Promoting a Scientist's Duty of Care 4.0

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I. Abstract

This paper argues for the need to introduce and strengthen more flexible forms of cooperation at the grassroots level in order to deal with current non-proliferation challenges. There is an important role to play for scientists, engineers, academicians, experts and others working at different types of organisations: profit and non-profit. The rapidly changing security environment, as well as the considerable time lag in mitigating such risks through legislative frameworks, increasingly call for such cooperation. Reinforcement of these forms of cooperation is beneficial to the preventive approach to mitigating security risks and threats.

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I. Introduction: The Need for A Scientist's Duty of Care 4.0

Within the current times of the fourth industrial revolution, the scientific community has a special duty of care (i.e. a 'duty of care 4.0') to ensure that security aspects are accounted for in scientific thinking from the beginning of work. Such an approach is especially important when research and development include chemical, biological, radiological or nuclear (CBRN) agents and materials but also where they involve new sensitive technologies, such as artificial intelligence (AI). New emerging technologies must remain secure and peaceful.

The recommendations made in this paper are derived from a brief description of the current state of weapons of mass destruction (WMD) non-proliferation including setbacks perceived by the author from his time with the European Commission where he had responsibilities regarding this challenge. In making the argument for expanded bottom-up efforts, this paper does not seek to minimise the importance of the top-down (legally-binding) efforts in strengthening WMD non-proliferation. Indeed, the EU has been and must continue to be a champion and a norm-setter for such measures on the international stage. Instead, these recommendations are based on the need to recognise emerging challenges and to address the human dimension of the non-proliferation policies in connection with these challenges.

Instead, this paper makes the case for the expanded use of 'Science Centres' as a tool to promote bottom-up engagement of scientists. This paper is not alone in acknowledging the advantages of the Science Centres model, such as the International Science and Technology Center (ISTC), established in Moscow and currently operating in Kazakhstan, as a tool to adapt to evolving changes in the security landscape.[2] However, in general, the role of the Centres in promoting safety and security deserve stronger recognition and increased financial support.

Recently, the existing Science Centres (i.e. the Kazakh-based ISTC and the Science and Technology Centre (STCU) in Kiev) have been modernised significantly with the view to responding quickly and efficiently to the challenges ahead. For example, the legal framework of the ISTC has been substantially revised, allowing for the organisation to work globally. The international community should make use of the opportunities that these transformations provide.

Other flexible forms of cooperation and engagement at the expert grassroots level have also reduced risks and threats. One such programme, functioning on a voluntary basis, is the EU's CBRN Centres of Excellence Risk Mitigation Initiative. This programme also merits further strengthening to enable activities on a wider geographical scale. There is a case to be made for

[2] ISTC describes itself as an intergovernmental organization connecting scientists from Kazakhstan, Armenia, Tajikistan, Kyrgyzstan, and Georgia with their peers and research organizations in the EU, Japan, the Republic of Korea, Norway and the United States. ISTC facilitates international science projects and assists the global scientific and business community to source and engage with CIS and Georgian institutes that develop or possess an excellence of scientific know-how. At the end of the Cold War, the ISTC operated from Russia as a means to redirect WMD scientists after the Cold War. In recent years the ISTC has been operating out of Kazakhstan after closing its offices in Moscow in 2015.

transforming the existing regional secretariats established under this initiative to cover a wider set of security issues.

An overview of other relevant grassroots initiatives by academia, researchers, industry and public authorities to promote a culture of responsibility shows a mixed picture of success. Therefore, the Science Centres, and other programmes such as the EU CBRN Centres of Excellence Risk Mitigation Initiative, should be invited to play a more active role in promoting these ways of flexible cooperation.

This paper first provides a perspective on the need to find new ways to deal with emerging challenges. It then outlines the main instruments available to officials, including most particularly European officials, in dealing with such emerging challenges. The paper then sets out what a bottom-up approach might look like drawing on experiences from engaging Iraqi WMD-related scientists. Finally, it provides practical recommendations for European officials on how to foster bottom-up approaches.

II. Recognising emerging challenges

The societal benefits of scientific and technological developments are clear. Digitalisation has led to economic transformations, improved healthcare and benefits in many other sectors, such as education. However, whilst digital technologies have delivered vast benefits for an unprecedented number of people, they have also become associated with significant challenges the world must face.[3] These challenges are particularly acute in the security domain, especially if chemical, biological, radiological or nuclear (CBRN) agents and materials are involved. For example, synthetic biology supports the development of new medical solutions, but also raises the possibility of new man-made pathogens.

Expanding global trade and interconnected data networks also increases the opportunities for state and non-state actors to acquire dual-use equipment and technology.[4] These threats and trends are exacerbated by rapidly-changing technologies (e.g., additive manufacturing, powerful computer-aided design applications and cyber-attack tools) and greater diffusion of dual-use knowledge that may provide proliferators easier access to WMD capabilities. Moreover, increased intangible technology transfers, such as the transmission of software and technology by electronic data, including brokering and transit, pose new challenges for verification and control.[5]

As an example, in recent years, researchers have achieved key milestones in AI technology significantly earlier than predicted in prior projections. This rapid progress is likely to have an impact on national and international security. Special attention has been drawn by a group of experts from the scientific community to the dramatic impact of a new kind of warfare of unmanned ground or aerial vehicles (UAVs) based on the use of AI technologies.[6] In this

[3] Technology for the many: A Public Policy Platform for a Better, Fairer Future, Tony Blair Institute for Global Change, London, November 2017, page 3.
[4] Commission Staff Working Document, Impact Assessment, Report on the EU Export Control Policy Review, Brussels, 28.9.2016, SWD (2016)315 final, p 7. In general terms, “dual-use” can be defined as the potential of military application of any technology originally designed for non-military, civilian purposes, and vice versa.
[5] Op cit, pages 3 and 4.
[6] Artificial intelligence and national security, George.C.Allen, Taniel Chan,Belfer Center for Science and International affairs, Harvard University, Boston, July 2017, page1.

context, an important 'breakthrough' was the first case of an attack using a swarm of drones loaded with explosives that allegedly took place in Syria in January 2018.[7]

The group of scientific experts issued the following recommendations outlining possible solutions for mitigating these emerging risks:

- AI researchers should acknowledge how their work can be used maliciously;
- Policy-makers must learn from technical experts about these threats;
- The AI world must learn from cybersecurity experts how best to protect its systems;
- Ethical frameworks for AI need to be developed and followed; and
- More people need to be involved in the discussions, such as ethicists, business leaders and the general public.[8]

A. The need for a bottom-up approach

Despite international and regional policy regimes, recent proliferation-related events have taken place. This activity includes the development of the illicit nuclear programme in North Korea, the deployment of chemical weapons in Syria, the use of a highly toxic VX agent killing the half-brother of Kim Jong Un and the recent attack in the UK through the use of a military grade highly toxic nerve agents belonging to the Novichok group.

Indeed, these developments require further reflection on ways to make overall non-proliferation policies more effective. Obviously, all legally-binding efforts strengthening non-proliferation efforts must continue. The various upcoming review conferences will be crucial for determining the future of a number of these global regimes.

An interesting trend in bottom-up approaches is that like-minded partners are seeking new forms of practical cooperation within and outside existing legal frameworks. For example, France launched in January 2018 an international partnership against impunity for the use of chemical weapons, supporting the strengthening of cooperation among experts. The first meetings of this initiative have taken place. The Benelux countries have committed to strengthening the implementation of the Biological and Toxin Weapons Convention (BWC) in their countries through mutual peer reviews. The UK and Norway Initiative is bringing together non-nuclear-weapon states (NNWS) and nuclear-weapon states (NWS) to discuss verification tools and methods for nuclear dismantlement, and to explore how all states party to the NPT can contribute to their Article VI obligations.[9]

However, despite such developments and noting the emerging needs, the overarching question remains as to what additional policy initiatives should be taken in order to respond more adequately to current and future security threats and risks. As indicated above, the challenges mainly relate to the widespread use of CBRN-related agents and materials, but also to the

[7] www.independent.co.uk on 10 January 2018.
[8] The Malicious Use of Artificial Intelligence: Forecasting, Prevention, and Mitigation. Future of Humanity Institute, University of Oxford, Centre for the Study of Existential Risk, University of Cambridge, Centre for a New American Security, Electronic Frontier Foundation, Open AI, 20 February 2018.
[9] French Ministry of Foreign Affairs, 23 January 2018 and Working paper on initial observations on a BTWC peer review submitted by Belgium, The Netherlands and Luxembourg to the Meeting of States Parties of the Biological and Toxin Weapons Convention, 14-18 December 2015 in Geneva (BWC/MSP/2015/MX/WP.13) and https://www.gov.uk/government/publications/uk-norway-initiative-on-nuclear-warhead-dismantlement-verification. Equally, the various gift baskets under the Nuclear Security Summit process promote cooperation among experts to enhance nuclear security worldwide for example outside the IAEA framework.

application of emerging and disruptive technologies, with respect to, for example, the security impact of AI.

Given the rapidly-evolving situation and within the overall policy context, recommendations are made in this paper for placing greater emphasis on the use of bottom-up, grassroots-relevant forms of cooperation by academia, researchers, industry and public authorities. In particular, scientists and scientific institutions will have to play a much greater role in reducing risks and threats at the earliest possible stage of scientific and technological developments.[10]

This is particularly important in light of the high-profile examples of scientists engaging in nefarious activity. For example, the Pakistani metallurgist A.Q. Khan is known for his role in developing Pakistan's nuclear arsenal, and who confessed in 2004 to having illegally provided nuclear weapons technology to Iran, Libya and North Korea over the course of decades. Kim Jong Sik and Ri Pyong Chol are on the US sanction list. Both are major figures in the development of North Korea's intercontinental ballistic missile (ICBM) programme. North Korean experts have trained and supported Syrian technicians since the 1990's to support Syria's chemical weapons programme.[11] Terrorist groups such as Al Qaeda have made repeated attempts to recruit nuclear expertise in order to develop a nuclear programme.[12] In 2014, a laptop owned by a Tunisian expert in chemistry and physics and recovered from a hideout of the Islamic State in Syria contained documents on how to develop biological weapons.[13]

It is clear that scientists can be misused for proliferation programmes. It is equally clear that experts with specific knowledge on sensitive technologies can and must ensure that disruptive emerging technologies remain secure and peaceful.

[10] For a systematic overview of the risks of new technologies, see ;Peril and Promise: Emerging Technologies and WMD, Natasha Bajema and Diane DiEuliis, Center for the study of WMD, National Defence University, Washington, May 2017.
[11] Bruce. E. Bechtel Jr, Angelo State University, Book to be published, The New York Times, 27 February 2018
[12] CTR and the 2017 threat environment, William Tobey, Harvard University, CTR programs and the Next Ten Years and Beyond,18-19 September 2017, NAS, Washington.
[13] Combating the spread of WMD: A success story for the US-EU Partnership, J.Jenny and S.Limage, in War on the Rocks, Texas National Security Network, University of Texas, 1 March 2018.

III. Bottom-up approaches

In 2009, the G8 drew attention in a set of recommendations to the global spread of sensitive knowledge, highlighting the importance of the engagement of scientists.[14] Amongst these were the promotion of grassroots cooperation models and raising awareness and responsibility as approaches to prevent unintended malicious misuse of knowledge.[15]

The G8 stated that the human factor is a key element in any effective non-proliferation policy. The also noted that scientists with specific knowledge about sensitive CBRN-related technologies, including dual-use technologies, play an important role in this respect, for example, in working together on projects that advance international, regional or bilateral non-proliferation objectives.

The lessons learned through the ISTC and the STCU, and through other bilateral programmes, could be used to contribute to global non-proliferation efforts. At the same time, greater effort should be made: (i) to foster awareness of the multiple uses of high-risk materials and sensitive know-how and technologies, thereby contributing to a risk-conscious culture among scientists at all levels; and (ii) to improve education and training in areas where knowledge and expertise are rapidly advancing.[16]

As a possible way forward, the development of and experience with cooperation models, such as those of the Science Centres, the EU's CBRN Centres of Excellence Risk Mitigation Initiative and other forms of cooperation promoting a culture of responsibility, are highly relevant. This paper further examines the progress made with these various policy tools.

A. The Science Centres model

The Science Centres were established in the mid-1990s. They were built on the experience gained by the USA-USSR lab-to-lab scientific cooperation initiated at the end of the 1980s after the Chernobyl accident in 1986.[17]

The Nunn-Lugar Cooperative Threat Reduction (CTR) policy, later known as the Cooperative Threat Reduction Program, also assisted in the establishment of the Centres. The US took a principal role in the dismantlement of the military industrial complex in the former Soviet Union under this programme. The CTR and related programmes focus on protecting and eliminating CBRN stockpiles, securing nuclear weapons-usable materials and eliminating delivery systems. Some of the programme's first successes came in 1992 when Ukraine,

[14] Scientists are defined as individuals at all levels in possession of proliferation-critical knowledge, including engineers and technicians having technological skills or WMD-related knowledge or any dual-use expertise in sensitive CBRN areas of proliferation concern. GLOBAL PARTNERSHIP WORKING GROUP (GPWG), "Recommendations for a coordinated approach in the field of global weapons of mass destruction knowledge proliferation and scientist engagement". Available online at:
http://www.g8.utoronto.ca/summit/2009laquila/2009-report-gpwg-b-recs.pdf

[15] Recommendations for a coordinated approach in the field of global weapons of mass destruction knowledge proliferation and scientist engagement, Global Partnership Working Group, 2009, http://www.it/MAE/EN/Politica.Estera/G8/PresdenzaItaliana.htm.

[16] Op cit, pages 1-3.

[17] For a more detailed description, see S. Hecker, Doomed to Cooperate: How American and Russian Scientists Joined Forces to avert some of the Greatest Post-Cold War Nuclear Dangers, the Los Alamos Historical Society's Bathtub Row Press, Los Alamos, 2016.

Belarus and Kazakhstan agreed to return to Russia the nuclear weapons they had inherited and acceded to the Nuclear Non-Proliferation Treaty (NPT) as NNWS.[18]

In the 1990s, the multilateral Science Centres focused on identifying and supporting underemployed CBRN and aerospace scientists and engineers with skills that might be of interest to rogue states. The aim was to redirect their talents from military research and development to peaceful purposes, and to integrate them in the worldwide scientific community.

The two Science Centres were established as international organizations based on international agreements. In essence, the Centres operate as funding agencies for proposals submitted by research institutes. They do not conduct research themselves, but rather pool resources from among the main funding parties, such as the EU, the U.S. and Japan. In funding research and development activities, the Centres provide salary supplements, research equipment and supplies for laboratory experiments.[19] Over the years, their membership has expanded to include all countries of the former Soviet Union (except Turkmenistan). Numerous former weapons scientists, engineers and institutes funded through the Centers participated in peaceful collaborative research and development projects. Initially, the work mainly took place in so-called closed cities and institutes, such as Sarov, where Andrei Sakharov and other well-known scientists had worked in the past. Other examples are the 57 ISTC-financed projects in the chemical field carried out at the State Scientific Research Institute of Organic Chemistry and Technology (GosNIIKhT), the institute where the highly toxic Novichok agents were developed during the seventies and eighties.[20]

In all of these examples, the Science Centre model led to an improvement in safety standards and procedures. Over the years, scientists developed technologies for monitoring, containment, and surveillance of nuclear activities, as well as verification and detection methods in support of the implementation of non-proliferation policies. Numerous training activities took place to improve disease surveillance and to promote a biosafety and biosecurity culture in the laboratory. New technologies were developed, for example in support of reducing emissions harming environmental conditions. Numerous physical safety upgrades were implemented to avoid unauthorised access to sensitive installations as well as to prevent insider smuggling of hazardous materials to the outside world.

Between 1994 and 2017, the ISTC supported a total of 4,186 projects with a value of 962 million Euro, of which the total contribution by the EU and the U.S., the main funding parties, was respectively 305 million Euro and 451 million USD. Similar figures for the STCU show that almost 2000 projects were supported with a total investment of 89 million Euro by the EU and 176 million USD by the U.S. Overall, more than 100,000 scientists and engineers joined the activities of the two Centres.

Over the years, the Science Centres have adapted their work to take into account the changing proliferation landscape, threat analyses and the evolving needs of the parties. After 9/11 and

[18] For further details, see the Nunn- Lugar scoreboards, http://www.dtra.mil/Missions/Partnering/Nunn-Lugar-Scorecard.

[19] For a detailed overview on the origin and functioning of ISTC, see G. Schweitzer, Moscow DMZ, M.E. Sharpe, New York 1996 and G. Schweitzer, Containing Russia's Nuclear Firebirds, The University of Georgia Press, 2013.

[20] ISTC; the Daily Beast, 14 March 2018.

the adoption of UNSCR 1540 (2004), the Centres started to rebalance their activities towards global proliferation concerns. For example, more counter-terrorism initiatives were funded and more grants were related to dual-use concerns in the chemical and biological field.[21] Equally, more partner projects were funded (e.g., funding in support of private companies in order to promote the commercialisation of research findings).

B. Learning from past experience

The developments undergone by the two Science Centres over time provide valuable insights in three ways: first, they were subject to a continuous evaluation process which can be used to track their successes in integrating former Soviet researchers into the international scientific communities and promoting peaceful research applications; second, the responses of the Centres to backlashes, such as the withdrawal of Russia, Canada and Belarus in the years following 2010, provide insights into the flexibility of the model; and third, the current international activities undertaken by ISTC show the global applicability of the model and how they such activities can serve as an anchor for strengthening the Science Centre model in the future.

Over the years, a number of evaluations and audits of the functioning of the Centres were conducted which have identified the following impacts of the funded activities:

- A reduction of proliferation threats by providing new careers to scientists and engineers as well as through safety upgrades of scientific and other installations;
- The creation of a civilian research community in the countries of the former Soviet Union and modernisation of the research infrastructure;
- The integration of scientists of the former Soviet Union in networks of the international scientific community;
- The building of trust among scientists and engineers that previously had limited mutual contacts; and
- A contribution to the diversification of economic activities in some of the countries concerned through support for development, innovation and commercialization of new technologies.

The various evaluations of the work of the Science Centres - apart from some anecdotal evidence - were not able to quantify how many scientists and engineers were dissuaded from joining rogue WMD programmes. However, the results of the evaluations provided the basis for the necessary discussions on the future of both Centres. The parties realized the need to expand the activities of the Centres beyond the former Soviet Union in order to respond to emerging threats from other regions and from non-state actors.

These exchanges on expansion were intensified after the withdrawal of the Russian Federation from the ISTC announced by President Medvedev in 2010 and the departures of Canada in 2013 and Belarus in 2015. Meetings were held during which the remaining parties exchanged views on their experiences with the two multilateral scientist engagement programmes. The main conclusions were that the functioning and setup of the Centres was inadequate for achieving the goals of all parties involved, but that a re-organisation could lead to more efficient

[21] Second evaluation of the EU Instrument for Stability, Priority 1 (CBRN risk mitigation), final report, Brussels, October 2012, page 34.

procedures. Furthermore, in order to address the changing threat and risks landscapes, the activities of the Centres would have to be expanded, especially in terms of geographical range.

Specifically, four assessments of how to shape a road forward were identified:

First, the legal bases (i.e. the international agreements establishing the Centres) provided a maximum of legal certainty to allow for effective preparation and implementation of the tasks. However, the governance structure of ISTC needed to be reviewed, as well as the out-dated provisions on intellectual property protection. And while the secretariats were effectively managed, greater cost savings could be made through greater synergies in the activities of both secretariats. Second, the results of the funded programmes and projects were satisfactory and served the objectives of each of the partners. Funding triggered important follow-up research activities on a wider - more resource intensive - scale. However, the regional component of the work needed strengthening and the transfer of research results from the laboratories to the marketplace required further attention despite success stories in the medical, nuclear and oil and gas sectors. Third, the interaction among various research institutes had drastically improved and the necessary scientific networks had been developed.[22] There had been considerable trust building among scientists working at several different institutes. The scientific infrastructure in the various countries had been upgraded, but overall improvements remained uneven among the various institutes. Fourth, while the funding procedures were effective and transparent and were fit for purpose, further efficiency gains are possible.

However, the most important overriding conclusions were that:

- Both Centres needed to be further transformed given the current and future security landscapes that require faster, more flexible and more multidisciplinary responses;
- The objectives and strategies of the organisations needed reformulation and should, in particular, to be brought closer to the objectives of UNSCR 1540 (2004); and
- The geographic scope of the activities needed to be expanded given current and future CBRN and other relevant threats and risks.

This review process led to development of a new strategy for the STCU and a new Continuation Agreement for the ISTC, which entered into force on 14 December 2017.[23]

Among the most important changes brought about by the renewed ISTC agreement were:

- The establishment of new objectives, taking into account the new security challenges as compared with those of the 1990s;
- The extension of the geographical scope of the activities of the organization. The ISTC can now operate on a worldwide basis instead of only in the former Soviet Union republics;
- New rules and funding mechanisms that will enable the ISTC to be more effective in engaging scientists from more countries and from more diverse regions of the world;
- Easier accession procedures for new members, including the introduction of the concept of observer status at Board and other meetings;

[22] The added value of the Science Centres is also recognised in the Mid-Term Evaluation (2014-2017) of the Instrument Contributing to Stability and Peace (IcSP), Brussels, June 2017, pages 28 and 38.
[23] Agreement on the Continuation of the International Science and Technology Centre (ISTC), www.istc.int.

- Strengthening of independent scientific advice through the Scientific Advisory Committee; and
- The transfer of the ISTC Headquarters from Moscow to Astana, Kazakhstan.

The overall result of the renewed agreement is the reinforcement of the human dimension inside the overall WMD non-proliferation policies and beyond. As the first sign of expansion of the activities, pilot projects have been initiated in the Middle East and South/East Africa, as the work of the ISTC continues in Central Asia and the Caucasus.

In accordance with its new mission statement, the STCU, whose main focal countries are Azerbaijan, Georgia, Moldova and Ukraine, aims to address the global security threat of the proliferation of WMD-applicable CBRN knowledge and materials. The goals are:

- To support the integration of scientists with WMD applicable knowledge into global scientific and economic communities through national, regional, and international research collaboration;
- To develop and sustain a culture of non-proliferation and CBRN security awareness and responsibility through education, mentorship, and training;
- To promote international best practices and security culture to mitigate CBRN security threats.[24]

As discussed below, both Centres are currently at important crossroads.[25]

C. Programmes in Iraq as a model

The work of the Centres served as a blueprint for the EU programme to redirect the talents of scientists in Iraq and for a similar programme for Iraq funded by the USA.

The EU redirection programme (2010-2013) for former Iraqi WMD scientists was aimed at providing capacity building for the decommissioning of nuclear facilities, including site and radioactive waste management. The main scope of the initiative was to build sustainable capacity in decommissioning, dismantling and decontamination (3D) techniques through the re-engagement of former Iraqi weapon scientists in peaceful activities, while also facilitating their reconnection with the international scientific community. The project also provided support to the Iraqi Ministry of Science and Technology in the establishment of a characterization laboratory for uranium analysis required for decommissioning programmes and training. In total, around 80 nuclear scientists and experts were involved.[26]

The US programme provided support for the redirection of former Iraqi WMD scientists, technicians and engineers to civilian employment and discouraging the emigration of this community from Iraq. US assistance was also provided for the creation of the Iraqi International Centre for Science and Industry (IICSI).[27]

[24] STCU Vision statement, http://www.stcu.int/weare/MissionStatement/mission/index.php.
[25] For more details on both organisations, see the various annual reports.
[26] Final report, ICIS, Calabria, Italy, December 2013.
[27] Fact sheet, Office of the Spokesman, Department of State, Washington, December 2003.

D. The CBRN Risk Mitigation Centres of Excellence model

CBRN incidents may be accidental, due to human error, natural disasters or technical faults, or intentional, due to criminal or malicious motives, such as terrorist acts and sabotage.

CBRN risks represent a key threat to the security and health of human beings, the environment and critical infrastructures. Promoting a multi-hazards culture of safety and security in this area, from prevention to consequence management, is fundamental to development and stability. Disease surveillance, waste management, emergency planning, civil protection and cross-border trafficking of CBRN materials are areas of potential cooperation, e.g., work to promote biosafety as well as biological and chemical security at a regional level.

The EU has developed a set of actions for reducing the risks of CBRN materials inside and outside the EU. The objective is to reduce accessibility of CBRN materials, ensuring more robust preparedness, building stronger internal and external links on CBRN engagement and increasing knowledge and risks.[28] As part of the EU's external relations, an innovative approach is being developed under the EU CBRN Centres of Excellence initiative, with a budget of more than 200 million euro for the 2010-2020 period.

The initiative was launched in response to the need to strengthen the capacity of countries outside the EU to mitigate intentional, accidental or natural CBRN risks. The participating countries decide themselves on the priorities at the grassroots expert level. The special support mechanism, the Governance Team, is an integral part of the programme. Their training activities improve inter-agency cooperation both at the national and regional level. This specific programme brings the necessary reforms in order to adequately deal with CBRN-related challenges.

The initiative brings together experts, mainly from governmental agencies, to identify and respond to CBRN-related needs. International expertise on a permanent basis is made available to the regions concerned to assist in this work. Specific identified risks and threats are addressed by region or group of regions on a project-by-project basis (see below).

The essence of the work is a voluntary demand-driven, bottom-up approach that promotes ownership of the work in the partner countries.

This initiative, driven and implemented by the European Commission (DG International Cooperation and Development - DEVCO), establishes regional platforms to tackle all aspects of CBRN risks arising from natural disasters, accidental catastrophes, and criminal behavior by involving all the key stakeholders at a very early stage, thereby fostering the development of expertise in the countries concerned. Each of the 59 partner countries appoints its own national focal points (NFPs) to coordinate the work to be done in that country. National CBRN inter-ministerial teams gather representatives from all relevant agencies dealing with CBRN issues, such as diplomats, police, first responders, and judges. They total more than 1,000 officials worldwide.[29]

[28] Communication from the Commission on an Action Plan to enhance preparedness against chemical, biological, radiological and nuclear security risks, Brussels, 18.10.2017, COM(2017) 610 final.
[29] Each of the countries adhere to one of the eight regional secretariats depending on their geographical location. Regional secretariats are located respectively in Tbilisi, Amman, Rabat, Algiers, Tashkent, Abu Dhabi, Nairobi, and Manila. For more information, see also www.cbrn-coe.eu.

The NFPs, which include local and international experts, meet on a voluntary basis to identify and discuss needs and solutions. Regional roundtables are organised twice a year to identify regional priorities, cross-border CBRN cooperation (including table-top and real-time field exercises) and follow-up of regional activities. Partner countries define their needs on a voluntary basis with the help of a needs assessment toolkit and develop national action plans in which they prioritize their needs. There are currently 27 completed and 18 on-going projects.

This methodology has been well tested but has taken longer than expected in organising structures in partner countries. This is due to political circumstances, the varying extent of high-level national support, the heterogeneous nature of the partner countries, the limited previous experience in the area of CBRN risk mitigation and the extent to which the relevant structures (national teams for instance) had been established.[30]

E. Other voluntary cooperation and engagement models

In 2009, the EU's new Lines for Action were adopted in line with action taken through the G8. These focused on containing sensitive knowledge and know-how.[31] They were later reinforced by the EU in 2013.[32] These New Lines of Action called for protection of scientific and technical assets related to scientific activities of a sensitive nature, and for academic and scientific circles to be better informed about non-proliferation issues in general and in particular the potential risks related to their activities. A number of measures were suggested, such as enhanced exchanges between universities, laboratories and Member States' relevant authorities. The adoption of codes of professional conduct, the introduction of voluntary safety and security standards, a greater role for academia as well as other actions to promote a culture of responsibility in dealing with safety and security issues were recommended. Development of guidelines, sharing of best practices and enhanced communication efforts and outreach are also seen as important.

The importance of such tools has been stressed in other fora as well. For example, during a conference discussing 10 years of implementation of UNSCR 1540, the usefulness of self-governance and the adoption of codes of practice by industry, scientific bodies and academia was recognised as a way of contributing to a number of objectives of resolution 1540. Codes of conduct should, where possible, be included in education curricula for relevant courses.[33]

More recently, as noted above, a group of scientific experts, including researchers and academics, proposed various ways to better forecast, prevent, and mitigate the threats as a result of potential malicious use of AI technologies. They called for the promotion of a culture of responsibility, highlighting the importance of education, ethical statements and standards, framings, norms and expectations.[34]

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[30] European Court of Auditors, Special Report 2014/17, Can the EU's Centres of Excellence initiative contribute effectively to mitigating chemical, biological, radiological and nuclear risks from outside the EU?, page 14.
[31] Council Conclusions and new lines for action by the European Union in combatting the proliferation of weapons of mass destruction and their delivery systems, 8-9 December 2008.
[32] Council conclusions on ensuring the continued pursuit of an effective EU policy on the new challenges presented by the proliferation of weapons of mass destruction (WMD) and their delivery systems Foreign Affairs Council meeting Luxembourg, 21 October 2013.
[33] 1540: 10 years on: Opportunities, Challenges and Effective Practices for the Resolution's Implementation, Ian J Stewart, and Rajiv Nayan, (2014), CSSS Occasional Paper, page 15.
[34] Op Cit, page7.

The World Economic Forum Young Scientists Community – a group of leading researchers under the age of 40 from diverse fields and all regions of the world – came together to identify and reflect on the cross-cutting ethical issues they are faced with. They developed a universal Code of Ethics intended to serve as a tool to nurture a positive change of culture in the research world by not only guiding and shaping the behaviour of individuals, but also the processes of the scientific institutions that are to facilitate this cultural shift. The Code states, inter alia, that "[e]very researcher must consider each experiment's potential to cause harm and evaluate whether the generated knowledge can be detrimental to society."[35]

While this is not an exhaustive description of the state of implementation of these kinds of voluntary measures, several points are apparent from similar examples.

First, a number of EU Member States, such as Croatia, Germany, Hungary and the United Kingdom, have undertaken specific initiatives to reach out to academia. Compared to industry outreach, however, this type of stakeholder outreach is still in its initial stages and will require dedicated funding.

Second, only a limited number of universities and research institutes in Europe have developed internal compliance programmes (ICPs) or guidelines (e.g., Cambridge University in the UK and the Leibnitz Institute in Germany), although codes of conduct are being developed in a small number of research communities.[36]

Third, a number of scientific associations have proposed codes of conduct for biosecurity. As Espona et al note, these associations include the International Union of Microbiological Societies (2006), the Royal Netherlands Academy of Arts and Sciences (KNAW) (2007), the International Association for Synthetic Biology (2009), Italy (2010), Germany and international associations of Biological Resource Centres (both in 2013), and Indonesia (2015). 37 A review has shown that most codes of conduct for research target biosecurity or unspecified dual-use research in general.38 In the chemical sector, for example, the European Chemical Industry Council (CEFIC) has proposed a model code of conduct promoting safety and security. The aim is to continuously improve the environmental, health, safety and security knowledge and performance of our technologies, processes, and products over their life cycles so as to avoid harm to people and the environment.[39]

Fourth, awareness-raising initiatives have been undertaken by social scientists interested in ethics of dual-use research. These have taken the form of online and in person courses for students, and dedicated sessions at academic events. A leading example is the inclusion of biosafety and biosecurity in the training of teams participating in the international Genetically Engineered Machines (iGEM) competition.[40]

[35] www.wef.ch/coe.
[36] The dual-use export control policy review: balancing security, trade and academic freedom in a changing world, Sibylle Bauer and Mark Bromley, March 2016, NP paper 48.
[37] The Dual-Use Dilemma: Raising Awareness among the Academic and Scientific Communities in Central Asia and Eastern Europe, Maria.J.Espona, Jean-Pascal Zanders, Ineke March, contribution submitted to ISECON 2018 – to be published.
[38] Ibid.
[39] http://www.cefic.org/Responsible-Care.
[40] Op cit.

In the field of export control, ICPs are useful tools for the attainment both of a climate of awareness and responsibility within exporting organizations and the fulfilment of export control requirements by exporters. Effective ICPs may function in synergy with codes of conduct or other agreed guidelines and comprise a clear policy and standardised procedures ensuring that all employees are aware of and compliant with export control obligations relating to their work. The adoption of ICPs has been a common practice in industry for a number of years. On the contrary, most academic and research institutes - at least in Europe - do not have compliance mechanisms and awareness-raising tools in place *vis-à-vis* export control legislation even though they can be affected by the legal consequences deriving from such laws.[41]

In the area of nuclear safety and security, the IAEA is making use of "soft law" codes of conduct, guidance notes and handbooks and the development of standard operating procedures intended for use by the relevant public authorities in the countries concerned (mostly for use by the nuclear regulatory bodies). For example, an important component of the global safety and security regime is the 2005 Code of Conduct on the Safety and Security of Radioactive Sources. A large majority of IAEA Member States have adhered to this Code of Conduct along with the related supplementary guidance notes.[42]

IV. Conclusions and recommendations

In these days of the fourth industrial revolution, the scientific community and other experts have a duty of care 4.0 to ensure that security aspects are incorporated in scientific thinking and development from the early stages of scientific research especially when dealing with CBRN agents and materials[43]. They are ideally placed to identify issues of proliferation concern well in advance and to suggest solutions to policymakers. At the EU level, the Joint Research Centres play this important role. The knowledge and tools provided through scientific research help to protect societies against CBRN risks. By way of example, the EU Research and Development programme "Horizon 2020" includes a funding area on secure societies which includes the sharing of best practices.[44] The Euratom Research programme places a strong emphasis on developing nuclear skills and competence. The objective is to maintain the highest norms in nuclear safety and safeguards inside the EU, provide solutions for waste management and carry out research in order attain the highest level of protection from radiation. All funded projects must comply with the relevant national, EU and international rules on dual-use items.[45]

[41] Interferences between non-proliferation and science: 'exporting' dual-use know-how and technology in conformity with security imperatives, Christos Charatsis, 6 April 2016, University of Liege.
[42] www.iaea.org. Code of Conduct.
[43] There is presently no clear guidance on how early in the scientific process proliferation risks should be taken into account. Export control guidelines exempt 'basic scientific research' but this is somewhat of a nebulous term. To add clarity, governments and researchers are exploring the use of 'Technology Readiness Levels' as a means to gauge how early in the scientific process regulation should kick in. It could be argued that responsible scientists would seek to understand risks even before the point at which regulation takes effect, which is perhaps the purpose of codes of conduct. See for example, Stewart, I., "Examining Intangible Technology Controls" https://projectalpha.eu/examining-intangible-controls.
[44] In the 2014 to 2020 period, the Horizon 2020 programme is allocating some 1.7 billion euro to security research. This is about 50% of all public financing for civil security research in the EU. EU-funded security research brings together policy-makers and practitioners as well as industry and academia.
[45] EC Guidance note — Research involving dual-use items. European Commission: http://ec.europa.eu/research/participants/data/ref/h2020/other/hi/guide_research-dual-use_en.pdf

Scientists and experts, and their institutes, are not just part of the problem; they are also part of the solution. The fostering of bottom-up approaches to scientist engagement is a vital complement to state-centric top-down approaches. Nonetheless, work should, of course, continue to update international norms to contain these developments. However, within the overall non-proliferation context, more and better use should be made of various grassroots related models such as that of the Science Centres, the CBRN Centres of Excellence and other forms of cooperation promoting a culture of responsibility.

With this in mind, a number of specific recommendations are offered:

Strengthening of the Science Centres model: The Science Centre concept has proven to be an effective and flexible tool to address proliferation concerns. It offers the opportunity for critical security tools of direct benefit to the international community.[46] Work has evolved from the redirection of the talents of scientists in the early nineties to the funding of more enhanced forms of cooperation on an equal partnership basis. Recently, the Centres have undergone major transformations. The task of existing and new parties is to make use of the opportunities that these transformations provide.[47] The legal frameworks have been overhauled substantially, allowing for the organisations to work globally and more effectively. A strategy is under development to include new members. Belarus, Canada and Russia are to review their withdrawal decisions and efforts are to be made to reengage with Uzbekistan (at present this country is a dormant member of STCU).

Despite these changes, the role of both Science Centres within the overall-proliferation toolkit is still underappreciated, notwithstanding the fact that they are specifically referenced in the Annex III of the Joint Comprehensive Plan of Action (also referred to as "the Iran deal") as a possible vehicle for the implementation of foreseen actions to promote civil nuclear safety cooperation with Iran. The experience of the Science Centres could serve as a model for Syria, targeting chemical weapons engineers, and the nuclear scientists of North Korea once a process of denuclearization on the Korean Peninsula starts. Illustratively, South Korea's Ambassador to Russia, in a statement on the tenth anniversary of the ISTC, declared that he was looking forward to the day that North Korea would be a member of that Science Centre.[48]

Reinforcement of the CBRN Centres of Excellence model: Other forms of engagement, such as under the EU CBRN Centres of Excellence Risk Mitigation initiative, with a strong bottom-up approach have led to encouraging results. Significant governmental reforms have taken place to prevent, and more adequately to respond to, CBRN risks.

This EU programme is to be given more resources in the immediate future to allow further transformations of the Regional Secretariats to security platforms covering a wider spectrum of security issues at regional level. There is also a need to expand its geographical scope. For this to happen, much depends on the future decisions by the EU under the new Multiannual Financial Framework 2021-2027.

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[46] S. Limage. Non- proliferation Programs: Sustaining the Momentum, Arms Control Today, Washington, May 2017.It provides also further details on the negotiation process towards the renewed agreement.
[47] Annual Statement 2017 by Ronald. F. Lehman, Chair of the ISTC Board, to be published.
[48] Cooperation and Threat Reduction: Learning Curves and Forgetting curves, Opening Remarks by Ronald. F. Lehman, NAS CTR Workshop, Washington, 18-19 September 2017, page 3.

Accelerated introduction of other voluntary cooperation and engagement models: The adoption of “softer” approaches to combat proliferation shows mixed results, despite their importance. The considerable time lag between the emergence of new technologies and their inclusion in legislative frameworks calls for flexible responses. Effective codes of conduct, independent peer reviews, awareness raising and other actions, such as mutual risks assessments, should be introduced on a broader scale to promote a culture of responsibility. Initiatives are being taken at the national and international level to advance their adoption by industry, academia and scientific bodies. The Science Centres and the EU CBRN programme should assist in this process.

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