Status and Prospects of South Korea's Science Diplomacy:

Focusing on Grassroots Science Diplomacy Activities

Science and Technology Diplomacy Platform / Corresponding Author: Kim, Seunghwan[1]
Professor of Physics, Pohang University of Science and Technology

Abstract

In the increasingly uncertain and complex international relations of the 21st century, scientific behaviors and contexts are changing drastically, and more and more countries are seeking to integrate science and technology into their diplomatic, economic, and security frameworks from a national strategic perspective. The private sector also often serves as a communication and liaison axis, and science and technology diplomacy is now used to enhance a country's global image and influence. This is leading to more active involvement of the private science and technology community and diplomats with a good understanding of science and technology, as well as an increasing role for grassroots scientists and non-governmental scientific organizations.

Now that various forms of collaboration between scientists, engineers, and those involved in public diplomacy are needed, on April 20, 2017, scientists, engineers, researchers, international research institutes, science and technology policy experts, journalists, and many other people interested in science and technology diplomacy in Korea gathered to organize a grassroots group called the Science and Technology Diplomacy Club. Unfortunately, this grassroots gathering was put on hold by the COVID-19 pandemic, but they gathered again in May 2022 to re-launch the Science and Technology Diplomacy Club under a new name, the Science and Technology Diplomacy Platform.

Through these activities, they examined the overall trends from an economic and international policy perspective, and discussed the issues of science and technology diplomacy not only in terms of climate change, energy, and space/oceans, but also from an economic security perspective, such as supply chain and technology control. They also surveyed the perceptions of the science and technology and diplomatic communities on the three types of science and technology diplomacy, categorized science and technology diplomacy in the light of economic security into four areas, and suggested responses accordingly.

1. Beginning of a grassroots science diplomacy meeting

In recent years, the global community has been threatened by numerous challenging issues that have no solution but interaction and diplomacy. These highly complex, interdisciplinary, and global agendas require scientific approaches and solutions. In this context, there are compelling reasons and abundant opportunities for the global scientific community and relevant stakeholders to engage in scientific cooperation and science diplomacy.

In the 21st century, especially in the context of increasingly uncertain and complex international relations, scientific behavior and contexts have changed dramatically, and a growing number of countries have

[1] e-mail: swan@postech.ac.kr

sought to integrate science and technology into their diplomatic or economic security frameworks from a national strategic perspective.

However, even at the private level, science diplomacy as an axis of communication and connection is increasingly used to enhance a country's global image and influence beyond international cooperation. Therefore, the role of grassroots scientists, non-governmental scientific organizations, and institutions is increasingly being played, along with the active participation of diplomats and policymakers with a high understanding of science and technology.

In fact, scientists are fundamental and pioneers, working across boundaries, such as the poles, the deep sea, and space. Armed with a universal methodology of evidence-based communication, they have a long history and network of contacts in solving common challenges through solidarity and cooperation with people from different countries. In this sense, scientists from various fields can play an excellent role on the international stage as citizen diplomats. In an increasingly conflict-ridden and uncertain future, the need for more persuasive and smart public diplomacy and the enhancement of national soft power is emphasized.

At a time when various forms of collaboration between the science and technology and public diplomacy communities are being called for, a grassroots gathering of scientists, researchers, international researchers/institutions, science and technology policy experts, journalists, and other stakeholders in science and technology diplomacy who are interested in or active in science diplomacy began on April 20, 2017, under the name of the Science Diplomacy Club. To serve as a cross-border platform for strengthening the internal and external capacities of science diplomacy and spreading related policy research and agendas, I, a policy advisor to the Ministry of Foreign Affairs and chairman of the KOFST Center for Science Diplomacy, and Bae Young-ja, a professor of political science and diplomacy at Konkuk University, co-led the club to explore the compatibility of science and diplomacy.

Through my continued attendance at the annual meeting of the American Association for the Advancement of Science (AAAS) and visits to its headquarters in Washington, DC, I have had the opportunity to meet a wide range of people involved in U.S. science diplomacy and to be exposed to its activities. In particular, AAAS scientists have a very effective system that is executed by close public-private partnerships and close connections between private organizations. In Korea, it remains a challenge for various science and technology organizations and institutions, including KOFST, The Korean Academy of Science and Technology, academic societies, and overseas Korean societies, to establish a solid collaborative network and actively engage grassroots scientists.

Based on a long-standing exchange of visits and networking with the Center for Science Diplomacy of the American Association for the Advancement of Science (AAAS), I co-organized a science diplomacy session with AAAS/APCTP and led a discussion on "Scientific Drivers of Science Diplomacy across Asia-Pacific Region" at the U.S.-Korea Science and Technology Annual Meeting (UKC 2017), co-hosted by the Korean Federation of Science and Technology Societies (KOFST) and the Korean-American Scientists and Engineers Association (KSEA) in Washington, DC, USA. The forum was well attended by domestic and international science diplomacy opinion leaders, raising the profile of science diplomacy and building consensus on the importance of science diplomacy in the Asia-Pacific region.

Based on this, I organized the Inaugural Forum of the Korea Science Diplomacy Club in September 2017 in Seoul to discuss various agendas under the theme "Science Diplomacy for Korea and Its Neighbors". The forum served as a suitable venue for various domestic stakeholders and groups interested in the theme of science for diplomacy to gather for the first time to understand current issues in science diplomacy and discuss future directions. I subsequently co-organized the Asia-Pacific Science Diplomacy Forum with APCTP in Pohang in 2018 under the theme "Scientific Cooperation and Science Diplomacy in Asia-Pacific Region".

I organized the National Assembly Science and Technology Diplomacy Forum with the National Assembly Foreign Affairs Committee under the theme of "Baekdusan Volcano Eruption - Solving through Science and Technology Inter-Korean Cooperation," a session on Science Diplomacy with the Ministry of Foreign Affairs at the Jeju Peace Forum, and a Science Diplomacy session at UKC 2018 in New York City, USA. I also co-organized a workshop for science diplomacy experts with the National Diplomatic Academy and participated in a keynote session at the IFANS Signature Conference.

The following year, in 2019, I participated in the

Science and Technology Diplomacy session of the National Academies of Sciences and Engineering at the AAAS 2019 Annual Meeting. I invited Dr. Bill Colglazier, former Science and Technology Advisor to the U.S. Department of State, to discuss U.S. science diplomacy at the Science Diplomacy Forum's regular breakfast, making it a recurring cross-platform event. I also continued to support the private sector, such as the South Korea-North Korea Cooperation in Science and Technology and the Mt. Paektu Volcano Research (MPGG) activities. I activated policy research and communication dissemination platforms in collaboration with other science diplomacy-related organizations such as the National Academy of Sciences, STEPI, the APEC Center, and AAAS.

As a representative of Korea, I also participated in The Foreign Ministries Science & Technology Advice Network (FMSTAN) to discuss key agendas of science diplomacy and science and technology advice at the private sector level, cooperate, and share country experiences.

The FMSTAN was launched in Washington in 2016 as an informal network of senior foreign ministry science advisors under the auspices of the U.S. Department of State's Science and Technology Advisor and has been discussing science diplomacy and advisory issues through various collaborative networks held around the world. In addition, the Science Diplomacy Club started meeting in 2017 and conducted various advisory and networking activities related to science diplomacy until 2019. Also, the club conducted various policy projects, including "How to Build a Korean Global Science Diplomacy Lab to Create a Foundation for Science Diplomacy," co-conducted by Professor Bae Young-ja as the research director.

The grassroots gathering was temporarily suspended due to the COVID-19 pandemic, but in May 2022, it was relaunched as the <Science Diplomacy Platform> from the <Science Diplomacy Club>.

The <Science Diplomacy Platform>, described below, sought to strengthen the capacity of practicing experts in science and technology diplomacy, especially in light of the changed environment of economic security and intensifying technology competition between the United States and China. The platform meets regularly once a month and aims to identify various science diplomacy issues and propose alternatives for Korea's science diplomacy. Catalyzed by a series of recent domestic science diplomacy-related activities, the need for awareness and capacity building in science diplomacy is growing as concerns and pan-governmental responses to the intensifying competition for technological supremacy on the global stage spread.

2. Key Issues in Science Diplomacy

The Science Diplomacy Platform held its first meeting in May 2022 with a presentation by Prof. Lee Geun of the Department of Economics at Seoul National University on the topic of capitalist paradigm shift and Korea. Changes in the global economy and the competition for technological supremacy between the United States and China pose challenges and opportunities for Korea as a trading nation, requiring a new approach to trade and diplomatic relations, including reorganizing supply chains and establishing new relationships with China. In this changing environment, it is necessary to expand the role of science and technology as a soft power through science diplomacy.

At its second meeting in June, the Platform hosted Dr. Lee Geun, President of the Korea Foundation for International Exchange at Seoul National University, to discuss the topic of science and technology from a diplomatic perspective in the era of economic security. The meeting covered the distinction between traditional and emerging security, science and technology security and supply chain issues, and suggested Korea's response from an international political perspective. The response directions are: first, blocking the network effects of China's internet network and AI pursuit by regulating the outflow of semiconductor technology; second, strengthening and reorganizing supply chain resilience; third, building trust among like-minded countries; and finally, investing in cybersecurity and security technologies and strengthening international solidarity. Through the two meetings, the Platform discussed Korea's response to the recent changes in the economic and security environment from an economic perspective and an international political perspective. From an economic perspective, the platform advocates for the continued utilization of U.S. security, technology, and Chinese markets in the U.S.-China technological hegemony competition for the evolution of Korean capitalism under the premise that complete decoupling is not possible. On the other hand, from an international political perspective, the platform takes the position of building a new world order by strengthening solidarity with allies while accepting a certain degree of market decoupling against mega-revisionism to secure economic security in the global system. These two perspectives, with their different approaches to China, pose challenges to the role of science diplomacy as a soft power.

The platform covered climate change and energy (secondary batteries), space and maritime diplomacy, and quantum technology as issues in the field of science and technology. Regarding climate change response, it is expected that the hegemonic competition between the United States and China in the trade and technology sectors will lead to the issue of climate change response[2]. In response to China's growing investment in energy transition, energy independence and supply chain control are important issues in the geopolitical balance of power, and the U.S. is also proposing to reform laws and regulations to strengthen renewable energy such as wind, solar, batteries, and hydrogen, and to enhance innovation and capital investment. In addition, the U.S. is considering introducing a carbon border tax as part of its response to climate change, raising concerns for domestic exporters[3]. Climate finance is based on the idea that global warming, which is an outgrowth of energy use and economic activity, can be effectively addressed by combining economic principles and finance. The core of climate finance is the climate bond and carbon credit markets, and it does not view climate change as a simple environmental problem. The reason for climate change is the use of fossil energy, and the energy industry is the most necessary and important long-term investment for the global economy, accounting for about 10-15% of global GNP. In other words, the environment is energy and economic issues.

RE100 stands for 100% Renewable Energy, which is a voluntary campaign in the financial markets for companies to purchase or generate all of their electricity needs from renewable energy sources by 2050. ESG is an acronym for Environment, Social, and Governance, a business philosophy that states that sustainable development can only be achieved by considering transparent management, such as environmental protection, socially responsible management, and improved governance. It is a new investment guideline of global financial capital that does not invest in companies that avoid ESG. A carbon border tax is a tariff imposed on high-emitting businesses, also known as the Carbon Border Adjustment Mechanism. The tax is imposed on products produced and imported from countries that emit more carbon dioxide than their own, and was introduced on July 14, 2021, when the European Union announced Fit for 55, a legislative package to reduce Europe's greenhouse gas emissions by 55% in 2030. It will first apply to high-carbon items such as steel, aluminum, cement, fertilizer, electricity, organic compounds, plastics, hydrogen, and ammonia, and will be officially applied from January 2027. The U.S. has also proposed a bill to impose a carbon border tax on certain items first, which will be introduced in 2024.

As climate change-related science and technology are intertwined with financial markets, carbon border taxes and ESG are becoming a reality. For Korea, where exports are important, it is urgent to establish a renewable energy transition system. On the other hand, regarding the speed war with the emergence of ESG and the trend of preferring renewable energy and green technology, financial institutions including investment banks have declared that they will not invest in coal power plants. As commercial financial institutions refused to lend to coal power plants, private equity funds did, and many coal power plants continue to operate as before, creating a hidden aspect of carbon neutrality. In addition, due to cost concerns, interest rates are eventually tied to inflation, and companies that have made ESG claims eventually realize that the return on investment is deteriorating, even though ESG support is important, leading to a stagnation of ESG flows. In other words, climate change is not only an environmental issue, but it is also related to international finance and supply chain issues, requiring a comprehensive response to the issue and coordinating the roles of decentralized ministries.

In the case of secondary batteries, there is always the possibility of supply and demand instability due to the regional concentration of raw materials and production constraints. Given the potential for weaponization of resources, it is inappropriate to rely on a single country for key minerals and raw materials, and joining U.S. efforts to diversify supply lines and cooperate with friendly countries can improve Korea's resource security. In areas

[2] For more information, see Yonhap News Agency (https://www.yna.co.kr/view/AKR20210402044500009)

[3] Read more at https://dbr.donga.com/article/view/1206/article_no/10103

where Korea is competitive, such as semiconductors and secondary batteries, there are opportunities for Korean companies due to increased U.S. government support and supply chain reorganization. In other words, the substitutability of Korean products for Chinese products and the tax incentives for Korean companies to enter the U.S. are expanding, but in the long run, competition may intensify due to the enhanced capabilities of U.S. companies.

As the U.S. government emphasizes working with allies to weaken China's position in the supply chain, there are risks of a Chinese backlash, and negative impact is expected if China imposes export restrictions on raw materials. Korea's position in the supply chain is expected to be enhanced by policy support and technology enhancement, but it is necessary to prepare for raw material procurement risks. In preparation for rising raw material prices and a deepening supply-demand imbalance, Korea should diversify its supply lines to ensure stability in raw material procurement and expand investment in core minerals. In addition, Korea should support the overseas mineral development of the four major cathode material manufacturers (L&F, EcoPro BM, COSMO ADVANCED MATERIALS & TECHNOLOGY, and POSCO CHEMICAL) and direct investment in mineral development for secondary battery manufacturers, and expand the stockpile of core minerals and encourage the recycling of waste materials.

Due to the concept of space security as a hegemonic competition, the militarization/weaponization of space can be seen as the end of the future battlefield, and the absence or weakness of defense capabilities in space can be thought of as being excluded from the hegemonic competition. Given that, major nations such as the United States, Russia, Japan, and France are already considering expanding and reorganizing their space agencies. Militarization of space is the use of satellites in a country's military system, such as the installation of GPS on combatant missiles in the Gulf War (1992), Kosovo War (1999), and Afghanistan War (2001), and the operation of 192 military satellites in the United States. Weaponization of space is the introduction of practical weapons systems into space and is classified into earth-to-space, space-to-space, and space-to-earth space weapons. Space assets can be utilized for disarmament activities, humanitarian and rescue activities, military support, conflict prevention, peacekeeping, ship protection, marine environment protection, and monitoring of illegal fishing activities. Developed countries are utilizing space technology as an instrument of foreign policy (diplomatic capability) by establishing space as an area of foreign policy and focusing on securing leadership in the process of establishing international norms for space activities and international governance.

Since space technology is subject to export control as a strategic technology, it is necessary to secure technological sovereignty over the original technology. For this purpose, R&D investments are needed to secure original technologies for ultra-high resolution optical technology, radar technology, infrared technology, navigation technology, and launch vehicle technology. It is also necessary for the government to guarantee demand to ensure that companies can stably enter the space industry through support for corporate growth in line with the new space trend. The US continues to provide opportunities for innovative companies through its COTS (Commercial Launch Vehicle Development), CRS (Commercial Operations), and CLPS (Commercial Lunar Transport) programs. As space is expanding beyond R&D into new areas such as space security, space diplomacy, and space economy, it is necessary to reflect the needs of various actors and expand their roles. Current issues in Korea-U.S. cooperation include Korea's space development and U.S. export control policy, which directly affects Korea through the U.S. Department of State's ITAR, which relates to exports of satellite and launch vehicle components to Korea. The U.S. policy on foreign launch vehicles does not support or encourage the independent development of foreign launch vehicles, so there is a need for bilateral coordination to relax export control policies in the future.

About 50% of the carbon dioxide emitted by human activities has remained in the atmosphere, accumulating heat in the Earth's atmosphere. The oceans have absorbed more than 90% of this heat, significantly reducing atmospheric temperature change. While the ocean has had an overwhelming influence on climate moderation, it has also led to negative impacts such as rising water temperatures, decreasing sea ice and rising sea levels, decreasing dissolved oxygen concentrations, and increasing ocean acidification. International cooperation is essential to address these marine environmental challenges. The unexplored deep oceans contain a wealth of mineral resources, including elements essential to modern industry such as rare earths. In special environments such as deep-sea hydrothermal

Table 1 U.S. export control system (legal basis and jurisdiction)

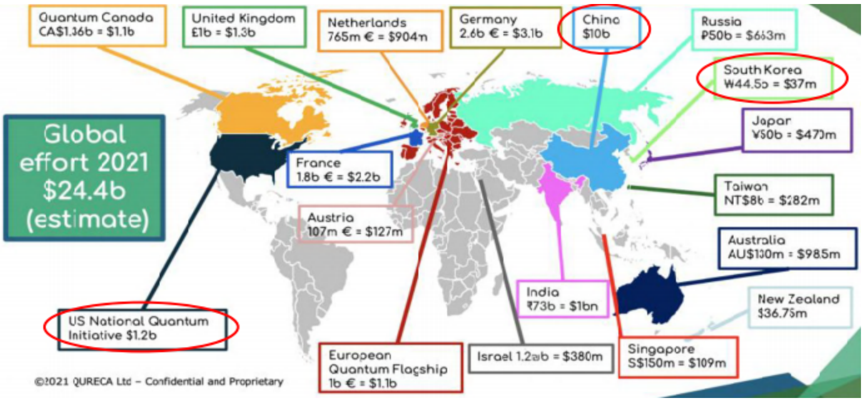
Classification	BIS	DDTC	NRC	OFAC
Laws	EAA (Export Administation Act)	AECA (Arms Export Control Act)	AEA (Atomic Energy Act)	TWEA (Trading with the enemy Act)
Federal Rules	EAR (Export Administation Regulations, 15 CFR 730-774)	ITAR (International Traffic Arms Regulations, 22 CFR 120-130)	10 CFR 110 10 CFR 810	31 CFR 500-599
Control List	CCL(Commerce Control List)	USML (United States Munitions List)		
Control Target	Dual Use Items	Defense articles, etc.	Nuclear items, etc.	Economic and educational restrictions on certain countries, etc.

vents, there is a possibility of securing not only rare earths but also useful genetic resources from organisms that survive in extreme environments. As mentioned above, Korea has continued its efforts to mine deep-sea minerals by securing deep seabed areas through the International Seabed Organization, and has recently continued to explore deep seabed/hydrothermal vents through national research and development projects. However, such deep seabed mining activities can destroy sensitive deep-sea ecosystems, so the issue needs to be resolved in a way that builds international consensus. To minimize the effects of climate change, countries are declaring themselves carbon neutral and companies are rapidly innovating to reduce their carbon footprint. However, we need to be prepared to utilize the oceans in case these efforts fail. Currently, international treaties prohibit dumping carbon into the ocean, but there are other ways to promote carbon absorption in the ocean, such as promoting marine biological activity and increasing ocean alkalinity, which require international joint research and diplomacy to build international consensus. In summary, ocean issues should be resolved through international cooperation as a shared resource, and international cooperation is an important means, especially as it is closely related to climate issues such as carbon neutrality. On the other hand, Korea's lack of interest in international issues, domestic experts' participation , and poor support for maritime ODA is a reality. The maritime sector is not subject to technological hegemony due to the dual technology nature of the space sector, thus, the maritime sector is expected to play a role as a window of cooperation in the event of a division centered on the United States and China.

Fierce competition between the United States and China to advance quantum technology is expected in the coming years. Just as the Soviet Union's Sputnik shock led to the overhaul of the U.S. science education system and the Apollo space program, China launched a quantum cryptography link between Beijing and Shanghai in 2017 and a 76-qubit quantum computer in 2020. The United States announced the National Q Initiative in 2018, led by industry and academia. As such, advanced countries centered on the United States and China are investing heavily in R&D to develop quantum technology. On the other hand, Korea is in the early stages of fund-oriented research and development, and the scale of investment is much lower than that of advanced countries.

In addition to the United States, Germany and France are also investing heavily in quantum computing, but in the era of digital computing, Europe is lagging behind the United States, and Japan, which developed the first superconducting qubit in 1999, has not yet caught up with the United States. China is also investing heavily in quantum technology, but while science such as quantum technology relies on individual creativity, Chinese scientists are subject to political influence, and some scientists in China have negative views. As we move from an era of cooperation to an era of competition, the field of quantum technology, given its technical difficulties, requires international collaboration, just like nuclear fusion, but competition and blockage make collaboration difficult. In the case of nuclear fusion, a large global team system is required. However, in the case

Figure 1 Investment Status of Quantum Technology Development



of quantum technology, with some differences, there is a possibility that it may develop into competitive research by researchers with creative and genius talents, resulting in a continuous competitive system.

With the exception of quantum technology, which is an emerging technology, science diplomacy activities have been conducted in various fields such as climate change, energy, space, and oceans. Security issues are increasingly converging in the realm of science and technology, including the expansion of the scope of technology control systems, due to supply chain issues such as the dual-use nature of space technology, weaponization of resources in the secondary battery sector, and carbon border taxes in the climate change sector, and security characteristics of technologies such as quantum technology, at a time when technological security is becoming more critical due to the U.S.-China technological supremacy competition. Therefore, representing Korea's national interests may be limited without understanding not only the knowledge of science and technology but also the international situation, including geopolitical and environmental changes. In such an environment, a strategic response to science and technology diplomacy is required, and the next meeting explored the topics of economic security and technology control.

Recently, discussions on economic security, IPEF, Chip4, IRA, Semiconductor Support Act, etc., have appeared one after another, and these issues are related to economic security and are expected to continue to occur as part of long-term structural changes. Therefore, it is necessary to capture the overall flow rather than get bogged down in individual issues and to take a consistent response rather than a fragmented approach. The fragility of globalization, rising geopolitical tensions, and the weaponization of interdependence have led to the securitization of technology with accelerated technological transformation. The goal of the Korean-style economic and security strategy is to maximize strengths and minimize weaknesses by Strengthening the manufacturing ecosystem, promoting a norm-based free trade order, creating fair competition conditions, leading digital norms, promoting human rights and democracy, building bridges between developing and developed countries, and utilizing the attractive assets of the Korean Wave to expand diplomacy. The goal also includes enhancing the autonomy and resilience of the Korean economy by securing indigenous technologies and resources, reducing external dependence of the market, strengthening security, and pursuing peace. It is necessary to seize the opportunities created by the protectionist realignment and to ensure that the advancement of manufacturing and the pursuit of myopic economic interests do not infringe on security interests by capitalizing on Lagger's advantage, deepening the U.S.-ROK alliance, combining economic security sensitivity with economic strength, leveraging the status of a middle power among great powers, in a time of technological paradigm shifts, maximizing opportunities and minimizing threats. Based on this, a Korean-style economic and security strategy should be a combined and linked strategy that responds to the inseparability of economy and security and maximizes national interests by using various policy instruments in both the economy and security to promote synergy between economy and security by referring to the Japanese case.

The resurgence of the era of "economic security indivisibility" calls for an economic security strategy, and the logic of security, which is directly related to the safety and existence of the people, is overwhelming the logic of the economy. It is necessary to find a Korean-style economic security strategy that links the economy and security and minimize the risk of involvement and abandonment by pursuing independent national interests separate from the intentions of great powers. That is, we should balance security and markets in trust with friendly countries. In other words, we should avoid getting caught up in individual issues such as supply chain, IPEF, MSP, Chip4, etc., but capture the structural characteristics to maximize opportunities and minimize threats of protectionism. Establishing a domestic implementation system for the economic and security strategy and preparing conditions to maximize national interests is also necessary. Korea's economic and security strategy in the wake of GVC reorganization should focus on reorganizing the three-dimensional supply chain by distributing each item to each VC, maximizing the economic and security benefits of joining TVCs, and minimizing the economic and security risks of joining TVCs.

International export controls began in 1949 with the creation of the Coordinating Committee for Multilateral Export Controls (COCOM) to control exports to the former Soviet Union. International export controls expanded in the 1970s, beginning with non-proliferation

Table 2 Direction of GVC change

Value Chain (reorganization)	Major Items (Item Examples)	Collaboration Area	How it works	Participants
GVC (off-shoring)	Labor-intensive commodities (textiles, apparel, appliances, furniture, etc.)	Worldwide	Efficiency	Company
RVC (near-shoring)	Market access focus and decarbonization targets (parts subject to FTA preferential rules of origin, flowers)	Neighboring regions	↕	↕
DVC (re-shoring)	High-tech, dual-use core products that can be internalized (semiconductors, large-capacity batteries, key minerals, pharmaceuticals, etc.)	Domestic		
TVC (friend-shoring)	High-tech dual-use core products that are difficult to internalize (semiconductors, large-capacity batteries, core minerals, pharmaceuticals, etc.)	Worldwide allies	Resilience	Country

Table 3 International Export Control Initiation and Evolution

Classification	International Export Control Regimes				Nonproliferation Treaties	
	Wassenaar regime	Nuclear Suppliers Group	Missile Technology Control Regime	Australia Group	Chemical Weapons Convention	Biological Weapons Convention
Established	1996	1978	1987	1985	1997	1975
Member Countries	42 countries	48 countries	35 countries	43 countries	192 countries	174 countries
Korea Joined	1996	1995	2001	1996	1997	1987
Control Target	Conventional weapons (firearms, gunpowder, etc.) and dual-use items (materials, machinery, electronics, chemicals, etc.)	Nuclear energy items and dual-use items (centrifuges, etc.)	Missile-related items (missiles, rockets, navigation systems, etc.)	Biological and chemical weapons materials and manufacturing equipment (viruses, toxins, etc.)	Class 1,2,3 toxic chemicals and raw materials	here are no internationally defined items, but 67 biological agents are regulated in Korea's Chemical Weapons Prohibition Act.

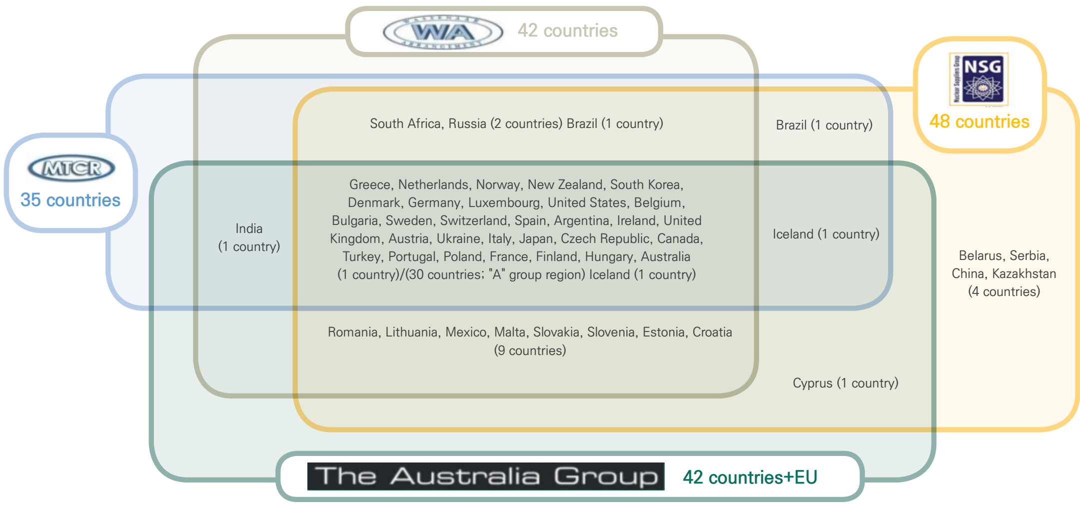
*In the international export control system, the basic principles for export control and the performance and standards of items are set, and member governments implement specific procedures and standards in their national laws.

treaties for nuclear (Non-Proliferation Treaty (NPT), 1970), then biological (Biological Weapons Convention (BWC), 1975) and chemical treaty(Chemical Weapons Convention (CWC), 1997). Multilateral export control regimes were established, starting with the Nuclear Suppliers Group (NSG) in 1974, followed by the Austria Group (AG) in 1985, the Missile Technology Control Regime (MTCR) in 1987, and the Wassenaar Arrangement (WA) in 1996.

Each of the four international export control regimes has a different scope of membership: the Wassenaar Arrangement includes 42 countries, the Nuclear Suppliers Group consists of 48 countries, the Missile Technology Control Regime contains 35 countries, and the Australia Group consists of 42 countries plus the EU. South Korea and Japan are included in all of them, while China only participates in the Nuclear Suppliers Group. Strategic goods are conventional weapons, weapons of mass destruction (WMD), missiles, and the goods, software, and technology available for their manufacture and development. U.S. interests in controlling strategic goods and military technology have expanded the scope of high-tech guidance, and the emergence of a new control regime that excludes China and Russia could result in a high-tech blockade. In the existing Wassenaar system, European countries have been cooperating under the leadership of the United States and the United Kingdom. The only countries that can be critical of this system are Russia, Japan, and South Korea, which are the most technologically advanced countries outside the U.S.-EU and Commonwealth. Regarding the possibility of a new control regime, there is no such need for a new regime because the FDPR (Foreign Direct Product Rules) regime, which allows for the blockade of technology and goods that the United States is the sole global supplier of, can be implemented under the FDPR regime. If a non-U.S. country wanted to do this, a new regime would be necessary, at least if the country had equal or more excellent technological capabilities than the United States. In the case of Korea, technology exchanges with friendly countries may not work well under the new system, requiring measures to minimize the loss of market opportunities and damage. Therefore, developing a plan to pursue Korean national interests by industry is crucial. In other words, it may be best to devise systematic scenarios on maximizing national interests for each industry, such as semiconductors, and find ways to minimize damage through favorable negotiations with friendly countries before major changes.

In response to China's economic rise, the United States is pursuing new forms of economic and security policy, including not only trade policy but also supply chain reorganization and industrial policy[4]. Economic security refers to sufficient access to and utilization of national resources, finances, and markets to maintain a country's power and wealth at a certain level. The traditional

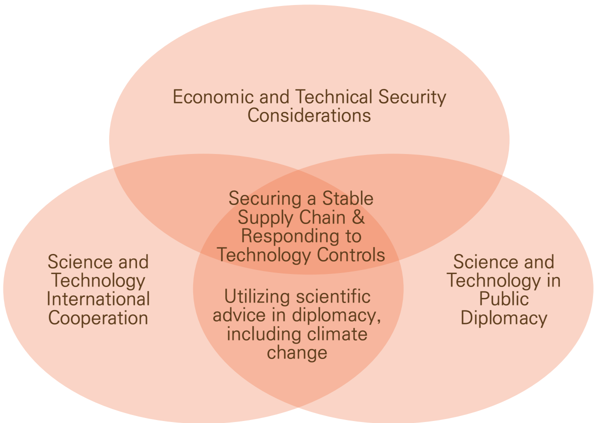
Figure 2 Membership Status of the Four International Export Control Regimes



perception of the economy-security relationship in international politics is that the economy is subservient to security, and economic means are used for the ultimate purpose of national security. Since the 2000s, the spread of globalization and the expansion of global supply chains have led to the development of stronger economic and security linkages. The GATT Article 21 security exception gives countries discretionary authority to determine whether measures restricting trade are in their national security interests and has been invoked rarely in practice. The Trump administration in the United States has changed the traditional relationship between economics and security, meaning that economics no longer has the upper hand. A balanced relationship between economics and security is required, and the US-led Indo-Pacific Economic Framework (IPEF), which covers not only trade but also labor, environment, and competition policies, is expected to develop a new relationship.

Rather than the expression 'science diplomacy', Korea recognizes and uses it separately as international cooperation from the perspective of science and technology and public diplomacy in the field of science and technology, making it necessary to establish the concept of science diplomacy. It can be categorized into 'diplomacy for science' and 'science for diplomacy' in the three types proposed by the Royal Society, and 'science in diplomacy' can fall into the convergence area of the two perspectives. To date, there is no official consensus definition of science diplomacy, and it is necessary to establish a concept that can be used in science and technology diplomacy activities and policy-making processes. In addition, in the context of strengthening economic security and technology control due to the deepening technological hegemony of the United States and China, diplomatic activities for science and technology and the utilization of science and technology for diplomacy as public diplomacy are increasingly converging. Science diplomacy can be seen as a new area of convergence that not only utilizes scientific advice for diplomacy, such as climate change, but also secures stable supply chains and responds to technology control in consideration of economic and technological security. Korea has named a new convergence area considering economic security/technological security as "diplomacy in science," a new type of science diplomacy, and defined it as activities to control science and technology related to economic security/technological security in order to secure technological sovereignty and supply chain. South Korea presented this as a type of science diplomacy that aims at science and technology but mobilizes imperative means such as controlling science and technology in consideration of economic and technological security. While the existing 'diplomacy for science' type was based on persuasive means such as cooperation and competition, the 'diplomacy in science' type was categorized as a type that secures technological sovereignty and stable supply chains through norms and controls.

Figure 3 Areas of science diplomacy considering economic security



[4] For more information, see Economic Security Concepts and Assessment of Recent Trends (2022).

Table 4 Classification of Science Diplomacy Types

Category	Purpose: Science and Technology	Purpose: Diplomacy
Commanding means (Norms and Control)	〈Diplomacy in Science〉 Norm-based control activities to secure science and technology resources in consideration of economic security ▸ Securing overseas resources/strategic materials, supply chains, etc.	〈Science in Diplomacy〉 The use of scientific and technological standards, institutions, norms, and other controls to get others to do something they don't want to do ▸ Role of science and technology as scientific advice
Persuasive means (Cooperation and competition)	〈Diplomacy for Science〉 Cooperation through persuasion and argumentation based on science and technology achievements ▸ International cooperation in science and technology: joint research, joint scientific committees, etc.	〈Science for Diplomacy〉 Utilizing science and technology as a persuasive resource for inducement/reward ▸ Science and technology ODA, inter-Korean cooperation, etc.

3. Experts' Perceptions of Science Diplomacy

Before discussing how to respond to science and technology diplomacy by type, we surveyed experts in related fields about the types of science diplomacy based on the distinction between 'diplomacy for science' and 'science for diplomacy' from the three types proposed by the Royal Society.

The results showed that 'diplomacy for science and technology' was the most common (94.9%), followed by 'science and technology for diplomacy' (72.9%) and 'science and technology in diplomacy' (71.5%).

In terms of the types of the most desired science diplomacy activities in the future, "diplomacy for science and technology" was the most popular (83.1%), followed by "science and technology for diplomacy" (66.1%), and "science and technology in diplomacy" (59.3%)" in order. The ranking of preferences for the types of science diplomacy activities currently being carried out and the desired areas are the same, with science and technology in diplomacy receiving a slightly lower share.

When looking at activities in the field of diplomacy for science and technology, 'Inter-institutional exchanges such as signing MOUs' was the most common (69.5%), followed by 'Joint research' (66.1%), 'Human resource exchanges such as dispatching personnel to overseas research centers' (50.8%), and 'Human resource exchange including attracting overseas researchers' (49.2%). Regarding future desired activities in the field of diplomacy for science and technology, 'Attracting overseas research institutes' was the highest at 27.1%, followed by 'Information exchange' (23.7%), 'Human resource exchanges such as dispatching personnel to overseas research centers' (22.0%), 'Joint research', 'Human resource exchange including attracting overseas researchers', and 'Support for joint science and technology committees' (20.3% each).

Figure 4 Areas of science diplomacy activities (multiple responses)

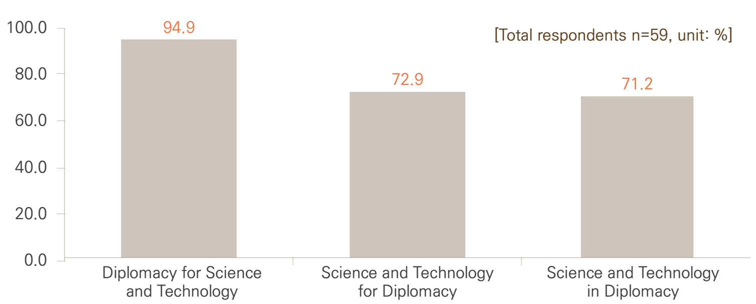


Figure 5 Areas for desired future science diplomacy activities – Overall (Multiple responses)

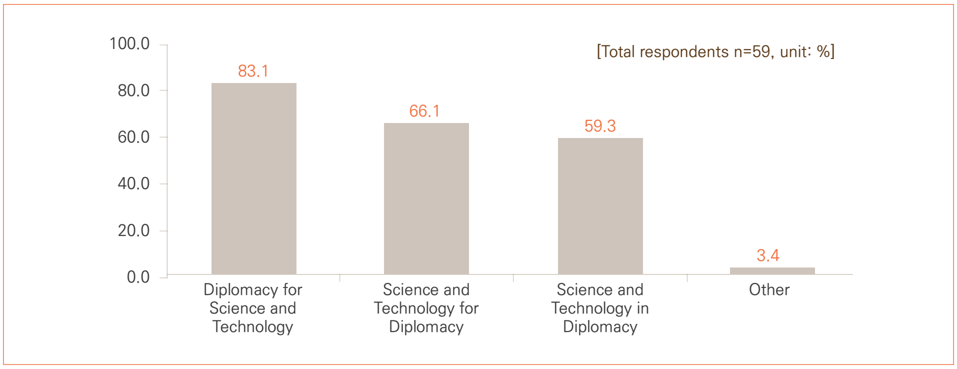


Figure 6 Areas of science diplomacy activities – Diplomacy for science and technology (multiple responses)

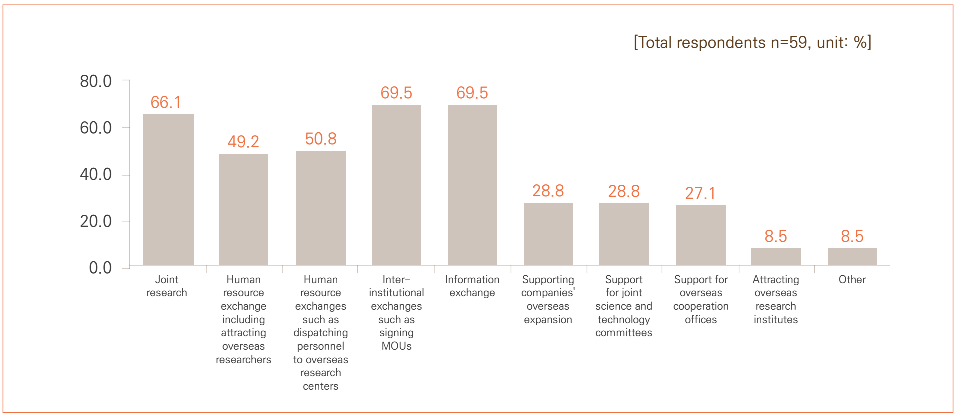
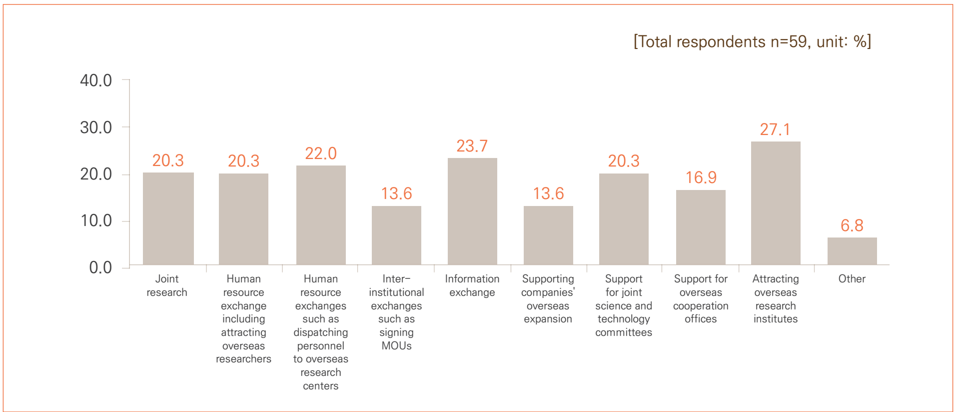


Figure 7 Areas of desired future science diplomacy activities – Diplomacy for science and technology (multiple responses)



When it comes to activities in science and technology for diplomacy, 'Science and technology ODA' was the most frequently cited (62.7%), followed by 'South Korea-North Korea science and technology cooperation' (23.7%) and 'Science and technology cooperation with countries without diplomatic relations or amicable relations' (18.6%). In terms of desired future activities in the field of science and technology for diplomacy, 'Science and technology ODA' was the most common (32.2%), followed by 'Science and technology cooperation with countries without diplomatic relations or amicable relations' (28.8%) and 'South Korea-North Korea science and technology cooperation' (23.7%).

When looking at activities in science and technology in diplomacy, 'Advising international organizations such as OECD and UN on science and technology' was rated the highest at 50.8%, followed by 'Participating in or supporting diplomatic activities such as intergovernmental organizations such as the IPCC' (47.5%), and 'Activities in international organizations such as space, ocean, polar, etc.' (30.5%). Among the desired future activities in science and technology in diplomacy, "Advising international organizations such as OECD and UN on science and technology" was the most common answer (37.3%), followed by "Activities in international organizations such as space, ocean, polar, etc". (23.7%), and "Participating in or supporting diplomatic activities such as intergovernmental organizations such as the IPCC" (22.0%).

Figure 8 Areas of science diplomacy activities – Science and technology for diplomacy (multiple responses)

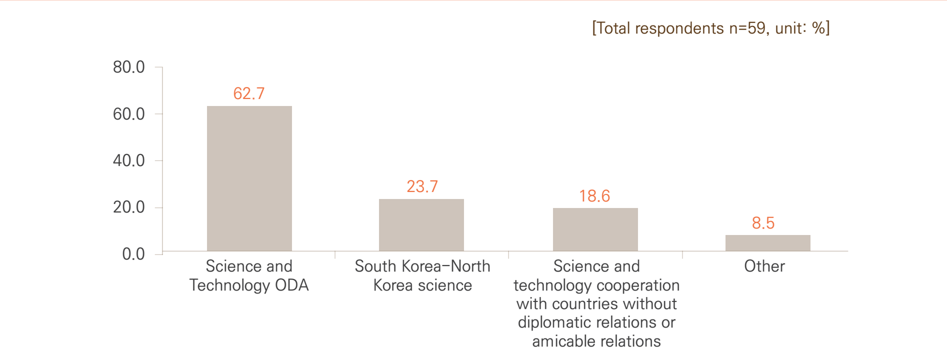


Figure 9 Areas of desired future science diplomacy activities – Science and technology for diplomacy (multiple responses)

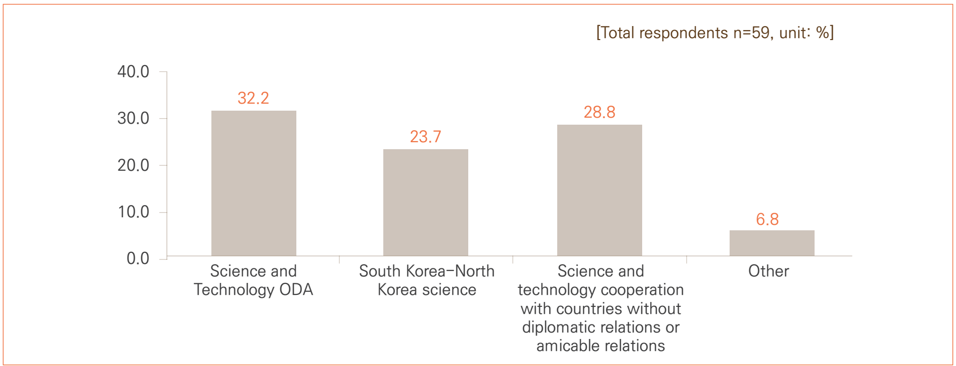


Figure 10 Areas of science diplomacy activities – Science and technology in diplomacy (multiple responses)

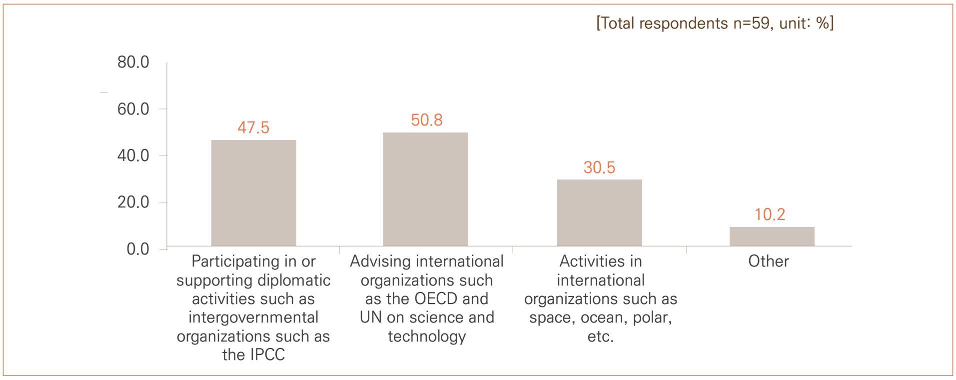
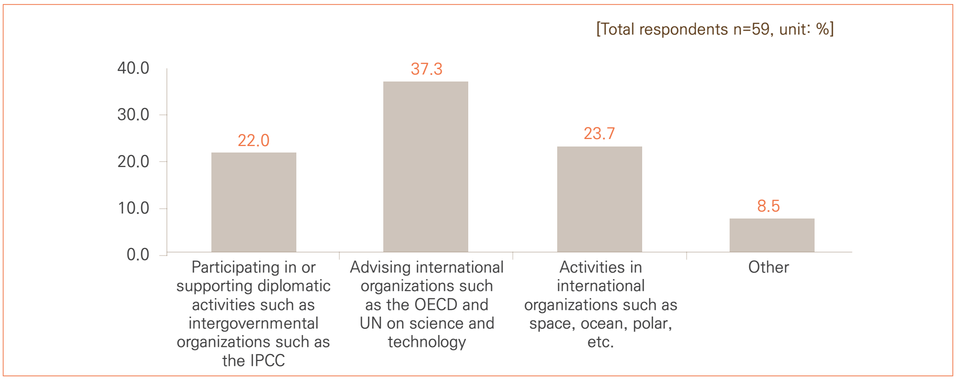


Figure 11 Areas of desired future science diplomacy activities – Science and technology in diplomacy (multiple responses)



As the scope of science diplomacy is unclear compared to international cooperation in science and technology and is used in various forms in many places, we conducted a survey to determine the extent to which various sectors are recognized as science diplomacy, considering Korea's major technologies. The results of the survey on whether science diplomacy is included in various fields showed that 'Climate Change' had the highest response of 91.5%, followed by 'Energy' (89.8%), 'Digital sector' (86.4%), 'Healthcare' (84.7%), and 'Supply Chain' (74.6%). The climate change, energy, digital, and health sectors, which are already active in science diplomacy, were found to be the highest, while the supply chain sector was also recognized as a key area of science diplomacy due to the competition for technological supremacy between the US and China.

41.2% of the respondents (n=51) who said that digital fields such as ICT and cybersecurity are included in science diplomacy answered that the digital sector is "Diplomatic activities for science and technology," followed by "Science and technology for diplomatic activities" (29.4%) and "Science for international organizations and intergovernmental organizations" (19.6%).

Of the respondents (n=54) who said that climate change is included in science diplomacy, 44.4% said that it is included in the "Science for international organizations and intergovernmental organizations" category, followed by "Diplomatic activities for science and technology" (29.6%) and "Science and technology for diplomatic activities" (18.5%).

Figure 12 Perceptions of science diplomacy type classification

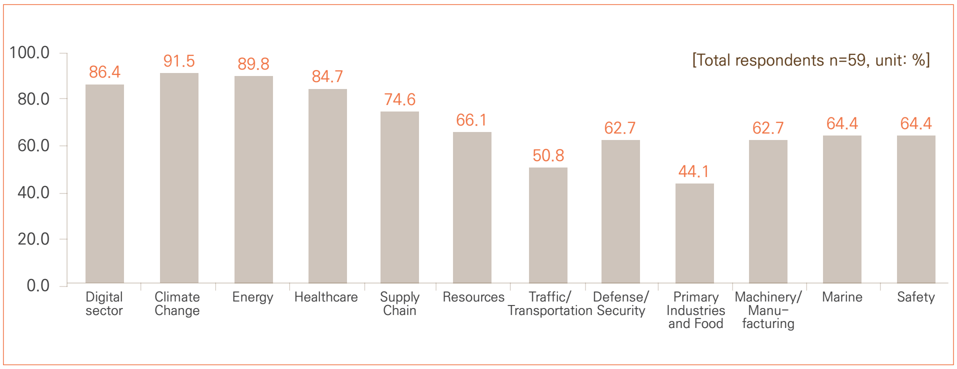


Figure 13 Classification of science diplomacy types – Digital sectors such as ICT and cybersecurity

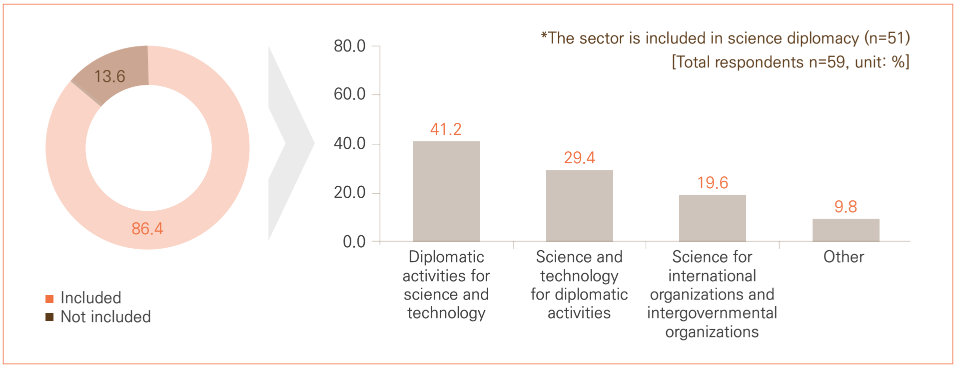
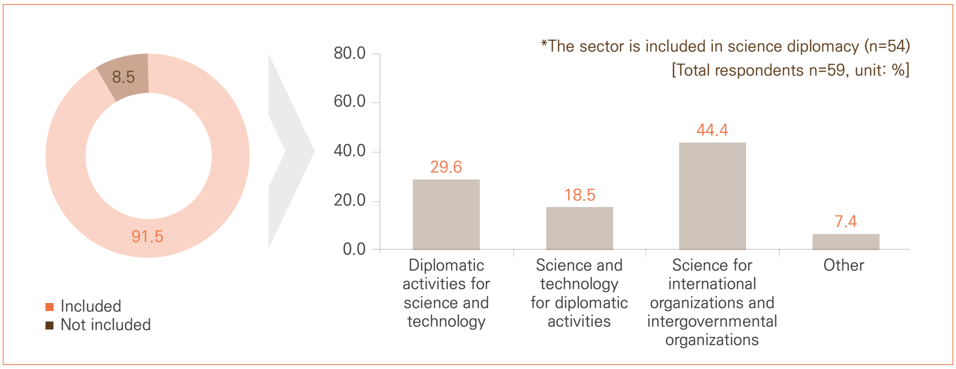


Figure 14 Classification of science diplomacy types – Climate change sector



45.3% of respondents (n=53) said that the energy sector is included in science diplomacy, followed by "Diplomatic activities for science and technology" (22.6%) and "Science for international organizations and intergovernmental organizations" (20.7%).
50.0% of respondents (n=50) said that the health sector, including infectious diseases and vaccine intellectual property, is included in science diplomacy under the category of 'Diplomatic activities for science and technology.' 'Science and technology for diplomatic activities, Science for international organizations and intergovernmental organizations' followed with 18.0% each.
63.6% of the respondents (n=44) who said that supply chain issues, such as reorganizing the semiconductor supply chain, is included in science diplomacy answered that supply chain is included in the type of 'diplomatic activities for science and technology', which was followed by 'science and technology for diplomatic activities' (15.9%) and 'science used in the activities of international organizations and intergovernmental organizations' (2.3%).
41.0% of the respondents (n=39) who said that resource sector such as rare earths and natural gas is included in science diplomacy said that the sector is included in the type of "diplomatic activities for science and technology," followed by "science and technology for diplomatic activities" (33.3%) and "science used in the activities of international organizations and intergovernmental organizations" (7.7%).
36.7% of respondents (n=30) who said that the traffic/transportation sector, such as Siberian railways, unmanned aerial vehicles, and autonomous driving, is included in science diplomacy, responded that the sector is included in the type of 'diplomatic activities for science and technology', followed by 'science and technology for diplomatic activities' (33.3%), and 'science used in the activities of international organizations and intergovernmental organizations' (13.3%).

Figure 15 Classification of science diplomacy types – Energy Sector

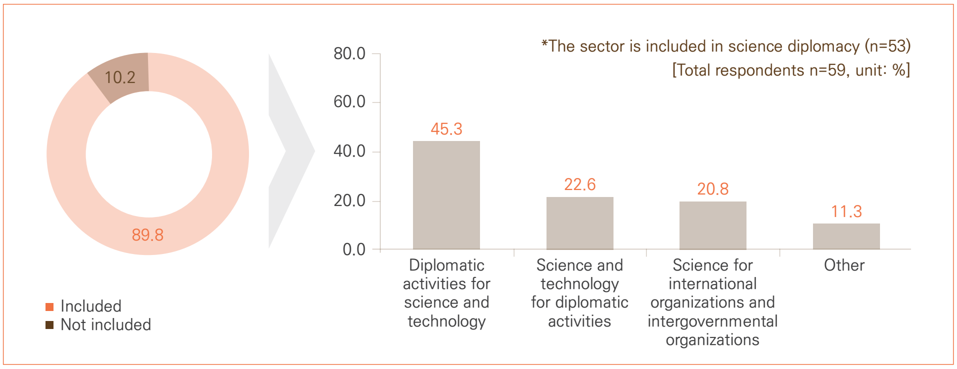


Figure 16 Classification of science diplomacy types
– Healthcare, including infectious diseases and vaccine intellectual property rights

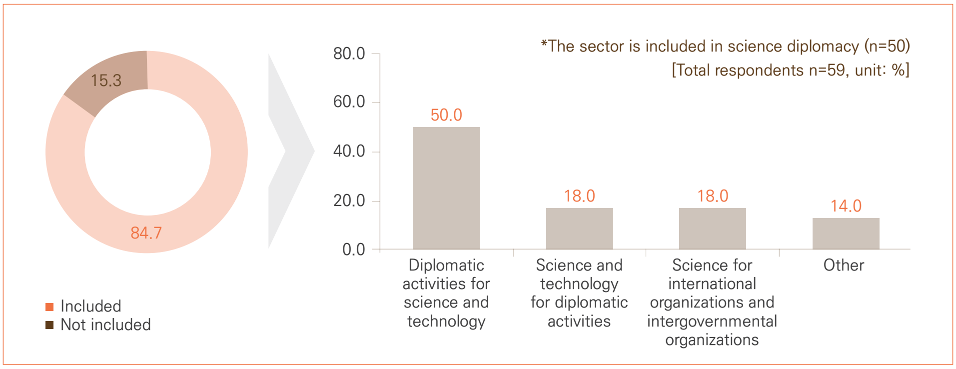


Figure 17 Classification of science diplomacy types
– Supply chain, including reorganization of the semiconductor supply chain

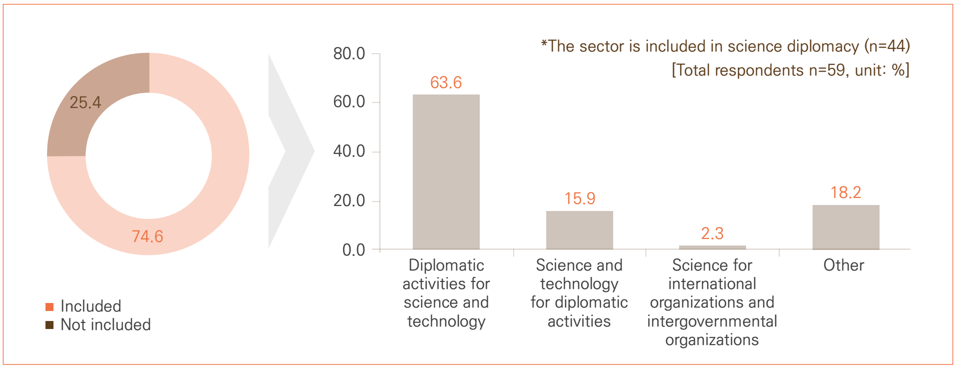


Figure 18 Classification of science diplomacy types – Resource sector such as rare earths and natural gas

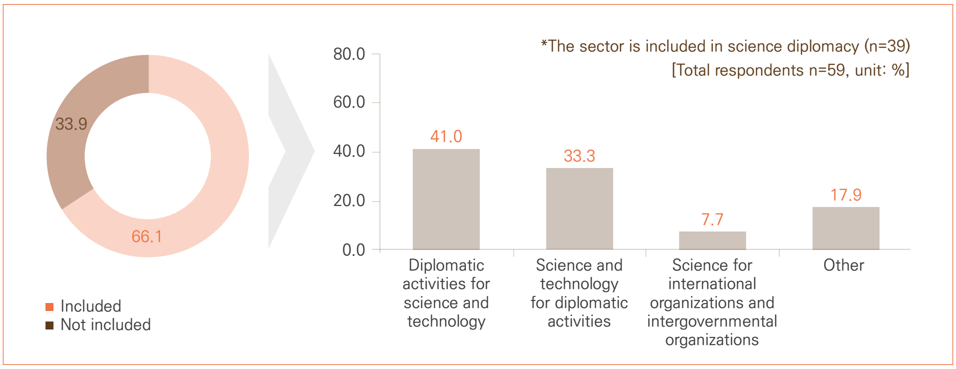
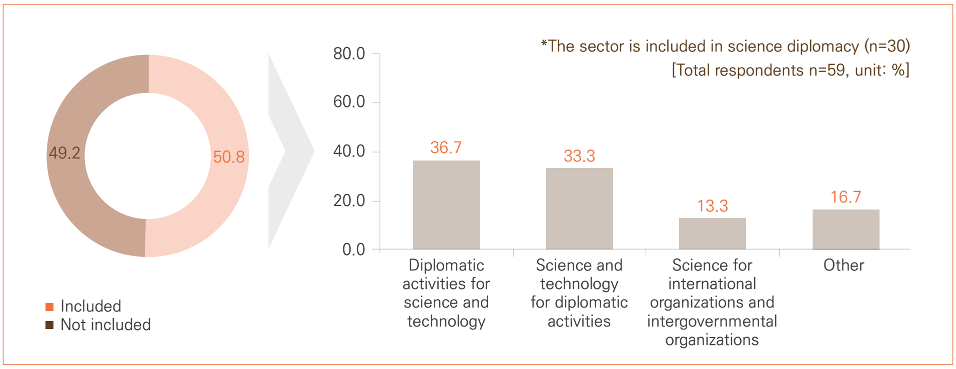


Figure 19 Classification of science diplomacy types – Traffic/Transportation sector, including Siberian Railway, unmanned aerial vehicles, autonomous driving, etc.



48.6% of the respondents (n=37) who included the defense/security sector in science diplomacy said it was included in the "science and technology for diplomatic activities" category, followed by "science and technology for diplomatic activities" (21.6%) and "science used in international organizations and intergovernmental organizations" (16.2%).

38.5% of respondents (n=26) who said that primary industries such as agriculture, forestry, and fisheries and the food sector are included in science diplomacy responded that they are included in the type of "diplomatic activities for science and technology," followed by "science and technology for diplomatic activities" (26.9%) and "science used in international organizations and intergovernmental organizations" (11.5%).

62.2% of respondents (n=37) who responded that the mechanical/manufacturing sector, such as industrial robots and shipbuilding plants, is included in science diplomacy said that the sector is included in the type of "diplomatic activities for science and technology," with "science and technology for diplomatic activities" (16.2%) and "science used in the activities of international organizations and intergovernmental organizations" (8.1%)" following up next.

39.5% of the respondents (n=38) who said that marine areas such as the polar regions and the deep ocean floor are included in science diplomacy said that they are included in the type of "science used in the activities of international organizations and intergovernmental organizations," followed by "diplomatic activities for science and technology" (34.2%) and "science and technology for diplomatic activities" (10.5%).

39.5% of the respondents (n=38) who said that safety sectors such as disaster monitoring/response/rescue and wardening are included in science diplomacy responded that they are included in the type of 'diplomatic activities for science and technology', followed by 'science used in international organizations and intergovernmental organizations' (28.9%) and 'science and technology for diplomatic activities' (21.1%).

Figure 20 Classification of science diplomacy types –Defense/Security Sector

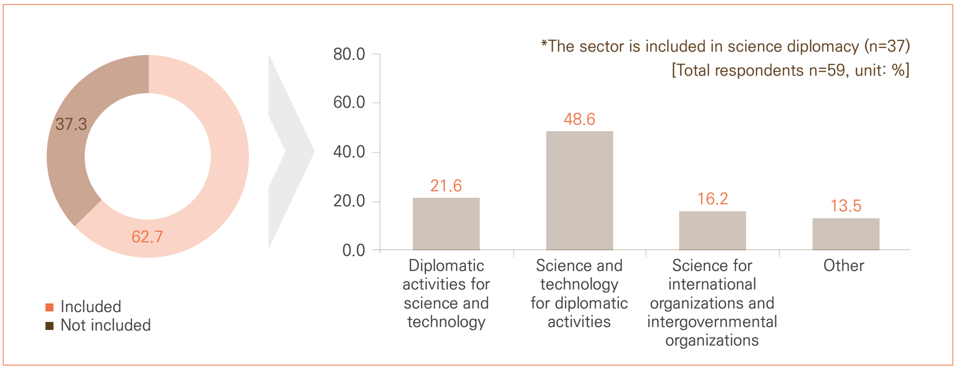


Figure 21 Classification of science diplomacy types
– Primary industries, such as agriculture and forestry, and the food sector

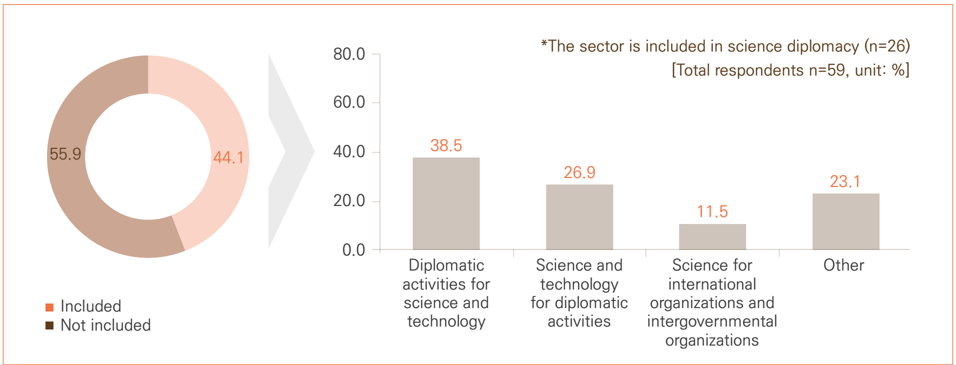


Figure 22 Classification of science diplomacy types
– Mechanical/manufacturing sector such as industrial robots, shipbuilding plants, etc.

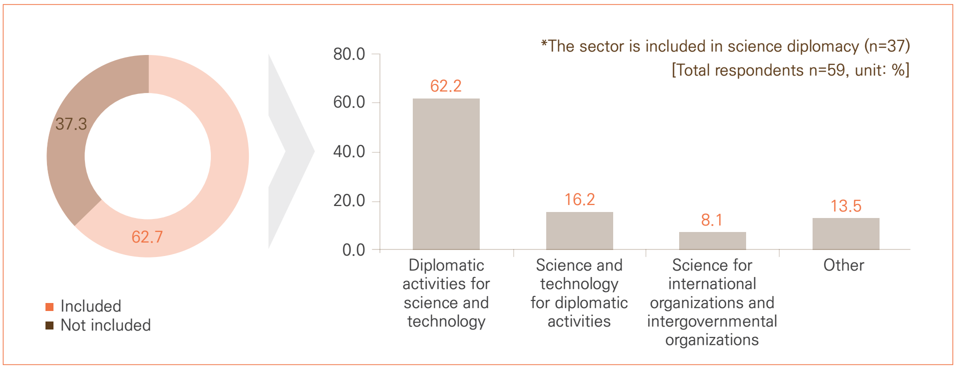


Figure 23 Classification of science diplomacy types – Marine sector such as polar regions and the deep ocean floor

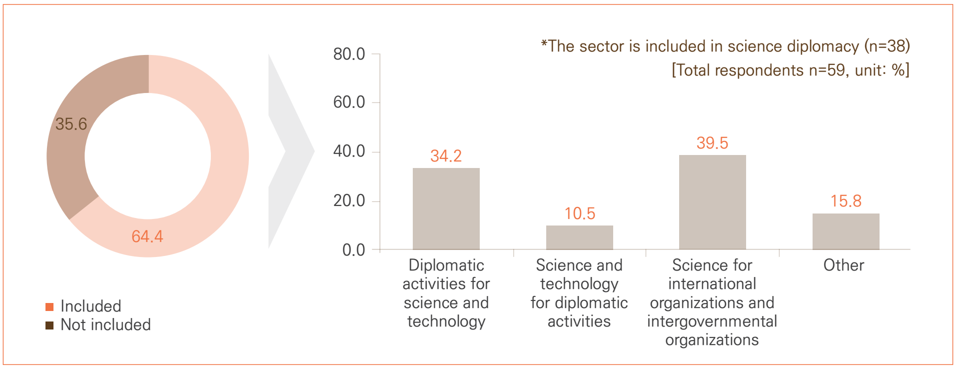
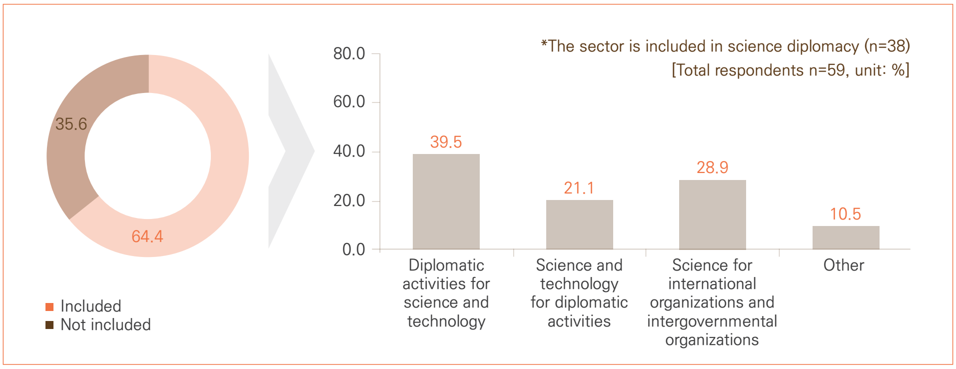


Figure 24 Classification of science diplomacy types
– Safety sector, such as disaster monitoring/response/rescue, warden, etc.



Across the three types, the digital, health, and semiconductor supply chain sectors, which are highly technical in nature, are more dominant in the diplomacy for science and technology type. Climate change, polar, deep-sea, and maritime sectors, where international organization activities are critical, are prominent in science and technology in diplomacy. The energy sector, related to climate change, is differentiated from the climate change sector as they were dominant in diplomacy for science and technology. The defense/security sector was less categorized as a science diplomacy type, but science and technology for diplomacy was the most dominant type. Science diplomacy types were not exclusively categorized by the different sectors, but three types co-existed, with one type being relatively dominant.

4. Direction of Science Diplomacy Response by Type

First, 'diplomacy for science and technology' is a type of international cooperation activity for science and technology, which is more active than the other types of science diplomacy. ' 'Science and Technology in Diplomacy' and 'Science and Technology for Diplomacy' are types of activities centered on public diplomacy, and each requires more active activities by enhancing science and technology expertise and expanding the role of science and technology in public diplomacy. 'Diplomacy in Science and Technology' is a newly added category gaining importance due to the competition for technological supremacy between the United States and China. In light of technological security, it is necessary to enhance cooperation with allies and secure the acquisition of advanced technologies and a stable supply chain for Korea through bilateral and multilateral cooperation, especially in the technology control system. The roles of ministries related to science and technology, which currently conduct international cooperation mainly for science and technology, and ministries related to foreign affairs, which conduct public diplomacy that utilizes science and technology as a tool, are expanding as the importance of science and technology grows. For example, 'diplomacy in science and technology' is where cooperation between science and technology and public diplomacy is highly needed. Geopolitical factors are also becoming essential considerations, as economic security has emerged as a combination of economy, technology, and security, and the U.S.-centered Indo-Pacific strategy has been newly announced. Therefore, science diplomacy must keep pace with Korea's foreign policy and strategy, and the role of science and technology (diplomacy) as soft power is becoming more critical in the current situation where competition is becoming more intense than cooperation. As we have already seen in the dispute over materials, parts, and equipment with Japan, resources and technology issues are at the root of trade issues, and the competition for technological supremacy between the United States and China is also aimed at securing resources and supply chains.

For country-level strategies, we need to distinguish between state and market. In state-to-state relations, we should enhance cooperation with friendly countries where we can build trust. For markets, we should consider not only cooperation for public relations in supply chains centered on friendly countries but also competition within friendly countries through self-reliance. In addition, we need to consider technological fields and security in drawing up cooperation agendas between countries, which are currently centered on technological fields. To have an advantageous position in relations between countries centered on friendly countries, we need to secure our own technologies, such as post-semiconductors, which cannot be replaced more than anything else as we need technological competitiveness, such as post-semiconductors, as seen in the semiconductor issue. In this situation, Korea has selected 12 national strategic technologies and is making efforts to secure technological sovereignty by creating cooperation strategies and roadmaps for them. In securing these technologies, responding to economic and technological security issues is necessary by preparing relevant market and supply chain issues in advance. A science diplomacy strategy is essential to secure these core technologies, which will require more strategic promotion of the existing science and technology international cooperation ('diplomacy for science and technology') and enhancement of Korea's science and technology leadership in the region. We must move away from the current strategy of being a chaser and take the lead in creative innovation through reciprocal joint research. When technology related to economic and technological security requires technology control, such activities require securing rare resources such as rare earths and managing strategic technologies and materials related to security (a type of diplomacy in science and technology).

It is necessary for Korea to actively participate in agendas that require multilateral cooperation, such as solving global problems such as climate change and energy and achieving the UN's sustainable goals. Agenda-oriented science diplomacy responses are needed to address global issues, including climate change and space diplomacy, such as solving space debris, and maritime diplomacy, such as carbon reduction and improving the marine environment. The dominant type of science diplomacy will be 'science and technology in diplomacy.' For Korea's active participation, an effective response is required in conjunction with the national mission, and a national-level strategy linking the science and technology strategy, industrial trade strategy, and public diplomacy strategy is needed. Regarding science diplomacy, which is approached from public diplomacy, it is the 'science and technology for diplomacy' type of science diplomacy, which the Ministry of Foreign Affairs mainly promotes.

In addition to expanding cooperation with developing countries such as India and ASEAN countries as alternative markets in case the supply chain decouples from China to a certain extent, it will be necessary to maintain a separate science diplomacy dialog with China. It is impossible to find a complete substitute for the Chinese market in the short term, and it is necessary to consider long-term cooperation strategies with countries that can replace China in light of this situation.

When examining science diplomacy by focusing on the types of science diplomacy, it can be seen that there are two main directions: the direction of expanding the role of science and technology in international cooperation centered on the science and technology community and the direction of increasing the scope of science and technology for public diplomacy centered on the diplomatic community. In other words, the intersection of science diplomacy activities conducted for science and technology and science diplomacy activities that utilize science and technology as a means of public diplomacy is widening. This has become the backdrop for establishing the Ministry of Foreign Affairs' Science Diplomacy Bureau and is manifested in the defensive attitude of the Ministry of Science and ICT, which is wary of expanding the role of science and technology in public diplomacy. It is time for a natural convergence of these two trends and organic cooperation through dividing roles between the two ministries.

One of the most challenging issues in the direction of science diplomacy is establishing a relationship with China. The background of this study is the competition for technological supremacy between the United States and China due to China's growth. China is also the country with which Korea has the most trade relations. Considering China's current policies and strategies, further exploration of the direction of Korea's science diplomacy response is necessary.

At the turn of the century, China is mobilizing its political, diplomatic, economic, scientific, technological, and military strategies around the Belt and Road Initiative (BRI) to achieve the great revival of the Chinese people (the Chinese Dream). China's grand strategy aims to become a socialist modernizing power in the middle of the 21st century, with the ultimate goal of becoming a world-class, innovative nation in 2035. China is emphasizing a national science education and technological innovation strategy by transforming China Manufacturing 2025 from a manufacturing giant to a manufacturing powerhouse, as reported in the 14th Five-Year Plan and the 20th Party Congress. China's R&D investment and number of patents in high-tech fields has already surpassed that of the United States (excluding bio), and China is investing heavily in new technologies such as AI and quantum. The country also aims to share its leading defense technologies with the private sector to achieve both economic growth and military modernization. China is pushing for dual-use civil-military technology innovation with Hikvision, Dahua Technology, Megvii, iFlytek, SenseTime, E2 Technology, Isintechnology Mayapico, etc. Through the Belt and Road Initiative (BRI), China also seeks to deepen united cooperation with developing countries and build a digital community along the Belt and Road by promoting policy communication (internet development strategy and policy communication), infrastructure connection (internet communication network, data center, etc.), trade communication (e-commerce), financial integration Financial currency economic system connection integration), and people-to-people communication (people-to-people connection in digital space and digital talent education). Through the Belt and Road Initiative (BRI), China also seeks to deepen united cooperation with developing countries and build a digital community along the Belt and Road by promoting policy communication (internet

development strategy and policy communication), infrastructure connection (internet communication network, data center, etc.), trade communication (e-commerce), financial integration Financial currency economic system connection integration), and people-to-people communication (people-to-people connection in digital space and digital talent education). In 2018, China launched health diplomacy, the global expansion of China BeiDou, and the BRI Alliance of International Science Organizations (ANSO) with developing countries to expand to 67 members in November 2021, connecting 50 countries and regions in Asia, Africa, Europe, South America, and Oceania.

Along with Japan, China is Korea's closest neighbor, and we have very close trade ties through markets. The U.S.-China technological hegemony competition is forcing South Korea to decouple from China to a certain extent. The challenge for South Korea is decoupling the existing close coupling and maintaining a future relationship amidst this competition (control) and conflict. To prepare for decoupling from China, South Korea must first secure trust with its allies and develop alternatives to the Chinese market. While the Moon administration's New Southern Policy is increasing cooperation with India and ASEAN countries, South Korea should be prepared for a painful transition period because those countries are not a substitute for the Chinese market. Korea must strengthen technological innovation and solidarity, secure an open trade environment through universal values and norms while considering technological security, and diversify diplomacy with developing countries. Digital diplomacy through digital transformation and Korea's foreign policy and science diplomacy strategy as a middle power in the new Cold War are required.

In the complex U.S.-China technological hegemony competition structure, Korea needs to respond to a single issue through bilateral and multilateral cooperation. In value chain reorganization at the bilateral cooperation level, Korea should selectively choose GVCs (off-shoring), RVCs (near-shoring), DVCs (re-shoring), and TVCs (friend-shoring) by item, considering the degree of technological security relevance of the item, to promote balanced cooperation. In particular, as the U.S. Indo-Pacific strategy to counter China is expected to be promoted through multilateral cooperation, it is necessary to inherit Korea's existing New Southern Policy and promote it in harmony with the more comprehensive Indo-Pacific Regional Strategy. We should actively participate in reorganizing the U.S. supply chain to secure our position and role and resolve cross-border issues such as Korea-Japan relations through bilateral cooperation and multilateral cooperation on small and large scales.

References

Bae, Youngja (2015). How to Enhance Global Leadership through Strengthening Science Diplomacy Capabilities, National Science and Technology Advisory Council

Bae, Youngja (2016). US-China Hegemonic Competition and Science and Technology Innovation, International and Regional Studies, Vol. 25, No. 4, pp. 31-59

Kang, Jinwon (2022). Exploring the Direction of Science Diplomacy to Respond to the US-China Competition for Technological Supremacy, KISTEP

Kang, Jinwon, Lee, Jungtae and Kim, Jinha (2023). Direction of Korea's Science Diplomacy in the Era of Competition for Technological Supremacy, KISTEP Issue paper (2023-10)

Kim, Seung-Hwan (2017). The Science & Technology Kim, Seung-Hwan (2019). Science Transcending Boundaries, The Science & Technology

Kim, Yang-Hee (2022). The Search for a Korean-style Economic and Security Strategy and IPEF, Institute for Diplomacy and Security Studies

Lee, Hyo-Young (2022). the Concept of Economic Security & Assessment of Recent Trends, Institute for Diplomacy and Security Studies, National Diplomatic Academy of Korea

https://dbr.donga.com/article/view/1206/article_no/10103 (Climate finance hegemonic war clouds coming)

https://www.hellodd.com/news/articleView.html?idxno=61116 (All over the world, science diplomacy organization activities, Korea?)

https://www.yna.co.kr/view/AKR20210402044500009 (US-China Hegemonic Competition, Climate Change Response is Next)