them abroad. Given India's increasing role in Science and Technology it is clear that India will have to further expand its external Science Diplomacy network in the most appropriate way. Operational guidelines for diplomats to carry out Science and technology work in the field can be devised similar to that for economic diplomacy.

Latest now discuss the area of science for diplomacy. This involves using science and technology cooperation to build bridges between countries which have troubled relations. There are several examples of this in the past. The US has used science cooperation to build bridges with countries such as the Soviet Union during the cold war, as well as with China, North Korea, Cuba , and Iran. The underlying principle is that scientists being more objective can work together on problems of common interest to countries, and they can serve as a channel of communication if required. Among South Asian countries one can envisage a science and technology effort aimed at tackling common problems such as air pollution, weather forecasting, energy and environment, health and disease control. The potential is there but so far it remains to be exploited.

THE SESAME PROJECT

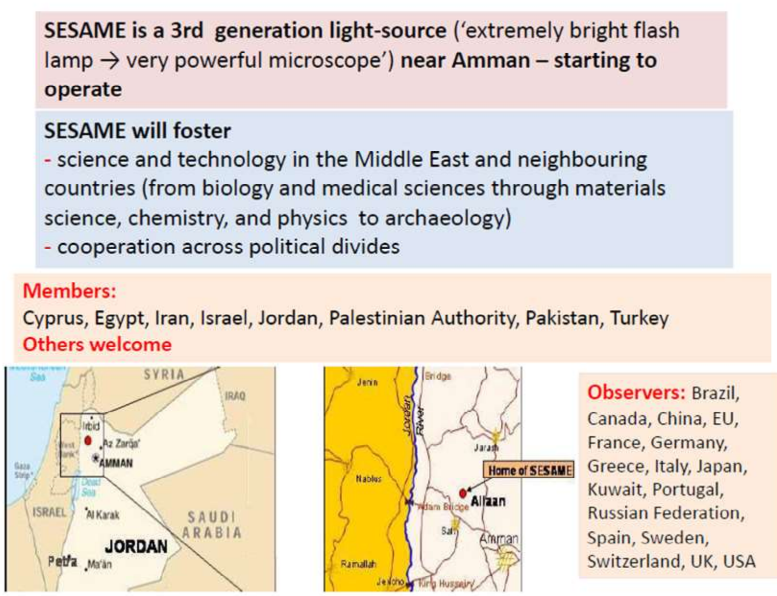

Figure 6

And interesting case of science for diplomacy is the SESAME project. (see Figure 6) This is a research facility located in Amman, Jordan. The accelerator produces beams of X Rays of widely varying energies which are useful for scientific experiments. The facility started operating in 2017. The 8 members include Israel, Iran, Palestinian authority, and Pakistan.

Despite troubled political relations among several countries, their scientists are managing to work together. About 20 other observer countries are supporting this project.

An important upcoming project is the EU's Horizon Europe (2021-27) with funding of about Euros 100 billion. This project is an important opportunity for Universities and Research institutions in India to participate with EU counterparts in various research activities. I would encourage you to follow the developments related to Horizon Europe closely. It is hoped that India will get the same opportunities for its researchers to participate that was available in the previous EU programmes - Horizon 2020 and Framework Programme 7.

Let us look at some science and technology areas where India has had to face diplomatic challenges. The first such area is nuclear technology. India did not sign the discriminatory Non Proliferation Treaty and has developed its own independent strategic nuclear capability. This resulted in India being put on a nuclear embargo as far as nuclear technology, equipment and materials are concerned. Therefore India had to make a big indigenous effort to develop its capability in the nuclear field. Finally during 2005-08, through difficult negotiations with the US , IAEA, and other countries India was able to secure recognition of its responsible nuclear posture and get a waiver from the NSG that enabled normal nuclear commerce. This was the result of a major effort in science diplomacy on the part of our scientists and diplomats working together. Today India is treated as a de facto nuclear weapons state as far as the nuclear regime is concerned. India has also embarked on an ambitious nuclear power programme involving both indigenous reactors and imported reactors and a unique Thorium based fuel cycle.

In the area of Climate Change and energy India occupies a major position. A solution to global climate change requires the support of large countries such as India and China. India has committed to reducing carbon intensity of its GDP and has also launched a major initiative - the International Solar Alliance (ISA) with France. India is making a major effort to move away from fossil based energy production. However its needs for economic growth are great and cannot be sacrificed. Both technology and finance are critical for India and other developing countries to move into a low carbon pathway. Despite the lack of commitment on the part of certain countries, India will continue to make all possible efforts to tackle climate change. The ISA, launched recently, is a global platform to bring together technology and finance for solar energy projects. Its membership can now include all members of the UN. There has been rapid progress in solar photovoltaic technology and energy storage technology, which has brought down the cost of solar energy considerably and future developments look promising.

In the Information and Communication Technology Sector, India has made good progress and is a major supplier of IT related services to the world. This sector has witnessed rapid change and technological development which is continuing in areas such as artificial intelligence, digital manufacturing, internet of things, etc.. There is concern over the disruptive effect of these technologies especially on employment. In addition the emergence of cyber crime, cyber terrorism, cyber warfare, and misuse of social media has created new problems which require action at the international level. Lethal autonomous weapons, which integrate artificial intelligence into weapons platforms are being rapidly developed. Concern over the use of such "killer robots" has led to International discussions over how to regulate the use of these weapons. These global challenges will have to be met through science diplomacy..

Rapid advances in life sciences have also thrown up new challenges for science diplomacy that are being discussed in international forums. Today we can rapidly sequence genomes of organisms, modify them with high precision and even introduce synthetic genes. This has tremendous potential applications in health, agriculture, food, environment, energy, and industry. But concerns have emerged including the use of genetically modified agricultural and food products, assisted human reproduction, genetic modification of humans, and the potential for creation of deadly bioweapons and bioterrorism.

Managing the oceans has also given rise to science diplomacy challenges. Marine biodiversity in the oceans is under threat due to over exploitation, pollution and climate change. Efforts are going on to negotiate a new wide ranging international treaty that will protect marine biodiversity in the areas beyond national jurisdiction. Discussions indicate that there are many divisive issues involved which will require difficult negotiations. In the case of India, the two large marine ecosystems (LMEs) we are concerned with - the Bay of Bengal and the Arabian Sea are both at high risk and need protection of their biodiversity.

There are a number of science diplomacy challenges in outer space. The fact that satellites can be used for both civil and military purposes has given rise to anti-satellite weapons technology. This has been already tested by countries such as the US, Russia, China, and now India. There is a danger of militarisation and weaponization of outer space. Space debris which has accumulated around the earth over decades is now posing a threat to space flight. As we move from exploration of the Moon and Mars to exploitation, questions of mineral and other rights on extra terrestrial bodies (principle of common heritage of mankind versus first come first serve) are likely to surface.

As we can see, the the future agenda for science diplomacy is likely to become increasingly complex and challenging. New developments in future will add new challenges for scientists, diplomats and policymakers. Therefore it is important for developing countries to be adequately prepared to tackle these challenges and protect their interests. Developing countries will need to strengthen South-South cooperation to achieve the sustainable development goals together with willing partners from the North.

Thank you.