Conference Report

SCIENCE · PEACE · SECURITY ’21
The Impact of new Technologies: Destabilizing or Enabling Resilience?
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DSF Deutsche Stiftung Friedensforschung
german foundation for peace research
fonas Forschungsverbund Naturwissenschaft, Abrüstung und internationale Sicherheit
VolkswagenStiftung

Executive Summary

The impact of the rapid technological change on peace and security continuously grows and becomes increasingly complex. Against the background of a quickly deteriorating security environment, the international conference SCIENCE · PEACE · SECURITY '21 (RWTH Aachen University, 8-10 September 2021) examined the role of emerging technologies. The 60 speakers and 220 participants came from the natural, technical and social sciences. Diplomats and representatives from international organisations participated in the discussions. Topics included nuclear, chemical and biological arms control, autonomy in weapon systems, cybersecurity and the militarization of space among others.

The main outcome was that all of these issues could be more effectively addressed by new approaches to rigorous interdisciplinary research collaboration to create policy-relevant knowledge and by tightening the nexus between the scientist and policy communities. Both can only be achieved and sustained by funding novel structures that enable scientific-technical scholars to engage on these topics.

Key problems to be addressed by integrating natural, technical and social science perspectives include early risk assessment of potential dual-use research and technologies – especially in bio-security and epidemiology as well as IT and robotic research. Ways forward are the inclusion of norms into technology design as well as addressing questions of responsibility and standards. For military-usable technologies, entirely new regulatory approaches are necessary to prevent escalatory dynamics and to maintain accountability structures, moving from object-based to behaviour-based approaches.

Scientific-technical research contributes to peace and security in positive ways. A prominent example are nuclear verification techniques. While instruments to monitor nonproliferation and test ban commitments benefit from further improvement, many gaps on how to verify future arms control and disarmament agreements still exist and must be urgently closed.

The best cutting-edge scientific and academic expertise that is required for these complex research tasks is found in universities and other independent research institutes. Typically, however, decisionmakers draw knowledge from governmental institutions because of ease and existing connections. Therefore, efforts should be made to better connect the policy and academic communities. Communication between both can be improved by meeting on a regular basis and not only when advice on a specific issue is sought. This can foster more stable relationships and increase an understanding of each other.

Lastly, opportunities should be improved for the younger generation of scientists and technologists to engage with policymakers. It is crucial to educate and engage early-on the next generation of scientifically-literate policymakers and security-aware scientists.

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Today's international security environment is increasingly being marked by the demise of the classical arms control architecture, the rise of great power politics and eroding trust among states. The future course of the world order is unclear. New developments in military and dual-use technology as well as weapon modernization programmes are important factors and add complexity to any effort towards peace and security.

It is in this environment that the international conference SCIENCE · PEACE · SECURITY '21 examined the impact of new technologies, in particular emerging technologies. How can a more resilient security environment be achieved? Which research contributions and policy measures towards crisis resolution, confidence-building and arms limitations are possible in this world?

These questions can be answered by interdisciplinary approaches and studies – in particular by bringing natural, technical and social scientists as well as decisionmakers together. At the moment, there is no sufficient dialogue between these disciplines and experts. The conference offered a chance to think creatively beyond borders, find ideas for new interdisciplinary research and perhaps even forge new collaborations. The contributions to this conference came from many different disciplines and allowed us to put together a very diverse programme: During the conference, physicists, chemists, biologists, geographers, computer scientists, mathematicians, political scientists, legal scientists and ethics scholars presented their research.

Furthermore, also practitioners participated in the conference, including diplomats and representatives from international organisations. Clearly, the dialogue between scholars and practitioners is crucial for the success of international peace, security and disarmament efforts. The political objectives of nonproliferation, disarmament and arms control are met through multilateral treaties and arrangements. Negotiating and upkeeping those is the job of diplomats who need a good understanding of the topics, including the scientific and technical background.

1. Challenges and opportunities at the intersection of science, peace and security

The world is becoming increasingly complex and insecure; it is marked by multipolarity, great power competition, rapid technological change, strategic unpredictability as well as disinformation, which result in more mistrust, violence and arms investments. Examples that illustrate the worsening state include a renewed nuclear arms race which is marked by an increasing number of deployed weapons, the development of new delivery systems such as hypersonic weapons or nuclear-powered cruise missiles, the erosion of arms control regimes including the end of the Intermediate-Range Nuclear Forces Treaty (INF) or the difficulty to maintain the Joint Comprehensive Plan of Action (JCPOA) that limits, inter alia, the Iranian nuclear programme but also includes sanctions relief or stronger verification standards.

Beyond nuclear, new technological and military developments are worrisome: Examples are an increasing autonomy in weapon systems and concepts to base for example early warning and command and control systems on artificial intelligence. The man-made cyber-domain allows borderless communication and services worldwide, but has also become increasingly

militarized and weaponized. As many incidents show, technical vulnerabilities can be exploited for espionage, sabotage or disruptive attacks on critical infrastructure by state actors to escalate conflicts. The most powerful military actors aim for digital supremacy, which will replace 20th century air supremacy as over-arching goal if this is not the case already. States are investing increasingly in hybrid defence strategies by using irregular forces or disinformation campaigns. A consequence is that threatening the use of nuclear weapons to react to cyberattacks is discussed. Clearly, hybrid wars are harder to predict.

Even though biological and chemical weapons have been legally banned for decades, chemical weapons have recently been used on several occasions, including in Syria or the poisoning of Russian citizens. Some advances in biotechnology augment the dual use dilemma, for instance in gain-of-function research or novel invasive environmental biotechnologies. The convergence of chemistry and biology introduces new challenges to regulating these weapons.

Further important issues which have also been discussed during the conference are the increasing militarization of space, the dual use potential of quantum computing, sensor technology, laser-based systems as well as stealth technologies. Importantly, technological convergence will become more relevant as synergetic aspects of these various technologies are brought together in the military context.

Against this background, scientific and technical expertise in peace and security research is essential to provide the scholarly background that informs decisionmakers. These disciplines must be involved in assessing risks of new military technologies and the dual-use potential of developments in research. Beyond this, they are instrumental in exploiting innovative science and technology as opportunities to the benefit of peace and security.

While it is impossible to capture all the topical areas addressed during the conference (for which we refer to the full Conference Proceedings available at https://publications.rwth-aachen.de/record/842143, DOI: 10.18154/RWTH-2022-02256), two of the major themes are highlighted next to dive into some more depth. In both, natural scientists and engineers must come together with social scientists to create policy-relevant knowledge. They are very different topics requiring very different expertise, which speaks to the diversity of the field.

Addressing dual-use aspects of emerging technologies

Advances in security-relevant areas often have a dual-use character, as – in addition to their beneficial use to society – some may at the same time also carry the potential to cause harm. The speed and diffusion of innovation is accelerating, resulting in the need to adapt awareness and regulation of possible high-risk technologies. Thus, research and development in these areas need attention from both researchers and political decisionmakers. This includes early risk and technology assessment. Discussion within the research community and the society - on possible effects and legitimate applications - needs profound knowledge of the scientific base of the technological artefacts. Possible fields of security relevant research and development include, but are not limited to, bio security and epidemiology, IT and robotic research, among others.

Some ways to address dual-use issues are design approaches which work on the inclusion of norms into the technology design such as Responsible Research and Innovation (RRI) and Value Sensitive Design (VSD) as well as technology assessment, preventive arms control and addressing the questions of responsibility, norms and standards. It is evident that addressing these aspects requires knowledge from a variety of disciplines.

Among a wider range of technologies, one focus of the conference was on informatics-related topics, which are of particular importance. This discussion included artificial intelligence as well as technologies and platforms enabling information warfare.

Machine learning elements are increasingly being used across various industries, for example in finance, healthcare, or security applications. Similarly, militaries around the globe seek to integrate these elements, hoping to gain an edge over their adversaries by accelerating decision-making and exploiting larger amounts of data. This not only creates mounting pressure for others to follow suit, indicating the early stages of a new type of arms race, but also gives rise to some unique ethical, legal, and security challenges. Research must further contribute to addressing these.

On technologies and platforms with a potential to enable information warfare: Significant increases in fake news, disinformation and influence campaigns are undermining trust in experts, institutions, and other traditional sources of authority. Nonproliferation norms and regimes are no exception. Yet, there has been little systematic research to deepen understanding and to enhance international awareness of contemporary influence campaigns that undermine nonproliferation norms and regimes. Similarly, there has not yet been sufficient emphasis on increasing the ability of governments, media, international organisations, and professional societies to detect and respond to them, or prevent misuse of suited platforms in the first place. Besides technical research – for instance on detection and mitigation – studies building typologies of disinformation campaigns and means of narrative dissemination could be a way forward.

Confidence-building, regulation and verification

Arms control treaties and related regimes in different domains (CBRN, conventional weapons, outer space etc.) have been established in the last 50 years to increase predictability, transparency for war prevention and sustainable peace. In some, verification measures have played an important role. Additionally, transparency and confidence-building measures (TCBMs) aim to influence the perception of antagonists and to remove inherent ambiguity surrounding national military policies.

Given future political and ethical challenges stemming from military and technological developments, new TCBMs in different domains are a potential way forward. They can be implemented in the full weapons cycle including research, engineering and deployment. At the conference, current deficits and challenges for TCBMs within the current arms control, nonproliferation and disarmament framework were debated and further proposals to address future challenges in the areas of confidence-building, arms control, verification and threat reduction were discussed.

For instance, it was found that new missile technologies, biological weapons and deployed conventional forces need more transparency due to the demise of respective arms control treaties or their lack of efficiency. With regard to emerging technologies broadly, entirely new regulatory approaches are necessary to prevent escalatory dynamics and to maintain accountability structures. While classical arms control measures are typically based on object-based approaches such as counting tanks or aircraft, these will need to be addressed by behaviour-based approaches.

Science-based advice is crucial in all these areas, as a detailed understanding of the various technologies is key to develop effective and targeted confidence-building, regulatory or verification measures. Technical expertise and research are not only necessary to develop approaches that address emerging technologies. They are at least equally important in the classical fields, including nuclear arms control.

While verification techniques to monitor nuclear nonproliferation commitments (Safeguards) are constantly being improved, as well as the verification regime of the Comprehensive Test Ban Treaty, many open questions remain on how to verify future arms control and disarmament agreements. This begins with urgently required methods and techniques to verify limits on the number of warheads a state possesses, which may well be part of a potential successor agreement of the New START Treaty. It continues with more intrusive and more complex regimes to verify deep cuts, at some point in the future perhaps down to states giving up their nuclear arsenals.

Cutting-edge technology will be required, as some of the challenges are highly complex. For instance, confidence in disarmament processes must be built under the significant constraint that weapon states seek to protect proliferation-sensitive and otherwise classified information. Another example is the difficult detection of undeclared warheads, which do not possess signatures that could be measured from afar. Much more research and development, testing and evaluation of technologies is needed.

2. The Need to Integrate Natural, Technical and Social Science Perspectives in Joint Research on Peace and Global Security

Today, there is a rather active and important social science research community that addresses the role of technology for peace and global security. The fast-paced technological developments including the convergence of disciplines and the complex interplays that technological innovations have with regard to their impact on peace and security, however, require substantive and disciplinary expertise from scientists and engineers.

In addition to technology assessments – typically examining risks – science and technology can also contribute to peace and security in positive ways. Equally important as recognizing the need to bring in expertise from the natural and engineering sciences, however, is the insight that political and social problems can rarely be solved solely by technological innovation.

In a nutshell, neither can social scientists alone offer the required expertise to address such challenges, nor can natural scientists or engineers alone. The need for interdisciplinary

approaches in this area is of course not new. Nevertheless, there is much room for expanding and strengthening collaboration. The German Science and Humanities Council emphasized this conclusion in its recent evaluation of the field of peace and conflict studies.

The most effective way is to foster integrated research projects where the fields do not work side by side or where one merely provides some specific input to questions largely addressed by the other. Instead, in an integrated project, research questions are solved by constant dialogue that results in a joint understanding.

Within the above-mentioned areas of emerging technologies and confidence-building, the examples of cybersecurity and nuclear verification regimes illustrate the need for integrated approaches. In the cyber context, social and computer scientists have different perspectives of what security means. A comprehensive understanding of what is meant by "cybersecurity" that accounts for technological as well as social aspects is a crucial step to more effectively address it. Therefore, the highly complex technological problems for instance about digital encryption and disinformation urgently need a dialogue between political scientists, policymakers and computer and data scientists.

Nuclear verification regimes are very complex and challenging both in technical and political terms: While advances in detection technologies and analysis methods can enhance verification capabilities, the perceptions that the involved stakeholders have of each other certainly influence how well confidence-building through verification can succeed. How do technical, political and social processes then need to be intertwined so that verification can be as effective as possible in a challenging and constantly changing security environment?

Such interdisciplinary dialogue requires appropriate formats, incentives and funding to collaborate. Today, not sufficient opportunities exist in this regard. Furthermore, it can even be seen as an impediment to careers: In academia, evaluations typically follow disciplinary criteria. Such dialogue is difficult as an uphill struggle, as it requires space to learn about other disciplines' approaches and methods, and develop a common language. These tasks demand effort and patience.

Lastly, beyond the communities of researchers that have built their career or plan to build it on topics of technology and security, reaching out and involving natural and technical scientists that have relevant disciplinary expertise is crucial. Experts on cyber, artificial intelligence, quantum technologies and space are just a few examples. They could collaborate with the arms control community on a project basis, but need incentives to do so, including appropriate funding opportunities.

To further strengthen this field of "scientific-technical peace research", new governmental initiatives are necessary: Within the disciplinary structure of the academic system, it is difficult or impossible for interdisciplinary research groups to grow without external support. Such support should also be in the interest of governments, as they benefit from the technical experts advising them, and as the outcome of integrated interdisciplinary research that such support enables will address their needs in the most comprehensive and effective way.

3. Overcoming the Gap of Scientific and Political Cultures

Natural and social science research provide a crucial component of political decision-making in conflict resolution, arms control, disarmament and international security. Political decisionmakers and diplomats are necessarily generalists, who do not have the time to reflect deeply on specific issues, especially if at the root are technically arcane complexities of new and rapidly evolving technologies. There are only very few opportunities for specialist careers. The pressure of office does not often reward deep reflection, but rather action. Therefore, on these complex issues, they need the help of science.

Furthermore, government officials are less free to develop their thoughts on issues of technology and security, or disarmament and arms control more broadly. Academic scholars are less bound by political narratives, which creates a chance for them to shape the agenda. Their creative ideas can give important impulses to decisionmakers. Tightening the nexus between the scientist and policy communities is crucial.

This creativity can only be fully developed in independent institutions. Typically, however, decisionmakers draw knowledge from their governmental institutions because of ease and existing connections. These can be intelligence services, national research labs or regulators. These experts can, however, only cover part of the picture and academic thinking. Reaching out to and supporting non-governmental scientists will allow them to profit from a diversity of experience and views as well as often more cutting-edge technical knowledge.

Naturally, however, there is a gap between the world of science on the one hand and politics, diplomacy and government on the other. A sober analysis of the different aspects of these two cultures is necessary in order to propose ways to overcome the gap. Science is mainly ruled by rationality, open exchange and neutrality. In the realm of politics, different interests, rhetoric and changing norms are dominating the discourses on the use of scientific-based technologies for armament and disarmament. Sometimes, scientists (outside the peace and security research communities) are not sufficiently aware of the political, security, military or other contexts of their work. Policy-makers may not always have a technical background or understand scientific methodology in general. Lastly, there is not always sufficient recognition for scientists to engage in policy advocacy, or for decisionmakers to foster relationships with scientists.

The question then is how to connect these very different communities, what are key elements for an effective two-way engagement. So far, typically, policy-makers turn to scientists (only) when they have a concrete technical issue. A way to significantly improve communication between both communities is to connect on a regular basis, and not only when advice on a specific issue is sought. This can foster more stable relationships, and increase an understanding of each other: What are policymakers looking for from scientists and technologists? What are scientists and technologists looking for from policymakers? A way forward is for scientists to invite policy-makers to their discussions.

Certainly, there is historical experience to draw from, such as the Pugwash Conferences on ‘dialogue across divides,’ OPCW’s interactive ‘Science for Diplomats’ initiative, Article 36’s informal retreats for experts and policymakers, or the working groups of the International Partnership for Nuclear Disarmament Verification, where scientists work alongside

diplomats. All these experiences should be critically reviewed in regard to how effective they are/were in bridging the divide, and what one can learn to improve the dialogue.

Last but certainly not least, ways should be thought about to motivate the younger generation of scientists and technologists to engage with policymakers in nonproliferation and disarmament. How can opportunities for them be improved? It is crucial to educate and engage early-on the next generation of scientifically-literate policymakers and security-aware scientists. It is these people who will later have impact as experts in national and international institutions as well as academia.

Background: The Conference

The SCIENCE · PEACE · SECURITY'21 conference was held online 8-10 September 2021. It was organized by the research group Nuclear Verification and Disarmament of the RWTH Aachen and financed by the German Foundation for Peace Research, the VolkswagenStiftung and the Research Association for Science, Disarmament and International Security (FONAS). It involved about 220 registered participants, 60 speakers, and 15 posters. There were 18 sessions, one poster session, and 7 plenary talks. It furthermore featured virtual coffee and break rooms, giving attendees the opportunity for informal exchange.

The conference series SCIENCE · PEACE · SECURITY, started in 2019 and held biannually, is not least a response to the 'Empfehlungen zur Weiterentwicklung der Friedens- und Konfliktforschung' ('recommendations for the further development of peace and conflict research') published by the German Council on Science and Humanities in July 2019. In these recommendations, the council explicitly calls for an expansion of the field's interdisciplinarity, a strengthening of scientific peace and conflict research, as well as the promotion of the field's internationalization in Germany.

As demanded by the Council, this conference aimed for international connection in peace and conflict research. The program committee was comprised of scientists from all over Europe. About 50% of the registered participants stemmed from Germany, the rest primarily from Europe. Nevertheless, all continents except Australia were represented.

Among the attendees were international experts from the universities of Harvard, Texas A&M, Berkeley, Princeton, Maryland, North Carolina and Boston (USA), Stellenbosch (South Africa), Universidad Militar Nueva Granada (Columbia), KAIST (South Korea), Tsinghua (China), Oxford, King's College, Manchester and Leicester (GBR), Rome and Genua, Barcelona, Prague, Vienna, Leiden, Antwerpen, Uppsala, and Southern Denmark. Diplomats and international organizations were represented by speakers from the CTBTO, the OPCW, UNIDIR, the EU External Action Service, the German Federal Foreign Office as well as the Bundeswehr.

The Conference Proceedings are published by RWTH Publications free of charge, a selection of conference contributions will be published as peer-reviewed papers in a special issue of the Journal of International Peace and Organization (Friedens-Warte). The follow-up conferences are already in planning - SPS'23 is scheduled at TU Darmstadt.