Science and Sanctions: Lessons learned from twelve years of collaboration with the Democratic People's Republic of Korea (North Korea)

The use of international sanctions has increased dramatically since the end of the second World War (Figure 1) and these have become more complex due to their multinational nature when implemented through the United Nations or European Union. However, over this same period, science has become more international, with multinational collaborations becoming the norm. This apparent paradox of simultaneously restricting and encouraging international collaboration creates many challenges for scientists and gives rise to the following questions: *How do international sanctions affect scientific collaboration? What are the most effective avenues to maintain scientific collaboration during times of geopolitical strain?* This paper investigates the unintended impacts of sanctions on scientific collaboration based primarily on the author's experiences of collaborative research at a time of sanction development and implementation in the Democratic People's Republic of Korea (DPRK, the formal name for North Korea).

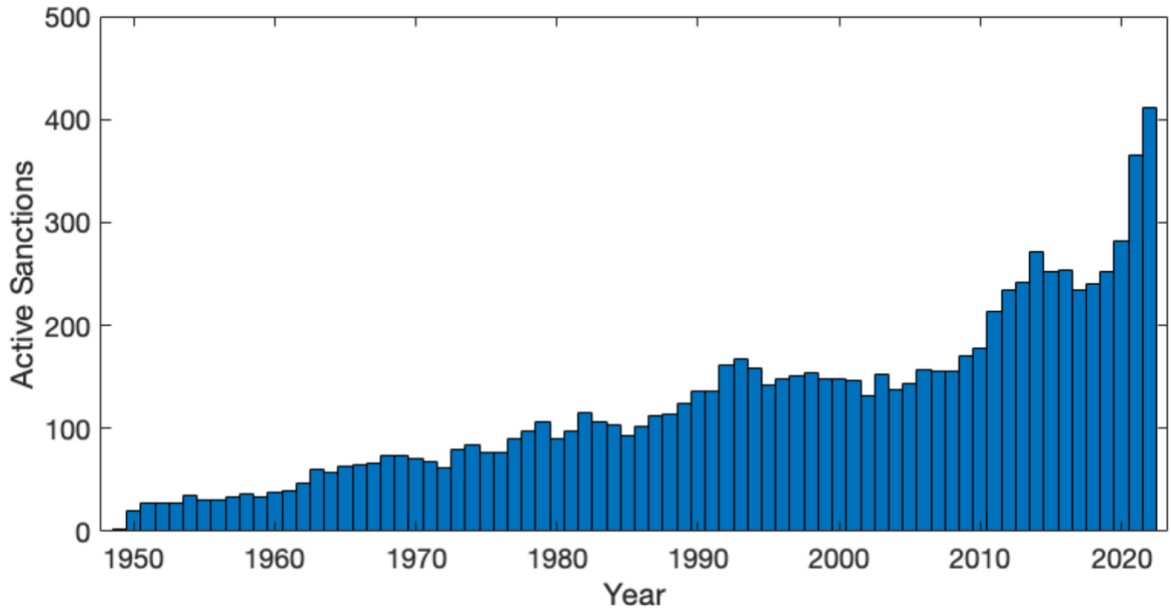

Figure 1: Global number of active sanctions from 1949–2022. Data from the Global Sanctions Database.[1]

The impacts of sanctions on science

Sanctions are a political tool that commonly use economic pressure to attempt to achieve foreign policy objectives. They are designed to put pressure on a country to effect change, such as to improve democratic or human rights, reduce terrorism, change policy or, as in the case of recent sanctions on Russia and Belarus, ending or preventing conflict. At one end of the spectrum of approaches are so-called "smart" sanctions, usually financial or travel restrictions, which target individual people or companies who have acted in a particular manner or who may be able to influence policy in the targeted country. At the other end of the spectrum are sanctions that cover a much wider remit and attempt to encourage local populations to put pressure on their governments. Sanctions can target trade, travel, financial transactions, and the military.[2] Overall, the use of sanctions has increased since 1950 (Figure 1), although there has been a move to more targeted sanctions over this time. At face value this move toward targeted sanctions may have benefits for scientific collaboration, with these sanctions having fewer unintended consequences. However, broad sanctions continue to be used such as in the case of the DPRK, Iran or most recently, Russia and Belarus.

Different types of sanctions have different impacts on science. For example, trade sanctions, where the import of materials is restricted, can mean that scientific equipment cannot be maintained or upgraded. This was the case in Iran, where in 2018 the Royan Institute in Tehran reported being unable to import specialized equipment for genetics research.[3] Even obtaining free and open-access software and related updates can be challenging in the face of trade sanctions, as documented in Sudan.[4] Untargeted travel restrictions limit person-to-person contacts, restricting opportunities for collaboration and interaction at international meetings, creating gaps in knowledge between researchers in different countries. The Pyongyang University of Science and Technology faced this issue when the United States banned American citizens from traveling to the DPRK, resulting in difficulties recruiting teachers.[5] Publishers or service providers may seek to minimize their risks by implementing restrictions on scientists from targeted countries.[6] For example, Elsevier currently restrict access to peer review, editing and other services thus preventing publication by authors from the DPRK, Crimea, Donetsk and Luhansk. Financial sanctions may restrict the movement of funds between research institutions. This impacted the operations of the SESAME

synchrotron in Jordan when Iran could not pay their share.[7] Even military and weapons sanctions can impact scientists, because much scientific equipment is considered "dual use", having both a civilian and military use. This has been a significant issue in life sciences, where much research overlaps with areas of biosecurity.

Scientific collaboration with the Democratic People's Republic of Korea

Sanctions have been in place against the DPRK since the beginning of the Korean War in 1950. However, following the DPRK's first nuclear test in October 2006, they were significantly escalated through a series of UN Security Council resolutions. On top of these multinational sanctions, a number of countries have imposed unilateral sanctions. Together, these sanctions cover trade, travel, financial transactions, and military operations/weapons, adding up to some of the most comprehensive sanctions imposed on any country.

Since 2011, I, together with colleagues from the Mount Paektu Research Centre (www.themprc.org) have collaborated with DPRK and Chinese scientists to understand the history and origins of Paektu volcano (Changbaishan in Chinese) on the border of the DPRK and China.[8] Over the period of our collaboration, as well as an increase in sanctions, there have been changes in leadership, nuclear testing, intercontinental ballistic missile launches, and joint military exercises between U.S.–South Korean forces, seen as a provocation by the DPRK government (Figure 2). This has given us a unique experience in developing and conducting collaborative science during a time of changing sanctions and turbulent geopolitics. We have found that the project has been impacted by all the different types of sanctions: trade, financial, travel and military/weapons embargos, but despite this, we have been able to achieve all our scientific goals, jointly publishing a number of papers with our DPRK colleagues[10] and maintaining a collaboration through a period of significant political change on the Korean Peninsula (Figure 2).

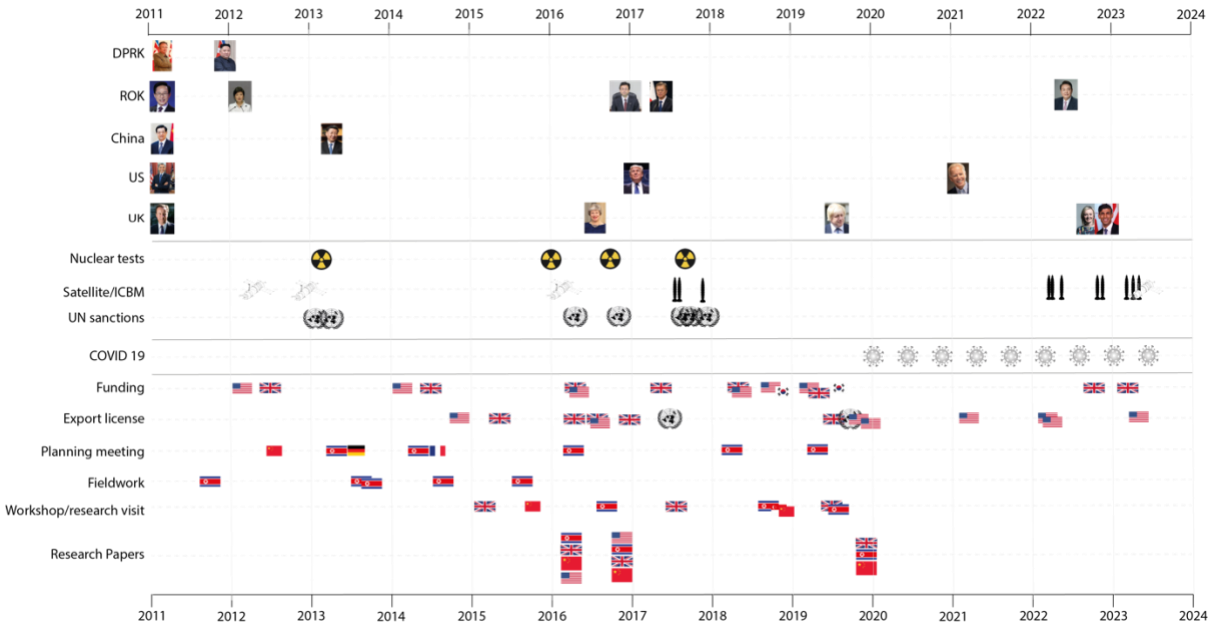

Figure 2: ~~Changes in national leadership, major events, sanctions, global events, and activities by the Mount Paektu Research Centre from 2011 to 2023.~~ Changes in national leadership, weapons testing, UN sanctions and global events (COVID19) that have impacted the Korean Peninsula. Also shown are new grants awarded to the MPRC (Funding), applications for export licenses, person to person meetings between DPRK and international scientists such as planning meetings, fieldwork and workshops/research visits and joint DPRK-MPRC publications.

Impact of trade and military sanctions: The first consequence of sanctions on our research project arose due to the extra bureaucracy needed to comply with them. The time between receiving funding for the project and beginning the experiments was eighteen months, mainly because of the need for lengthy discussions with branches of the U.S. and UK governments regarding the aims of our project and the equipment required. Reassuring my host institution at the time (Imperial College London) that the collaboration would not harm their international reputation also required time and effort.

As we had little experience in this area, we relied a great deal on support from the American Association for the Advancement of Science (AAAS) and the Royal Society of London. These organizations had recently published their seminal report on science diplomacy.[9] They recognized the positive impact such international collaboration could have (so-called *science*

for diplomacy), while also the importance the diplomatic community would play in assisting such a project to be successful (*diplomacy for science*). Through their support and network, we communicated effectively with international governments, allowing us to secure export licenses from the UK and U.S. governments. The Royal Society also agreed to sign crucial memorandum of understanding and research agreements with our DPRK collaborators that provided confidence to our DPRK partners while allowing our universities to minimize any perceived risks to their reputations. However, at the end of this process, we were still refused licenses for some equipment, namely induction coils, which are sensitive magnetometers. These are considered dual use, as they can help detect submarines, which meant we could not use them. To date, we have submitted sixteen separate requests for licenses or exemptions to the UK and U.S. governments and the UN Security Council, which has taken significant time and legal fees. These issues continue, with the latest round of export licenses not allowing us to temporarily export some basic equipment from the UK to the DPRK, such as laptop computers.

Impact of financial sanctions: UN Security Council Resolution 2094 (March 2013) was designed to restrict the DPRK's access to the international monetary system, a measure enhanced through United States unilateral sanctions in August 2017. In practice, this means no bank currently allows transactions to be made to any DPRK entity. There is no solution to this beyond providing finances in person. The challenges of such a restriction has been documented by the NGO community working in the DPRK, with many organizations being forced to withdraw.[10] It has also meant that conducting scientific projects since the early days of the COVID pandemic when DPRK closed their borders, has been nearly impossible, as there is no mechanism to provide funds for our local partners' expenses. These sanctions and the requirement to deal in cash increases risks associated with the project~~,~~ makes funders and universities uneasy, and limits the scale of collaboration by restricting the dollar amounts of any financial transactions.

Impact of travel-related sanctions: A third impact on our work began in July 2017 when the U.S. government began to require any U.S. citizen traveling to DPRK to apply for a single-use authorization, which are only provided for very specific reasons. This ban, and the subsequent blanket ban on DPRK citizens travelling to the United States, halts opportunities

for person-to-person engagement between scientists. For our work, which is largely conducted by scientists from outside of the United States, this has had limited direct impacts. However, the same cannot be said about restrictions imposed on August 6, 2019 for those wanting to travel to the United States using the U.S. visa waiver system. This system, which allows citizens from 40 countries (including the UK) to travel to the United States without applying for a visa was revoked for anyone who had traveled to the DPRK since March 1, 2011, meaning all members of our project who had travelled to the DPRK were impacted. As we develop new projects, it is increasingly challenging to find international scientists prepared to lose their ability to easily travel to the United States. This makes it harder to run workshops within the DPRK. As a result, we can only engage with a very small number of DPRK academics at a time, rather than developing wider and more fruitful partnerships.

Stable collaboration during unstable times

Changing sanctions can impose great uncertainty on a project. In our case, following a nuclear test by the DPRK in 2016, the UN Security Council passed resolution 2321 (November 2016) explicitly imposing a blanket ban on all scientific or technical cooperation with the DPRK. It also directed the 1718 Committee (the administrative arm of the UN Security Council related to DPRK sanctions) to evaluate each proposed engagement on a case-by-case basis; alternatively, the state involved in the scientific research (in our case, the UK government) can report to the committee that the work will not violate the sanctions. Our project was able to take the latter approach. In practice, this involved the UK government informing the 1718 Committee that the research project does not violate the sanctions and can continue. This sets a precedent, presenting a mechanism by which engagement can continue in areas seen to be mutually beneficial and in areas that carry a low risk of violating sanctions, such as the environment and health. Navigating this sanction was a key moment in our collaboration with DPRK scientists. It took time for us and our DPRK colleagues to establish a working relationship, involving many-in person meetings in London, Pyongyang, Beijing, and various European cities to build trust and cultural understanding (Figure 2). These sanctions, which could have caused a hiatus in collaboration would have threatend this and would likely have required another significant period of trust-building once sanctions were relaxed.

Our experiences show that, while sanctions may necessitate extra time, work and costs, it is still possible to maintain scientific collaboration even under the most severe sanctions. While these lessons may be useful to others working in the DPRK, how transferable they are to other countries under sanction?

The most significant increase in sanctions in recent years have been those imposed on Russia and Belarus following the invasion of Ukraine. This is the first time that significant international sanctions have been imposed on a country with such a large international scientific output. According to Digital Science's Dimensions database on scientific publications, Russia published 5,736 papers with U.S. authors and 2,934 with UK authors in 2022 alone. By contrast, DPRK scientists published 38 papers with U.S. authors and 15 with UK authors over the last ten years (2012–22). Therefore, it is practical for science projects with the DPRK to be dealt with on a case-by-case basis. This is clearly impossible for projects involving Russian academics and institutions, meaning blanket bans on collaboration are arguably the only feasible choice.

Following the sanctions on Russia, funders and institutions acted quickly to ~~reduce exposure~~ cut ties to Russia. The United Kingdom, European Union, and United States halted all projects with Russian involvement.[11] However, this action risks damaging the scientific relationships key to working towards global challenges such as climate change. One example is permafrost research. Permafrost in the Arctic stores about twice the amount of carbon as the atmosphere, yet this area is warming faster than any other region on Earth, meaning it could accelerate climate change as the carbon is released. Permafrost covers over 60% of Russian territory, meaning it is particularly at risk of thawing. Before the Russian invasion of Ukraine, many international collaborations existed to monitor the permafrost in Russia[12], feeding into global climate models as well as addressing the local risks as the soil properties change. However, German scientists from the Alfred Wegener Institute have not been able to visit Russia since 2021, and there are fears that equipment failures and a lack of replacements will stop long-term monitoring efforts. Other researchers studying how rainfall affects permafrost have not been able to provide specialized equipment, meaning experiments are failing.[13] It shows that, like our experience in DPRK, the mixture of increased bureaucracy, reputational

risk for institutions and sanctions on trade and finance are starting to hamper research projects.

To add to this anecdotal evidence, I present data showing the impacts of the sanctions on permafrost research. Figure 3 compares the number of publications that include the keyword “permafrost”, published by researchers based at institutions from different countries. Before 2021, most countries showed a gradual increase in the number of papers published on permafrost, with the exception of China, which had an exponential increase in publications. The number of papers published relative to 2021, the last year before sanctions were imposed on Russia, show that most countries published similar numbers of papers on permafrost in 2021 and 2022. ~~The number of papers published relative to those published in 2021 show a relatively static number of publications for most countries.~~ However, when comparing publication rates filtered by source of funding, different trends are observed. For research fully or partially funded by countries that have imposed blanket bans on research with Russia (e.g., the United States, Germany, and the United Kingdom), the number of publications with Russian authors drops by 19%, while those with other nationalities remain steady. By contrast, China has imposed no restrictions on scientific collaboration with Russia. Research fully or partially funded by China has resulted in a small increase in papers with Canadian- (5%), United States– (12%) and German-based (16%) authors, and a much larger increase in papers with Russian (32%) and UK (47%) based authors. The increase in papers with Russian based authors is similar to the 39% increase in permafrost research by Chinese authors more generally. It is hard to draw a direct comparison between the sanctions and these trends. The data is limited to only a single year after the introduction of sanctions. There might be other drivers of change as well, such as different regional impacts of COVID-19 or the more direct, non-sanction related impacts of the conflict in Ukraine on Russia, but it is consistent with the reported evidence that science collaborations between the United States and European countries and Russia are being impacted by sanctions.[14]

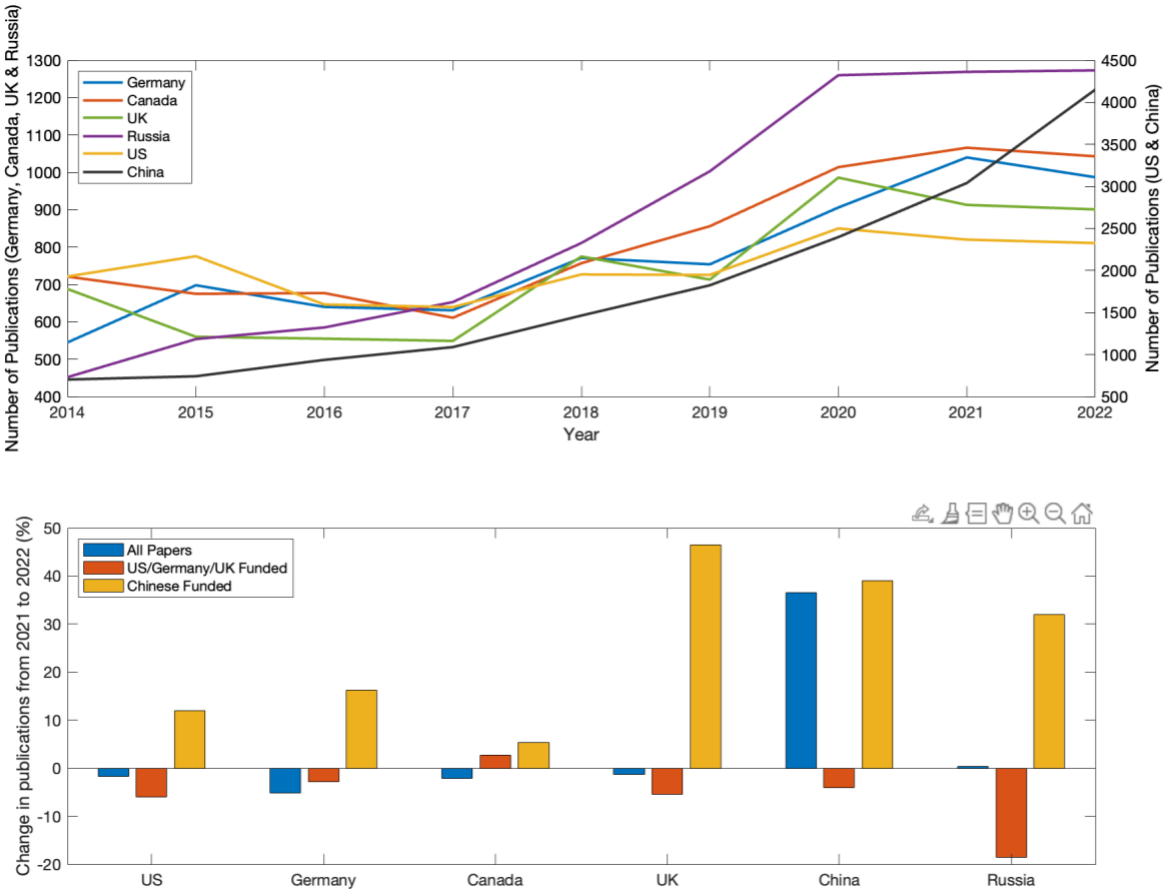

Figure 3: a) Number of papers published each year with the word "permafrost" in their metadata or text. Note the different axes for papers from the United States/China and Russia, Canada, and Germany. b) Relative change from 2021 to 2022 in the number of papers published.

A way forward

Our experience with the DPRK shows that it is possible to maintain collaborations with countries under severe sanction while also complying with those same sanctions. However, this does come at a cost. It has been well documented within the humanitarian aid community that working on a case-by-case basis and the severe implications of imposing blanket financial and travel bans results in increased delays and costs.[15] One strategy for speeding up requests for exemptions proposed by the humanitarian community is the development of a "white list" of pre-exempted equipment.[16]. While this is not without issues, potentially reducing flexibility to respond to crises that require items not on the list, it would allow a more rapid approval of repeat humanitarian projects, which currently need

to be reviewed every six months. The individual nature of many scientific projects and the requirement for bespoke pieces of equipment and approaches means this is unlikely to be applicable to science. However, identifying strategic, low-risk areas of research that are likely to be exempted from travel restrictions or other sanctions would allow researchers to develop collaborative projects that have a reasonable chance of being approved. Such preparation could both reduce bureaucracy, while also offering reassurance to academic institutions, funders, publishers, and other stakeholders that these kinds of engagement are encouraged. Indeed, such an approach could act as motivation to academics – highlighting priority areas for research funding and directing scientific attention in countries under sanction towards mutually beneficial areas of scientific research. Learned societies/national academies or international scientific organizations such as UNESCO are well placed to lead such efforts and act as initial conduits for collaboration, allowing scientists to maintain links and explore research in these strategic areas.

International sanctions are designed to obstruct development in strategic areas and will have inevitable consequences outside the foreign policy objectives for which they are designed. However, the apparent friction between the need to collaborate to resolve global challenges and a desire to isolate countries is a significant challenge. It is impossible to remove any area of science from political factors, particularly in a time of active conflict, but our work in DPRK shows that there remains a willingness from academics, governments, institutions, and funders to support research during political strain.

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