1.5.3. Recent trends and future issues in science and technology diplomacy

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Abstract

In this paper, we introduce recent trends and historical changes in science and technology diplomacy, considering how these topics interact. We then introduce the circumstances under which science and technology diplomacy is increasingly attracting attention worldwide, including in advanced and developing economies, for security, political, and economic reasons, in response to the rise in international geopolitical tensions in recent years, such as the novel coronavirus disease (COVID-19) pandemic and Russia's invasion of Ukraine, and the rapid development of emerging technologies, such as AI, quantum, and biotechnology, and their major social impacts. Finally, we consider the global movement toward reviewing the future of science and technology diplomacy and the issues surrounding it.

Keywords

Science and technology diplomacy, science advice, government science and technology advisor, COVID-19 pandemic, securitization of STI, governance of emerging technologies, FMSTAN, INGSA, ISC, AAAS, Royal Society of London, Global South

1. Introduction

In the 21st century, the interactions and relationships between security and politics and between the economy, science, and technology have become important at the global, regional, national, and local levels to address global crises and social issues, such as climate change, the COVID-19 pandemic, large-scale natural disasters, energy, food, water issues, security/geopolitical tensions, and cybersecurity. As a result,

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interest and expectations for science and technology diplomacy have been increasing worldwide.

What is science and technology diplomacy? Broadly speaking, it is the interaction between science and technology and diplomacy, and it includes various international activities of science and technology throughout human history. For example, in response to the global political and military situation during the First and Second World Wars, the organization for international scientific cooperation, which had been led by Germany, shifted to the United States and the United Kingdom as leaders. The foundations of science and technology diplomacy are closely related to the changes in modern Western society and economy (Gluckman, 2022; Iwabuchi, 2021); it is a form of diplomacy that utilizes science and technology as a diplomatic tool. It was only in the 21st century that conceptualization began to be seriously discussed, and systems and methods were accumulated for each case, such as for climate change. In 2009, American Association for the Advancement of Science(AAAS) and Royal Society of London(RS) jointly proposed the concept and three types of science and technology diplomacy, and a specialized journal was published by AAAS. Since then, papers and reports on science and technology activities have been published in various fields, but most of them are descriptive, and a framework or method for integrating them has not been fully established yet. Furthermore, reflections on the response to the COVID-19 pandemic have demonstrated the need to review the purpose and organizational methods of conventional science and technology diplomacy. Currently, many experiences and cases are being accumulated and analyzed internationally by the International Network for Governmental Science Advice (INGSA, https://ingsa.org/), and an international movement has begun to help advanced and developing economies to work together to formulate theories about the nature, structure, and methods of science and technology diplomacy in a new era. In Japan, the term used literally means “science and technology diplomacy”, but overseas the term “science diplomacy” is often used synonymously.

As mentioned above, science and technology policy, its systems, and international relations are currently under pressure to undergo major changes, and fostering a perspective that provides a bird’s-eye view of the light and shadows of historical changes in science and technology diplomacy and policy is becoming important (STS Forum, 2023) (Reference 1). One such case is the international research cooperation that has developed since the establishment of modern science in the 17th century. Examples of this include the strengthening of the military power of science and technology and international cooperation during the First and Second World Wars, the creation of international rules for the development, use, and regulation of nuclear energy, space, and oceans, and the establishment of international organizations such as the International Atomic Energy Agency and the Intergovernmental Panel on Climate Change (IPCC) after World War II. Regarding international rules, science and technology such as nuclear power and space have a decisive impact on military power and the survival of humanity; therefore, the governments of the United States and the Soviet Union cooperated to create a framework for the international control of technology. The IPCC was established as a mechanism for international collaboration of data analysis, impact assessment, and the bridging of science and politics, based on the accumulation of scientific data on the cause of global warming. Multidisciplinary and international activities by countries, international organizations, and non-governmental organizations on climate change, biodiversity, SDGs, and other topics

are expanding, and there is an increasing number of papers and reports based on these experiences (AAAS, 2022). In Japan, the Great East Japan Earthquake and the Fukushima nuclear power plant accident served as major opportunities for strengthening the scientific advisory system and the science and technology diplomacy system. The authors have been involved in these science and technology diplomacy practices for many years.

In addition to these individual activities, there has been a sharp increase in recent years in the number of cases that demonstrate how science and technology interact with security, political, economic, and social issues beyond individual areas and national borders. Therefore, concepts need to be organized and theorized from a comprehensive perspective. Important issues for science and technology diplomacy at present include the strategic competition and struggle for supremacy between the United States and China in cutting-edge technology, and the dilemma of international cooperation on global issues.

In this paper, we first introduce recent trends and historical changes in science and technology diplomacy. Next, we discuss the circumstances under which science and technology diplomacy is increasingly attracting attention worldwide, both in advanced and developing economies, from security, political, and economic perspectives, in response to the COVID-19 pandemic in recent years, increasing international geopolitical tensions such as Russia's invasion of Ukraine, intensifying conflict between the United States and China, and the rapid development of emerging technologies, such as AI, quantum technology, and biotechnology, as well as their large social impacts. Finally, we consider future issues.

2. Concept and framework of science and technology diplomacy

Science and technology diplomacy involves various players as well as multi-layered structures and functions, depending on the target case and region, in a variety of fields, with diverse parties and organizations, ranging from the policy layer to the funding and R&D implementing organization layers, and a cross-border network is expanding. Below, we introduce two reports that have contributed to organizing these complex functions and structures and clarifying the concept and framework of science and technology diplomacy. These are the foundation of our present activities.

2-1. Establishment of the concept of science and technology diplomacy and three types–2010: British Royal Society and AAAS

In modern society, science and technology have played important roles not only in creating new knowledge but also in strengthening national power, including military and economic power, and in solving social and global issues such as climate change. Many of these science and technology activities are conducted through international cooperation. In 2010, these diverse international activities were organized under the single concept of "science and technology diplomacy" (Royal Society and AAAS, 2010). The Royal Society of London and the American Association for the Advancement of Science (AAAS) co-sponsored a large-scale international workshop on the role of science and technology in diplomacy, which was held over the course of two days with the participation of advanced and developing economies, United

Nations organizations, industry, academia, and government media. As a result, the concept of "science and technology diplomacy" and the following three types were proposed.

① Science in diplomacy: Utilizing scientific and technological knowledge in decision-making and implementation of foreign policy.
② Diplomacy for science: Promoting international scientific and technological cooperation through diplomacy.
③ Science for diplomacy: Building political and economic trust and improving relations between nations through international cooperative activities in science and technology.

In response, the AAAS established the Center for Science Diplomacy in 2012 and published the online journal *Science & Diplomacy* to disseminate the concept of science and technology diplomacy and introduce practical examples. Additionally, the Center for Science Diplomacy has made major contributions to the development of science and technology diplomacy network by utilizing its non-governmental status to support international scientific collaboration with countries that the US government has difficulty officially accessing, such as Cuba. Since its founding, the number and complexity of challenges in science and technology diplomacy have increased, as have the number of countries and organizations involved in the center, and the international situation has become more tense. Experts have suggested that, while the three types are important for analysis, they are insufficient for the new practice of science and technology diplomacy that have developed in recent years, and that a new concept is needed. Specifically, based on the accumulation of experience and case studies from the COVID-19 pandemic, climate crisis, SDGs, and others, the need for greater practicality and diversity in the scope and framework of science and technology diplomacy that go beyond the above-mentioned three types has grown. Activities that are useful both globally and regionally or locally are increasingly necessary, and each country and region must have the ability to set and solve problems and capacity building. To that end, the social system, history, culture, and other aspects that are specific to a country or region must be considered. The trends in recent years are shown below.

2-2. Three practical frameworks for science and technology diplomacy: 2018

Considering the above-mentioned issues, science and technology advisors to the foreign ministers of the United States, United Kingdom, Japan, and New Zealand, who have led the establishment and expansion of international science and technology diplomacy networks (FMSTAN and INGSA), jointly worked to propose the following three practical frameworks in 2018. These frameworks were based on the understanding that we have entered a new era in which science and technology diplomacy is not only discussed and analyzed at the policy layer but also used practically (Turekian, Gluckman, Kishi, Grimes, 2018).

① Actions to achieve national interests
② Actions to achieve cross-border common interests
③ Actions to achieve solutions to global issues

The proposed frameworks and actions are widely used in the field of science and technology diplomacy because they are both practical in terms of the actions taken and they confirm objectives and positions. This can be explained as follows.

(1) Actions to achieve national interests

○ Strengthening a country's international voice/influence/soft power/reputation
  • Scientific and technological cooperation, human resource development and circulation, STEM education support, development assistance.
○ Strengthening a country's security
  • Response to various crises/threats (e.g., artificial, natural, cyber), advance preparation, response, and management of crises.
  • Responses to political and military tensions (e.g., US–Russia, US–China, US–Arab, Japan–US).
○ Strengthening a country's economic power and resolving conflicts
  • Trade, technological development support and cooperation, strengthening of supply chains, responses to economic coercion, intellectual property, international standards and management, WTO.
○ Strengthening scientific and technological capabilities of a single country and international cooperation
  • Education and research environment (e.g., universities), technological capabilities, development and operation of R&D infrastructure, knowledge and technology, protection and access management of researchers.

(2) Actions to achieve cross-border common interests

○ Cross-border crisis and disaster management and cooperation (e.g., COVID-19 pandemic, floods, earthquakes, tsunamis, fires, volcanoes).
○ Resource management: Development of minerals, forests, water, etc., and environmental and conservation management.
○ Human resource development, international mobility of researches, and construction and operation of large-scale R&D facilities.

The scope of the proposal in item (2) has expanded and become more complex than when this paper was originally published because of the intensifying conflict between the United States and China as well as the impact of Russia's invasion of Ukraine. This now includes joint programs between like-minded countries,

such as the decoupling and bloc formation between so-called democratic countries and authoritarian countries such as China and Russia, protection of technology governance and cutting-edge researchers, and strengthening of supply chains. Item (2) will be explained in detail in Section 4 below.

(3) Actions to achieve solutions to global issues

- ○ Visible issues: Climate change, sustainability (SDGs), pandemic, control of nuclear / chemical / biological weapons, etc.
- ○ Responding to and managing data collection and use in invisible non-governed spaces (ocean, space, polar regions, AI, cyber), and creating rules and systems.

3. Global expansion of science and technology diplomacy community: 2010 and beyond

As embodied by the 2015 UN SDGs resolution, the importance of science and technology has increased markedly in international politics, economics, security, climate change, and environmental policy since 2010, with each country strategically strengthening its science and technology diplomacy efforts. The players are expanding to emerging and developing economies in addition to advanced economies in Europe and the United States, and they are diversifying to include NGOs and private companies. An international network of scientific advisors and related organizations expanded, and INGSA was launched as an NGO in 2014. INGSA holds general meetings every two years (Auckland (2014), Brussels (2016), Tokyo (2018), Montreal (2021), Rwanda/Kigali (2024)). INGSA has established regional branches (e.g., in South Asia, Africa, United States) and works from the bottom up to collect and disseminate examples of scientific advice, develop methodologies, and capacity building.

Around the same time, several countries established foreign ministers as science and technology advisors, and in 2015, the Foreign Ministries Science & Technology Advice Network (FMSTAN, https://ingsa.org/divisions/fmstan/) was launched. There are currently about 30 participating countries; they share information and exchange opinions on the relationship between each country's diplomatic matters and science and technology. In Japan, following the Great East Japan Earthquake and the Fukushima nuclear power plant accident, efforts were made to strengthen the system of scientific advice and science and technology diplomacy. To that end, the Science and Technology Advisor to the Minister of Foreign Affairs and the Advisory Board for Promoting Science and Technology Diplomacy were established in 2015, and they are currently active internationally as core members of FMSTAN.

In 2018, the International Council for Science (ICSU, established in 1931) and the International Social Sciences Council (ISSC, established in 1952) merged to form the International Science Council (ISC). The ISC is referred to as the "United Nations of scientists" and aims to ensure the foundation and quality of scientific research, interdisciplinary collaboration between the natural and social sciences to address social issues, and development of a knowledge base for scientific advice. This is a major turning point in the history of modern science, where fields have become increasingly fragmented.

Peter Gluckman, the second president of the ISC, is a leader in science and technology diplomacy and the global science advice network; he has discussed the potential, weaknesses, and lessons of multilateralism and science and technology diplomacy in the wake of the COVID-19 pandemic (Gluckman, 2022). The main points of his argument are as follows.

- When responding to the COVID-19 pandemic, the systems in each country were generally incapable of risk assessment, management, and communication. Distrust in government and experts increased.
- COVID-19 data were shared, and vaccines were developed at a rapid pace, but there were large inequalities in distribution between countries. Strengthening the global risk assessment, management, and communication within the WHO and UN systems is essential. Currently, the ISC and the United Nations are jointly considering the creation of a global scientific advice system.

Although the COVID-19 pandemic was truly a global disaster, one positive outcome was the realization by many global citizens that science and technology, scientific advice, and international collaboration were necessary to overcome the disease. This also contributes to the spread of science and technology to emerging and developing economies, as mentioned at the beginning of this section. At the G20 Leaders' Summit in 2023, the outcome document of the G20 Chief Scientific Advisers Roundtable, which called for the "creation of a global science advisory mechanism using science diplomacy as a tool," was adopted as an annex (detailed in Section 7-1).

4. Strategic importance of science and technology as well as science and technology diplomacy as the foundation of national power: Perception of the times

4-1. Security, science, technology, and innovation (STI) policy, and science and technology diplomacy

In this section, we focus on the 2023 edition of the OECD Science, Technology, and Innovation Outlook (Outlook 2023) (OECD, 2023-1), which is published every two years as a core report by the OECD and has a major impact on global science, technology, and innovation policy. This report emphasized the recent "rapid overlap between STI policy, industrial policy, national security policy, and foreign policy," which can be said to be a paradigm shift in conventional international science and technology cooperation. The OECD views this situation in light of the concept of the "securitization of STI" and emphasizes the importance of bridging science and technology policy with other policies, as well as with international cooperation, not only to respond from a security perspective but also to deal with crises for humanity and the earth, such as climate change, energy, food, various supply chains, and large-scale disasters.

Therefore, the OECD Outlook 2023 analyzes international politics in an unprecedented manner;

therefore, despite the long text, the relevant parts are cited below (translations by author).

“ as China is often seen as a systemic rival to liberal market economies, its rise also raises policy concerns that have deepened in recent years as relations have deteriorated. These include growing competition in critical technologies that are expected to underpin future economic competitiveness and national security, diverging values and interests that challenge the international post-Second World War rules-based order, and growing vulnerability from supply-chain interdependencies.
Technology lies at the core of these concerns, prompting technology leaders such as the European Union and the United States to promote technological sovereignty and strategic autonomy as strategic policy goals. Countries have adopted policies to restrict access to technologies (protection), invest in ambitious domestic industrial policies to bolster their economic competitiveness (promotion) and strengthen international technology alliances with like-minded countries (projection).・・・・・・Policy domains such as trade, foreign affairs, defence and industry are driving many of these policy developments, while research and innovation ministries and funding agencies have played a less central role.・・・・”

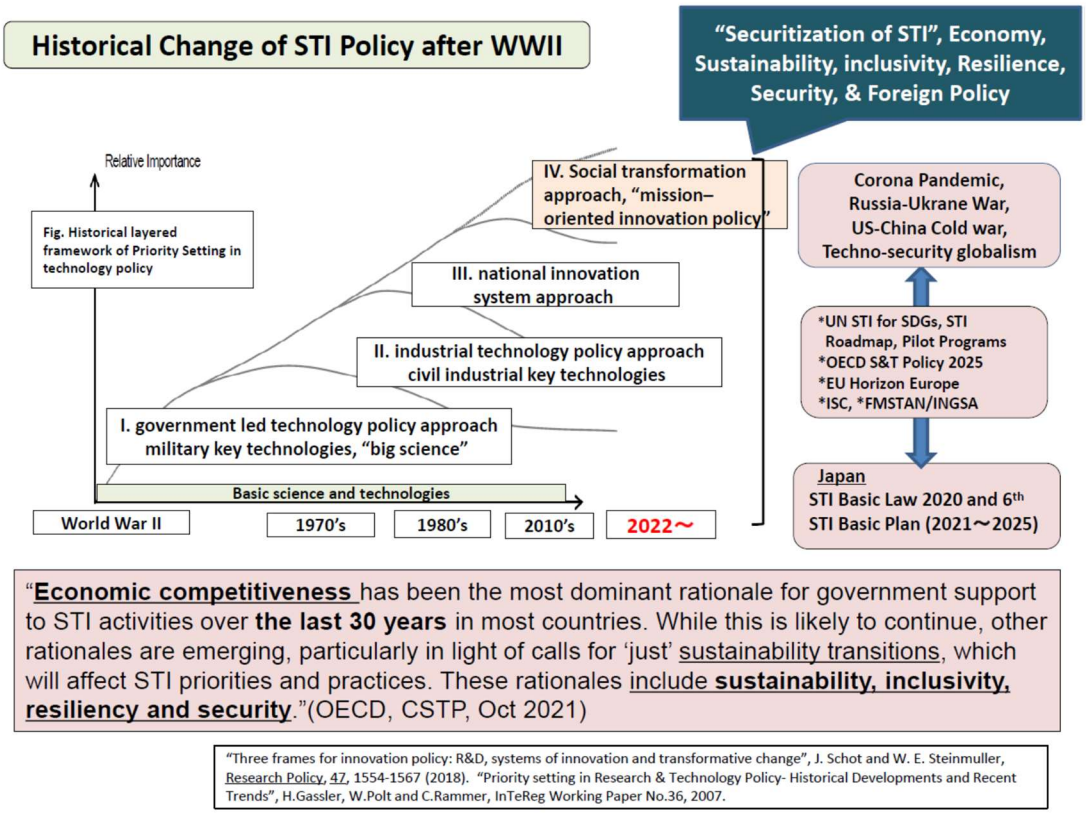
In *International Politics*, the classic work by Hans Morgenthau, industrial power, military armament, science and technology, and the ability to innovate are emphasized as the essence and various elements of national power; these elements are also given a similar treatment in recent studies of international politics (Morgenthau, 2013; Kosaka, 1966; Nakanishi, 2003; Hosoya, 2012; Sakamoto, 2011). In other words, the main elements of national power are (1) security and military power, (2) economic and industrial power, and (3) soft power (culture, academic science, etc.). Science and technology have traditionally been positioned as elements (3), but rapid changes and developments in the international situation and technology in recent years have resulted in the growing recognition that science and technology such as AI, semiconductor technology, and biotechnology, and its associated policies are extremely important as a foundation for national security and industrial competitiveness. This in turn has emphasized the extreme importance of strategy and steering of science and technology diplomacy, including competition and cooperation between countries and regions. In the outcome document of the First EU Science Diplomacy Conference held in Madrid in December 2023, the EU emphasized the “use of science diplomacy as soft and hard power” (EU, 2023), encouraging a major shift in thinking.

4-2. International economic and social system, STI, and science and technology diplomacy

The OECD further indicates that sustainability, resilience, well-being, and security will be important aspects in the future, in addition to economic value, which has been the overriding objective of STI policy for the past 30 years. Russia’s invasion of Ukraine and the new Cold War between the United States and China are forcing major changes in the international economic and social system.

In the United States, this is called the New Washington Consensus, where there has been progress in the

redesigning of the globalization, openness, and prioritization of efficiency in economic policy, and emphasis on efficiency in business location, logistics, and financial systems that have been mainstream over the past 30 years, and the resulting deeply economically and technologically interconnected global system (Sullivan, 2023). As the world witnesses the rise of anti-globalism, nationalism, and populism, there have been proposals and discussions of concepts such as decoupling, de-risking, and resilience in various sectors. As a result, the international economic rules, human rights, and democracy that were established after World War II have been seriously destabilized, and there are concerns that science and technology activities will be divided between blocs. This is an important perspective for future science and technology diplomacy. Having such a historical perspective at such turning points is important. The figure below shows the evolution of STI policy after World War II, and the increasing importance of science advice and science and technology diplomacy in recent years. It is thought that this trend will be reflected in Japan's 7th STI Basic Plan and the EU's consideration of a post-Horizon Europe.



5. Modes of science and technology diplomacy: Track 1 and Track 2

Cross-organizational responses and interdisciplinary collaborative approaches have become necessary in science and technology diplomacy in recent years, and it has become important to both domestically and internationally strengthen horizontal and vertical coordination and collaboration mechanisms at multiple layers, such as at policy, funding, research implementation organization, and individual researcher levels, as well as the development of human resources who can connect them.

The modes of science and technology diplomacy can be broadly classified into the following two types, depending on the organization and personnel in charge.

- Track 1: Ministry of Foreign Affairs and diplomats conduct external discussions and negotiations in line with government policy.
- Track 2: Science and technology community and NGOs lead external discussions and negotiations. When public funds are needed, the government often provides backing as well.

The two tracks have a mutually complementary relationship, and as the needs and methods of science and technology diplomacy diversify and the number of participants increases, it is expected that Track 2 and Track 1.5, which are intermediate tracks between the two, will play a major role. Securing the quantity and quality of organizations and human resources responsible for Track 2 is a major challenge for a society like Japan, where the mobility of human resources is low. This is described in detail in Section 7-4.[3]

6. Diversification and position of players in science and technology diplomacy at a turning point: Think and Act beyond the boundaries

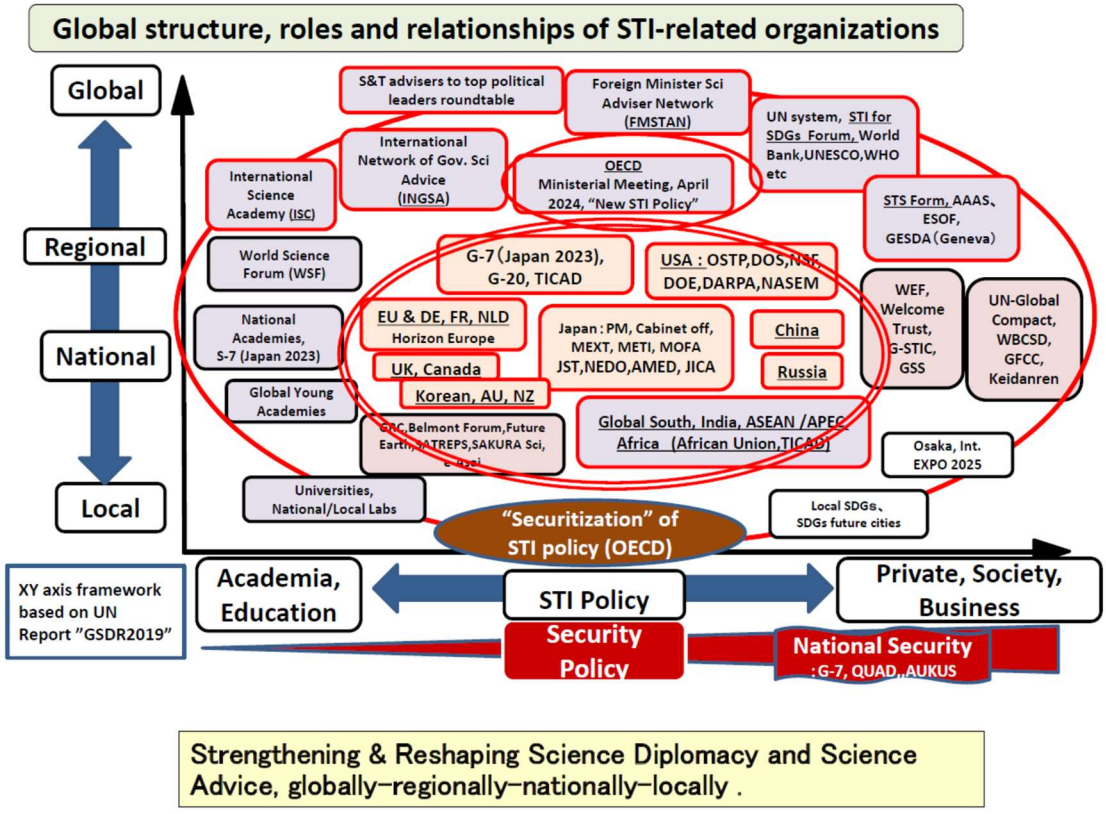
A country's science and technology promotion structure consists of a multi-layered structure of policies, programs/funding, research institutions, and individuals (scientists, academies). In recent years, the governments, organizations, and individuals that constitute each layer have expanded their international networks beyond boundaries. The main players include national governments, scientific advisors to heads of state, universities, national laboratories, research funding institutions, science academies, private companies, and NGOs, as well as international organizations such as the ISC, FMSTAN, INGSA, OECD, World Science Forum (WSF), United Nations, and its agencies (e.g., World Bank, UNESCO, WHO, UNEP).

It is important to have a broad overview of this structure and function from a global perspective and confirm the positions and roles of each player, as well as their mutual relationships. The diagram below is described as the basis for this. The suggestions of the United Nations Global Sustainable Development Report (GSDR 2019) were used as a basis to set the global, regional, national, and local actors on the vertical axis, and science and technology, politics, government, business, and security sectors on the horizontal axis to position associated organizations on a two-dimensional plane. The positions, roles, and relationships of each organization in the diagram are not fixed; instead, they change depending on the international political, economic, and technological situation.

There is a concept in international politics that modern international politics is composed of three phases and norms that coexist and compete: (1) the sovereign state system, (2) the international community, and

[3] The Ministry of Foreign Affairs of each Track 1 country has a department / office in charge of science and technology, and embassies have diplomats in charge of science and technology. There has been a recent increase in international issues that require scientific and technological expertise, such as climate change and AI, which has necessitated the involvement of experts as well as diplomats. Many countries are also establishing science and technology advisors to prime ministers and foreign ministers. For example, at the G7 and G20 meetings in 2023, international cooperation in the governance of AI, global warming, and emerging technologies was a major diplomatic issue related to science and technology at the summit level, and the international network of these advisors plays an important role.

(3) global citizenship (Gluckman, 2022). This concept is thought to provide important suggestions when considering potential actions based on this diagram.



7. Several new challenges for science and technology diplomacy

In the face of drastic changes in the global situation, we discuss the following challenges surrounding science and technology diplomacy: expanding presence of the Global South, governance of emerging technologies such as AI and biotechnology, strengthening intelligence functions, and strengthening the training of human resources that can bridge science and technology with politics and diplomacy. These are scheduled to be important topics for discussion at the OECD Science and Technology Policy Ministerial, which will be held for the first time in nine years in April 2024 (OECD, 2023-3).

7-1. Expanding presence of the Global South in the arena of science and technology diplomacy

At the 2023 G20 Summit hosted by India, a report by the G20 Chief Science Advisers' Roundtable 2023 was released that discussed strengthening scientific advice and science and technology diplomacy; this topic has begun to attract attention on a global scale, including in the Global South.

(Excerpt from "A way forward: Creating an inclusive, continuous, and action-oriented Global Science Advice Mechanism")

"Item 15: We will work towards creating a robust, relevant, and effective mechanism that brings chief science advisers and their nominated equivalents together to deliberate on contemporary issues that demand effective global science advice to address existing knowledge asymmetries that benefit global society equitably. G20-CSAR [G20 Chief Science Advisers' Roundtable] has set the stage for further discussions and deliberations where members and international organisations can converge on various multidisciplinary issues to impart synergistic science advice. Science Diplomacy can be used as a tool to enhance the synergies between the actors involved in this mechanism. G20-CSAR intends to further this mechanism that is accessible, inclusive, action-focused, outcome-oriented, and dynamic with scientific integrity and rigour at its core, which strengthens the overall science advice ecosystem."

7-2. Governance of emerging technologies and importance of strategic science and technology diplomacy

Emerging technologies, as represented by generative AI, are developing rapidly, and the duration before they have an impact on society is becoming much shorter. Emerging technologies include not only AI but also biotechnology (e.g., neuroengineering, synthetic biology), quantum technology, drones, sensors, metaverse/electronic currency, autonomous systems and weapons, space development, ocean development, and geoengineering. Anticipating the development and impact of these emerging technologies and implementing appropriate regulations to avoid inhibiting innovation and risks is important. Which people will handle these activities, and in which organizations, in which locations, and in what manner? This is a major issue worldwide and was a major agenda item at the G7 Summit in 2023, making it subject to technology governance that cannot be handled by any single country and that requires bilateral and multilateral cooperation and competition.

The OECD Outlook 2023 has harshly indicated that "research ministries and funding institutions are still not playing a central role" in the era of securitization of science and technology". However, the OECD, United States, EU, and others are considering policies from three perspectives: promoting emerging technologies, protecting technical expertise and researchers, and projecting emerging technologies. Japan's STI community requires structural changes to its STI goals and systems in response to new demands for economic security, from the policy level to each of the layers of funding, research implementation institutions, and researchers.

7-3. Strengthening strategic intelligence functions as the foundation of science and technology diplomacy

As previously mentioned, as we enter an era of uncertainty in which the OECD emphasizes the "rapid overlap between STI policy, industrial policy, national security policy, and foreign policy", countries and international institutions are strengthening their strategic intelligence functions, including those designed

to anticipate future developments (foresight).

Important elements in foresight are setting issues at various levels of granularity, technology direction, and impact/risk assessment, monitoring methods, stakeholder participation, and consensus building, and international platform creation, which are due to the use of AI and digital technology for everything from policy formation to funding design (e.g., G7 AI guidelines review process (Ministry of Foreign Affairs, 2023); establishment of the Global Forum on Technology (GFT) as technology governance by the OECD (OECD, 2023-2); the Swiss GESDA project, which combines technology forecasting and diplomatic strategy (GESDA, 2023; knowledge infrastructure and knowledge integration program by EU / JRC, etc.) (EU Joint Research Center, 2023)).

The United Nations has become dysfunctional because of Russia's invasion of Ukraine and the conflict between the United States and China, which has made it difficult to achieve the UN resolution SDGs (2030). Under these circumstances, UN Secretary-General Antonio Guterres has proposed "Our Common Agenda," which holds a post-SDGs perspective (Ministry of Foreign Affairs, 2023); in this context, the ISC and specialized UN agencies (e.g., WB, UNEP, UNDP, WHO, UNESCO) are working together to strengthen the international scientific advisory function (Gluckman, 2022).

Consideration of culture, language, and sensibilities is increasingly being emphasized as a part of the reform of effective scientific advice in the post-COVID era in order to communicate and build trust between science, politics, and society. Examples include the United Nations Report "Global Sustainable Development Report 2023" (UN, 2023), the Global Young Academy 2022 Annual General Meeting (held in Japan) theme "Harmonizing Reason with Sensibility: Regenerating science for an inclusive and sustainable future" (Science Council of Japan, 2022), and INGSA-led international comparative studies such as differences in functions by language and cultural area. In August 2023, the United Nations Secretary-General Antonio Guterres announced the creation of a new scientific advisory board to advise UN leaders on breakthrough advances in science and technology and how to harness the benefits and reduce potential risks of these advances. The advisory board is composed of a group of seven prominent scientists, a group of chief scientists from various United Nations agencies, the Rector of United Nations University, and a special technical envoy.

7-4. Developing human resources that can bridge science, technology, and diplomacy

An urgent issue worldwide has been the development and securing of professional human resources that understand the rapidly changing political and economic situation of the world, understand the development direction and social impact of emerging technologies such as AI and quantum technology, and can respond to international discussions: that is, human resources responsible for science and technology diplomacy.

The United Nations and ISC have jointly proposed four new-era science and technology stakeholders that bridge science, political administration, and society (including the international community) (United Nations, 2021): scientific knowledge generators (traditional researchers), knowledge synthesizers, knowledge brokers, and communicators to internal and external political administration. The EU similarly

emphasizes the training of "scientists for a new type of policy." Achieving these goals requires not only improving the abilities of individual scientists but also establishing incentives and career paths, and reforming the human resources evaluation system, which will lead to reform of the entire science and technology system.

Japan has often asked academics with specialized knowledge to participate in international conferences related to STI policy in recent years. This is different from overseas practices and needs to be improved. Academics who are accustomed to the analytical methods of scientific research and the production of papers struggle to enter the international arena and fulfill their expected roles in the field of diplomacy, which has different values, speed, and objectives, without sufficient training. Diplomacy is referred to as domestic politics, and it is important to connect and coordinate with each domestic ministry and policy. Important long-term initiatives are to develop and secure human resources with this kind of background and ability from a young age through an interdisciplinary and practical curriculum. These are also important facets for Japan's national interests and for improving its research capabilities.[4]

8. Toward a review of framework of science and technology diplomacy

8-1. Year 2025 marks 15 years since the establishment of the science and technology diplomacy concept

During the 15-year period leading up to 2025, humanity has faced world history-level events that are said to be unprecedented since World War II, such as the COVID-19 pandemic, the Russia–Ukraine war, and the escalating conflict between the United States and China. Given these circumstances, in order to conduct a fundamental review of the framework and practice methods of science diplomacy, the AAAS and the British Royal Society, which have been leading the creation of the current framework for science and technology diplomacy, are planning an international conference and are conducting discussions with diverse parties and organizations worldwide regarding the goals and methods of science and technology diplomacy in a new era, setting 2025 as a target year (Montgomery and Wiggins, 2024). Associated stakeholders and organizations discussing the current potential and value of science and technology diplomacy, new methods, etc., worldwide, and theorizing from multiple perspectives, are also extremely important for communication, trust building, and collaboration between stakeholders.

8-2. Recent movements

As the world situation changes rapidly, the concept of science and technology diplomacy is also spreading to countries in the Global South. Notably, at the G20 Leaders' Summit in September 2023, the outcome document of the G20 Chief Scientific Advisers Roundtable (held in August 2023), which called for the "creation of a global science advisory mechanism using science diplomacy as a tool," was adopted

[4] Initiatives have been underway for some countries and international organizations for many years to develop career paths that will help people with research experience play an active role in STI policy and science and technology diplomacy.

as an annex. Additionally, at the STS Forum Annual Meeting held in Kyoto in October 2023, Prime Minister Kishida stated, “International cooperation through science and technology, human resource development, and science diplomacy (science for diplomacy) are essential for solving global issues such as climate change and energy issues.”

Starting with the First EU Science Diplomacy Conference held in Madrid in December 2023, a new examination on the nature of science and technology diplomacy has begun. The EU held this conference with the following objectives in mind: (1) understanding the status of the formulation of the European Science Diplomacy Framework; (2) discussing how to proceed in the future; (3) providing a forum for dialogue, co-creation, and participation by a wide range of stakeholders, and promoting science diplomacy outside the EU; and (4) increasing the willingness of those involved in science diplomacy to actively participate and visualize the ongoing process. The results of the conference comprised 12 items, including “the need to rethink European science diplomacy in a decoupled and multipolar world and to reflect on its use as soft and hard power, based on the concept of being as open as possible but also being as closed as necessary” (see Reference 3). In this context, science had previously been positioned as the soft power of diplomacy, but the emphasis on hard power and the means of national power could be seen as major shifts in the framework.

In January 2024, the Royal Society and AAAS announced in an editorial in *Science Diplomacy* that they would transform the framework for science and technology diplomacy in 2025. To that end, the two organizations would hold an open and comprehensive dialogue over the next year on the role of science and technology diplomacy in a changing geopolitical environment. Simultaneously, contributions to a special issue in *Science Diplomacy* are invited, and they are seeking opinions of a diverse range of stakeholders working at the intersection of science and foreign policy. Journal Science Diplomacy of AAAS published

“ The Special Issue : Science Diplomacy - 15 Years On”, in October 2024.

8-3. Summary

We conclude this paper by listing the following topics that are important for future discussion.

1. Creating a shared awareness that we are entering a period in which there is overlap between STI policy, industrial policy, national security policy, and foreign policy is important, as is ensuring and balancing research integrity and research security under this framework (UN, 2020).
2. In science and technology activities and diplomacy, ensuring a double-track balance of the fierce competition from the axes of security and international economy and cooperation between like-minded countries, and multilateral cooperation to solve global-scale issues, will be required. A de-risking rather than decoupling perspective is necessary.
3. Recognizing the global, regional, national, and local hierarchical structures and ensuring the dynamic ability to cycle between them is important. Japan is contributing to the participation of new players in the Global South, such as the G20.

4. A combination of diverse approaches from Track 1, Track 2, and Track 1.5 will be important for effectively implementing science and technology diplomacy.
5. Securing the development of human resources who connect science with domestic and international political sphere is important.
6. EBPM will be introduced to science and technology diplomacy policy formulation and implementation. To that end, intelligence functions, as well as risk assessment, management, and communication functions, need to be strengthened. International joint research will be planned on the theme of the science of science and technology diplomacy.

9. References

9-1. (Reference 1) Overview of historical changes in science and technology diplomacy and science and technology policy

The historically important role of science and technology diplomacy is the promotion of cross-border activities in science and technology. In ancient times, there was international research cooperation on topics such as polar observations, meridian measurements, and the standardization of academic terminology and scientific methodologies, which formed an important foundation for the development of modern Western society and science (Iwabuchi, 2021). In this vein, the German scientific community spearheaded the establishment of the International Association of Academies (IAA) at the end of the 19th century. Another aspect of science and technology diplomacy is responding to the interaction between the development, rise, and fall of science and technology, and the international situation of security, politics, and economics. Many international mechanisms related to science and technology have been formed historically in response to international situations. Here, the periodization suggested by ISC President Gluckman (Gluckman, 2022) is used to divide the period from the beginning of the 20th century to the present into the following four periods, and their changes are described below (Iwabuchi, 2021; Arimoto, 2021).

- Period 1 (1900–1945): “Era of global conflict”
- Period 2 (1950–1990): “Era of the East–West Cold War and construction of a new international system”
- Period 3 (1990–2015): “Era of intensifying international economic competition and globalization”
- Period 4 (2015–present): “Era of global issues, strategic competition, and decoupling”

The following are noteworthy events related to science and technology diplomacy during these four periods.

(1) Period 1 (1900–1945): “Era of global conflict”

① At the end of the 19th century, Germany spearheaded the establishment of the International Association of Academies (IAA) to promote international research cooperation in areas such as polar observations and meridian measurements.

② In 1919, after the end of World War I, the International Research Council was established, led by the British and American academies of science, in place of the IAA. Under the Versailles regime, the scientific communities of the Axis powers were initially excluded, but thanks to the efforts of Einstein and others, Germany and other countries were allowed to join in 1931, and the organization was reorganized as the International Council of Scientific Unions (ICSU), which remained until 2018.

③ During the inter-war period between the World Wars, the International Committee for Intellectual Cooperation was established as a part of the activities of the League of Nations, and with the participation of Bergson, Marie Curie, Einstein, and others, an international framework was created for the promotion of international intellectual and scientific exchange. Inazo Nitobe served as the secretary general. Kunio Yanagita, who was a founding figure of Japanese folklore studies, also worked as a staff member for this committee for a time. This committee is connected to the current United Nations / UNESCO and can be said to be a typical example of liberal science diplomacy.

④ Reflecting the era of war, both the Allied and Axis powers promoted international scientific and technological cooperation to strengthen their military power. A famous example is the British Tizard Mission of 1940 during World War II. This led to stronger military science and technology cooperation between the United States and United Kingdom, and the acceleration of the development of atomic bombs, radar, and other devices.

(2) Period 2 (1950–1990): “Era of the East-West Cold War and construction of a new international system”

① Under the severe East–West Cold War in the post-World War II period, science and technology, such as nuclear power and space exploration, had decisive impacts on military power; therefore, an international organization for the control of nuclear technology was established between the East and West in response to the technology-induced threat to human survival (International Atomic Energy Agency, IAEA). Additionally, major powers sought to enhance their national prestige by promoting international research cooperation for large projects such as nuclear power and space exploration.

② Advanced economies took the lead in enhancing systems for international research cooperation, promoting human resource exchanges, and accepting international students to universities, and science and technology came to attract attention as “soft power” in international politics.

③ International cooperation in science and technology came to be seen as a means for alleviating the escalation of the Cold War and conflicts, and for maintaining peaceful bilateral and multilateral relations. The European Organization for Nuclear Research (CERN, Switzerland) and the Synchrotron-Light for Experimental Science and Applications in the Middle East (SESAME, Jordan) are emblematic examples of these. Scientific groups and non-governmental organizations (NGOs) as well as national governments will play important roles as players in these activities. This is called Track 2 diplomacy.

④ Examples of NGO activities that have had a major impact on international politics are shown below.

- Russell and Einstein spearheaded the Pugwash Conferences upon reflection on the development and use of the atomic bombs in World War II, which had a major impact on discussions on the Treaty on the Non-Proliferation of Nuclear Weapons and the Treaty on the Prohibition of Nuclear Weapons.
- The International Geophysical Year was established by the United Nations (1957), and under the leadership of the ICSU, research organizations from various countries cooperated to conduct earth observation research, which led to the establishment of the Antarctic Treaty (1959) and others. Furthermore, the refinement and international spread of global warming research led to the Villach Conference, the establishment of the IPCC (1988), the Rio Summit (1992), and the establishment of the Framework Convention on Climate Change. Additionally, international joint research into the mechanism of ozone layer depletion led to the Montreal Protocol, which regulated fluorocarbon gases. These two cases are typical examples of how the accumulation of scientific knowledge influenced international politics.

(3) Period 3 (1990–2015): "Era of intensifying international economic competition and globalization"

① With the end of the East–West Cold War (1989), there was a major shift in the objectives of each country's science and technology policies, from enhancing national prestige and strengthening military power to realizing economic value and strengthening international competitiveness.

② Alongside this shift, science and technology diplomacy expanded into various areas, including traditional international research cooperation, international activities for strengthening economic competitiveness, protecting intellectual property, and standardization.

③ A typical example is that in the 1980s, trade conflict between Japan and the United States over automobiles and semiconductors led to technology conflicts, followed by the revision of Japan–US agreements on science and technology cooperation. During this process, the United States levied harsh criticism based on their own evidence, with statements such as "Japan free-riding on high-tech elements," "symmetrical access obligations," and "Japan's industrial technology policy," and expert meetings were repeatedly held between Japan and the United States. This subsequently led to a shift in basic research in Japan's science and technology policy, a review of the industry–academia–government collaboration system, and a major impact on changes in STI policy in general, including strengthening policy research (Turekian, Gluckman, Kishi, and Grimes, 2018).

④ The science and technology policies of each country began to emphasize the relationship between science and technology and society, and the creation of social value (i.e., innovation), and these topics came to be actively discussed internationally, including among the OECD. Participants now included experts in social sciences in addition to science and technology, which made it important to develop a diverse range of specialized human resources.

⑤ Even as international economic competition intensifies, multinational R&D projects, such as the International Space Station, Human Frontier Science, Earth observation data projects, and deep space exploration, continued.

⑥ A specific program of science and technology diplomacy that Japan has been engaged in since 2008 is the support of international joint R&D projects to address global issues by industry, academia, and government from Japan and developing economies under joint funding from JST (+AMED) and JICA (SATREPS program, https://www.jst.go.jp/global/about/about.html).

(4) Period 4 (2015–present): "International spread of science and technology diplomacy: Era of global issues, strategic competition, and decoupling"

① The objectives of science and technology policy have expanded and diversified from emphasizing economic value to emphasizing sustainability, resilience, well-being (quality of people's lives), and national security. This has been accompanied by the demand for major changes in the methods and human resources of science and technology diplomacy. For example, in recent years, the OECD has taken up issues such as securitization in STI policy, interdisciplinary co-creation, mission orientation, career paths for human resources, and technology governance as themes for science and technology policy research.

② During this period, the players in science and technology diplomacy have expanded and diversified from advanced economies in the West to developing economies. There has been a dramatic increase in the importance of science and technology in international politics, economics, security, climate change, and environmental policy. The United Nations SDGs resolution has had a major impact on the science and technology diplomacy efforts of each country. In Japan, following the Great East Japan Earthquake and the Fukushima nuclear power plant accident, efforts were made to strengthen the scientific advice and science and technology diplomacy. To that end, the Science and Technology Advisor to the Minister of Foreign Affairs and the Advisory Board for Promoting Science and Technology Diplomacy were established in 2015, and they became key members in the international circle of science and technology diplomacy.

③ Building an interface between science, politics, and society (scientific advice) has become important at both the national and global level for responding to diverse needs and issues in politics, economy, environment, and daily life, and governments and academies have been developing principles, methods, and codes of conduct for scientific advice. The OECD has compiled reports on systems and methods of scientific advice, such as "Scientific Advice for Policy Making" (2015) and "Scientific Advice During Crises" (2018); in Japan, the Science Council of Japan has compiled norms for "scientific advice" (2013).

④ During this period, there was an expansion of the international network of scientific advisors and organizations, with the establishment of the International Network for Government Science Advice (INGSA, 2014) and the Foreign Ministries Science & Technology Advice Network (FMSTAN, 2015). INGSA holds general meetings every two years (Auckland (2014), Brussels (2016), Tokyo (2018), Montreal (2021), Luanda / Kigali (scheduled for 2024)) and is an international leader in reviewing advice systems, developing methods, training, and disseminating human resources, and collecting practical examples.

⑤ In 2018, the International Council for Science (ICSU, 1931) and the International Social Sciences

Council (ISSC, 1952) merged to form the International Science Council (ISC). The ISC aims to ensure the foundation and quality of scientific research, promote interdisciplinary collaboration between the natural and social sciences to address social issues, and develop a knowledge base for scientific advice. This can be said to be a major turning point in the history of modern science, where fields have become increasingly fragmented. The ISC is working with the United Nations to strengthen the global scientific advisory system.

9-2. (Reference 2) Report of the Expert Panel on the State of Science and Technology Diplomacy (May 8, 2015, Ministry of Foreign Affairs) (Ministry of Foreign Affairs, 2015)

This report was used as the basis for establishing Japan's first science and technology advisory system at the Ministry of Foreign Affairs. Its contents are still highly suggestive when considering the specifics of science and technology diplomacy, so the key points of the recommendations are listed below.

Responding to global issues and utilizing diplomatic opportunities

- Recommendation 1: Establish a diplomatic stance of "taking the lead in resolving global issues through science, technology, and innovation, and striving to achieve a desirable international environment" (clearly position science and technology diplomacy as a new axis of Japanese diplomacy).
- Recommendation 2: Build a system to quickly identify "next issues" that will become important in the international community in the future and for which Japan can easily demonstrate leadership.
- Recommendation 3: Use the identified issues as a basis for presenting a diplomatic agenda with scientific evidence and lead international efforts.

Strengthening cooperative relationships with diplomatically important partner countries and emerging economies

- Recommendation 4: Promote strategic joint R&D with partner countries of high diplomatic importance.
- Recommendation 5: Support the overseas expansion of Japanese companies, as well as actively support the development of innovative human resources in emerging economies and the improvement of science, technology, and innovation policymaking capabilities.
- Recommendation 6: Implement trilateral cooperation that utilizes ODA in collaboration with the Science and Technology Research Partnership for Sustainable Development (SATREPS) and third-party countries to strengthen cooperation with emerging and developing economies and promote the launch of strategic joint projects for emerging economies and countries that have graduated from ODA, with an emphasis on innovation.
- Recommendation 7: Strengthen cooperation in human resource development (e.g., support for

engineering universities) and proceed with building next-generation networks.

- Recommendation 8: Utilize scientific and technological human resources for diplomatic activities through private-sector exchanges.

Strengthening the use of scientific knowledge in the formulation and implementation of foreign policy

- Recommendation 9: Establish a science and technology advisor to the Minister of Foreign Affairs on a trial basis.
- Recommendation 10: Build domestic and international networks to strengthen collaboration with related ministries, agencies, academic experts, and industry, and develop a system to support the science and technology advisor to the Minister of Foreign Affairs.
- Recommendation 11: Strengthen the capacity and number of science and technology officers at Japan's overseas diplomatic missions (e.g., deepen information sharing and collaboration with the Ministry and other diplomatic missions, expand training opportunities).

Developing human resources to support science and technology diplomacy

- Recommendation 12: Have mid-career and young researchers participate in foreign policy planning (work within the Ministry of Foreign Affairs, assist science and technology advisors, send them to international institutions).

Strengthening external communications and networks

- Recommendation 13: Actively communicate the message of "leading the way in resolving global issues through science, technology, and innovation, and striving to achieve a desirable international environment" to the international community from high-level positions such as the prime minister and foreign minister.
- Recommendation 14: Promote intellectual exchange while strategically targeting influential science and technology-related organizations and strengthen the science and technology diplomacy network.
- Recommendation 15: Strengthen the dissemination of Japan's science and technology to the outside world by dispatching scientists and collaborating with domestic and overseas exhibition facilities (e.g., Japan House).

○ Japan's Ministry of Foreign Affairs science and technology advisory system and Advisory Board for Promoting Science and Technology Diplomacy

Please refer to the URL below for the activity status of the science and technology advisor to the Ministry of Foreign Affairs and the Advisory Board for Promoting Science and Technology Diplomacy, which were established in 2015 based on the above recommendations.

- https://www.mofa.go.jp/mofaj/dns/isc/page24_001500.html
- https://www.mofa.go.jp/mofaj/dns/isc/index.html

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