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EDITORIAL

This issue of the Science Diplomacy Review is the first issue after we lost our founding editor Ambassador Dr Bhaskar Balakrishnan. As we navigate this transition, we remain committed to our mission to advance the discourse and practice of science diplomacy, inspired by his vision and legacy. His pioneering leadership and dedication have been the cornerstone of the Science Diplomacy Programme at RIS.

The developments in science diplomacy highlight the significance of international scientific collaboration in addressing global challenges. Earlier this year, the World Health Organization together with the G20 launched the Global Health Security Network, aiming towards greater international cooperation through sharing data in real-time, joint research efforts and coordinated policy responses. Further, we see the progress towards the Pandemic Treaty where the Intergovernmental Negotiating Body completed the draft, which received broad support from member states. However, the final negotiations are scheduled in the coming weeks. With the growing impacts of emerging technologies, especially with the advances and transformative impact of Artificial Intelligence, technological governance has assumed greater significance. The Global AI Ethics Consortium formed at the beginning of the year brings together several stakeholders to develop international standards and guidelines for the ethical use of AI. Further, recognising the risks and significance of cybersecurity about fifty countries signed the landmark Cybersecurity Framework Agreement to enhance international cooperation in combating cyber threats and protecting critical infrastructure. Several bilateral and regional science diplomacy initiatives like the Indo-Pacific Science and Technology Partnership and European Union-Africa Research and Innovation Agenda focus on partnership on key themes/areas.

While these are positive developments, there are many challenges as well. The impacts of the Russia-Ukraine war, the conflict in the Middle East, the resurgence of techno-nationalism and technological sovereignty as guiding principles and the global race in high technology have raised questions about the role and scope of science cooperation among the countries. The precise implications of these developments for Science Diplomacy remain unclear, despite its increasing prominence. However, these challenges underscore the continuing importance and relevance of science diplomacy in the years to come.

The paper by Jaggi, Khemraj and Goveas explores the scope of education as a tool for international cooperation and diplomacy. The authors provide an Indian perspective and how it has facilitated knowledge exchange and cultural diplomacy. They emphasise the transformative potential of integrating education into diplomacy. Recognising the role of science diplomacy in addressing global challenges, the paper by Pardeshi and Dhodapkar focuses on plastic pollution. Authors offer recommendations for plastic waste management and circular economy as well as on tackling plastic pollution in oceans.

The paper by Namdeo and Koley suggests science diplomacy as a promising avenue for India and envisages a key role for India in leading the global Open Science Movement. The next paper is by Late Ambassador Bhaskar Balakrishnan on the issues, challenges and prospects of the Biodiversity Beyond National Jurisdiction (BBNJ) Treaty and major issues in marine biodiversity governance and conservation. The event report by Dorairajan on the workshop held at the Abdus Salam Centre for Theoretical Physics, ICTP, Trieste, Italy focuses on international cooperation for building capacity for women physicists.

As in the past, we would keep continuing our efforts through Science Diplomacy programme at RIS to provide a platform for exchanges of research and views on various facets of Science Diplomacy, especially its key role in addressing global challenges, including sustainable development. We plan to expand and strengthen the purview of Science Diplomacy Programme, details of which will be forthcoming. We invite your feedback and responses and encourage stakeholders to contribute to the Journal.

PAPER

Education as a Tool for International Cooperation and Diplomacy: An Indian Perspective

Monika Jaggi*, Khemraj** and Jenice Jean Goveas***

Monika Jaggi

Khemraj

Jenice JeanGoveas

Introduction

The 21st century envisages soft power as the most effective weapon in the armoury of diplomacy (Nye, 2008; Peterson, 2014). The past decade has witnessed on increasing emphasis on Science for Diplomacy, where scientific collaboration and exchange have been used to strengthen international relations and address global challenges. It goes beyond traditional diplomatic methods and leverages scientific cooperation to build bridges and foster mutual understanding between nations (Krasnyak & Ruffini, 2020). In this paper, we discuss another similar tool of soft power; i.e., Education.

Education diplomacy involves the strategic use of education policies, programmes, and initiatives to foster international collaboration and promote a nation's interests globally. It encompasses efforts to build educational partnerships, facilitate student and faculty exchanges, and enhance the reputation of a country's education system. Although the term has not been greatly formalised, countries have often used higher education and academic exchange to influence international relationships (Li, 2018). It can boost a country's economy, advocate its priorities and political interests, and create commercial value (Vaxevanidou, 2018). Quality higher education not only aids in raising an individual's socioeconomic status but also generates a country's most crucial resource: human capital (McNutt, 2022). Education has thus become an ideal instrument of soft power and public diplomacy, with technological development playing a crucial

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role in its rise as a distinct diplomatic practice (Kıran and Açıkalın, 2021).

Education diplomacy can help countries establish collaborative partnerships that promote opportunities in the education sector. It is a form of relatively "new diplomacy" that incorporates features of traditional diplomacy for a wider variety of issues and actors than a restricted notion of foreign policy and international relations. Historically, education has played a pivotal role in colonial endeavours, serving as a tool of influence. In the post colonial era, education continues to be instrumental in advancing national interests (Peterson, 2014).

Despite the growing importance of education in diplomatic agendas, limited literature exists underpinning education's close relation to foreign policy matters. This paper aims to establish the role of higher education in a country's diplomatic toolkit by presenting the status, scope and challenges of Indian education diplomacy. It explores the literature and other secondary sources and deciphers the potential of education diplomacy in boosting India's culture and global image.

Education Diplomacy

Education Diplomacy may be understood as the diplomatic tactics that bridge international cooperation, solve education challenges, and foster transformative agendas for equitable and inclusive, quality education (Murphy, 2018). Extensive research on secondary data sources has shed light on the pivotal role of educational exchanges and scholarships in shaping a country's soft image and promoting its culture and history to foreign audiences, irrespective of its size or geopolitical influence (Khan *et al.*, 2020). This involves diverse stakeholders fostering positive policy environments through interpersonal connections. These "Education diplomats"are individuals or groups who facilitate international relations, collaborations, and partnerships in education. Their role involves advocating for educational opportunities, addressing systemic challenges, and leveraging education as a tool for international cooperation and diplomacy. They work on behalf of governments, institutions, or organisations to promote educational

Figure 1: Skills of an Education Diplomat

Source: Authors' Compilation based on the review of literature.

exchange programmes, establish academic alliances, negotiate educational policies, and facilitate cultural understanding between countries. They strengthen ties, foster mutual understanding, and enhance educational outcomes on a global scale. Such diplomats require diverse diplomatic and intercultural skills to facilitate agreements, encourage collaboration, and advance national education agendas (Figure 1).

Education diplomacy can enable diverse groups with multiple priorities to work together towards positively transforming global education while promoting it as a fundamental human right. Alternatively, educators at the local level can inform those working at the national and international levels about local educational needs and challenges. Education diplomacy can thus improve education as a human right, as well as solve international development challenges (Whitehead, 2016).

Education for Diplomacy and Diplomacy for Education

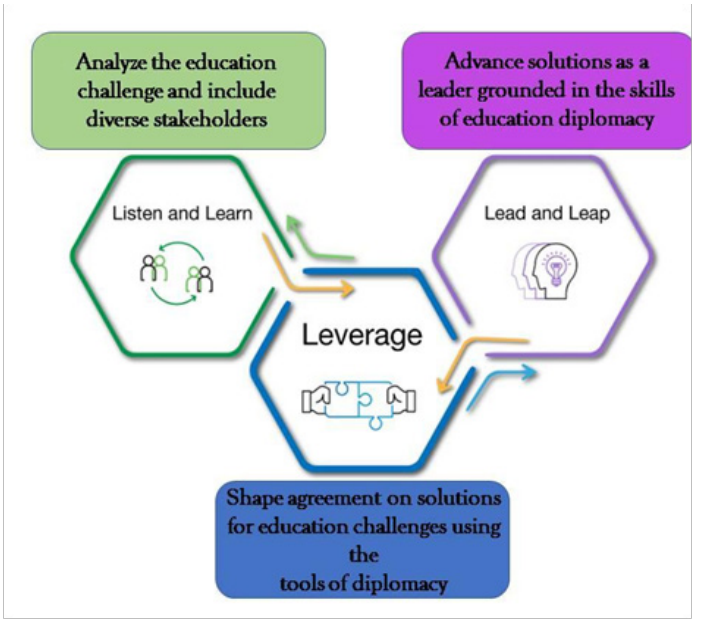
Vaxevanidou (2018) encourages the adoption of public diplomacy in education as a tool for soft power and to promote a country's strength, culture, and interests globally. The Fulbright programme, the Chevening Awards, the Humboldt fellowships and the New Colombo Plan offered by the USA, UK, Germany and Australia, respectively, are a few examples of where education aids countries in achieving their soft-power goals (Sheng-Kai, 2015). China established Confucius Institutes in 2004 to promote the Chinese language and culture internationally (Peterson, 2014).Education diplomacy has been accelerated by globalisation. It fills knowledge voids while connecting people and cultures.

Education diplomacy also fosters collaboration to solve educational challenges. These include achieving gender equality, inclusivity, international accreditation, student exchanges, and others. Intercultural communication is a key skill in both traditional and educational diplomacy. It helps to deepen understanding and build bridges between groups shaped by different cultures, including organisations, disciplines, sectors, communities, social and political systems, and nations. Implementing education management strategies in a multi-faceted diplomatic process has found traction in local, regional, and global diplomacy (Murphy, 2018). In this context, a few practices of education diplomacy are:

- Establishing international partnerships with institutions and coordination of programmes.
- Implementing exchange programmes for students and academic staff.
- Providing scholarships and funding opportunities to domestic and foreign students.
- Organising international and multidisciplinary conferences.

To leverage education diplomacy for building an international reputation and attracting investors, a country must expand its educational capabilities. Navigating the nuances where governments are not the sole actors in the education landscape adds a level of complexity. Hence, education management, planning and policy require a multidimensional and multi-stakeholder approach. Advancements in communications technology necessitate a scale-up of education diplomats. Faculty, administrators, and academic staff at all levels need to be equipped with enhanced diplomatic leadership skills. In its earlier existence, the Center for Education Diplomacy, which is no longer operational,

Figure 2: The "5L" Education Diplomacy Framework



Source: Höne, K. E. (2018). Education and Diplomats: A Changing World Demands Our Attention. Childhood Education, 94 (3), 4–9.

provided training in education diplomacy through its innovative "5L" Education Diplomacy Framework, as depicted in Figure 2.

The Asian Landscape in Higher Education

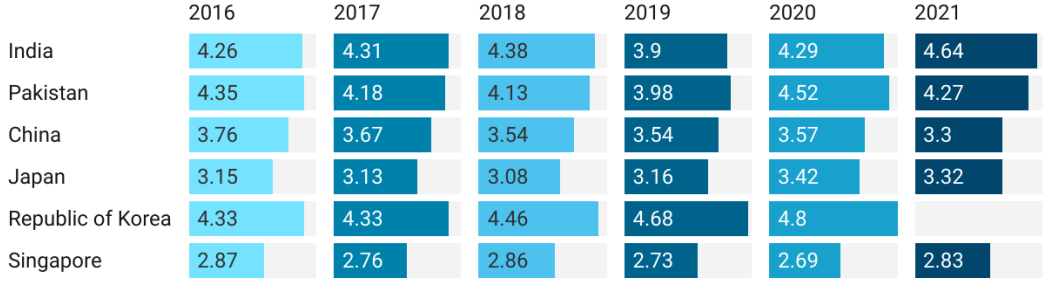
Asia has become a leader in higher education, research, and international university cooperation. With a high number of students, top universities, and a strong focus on STEM, Eastern Asia is a hub for multinational cooperation in higher education (Postiglione, 2019). The diversity in both the number and variety of countries hosting significant numbers of students has been increasing. Emerging players like Chinaand South Korea now rank among the top hosting countries, indicating a slight shift in the landscape of student mobility (Castiello-Gutiérrez, 2019; Pawar, 2024).

In the latest edition of *Times Higher Education's* World University Rankings (THE, 2024), the USA is the most-represented country overall, with 169 institutions and also the most-represented in the top 200 (56). With 91 institutions, India is now the fourth most-represented nation, overtaking China (86) (THE, 2024). Furthermore, participation has expanded to 108 countries/regions, featuring 1,904 universities – an increase from 1,799 in the previous year, notably driven by significant contributions from Asia. India demonstrates the most substantial growth, with 20 newly ranked institutions. Turkey and Pakistan also contribute significantly, enhancing Asia's dominance in overall representation and placing it within the top 200. Notably, China's top universities, Tsinghua University and Peking University, are approaching the top 10, securing 12th and 14th positions, respectively, showcasing China's rapid ascent. The number of Chinese universities

in the top 200 has increased from seven in 2020 to 13, with each institution significantly improving its rankings, and the total number in the top 400 has doubled from 15 in 2021 to 30 in 2023. The continent has shown remarkable improvement in average overall score, rising from 31 to 35.7, and has excelled in the teaching and research quality pillars (Patrick, 2023).

China, Singapore, Japan, Korea, and India have introduced various schemes to entice foreign students. Internationalising higher education is at the top of their priority list. China is on its way to becoming a global destination for higher education. The country has replaced Australia as the third largest destination for international students after the USA and the UK (Postiglione, 2019). A comparative graph of

Figure 3. Government Expenditure on Education as a Percentage of GDP (%) for Selected Asian Countries



Source: Authors' Compilation from http//sdg4-data.uis.unesco.org/
Note: Data for the Republic of Korea for the year 2021 is not available.

Table 1: Student Mobility Ratio for the Selected Asian Countries

Country	Inbound students	Outbound students	Student mobility ratio
India	46,659	508,174	0.09
Bangladesh	2,281	52,799	0.04
China	210,903	1,021,303	0.21
Japan	222,661	29,385	7.58
Republic of Korea	118,528	90,196	1.31
Singapore	58,269	19,508	2.99
Sri Lanka	1,246	29,199	0.04
Malaysia	100,437	48,810	2.06
Vietnam	7,760	137,022	0.06

Source: Authors' Compilation from *https://uis.unesco.org/en/uis-student-flow.*

the government's spending on education for selected Asian countries is depicted in Figure 3.

Palit *et al.* (2021) reported that the majority of Asian countries are net importers of education services, characterised by student mobility ratios below one. These are countries where more students are moving out to foreign countries compared to international students coming in. Notably, India and China are the top countries with a large number of outbound students, while Malaysia, Singapore, Japan, and South Korea act as net exporters, attracting more foreign students to their educational institutions. Table 1 depicts the current student mobility ratios for the selected Asian countries.

India's Education Diplomacy

India has a rich history of educational exchanges dating back to ancient universities like Takshashila and Nalanda, attracting students from countries like China, Korea, and Indonesia. India is considered to be one of the oldest knowledge societies globally (Sharma, 2012). India's extensive and independent higher education system comprises over 1,168 universities, 45,473 colleges, and 12,002 standalone institutions (AISHE, 2021-22). Lately, India has been diving headfirst into globalizing its higher education sector. It ranks second globally in sending students abroad (Varghese, 2020). Some of India's formal attempts at education diplomacy are listed below:

- ***The Indian Technical and Economic Cooperation (ITEC):*** It serves as a powerful diplomatic tool for India. Established in 1964, ITEC aims to foster international relations and cooperation by enhancing the skills and capabilities of partner countries through training and knowledge exchange programmes in India. ITEC is administered by India's Ministry of External Affairs (MEA) and implemented through Indian missions abroad. ITEC offers training programmes and courses in various fields such as information technology, nanotechnology, agriculture, healthcare, renewable energy, policy training, etc. ITEC also provides scholarships for students from partner countries to pursue courses in Indian universities and institutions. The programme exemplifies India's commitment to sharing its expertise and resources for the collective progress of the global community.

- ***Fulbright-Nehru Fellowship:*** This Programme is a diplomatic outcome of the 1950 Indo-US agreement. It is administered in India by the United States-India Educational Foundation (USIEF), a binational organisation for promoting academic exchange and cultural understanding between India and the USA. It provides scholarships to outstanding Indian students, scholars, and professionals to study, teach, and conduct research in the USA and vice versa. The programme also builds lasting connections and mutual respect between scholars and professionals from both countries. It serves as a conduit for people-to-people diplomacy, creating a foundation for sustained collaboration and goodwill between India and the USA.

- ***C.V. Raman Fellowship for African Researchers:*** India's Department of Science and Technology (DST) and MEA, through the Federation of Indian Chambers of Commerce & Industry (FICCI), launched the C.V. Raman

Fellowship for African Researchers programme under the India-Africa Forum Summit 2010, to promote human capacity building through scientific and technological cooperation between Africa and India. It provides opportunities for African researchers to conduct research in India to advance their research capabilities in natural and engineering sciences while fostering scientific and technological cooperation between Africa and India.

- ***ICCR Scholarships:*** Since 1950, the Indian Council for Cultural Relations- an organisation under MEA - has been administering various annual scholarship programmes and awards to foreign students from about 180 countries for different degree levels in Indian universities. This programme aims to promote cultural exchange and strengthen people-to-people ties.

- ***National Academic Depository (NAD):*** While not a traditional diplomacy programme, NAD was launched to store academic certificates digitally, making it easier for international employers and educational institutions to verify the credentials of Indian students and professionals. It was launched in 2017 and facilitates the mobility of students and professionals by providing a standardised and easily accessible repository of academic records.

- ***Study in India:*** Launched by the Indian government in 2018, this programme promotes India as a world-class educational hub for international students wanting to pursue their higher education in India. The Visiting Advanced Joint Research (VAJRA) faculty programme was also introduced in 2017 to provide training in cutting-edge fields to visiting scholars and faculty from abroad. This programme is open to scholars and faculty from all countries, including Non-Resident Indians (NRIs) and Indian Overseas Citizens (OCI) (PIB, 2017).

In addition to the above, India has entered into numerous bilateral agreements and Memoranda of Understanding (MoUs) with various countries to facilitate academic collaborations, joint research projects, and student exchanges. It has established independent bodies under intergovernmental agreements, such as the Indo-French Centre for the Promotion of Advanced Research, the Indo-US Science & Technology Forum and the Indo-German Science and Technology Centre. The Shastri Indo-Canadian Institute is an example of a bilateral organisation established in 2005 to promote intellectual and cultural connections between India and Canada. It provides funding for research and hosting seminars to create more inclusive bilateral links between academia, government, business, and civil society organisations.

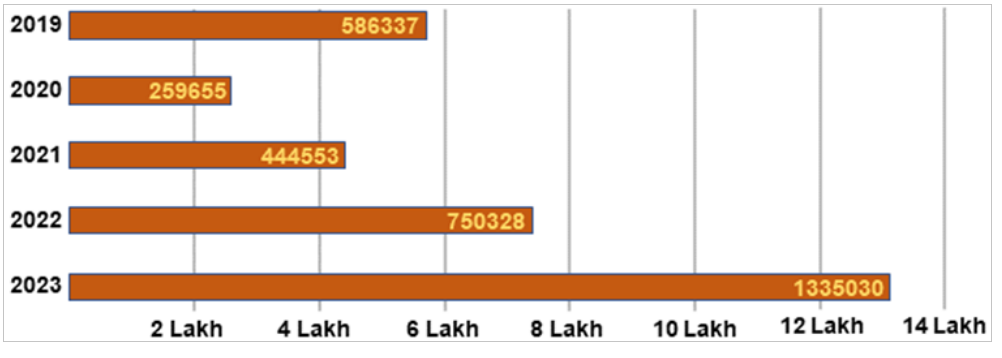
The University Grants Commission (UGC) has implemented numerous international educational exchange programmes, including fellowships, research programmes, and scholarships, such as the Indo-Israel Joint Research Project, UGC-UK India Education and Research Initiative, Indo-German Partnership in Higher Education, Indo-Norway Programme, Stipendium Hungaricum Scholarship Programme, and Raman Fellowship for Post-Doctoral Research. These programmes provide opportunities for Indian scholars and exchange programmes for scientists and project-based staff.

In 2020, India released its National Education Policy (NEP, 2020), which promotes a holistic, flexible, and multidisciplinary approach to education with a focus on access, quality, and accountability. In addition, massive open online and multi-modal learning is also being advocated through e-learning platforms like DIKSHA, SWAYAM MOOCs platform, Virtual Labs, e-PG Pathshala, and National Digital Library, etc. (PIB, 2022a). India plans to internationalise higher education by establishing networks with other countries through several student and scholar exchange programmesand allowing high-performing Indian universities to set up campuses in other countries while inviting the top 100 universities globally to operate in India (PIB, 2022b). A legal framework will be formulated to facilitate this access, and such universities will be given special treatment in regulatory, governance, and content norms on par with other autonomous institutions in India.

The Indian Ministry of Education (MoE) intends to enhance the quality of higher education through partnerships with renowned global educational and research organisations. This is accomplished through establishing linkages and international partnerships in academia and research. DST facilitates these activities in coordination with the MEA, Indian Missions Abroad, S&T counsels, stakeholders in scientific, technological and academic institutions, government agencies, and various industry associations in India. These efforts have led to a surge in the number of Indian students studying abroad (Figure 4). One of the key practices of education diplomacy involves forming international partnerships with institutions and coordinating programs. These efforts contribute to increasing both outbound and inbound numbers of students.

As highlighted by Lima (2007), educational exchanges serve three key roles: fostering mutual understanding, enhancing the host country's image, and projecting the foreign policy objectives of the host country. In line with these principles, India has strategically increased budget allocation to various scientific ministries and departments (Table 2) and strengthened its global networks through multiple initiatives, such as educational exchange programmes, MoUs, and joint declarations with other countries. This multifaceted approach

Figure 4: Number of Indian Students Studying Abroad



Source: Authors' Compilation from Ministry of External Affairs (MEA, 2022, 2023, 2024).

Table 2: Detailed Budget Allocation to Various Scientific Ministries and Departments, GoI

Agency	Scientific budget (Rupees in Crores)		
	2022-23 Actual	2023-24 (Revised Estimates)	2024-25 (Budget Estimates)
Department of Atomic Energy[1]	24,641.61	26,799.78	24,968.98
Department of Space[2]	10139.43	11070.07	13042.75
Department of Agricultural Research and Education (DARE), Indian Council of Agricultural Research[3]	8,399.72	9,876.60	9,941.09
Ministry of Electronics and Information Technology[4]	8199.25	14421.25	21936.9
Department of Science and Technology[5]	4436.26	4891.78	8029.01
Department of Scientific and Industrial Research[6]	5,852.14	6,202.53	6,323.41
Department of Health Research (DHR), Indian Council of Medical Research[7]	2,422.76	2,892.83	3,301.73
Ministry of New and Renewable Energy[8]	7,563.37	7,848.00	19,100.00
Department of Biotechnology[9]	2044.74	1607.32	2275.7
Ministry of Environment, Forest and Climate Change[10]	2389.3	3231.02	3330.37
Ministry of Earth Sciences[11]	1,568.86	2,879.02	3,064.80

Source: Authors' compilation from various sources.

includes collaborations, scholar/student/researcher exchanges; sharing of information/publications; organising joint seminars/workshops/conferences. Efforts are also underway to promote mutual recognition of qualifications and develop institutional links.

Education diplomacy, as highlighted by Nandy (2020), functions as a foreign policy instrument for fostering regional collaborations, exemplified by India's active engagement with international organisations and multilateral bodies like UNESCO, BRICS, BIMSTEC, ASEM, SAARC, IBSA, ASEAN, EAS, OECD, and IOR-ARC, underscoring its dedication to nurturing meaningful educational partnerships on a global level. Some such initiatives include:

- ***India Science and Research Fellowship (ISRF):*** Implemented in 2015, this initiative aims to develop

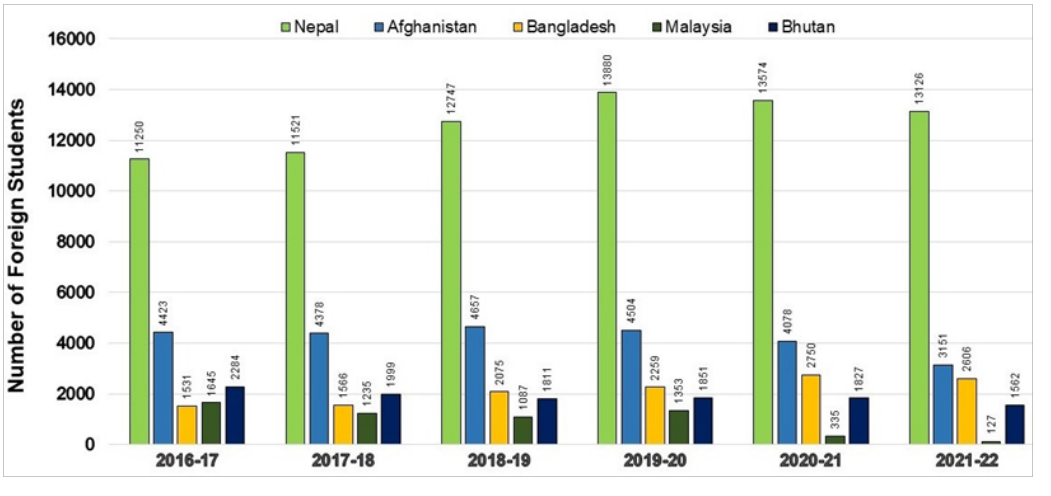
S&T partnerships with neighbouring countries, namely Afghanistan, Bangladesh, Bhutan, Maldives, Myanmar, Nepal, Sri Lanka and Thailand. Scholars work in India's premier research and academic institutions to undertake R&D across all major disciplines of science and technology, including engineering and medical sciences, for 3- 6 months.

- ***SAARC (South Asian Association for Regional Cooperation) Scholarships:*** The SAARC Scholarship Scheme, started in 2007, aims to provide people-to-people contact for students from SAARC member countries to pursue higher education in one of the member countries. India has been actively involved in providing scholarships to students from other SAARC member countries, fostering regional cooperation in education. In addition, the South Asian University (SAU), started in 2010, is an international university sponsored by the SAARC Member States through an inter-governmental agreement, with its campus in New Delhi.

- ***ASEAN-India Educational Cooperation:*** This initiative began with the signing of the ASEAN-India Partnership for Peace, Progress, and Shared Prosperity in 2002. The partnership laid the foundation for collaboration in various fields, including education. Educational cooperation focuses on promoting academic and cultural exchanges and fostering collaboration between India and ASEAN member countries. India offers various scholarship programmes for foreign students, including scholarships for Bhutanese students and scholars (MEA, 2017). In 2019, several MoUs and agreements were inked in the education sector, marking another significant milestone in the bilateral collaboration between the two countries (MEA, 2019).

India has strong educational ties with Sri Lanka and Bangladesh, with various bilateral schemes and initiatives launched to boost S&T cooperation (MEA, 2015; Mishra and Das, 2020; Nandy, 2020). India has also extended around 3000 scholarships to Nepalese citizens for UG, PG, and PhD

Figure 5: Country-Wise Distribution of Foreign Students Studying in India



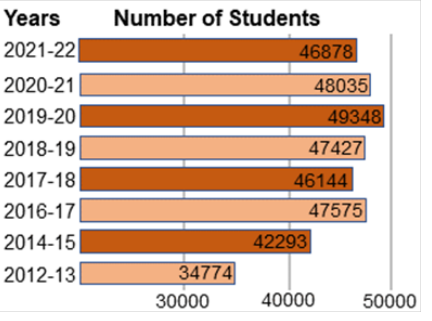
Source: Authors' Compilation from AISHE, 2020–21, 2021–22.

programs and has contributed to school construction in Nepal (Saroha, 2019). The country has a significant intake from neighbouring South Asian countries such as Nepal (13126), Afghanistan (3151), Bangladesh (2606), Bhutan (1562), and Sri Lanka (656) (AISHE, 2021-22) (Figure 5). Under its education diplomacy towards Afghanistan, the Indian Government has been offering scholarships to Afghan students to study various courses (Singh *et al.*, 2021).

India and France have a close partnership with a goal of 20,000 Indian students in France by 2025 (Times Now, 2022), while India and Germany share strong ties in research, technology, and higher education cooperation (Agarwal, 2022). In 2022, the number of Indian students in Germany tripled over the past decade, making them the second-largest group of foreign students, with 34,134 enrolled (Nair, 2022).

Such initiatives have certainly elevated India's position in the education sector. According to AISHE (2019-20, 2020-21, 2021-22) data, the number of international students increased from 34,774 in 2012–13 to 46,878 in 2021–22, with students coming from 170 countries globally (Figure 6). Nations like Nepal (28%), Afghanistan (6.7%), the USA (6.2%) and Bangladesh (5.6%) make up the largest proportion of international students. The United Arab Emirates (4.9%), Bhutan (3.3%), Nigeria (3.0%), Tanzania (2.7%), Zimbabwe (2.3%) and Sudan (2.1%) were among the top 10 nations for student numbers. The state distribution identified Karnataka as having the highest number of international students (6004), followed by Punjab (5971), Maharashtra (4856), Uttar Pradesh (4323), Tamil Nadu (3891), Gujarat (3593), Andhra Pradesh (3115), Delhi (2771), Odisha (2362) and Haryana (1703).

Figure 6: The Number of International Students in India



Source: Authors' Compilation from AISHE, 2019-20, 2020–21, 2021–22.

Note: Data for the academic years 2015–16 and 2013–14 are not available.

The overall impact of these programmes can be summarised as follows:

a. **Building People-to-People Connections:** Such programmes create opportunities for professionals from diverse backgrounds to undergo training in India. This fosters direct interactions, cultural exchange, and the development of personal connections between individuals, laying the groundwork for back-channel diplomacy.

b. **Projecting Positive Image:** Valuable training and capacity-building programmes contribute to India's positive image as a knowledge-sharing and cooperative nation. The skills and knowledge gained by participants serve as a testament to India's commitment to assisting in the development of partner countries.

c. **Strengthening Soft Power:** These efforts create a favourable view of the country among professionals who have directly benefited from the programme and can carry the Indian goodwill back to their home countries. Some examples of global leaders who have studied in

India include Jigme Singye Wangchuck-former King of Bhutan, who completed his secondary education at St. Joseph's College in Darjeeling; Hamid Karzai-former President of Afghanistan, who completed his Bachelor of Arts in Political Science from Himachal Pradesh University; Ram Baran Yadav-First President of Nepal who completed his medical studies from Calcutta.

d. **Fostering Economic Cooperation:** Education diplomacy programmes not only enhance human capital but also contribute to economic cooperation. As professionals return to their countries equipped with new skills, they become potential contributors to economic development by creating avenues for collaboration and trade.

e. **Long-Term Diplomatic Relationships:** These programmes can lay the foundation for long-term diplomatic relationships. The Alumni maintain ties with India, becoming a network of professionals who share positive experiences and a strong connection to the country.

f. **Addressing Global Challenges:** Providing training in areas such as technology, healthcare, and sustainable development aligns with diplomatic efforts to collaborate on issues of global significance and fosters a sense of shared responsibility.

Conclusion

Recent years have seen an escalation in the intellectual exchange in education for building international relations (Peterson, 2014). Today, more and more countries rely on college scholarships to advance national interests on the global stage (Aras and Mohammed, 2018). According to Castiello-Gutirrez (2019), higher education is a tool for promoting political and social soft power. China has taken a giant leap in education diplomacy by offering scholarships to African and other nationals, eventually facilitating Chinese politics worldwide (Khan *et al.*, 2020). India is emerging as a global study destination with affordable and quality education. This trend has the potential to boost economies by attracting foreign investments. Developed countries encourage international student enrollments because higher education offered to foreign students is considered a service export that can greatly benefit their economy (Pawar, 2024). India should invest in educational scholarships and research collaborations to connect with top institutions and researchers to continue this momentum. It is also important to establish partnerships among nations at all levels, including the school level, to provide students with exposure to a diversified curriculum and promote innovative thinking with a better academic profile (Vir, 2022). India has been investing in the education sector but lags in R&D spending. Policymakers should prioritise investing in education diplomacy, which involves strategic initiatives aimed at fostering international collaboration in education and STI. By actively engaging in education diplomacy, India can attract more talent from around the world, cultivate knowledge exchange networks, and foster innovation ecosystems. This approach would not only enhance the global competitiveness of a nation's education and research sectors but also contribute to achieving self-reliance by promoting indigenous STI development and capacity-building initiatives.

As we enter a period of accelerated global engagement, country-to-country education diplomacy is being overtaken by institution-to-institution relationships and a broad array of actors (Peterson, 2014). This makes the education diplomacy scenario far more complex for all stakeholders involved. It also means that governments may not necessarily

be the prime actors, and several new opportunities and challenges may emerge in this space. While governments may view college and university cross-border activity as an important part of their diplomatic efforts, institutions are now acting more independently, based on their strategies and motivations, even beyond national borders. The growing popularity of online education has brought about a paradigm shift in the education landscape and can also have various consequences for education diplomacy.

Nevertheless, the future of education diplomacy holds immense promise as a key driver of global collaboration and understanding. As our world becomes increasingly interconnected, the role of education in shaping diplomatic relations cannot be overstated. Education diplomacy provides a pathway towards fostering mutual respect, tolerance, and shared knowledge, essential elements for building sustainable partnerships among nations. Its significance lies not only in the exchange of students and scholars but also in the shared development of educational policies, research initiatives, and cultural understanding. Recognizing education as a fundamental instrument of soft power diplomacy is imperative, as it transcends political boundaries, creating lasting impressions and forging connections at the people-to-people level. Moving forward, every country must recognise the transformative potential of education diplomacy and integrate it into their diplomatic toolkit.

Endnotes

[1] Demand No. 3, Department of Atomic Energy, Notes on demands for grants, 2024-25.

[2] Demand No. 95, Department of Space, Notes on demands for grants, 2024-25.

[3] Demand No. 2, Department of Agriculture Research and Education, Notes on demands for grants, 2024-25.

[4] Demand No. 27, Ministry of Electronics and Information Technology, Notes on demands for grants, 2024-25.

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Global Plastic Pollution Crisis and Science Diplomacy: Towards a Circular Economy

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Introduction

Plastic pollution has reached a crisis level across the globe due to the pervasive use of plastic and its improper recycling and management. The substantial dependence of humans on the plastics and resultant skyrocketed demand is creating a prevalent plastic footprint in the environment (Boucher and Billard, 2017). The diverse and multifaceted impacts of plastic pollution on humans, fauna and flora as well as the natural ecosystems are detrimental(Morrison *et al.*, 2022). The presence of plastic in nature can interfere with natural processes and exhibit negative impacts on habitats, subsequently reducing the adaptability of ecosystems to climate change.[1] Enormous generation of plastic and subsequent cycles of use and disposal contribute to a large amount of Green House Gas (GHG) emission (Horton, 2022). Plastic pollution in the soil has the potential to affect the food production capabilities of soil which in turn affects the socio-economy (Rajmohan *et al.*, 2019). The small fragments of plastics, normally referred to as 'microplastics' have become a serious cause of concern due to their omnipresence in freshwater (Li *et al.*, 2021), marine ecosystems (Gallo *et al.*, 2018), food chain (Sanchez *et al.*, 2014) and human organs (Amato-Lourenço *et al.*, 2021), (Zarus *et al.*, 2021). Thus, solutions with strategic interventions are the need of the hour to control and mitigate plastic pollution considering its terrible impacts.

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The circular economy of plastics (CEoP) is rapidly gaining attention due to its promising approach of reducing the negative externalities of plastic (Dhodapkar *et al.*, 2023; Pardeshi *et al.*, 2023). However, the CEoP transition requires a systemic approach and bold actions from various stakeholders across the full plastic life cycle to implement tactical interventions (Dhodapkar *et al.*, 2023).

An international legally binding agreement i.e. Plastic treaty is an outcome of a historic resolution at the UN Environment Assembly (UNEA-5) to end plastic pollution by 2024. The plastic treaty aimed to tackle the entire life-cycle of plastic, starting from the extraction of fossil fuels, the design and the production of plastics, its consumption, and associated waste management. The ultimate goal of the treaty is the transition to circular economies that prioritise reusable materials and minimise waste. The plastic treaty, based on three initial draft resolutions from various nations, established an Intergovernmental Negotiating Committee (INC) in 2022 with the target of completing a global draft legally binding agreement by the end of 2024. It is expected to present a legally binding instrument with diverse alternatives to address the full lifecycle of plastics, the design of reusable and recyclable products and materials, and the need for enhanced international collaboration to facilitate access to technology, capacity building and scientific and technical cooperation.[2]

This paper discusses science diplomacy for policy-making and amendments for viable plastic waste (PW) management to achieve a true CEoP. Plastic pollution, impacting various dimensions of climate change, livelihoods, health, socio-economy and geopolitics, is a major unsolved global environmental issue. Moreover, multiple regulatory gaps, issues in international plastics governance, lack of harmonisation of international laws, weak coherence across national policies and inadequate science–policy interaction pose significant challenges for policymakers and are instrumental for a global plastic treaty. Science diplomacy has attained a stronghold in foreign policy to resolve global environmental issues such as environmental degradation and depletion of the ozone layer (Moedas, 2016). The different policy instruments under science diplomacy a have strong potential to significantly contribute towards progress in solving the complex problem of plastic pollution (Beltran *et al.*, 2024).

The paper highlights the severity of plastic pollution, followed by some intervention and waste management policy amendments enabling plastic reduction. The first part of the paper provides an overview of Plastic pollution and its significant effect on humans and the environment. A brief idea on the PW generations presented. The effects of plastic pollution on different ecosystems, including land, water, soil and air are described. An overview of microplastic generation and its harmful impacts are also described in this section. The second part deals with intervention and alternatives required in the full life cycle of plastic for reduction and mitigation of PW. A few recommendations including Green and eco-design increase in the PW recycling rates, and reducing the use of virgin plastic and polymers are suggested. Moreover, Extended Producer Responsibility (EPR), support for the Global Plastics Treaty, planetary boundaries approach, public-private partnership and incentivisation

for certain stages of the plastic values chain are also proposed. The cutting-edge research and concerted efforts towards reducing PW generation and its leakage as well as the foundation of an inclusive monitoring scientific body are also described to reduce plastic pollution. The paper concludes with a section on PW management policy enabling plastic reduction wherein regulatory, economic and information policy instruments are presented.

Ubiquity of Plastic Waste and Subsequent Plastic and Microplastic Pollution

Plastic is currently present all across the globe, including air, soil & sediments, surface waters, marine ecosystems as well as in waste water, and sludge (Morrison *et al.*, 2022). The severity of the situation can be understood by various predictions regarding PW. A huge amount of PW is generated globally every year.[3] A large amount of plastic gets accumulated in the environment due to its durable nature.

Mismanaged PW in the form of litter is leaked to aquatic ecosystems creating problems of plastic pollution in water bodies (Coyle *et al.*, 2020). An anticipated amount of 150 million metric tonnes (MMT) of PW was circulating in the marine environment till 2016. Moreover, it is also predicted that PW would be outweighing fishes in the ocean by 2050.[4] The amount of plastic pollution entering the terrestrial and aquatic environment is predicted to grow by an additional 710 MMT between 2016 and 2040, in spite of rising awareness and efforts for PW reduction(Lau *et al.*, 2020).

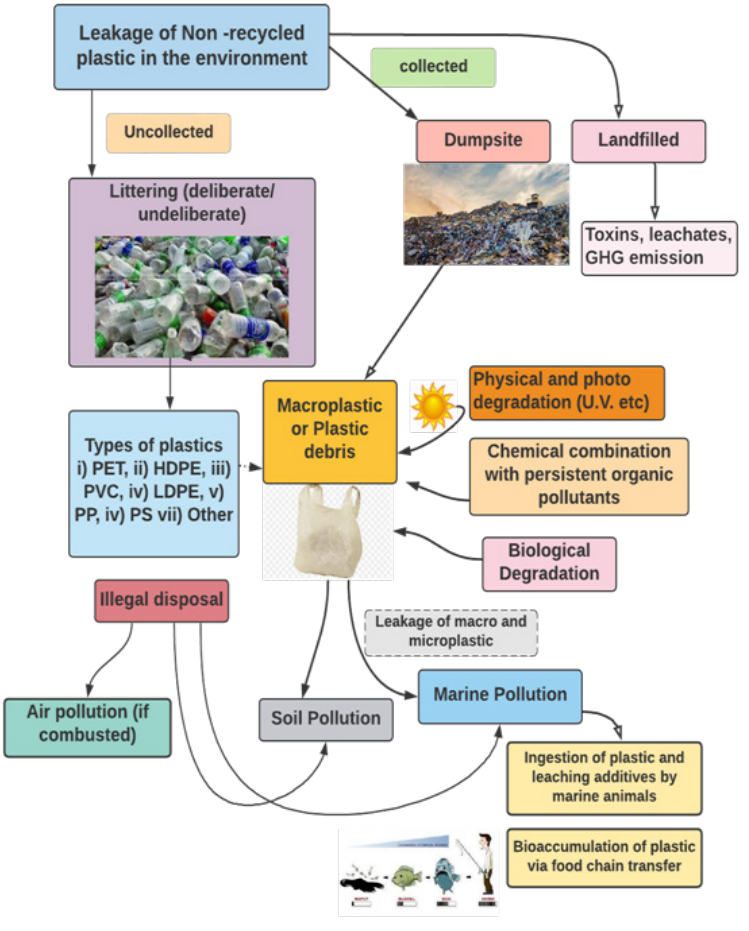
Various biotic and abiotic processes in the environment including exposure to high temperature and UV light, microbial activity and abrasion lead to the degradation of plastics. This results in the formation of minor plastic fragments with altered surface properties. These plastic fragments are classified as macroplastics (with particles >2.5 cm), mesoplastics (with particles 2.5 cm- 5mm), microplastics (with particles between 1mm-5 mm) and nanoplastics (with particles between 1 nm and 100 nm);Beaumont *et al.*, 2019). Microplastics are classified as primary and secondary microplastics. Primary microplastics are deliberately manufactured using polyethylene for many personal hygiene products. Another key source of primary microplastics is the raw materials used in the manufacture of plastic items. Secondary microplastics result from the breakdown of larger plastic particles when exposed to physical, chemical and biological processes, leading to their fragmentation (Boucher and Billard, 2017). The terms macro litter, anthropogenic litter, plastic litter, marine litter, marine plastic and plastic debris are most used for indicating micro-plastics. Microplastics are generally composed of the most produced and consumed diverse polymer types from a multitude of sources and exhibit different sizes, colour, and shapes. Polyethylene terephthalate (PET), high-density polyethylene (HDPE) polyvinyl chloride (PVC), low-density polyethylene (LDPE), polypropylene (PP), polystyrene (PS), and other polymers such as polyurethane, and polyamide are diverse.

Plastic Waste Generation in India

An estimated 34.7 lakh tonnes per annum (TPA) of PW was produced in India as per the annual reports of the Central Pollution Control Board (CPCB, 2019). Significant

initiatives to manage PW are implemented at the local, state and national levels, in spite of the significant challenge of managing PW due to rapid urbanisation, increasing population and growing economy. About 15.8 lakh TPA of PW produced was recycled and 1.67 lakh TPA of PW was co-processed and produced during 2018-19 with a collection efficiency of 42 per cent. Recyclable thermoplastics constitute 94 per cent of total PW generated, whereas the remaining 6 per cent comprises other types of thermosets. A majority of PW arose from flexible and rigid packaging. India has a higher rate of PW recycling (nearly 61 per cent) compared to other nations (Shanker *et al.*, 2023). 12 per cent of PW is reutilised whereas the remaining 27 per cent is mismanaged. A large portion of the collection, segregation and recycling is handled by the informal sector, whose livelihood and productive employment depend on waste(Neo *et al.*, 2021). Mechanical recycling is predominant with a 94 per cent share in PW recycling and typically includes collection, segregation, washing, grinding and thermo-mechanical extrusion of the PW without significant alterations to its chemical structure (Pardeshi et al, 2023;

Figure 1: Fate of Mismanaged Plastic Waste in the Environment



Source: Authors' compilation.

Sharma *et al.*, 2024). Fate of mismanaged PW and its consequent leakages in environment is presented in the following flowchart.

The mismanaged part of PW is either dumped or landfilled. Similarly, uncollected PW littered in the ground can serve as a source of microplastic generation. Subsequently, it may find its path to the river and ocean water systems posing a serious pollution threat. Leakage of PW to the environment can also take place during PW recycling. This includes an accidental release of toxic chemicals used in the production of recycled polymer such as additives, colours, stabilisers, halogenated flame retardants etc.

India has a vast coastline of approximately 7,500 km along the Arabian Sea in the west and the Bay of Bengal in the east (Vanapalli *et al.*, 2021). Fishing industry is a significant contributor to marine litter in the oceans. Abandoned, lost or otherwise discarded fishing gear is significant in marine plastic pollution. Persistent of microplastics in beaches, coastal water, and sediments are reported (Jayasiri *et al.*, 2013) Veerasingam *et al.*, 2020); Sruthy and Ramasamy, 2017. The investigations regarding marine debris are an emerging area of research in India (Sruthy and Ramasamy, 2017); (Karthik *et al.*, 2018); (Veerasingam *et al.*, 2020); (Kaladharan *et al.*, 2020). The source and debris characteristics, its accumulation, seasonal variation and transport pathways are still inadequately studied (Kumar *et al.*, 2016), (Mugilarasan *et al.*, 2021). Plastic and microplastic pollution have many detrimental effects on various as discussed in the subsequent paragraphs.

Ecosystem-Wide Effects of Plastic Pollution

Land and Soil Ecosystem: PW littered in the environment presents a very unaesthetic view, causing clogging of drains and leading to blockage of sewage system. This subsequently results in the formation of favourable conditions for the breeding of mosquitoes and other pathogens responsible for vector-borne diseases. The drainage systems also clog due to PW which results in water lodging during the heavy rains. Ingestion or entanglement of PW by street animals could lead to severe physiological impacts inducing acute or lethal consequences (Morrison *et al.*, 2022). PW is a considerable source of toxic chemicals in the environment. Precursors of polymers including monomers, oligomers, stabilisers, additives, plasticisers, dyes, and heavy metals were observed to be released into the soil, ground and surface water (Lambert, 2013).

Mismanaged PW is a form of combined pollution as it can act as a vehicle for other environmental pollutants such as persistent organic pollutants (POPs) and heavy metals. It can also provide a habitat for microorganisms and pathogens in the environment and also facilitate the transport of invasive species across habitats (Gallo *et al.*, 2018).

Mismanaged PW from the land, dumpsites and landfill can serve as a source of microplastic pollution. The impacts of microplastic pollution on land ecosystem are an emerging area of research (Li *et al.*, 2021).

Aquatic Ecosystems: Mismanaged PW and subsequent microplastic pollution

are emerging as a severe anthropogenic concern in the aquatic ecosystems across the globe. Land-based sources are the major culprit for this situation. Mismanaged PW gets readily transported by the flow of water due to its buoyancy (Eriksen *et al*., 2014). The accumulated plastics in the ocean basins can be broadly classified into four levels based on their sizes: megaplastics, macroplastics, mesoplastics, and microplastics (Thushari and Senevirathna, 2020).

Entanglement and ingestion are some of the critical issues associated with macroplastic fragments. Plastic rope in fishing gears causes entanglement to marine organisms such as sea turtles, mammals, and different types of sea birds whereas small plastic fragments cause ingestion. According to the studies of Gall and Thompson (2015), more than 13,000 aquatic organisms from about 208 species encountered issues related to ingestion, whereas more than 30,000 individuals from 243 species suffered from entanglement due to ocean macro plastic debris (Laist, 1997). These numbers lack reports from Asia, Africa and the Polar Regions. Entanglement and ingestion caused direct lethal effects resulting in the death of organisms. Indirect sub-lethal effect caused impaired reproduction ability, reduction in capturing food, the inability to escape from predators due to loss of sensitivity and mobility, and stunted growth (Gall and Thompson, 2015).

Microplastics have much potential for ingestion due to their small size. It can affect the cellular level of the organism by inducing mitochondrial stress, formation of reactive oxygen species, inducing cellular damage and altering hormonal regulation. Several toxic chemicals e.g. Bisphenol-A (BPA), metal ions, monomers, oligomers, and flame retard ants incorporated with plastics get accumulated with the ingested plastic inadvertently(Lithner et. al., 2011). These toxic chemicals such as BPA and phthalates may cause considerable impacts on the growth and reproduction of organisms also causing genetic mutations in them (Oehlmann *et al.* 2009). Morover, their population shows substantial negative growth due to the presence of toxic substances in the diet. Microplastics ingested by fish, mussels, oysters, and crabs enter the food chain due to the consumption of these food by humans (Gall and Thompson, 2015).

Air Pollution: Potential health effects of exposure to plastics on humans comprise respiratory irritation, reduced lung capacity, cough, cardiovascular disease, asthma, and cancer (Karbalaei *et al*., 2018). The microplastics present in the air may cause immune dysfunction, inflammation, neurotoxicity, and changes in metabolism (Coffin and Weisberg, 2022). The extent of the impacts of microplastic on human health and air quality index is an emerging research area (Sridharan *et al.*, 2021). Decomposition of landfilled plastic releases CO2 and methane in the air while burning if PW can significantly contribute to CO2, causing global warming. Heavy metals, dioxins, and furans are also released due to the open burning of PW(Okunola *et al.*, 2019).

The ecosystem-wide effects of plastic pollution suggest that mismanaged PW and microplastics have a wide spectrum of harmful impacts ranging a wide spectrum of human and ecosystem. Thus, safeguarding the ecosystems from mismanaged PW is significant to reduce

its hazards on human, areal and aquatic organisms, and to maintain environmental vitality.

Intervention and Circular Economy Enablers for Reducing Impacts of Plastics and Microplastics in The Environment

A viable action plan followed by its strict implementation with cumulative efforts from various stakeholders involved in the plastic value chain is required to mitigate the impacts of plastics and microplastics in the environment. A cross-sector and multi-stakeholder is important in this regard. These interventions need to be implemented in the entire plastic value chain starting from the reclamation of existing PW to reducing the amount of new plastic entering the ecosystem. Thus, some key considerations and recommendations are laid out in the following paragraphs.

a. Setting up countrywide targets for PW reduction and PW recycling is required to prevent plastic leakage in the environment. A circular economy roadmap to reduce PW considering the economy, environment, technologies with emphasis on data transparency, circular business models, PW recycling technologies and use of alternative materials can serve as an action plan. The National Circular Economy Roadmap for Reducing Plastic Waste in India is made with a comprehensive view of the entire plastics value chain and systemic recommendations towards a circular economy for plastics (Dhodapkar *et al.*, 2023). A transparent accounting mechanism and robust action plan considering socio-economy, climatic conditions and the amount of PW generated for every nation would help to guide the global policy efforts in a bottom-up approach.

b. An undivided decision by 175 United Nations member states to negotiate a global and legally binding treaty i.e. Global Plastics Treaty is scheduled for completion by the end of 2024. Global Plastics Treaty can be seen as a critical opportunity for coordinated action on a global scale and an important tool to deal with plastic pollution considering the entire life-cycle of plastic. The treaty's domain is huge, encompassing the extraction of fossil fuels, polymer design, production, consumption subsequent waste management. It is supposed to emphasise on root cause i.e. plastic production rather than downstream PW management. However, the divergent interests of nations and industries in plastic-petrochemicals and legitimate concerns about trade implications present formidable challenges for the Global plastic treaty compelling it to focus on downstream waste management.[5]

c. Cutting edge-research and concerted efforts are required to fill the knowledge gaps about plastic and microplastics present in the environment. This research must cover different aspects such as the route of inflowing plastic and microplastics in living organisms and ecosystems and its consequential impact (Gallo *et al.*, 2018); (Rai *et al.*, 2021); (Vaid, Sarma, and Gupta, 2021). Recent reviews highlighted several important gaps in research to date in the research focusing on the impacts of plastic pollution (Horton, 2022). Bucci *et al.* (2020) found that 97 per cent of field

experiments focused on macroplastics, whereas, 96 per cent of laboratory experiments focused on microplastics. Polyethylene and polystyrene were majorly studied polymers, and only a few studies investigated PVC, PET, polypropylene, and others. Studies on marine environment are dominant and comparatively less research considered freshwater and terrestrial ecosystems. Perceptive the effects of various plastic types with different sizes and shapes on different ecosystems is significant to study the impacts of plastic pollution.

Novel methods of laboratory testing of microplastics for toxicity and other analyses are important. Plastic recycling technologies and the use of alternative materials for plastic can effectively reduce microplastic pollution as macroplastics are a source of microplastic generation. Similarly, microplastic prevention technologies are essential. Many technological innovations are in progress for clean-up and remediation for a variety of plastic capture approaches (Schmaltz *et al.*, 2020). Scalability and effectiveness of these technologies are significant for the development of competent PW mitigation.

Utilisation of plastic-degrading bacteria can serve as a novel approach (Sheth *et al.*, 2019). However, the efficiency and cost of further refinement of these naturally evolved enzymes are costs of concern (Tournier *et al.*, 2020).

d. Planetary boundaries approach is proposed to define the limits of waste production. Planetary boundaries are defined for climate change, genetic diversity, land-system change, and freshwater use (Folke *et al.*, 2020). Generation of greenhouse gasses due to plastic production and consumption, and the impact of plastics on humans and animals could be understood with the help of the planetary boundaries approach. Efforts for measurement of the planetary boundary for plastic pollution are significant for defining a limit for plastic pollution, which in turn may assist the global policy development (Diana *et al.*, 2022).

e. Foundation of an inclusive scientific body to develop standards for evaluating plastic pollution leakage and transparent reporting mechanisms to identify the trans-boundary nature of the problem. Development of best practices to reduce and mitigate plastic and microplastic pollution in nature is significant.

f. Public-private partnership initiatives from stakeholders of the plastic value chain including government, brand manufacturers, waste management bodies, Producer Responsibility Organisations (PROs), consumers, and the informal sector leaders can lead to capacity building and infrastructure development for sustainable PW management.

g. Product design is an important aspect which can positively affect the life span and reusability of plastic products. Restricted use of polymers and use of alternative sustainable materials can be implemented in the product design stage. Implementation of green engineering principles, eco-design and eco-labelling is important. Private players, including medium and small enterprises, can be encouraged to adopt greener activities in production.

There is a need to develop recyclable, cost-effective plastics as a viable substitute for their non-recyclable counterpart, and therefore it is important to explore and unlock the market potential of recycled plastics. It is crucial to scale up critical infrastructure for PW recycling and adequate investment in end-of-life innovation.

h. Incentivisation for various stakeholders and consumers involved in the plastic value chain and investment in an ecologically supportive PW management system is significant to attain a reduction in PW, increased recycling rate and environmental benefits.

PWM Policies for Enabling Plastic Reduction

The theme of World Environment Day in 2023 was #BeatPlastic Pollution focusing on solutions to plastic pollution which could be achieved by collective efforts of various stakeholders involved in the plastic value chain. This includes governments, policymakers, waste management bodies, private players, and consumers. Reduction in PW and subsequent microplastic pollution can be achieved by regulatory frameworks and market-based policy instruments. The worldwide Initiatives to end plastic pollution are described in the subsequent paragraphs.

a. Global Initiatives to End Plastic Pollution

An international plastic treaty to end plastic pollution- A Joint call for an international legally binding agreement on plastics and plastic pollution was presented at the third United Nations Environment Assembly (UNEA-3), December 2017. An Ad-Hoc Open-Ended Expert Group (AHOEEG) was also formed to address marine plastic waste and microplastics. The fourth session of UNEA (UNEA-4, March 2019) included a resolution on 'Marine Plastic Litter and Microplastics', and 'Addressing Single-use Plastic Products Pollution'. Accordingly, India took the resolution to phase out SUPs. 'Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal' included plastic waste in 2019. A total of 187 countries committed to resolve the crisis of PW with the help of the international treaty. Fifth UNEA (UNEA 5.2, May 2022), initiated discussions for an innovative global treaty to stop plastic pollution. Subsequently, an Intergovernmental Negotiating Committee (INC) was formed for the development of an international plastic treaty by 2024.

Several national governments have taken action and formed policies to combat plastic pollution. Diana *et al* (2022) reviewed several policy documents and related research articles and classified the various policy instruments used by governments with aim to investigate an evidence-based policy formation for PW reduction. They also formed a global database of a Plastics Policy Inventory[6] as demanded by the United Nations Environment Assembly. They observed that the national and sub-national governments used bans and restrictions on SUP and some other polymeric materials most commonly. Merely, ten policies targeted microplastics.

Knoblauch and Mederake (Knoblauch and Mederake, 2021)

reviewed about 45 articles describing policies of various nations for plastic pollution reduction. The actions include various control instruments, from prohibitions, bans and levies, taxes, and voluntary contracts between public and private partners. They also concluded that most of the policy documents have thrust on bans of SUPs.The policies focus profoundly on the consumption phase, but there is a lack of research focusing on the production phase.

b. **National Policy Interventions of India**
The policy instruments for addressing the PW crises in India are a ban on SUPs items and an EPR on plastic packaging. Ministry of Environment, Forest and Climate Change (MoEFCC) notified the Plastic Waste Management (Amendment) Rules, 2021, which prohibited the manufacture, import, stocking, distribution, sale, and use of SUP effective from July 1, 2022. This also includes polystyrene and expanded polystyrene SUPs. Moreover, the MoEFCC notified the Guidelines on EPR for plastic packaging through the Plastic Waste Management (Amendment) Rules, 2022 are presented which insist on mandatory targets on EPR.

Numerous other policy instruments and institutional arrangements are implemented to manage the PW crisis. Apart from the PWM rules Ministry of Housing and Urban Affairs (MoHUA) has strived for source segregation, collection, transportation, and recycling of PW under the flagship of Swachh Bharat Mission-Urban (SBM-U) 2.0. Initiatives such as 'Swachh Survekshan' which is an annual survey of cleanliness and hygiene and 'Star Rating Protocol' with the aim to form a mechanism for garbage-free cities are taken in line with PWMR, 2021. Constitution of a National Level Task Force and Special Task Force (STF) for the SUP elimination and the comprehensive action plans for PWM. Online platforms such as National Dashboard (for elimination of SUPs), Central Pollution Control Board (CPCB) (Monitoring Module for Compliance on Elimination of SUPs), and CPCB (Grievance Redressal App) are other important initiatives. Several states have executed their own system and regulations for PWM. Material Recovery Facilities (MRFs) are formed in urban local bodies (ULBs).[7]

Conclusion and Recommendations

Considering the actions captivated at the international and national levels, a variety of key concerns are still required to figure out sustainable and viable solutions for PW management. A few generalised set of recommendations for achieving a true plastic CEoP is described below.

a. Ban on SUPs is the most widely used regulatory policy instrument. This is quite successful as the plastic bag consumption reduction between 27 per cent and 100 per cent was observed after policy implementation as per the peer-reviewed literature (Diana *et al.*, 2022). Lack of compliance was also observed in the imposed restrictions on the manufacture and usage of banned SUP products in many cases. Thus, more powerful mechanisms are required to monitor compliance with the SUP ban in order to make it successful.

b. Strict compliance with policy instruments such as EPR can assure better PW management by imposing

responsibility on companies for collection, recycling, and waste management. The promotion of the "6Rs" framework: redesign-reduce-remove-reuse-recycle-recover is significant.

c. Policies for PW recycling and the use of recycled plastic instead of virgin plastic in products are significant. Similarly, the use of sustainable and eco-friendly alternatives to plastic with comparably lower environmental footprints is required.

d. Economic policy instruments such as incentivisation to various stakeholders at various stages of the plastic value chain, tax exemptions, grants/loans and subsidies to support businesses are essential.

e. Information policy instruments in the form of outreach and awareness for various stakeholders especially producers and consumers are vital for the minimisation of PW.

f. An effective combination of policy than individual policy interventions may have a better impact (Dhanshyam and Srivastava, 2021)

Policy recommendations to tackle plastic pollution in Oceans:

i. The land–based pathways, hotspots and point sources of marine litter must be identified and their contribution to the ocea plastic pollution must be quantified using the best available technologies.

ii. Inadequate waste water treatment significantly contributes to ocean plastic pollution, thus effective wastewater treatment can substantially reduce plastic and microplastic pollution. Similarly, dumpsites are a major contributor to plastic and microplastic pollution especially when situated close to water bodies. Thus, their proper management is essential to reduce plastic pollution.

iii. Consideration of degradation and rate of fragmentation of different polymers in marine environments is crucial. Similarly, the bio-degradability of plastic in marine environment is different. Elimination of non-recoverable plastic which has the potential to accumulate in marine environments is important.

iv. Review existing policy frameworks and other policy instruments addressing marine litter to identify the gaps and their effective enforcement and implementation of potential solutions is important at national levels as well as globally. Circular economy approaches are pertinent for a sustainable plastic waste management system and can tackle plastic pollution with a goal to achieve 'zero plastic waste'.

Endnotes

[1] (https://www.unep.org/plastic-pollution)

[2] (https://www.unep.org/news-and-stories/press-release)

[3] (https://www.statista.com/topics/5401/global-plastic-waste)

[4] (https://oceanliteracy.unesco.org/plastic-pollution-ocean/)

[5] `(https://www.thethirdpole.net/en/pollution/opinion-why-is-india-weakening-the-global-plastics-treaty/)

[6] (https://nicholasinstitute.duke.edu/plastics-policy-inventory)

[7] (https://www.mea.gov.in/bilateral documents.htm?dtl/36801/).

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Empowering Global Collaboration: India's Role in Open Science Movement

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Introduction

The progress of science has always been deeply intertwined with the accessibility of knowledge. Isaac Newton acknowledged that his breakthroughs were built on the insights of those before him, highlighting a timeless truth; i.e., science thrives on shared wisdom. This observation highlights why scientific knowledge should be accessible to all for a flourishing scientific enterprise and a well-informed community beyond academic institutions.

In the early 1500s, Nicholas Copernicus revolutionised our understanding of the cosmos by proposing that the Earth orbits the Sun. It took nearly a century for Kepler and Galileo to expand on his theory and another century for the heliocentric theory to gain widespread acceptance. Contrast that with today, where can new ideas be shared globally in an instant? How did we achieve this remarkable system of science?

In Europe, during the late sixteenth and early seventeenth centuries, a critical transformation occurred in the world of science. The era, which once favoured secretive research under the patronage of the nobility, evolved to embrace widespread dissemination of scientific findings, which the experts thoroughly scrutinised for universal validity before they hit the public domain. This cultural shift was possible due to the advent of scientific journals, enabled by the invention of the printing press and the establishment of a voluntary peer-review system. The global distribution of these journals, supported by the postal system, fostered an

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international network of science. Since the inception of copyright with the first act in 1710, it has been a vital means for authors and their publishers to earn from their creative works, especially in fields like book publishing (O'Brien, 2019). However, copyright discussions were never a central issue for academic researchers writing and publishing papers in scientific journals. With commercial journals coming into play, copyright often appears more as a mechanism for publishers to secure commercial benefits rather than a source of livelihood or a concern for the authors themselves.

Challenges in Scholarly Publishing

Today's scientific landscape is marred by challenges, primarily stemming from commercial publishers prioritising profit over the dissemination of knowledge. These commercial publishers are extremely

Table 1: Some of the Top Academic Publishers, their Headquarters, Revenues and Profit Margins

Publisher	Headquarter	Revenue (2022)	Profit margin (2022)	References
Elsevier	Amsterdam (Netherlands)	3.26 billion Euro ($3.572 billion)	37.8%	(Telescoper, 2023; RELX, 2022)
Springer Nature	Berlin (Germany)	1.8 billion Euro ($1.972 billion)	27%	(Springer Nature-Annual Report 2022; Springer Nature-Annual Progress Report, 2022; Brown, 2023)
Taylor and Francis	Abingdon (UK)	593 million pounds ($754 million)	34.9%	(Informa, 2023)
Wiley	Hoboken, NJ (USA)	$2,083 million	20.8%	(Wiley, 2022)
Alphabet (Google)	Silicon Valley (USA)	$297.13 billion	25.22%	(Companies Market Cap-Revenue, 2024; Companies Market Cap-Operating Margin, 2024)

Source: Authors' compilation.

Note: Details for Alphabet (Google) are provided for comparison of profit margins. The conversion rate from national currencies to USD is based on the prevailing rate on 6th January 2024.

profitable, with a profit margin in the range of 20-40 per cent, which sometimes is more than the profit margins of tech giant Google (Table 1). This approach has resulted in the hoarding of scholarly knowledge behind paywalls, making it inaccessible to many, especially in the Global South. Another key observation here is that all the top publishers of academic journals are located in the developed countries of the Global North. The stark divide in knowledge accessibility has not only created systemic inequities in publishing in reputed journals with high-impact factors but also led to the under representation of diverse scientific voices in mainstream discourse. The COVID-19 pandemic sharply brought this issue into focus, underscoring the urgent need for freely accessible scientific knowledge.

In response to these challenges, the concept of open science has gained renewed attention. Open science is an umbrella term to define a system of science that advocates for the outcomes of scientific research to be accessible to all, including the scientific community, policymakers, and the public. It encompasses a range of principles and practices designed to enhance collaboration, reproducibility, transparency, and inclusiveness in science. Overall, open science aims to create a dynamic community that transcends traditional boundaries of scientific disciplines and organisations, thus amplifying the societal impact of science and helping to attain sustainable development goals (SDGs).

Open science has become a critical discourse in the Indian science ecosystem as well. The fundamental principles of open science important for the Indian science system are:

i. Free access to scholarly publications and research data.

ii. Leveraging digital technologies to facilitate scientific processes.

iii. Fostering cooperation among various stakeholders in the scientific ecosystem.

iv. Sharing research infrastructure.

v. Recognising diverse knowledge systems.

vi. Prioritising science for societal benefit.

Among the open science principles, the open access debate has gained the most attention globally, so as in India. Open access is a subset of open science, focusing on removing barriers to accessing scholarly research publications. Open access ensures that the results of research, particularly those funded by public money, are available to anyone without paywall restrictions, thus promoting wider dissemination and use of knowledge.

India and Open Access

In the context of India, the approach towards open science is outlined in the 5th Science, Technology, and Innovation Policy (STIP) draft, which was released in December 2020 (Draft STIP, 2020). This draft emphasises open access to scholarly articles and research data from publicly funded projects, improving access to research infrastructure beyond academic and research institutions, strengthening Indian journals, and supporting open educational resources. One crucial element of the Indian open science draft policy

is One Nation, One Subscription, which aims to make a centralised provision to negotiate with publishers to make publicly funded research articles available to all researchers in the country.

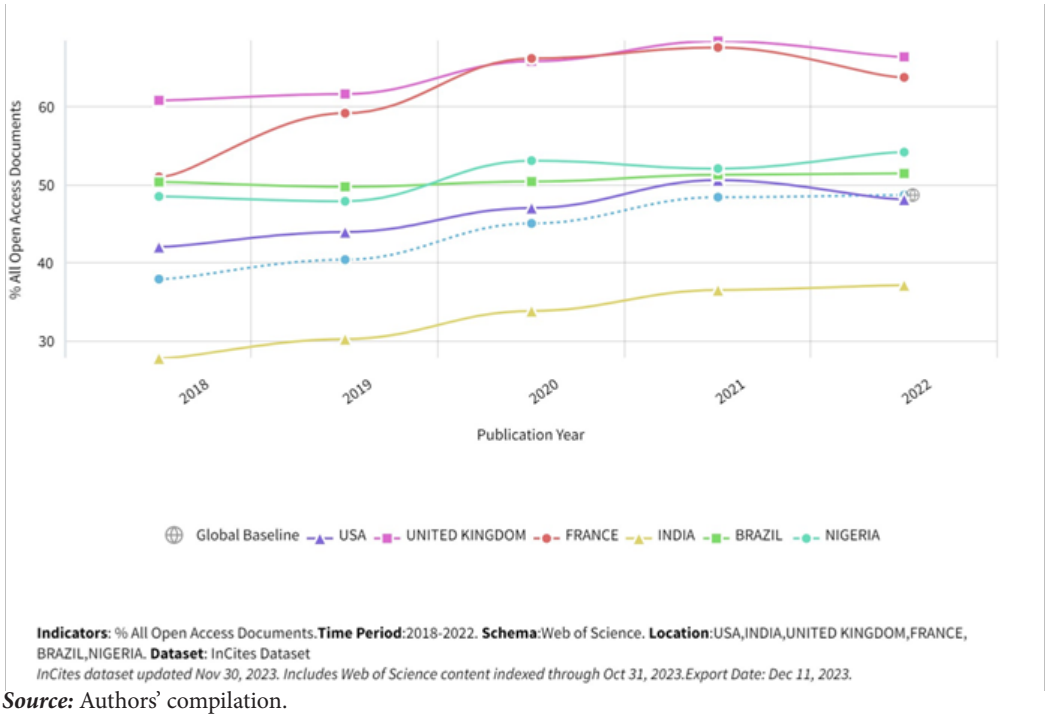
Open science principles aim to address critical issues such as the reproducibility of research, equitable access to literature, rising costs in research, misinformation, and a general decline in public trust in science. The pandemic demonstrated the effectiveness of this approach, as the swift sharing of data and research played a crucial role in the rapid development of treatments and vaccines. For example, the entire genome of COVID-19 was made publicly available in The Lancet just a month after the first patient was admitted to Wuhan hospital. Sharing of the Genome data was a crucial stage in the subsequent development of vaccines and treatments.

Open Science is now a pivotal topic of global discussion among scientists and science administrators. Initiatives like UNESCO's Recommendations on Open Science, the first international standard-setting instrument in open science, outline principles and actions to support this movement. Governments, research bodies, and science academies worldwide are aligning with these principles. Similarly, other initiatives in this area, including the White House policy guidance on open access, Wellcome Trust Open Research initiatives, Gates Open Research and the Plan S of the European Union, are driving the global acceptability of open science principles. (OSTP, 2022; Wellcome, no date; Gates Open Research, no date; Coalition S, no date)

For a country like India with relatively low R&D investments, inefficient resource distribution and highly bureaucratic science administration, promoting open science can provide opportunities to augment its scientific capacity and output, while democratising science and improving the scientific temper of the general populace. It would be especially beneficial to the state and local universities and colleges, which currently have very limited resources for R&D and contribute very little to the total scientific output of the country. One prominent example of the adoption of open science principles in the Indian research ecosystem is the Research infrastructure sharing guidelines and implementations of these guidelines in initiatives such as I-STEM (I-STEM, no date). The I-STEM facilitates the sharing of public-funded research infrastructure across the country. Many small institutions are now using the nearby facilities to conduct their analytical studies required in the research.

In fact, India shares these challenges of the science ecosystem with a large number of countries in the Global South. This could provide an opportunity for India to take a leadership position as the voice of the Global South to drive global discussions on open science towards an equitable and inclusive model. India is well placed to do this with its large and growing scientific community, rich scientific history, diverse expertise and its growing stature as a major power. Some steps have already been taken in this direction with the 'access to scholarly scientific knowledge' being one of the major agendas at the G20- Chief Science Advisors Round table (G20-CSAR) initiative led by the Office of the Principal Scientific Advisor. (G20 CSWG, 2024) Further, India has actively contributed to the deliberation during preparation of the UNESCO Recommendations on Open Science.

Figure 1: Percentage of all Open Access Documents for Brazil, France, India, Nigeria, the USA, the United Kingdom and Global Baseline Visualised for Years 2018 to 2022 in the Clarivate InCites Dataset. '% All Open Access Documents' are Defined as the Percentage of Articles Defined as OpenAaccess of Any Type



Source: Authors' compilation.

Way Forward for India in Open Science

However, a lot more could be expected from India including developing and sharing best practices in open research infrastructure, developing online platforms of international standards for sharing research publications and data, developing policy and framework for citizen science, and sharing the best practices on implementing the Scientific Social Responsibility guidelines (DST, 2022). Sadly, as shown in Figure 1, a relatively small fraction of total articles published from India are open access even compared to other countries in the Global South and the global baseline. India should also take a more proactive role in leading the respective discussions at the international forums including UNESCO and the International Science Council. Further, sharing the open science infrastructure and conducting capacity building activities can be considered for India's neighbours and other countries in the Global South. Open science with its emphasis on public engagement and possible impact on speeding up discovery and dissemination could also hold the key to best utilise science and technology for achieving the sustainable development goals.

These efforts, however, would require ambitious vision and serious coordination from India's science leadership. It would also require building synergy with ongoing initiatives like the ITEC programme of the

Ministry of External Affairs (ITEC, no date). India's leadership will be crucial for Global South to negotiate an equitable cost model based on GDP per capita, purchasing power parity and research intensity for the geographic pricing being implemented by the commercial publishers (Library Technology Guides, 2023). Here, science diplomacy could be employed to build and lead a coalition of 'like-minded' countries that could jointly negotiate for equitable and fair pricing for publication and access. Similar efforts could also help create and popularise alternative publishing models and platforms that are not commercially driven. Further, the I-STEM platform could be promoted and shared as a model for achieving similar goals in other countries.

In conclusion, science diplomacy for open science presents a promising avenue for India to address its unique challenges and aspirations. By harnessing the power of open, collaborative science, India can not only transform its scientific landscape but also significantly contribute to making academic knowledge more accessible to billions living in the Global South.

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PERSPECTIVE

BBNJ Treaty and Marine Biodiversity: A Science Diplomacy Approach to Issues and Challenges

Bhaskar Balakrishnan *

Bhaskar Balakrishnan

Introduction

As most of us know, life on Earth originated in the oceans before gradually migrating onto land and eventually air. The oceans provided a stable temperature for life to develop. About 2 billion years ago, there was a great oxygenation, probably caused by a bacterium known as cyanobacteria in the oceans. This resulted in raising the atmospheric concentration of oxygen from 2 to over 20 per cent and enabled the present form of aerobic life to emerge. This shows that the oceans can have a profound effect on the atmosphere and the climate. Without the oceans, therefore, it would have been impossible for life as it is today to have emerged.

As of 2021, the number of known marine species is about 240,000, but this figure represents only a small fraction of the estimated 1.5 million marine species on Earth. The extreme diversity in the microorganisms that live in the oceans, such as bacteria, phytoplankton, and various marine habitats, gives rise to diverse life forms; many are still unknown. Further, into the deep ocean depth exceeding 4000 meters to the continental shelf and the seashores, there exists a wide range of ocean habitats.

Today, biotechnology and genomics have witnessed several advances. Humanity has been able to manipulate the genes in living organisms and then use them to produce

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useful products. The same is happening with the marine species. Oceans are facing a big threat of pollution from land runoff, as well as plastics. The impact of climate change is also changing the characteristics of the oceans. Further, there are concerns about increasing human pressures posed by existing and emerging activities such as fishing, mining, marine pollution and bioprospecting.

The oceans already provide the world with goods and services worth at least USD 2 trillion every year. The blue economy is still in its early stages. Around 3 billion people depend on fish for livelihood and as a source of protein. More than half the world's marine species could be on the brink of extinction by 2100 and may remain undiscovered forever. Many useful chemicals used in the health industry, the health sector, as well as industrial compounds, can be derived from marine organisms. Marine biodiversity is particularly rich and vulnerable around seamounts, vents and sponges and cold-water corals. This is a very rich kind of spectrum. But if they go extinct, then humanity would not be able to produce those useful products. So, there is a need to protect marine biodiversity and reduce and restore marine habitats. That is what the whole ongoing exercise is about.

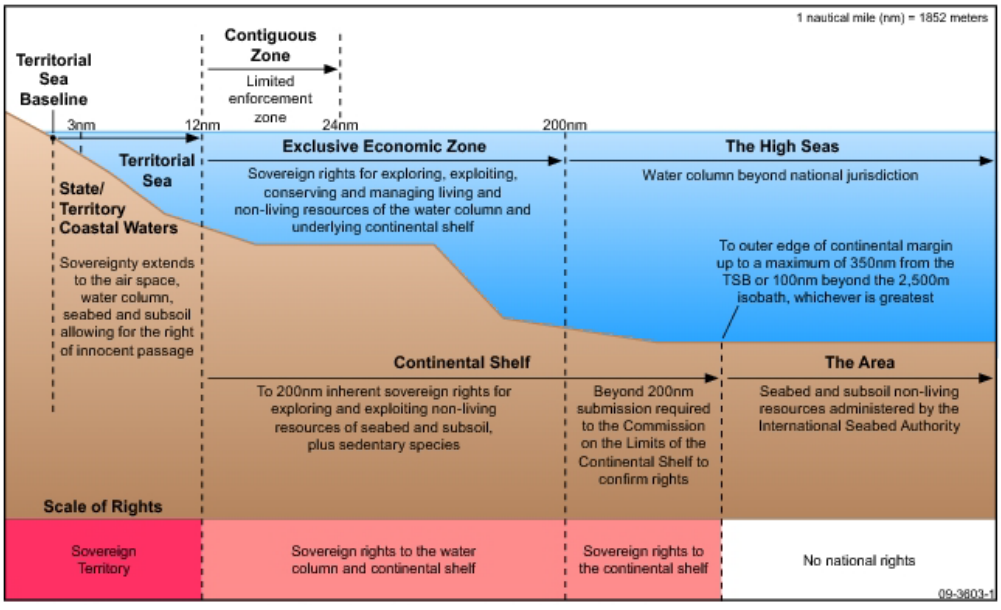
Governing Marine Biodiversity: Evolution of the Existing International Legal Regime

The United Nations Convention on the Law of the Sea (UNCLOS)does not refer to marine biodiversity as such, but it is regarded as establishing a legal framework for all activities in the ocean. That means it is a kind of umbrella treaty. Now, there are other instruments which deal with biodiversity. The Convention on Biological Diversity which entered into force in 1993 defines biodiversity and aims to promote its conservation. However, it doesn't distinguish between the land and the oceans. One of its aims is to promote the conservation of biodiversity. This was intended to apply to national territories, but for areas which are beyond national territories, which are open to everyone, the convention can be applied to processes and activities carried out by state parties, including activities in the open ocean.

Because of the concerns over biodiversity, especially in the oceans, a new emerging High Seas Treaty, also known as the Treaty on Biodiversity Beyond National Jurisdiction (BBNJ) has been concluded. This is a new international agreement, the need for which has been agreed and accepted by all countries for the conservation and sustainable use of biodiversity. The BBNJ covers about 61 per cent of the ocean which is accepted as the "high seas" the part of the ocean upon which states have no national jurisdiction over. The oceans are divided into different zones, some of which come under national jurisdiction, but 61 per cent of it is beyond any national jurisdiction. It is an open ocean. In the High Seas Treaty discussions, the Indian delegation is led by the Ministry of Earth Sciences (MoES) and has participation from the Centre of Marine Fisheries and Research Institute and the Ministry of External Affairs. The MoES is the nodal ministry tasked with coordinating all the activities regarding this agreement.

The UNCLOS demarcates the oceans into various zones based on the level of jurisdiction that countries can exercise over their seas. The treaty thereby designates various zones in the oceans as coming

Figure 1: UNCLOS Jurisdictions



Source: Kaluza, A., Lindow, K., & Stark, R. (2018). Investigating challenges of a sustainable use of marine minerals resources. Procedia Manufacturing, 21.

under the jurisdiction of different countries. Starting from the territory of the landmass, the first zone is the territorial sea, which is about 12 nautical miles, that is the national waters. Beyond this is the contiguous zone which extends up to 24 nautical miles where a little bit more freedom is given to other states (Figure 1). Adjacent to this is the exclusive economic zone, which is up to 200 nautical miles, where other countries can exercise their freedom of navigation, but the state to which it belongs has the right to the economic resources. UNCLOS also contains provisions regarding the delimitation of a continental shelf for which each country has to file a claim about how far the continental shelf extends. Once that claim is accepted by a UN commission, the country concerned has the rights to the resources on the seabed of the continental shelf. The High Seas Treaty concerns Areas Beyond National Jurisdiction (ABNJ), the zone adjacent to EEZ.

The UNCLOS is a kind of mother agreement. It started with the UN Seabed Committee in 1968. Then it was finally signed in 1982 and entered into force in 1994. The negotiations took a long time, as it was a very complex matter. Also, countries like Indonesia, which are archipelagos, had their own peculiar requirements about their territorial waters. And then there are countries which were keen on freedom of navigation of warships, submarines, a very complex set of issues. It took a long time before these could be resolved in the form of a treaty. Even then there was the issue of deep-sea mining, which was unresolved and that was discussed up to 1994. This resulted in a separate agreement on deep sea mining that entered into force in 1996. In 2001, another agreement on the conservation and management of fish stocks entered into force. These are regarded as the three main implementing agreements of the UNCLOS.

In 2017, the United Nations General Assembly decided to convene an intergovernmental conference (IGC) for another treaty for the conservation and sustainable development of marine biological diversity in areas beyond national jurisdiction. This was the starting point of the whole High Seas Treaty programme. This was preceded by the work done by the Ad Hoc Informal Working Group established by UN General Assembly Resolution 59/24 (2004) to deal with illegal, unregulated and unreported fishing. To address the complete challenges, the working group met, and recommended the BBNJ treaty. The working group met four times between 2006-2011 and identified the four major issues to be addressed: marine genetic resources, area management tools, capacity building and environment impact assessment. It further discussed the scope, parameters and feasibility of an international instrument under UNCLOS and recommended a decision to be taken by the UNGA on negotiating a new legal instrument to address these issues. The Rio+20 conference, in 2012 also gave a push to the whole process and it gained momentum.

The working group recommended a decision by the UN General Assembly to give the mandate for a legally binding instrument. Their first resolution was materialised in 2015 by establishing a preparatory committee to make recommendations to the General Assembly. The PrepCom considered the scope of this treaty, and also it worked out a list of issues which had to be dealt with. Even though on many of those issues there were differences of views it recommended to the General Assembly to convene an intergovernmental conference to draft the treaty as soon as possible.

The United Nations General Assembly, in 2017, established the Intergovernmental Committee. The committee specified a timeline of four sessions, with a completion date by 2020. But like most of the optimistic UN enterprises, it did not complete its work within the anticipated time. Several meetings were convened in 2018 and 2019 to meet the objectives. Then the COVID-19 pandemic shifted the discussions to online for the period September 2020 to February 2022 to share views on several issues in the draft.

The fourth session was held in March 2022 with COVID-19 restrictions. There was only limited participation. This gave rise to disappointment, especially among non-governmental delegations, because they were very keen to participate in this whole process. And because of the limited participation, they could not participate the way they had expected to. The fifth session held in August 2022, failed to negotiate a consensus and divergences remained. So, the Conference President Lee Hsien Loong of Singapore suspended the conference, indicating that its resumption would be contingent upon the directives of the UN General Assembly and the timeframe allotted by it. At that point, President Lee introduced a revised draft text, which basically summarised the work which has been done up to then. Of course, there are a lot of brackets in the text, and the understanding is that nothing is agreed until everything is agreed.

Core Components of the BBNJ Treaty

Marine Genetic Resources

The second part of the treaty which discusses Marine Genetic Resources (MGRs)seeks to achieve their sustainable

use, along with trying to ensure a fair and equitable sharing of benefits drawn from harnessing them. This is important because the genetic information contained in marine organisms can be used to produce a wide range of biochemicals. And marine genetic resources can benefit mankind through applications in pharmaceutical compounds, cosmetics, and a wide range of products. By modifying these marine organisms, and tweaking the DNA, different types of products can be created. Further, organisms found in the deep sea, have interesting characteristics such as luminescence. A lot of valuable properties of these organisms can be of use for industry and human applications. Decoding the genetic makeup of any species, reveals a sequence of amino acids in the DNA, which can be converted into a digital form. From this digital sequence, the structure of DNA can be decoded and can be transmitted to another organism. Digital sequence information is a way of holding the information about the DNA. Therefore, access to it is very important, even for people who are not exactly there, where the organism is found.

Already some medicines have been derived from marine organisms, like Cephalosporin, which is a very common medicine used for the control of bacteria and for conducting clinical trials of other compounds such as cytotoxic compounds. These products are important for cancer treatment and more than 1000 new compounds are being added to the pipeline of trials with varying potencies and biological functions. This just goes to show that this field is a very active one with a lot of interest in the pharmaceutical sector. The marine biotechnology market is forecast to reach over 7 billion by 2026, and it's growing very fast. And the growth is rapid in medicine, energy and agriculture.

UNCLOS gives all countries the right to conduct marine scientific research in the open seas. However, these rights are conditional on certain duties and adherence to the UNCLOS, which should protect the marine environment. However, these stipulations are general and not clearly defined in the treaty. Now, there were persisting divergences of views between member-states, and the UN member states on several aspects of marine genetic resources in the draft treaty text. Put simply, some people felt that if MGRs could be found in the open sea they should belong to all countries. But others believed that finders should be keepers. There's a big gap there in the views of states. So, before the BBNJ treaty entered into force, the issues surrounding MGRs remained a grey area with a lot of challenges.

In the high seas, the collection and exploration of organisms require a lot of technical human and financial resources. Only a few countries actually are equipped to do that. Some of the requirements are for research vessels to be equipped with modern sampling tools, including for deep sea research, and for people who are trained in all disciplines of marine sciences. This is somewhat of a handicap for developing countries to have all this expertise with them. Onshore laboratory facilities of various levels of sophistication are also required. The deep-sea research vessels can cost $25,000-$100,000 per day, chartering fees, and they are generally operated as public-funded facilities. China has already got about 60 marine research vessels in use and it is building a new one. They clearly seem to have recognised the importance of biological resources in the seas.

Who are the main actors who are exploiting MGRs? It turns out surprisingly

that one single company in Germany, BASF, has already registered about 47 per cent of all marine sequences. Its repository already exceeds the share of all the other 220 companies. Among universities, the Weizmann Institute based in Israel is the leader. Among countries, Germany, the US and Japan have the bulk of the patents. It's clear that this whole patent activity is highly concentrated not only among countries but among universities and corporations.

So, there is a need for inclusive and better participation by all states, and in this whole field of exploitation of marine genetic resources. It is necessary to clarify the legal regime for sharing and access to these resources. At present, there is no clear legal regime. That is why companies are going ahead and patenting as much as possible, because they realise that, when a legal regime comes, they will have to comply with certain requirements. There is also a need for greater transparency regarding the origin of the species. When something is patented, its origin should be disclosed, because that might be in an area where the countries around that area may have the right to this information. So, transparency is a problem for all these patents. Patent ownership also needs to be made clearer. And activities of corporations with a disproportionate influence over the patenting of marine biodiversity need to be watched carefully.

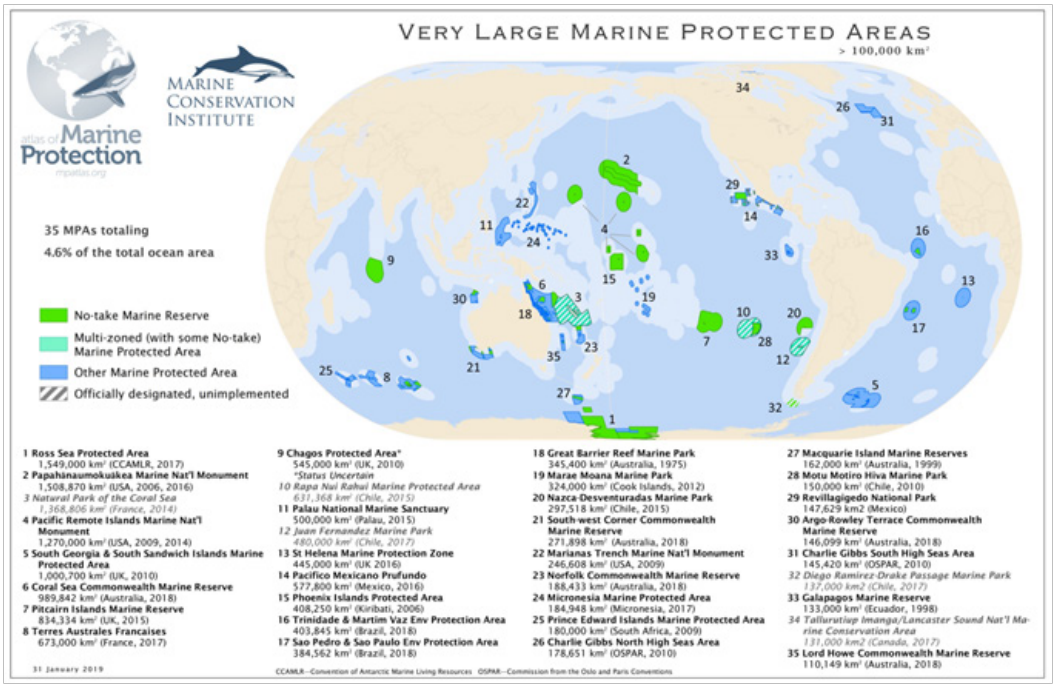
There is a need for mandatory disclosure of the origin of MGR and its country of origin. A lot more work needs to be done about who are the dominant players in marine genetic resources and whether this dominance by a few actors is actually a good thing for equity and better ocean management in the long term. The idea that genes could be patented has been an important motivation for many pharma companies and some have actually tried to patent genes. But the US Supreme Court in 2013 in Association for Molecular Pathology v. Myriad Genetics gave an important decision saying that genes which occur naturally cannot be patented, but artificial gene sequences or gene sequences formed by modifying natural genes can be patented. This is applicable to naturally occurring MGRs also.

Area-based Management Tools

Area-based management tools are emphasised in the draft treaty. They are termed as such because they are important means to manage select areas of the ocean can be managed, somewhat similar to national parks or reserve forests. Because, when marine life is being threatened, the obvious answer is to create a zone where fishing is either restricted or prohibited so that the marine life doesn't get totally fished out of existence. Marine Protected Area (MPA) is a term that has been widely used area-based management tool. An MPA is an area of the ocean, where the government has placed limits on human activities, and the goals are to protect marine habitats, and biodiversity, sometimes to conserve historic sites. And there are different names, marine parks, marine conservation zones, all kinds of things.

MPAs can be established along coastlines of states, in estuaries, in the Great Lakes, or even in the open ocean. In cases where one government has power over the coastal or open ocean, then of course, they can set up the protected areas. But when it comes to the open seas, where no single government holds jurisdiction, it requires international agreement. And that is why this whole subject has come into the

Figure 2: Marine Protected Areas



Source: Marine Conservation Institute, 2024.

High Seas Treaty. If protected zones are to be set up over 61 per cent of the oceans, then there has to be some framework to manage this process systematically. Without a robust framework, countries may independently declare protected areas and attempt to enforce them which would lead to conflict with fishermen.

So different types of restrictions are there. Some protected areas allow no human entry, some allow no fishing, and collecting, some allow fishing during parts of the year, and so on. The level of protection can vary with the time of the year and with location. So there are very large, marine protected areas in the US, amounting up to at least one and a half million square kilometres. The small Pacific Island of Kiribati boasts a substantial protected area of nearly half a million square kilometres.

In Figure 3 the green patches are all the marine protected areas, which have already been set up. And most of them are in areas which belong to some state or the other. There are very few which are there in the open ocean.

The part of the treaty focused on area-based management tools establishes a process for countries to set up a protected area. First, they must identify the area and the rationale for its selection. They must then submit information regarding whether they have consulted the stakeholders, including other affected countries and the local population, to gauge their agreement with the project. Then the international community will take a decision and it goes to the Conference of Parties once the treaty is signed. The Conference of Parties, the highest body, will take the final decision on the establishment of

protected areas, addressing questions of international cooperation and coordination. Countries will need to collaborate on the implementation, monitoring, review, and reporting obligations. To ensure the effectiveness of these marine protected areas there must be some mechanism for periodic reporting on their success in protecting biodiversity, detailing results and identifying any problems.

There is one type of Large Marine Ecosystem (LME) which has been there for a long. It was defined by the US National Oceanic Administration, as well as the UNGEF. They're mostly on the coastline of different countries. And there are 66 of them. These have been identified because of the rich marine biodiversity. As you go out from the land, the zone near the coast is where you have a lot of marine life because of a lot of nutrients and it's not so deep. As you go out into the deeper ocean and the extremely deep part of the ocean, the amount of marine life becomes less, it's largely some fish moving around, or at the bottom you have a specific type of marine species. But there is an important number and richness of marine life that is largely around the coast. And that is precisely the area that fishermen depend on because they go out, catch fish, and come back.

Out of 66 LMEs, which have been designated across the world, two of them are in the Arabian Sea and the Bay of Bengal. The whole idea of designating LMEs was that the countries which are bordering the LMEs should get together and work to conserve marine resources because they are trustees of the respective parts of the ocean, and they should do something to protect marine biodiversity. And then, of course, the UNGEF decided to fund such projects through the FAO, through other UN agencies, and some of them did succeed. The Gulf of Guinea has such a project. But by and large, most of

Figure 3: LME 32 in the Arabian Sea

Total area:3,950,421 km2. Very high risk
Coastal area: 513 873 km2. Population of 28 mn (2010) is projected to increase to 109 mn (2100)
Bordering countries: Bahrain, Djibouti, India, Iran, Iraq, Kuwait, Oman, Pakistan, Qatar, Saudi Arabia, Somalia, United Arab Emirates, Yemen.

Source: Author's compilation.

Figure 4: LME34 in the Bay of Bengal

Total area:3,657,502 km2, Very High Risk
Coastal area: 874 413 km2. Population of 323mn (2010) projected to increase to 502 mn (2100)
Bordering countries: Bangladesh, India, Indonesia, Malaysia, Maldives, Myanmar, Sri Lanka, Thailand

Source: Author's compilation.

these, especially those in the developing countries have remained neglected. I doubt whether anybody in India even knows that there are two LMEs where we are sort of the main custodians.

Figure 5 shows the Arabian Sea which is LME 32. This has been categorised as very high risk. 28 million people depend on this particular LME and their numbers will go up to 109 million later. As the bordering countries include India, Pakistan, the Gulf states and some of the African states, it is geopolitically a very complex problem to arrive at a system for managing the particular LME. So, nothing really has happened with the LME 32.

Figure 6 represents LME 34 situated in the Bay of Bengal where India has a big role to play. It is at a very high risk and as many as 320 million people depend on it for their livelihood. The countries, which border it, are much more cohesive groups. Geopolitically, it would be more feasible to get them all together to work. The BIMSTEC, the Indian Ocean Rim Association, and the ASEAN already exist. So, perhaps something is possible in this particular LME.

Capacity Building and Technology Transfer

The next part of the treaty is about Environmental Impact Assessment that covers the points about who conducts such assessments, how will it be done and who reviews it and who takes the final decision. Following this, the treaty discusses capacity building and transfer of technology (CBTT) issues. Discussion on this particular subject has been much less divisive. The main issue is that developing countries want much more ambitious commitments, while the developed states are trying to avoid strong provisions and obligations. The developed states are trying to dilute the language because they don't want to be held accountable for doing more on capacity building and transfer of technology.

There is likely to be a dedicated capacity-building transfer of technology committee, which will be set up. The committee will monitor and review the kind of capacity-building activities which are going to be supported. There is a lot of discussion on how capacity-building activities can be included in the treaty- whether to put it in the text, which means it will be difficult to amend it if needed or in an annexure which will be a kind of indicative non-exhaustive list of activities. It could form part of the agreement, and it can be periodically updated. Some countries prefer deferring the development of a list to the Conference of Parties or the CBTT committee, arguing against detailing everything in the treaty at this stage. However, developing countries want some basic topics to be listed in this to ensure they are addressed. But generally, the discussions have been less divisive compared to the ones on marine genetic resources.

Emerging Challenges to Marine Biodiversity Protection and the Way Forward

There are a number of other processes and legal instruments which go on which affect marine biodiversity, in an indirect way or direct way. Several conventions have been signed and agreed upon by almost all countries. The Basel Convention, 1992, is about the transboundary movement of hazardous waste. In other words, you can't decide to dump hazardous waste somewhere in Africa or in India. The country dumping the waste would have to consult the receiving country and it has to be informed consultation. The Rotterdam Convention, 2004 is about the movement of hazardous chemicals, basically, across the sea. Informed consent is again required, if you have harmful chemicals coming in or moving near a country's waters, it has to be informed.

The Stockholm Convention which entered into force in 2004 is on persistent organic pollutants. There are a lot of chemicals- organic chemicals, which remain for a long time in the environment. And they sort of percolate through the food chain. For example, DDT. The Stockholm Convention lists out these chemicals which need to be phased out or controlled, and there is a lot of discussion before any chemical is listed because obviously the industries are affected. Then there is a process to arrive at a treaty on plastics and this includes marine litter and plastics in the oceans, and the harmful effects of microplastics.

The UN Environment Assembly held in 2022, took a decision that a group like the IPCC on pollution and waste management of chemicals would be set up. This was a landmark decision. This implies that an expert scientific committee, can provide annual reports about the hazardous pollution and waste management of chemicals. Now, this includes air pollution, which is a major problem for us. So, this is keenly followed and further movement is awaited in this direction. The second initiative was actually taken by India, which is a resolution calling for a legally binding treaty to end plastic pollution. This was adopted unanimously and both the processes are underway. The prime minister himself has talked about the treaty to end plastic pollution.

Microplastics is another major concern. Plastics discarded in the ocean break down into smaller particles over time, and once they fall below five millimeters in size, they are ingested by marine organisms. These

particles then accumulate in the marine food chain and eventually enter our bodies through seafood consumption. The issue is twofold: not only are microplastics a physical problem, but they also pose a chemical threat. Microplastic particles can absorb and concentrate other pollutants, enhancing their harmful effects. This problem is pervasive, with plastics visible on the ocean surface, at the seabed, and along beaches. Despite our tendency to view plastic waste as a distant problem, it inevitably impacts us as these pollutants re-enter our environment.

Capacity building and research and development in marine biosciences is important. Developing countries need to strengthen their ability in this field. India has proposed a resolution calling for a treaty to end plastic pollution. This again, is a very noteworthy initiative. Of course, it's a challenge even for India to get rid of single-use plastics, but we have to try it.

Note: This paper is based on the 46th Science, Technology and Innovation Policy (STIP) Forum public lecture delivered by Ambassador Bhaskar Balakrishnan on 30

Box 1: Biodiversity Beyond National Jurisdiction Agreement

The BBNJ Agreement was adopted by consensus by over 200 countries on 19 June 2023 at the 5th Intergovernmental Conference held in New York. Along with the Preamble, the Treaty consists of 12 parts which have 76 articles and 2 annexes.

- **Part I (Articles 1-8)** consists of general provisions and includes definitions, objectives and general principles. The scope of the treaty

- **Part II (Articles 9-16)** entails provisions that pertain to marine genetic resources (MGR) and the utilisation of digital sequence information drawn from them. While striving to ensure the sustainable use and conservation of MGRs, these provisions also seek to achieve a fair and equitable sharing of benefits drawn from their exploitation.

- **Part III (Articles 17-26)** of the Treaty contains provisions concerning the institution of area-based management tools including marine protected areas. As per article 19, state parties to the treaty may individually or collaboratively submit a proposal to establish an MPA to the treaty secretariat. The constituent elements of such a proposal are also outlined. The process for reviewing such a proposal is laid down in Articles 20 and 21. Articles 25 and 26 pertain to monitoring and review and implementation respectively.

- **Part IV of the Treaty (Articles 27- 39)** pertains to Environmental Impact Assessment (EIA). It lays down the requisite processes and thresholds based on which the state parties should conduct and report EIAs. Article 28 of the treaty herein imposes an obligation on the state parties to conduct EIAs.

- **Part V (Article 40- Article 46)** contains provisions concerning capacity building and the transfer of marine technology. The provisions herein seek to extend

assistance to developing country parties to comply with the treaty and help with its implementation.

- **Part VI (Article 47- Article 51)** elaborates upon institutional arrangements including the Conference of Parties, Secretariat and the Scientific and Technical Body.
- **Part VII (Article 52)** pertains to financial resources and funding mechanisms.
- **Part VIII (Article 53-55)** contains provisions relevant to implementation and compliance
- **Part IX (Article 56-Article 61)** lays down the process for settlement of disputes.
- **Part X (Article 62)** calls on the parties to the agreement to encourage non-parties to adopt legislation which is consistent with the treaty.
- **Part XI (Article 63)** calls on parties to fulfil their treaty obligations in good faith and not in a manner that would amount to an abuse of right.
- **Part XII (Articles 64-76)** consists of provisions which detail the processes for signature, ratification, amendments, reservations and denunciation.

December 2022. The BBNJ treaty was being negotiated at the time. The Agreement was subsequently adopted on 19 June 2023 and remains open for signatures until 20 September 2025. The draft of the lecture has been updated and revised accordingly to reflect this. India has joined the Agreement and is expected to ratify it soon.

EVENT REPORT

International Co-operation to Enable Capability Building for Women in Physics

Uthra Dorairajan*

Uthra Dorairajan

Introduction

In the world of science, particularly in disciplines like physics, the gender gap is a long-standing challenge; the reasons for this are diverse and deeply rooted, ranging from societal expectations and unconscious biases to a lack of supportive networks and role models. Gender equality is a goal in itself, as recognised by the UN SDG5. To achieve this, there is an evident need to create platforms where women can connect, share their challenges and empower each other. As a step towards fostering inclusivity and diversity in science, The Abdus Salam Centre for Theoretical Physics, ICTP, Trieste, Italy organised a Career Development Workshop for Women in Physics in a hybrid format during 6-10, November 2023. This workshop combined a variety of highly interactive sessions, world café format discussions, talks by inspiring women, panel discussions, poster presentations and skill-enhancing training sessions. Along with the regular capacity-building exercises, it included drama therapy workshops, sessions on negotiation skills and understanding dilemmas that were unique and consciously designed. This workshop brought together 118 women that included more than 90 online participants from 46 countries across the globe (ICTP).

Ensuring Safe Space

Science diplomacy calls for multi and transdisciplinary as well as intercultural sensitive approaches and adopting gender perspective (S4D4C). This workshop was curated with such a perspective that is necessary for a deeper and broader understanding of various aspects that help or hinder the growth of women world. To achieve this, a safe, bias-free environment where women can share their experiences and

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gain self-confidence through dialogues becomes crucial. Creating such a safe space is the mission of the workshop as conceived by Prof. Shobhana Narasimhan, JNCASR, India. With the first edition held in 2013, this workshop has been organised for the past decade at ICTP by her along with Prof Elizabeth Simmons, University of California, San Diego and Dr Erika Coppola, ICTP. The opening remarks by them set the tone and a creative ice-breaking session through drama therapy helped all the participants travel together in the same plane during the workshop.

Being Relevant for Global Opportunities

Horizon 2020 project GENDERACTION briefing paper highlights key gender issues for international STI cooperation. For better promotion of gender equality in policy design and implementation of STI at the international level, it recommends anonymisation, different career paths, flexible age limits in mobility schemes, special efforts to reach women researchers for collaboration and recognising publications in different languages. It is important to create awareness and sensitise people in academia, R&D, and innovation hubs to evolve better pathways to support women workforce. These came to fore in different sessions of this workshop which helped the participants build skills to manoeuvre in the international S&T arena. Mini workshops on preparing an effective CV threw light on these. Inputs on the upskilling, updating CVs, elements to be highlighted and those to be avoided were practical to every research scholar, academician or scientist participant of the workshop. They encouraged different formats with relevant details based on the purpose, viz., applying for funding, special grants, academia, post-doc positions, attending seminars/ conferences and based on international/ national purposes. Due to the socio-cultural background prevalent in general, many of the participants, especially from the developing countries were surprised to learn about anonymisation of curriculum vitae. Exchanging CVs with participants from other countries for reviewing and rewriting changed our perspective. Every participant got to understand new elements and was sometimes taken by surprise, where a few countries expected the CV to be bilingual, and specify marital status/children present, especially in the case of women researchers and teachers. Importance of having an updated website with a QR code or a video CV was brought up during the discussion, to set the career trajectory in contemporary times.

Future Policy Actors

World Café format discussion on how your country values scientists/women/ women scientists brought various issues to the table, reflecting the epistemic inequalities which are an effect of existing power and knowledge structures, including one relating to gender. Issues on granting maternity/medical leave on time, unhealthy working conditions, and access to information are a few issues women face which are unattended and make the pipe more leaky. A few solutions, laws/ rules followed, women's re-entry fellowships surfaced which were reassuring and emboldened the younger participants to become change makers and communicate to the policymakers as stakeholders. For effective engagement in science policy, negotiation is one of the key soft skills to be developed. The European Commission's Joint Research Centre insists why researchers need to collaborate closely with policymakers in order to address the wicked problems of our age [EU]. Mini workshops on negotiation opened the floor for this, by engaging the participants

in mock negotiations. These role-play simulations allowed them to identify the boundaries and optimal conditions for applying their scientific expertise and explore ways to become future policy actors.

Skillset for S&T World

Training sessions on the art of visual presentation and on giving scientific presentations helped the research scholars and academicians grasp the nuances of creating clear, concise and compelling slides to make a huge impact on their audience. Discussions during publishing without perishing added an altogether different dimension to how we look at research outcomes and our biases. Based on these inputs, participants presented their works and identified the scope for improvement. Researchers face dilemmas often while making decisions on choosing the right methodology, journals, career moves, collaborations, applying for awards, being inclusive and many more. In an interactive session on dilemmas, participants were asked to resolve and discuss situations in the context of a critical dialogue. This creative approach elicited questions on the moral compass, helped everyone to look for alternative paths and raised awareness of maintaining scientific professionalism and integrity.

Global Opportunities in STI

Access to information and gender equality are closely linked goals that are instrumental for the achievement of the SDGs as a whole. In the current digital era, information and platforms for networking for science research, and sharing resources have the power to mitigate inequalities. Talks by eminent scientists on the opportunities at international agencies like ICTP, OWSD and Physics without Frontiers opened up an arena for engaging in their activities, research collaborations and science outreach. Training sessions on writing successful grant applications, leveraging social media for career connections and panel discussions on how to pick a research topic gave a better perspective to the participants on what is required of them to achieve global partnership.

Empowering Women

Discussions on gender and power structures in academe, gender in the context of the Intergovernmental Panel on Climate Change (IPCC) along with gender equality and inclusivity in scientific research highlighted the areas where we need to progress towards a better world. It calls for international cooperation in STI, multilateral and regional conversations through policies, and academic diplomacy amongst others. Panel discussion on balancing family and career brought diverse issues women face ranging from taking career breaks, relocation, starting a family, travel, taking leadership responsibilities, managing demands as care-givers and probable solutions. Participants and panellists shared their personal stories that illustrate the determination of women to persevere despite obstacles. Drama therapy sessions on challenges in the workplace provided a non-judgemental space to delve into their experiences and explore solutions to grow together as leaders. As the shadow pandemic is threatening women's basic rights and dignity, it is time to focus on the mental health impact on women along with their emotional and physical health.

Conclusion

This workshop for Career Development for Women in Physics which stands as a beacon of hope and unity reinforced the notion that women need not navigate challenging terrains alone. Organising workshops of this nature across the country can

facilitate participatory discussions, receive policy recommendations and ensure their contributions regarding their health and well-being to shape the G20 agenda. By encouraging such unconventional models in STI, it is possible to collectively progress towards championing 'Gender Equality and Empowering All Women and Girls' as incorporated in the G20 New Delhi Leaders' Declaration 2023.

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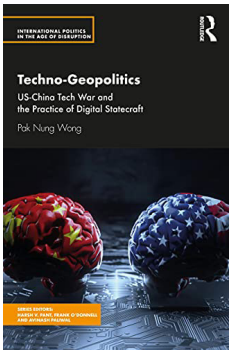
Techno-Geopolitics U.S.-China Tech War and the Practice of Digital Statecraft



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Place: **London and New York**
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Shekhar Jain*


Shekhar Jain

The book by Pak Nung Wong, *Techno-Geopolitics: U.S.-China Tech War and the Practice of Digital Statecraft*, is an intriguing read about the tech rivalry in today's world. The book delves into the U.S.-China Tech War and the concept of 'digital statecraft', discussing new-age technologies and initiatives undertaken by the U.S. and China. It explores topics such as 5G, Artificial Intelligence, and Robotics, and the contestation surrounding them within the context of the larger world order. The book contributes to a range of recent reports and publications on this subject (Jain, 2021). One of the highlights of the book is that it is crisp, pertinent and contextualises the discussion in light of historical as well as contemporary events.

The book is divided into five chapters. The introductory chapter highlights the deeper aspects of the US-China trade war, focusing on the technological competition for global economic supremacy. It places the U.S.-China Tech War in a historical context, drawing parallels with the US-Japan trade war. The chapter also discusses the spillover effect of this rivalry in international forums like the WTO. It addresses arguments linking the US-China trade war to increase US trade and current account deficits. Lastly, it highlights the impact of the COVID-19 pandemic on this

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trade war, exposing the U.S.'s biomedical and biotechnological undercapacity and its dependence on China and other countries in these aspects.

The second chapter places the US-China tech rivalry beyond the dualism of techno-nationalism and techno-globalism and argues of a new theoretical framework of techno-geopolitics. In this new framework, the author has attempted to see the novel aspects of U.S.-China techno-geopolitical containment and counter-containment. This new framework emphasises on the relevance of nonhuman agencies like artificial intelligence, Robotics in future global security, industry and social landscape. In the third chapter, the book discusses the case of 5G in detail explaining the containment and counter-containment efforts of the US and China. The book separately discusses the case of 5G in European, American and Asian contexts. The discussion concludes that the Huawei 5G ban achieved very little for the US because of the U.K.-China realist cybersecurity interdependence. The interdependent relationship between the United Kingdom and China which balances aspects of both cooperation and competition is central to S&T cooperation as well as science diplomacy. Their relationship is marked by the UK's need to engage with China because of its technological advancements, which benefit its infrastructure, and increasing economic influence, but at the same time it safeguards its strategic and national security interests through regulatory frameworks and cybersecurity measures to mitigate potential risks.

The fourth chapter of the book discusses five key questions about Chinese security and intelligence capabilities which involves understanding its meaning in several contexts such as evolution, agenda of the Chinese government, capabilities of the Chinese government, and roots of the emergence of its security and intelligence apparatuses. The fifth chapter revisits the discussions in earlier chapters and summarises the idea of 'Digital statecraft'.

Overall, the book highlights the interplay between technology and geopolitics, where the growing technological advancements (especially in terms of emerging technologies,) are affecting and reshaping the existing geopolitical dynamics. The concept of digital statecraft which focuses on the use of digital technologies for geopolitical clout is well introduced by the author. This provides a new understanding of the role of digital technologies in diplomacy and increasing influence. Through empirical case studies, the book traverses through in-depth analyses of various dimensions of technology, international relations, geopolitics and the multifaceted nature of tech rivalries and power and supremacy dynamics. The US-China tech rivalry forms the fulcrum of the book. Further, the book underscores the impact and implications of such a tech war for the global order. The author also discusses some strategies employed by the two countries to navigate through the tech rivalry. However, the book also brings forth the examples of cooperation and competition between countries especially with respect to technology, with growing techno-nationalism and technological sovereignty.

However, without discrediting the merits of the arguments made in this book, there are some points to criticism too. First and foremost, the discussion of the historical context appears short and

indicative. The author may have extended the draft with more details on the historical context while some details like explaining the technicalities of 5G in chapter 3 could have been avoided. Additionally, the role of the Chinese patent regime in establishing their technological proof could have been given more space (Love et al., 2015). Furthermore, some reflection on the Chinese informal sector might have been useful in understanding the Chinese technological space which makes them a manufacturing and export powerhouse in many product segments (Liu, 2020). Irrespective of these critics the book is an important contribution in the area of the US foreign policy and China studies and must be studied by the scholars working in this area.

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DR BHASKAR BALAKRISHNAN
22 September 1947 - 21 January 2024

With profound grief, we would like to inform about the demise of Dr Bhaskar Balakrishnan, Science Diplomacy Fellow at RIS, on 21 January 2024. He was the founding Editor of the *Science Diplomacy Review* and led the Science Diplomacy Programme at RIS. He was also the founding editor of the *Science Diplomacy News Alert*.

After finishing his PhD in Theoretical High Energy and Particle Physics from the State University of New York at Stony Brook, USA, he taught at Stony Brook and Panjab University. He also worked at the Massachusetts Institute of Technology, Cambridge, before joining the Indian Foreign Service (IFS) in 1974.

He held diplomatic assignments in Indian Missions in Geneva (1976-78, 1982-85), Khartoum (1978-80), Damascus (1986-89), Lusaka (1989-92) and Vienna (1992-95), besides senior positions in the Ministry of External Affairs in New Delhi. He also worked in UNIDO, Vienna as a Special Assistant to the Director General (1995-98). During 1999-2001, he headed the Investment & Technology Promotion Division of the Ministry of External Affairs concerned with the promotion of foreign investment and technology flows, economic reforms, energy, and transportation. He represented the Ministry in several inter-ministerial bodies such as the Foreign Investment Promotion Board, the Genetic Engineering Approval Committee, Steering Committee on Biomedical Research, and Task Force on Information Security. During 2001-2005, he was India's Ambassador to Cuba, concurrently accredited to Haiti and the Dominican Republic. Following this, he served as the Ambassador of India to Greece until his superannuation in 2007. In his long career as a Diplomat he represented India at *inter alia*, IAEA, Vienna. He played a key role in establishing ICGEB, New Delhi and worked with UNIDO and the Government of Italy for that.

After retirement in September 2007, Dr Balakrishnan worked briefly as Executive Director of the Asian Heritage Foundation, New Delhi, which works for the welfare of rural and poor artisans involved in creative and cultural industries. He was an adjunct faculty member at the JSS University, Mysore. He has delivered several lectures on important issues such as biotechnology development, IPRs and access to drugs, climate change and energy, nuclear energy, etc. to students and faculty and public. He also conducted training

workshops for diplomats of the Mauritius Foreign Ministry, under an Indo-Mauritius bilateral programme. In January 2011 and May 2015, he organised training courses for diplomats of South Pacific Island countries under a project of the Ministry of External Affairs. He had also delivered lectures on special topics as part of the training programmes conducted by the Foreign Service Training Institute of the Ministry of External Affairs for foreign diplomats including diplomats from Afghanistan, ASEAN diplomats, and India. During 2013-2014, he was a member of India's 16-member National Security Advisory Board (NSAB). He was the President of the Association of Indian Diplomats (AID), during 2015-16 an association of over 250 former Indian Ambassadors.

He authored the book '*Technology and International Relations: Challenges for the 21st Century*, published in 2018, in collaboration with the Indian Council for World Affairs (ICWA), published by Vij Books.

Dr Bhaskar Balakrishnan joined as a Fellow in Science Diplomacy at RIS, New Delhi in 2018. Since then, he had contributed immensely and played an instrumental role in shaping and strengthening the Science Diplomacy Programme and the concept and praxis of Science Diplomacy. As part of this, he delivered lectures on several platforms and published extensively on science diplomacy and related themes. He played a key role in efforts towards active engagement with the NRI/PIO STEM professionals as well as building networks with science diplomacy actors/stakeholders in India and abroad. He established contacts with India's science counsellors in the USA, Germany and Russia. He was also deeply involved in India's Space-related capacity building efforts. Thus, paving the way for an Indian Science Diplomacy, and bringing forth a Global South perspective of Science Diplomacy. He also served as the Co-Chair of the Gene Therapy Advisory and Evaluation Committee (GATEC) of the Indian Council for Medical Research (ICMR) set up in 2020. During India's G20 Presidency of 2023, he collaborated with S20 (Science 20) and contributed to the S20 process.

Dr Balakrishnan had a myriad of interests in varied themes like international cooperation, energy, environment, biotechnology, gene editing, information technology, semiconductors, development cooperation, international negotiations on global commons and multilateral governance. By bringing and bridging the worlds of science and diplomacy, he brought invaluable insights and policy perspectives. His deep interest and unwavering spirit for science diplomacy could also be seen in his capacity-building efforts. Just before his sad demise, he was working with his colleagues on developing a course on Science Diplomacy for the Capacity Building Commission, Government of India.

He is survived by his wife and their two children. Dr Balakrishnan will be deeply missed for his finest intellect and catholicity besides as the pioneer and thought leader of Science Diplomacy in India. His absence creates a significant void in the Science Diplomacy Programme at RIS but we are committed to continuing his legacy and elevating his work to greater heights and glory.

SDR Team

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

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

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.

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

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

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