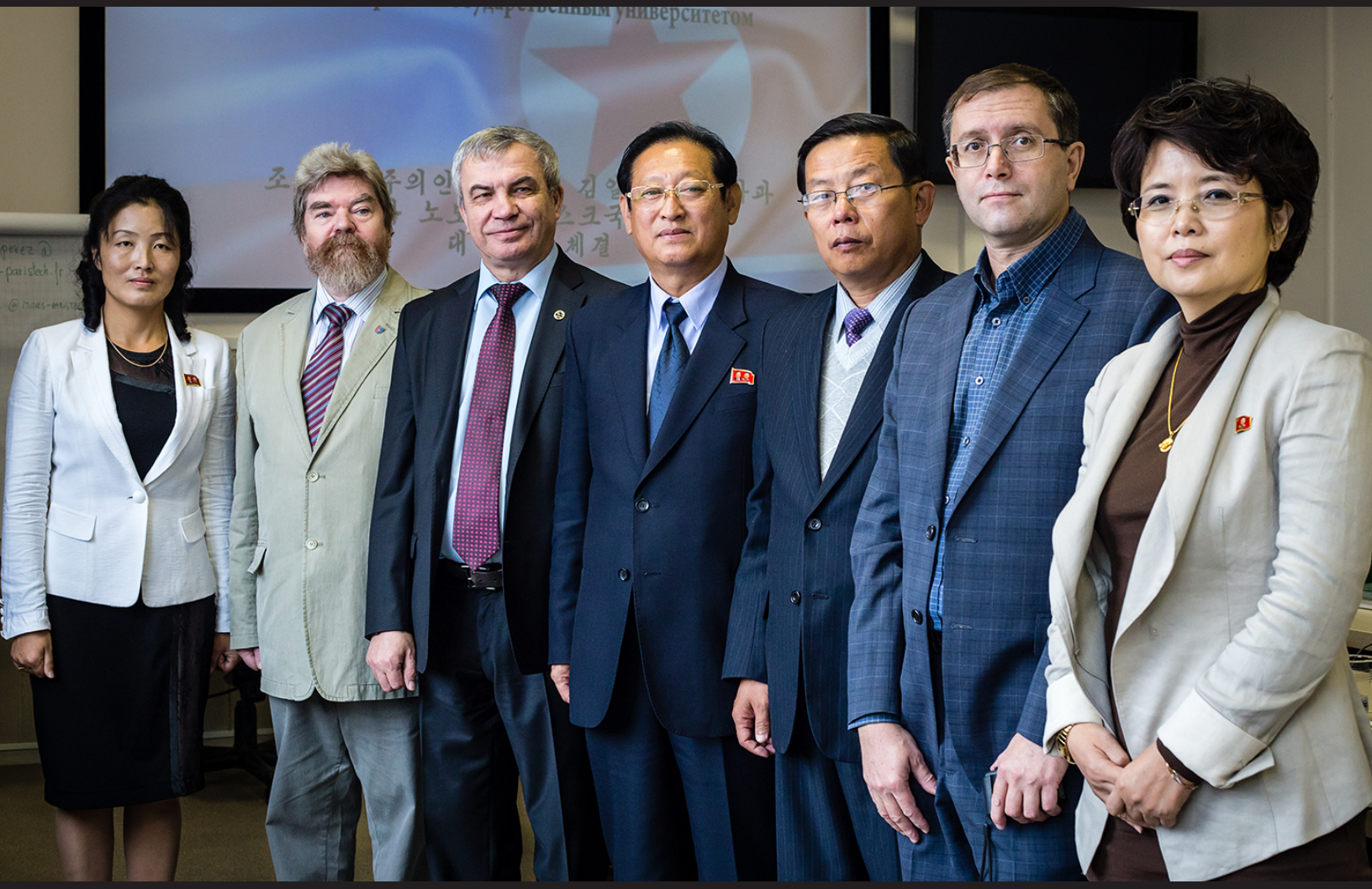


CNS

OCCASIONAL PAPER

#43 · DECEMBER 2018

North Korea's International Scientific Collaborations: Their Scope, Scale, and Potential Dual-Use and Military Significance

By Joshua H. Pollack and Scott LaFoy

with contributions from Andrea Berger, Ferenc Dalnoki-Veress, Chen Kane, Miles Pomper, Ramya Ramjee, and Grace Vedock

Middlebury Institute *of* International Studies at Monterey

James Martin Center for Nonproliferation Studies

James Martin Center for Nonproliferation Studies
nonproliferation.org

The James Martin Center for Nonproliferation Studies (CNS) strives to combat the spread of weapons of mass destruction by training the next generation of nonproliferation specialists and disseminating timely information and analysis. CNS at the Middlebury Institute of International Studies at Monterey is the largest nongovernmental organization in the United States devoted exclusively to research and training on nonproliferation issues.

Middlebury Institute for International Studies at Monterey
www.miis.edu

The Middlebury Institute for International Studies at Monterey provides international professional education in areas of critical importance to a rapidly changing global community, including international policy and management, translation and interpretation, language teaching, sustainable development, and nonproliferation. We prepare students from all over the world to make a meaningful impact in their chosen fields through degree programs characterized by immersive and collaborative learning, and opportunities to acquire and apply practical professional skills. Our students are emerging leaders capable of bridging cultural, organizational, and language divides to produce sustainable, equitable solutions to a variety of global challenges.

James Martin Center for Nonproliferation Studies
Middlebury Institute of International Studies
460 Pierce Street
Monterey, CA 93940, USA
Tel: +1 (831) 647-4154
Fax: +1 (831) 647-3519

Disclaimer

The views, judgments, and conclusions in this report are the sole representations of the authors and do not necessarily represent either the official position or policy or bear the endorsement CNS or the Middlebury Institute of International Studies at Monterey.

Cover image: Novosibirsk State University representatives receive a delegation from Kim Il Sung University led by Thae Hyong Chol, 2015. Credit: Novosibirsk State University.

North Korea's International Scientific Collaborations: Their Scope, Scale, and Potential Dual-use and Military Significance

James Martin Center for Nonproliferation Studies

Joshua H. Pollack and Scott LaFoy

with contributions from Andrea Berger, Ferenc Dalnoki-Veress, Chen Kane, Miles Pomper, Ramya Ramjee, and Grace Vedock

TABLE OF CONTENTS

ABBREVIATIONS

CKNI	China National Knowledge Infrastructure
DBID	unique database identification number
DOI	digital object identifier
DPRK	Democratic People's Republic of Korea
FEFU	Far Eastern Federal University (Russia)
FMS	Flexible Manufacturing Systems
GPS	global positioning system
GPSH	Grand People's Study House
JINR	Joint Institute for Nuclear Research
KCNA	Korean Central News Agency
KCUT	Kim Chaek University of Technology
KISU	Kim Il Sung University
PUST	Pyongyang University of Science and Technology
SANS	Second Academy of Natural Sciences, a.k.a. the Academy of National Defense Sciences
SAOS	State Academy of Sciences, formerly the Academy of Sciences
SPA	Supreme People's Assembly
UNS	University of Natural Science, formerly the University of Science

Executive summary

North Korean leader Kim Jong Un has described research and development as crucial to his regime's efforts to overcome the international sanctions regime. By developing key technologies indigenously, North Korea seeks to reduce its need to import sensitive goods that might otherwise be denied to it through export controls, sanctions enforcement, or lack of funds. Direct collaboration between North Korean and foreign scientists is playing an expanding role in the regime's pursuit of technological advancement.

To assess the extent of this activity, and to identify collaborative research involving dual-use technologies and other technologies of potential military significance, the James Martin Center for Nonproliferation Studies (CNS) of the Middlebury Institute of International Studies at Monterey has developed a new dataset capturing publications coauthored by North Korean scientists and foreign scientists between 1958 and April 2018.

About 95 percent of the articles in the dataset concern the natural sciences, engineering, computer science, or mathematics, mirroring the general orientation of the North Korean scientific establishment. China is the most heavily represented partner country, followed distantly by Germany.

Based on an initial evaluation, at least 100 published articles jointly authored by North Korean and foreign scientists have identifiable significance for dual-use technology, weapons of mass destruction (WMD), or other military purposes. Areas of concern or potential concern include:

- Uranium purification (Romania, 1991–92)
- Insulation of high-voltage cables for nuclear power plants (China, 2007–12)
- Materials science with a potential nuclear application (China, 2012)
- Damping technology applicable to space/missiles (China, 2016–17)
- Mathematical modeling applicable to space/missiles (China, 2006–16)
- Special heavy vehicles and production systems (China, 2011–16)
- Precision machine tools (China, 2016)
- Carbon composites (China, 2012)
- Other materials science with potential military applications (China, 2011–18)
- Optical tracking and image parsing (China, 2011–16)
- Remote sensing and satellite-imagery processing (China and United States, 2010–13)
- GPS-related work (Germany and China, 2007 and 2016)
- Laser and plasmonics research (Germany and China, 1998–2016)

- Biological research potentially of a dual-use character (China and Australia, 1987–2017)
- Cybersecurity (China, 2012)

Some of these activities may be contrary to provisions in international and national sanctions regimes. UN Security Council resolutions forbid the provision to North Korea of "technical training, advice, services, or assistance" related to a list of banned items that includes dual-use and military-related "technology." The definition of "technical assistance," for this purpose, includes the transfer of technical data, instruction, skills, training, working knowledge, and consulting services. The sanctions regime may therefore provide leverage against the continuation of some areas of collaborative research.

UN member states must decide what research activities by their nationals or within their territory lie within the scope of sanctions, and which activities are better avoided, even if they are otherwise permissible. The establishment of an agreed set of common principles or guidelines is warranted.

The context for scientific collaboration

North Korea's leaders consider investments in science and technology to be crucial both to national defense and to the national economy. The Kim regime emphasizes the importance of developing North Korea's indigenous (or "*Juche*-oriented") science and technology, which is, among other qualities, more resistant to the effects of the international sanctions regime.[1] At the same time, North Korea's leaders have also called for the systematic acquisition of foreign-origin scientific and design information with a view to attaining state-of-the-art technology and know-how as rapidly as possible. Direct collaboration with foreign research institutions appears to have played an expanded role in this strategy since about 2010.

North Korea's scientific establishment

North Korea (formally the Democratic People's Republic of Korea, or DPRK) dates its efforts to promote science to 1952, during the Korean War, when it established an Academy of Sciences (now called the State Academy of Sciences, or SAOS).[2] During the early Cold War, North Korean science benefited from training and resources provided by the Soviet Union; this assistance included membership in the Joint Institute for Nuclear Research (JINR) in Dubna, USSR, from its inception in 1956; and the construction of the Yongbyon Nuclear Research Center in North Korea in the mid-1960s.[3]

Official news media and defector accounts describe a system centered on SAOS, which has branches around the country. Although several institutes within SAOS perform research that supports North Korea's nuclear complex, nuclear-specific research and development falls under the aegis of a separate institution, the Ministry of Atomic Energy Industry, formerly known as the General Bureau of Atomic Industry.[4] Another institution, known either as the Second Academy of Natural Sciences (SANS) or the Academy of National Defense Sciences, appears to be primarily responsible for missile development.[5] Its main missile-related facility, sometimes called the Sanum-dong Missile Research and

[1] "The *Juche* idea," attributed to Km Il Sung, refers to an ideal of national self-determination—the opposite of "flunkeyism," or the acceptance of subordination to other states. The North Korean media often refers to the country's science and technology as "*Juche*-oriented," meaning that it is indigenously developed and suited to local conditions and requirements.
[2] "State Academy of Sciences DPR Korea," (brochure), Pyongyang, 2011, https://web.archive.org/web/20170211082618/http://usdprkscience.org/wp-content/uploads/2013/04/Branch-academies-and-affiliated-institutions.pdf.
[3] Georgy Kaurov, "A Technical History of Soviet–North Korean Nuclear Relations," in James Clay Moltz and Alexandre Mansourov, eds., *The North Korean Nuclear Program: Security, Strategy, and New Perspectives from Russia* (New York: Routledge, 2000), pp. 15–20; Alexander Zhebin, "A Political History of Soviet–North Korea Nuclear Cooperation," in Moltz and Mansourov, eds., *The North Korean Nuclear Program,* pp. 27–37.
[4] Lee Chae-sung, *Technocrats Who Move North Korea* [in Korean], (Seoul: Ilbit, 1998); Valery Denisov, "Nuclear Institutions and Organizations in North Korea," in Moltz and Mansourov, eds., *The North Korean Nuclear Program,* pp. 21–26.
[5] United Nations, "Second Academy of Natural Sciences," October 29, 2014, https://www.un.org/sc/suborg/en/sanctions/1718/materials/summaries/entity/second-academy-of-natural-sciences. See also "Kim Jong Il's Nuclear Missile Scientist: There Is a Genius Scientist Who Supports North Korea's Missile Technology" [in Japanese], *Bungei Shunju*, September 2006.

Development Center, is located on the northern edge of Pyongyang, adjacent to the SAOS main campus.[6] Another organization, the National Aerospace Development Administration, formerly known as the Korean Committee for Space Technology, is responsible for space-launch facilities and activities.[7]

North Korea has several universities and colleges, heavily focused on mathematics, natural sciences, engineering, and technology. North Korea's flagship university, Kim Il Sung University (KISU) in Pyongyang, also has a humanities faculty. The country's two other most important universities are the Kim Chaek University of Technology (KCUT) and the University of Natural Science (UNS, formerly called the University of Science), both in Pyongyang. UNS is affiliated with SAOS and was originally located at its main campus.[8]

The universities now play the key role in training the country's scientific personnel. Early in the Cold War, North Korea's leading scientists and science educators had been trained in Japan during the colonial period (1910–45); some were recruited from South Korea before the start of the Korean War in 1950. Later, leading North Korean scientists included those trained in the Soviet Union. But in recent decades, the North Korean scientific establishment appears to have turned to locally trained personnel.[9]

Pyongyang is also home to two major institutions aimed at providing the public with educational opportunities in science: the centrally located Grand People's Study House (GPSH), which opened in the early 1980s, and the architecturally avant-garde Sci-Tech Complex, which opened in 2015. North Korean television routinely carries schedules of public lectures on technical subjects at GPSH.

North Korea has scientific publishing houses that produce technical journals in a variety of fields, some dating back to the 1950s. Most of these journals appear quarterly; KISU, KCUT, and UNS each produces its own monthly scientific journal. While the articles in these journals appear to be authored solely by North Koreans, they never include authors' affiliations. Until the 1990s, the citations in these journals were drawn primarily from Soviet, Chinese, and Japanese sources, as well as a certain number of West German sources. Subsequently, after the North Korean scientific establishment gained access to the Internet and international scientific databases, the pattern of citations has become global. Earlier North Korean publications also have begun to appear frequently in citations.[10]

North Korea also issues patents, mostly to North Korean researchers. The full text of patents does not appear to be routinely available, but newly issued patents are announced in summary form in a journal dedicated to this purpose.

---

[6] Ankit Panda, "Why North Korea Is Likely Planning a Satellite Launch in 2018," *The Diplomat,* January 12, 2018, https://thediplomat.com/2018/01/why-north-korea-is-likely-planning-a-satellite-launch-in-2018/.
[7] United Nations, "Korean Committee for Space Technology," October 29, 2014, https://www.un.org/sc/suborg/en/sanctions/1718/materials/summaries/entity/korean-committee-for-space-technology.
[8] Lee, *Technocrats Who Move North Korea*; Choi Sung, "NK's Top-Notch Science Education and Research Institute," *Korea IT Times,* August 22, 2011, http://www.koreaittimes.com/news/articleView.html?idxno=16411.
[9] See the biographical vignettes in Lee, *Technocrats Who Move North Korea*.
[10] For background on North Korea's scientific journals and Internet access, see: Stephen C. Mercado, "Hermit Surfers of P'yongyang: North Korea and the Internet," *Studies in Intelligence,* Vol. 48, No. 1 (2004), https://www.cia.gov/library/center-for-the-study-of-intelligence/csi-publications/csi-studies/studies/vol48no1/article04.html.

Official guidance on science and technology

After a period of neglect, North Korea's leaders set out in the mid-1980s to renew the national commitment to science and technology. In the summer of 1985, Kim Jong Il urged senior Korean Workers' Party officials to pay more attention to science and technology, taking full advantage of knowledge and equipment available abroad. Among other points, he urged them to "work actively to establish scientific and technical exchange with the developed countries… in order widely to introduce the latest advances."[11] In December 1988, North Korea's Supreme People's Assembly enacted a law that aimed to increase investments in the livelihood of its top scientists, national science-education programs, and strategic research initiatives, emphasizing the pursuit of new technologies that could be applied in production settings.[12]

Kim Jong Un after delivering an address to a National Meeting of Scientists and Technicians on November 14, 2015. Source: *Rodong Sinmun*, November 15, 2013.

[11] Kim Jong Il, "On the Further Development of Science and Technology," August 3, 1985, http://www.korea-dpr.info/lib/Kim%20Jong%20Il%20-%204/ON%20THE%20FURTHER%20DEVELOPMENT%20OF%20SCIENCE%20AND%20TECHNOLOGY.pdf.

[12] The law was amended in May 1999; only the later text is available. See: "North Korean Decree: Science and Technology Act" [in Korean], *Tongil News*, April 5, 2003, http://www.tongilnews.com/news/articleView.html?idxno=43017.

As of 1988, North Korea's authorities also began issuing multiyear development plans for science and technology. How much they accomplished in the next several years is doubtful; the loss of Soviet aid, followed by the collapse of the North Korean economy and the famine of 1994–98, left few resources to spare. Only space and missiles appear to have remained a high priority.

Subsequently, science started to regain importance. In January 1999, just months after North Korea's first space launch attempt, the New Year Joint Editorial—Kim Jong Il's preferred method for communicating policy—declared, "Science and technology is the powerful driving force for the construction of a powerful state. The rehabilitation and development of the fatherland depends on the hands of scientists and technicians."[13] In January 2000, the New Year Joint Editorial declared, "Ideology, the gun barrel, and science and technology are the three pillars in the construction of a powerful state."[14] This slogan continues to be recalled from time to time in the official media.

Kim Jong Un visits with scientists at Kim Chaek University of Technology in Pyongyang. Source: Korean Central Television, September 29, 2018.

Under Kim Jong Un, who assumed power in late 2010, scientists have become an increasingly visible and privileged class, receiving public honors, awards, and special favors such as new housing developments near their workplaces. Scientists, as opposed to Party or military officials—or any other group besides the Kims themselves—have been credited with the country's achievements in developing missiles and nuclear weapons.

Kim Jong Un has specifically portrayed research and development as crucial to overcoming the international sanctions regime. In remarks delivered at a multiday "national meeting of

[13] New Year's Day Joint Editorial [in Korean], *Rodong Sinmun*, January 1, 1999.
[14] New Year's Day Joint Editorial [in Korean], *Rodong Sinmun*, January 1, 2000.

scientists and technicians" in Pyongyang in November 2013, Kim referred to the need to overcome the "scientific and technological blockade and sanctions policy" of "the imperialists" (i.e., the United States) by investing "great strength" into advancing national science and technology. The level of scientific and technological development, he said, "determines national power and decides the country's and nation's status and future."[15]

In the run-up to the Seventh Party Congress in May 2016, Kim's major speeches began to emphasize the importance of national "self-reliance and self-development" based on investments in science and technology. This slogan has now replaced Kim Jong Il's "military-first politics" as the primary ideological theme of the Kim Jong Un era.[16]

Building international institutional relationships

North Korea's official news media, particularly its externally oriented official news agency, the Korean Central News Agency (KCNA), has published a number of reports describing forms of international scientific collaboration, especially since 2010. These reports place KISU in a leading role in North Korea's international science diplomacy. They give special attention to the role of its president, Song Ja Rip, who also was appointed minister of higher education no later than early 2011. According to KCNA, KISU delegations led by Song traveled to Russia in January 2005;[17] to Germany in 2008;[18] to China in December 2007,[19] November 2010,[20] and May 2011;[21] to Mongolia in October 2011;[22] and to China and Vietnam in August 2012.[23]

Song's successor as both KISU president and minister of higher education, Thae Hyong Chol, is also a deputy of North Korea's parliament, the Supreme People's Assembly (SPA). Thae reportedly visited Mongolia in August 2015 and June 2018;[24] Russia in October 2015;[25] and China in May 2018.[26]

KCUT has also played a major role in these interactions. According to official media reports, delegations led by KCUT president Hong So Hon, who is also a deputy of the SPA, traveled to Russia in August 2001,[27] September 2004,[28] June 2018,[29] and October 2018;[30] traveled to Austria and Germany in May 2002;[31] visited Syracuse University in the United States in

[15] Kim Jong Un quoted in Ri Kang Chol, "Science and Technology Is the Basis of State Development" [in Korean], *Rodong Sinmun*, November 26, 2013.
[16] Kim Jong Un, "New Year's Day Address" [in Korean], *Rodong Sinmun*, January 1, 2017; Kim Jong Un, "New Year's Day Address" [in Korean], *Rodong Sinmun*, January 1, 2018.
[17] KCNA, "Delegation of Kim Il Sung University Leaves for Russia," January 22, 2005.
[18] KCNA, "Visits," March 22, 2008.
[19] KCNA, "Delegation of Kim Il Sung University Leaves for China," December 3, 2007.
[20] KCNA, "Visits," November 8, 2010.
[21] KCNA, "Delegation of Kim Il Sung University Leaves for China," May 4, 2011.
[22] KCNA, "Kim Il Sung University Delegation Leaves for Mongolia," October 10, 2011.
[23] KCNA, "Visits," July 31, 2012.
[24] KCNA, "Delegation of DPRK-Mongolia Friendship Parliamentary Group Leaves for Mongolia," August 4, 2015; KCNA, "Delegation of Korea-Mongolia Friendship Parliamentary Group Back Home," June 16, 2018.
[25] KCNA, "Delegation of Kim Il Sung University Leaves for Russia," October 16, 2015.
[26] KCNA, "Kim Il Sung University Delegation Leaves for China," May 2, 2018.
[27] Korean Central Broadcasting Station, August 30, 2001.
[28] Korean Central Broadcasting Station, September 7, 2004.
[29] KCNA, "SPA Delegation of DPRK Back Home," June 8, 2018.
[30] KCNA, "Delegation of Educational Officials Leaves for Russia," October 29, 2018.
[31] Korean Central Broadcasting Station, May 11, 2002.

February 2010;[32] and traveled to China in December 2005,[33] November 2010,[34] August 2011,[35] November 2011,[36] and September 2013.[37]

These lists do not appear to be comprehensive, and more details about these visits are sometimes available in foreign publications. A South Korean publication reported on an interaction between KISU's Song and the president of South Korea's Seoul National University during an October 2004 meeting in Vladivostok, Russia, that does not appear to have been mentioned in the North Korean news media.[38] A published interview with the president of Pohang University of Science and Technology in Pohang, South Korea, mentions a visit by KCUT President Hong in October 2002 as part of an "economic delegation" from the North to the South.[39]

Role of the United States. Interactions with the United States in particular appear to have been downplayed in KCNA accounts. According to American accounts, a consortium of US research institutions undertook a program of scientific diplomacy with North Korea, starting with interactions between Syracuse University and KCUT that began in 2001. This process of engagement reportedly also included a visit by a delegation from SAOS to Atlanta in 2011.[40]

Inter-university cooperation agreements. KCNA has also reported the signing of cooperation agreements between KISU and foreign universities. These include the University of Damascus (Syria) in May 2007,[41] Cairo University (Egypt) in July 2011,[42] and Liaoning University and the Harbin Institute of Technology (China) in September 2011.[43] This list does not appear to be complete. For example, a press release from Vietnam National University in Hanoi describes the signing of a memorandum of understanding with KISU in early August 2012.[44] A press release from Nanjing University in China also documents the signing of a similar agreement with KISU a few days later.[45] In October 2015, according to a press release from Novosibirsk State University in Russia, KISU's Thae visited, signing a partnership agreement between the two institutions—reportedly the third such agreement

[32] KCNA, "Delegation of Kim Chaek University Back Home," February 4, 2010.
[33] KCNA, "Visits," December 2005.
[34] KCNA, "Visits," November 2010.
[35] KCNA, "Delegation of Kim Chaek University of Technology Leaves For China," August 8, 2011.
[36] KCNA, "Delegation of Kim Chaek University of Technology Comes Back Home," November 30, 2011.
[37] KCNA, "Delegation of Kim Chaek University of Technology Leaves for China," September 28, 2013.
[38] "SNU Seeks Exchanges With Kim Il-Sung University," *Chosun Ilbo,* August 3, 2005.
[39] Yonhap News, September 8, 2003. For the "economic delegation," see Yonhap News, October 26, 2002.
[40] Cathy Campbell, "A Consortium Model for Science Engagement: Lessons from the U.S.-DPRK Experience," ScienceDiplomacy.org, June 28, 2012, http://www.sciencediplomacy.org/article/2012/consortium-model-for-science-engagement.
[41] KCNA, "Agreement Signed Between DPRK And Syrian Universities," May 16, 2007.
[42] KCNA, "Cooperation Between DPRK, Egyptian Universities," July 28, 2011.
[43] KCNA, "Agreements on Cooperation between Kim Il Sung University and Chinese Universities Signed," September 21, 2011. Also see the KCNA video report archived at: https://www.youtube.com/watch?v=1b3KFZOyPdQ.
[44] Vietnam National University, "Promoting Vietnam – DPRK Cooperation in Education," n.d., [around August 2, 2012], https://vnu.edu.vn/eng/?C2422/N13215/Promoting-Vietnam---DPRK-cooperation-in-education-.htm.
[45] Nanjing University, "President Song Ja Rip of DPRK Kim Il Sung University Visits Nanjing University," August 6, 2012, https://www.nju.edu.cn/english/05/85/c99a1413/page.psp.

between KISU and a Russian university, following Moscow State University and the Far Eastern Federal University (FEFU) in Vladivostok.[46]

Vietnamese and North Korean university presidents after signing a cooperation agreement, August 1, 2012. Source: Vietnam National University, Hanoi, Vietnam.

Several similar reports date to 2018. In June, a news report described a visit by a North Korean delegation led by KISU's Thae to the National University of Mongolia in Ulaanbaatar, and describing a proposal for "joint study" offered by the Mongolians.[47] In October, according to South Korean press accounts, KISU signed an "exchange and cooperation agreement" in the humanities and sociology with Germany's Berlin Free University.[48] In November, a Russian news report described the signing of a "memorandum of cooperation" between KCUT and FEFU in Vladivostok, providing for exchange programs and joint research. According to this report, FEFU already has similar agreements in place with KISU and the Pyongyang University of Area Studies.[49]

[46] Novosibirsk State University, "Partnership Agreement between NSU and Kim Il-sung University," October 23, 2015, https://english.nsu.ru/news-events/news/admission/partnership-agreement-between-nsu-and-kim-il-sung-university/.
[47] M. Anduari, "National University of Mongolia and Kim Il-sung University to expand the cooperation," Montsame, June 13, 2018, http://www.montsame.mn/en/read/135544.
[48] "N. Korean, German universities sign exchange agreement," Yonhap News, October 2, 2018.
[49] Interfax, "Russia's Far Eastern Federal University, N. Korea's Kim Chaek University of Technology sign cooperation memorandum," November 2, 2018.

North Korean and Chinese university presidents after signing a cooperation agreement, August 6, 2012. Source: Nanjing University, Nanjing, People's Republic of China.

Hosting international conferences. According to the official North Korean news media, KISU has played host to a series of "international academic symposia," as well as a "joint scientific conference" with Eurasia-Pacific Uninet in August 2012 on the theme of "Biomedical and Biotechnological Progress for a Healthy Society."[50]

The latter organization, according to its website, is an Austria-based international network of universities, with 162 member institutions across 13 countries, including KISU, KCUT, and 66 institutions in the People's Republic of China alone.[51] A summary of the Pyongyang meeting appears in the organization's yearbook for 2012/2013.[52]

KCNA also reported on the "first international academic symposium" held at the Pyongyang University of Science and Technology (PUST) in October 2011, drawing attendees from "China, the U.S., Canada, Britain, Italy, Brazil and Netherlands and overseas Koreans."[53] PUST is a privately funded, American-led, foreign-staffed university whose doors opened in Fall 2010.[54] Perhaps inspired by this example, the first of an annual series

[50] KCNA, "Joint Scientific Conference in Pyongyang," September 24, 2012.
[51] Eurasia-Pacific Uninet, http://www.eurasiapacific.net/index.php?page=content&pid=1.
[52] Eurasia-Pacific Uninet, "Annual Report 2012/2013," p. 112, http://www.eurasiapacific.net/data/File/Jahresbericht%20201213.pdf.
[53] KCNA, "1st International Symposium of Pyongyang University of Science and Technology Held," October 6, 2011.
[54] Pyongyang University of Science and Technology, "A Brief History of the Establishment of PUST," https://pust.co/index.php/about-pust/facts/.

of international academic symposia hosted at KISU ("For Social Progress and Prosperity") reportedly took place in August 2012, attended by representatives from institutions in Germany, China, and Poland, as well as from a pro-North Korean institution in Japan.[55] These events appear to have continued through 2018. KCUT also has reportedly hosted at least one international conference, in September 2018, with representatives from Russia, China, and Japan in attendance.[56]

Online presence. A more mundane form of outreach is the establishment of a presence on the World Wide Web. At least two of North Korea's leading universities have now done so, presumably to enhance their image abroad. KISU had established a public website by December 2014;[57] KCUT did the same no later than August 2018.[58]

[55] KCNA, "Intl Academic Symposium Opened," August 21, 2012.
[56] KCNA, "Int'l Conference on 70th Founding Anniversary of Kim Chaek University of Technology Held," September 20, 2018.
[57] Martyn Williams, "Kim Il Sung University Opens Website," North Korea Tech, December 13, 2014, http://www.northkoreatech.org/2014/12/13/kim-il-sung-university-opens-website/.
[58] Martyn Williams, "Kim Chaek University of Technology launches Internet web site," North Korea Tech, August 9, 2018, http://www.northkoreatech.org/2018/08/09/kim-chaek-university-of-technology-launches-internet-web-site/.

Methodology

Previous studies

North Korean scientists' work with foreign scientists, as documented in their joint publications, received a modest amount of attention abroad in 2017. At least four publications have addressed this issue.

An article in the *Wall Street Journal* in September 2017 drew attention to a paper published in *Transactions of the Chinese Society for Agricultural Machinery* in March 2017. The paper documents work by Kim Kyong Sol, who is affiliated with the Department of Mechanical Engineering at KCUT, three scientists affiliated with the School of Mechatronics Engineering at the Harbin Institute of Technology in China, and a fifth scientist affiliated with the Beijing Institute of Spacecraft System Engineering in China. Their research aimed at improving a technology for protecting payloads from vibrations and shocks during space launches; this work appears to be applicable, in principle, to missile payloads.[59]

An October 2017 report from the Project on Managing the Microbe at the Harvard Kennedy School identified three joint North Korean–Chinese papers in international scientific journals, dated 2016 and 2017, each documenting basic microbiological research undertaken in Norway's Svalbard archipelago.[60]

Geum Hee Jeong and Sun Huh of Hallym University in Chuncheon, South Korea, searched for scientific publications with North Korea-affiliated authors in a multidecade span in the Web of Science database, ending in 2016. The authors received 401 hits, which they reduced to 318 by eliminating false positives, i.e., South Korean or other researchers mislabeled as North Korean. Of these 318 papers, just 46 had only North Korean authors, while the rest were international collaborations, mostly involving researchers at institutions in China (197), Germany (51), Australia (10), the United States (5), and Italy (4). The authors found that new publications in their dataset exceeded double digits in a year for the first time in 2006, with an upward trend. The numbers of publications spiked to over 50 in both 2015 and 2016. Most of the North Korean authors were affiliated with KISU, KCUT, SAOS, or UNS, but numerous other institutions were also represented. The main topics were in physics, mathematics, materials science, chemistry, engineering, or biochemistry.[61]

In a separate article, Jeong and Huh searched for medical publications with North Korea-affiliated authors in the PubMed database through mid-July 2017. They found a total of 44 hits, which they reduced to 32 by eliminating false positives. Half were on medical topics; the rest concerned topics in agriculture and fisheries (7), natural sciences (5), and engineering (4). One paper was published in 1997; the rest appeared between 2014 and 2017. Of the 16 articles on medical topics, which was the authors' primary focus, foreign

[59] Jeremy Page and Alastair Gale, "Behind North Korea's Nuclear Advance: Scientists Who Bring Technology Home," *Wall Street Journal,* September 6, 2017.
[60] Hyun-Kyung Kim, Elizabeth Philipp, and Hattie Chung, "North Korea's Biological Weapons Program: The Known and Unknown," Project on Managing the Microbe, Harvard Kennedy School, Harvard University, October 2017, pp. 22–23, https://www.belfercenter.org/publication/north-koreas-biological-weapons-program-known-and-unknown.
[61] Geum Hee Jeong and Sun Huh, "Bibliometric analysis of publications from North Korea indexed in the Web of Science Core Collection from 1988 to 2016," *Science Editing,* Vol. 4, No. 1 (2017), pp. 24–29.

coauthors were from China (6), Finland (3), Germany (3), and the United States (2). Two papers had only North Korean authors. [62]

Assembling the dataset

To evaluate patterns of foreign collaboration as systematically as possible, the CNS project team turned to databases of scientific publications. Following the example of Jeong and Huh, the project team relied on author affiliations as a proxy for nationality.

After experimenting with different databases with broad international coverage, the project team found that a search of multiple databases provided the most comprehensive results. After selecting and searching three such databases, the project team, noticing the prominence of Chinese coauthorship, added a Chinese-language scientific database to the search.

A "North Korean" author is defined for the purpose of this project as an author whose stated affiliation includes at least one institution in North Korea. To count as an "international collaboration," an article must have both at least one North Korean coauthor and at least one coauthor affiliated with an institution outside of North Korea. In some cases, North Korean authors also had a second, foreign affiliation, probably reflecting a visiting appointment.

The initial dataset consisted of 6,415 total articles, which was reduced to 1,304 once duplicates and false positives were eliminated. In all, 1,139 entries were international collaborations; the remaining 165 were articles by North Korean scholars in foreign journals, without foreign collaborators.

Of the 1,304 valid and unique articles, 548 came from Web of Science, 235 from Scopus, 163 from Google Scholar, and 355 from China National Knowledge Infrastructure (CNKI), a Chinese-language database. The final entry is dated April 2018.

- Searches were conducted in Web of Science and Scopus with the keyword "North Korea." Searches for "DPRK" and "Democratic People's Republic of Korea" returned less useful results.
- The Google Scholar search was conducted using the names of North Korean scientists and institutions listed in a report produced in 2014 by a nonprofit research organization.[63]
- The CNKI search was conducted in Chinese with the keyword 朝鲜 (Cháoxiǎn), the most common Chinese name for North Korea. The results were machine-translated using Google Translate. As a result, some author names were rendered in the Mandarin reading of what are presumably Korean names.

Each entry in the database includes the title, publication year, journal, DOI (or other numerical identifier as available), general subject-matter area, collaborating states, and the

[62] Geum Hee Jeong and Sun Huh, "Bibliometric and content analysis of medical articles in the PubMed database published by North Korean authors from 1997 to July 2017," *Science Editing,* Vol. 4, No. 2 (2017), pp. 70–75.
[63] "DPRK Scientists," Institute for Physical Sciences, McLean, VA, IPS-RPT-53A-2014, May 19, 2014.

collaborating authors (with institutions). Each entry has also been assigned a unique database ID number (DBID) for tracking purposes.

As mentioned above, the project team treated affiliation with a North Korean institution as a proxy for North Korean nationality, rather than trying to confirm the identity and nationality of each author so affiliated. This approach captures collaborations that could be the result of visiting appointments, periodic travel, interactions over the Internet, or some combination of these approaches, as long as they result in a publication that is captured in one of the source databases.

The approach does not capture every possible relevant interaction, visiting appointment, or course of study abroad, not all of which may have generated publications that entered the source databases. Furthermore, publications that fail to include any North Korean affiliation are not captured. Mis-coding of a North Korean affiliation as non-North Korean (a false negative) will also result in a failure to include the publication, unless it appears by chance in a search and can be identified as mis-coded.

Cleaning the dataset

Searching Web of Science, Scopus, and CNKI yielded significant numbers of false positives—non-North Korean institutions misidentified as North Korean. The project team reviewed the raw data entry by entry to remove both false positives and duplicate articles, i.e., articles included in more than one of the four source databases.

Only 20 percent of the raw data collected consisted of unique, valid entries. The remaining 80 percent of entries consisted of false positives or duplicates and were therefore discarded. CNKI had an unusually high rate of false positives, with only 368 valid entries retrieved from 4,475 initial raw entries, despite the existence of distinct names in Mandarin Chinese for North and South Korea (Cháoxiǎn and Hánguó, respectively).

All four source databases contain mislabeled entries. Some cases involve locations with confusing or misleading names. Examples include Hwasong (a South Korean town that shares a name with several North Korean missile systems), Sari (an Iranian city sometimes confused with Sariwon, DPRK), Anji (a Chinese city sometimes confused with Anju, DPRK), and several South Korean locations whose name ends in "-buk" (Korean for "north").

Evaluating the data

The resulting dataset was divided into several categories based on an article's keywords. These categories were biology, chemistry, computer science, economics, engineering, environmental sciences, humanities, management science, materials science, mathematics, and physics.

Based on the categories, article entries and abstracts were distributed to specialists for expert judgments on the level of concern of the subject matter. These specialists included natural-science experts focusing on WMD, as well as regional specialists focusing in DPRK military and industrial programs. At least one specialist reviewed each of the

entries and associated abstracts, marking each as either "No Concern," "Possible Concern," or "Of Concern."

- "No Concern" was applied to articles with *no identifiable significance* for dual-use technology, WMD, or other military purposes.
- "Possible Concern" was applied to articles of *indirect, ambiguous, or unknown significance* for dual-use technology, WMD, or other military purposes.
- "Of Concern" was applied to articles with *identifiable significance* for dual-use technology, WMD, or other military purposes.

Caveats

Incompleteness of the source databases. Each of the four source databases contains some materials that the others do not, meaning that each one, by itself, is incomplete. Further gaps in source material almost certainly exist. This inference was confirmed near the end of the study period by the incidental discovery of an online profile for a North Korean scientist. Of the 49 articles listed in the profile at the time this report was drafted, 16 had foreign-affiliated coauthors, only 10 of which appear in the project's dataset.[64]

False negatives. Encountering a high rate of false positives in the initial dataset led the project team to check the source databases for false negatives. Examples discovered included the misidentification of Pyongyang as a South Korean city instead of the capital of North Korea, and the listing of North Hwanghae Province in North Korea as a Chinese province. It proved difficult to develop additional search terms that could reliably discover these types of errors. Additional, undiscovered false negatives almost certainly exist in the source databases.

Lack of affiliations in North Korean publications. Another potential source of incompleteness is the absence of author affiliations in North Korean scientific literature. Past examinations of these publications have not led to the observation of any authors with non-Korean names, but the possibility of foreign coauthors cannot be excluded. If they are present, no useful way of identifying them has been established. The project team did not attempt to search this literature.

Levels of concern. The categorization into levels of concern should not be considered authoritative or complete. Judgments will vary. Furthermore, about half of the articles were categorized as "Possible Concern," reflecting the limits of available expertise.

Data availability

Electronic copies of the CNS dataset are available for download from the CNS website, www.nonproliferation.org.

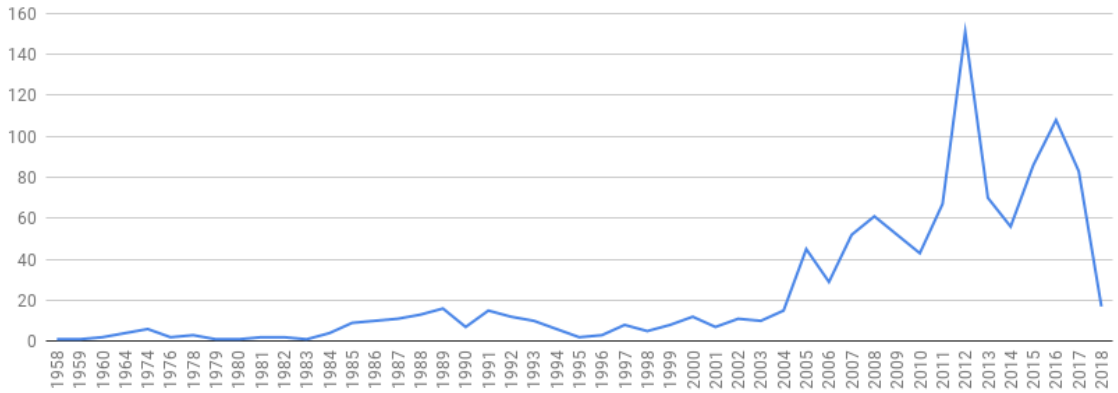
[64] Profile for Song Jin Im, Kim Il Sung University Department of Physics, ResearchGate, https://www.researchgate.net/profile/Song_Jin_Im2.

Findings

Trend over time

The numbers of international collaborations featuring North Korean scholars have risen significantly since 2004, but it is unclear how much of this apparent growth may be an artifact of the global trend of digitizing scholarly publications starting in the early 2000s. By global standards, North Korean researchers do not produce a large number of works with international collaborators; the project dataset peaks at 148 entries/year in 2012.

Figure 1. Collaborative publications by year (through April 2018).



Source: CNS dataset.

Distribution of subject areas

The major focus of the articles in the dataset is the natural sciences, engineering, computer science, and mathematics, similar to the main areas of North Korean research concentration as a whole. A handful of publications in humanities, economics, and other topics do appear, but account only for about 5 percent of the total.

Table 1. Summary of collaborations by subject (1958–April 2018).

Subject areas	Publications
Engineering	208
Biology	224
Chemistry	131
Physics	134
Computer science	94
Management sciences	3
Environmental sciences	96
Materials sciences	104
Humanities	38
Mathematics	81
Uncategorized	26
Total	**1,139**

Source: CNS dataset.

Engineering has historically been the single best-represented area. Engineering, for the purposes of this study, covers a range of subtopics including construction, heavy automotive industries, industrial machinery, precision machine tools, and electrical engineering. There is some overlap between engineering, physics, and materials sciences.

Non-concerning focus areas included health care (categorized under Biology), geology/volcanology (categorized under Environmental Sciences), and agricultural studies (categorized under Biology, Chemistry, or Environmental Sciences). A small trend of collaborative weather modeling work has been categorized as "Possible Concern," reflecting the potential of weather models to be of military interest.

Partner countries

North Korean scientists collaborate most often with colleagues from the People's Republic of China, followed by Germany. Of the 1,139 collaborations in the dataset, 913 involve China and 139 involve Germany. These totals overlap, as there are instances of tri-national collaboration that count toward both the Chinese and German totals.

- Collaborations with Chinese researchers are wide-ranging. They do not cluster around any particular topic.
- Collaborations with German researchers center on laser and plasmonics research, particularly with Joachim Herrmann at the Max Born Institute in Berlin.

After Germany, the top collaborating states were the United States (16 entries), Australia (14 entries), and Romania (13 entries).

- Romanian collaboration has primarily involved petrochemical research with researchers at the Oil & Gas University of Ploiesti, but publications on uranium

purification were published in 1991 and 1992 with researchers from the Institutul Politehnic 'Gheorghe Gheorghiu-Dej' București, now called the Polytechnic Institute of Bucharest.

Certain partners whose presence in the dataset were expected, such as India, did not appear. Others, such as Japan and Russia, are minimally represented. It is not clear why these states, which are known to have academic and industrial relationships with North Korea, have little or no presence in the dataset. It may be that the source databases do not effectively capture publications from these countries, or that the academic relationships in question are of a structure that was not covered by this project's search parameters.[65]

Minimal US–North Korean collaboration was found. These collaborations were largely of no concern, including benign work in geology and library sciences. Instances of collaborative remote sensing/satellite imagery work have been placed in the "Possible Concern" category.

Publishing abroad without foreign collaborators

As noted above, of the 1,304 unique entries in the dataset, 165 are "DPRK only" publications. Works published in foreign journals with only North Korean-affiliated authors include articles on dual-use topics including uranium enrichment through a chemical-exchange process, published in the *Russian Journal of Applied Chemistry* (DBID 75); and an experiment using a Tokamak, published in the UK-based journal *Radiation Effects and Defects in Solids* (DBID 156). A Tokamak is a means of achieving nuclear fusion at experimental scales.

Like the existence of at least one ResearchGate profile for a North Korean researcher, it appears that the submission of articles to foreign journals—typically in English—is a means of increasing the visibility and prestige of North Korean scientists, in order to help cultivate future collaborations.

Levels of concern

The project team categorized 548 items as "No Concern," 656 items as "Possible Concern," and 100 items as "Of Concern." Areas of concern are meant to indicate a need for further investigation.

These judgments are not authoritative. The high frequency of "Possible Concern" partly reflects the limits of available expertise, which may warrant additional efforts.

[65] For North Korean exchange students in Russia, see: Alexandra V. Dzero, "North Korean Students in Russia," Project Alpha, (n.d.) https://projectalpha.eu/issue-briefs-2/north-korean-students-in-russia/. For North Korean exchange students in India, see: Nilanjana Bhowmick, "India's embarrassing North Korea connection," Al Jazeera, June 21, 2016, https://www.aljazeera.com/indepth/features/2016/06/india-embarrassing-north-korean-connection-160620195559208.html.

Some specific areas of concern or possible concern

Uranium purification (Romania). Two articles (DBID 694 and 697) were published with Romanian scholars in 1991 and 1992 about the chemical purification of uranium with solvents. This subject is of concern due to the inherently dual-use nature of nuclear technology. Since this work preceded the establishment of the international sanctions regime, it appears to be mainly of historical interest.

Insulation of high-voltage cables for nuclear power plants (China). A series of 14 articles published with Chinese scholars between 2007 and 2012 address engineering concerns over water-treeing effects on cross-linked polyethylene cable insulation (DBIDs 446, 592, 595, 628, 1350, 1426, 2048, 2135, 2218, 2376, 2447, 2448, 2456, and 2455). A 2008 article from this series explicitly links this subject to the endurance and management of nuclear-power-plant cables (DBID 2048).

Materials science with a potential nuclear application (China). A 2012 article with Chinese coauthors (DBID 287) was identified as potentially applicable to nuclear fuel rod fabrication.

Damping technology applicable to space and missile development (China). Magneto-rheological (MR) dampers are a type of complex, heavy-duty shock absorber, whose applications include protection of payloads in space-launch vehicles, heavy industrial vehicles, and aviation. MR dampers' use in space launchers makes them a particular concern, given their presumable applicability to ballistic-missile payloads. Three collaborative articles with Chinese scholars appeared between 2016 and 2017 (DBIDs 158, 864, and 881), one including a researcher affiliated with the Beijing Institute of Spacecraft System Engineering.

Mathematical modeling applicable to space and missile development (*China*). North Korean scholars have engaged in mathematical modeling work with Chinese partners, at least some of which is categorized as "Of Concern." Modeling work with the Navier-Stokes equations is considered foundational for missile kinematics and physics, while the modeling of gravitic and magnetic anomalies applies mainly to satellite design and ballistic-missile guidance. Between 2006 and 2016, at least seventeen collaborative articles with Chinese scholars appeared on these topics (Navier-Stokes equations: DBIDs 39, 51, 63, 118, 226, 276, 281, 410, 483, 1427, 1951, 2133, and 2229; gravitic and magnetic anomalies: DBIDs 1321 and 2241.)

Special heavy vehicles and production systems (China). After the detection of the transfer of several large, special heavy chassis from China to North Korea, which were put to use as mobile intercontinental ballistic-missile launchers, awareness of the sensitivity of these items has grown. Between 2011 and 2016, at least six collaborative articles were published with Chinese researchers on automotive subjects, including one publication on active steering controls for multi-axis vehicles, a technology used in special heavy vehicles (DBIDs 163, 936, 1072, 2191, and 2484).

In addition, a 2012 article was published with Chinese collaborators on the design and implementation of Flexible Manufacturing Systems, or FMS (DBID 847). The official North Korean media reported on the implementation of FMS during a December 2015 leadership visit to the newly renovated 18 January General Machinery Factory, which produces V12 engines for heavy ground vehicles, potentially including North Korea's new generation of tracked missile-launch vehicles.

Precision machine tools (China). Computer Numeric Control machine tool development is of concern due to its contribution to the DPRK's industrial capacities, including military industries and the space and missile program. At least three articles on this subject were coauthored with Chinese scholars in 2016 (DBID 213, 2260, and 2300).

Carbon composites (China). Carbon composites, while encompassing a wide range of materials, are potentially applicable to advanced gas centrifuge rotors for uranium enrichment. They are also vital for large-diameter solid-propellant missiles. In August 2017, Kim Jong Un toured a chemical-industry facility affiliated with SANS, which showcased its carbon composite work for ballistic-missile systems. This facility was substantially expanded in the first half of 2018.[66] At least one article on carbon composites was produced in collaboration with Chinese authors, appearing in 2012 (DBID 1167).

Other materials science with potential military applications (China). At least three articles with Chinese coauthors that appeared between 2011 and 2018 dealt with Ti2AlNb and AZ31B Mg alloys (DBIDs 8, 47, and 64). These materials have been identified as applicable to manufacturing aircraft engines and airframes, respectively.

Optical tracking and image parsing (China). At least six articles were published on these topics between 2011 and 2016 (DBIDs 233, 250, 664, 942, 1026, and 1232). Optical image tracking, digital image parsing, video motion tracking, and facial recognition technology are all complex software developments that are of concern or potential concern. In the long term, this type of technology could contribute to missile guidance.

Remote sensing and satellite-imagery processing (*China and United States*). At least four articles were published on these topics with Chinese scholars between 2010 and 2013, and at least two were published with scholars from the United States in 2013 (DBIDs 2200, 2201, 2510, and 2523). Remote sensing work is not necessarily of immediate concern, but it may help to build the expertise needed for a domestic space industry. The research largely involved freely available, low-resolution LandSat and Terra/MODIS data that would not be useful for military applications. Gaining an understanding of the underlying data science is of potential concern.

GPS-related work (Germany and China). Two articles on GPS appear in the dataset, one of them focusing on suppressing GPS interference and noise (DBIDs 935 and 2018). This work may have applications to electronic warfare. One article was published with German coauthors in 2007; another was published with Chinese coauthors in 2016.

Laser and plasmonics research (Germany and China). Unstable cavity lasers and foundational research for gas-plasma antenna work are useful for communications, instrumentation, and range-finding, all of which have general-purpose military applications. Between 1988 and 2016, at least five articles coauthored with Chinese scholars have appeared on these subjects. Over ten articles coauthored with German scholars have appeared between 2010 and 2016 (DBIDs 192, 249, 377, 385, 390, 395, 449, 450, 703, 2014, 2104, and 2093).

Biological research potentially of a dual-use character (China and Australia). Several areas are of concern or potential concern. North Korean scholars have worked on collaborative projects involving organisms in the genus *Bacillus*, specifically *Bacillus subtilis* and *Bacillus thuringiensis*.

[66] Jonathan Cheng, "North Korea Expands Key Missile-Manufacturing Plant," *Wall Street Journal,* July 2, 2018, https://www.wsj.com/articles/north-korea-expands-key-missile-manufacturing-plant-1530486907.

While not concerning on their own, these organisms are related to *Bacillus anthracis*, the anthrax bacterium, and work applicable to one organism may be applicable to the others. One article was coauthored with Australian scholars in 2008, and two with Chinese scholars in 1987 and 2004 (DBIDs 549, 673, and 2293). At least three papers with Chinese scholars from 2012, 2016, and 2017 concern dual-use fermentation technology (DBID 867, 927, and 1162).

Cybersecurity (China). An article with Chinese coauthors that appeared in 2012 concerned the detection and mitigation of denial-of-service attacks (DBID 1149). This type of research could inform offensive cyber operations.

Collaborative research under the international sanctions regime

The international sanctions regime on North Korea is founded on a series of United Nations Security Council Resolutions starting in 2006.[67] Resolutions 1718 (2006) and 1874 (2009) effectively ban dual-use and defense-related cooperation between North Korea and other states, including "transfers to the DPRK" by the nationals or from the territory of an UN member state of "technical training, advice, services, or assistance" related to a list of banned items that includes certain kinds of "technology."[68]

The 1718 Committee, which is charged with monitoring the implementation of the resolution, has defined "technology" as "Specific information necessary for the 'development', 'production' or 'use' of a product. The information takes the form of 'technical data' or 'technical assistance'."

- "Technical data" may take "forms such as blueprints, plans, diagrams, models, formulae, tables, engineering designs and specifications, manuals and instructions written or recorded on other media or devices such as disk, tape, read-only memories."
- "Technical assistance," which may involve the transfer of technical data, make take forms such as "instruction, skills, training, working knowledge, consulting services."
- However, these controls "do not apply to information 'in the public domain' or to 'basic scientific research' or the minimum necessary information for patent application."[69]

The provisions and definitions may provide a basis for action at the United Nations, bilateral demarches to curtail sensitive cooperation, or other policy interventions.

[67] Detailed information is available at the website of the Security Council Committee Established Pursuant to Resolution 1718 (2006), https://www.un.org/sc/suborg/en/sanctions/1718.
[68] United Nations Security Council, Resolution 1718 (2006), para. 8.a.ii, p. 2.
[69] Letter dated 1 November 2006 from the Chairman of the Security Council Committee Established Pursuant to Resolution 1718 (2006) concerning the Democratic People's Republic of Korea addressed to the President of the Security Council, S/2006/853, November 7, 2006, pp. 8–9.

Conclusions

International scientific collaboration with North Korea is not a cut-and-dried issue. Even benign-seeming forms of research might be susceptible to abuse. Work on reforestation, for example, might be applied to shoring up rural hillsides, thereby mitigating the flood damage often experienced in North Korea in recent years—or it might be applied to camouflaging missile bases.[70]

In their outlines, these dilemmas are already familiar. Donor agencies have encountered comparable problems in supplying much-needed humanitarian aid to North Korea, fearing that it might be diverted from needy members of the general public to the military.[71]

As with aid, a blanket ban on scientific collaboration could have humanitarian repercussions. Among the publications in the CNS dataset are papers arising from a collaboration between North Korean, British, Chinese, and American scientists studying the interior of the Paektusan (Changbaishan) volcano, which straddles the North Korean–Chinese border. Improving the ability to predict eruptions should contribute to public safety in both countries, something that would be very difficult to argue against.[72] It is certainly not easy to imagine what harms could come from this work. In some areas, too, there is a *prima facie* case for more collaboration, not less; notably, there appears to be a great unmet need for epidemiological research within North Korea.[73]

Strategic considerations are also among the merits of scientific exchanges. Building person-to-person relationships across borders can provide insight, improve mutual understanding, and ultimately form the basis of sustained cooperation, including in areas related to arms control, verification, and disarmament. The experiences of American and Russian weapons scientists at the end of the Cold War may be instructive.[74]

Nevertheless, some forms of collaboration raise questions about the scrupulousness with which the relevant provisions of Security Council resolutions have been observed—if they have been observed at all. Any work directly related to the development of crucial equipment for nuclear reactors, for example, seems hard to justify as long as the relevant resolutions remain in place. If the international community is serious about the nonproliferation of WMD, it should take concerted action to address this neglected area. But as in other areas of the international sanctions regime, doing so will demand much

---

[70] Jeffrey Lewis and Dave Schmerler, "North Korean Missile Base at Yeongjeo-dong," Arms Control Wonk, December 6, 2018, https://www.armscontrolwonk.com/archive/1206442/north-korean-missile-base-at-yeongjeo-dong/.

[71] Roberta Cohen, "World Food Day: The Challenge of North Korea," Brookings Institution, October 8, 2013, https://www.brookings.edu/opinions/world-food-day-the-challenge-of-north-korea/.

[72] Alexandra Witze, "North Korea lets scientists peer inside dangerous volcano," *Nature News,* April 15, 2016, https://www.nature.com/news/north-korea-lets-scientists-peer-inside-dangerous-volcano-1.19751.

[73] Kwonjune J. Seung and Stephen W. Linton, "The Growing Problem of Multidrug-Resistant Tuberculosis in North Korea," *PLoS Medicine*, Vol. 10, No. 7, July 30, 2013, https://journals.plos.org/plosmedicine/article?id=10.1371/journal.pmed.1001486.

[74] Siegfried S. Hecker, ed., *Doomed to Cooperate: How American and Russian Scientists Joined Forces to Avert Some of the Greatest Post-Cold War Nuclear Dangers* (Los Alamos, NM: Bathtub Row Press, 2016).

more persistent efforts than have been observed to date.[75] It will also mean adding the world's research universities to the already sprawling list of entities to be enlisted into sanctions implementation.

China bulks especially large in any such undertaking. The disproportionate presence of Chinese institutions and researchers in the dataset may reflect a purposeful strategy, perhaps a form of positive inducement to North Korea. It may also reflect the sorts of strategic considerations discussed above. Chinese leaders may already be contemplating an intensification of research collaboration, even in areas that would seem to fall clearly within the ambit of the relevant Security Council resolutions.[76]

Ultimately, UN member states must decide what research activities by their nationals or within their territory lie within the scope of sanctions, and what other activities are better avoided even if they are otherwise permissible. But if states are to avoid contributing to North Korean WMD programs and military modernization—and to do so without sacrificing legitimate and beneficial forms of cooperation—the establishment of an agreed set of common principles or guidelines is warranted.

[75] Andrea Berger, *A House Without Foundations: The North Korea Sanctions Regime and its Implementation,* RUSI Whitehall Report 3-17 (London: Royal United Services Institute for Defence and Security Studies, 2017), pp. 51–53.

[76] According to the official North Korean account of Kim Jong Un's first visit to China as the leader of North Korea, he toured an exhibition of the recent technological achievements of the Chinese Academy of Sciences and was "briefed on the successes made in the field of natural science and technology such as nuclear physics, outer space, agriculture and energy." The latter detail did not appear in the Chinese report describing the same occasion. See: KCNA, "Kim Jong Un Pays Unofficial Visit to China," March 27, 2018; Xinhua, "Xi Jinping, Kim Jong Un hold talks in Beijing," March 28, 2018.

About the authors

Joshua H. Pollack is a senior research associate at the James Martin Center for Nonproliferation Studies at the Middlebury Institute of International Studies at Monterey and the editor of the *Nonproliferation Review*, the world's only refereed journal focused on the causes and consequences of the spread of weapons of mass destruction. Previously, Pollack served as a consultant to the US government, specializing in issues related to weapons of mass destruction, including proliferation, arms control, and deterrence. As a defense policy analyst at DFI International, Science Applications International Corporation, and Constellation West, his clients included the Defense Threat Reduction Agency, the Office of the Under Secretary of Defense for Policy, the Department of Homeland Security, the National Nuclear Security Administration, and the Plans and Policy Directorate (J5) of US Strategic Command. In 2015, he was named an Associate Fellow of the Royal United Services Institute. The author of numerous articles, Pollack is also a frequent commentator in major media outlets, including CNN, the *Washington Post*, the *New York Daily News*, Reuters, Vox, *Asia Times*, Voice of America, National Public Radio, and others.

Scott LaFoy is an open-source military analyst focusing on ballistic missiles, strategic military capabilities, and the Democratic People's Republic of Korea. He currently works as a risk consultant for a global audit and advisory firm. His views are his own and do not reflect those of his employer.

OCCASIONAL PAPERS AVAILABLE FROM CNS

online at https://nonproliferation.org/category/topics/cns_papers

#43 • North Korea's International Scientific Collaborations: Their Scope, Scale, and Potential Dual-Use and Military Significance

#42 • The Other Fissile Material: Strengthening National and International Plutonium Management Approaches

#41 • Monitoring Uranium Mining and Milling in India and Pakistan through Remote Sensing Imagery

#40 • Monitoring Uranium Mining and Milling in China and North Korea through Remote Sensing Imagery

#39 • Safeguards and Verification in Inaccessible Territories

#38 • Geo4Nonpro 2.0

#37 • All the World is Staged: An Analysis of Social Media Influence Operations against US Counterproliferation Efforts in Syria

#36 • North Korea's Information Technology Networks

#35 • Countering North Korean Procurement Networks Through Financial Measures: The Role of Southeast Asia

#34 • Open-Source Monitoring of Uranium Mining and Milling for Nuclear Nonproliferation Applications

#33 • WMD Proliferation Risks at the Nexus of 3D Printing and DIY Communities

#32 • Taiwan's Export Control System: Overview and Recommendations

#31 • Revisiting Compliance in the Biological Weapons Convention

#30 • Crowdsourcing Systems and Potential Applications in Nonproliferation

#29 • The Verification Clearinghouse: Debunking Websites and the Potential for Public Nonproliferation Monitoring

#28 • Geo4nonpro.org: A Geospatial Crowdsourcing Platform for WMD Verification

#27 • Searching for Illicit Dual Use Items in Online Marketplaces: A Semi-Automated Approach

#26 • 2016 Symposium Findings on Export Control of Emerging Biotechnologies

#25 • Outlawing State-Sponsored Nuclear Procurement Programs and Recovery of Misappropriated Nuclear Goods

#24 • Strengthening the ROK-US Nuclear Partnership

#23 • Replacing High-Risk Radiological Materials

#22 • A Blueprint to a Middle East WMD Free Zone

#21 • Biotechnology E-commerce: A Disruptive Challenge to Biological Arms Control

#20 • Countering Nuclear Commodity Smuggling: A System of Systems

#19 • Alternatives to High-Risk Radiological Sources

#18 • Stories of the Soviet Anti-Plague System

#17 • Ugly Truths: Saddam Hussein and Other Insiders on Iraq's Covert Bioweapons

#16 • Rethinking Spent Fuel Management in South Korea

#15 • Engaging China and Russia on Nuclear Disarmament

#14 • Nuclear Challenges and Policy Options for the Next US Administration

#13 •Trafficking Networks for Chemical Weapons Precursors: Lessons from the 1980s Iran-Iraq War

#12 • New Challenges in Missile Proliferation, Missile Defense, and Space Security

#11 • Commercial Radioactive Sources: Surveying the Security Risks

#10 • Future Security in Space: Commercial, Military, and Arms Control Trade-Offs

#09 • The 1971 Smallpox Epidemic in Aralsk, Kazakhstan, and the Soviet Biological Warfare Program

#08 • After 9/11: Preventing Mass-Destruction Terrorism and Weapons Proliferation

#07 • Missile Proliferation and Defences: Problems and Prospects

#06 • WMD Threats 2001: Critical Choices for the Bush Administration

#05 • International Perspectives on Ballistic Missile Proliferation and Defenses

#04 • Proliferation Challenges and Nonproliferation Opportunities for New Administrations

#03 • Nonproliferation Regimes at Risk

#02 • A History of Ballistic Missile Development in the DPRK

#01 • Former Soviet Biological Weapons Facilities in Kazakhstan: Past, Present, and Future

nonproliferation.org

Middlebury Institute *of*
International Studies at Monterey
James Martin Center for Nonproliferation Studies