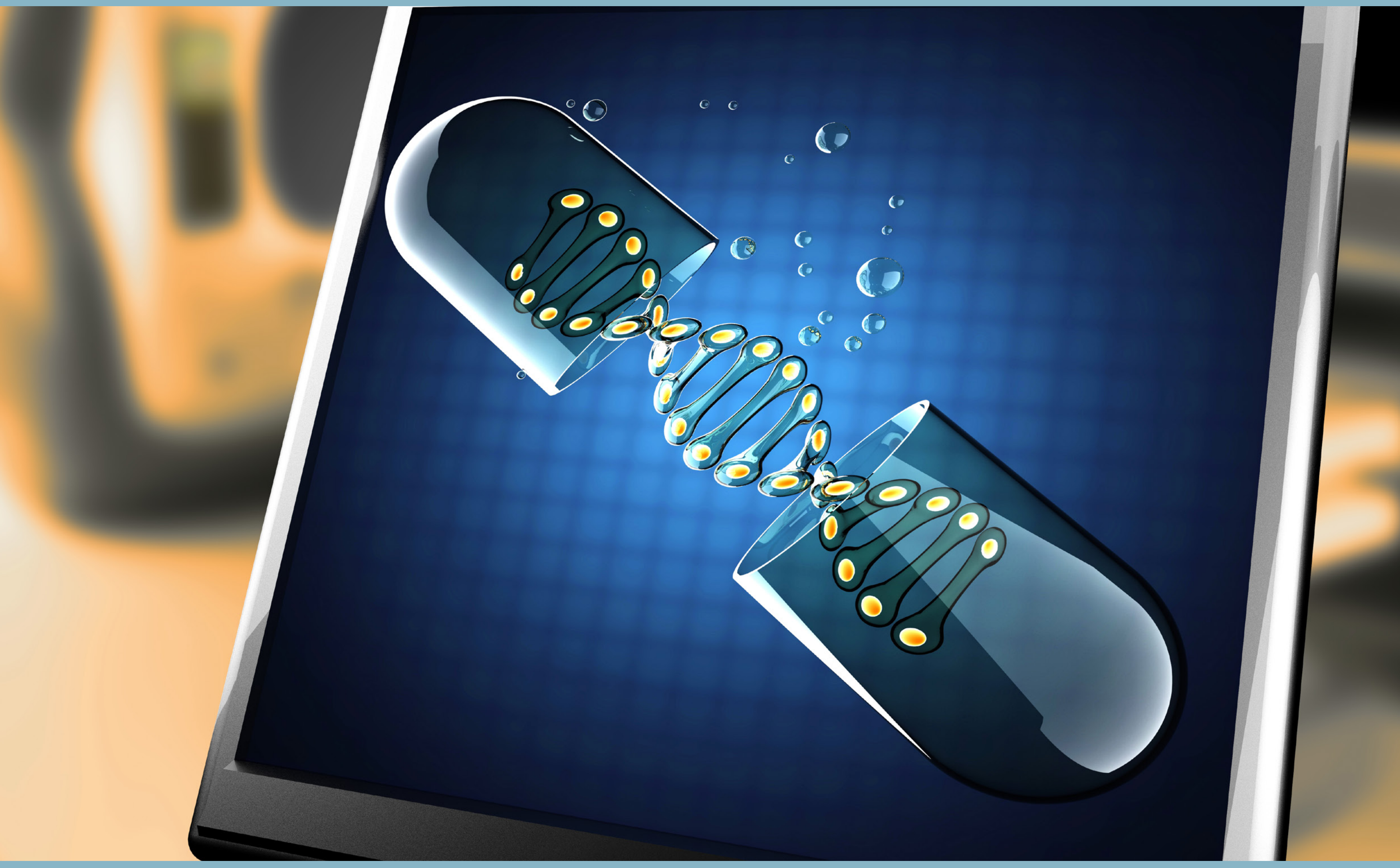
The Hague Centre for Strategic Studies

THE INCREASING THREAT OF BIOLOGICAL WEAPONS

HANDLE WITH SUFFICIENT AND PROPORTIONATE CARE



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SECURITY

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The Hague Centre for Strategic Studies (HCSS)

ISBN/EAN: 978-94-92102-43-0

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The Increasing Threat of Biological Weapons: Handle with Sufficient and Proportionate Care

Contents

Executive Summary

With the World Health Organization (WHO), North Atlantic Treaty Organization (NATO), and the U.S. Blue Ribbon panel publishing reports on the emerging risks of biological weaponry in recent months, there is a new sense of urgency regarding biological weapons. In August 2016, the United Nations Secretary General told the Security Council that “non-state actors are actively seeking chemical, biological, and nuclear weapons.” And as recently as the beginning of 2017, the World Economic Forum in its Global Risks Report 2017 indicated that technological innovation could put devastating biological weapons in the hands of state and non-state actors alike, further exacerbating geopolitical risks.

Much of this urgency is owed to technological advances in biotechnology and the concomitant attraction to non-state actors, in addition to that of nation states, to use biological agents as weapons due to their financial appeal and diverse impact. The relative ease with which pathogenic microorganisms, as possible ingredients for biological weapons, can be obtained, and the intent of non-state actors to use biological weapons based on historical precedent and recent increases in international terrorism, call for a renewed focus on this field.

The natural and synthetic development of biological agents, the ease in acquiring and spreading infectious diseases, and the variety of uses of these agents indicate the broadness in the scope of this field.

Actors with malicious intent will be increasingly less restricted to obtain biological agents and transfer these into weapons. While nowadays significant level of expertise and tacit knowledge is still required for successful delivery and disease manufacture, the ease of microbiological manipulation and the level of sophistication of, for instance, DIY-biologists or growing numbers of bio-science students is increasing. More and more methods are becoming (commercially) available to synthesize or manipulate DNA.

On top of that, actors do not necessarily have to launch a technically perfect attack to achieve their malicious objectives, as causing major panic and other disruption may already be sufficient. The difficulty of acquisition and maintenance of *large* quantities should not be underestimated. Previously, pathogens of large quantities and with high longevity were essential to fulfill their role as state-run offensive weapons. But today, the development and production requirements for weaponization for non-state actors are considerably lower. In that sense, it could be argued that possession as such could already trigger some societal impact and potential panic responses in tense times.

In light of these technological advancements, the dynamics are further catalyzed by changes in the global security context. Increasing media references to the possession or capture of biological agents, such as anthrax or ricin, by non-state actors, decentralization of terrorist networks leading to individual, small-scale attacks of which the preparation thereof remains undetected, and the anticipation of a larger-scale attack, suggest that reinforcing and strengthening present biosecurity and biodefense architecture are or should become a bigger priority in the Netherlands, the United States (U.S.), the United Kingdom (UK), and Austria – our countries of focus in this report.

The U.S. has the most advanced biosecurity and biodefense systems in place – partially due to the *Amerithrax Attacks* (2001) – while European states include biological weapons, and in turn bioterrorism, under the umbrella of CBRN-related activity. In the Netherlands, this comprehensive approach to CBRN requires interconnection between public and (semi-) private organizations as well as between civil- and military-oriented mechanisms for a diverse set of potential risk factors, a connection that is well-developed.

Due to the new dynamics of the threat and the limited resources that are currently allocated to countering the threat, it seems unlikely that the Netherlands, or other governments for that matter, is sufficiently prepared to deal with the requirements of this situation. While there is much in place that counter the outbreak of naturally developing contagious diseases (e.g., flu pandemics, zoonoses), improvements are needed in the coordination among current public and private organizations, in the clinical knowledge of identification of infectious diseases that have not occurred in the decades, in the preparation (detection) and protection (e.g., materials or vaccines) of first responders in affected areas, and the funding of research and development, specifically focused on the biological threat.

With limited funding available, determining what the minimum level of preparedness should be is an important question. Gaming exercises with the various organizations involved could assist in providing a first assessment of this level.

1 Introduction

This report examines the changing dynamics of the development and use of biological weapons.

In recent months, various renowned organizations such as the World Health Organization (WHO), North Atlantic Treaty Organization (NATO) and the United States (U.S.) Blue Ribbon panel have published reports on the emerging risk of biological weaponry, illustrating that they are in the limelight of the political debate with a new sense of urgency.

This report will highlight why there is this increasing sense of urgency; covering both trends related to technological advances in biotechnology and the concomitant increasing attractiveness to, especially, non-state actors to use biological agents as weapons for attack and spreading of fear. This occurs in an era in which the rise of terrorist attacks in Europe has governments and populations put additional emphasis in efforts to detect, prevent, and mitigate a wide spectrum of possible assault on countries' national security.

Subsequently, we will present the implications of the level of preparedness of national and international approaches and identify new or emerging measures that various countries are undertaking.

Ultimately, we will outline the current state of play in the Netherlands at a high level, with this providing a point of departure for discussion on whether the status quo is sufficient to tackle the upcoming issues addressed.

For the sake of limiting the size of the report, we have focused the analysis on a number of dimensions:

- Within the field of Chemical-Biological-Radiological-Nuclear (CBRN) weapons, biological weapons consist of a number categories. We will limit the discussion to infectious diseases as a whole and without focusing on either one of the Class A diseases – that which consists of biological agents that pose the highest risk to national security and public health.
- In looking at new policy initiatives and approaches, we have restricted ourselves to a set of countries which seem to be first movers on this topic. These countries are the United States, the United Kingdom, Austria, and - to a lesser extent - France and Germany. The purpose of investigating these countries is to find initiatives for consideration rather than presenting an overall analysis of how these underlying systems function.

The report first describes how and which diseases have potentially catastrophic effects if no countermeasures are implemented. Subsequently, we examine the shift in the biological weapons debate from state-centrism to non-state actors, their modus operandi and the development of capabilities. Lastly, we examine the policy context by highlighting various policy issues that arise from these developments and the different approaches that have been taken in light of them.

2 The Development of Biological Agents

2.1 Infectious diseases and conflict

Throughout history, infectious diseases have been used as weapons in conflict.[1] In medieval times, for instance, dead plague victims or anthrax-infected cattle were catapulted into a besieged city to infect its inhabitants.[2] Over time, states developed various biological weapons programs, such as Germany during World War I (e.g., anthrax, cholera) and Japan in World War II (e.g., anthrax, plague). The Geneva Protocol (1925) prohibited the use of chemical and bacteriological weapons in international armed conflicts. This prohibition was expanded by the Biological and Toxins Weapons Convention (BTWC) (1975) thus becoming the first multilateral disarmament treaty banning the development, production, and stockpiling of an entire category of WMD. In addition to the use in interstate conflict, there are also several examples of non-state actors deploying biological agents.[3]

The combination of a number of criteria make infectious diseases more suitable and powerful as a means of biological warfare or terrorism due to the following reasons:[4]

1. High morbidity and potential high lethality,
2. High infectiousness or high toxicity,
3. Suitability for mass production and storage without loss of pathogenic potential,
4. Suitability for wide-area delivery, and withstanding the delivery process,
5. Stability in the environment after dissemination, long enough to infect humans,
6. Suitability for being a biological agent, improved by genetic engineering and the weaponization process.

The U.S. National Institute of Allergy and Infectious Diseases (NIAID) has composed a pathogen priority list, which contains the most likely biological warfare agents. For this, it divides the emerging infectious diseases into three categories: A, B and C.[5] Category A consists of biological agents that pose the highest risk to national security and public health. This is based on factors such as the ease of dissemination and transmission, mortality rate, public health preparedness and the chance of public panic and social disruption. The NIAID has labeled six biological agents as category A, namely:

- Bacillus anthracis (anthrax)
- Clostridium botulinum toxin (botulism)
- Yersinia pestis (plague)
- *Variola major* (smallpox) and other related poxviruses
- Francisella tularensis (tularemia)
- Viral hemorrhagic fevers, such as Ebola

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[1] H.J. Jansen et al., "Biological Warfare, Bioterrorism, and Biocrime," *Clinical Microbiology and Infection* 20, no. 6 (June 2014): 488–96, doi:10.1111/1469-0691.12699.
[2] S. J. S. Flora et al., *Pharmacological Perspectives of Toxic Chemicals and Their Antidotes*, page 148 vols. (Springer Science & Business Media, 2004).
[3] V. Barras and G. Greub, "History of Biological Warfare and Bioterrorism," *Clinical Microbiology and Infection* 20, no. 6 (June 2014): 497–502, doi:10.1111/1469-0691.12706.
[4] Jansen et al., "Biological Warfare, Bioterrorism, and Biocrime."
[5] "NIAID Emerging Infectious Diseases/Pathogens," *NIAID*, accessed June 15, 2016, https://www.niaid.nih.gov/topics/biodefenserelated/biodefense/pages/cata.aspx.

Table 1 summarizes the main properties of the category A agents.[6] Whereas five of the infectious diseases listed have a high lethality, tularemia is usually not fatal but still causes primarily long-lasting effects.[7]

Disease	Agent	Organism Persistence	Infective dose	Human-to-human transmission	Infectivity	Incubation period	Symptoms	Mortality	Treatment
Anthrax	Spores of *Bacillus anthracis*	Very stable, spores may be viable for > 40 years in soil	8000 - 50 000 spores	No	-	1-6 days	Fatigue, fever, malaise, cough, mild chest discomfort, respiratory distress, shock	High	Ciprofloxacin or doxycycline
Botulism	Botulinum toxin produced by *Clostridium botulinum*	Weeks in non-moving food or water	LD50 is 0.001 µg/kg for type A (parenteral), 0.003 µg/kg (aerosol)	No	-	2 h to 10 days	Acute afebrile, symmetric paralysis descending from the head	Without supportive treatment: high mortality resulting from respiratory failure	Supportive treatment, trivalent or heptavalent antitoxins
Plague	*Yersinia pestis*	Up to 1 year in soil, but viable only for 1 h after aerosol release	100–20 000 organisms	High	Patients contagious for up to 3 days after starting treatment	1-6 days	High fever, headache, malaise, chest pain, cough, haemoptysis, stridor, dyspnoea, cyanosis	Very high if untreated, <10% with antibiotics	Streptomycin or gentamicin with ciprofloxacin or doxycycline
Smallpox	Variola virus: Variola major	Highly stable for up to 1 year in dust and cloth	10-100 organisms	Yes, transmission requires close contact	Mostly contagious during first week of rash	4-19 days	Severe headache, high fever, extreme prostration, backache, chest and join pains, anxiety, exanthema, maculopapular rash that becomes vesicular	Ordinary-type smallpox: 30% if unvaccinated; 3% if vaccinated	No antiviral treatment, vaccination immediately or up to 4 days after exposure can reduce mortality
Tularemia	*Francisella tularensis* ssp. tularensis	Weeks in water, soil, or carcasses, and years in frozen meat	10-50 organisms	No	-	1-25 days	Fever, chills, myalgia, arthralgia, headache, nausea, vomiting, diarrhea, sore throat	4–50% mortality without treatment. With treatment, 1%	Streptomycin or gentamicin
Ebola	Ebola virus	Unstable, very sensitive to climactic conditions	10-100 organisms	Yes, via direct contact with the blood, secretions, organs or other bodily fluids of infected people	-	2 to 21 days	Fever, severe headache, muscle pain, weakness, fatigue, diarrhea, vomiting, abdominal (stomach) pain, unexplained hemorrhage (bleeding or bruising)	High	No FDA-approved vaccine or medicine is available for Ebola

Table 1: Category A biological warfare agents and their properties

[6] Jansen et al., "Biological Warfare, Bioterrorism, and Biocrime"; "WHO | Ebola Virus Disease," *WHO*, accessed June 18, 2016, http://www.who.int/mediacentre/factsheets/fs103/en/

[7] "Tularemia", *Centers for Disease Control and Prevention* (October 25, 2015), accessed May 26, 2016, https://www.cdc.gov/tularemia/transmission/index.html.

2.2 Development of biological warfare agents

While pathogens can be adapted to weaponize biological agents, it is possible for an (willing) individual to carry the agent as a host in order to spread it as a weapon, becoming a living aerosol system. In general, the synthesis of biological agents requires the following steps[8] (see figure 1):[9]

1. Acquire the pathogen
2. Access information about bioweapons
3. Buy equipment
4. Grow the agent to the required quantity
5. Weaponize the biological agent by enhancing its stability and shelf life and processing the agent into a concentrated slurry or dry powder
6. Select a method of delivery to disseminate.

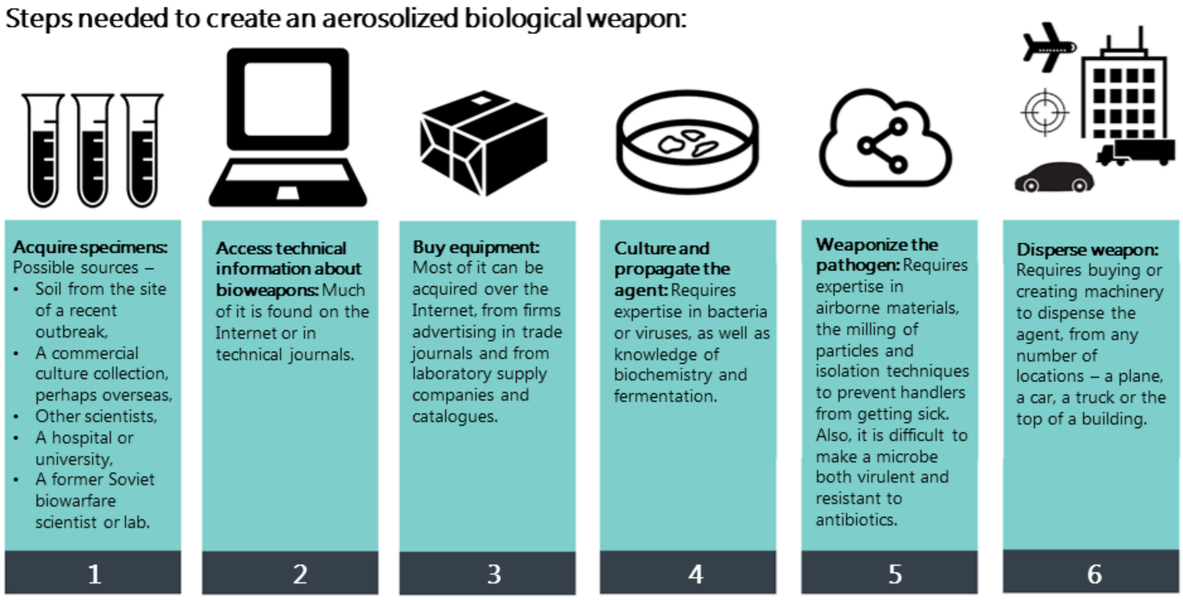

Figure 1: Steps needed in order to create biological agents.

Steps 1 through 4 are concerned with obtaining the biological agents, which can either be sourced from nature or produced synthetically, and establishing the infrastructure to develop them. Previously, these steps would have to be conducted in larger scale lab environments. Scientific developments described below make the threshold of successful creation considerably lower.

Subsequently, the biological agent must be weaponized. This process poses more hurdles than the first step of creating or getting the necessary agents.[10] To use biological agents in warfare, sufficient volumes have to be acquired and the agents should be processed to remain viable long enough. In this step, pathogens acquire properties to be heat resistant

[8] Jeffrey Hays, "Biological weapons and terrorism | Facts and Details," *Biological Weapons and Terrorism*, July 2012, http://factsanddetails.com/world/cat58/sub384/item2384.html.
[9] Washington Post, "The Making of a Biological Weapon," *The Making of a Biological Weapon*, 2004, http://www.washingtonpost.com/wp-srv/nation/daily/graphics/wmdbio_123004.html.
[10] Warner et al., "Analysis of the Threat of Genetically Modified Organisms for Biological Warfare."

and stable in environmental conditions such as exposure to air, humidity and UV light.[11] This can be done in three ways: biological agents may be freeze dried, processed with chemical additives or micro-encapsulated.[12] Increasing the ability to adapt to environmental instability by a biological agent through genetic modification is still more difficult than simply rebuilding an existing virus.[13] To deploy biological agents in civil environments, mass production and stable environments are much less requirements for their successful use.

Finally, the pathogen should be suitable for delivery. There are a number of ways in which a biological agent can reach and enter a human being: through inhalation, open wounds or swallowing.[14] This means that the pathogen needs to be aerosolized, distributed in food or water, or transferred from one human to another (e.g., through injection) for successful delivery.

The contamination of food or water supplies late in a distribution chain seems most feasible.[15] Nevertheless, this requires large quantities of (water-resistant) agents. Therefore, the most efficient means of delivery is airborne dissemination.[16] For this, the agents should be concentrated, dried, and made into small particles. It requires expertise to produce airborne materials. The particle size is an important property of the agent, as it determines if the pathogen will initially be inhaled and subsequently not be exhaled thereafter. Additionally, the agent must be robust enough to survive floating in the air for a lengthy period.[17] For example, this property is very hard to develop when it comes to the Ebola virus.[18] Furthermore, great care must be taken by the producer in this stage to prevent his or her infection. As pathogens are sensitive to sunlight, dispersal would be best at night, when the fewest people are in public places.[19] A final way of delivery is through the human body. Just as human corpses were used in the olden days, living people (e.g., a self-infected terrorist) might be able to carry a serious disease and infect those with which they come into contact.

2.3 Advances in biological research and technology

Several scientific and technological advances within the field of biotechnology and synthetic biology have increased access and the likelihood of the use of infectious diseases as biological

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[11] Garth L Nicolson and Nancy L Nicolson, *Project Day Lily: An American Biological Warfare Tragedy* (Philadelphia: Xlibris, 2005).
[12] United States. Office of Technology Assessment. Technologies Underlying Weapons of Mass Destruction. December 1993. OTA-BP-ISC-115, p. 93
[13] Suk et al., “Dual-use Research and Technological Diffusion.” 2011.
[14] Jansen et al., “Biological Warfare, Bioterrorism, and Biocrime.” 2014.
[15] Suk et al., “Dual-use Research and Technological Diffusion.” 2011.
[16] Eric Lukosi and Mark Prelas, “Weaponization and Delivery Systems That Terrorists use for Biological and Chemical Agents,” in *Technological Dimensions of Defence Against Terrorism* (IOS Press, 2013).
[17] “United States. Office of Technology Assessment. Technologies Underlying Weapons of Mass Destruction. December 1993. OTA-BP-ISC-115, p. 95
[18] “Ebola Bomb: Possible, But Not So Easy to Make,” accessed June 15, 2016, http://www.livescience.com/47260-ebola-biological-weapon.html.
[19] Lukosi and Prelas, “Weaponization and Delivery Systems That Terrorists use for Biological and Chemical Agents.”

weapons. These relate to the nature and the costs of doing research, and to the broadening of expertise across populations in Western countries such as, for example, Russia and China.

2.3.1 Development and acquisition of pathogens

Historically, biological agents used for biological attacks derived from natural resources or laboratories.[20] Nowadays, as the biological research field, in particular synthetic biology, has advanced tremendously, multiple techniques to synthesize and map DNA characteristics of biological agents have been developed.[21] For instance, techniques such as genetic engineering enable the possibility to synthesize infectious diseases from scratch, produce them more effectively and manipulate its DNA to increase its pathogenicity. Depending on the degree one aspires to modify DNA, the difficulty in doing so may increase or decrease.[22] Synthetic biologists have already shown how terrorists could obtain life forms that now exist only in carefully guarded facilities, such as polio and 1918 influenza samples.[23] The successful completion of these exercises demonstrated that even if infectious diseases are not naturally present or have been eradicated, they could theoretically be manufactured and re-emerge again.

"One potential misuse of synthetic biology would be to recreate known pathogens (such as the Ebola virus) in the laboratory as a means of circumventing the legal and physical controls on access to "select agents" that pose a bioterrorism risk. Indeed, the feasibility of assembling an entire, infectious viral genome from a set of synthetic oligonucleotides has already been demonstrated for poliovirus and the Spanish influenza virus".[24]

2.3.2 Decreasing costs of agents and equipment

Along with the progress in biotechnological research, the costs of synthesizing biological agents have decreased significantly.[25] Whereas the (incomplete) determination of the sequencing of 'inaugural human genomes' in 2001 took roughly ten years and cost $3 billion,[26] the complete sequence of the human genome was determined in 4 months and cost less than $1 million in 2008.[27] Currently, the synthesis of short sequences of DNA can cost as

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[20] World Health Organization, "The Independent Advisory Group on Public Health Implications of Synthetic Biology Technology Related to Smallpox" (Geneva: WHO, June 29, 2015).
[21] Vladimír Pitschmann and Zdeněk Hon, "Military Importance of Natural Toxins and Their Analogs," *Molecules* 21, no. 5 (April 28, 2016): 556, doi:10.3390/molecules21050556.
[22] Katia Pauwels et al., "Synthetic Biology" (Brussels: WIV ISP, September 2012); Jerry Warner et al., "Analysis of the Threat of Genetically Modified Organisms for Biological Warfare" (DTIC Document, 2011), http://oai.dtic.mil/oai/oai?verb=getRecord&metadataPrefix=html&identifier=ADA547199; Pitschmann and Hon, "Military Importance of Natural Toxins and Their Analogs."
[23] Maurer SM, Zoloth L. Synthesizing biosecurity. Bull At Sci (2007) 63:16–810.2968/063006004, p.16.
[24] Tucker JB, Zilinskas RA. The promise and perils of synthetic biology. New Atlantis (2006) 12:25–45 http://www.ncbi.nlm.nih.gov/pubmed/16832953, p.37
[25] Pauwels et al., "Synthetic Biology."
[26] J. Craig Venter et al., "The Sequence of the Human Genome," *Science* 291, no. 5507 (2001): 1304–51.
[27] David A. Wheeler et al., "The Complete Genome of an Individual by Massively Parallel DNA Sequencing," *Nature* 452, no. 7189 (2008): 872–76.

little as €0.30.[28] For example, the 3,215 base pairs of the Hepatitis B virus genome can be synthesized for less than €100.[29]

The graph below, the so called Carlson Curve, shows that the costs of synthesizing genetic material and DNA sequencing has decreased enormously.[30] These trends are expected to continue, making genome manipulation possible for institutions and organizations with a smaller budget.

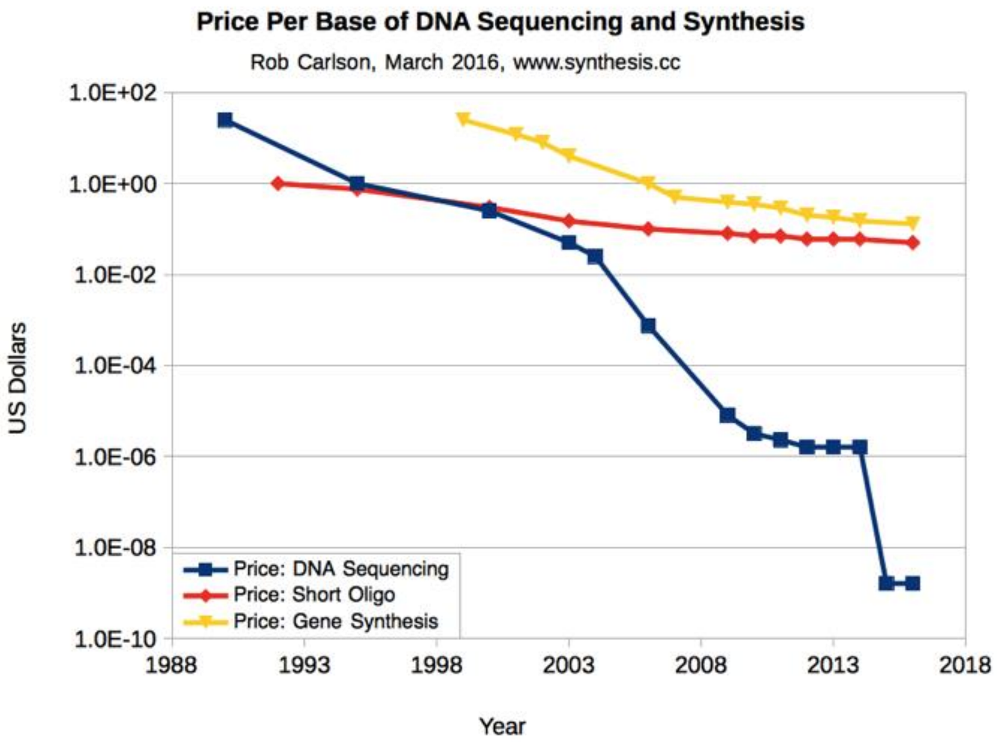

Figure 2: The evolution of the price per bases of DNA sequencing and synthesis, constructed by Rob Carlson. Oligo = Oligonucleotide, short DNA or RNA molecules.

Figure X, however, can be misleading. As purchasing oligonucleotides is easy and cheap (this process became automated in the 1970s), the assembling of these oligos into a genome requires specialist expertise and equipment.[31] Yet, the development of synthesizing methods and equipment will lower the expertise and the required equipment threshold. Furthermore, it is widely accepted these days that any bachelor student of biology will be able to design a functional genome.

2.3.3 Increasing interest, access to knowledge, and availability of equipment

As the synthetic biology research field has developed, the availability of information about biological agents has increased correspondingly.[32] As illustrated above, research has been

[28] Warner et al., "Analysis of the Threat of Genetically Modified Organisms for Biological Warfare."
[29] Pauwels et al., "Synthetic Biology."
[30] Rob Carlson, "On DNA and Transistors," March 9, 2016, http://www.synthesis.cc/cgi-bin/mt/mt-search.cgi?search=carlson+curve&IncludeBlogs=1&limit=20.
[31] Jefferson, Lentzos, and Marris, "Synthetic Biology and Biosecurity."
[32] Pauwels et al., "Synthetic Biology."

able to identify the complete genomes and coding sequences of most biological agents. All this information is publicly available in online databases such as the GenBank, the Ensemble project and the Viral Genome Resource.[33]

There is also a growing interest in biological science. The number of bachelor's degrees in biological and biomedical sciences in the United States is growing, as can be seen in figure X.[34] Whereas in 2000, approximately 80,000 students enrolled for a biological or agricultural sciences degree, in 2012, this number has increased to almost 130,0000 students. The number of Science & Engineering (S&E) graduate enrolments has increased as well, from about 493,000 to more than 615,000 between 2000 and 2013 - biological sciences were one of the primary field of studies.[35]

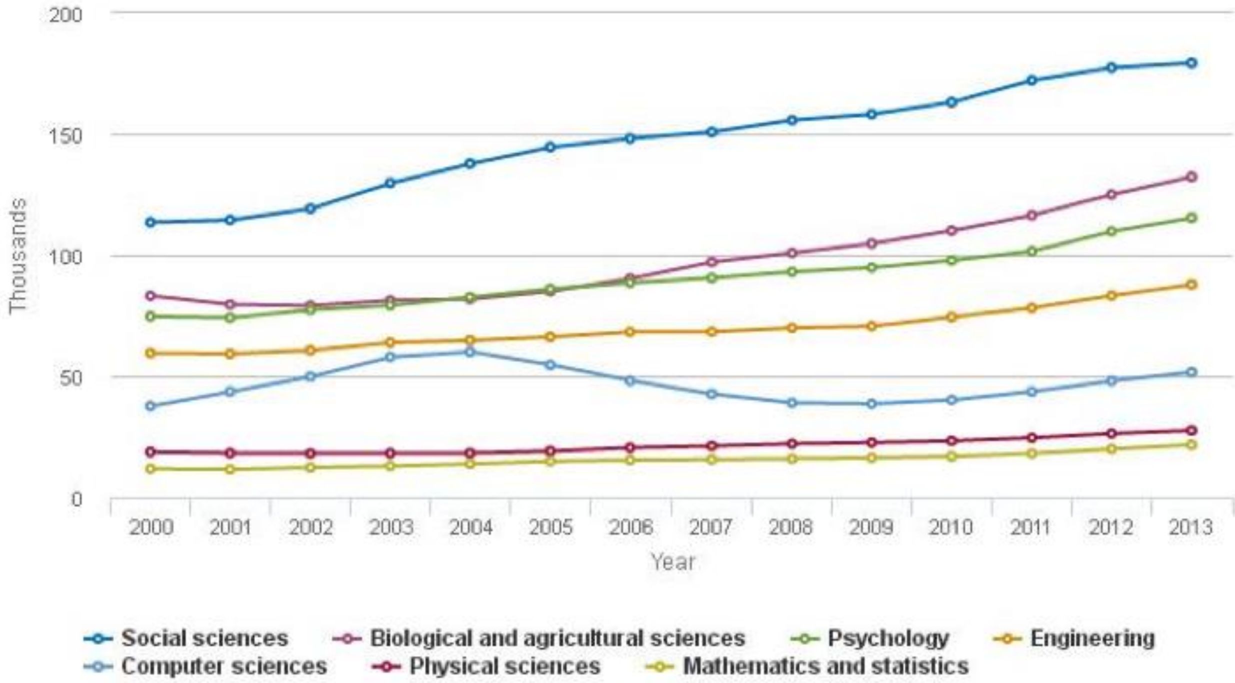

Figure 3: Number of S&E bachelor's degrees, by field, from 2000 to 2013 in the United States.

Knowledge can also diffuse to other parts of the world, through networks of scientists and exchange students returning home. For example, the producer of the Pakistani nuclear bomb, Abdul Qadeer Khan, received university degrees in Germany and the Netherlands.[36] He also gained working experience in a nuclear facility in the Netherlands before returning to Pakistan.

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33 NCBI, "Viral Genomes," *Viral Genomes*, accessed June 15, 2016, http://www.ncbi.nlm.nih.gov/genome/viruses/; "Ensembl Genome Browser 84," accessed June 15, 2016, http://www.ensembl.org/index.html; "GenBank Home," accessed June 15, 2016, http://www.ncbi.nlm.nih.gov/genbank/.

34 National Science Foundation, "Science and Engineering Indicators 2016," *National Center for Science and Engineering Statistics, WebCASPAR Database*, 2016, http:/ /webcaspar.nsf.gov.

35 National Science Board, "Highlights," *Chapter 2. Higher Education in Science and Engineering*, January 2016, http://www.nsf.gov/statistics/2016/nsb20161/#/report/chapter-2/highlights.

36 Tim Sweijs and Jaakko Kooroshy, "The Future of CBRN," Future Issue (The Hague: The Hague Centre for Strategic Studies, 2010).

Interest in synthetic biology is also increasing among hobbyists. Communities such as the Do-it-yourself biology (DIY biology, also called the biohackers community) are biotechnological social movements in which biology and life sciences are studied and practiced.[37] This is all done using the same methods as traditional research institutions. Within these platforms, information is exchanged freely, tutorials are given via YouTube videos and the tools and resources are available to anyone. A non-profit organization that originates from this movement is Genspace, that promotes access to biotechnology.[38] It opened its own Biosafety Level One laboratory in December 2010, just as BioCurious did in 2009 in San Francisco.[39] Courses are given here to the public and its members can use these spaces to work on their own projects.

Together with information on the genetic composition of biological agents, the equipment for synthesizing and sequencing genomes has become more sophisticated, cheaper, and accessible for hobbyists. At foundations such as BioBricks, which also aims towards the engineering of biology in an open and ethical manner, it is possible to share any standardized genetically encoded function for free.[40] This is not only open to companies and institutions, but also for individuals. Furthermore, BioBricks manages OpenWetWare (OWW), an online platform for "storing, managing and sharing research data and know-how".[41] Throughout these kinds of organizations, anyone can obtain knowledge, skills and equipment to develop and weaponize biological agents. For example, the International Genetically Engineered Machine Competition (iGem, originating from BioBricks) has generated a Registry of Standard Biological Parts. From this, DNA plates can be purchased, as well as assembly kits and protocols. Yet, apart from these non-profit organizations, there are also commercial firms that sell custom DNA oligos.

According to the *Economist*, 'Biohacking' groups are now experimenting with DNA as software they can manipulate the way hackers did with computers and the Internet. They could use these processes to create killer bugs or provide training for bioterrorists. Biosecurity experts envisage the possibility for actors to also use drones to spray toxic substances in much the same way commercial drones are already spraying pesticides.[42]

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[37] "An Institution for the Do-It-Yourself Biologist," DIYBio, accessed August 2016, https://diybio.org/.
[38] "Genspace - About," accessed June 15, 2016, http://genspace.org/page/About.
[39] Sam Kean, "A Lab of Their Own," *Science* 333, no. 6047 (September 2, 2011): 1240–41, doi:10.1126/science.333.6047.1240.
[40] "The BioBrick™ Public Agreement (BPA)," BioBricks Foundation, 2016, https://biobricks.org/bpa/.
[41] "Education Program," *BioBricks Foundation*, accessed June 15, 2016, http://biobricks.org/programs/education-program/.
[42] *The Economist*, "Improvised weapons. Hell's Kitchens", May 21, 2016, Print edition online, http://www.economist.com/news/science-and-technology/21699098-makeshift-weapons-are-becoming-more-dangerous-highly-sophisticated.

3 BW Threats in the Global Security Context

This chapter focuses on the various intents and capabilities of the use of biological weapons (BW), with a particular focus on non-state actors. The global security context is witnessing the rise of hostile non-state actors whose motivations, status and messages continue to mobilize individuals to their cause.[43] The strategic value of possessing BW could be considered higher to non-state actors than it is to state actors. With the evident rise in terrorist attacks in recent years combined with the aforementioned trend of easier access to technologies, a bioterrorist attack is becoming increasingly likely.

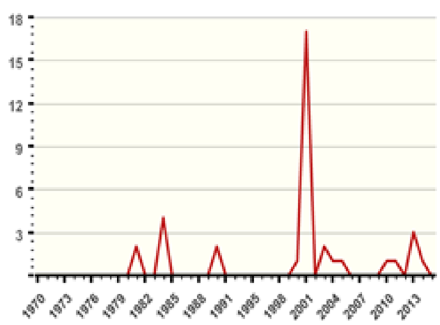

Figure 4: Number of biological terrorist attacks between 1970-2014. Source: GTD, 2016

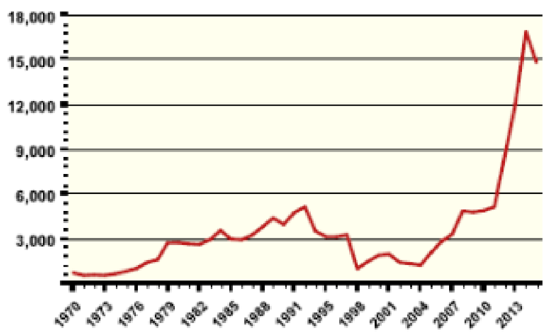

Figure 5: Number of all terrorist attacks between 1970-2014. Source: GTD, 2016

A significant and growing risk

- "If sufficient numbers of people were infected by the dispersal of a biological weapon, or if the agent were contagious and person-to-person transmission outran disease control measures, the result could be large-scale, possibly catastrophic epidemics. It is this outcome—the prospect of a pestilence intentionally unleashed on large civilian populations—that most concerns physicians, public health experts, and political leaders".

Inglesby et al., "Preventing the use of Biological Weapons", *Clin Infect Dis.*, 2000, http://cid.oxfordjournals.org/content/30/6/926.full#ref-15.

- "The biological threat has not abated. At some point, we will likely be attacked with a biological weapon, and will certainly be subjected to deadly naturally occurring infectious diseases and accidental exposures, for which our response will likely be insufficient.."

A National Blueprint for Biodefense: Leadership and major reform needed to optimize efforts. Bipartisan report of the blue ribbon study panel on biodefense, October 2015.

43 For example, a 2015 RAND Corporation report titled "A Persistent Threat: The Evolution of al Qa'ida and Other Salafi Jihadists" calculates that the number of Salafi Jihadists groups increased from 19 to 49 between 2000 and 2014, with a 6-fold increase in the number of active fighters during the same period.

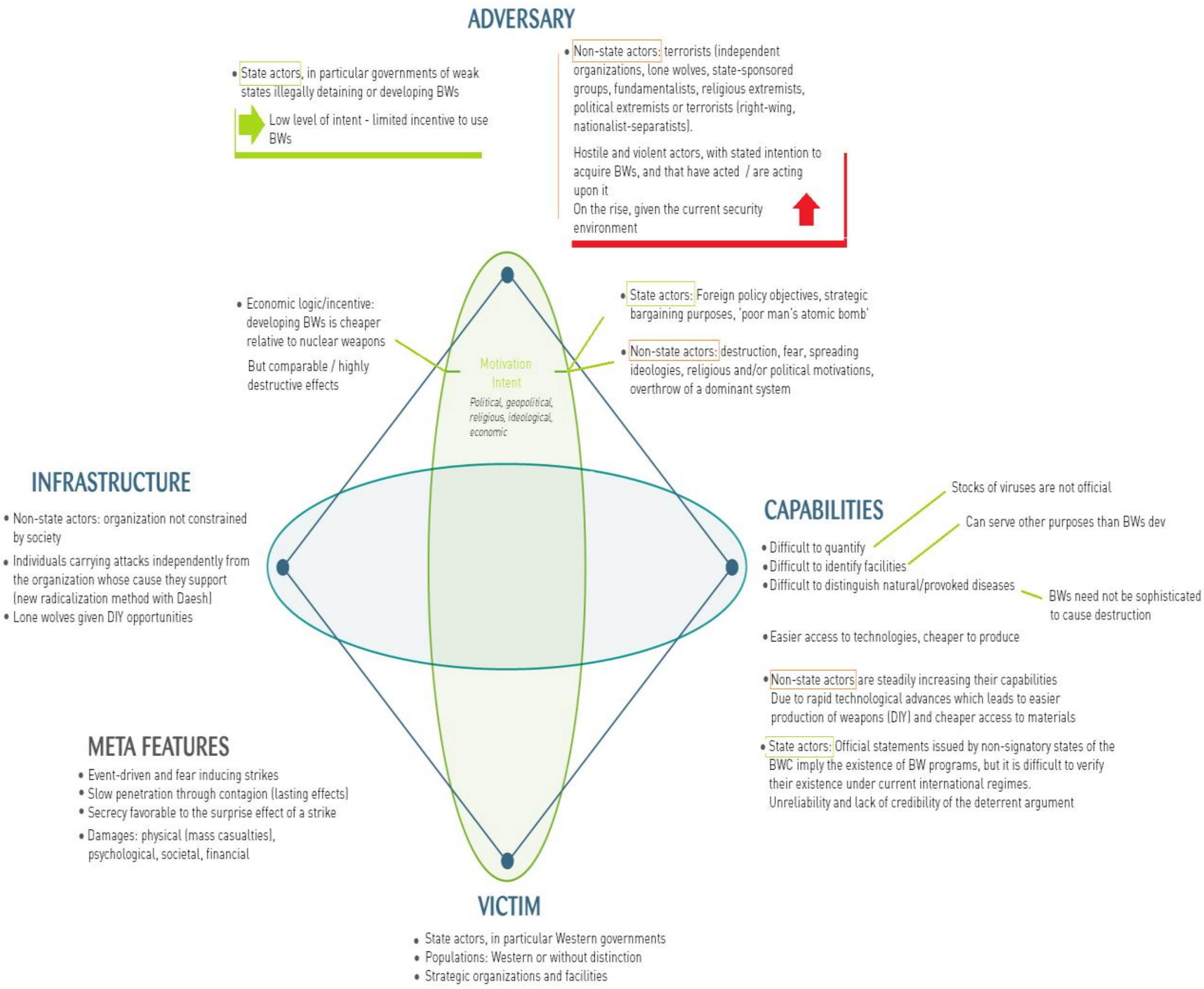

Figure 6: An HCSS Diamond Model of the relationship between Actors and Capabilities in the pursuit of BWs

3.1 State actors: Still going rogue?

3.1.1 Reasons for concern: Capabilities and ease of access

Developing BW remains a technical capability of most countries,[44] suggesting a large proliferation risk. Any state with a sufficient pharmaceutical, medical, and industrial apparatus has the ability to mass-produce BW.[45]

In contrast with nuclear programs, developing basic biological capabilities is affordable and at the same time could "inflict catastrophic effects."[46] For this reason, there are concerns over BWs being an attractive deterrent option among poorer, weak states, which could lead

44 Seth Baum, "On winter-safe deterrence and biological weapons", Roundtable: The Winter-Safe Deterrence Debate, March 20, 2015.
45 Martens, Maria. "Chemical, Biological, Radiological and Nuclear Terrorism: The Rise of Daesh and Future Challenges". NATO Science and Technology Committee, April 14, 2016. http://www.nato-pa.int/DocDownload.asp?ID=B488944A4D0205000AD8.
46 Hudson Institute, *A National Blueprint for Biodefense*, (n.p., 2015).

to a "biological revolution."[47] The nature of BW is such that relevant programs are inherently impossible to verify. States developing these are thus crossing the "red lines" of international norms.[48]

The U.S. Department of State assesses that China, Iran, North Korea, Russia, and Syria continue to engage in dual-use or biological weapons-specific activities and are failing to comply with the BWC.[49]

3.1.2 Limits to state actors' intent

The strategic value of BW as deterrents and for bargaining purposes is often a reason why state actors develop them. However, in spite of this, a number of counter-arguments question the deterrent nature. For instance, the destructive power of BWs is usually not very evident, they are banned by international law, and for a state's BW deterrence threat to be credible a state would have to reveal information on its BW capabilities forcing the international community to take action. Still, this greatly depends on the thresholds of BW weapon advancement, with lower thresholds making these counter-arguments less convincing.

Still, there are fewer incentives to use BW clandestinely compared to conventional weapons which produce an instant, direct effect.[50,51] In addition, the position of the US involves responding to biological attacks with the full range of capabilities – the threat of a considerable retaliation is high.

Box 1. Type of actors and likelihood of BW attacks: What recent BW events tell US
Historically, small-scale attacks were carried out by left or right-wing nationalist groups. The lure of using BW in a terrorist attack lies in the psychological impact on their audiences, domestic constituencies and international community. Like Aum Shinrikyo in Tokyo, large scale attacks from religiously motivated fundamentalist terrorist factions, as well as random communities with biological weapons expertise, could be expected.

It must be acknowledge that identifying a precise number of previous bioterrorist attacks has

[47] S.B. Martin, "The Role of Biological Weapons in International Politics: The Real Military Revolution", *Journal of Strategic Studies*, Vol. 25, Issue 1, 2002, http://www.tandfonline.com/doi/abs/10.1080/714004040.
[48] Enemark, Christian, Disease and Security. Natural Plagues and Biological Weapons in East Asia, 2007. Filippa Lentzos, Confidence & Compliance with the Biological Weapons Convention, Geneva Centre for Security Policy (GCSP) and King's College London, December 2014, http://www.filippalentzos.com/wp-content/uploads/2014/11/BWC-workshop-report-NEW-web.pdf.
[49] U.S. Department of State. (2015). Adherence to and Compliance with Arms Control, Nonproliferation, Disarmament Agreements and Commitments. Retrieved from http://www.state.gov/t/avc/rls/rpt/2015/243224.htmhttp://www.unog.ch/ 80256ee600585943.nsf/(httpPages)/7be6cbbea0477b52c12571860035fd5c?OpenDocument&ExpandSection=2%2C3 -_Section2
[50] Enemark (2007).
[51] RAND, "Assessing the Threat of Biological Terrorism", Statement by John Parachini, Policy Analyst, RAND Washington Office, 2001.

been difficult to scholars and practitioners alike, due to the covert nature thereof. The Monterey WMD Terrorism Database – the most extensive catalog documenting the acquisition and use of WMD by sub-state actors – has so far reported 1,100 incidents related to CBRN weapons, starting from the 1900s.[52] Simultaneously, the Global Terrorism Database listed only 36 such incidents taking place in the past 40 years.[53] "There is an extremely low incidence of real biological events in contrast to the number of hoaxes" and prevented attacks.[54] Nonetheless, the majority of bioterrorist attacks are small-scale, with the actors mostly resorting to anthrax, ricin and botulinum toxin. Therefore, **in spite of the low number of BW occurrences thus far, it is evident that biological agents can be indeed obtained and used by non-state actors.**

3.2 The rise of violent non-state actors

While state actors used to be the usual suspects developing and using BW, it is non-state actors that are now, as such, on the radar of the international community. The West is witnessing an increase in terrorist attacks, intense domestic terrorism threats, and is exposed to the expressed intent by non-state actors to use biological weapons in such attacks.

More vigilance is imperative given "the rise of Daesh in Iraq, Syria, which presents difficult new CBRN challenges" as a whole.[55] The same analysis states that "terrorist groups have the stated intention to acquire CBRN weapons, and they act upon it, steadily increasing their capabilities".[56]

This increase in visibility of non-state actors and their hostile intentions is further corroborated by a 2014 START report which pointed to jihadists groups, disgruntled actors, and domestic right-wing groups as presenting a "significant CB [chemical or biological] threat to the United States within the next decade".[57]

3.2.1 Distributed organization of non-state groups

Non-state actors pose a higher threat in terms of audience (ethereal, in the case of terrorists), and as they are submitted to fewer constraints by the rest of the society. Access to BW is known to have expanded to a broad range of individuals, including lone wolves or organized groups with hostile intentions.[58,59] In addition, one of the key changes in terrorist group

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[52] "Monterey WMD Terrorism Database," n.d. http://wmddb.miis.edu/.
[53] "Global Terrorism Database," n.d. https://www.start.umd.edu/gtd/search/Results.aspx?page=2&search=bio&charttype=bar&chart=weapon&ob=GTDID&od=desc&expanded=yes#results-table.
[54] Milton Leitenberg (2005).
[55] Martens (2016), p.1
[56] Ibid.
[57] START, "Anatomizing Chemical and Biological Non-State Adversaries", Research Brief, March 2014, https://www.start.umd.edu/pubs/STARTResearchBrief_Anatomizing.pdf.
[58] National Security *Council, National Strategy for Countering Biological Threats*, November 2009, http://www.whitehouse.gov/sites/default/ªles/National_Strategy_for_Coun-tering_BioThreats.pdf.

organization is the shift from a central to a fragmented structure. This radicalization method is reflected in the multiplication of domestic attacks by seemingly unaffiliated individuals carrying out jihad themselves.[60] This threat is not limited to individuals who were influenced by al Qaeda then, Daesh now, or the general jihadist movement – it also includes right wing extremists and separatists like it did in the 1980s.[61] This paves the way for bioterrorism to become a more common modus operandi.

Box 2. The case of Daesh: Cause for concern

- Biological weapons fit Daesh's media strategy: biological weapons "kill indiscriminately" with a "delayed impact, can be confused with natural disease outbreaks, or rather than kill, incapacitate".[62]
- Regarding Daesh's BW objectives, in 2014 a laptop captured from a Moroccan group member contained directives on how to develop and enhance BW, with the case in point being the plague.[63] If Daesh were intentionally to use a biological weapon they would more than likely release a pathogen or biotoxin.[64]
- The capabilities of the group have drastically expanded. Daesh is known to have a "high recruitment rate of university-educated fighters" including with CBRN related expertise, and controls territories "with advanced industrial facilities".[65] Taking into consideration the capacity of Daesh to manufacture such weapons, the plausibility and potential for such an attack could bring about widespread panic if successful. Daesh's high funding, previous use of chemical weapons and ease of obtaining some of the necessary equipment (such as DNA synthesizing equipment) via both formal and informal routes means that this should not be ignored.

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59 T.V. Inglesby al., T. O'Toole, and D.A. Henderson. "Preventing the use of Biological Weapons: Improving Response Should Prevention Fail." *Clinical Infectious Diseases* 30, no. 6 (June 2000): 926–29.

60 This threat was emphasized by statements by former Secretary of Homeland Security Janet Napolitano and former Director of the Federal Bureau of Investigations, Robert Mueller. See Risa A. Brooks, "Muslim "Homegrown" Terrorism in the United States," International Security 36, no, 2 (2011): 8.

61 Edwin Bakker and Beatrice de Graaf, "Preventing Lone Wolf Terrorism: some CT approaches discussed," Perspective on Terrorism 5, no. 5-6 (2011): 44. In January 2014, two Georgia men were found guilty of possession of a biological toxin for use as a weapon: see in Associated Press, "Jury Finds 2 Georgia Men Guilty in Ricin Plot," January 17, 2014, http://www.usatoday.com/story/news/nation/2014/01/17/ricin-georgia-guilty/4592157/. In November 2011, the men were arrested for plotting a ricin attack on federal officials. They were influenced by information they found online about U.S. citizens attacking government officials through rudimentary research of using caster beans to make ricin, a toxin. See in Ryan Jaslow, "Ga. Men Arrested for Allegedly Plotting Ricin Attack: What's Ricin?," CBS News, November 2, 2011, http://www.cbsnews.com/8301-504763_162-20128934-10391704/ga-men-arrested-forallegedly-plotting-ricin-attack-whats-ricin/.

62 RAND, "Assessing the Threat of Biological Terrorism", Statement by John Parachini, Policy Analyst, RAND Washington Office, 2001.

63 "Isis: Moroccan Daesh cell 'plotted biological weapons attack' say authorities." *International Business Times,* March 4, 2016. http://www.ibtimes.co.uk/isis-moroccan-daesh-cell-plotted-biological-weapons-attack-say-authorities-1547650.

64 Martens (2016).

65 Martens (2016), p.3.

- However, in order to manufacture a delivery system that has a large scale impact, for instance in a battlefield situation, Daesh would need an even higher level of expertise in both capacity and capability. Acquiring pathogens may prove relatively easy, but it is unclear whether this is the case in terms of weaponizing these on a much larger scale for large scale attacks.
- A NATO reports sums up this uncertain assessment: Daesh "would not face many hardships in obtaining the bio-reactors and agricultural sprayers required to weaponize naturally occurring pathogens". It could prove more difficult to obtain more advanced scientific expertise and capabilities involved in the development of biological weapons, but not unimaginable.[66]

3.2.2 BW as fit for purpose – Terrorism and death

Biological weapons are appealing to certain non-state actors because of what they represent. They can cause considerable damages – at the economic (financial losses), societal (disruptions, psychological impact) or physical level (highly contagious and deadly, mass casualties)[67]. This level of intent is rather high compared to that expected from state actors.

Non-state actors justify the use of BW by the vision they propagate. Terrorists in particular are expected to want to pursue BW for their high consequence, mass casualty attacks: "many of today's terrorists want a lot of people watching and a lot of people dead".[68] And fundamentalist terrorist groups justify the deployment of biological agents by the occurrence of diseases in religious texts.[69]

3.3 BW capabilities: More opportunities

3.3.1 Ease of production and ease of use

Modern materials and technologies required to manufacture BW for low-scale attacks are now cheaper and easier to use due to scientific advances, and relatively easy to access in global markets.[70,71] Simple lab techniques are required for the preparation of these agents; no sophisticated apparatus is needed.

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[66] Martens (2016), p.4.
[67] Markoff J. Synthetic Biology meeting lures an Intriguing Audience. New York Times 9th May 2014. (2014), http://www.nytimes.com/2014/05/09/science/a-synthetic-biology-conference-lures-an-intriguing-audience.html?_r=0.
[68] Jenkins, Brian. "The New Age of Terrorism." Santa Monica, CA: RAND Corporation, 2006. http://www.rand.org/pubs/reprints/RP1215.html.
[69] Jerrold M., Post. "Differentiating the Threat of Chemical and Biological Weapons: Motivations and Constraints" 8, no. 3 (2002): 187–200.
[70] National Security *Council, National Strategy for Countering Biological Threats*, November 2009, http://www.whitehouse.gov/sites/default/ªles/National_Strategy_for_Coun-tering_BioThreats.pdf.
[71] T.V. Inglesby al., T. O'Toole, and D.A. Henderson. "Preventing the use of Biological Weapons: Improving Response Should Prevention Fail." *Clinical Infectious Diseases* 30, no. 6 (June 2000): 926–29.

In 2010, an estimated thirty countries (including private firms) are considered to be capable of sequencing and synthesizing genes of 1000 base pairs or larger.[72] Sequencing, which is relatively easy, is concerned with "reading" the genome, i.e. determining the precise order of nucleotides within a DNA molecule. Synthesizing, which is comparatively harder, involves the natural or artificial creation of deoxyribonucleic acid (DNA) molecules.

There are a number of limitations to the development of BW capabilities and the manufacturing of diseases by non-state actors (see Box 3).

Box 3. Nuances to BWs as a threat

- A number of authors emphasize the limited or insufficient capabilities of adversary non-state actors in terms of feasibility and likelihood to attack.
- The assessment of precedents involving bio-weaponry reveals that "there is an extremely low incidence of real biological events in contrast to the number of hoaxes" and prevented attacks.[73] According to the Global Terrorism Database, since the 1970s, 36 incidents have been documented which were related to biological agents.[74]
- In line with the cases assessed, it can be observed that to date, the majority of bioterrorist acts have been carried out on a rather smaller scale, mostly resorting to anthrax, ricin and botulinum toxin. Therefore, it is evident that biological agents can be indeed obtained and misused by non-state actors, regardless of the scope of the planned attack. It is difficult to conclude the extent to which BW are in fact being developed, since production facilities require little space and are hard to identify – as they are similar to those used for other purposes such as vaccine production.[75]
- Reflecting upon the efficiency of past BW occurrences, roughly 3 bioterrorist acts so far have been documented as having received considerable media attention and caused extensive fatalities or casualties. Other attempts were countered either by the detention of perpetrators or the attempts did not materialize due to technical insufficiencies.
- The link between synthetic biology and DIYbio, and the level of sophistication of the experiments typically being performed in DIYbio community labs, is overstated according to some experts.[76] A conventional weapon attack is consistently seen as a more probable occurrence by those who argue lone actors and bioterrorism are not a true threat.[77] Conventional terrorist attacks may remain the primary modus operandi of some actors like Daesh – for now.

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[72] Analysis of the Threat of GMO for Biological Warfare.pdf

[73] Milton Leitenberg. "Assessing the Biological Weapons and Bioterrorism Threat." U.S. Government, December 2005. http://www.strategicstudiesinstitute.army.mil/pdffiles/pub639.pdf.

[74] "Global Terrorism Database," n.d. https://www.start.umd.edu/gtd/search/Results.aspx?page=2&search=bio&charttype=bar&chart=weapon&ob=GTDID&od=desc&expanded=yes#results-table.

[75] Martens (2016).

[76] Grushkin D, Kuilen T, Millet P. Seven Myths and Realities about Do-It-Yourself Biology. Washington, DC: Wilson Centre (2013); Jefferson C. The growth of amateur biology: a dual use governance challenge? In: University of Bath Biochemical Security 2030 Project, Policy Paper 3. Bath: University of Bath. (2013). Available from: http://biochemsec2030dotorg.files.wordpress.com/2013/08/jefferson-policy-paper-3-for-print.pdf

[77] Rachel Oswald, "Despite WMD Fears, Terrorists Still Focused on Conventional Attacks | GSN | NTI,"

Yet, it may be a matter of time before these are overcome, especially given the context of unstoppable technological advances.

- "The science, technology, and material required for CBRN weapons are increasingly accessible and becoming cheaper and easier to employ".[78]
- "The risk is evolving in unpredictable ways (...); advances in the enabling technologies will continue to be globally available; the ability to exploit such advances will become increasingly accessible to those with ill intent as the barriers of technical expertise and monetary costs decline".[79]
- "The biotech revolution has the potential to change the risks of biological terrorism in profound ways". Biotech knowledge is mostly freely available in the public domain, and the government has little control over biotech innovation and materials. Instead, the market is shaped by a multitude of private sector agents, ranging from one-person companies to large-scale pharmaceutical companies".[80]
- "The technology associated with the manufacture of biological weapons is relatively inexpensive, and because it is similar to that used in vaccine production facilities, it is easy to obtain. The microbial agents needed for most biological weapons are widely available. It is difficult to gauge the extent of biological weapons development in other nations since production facilities require little space and are not easy to identify".[81]

As previously stated, it remains difficult to assess the extent to which hostile actors already have or will likely develop the required resources (scientific expertise and infrastructure) to manufacture BW. What is certain is that as a result of easier and cheaper access to BW, "there is a growing risk that [these] might be obtained and used by non-state actors. New allegations have surfaced that tens of billions of dollars are being invested into bioweapons laboratories".[82] Artisanal production of BW may be seen as crude, yet concerns are rising from the community of policy experts over the risk of "nasty" attacks carried out with more sophisticated weapons.[83] In UN views, many deadly weapons could be rather easily improvised given what is commercially available already.[84]

NTI: Nuclear Threat Initiative, http://www.nti.org/gsn/article/despite-wmd-fears-terrorists-still-focusedconventional-attacks/.

[78] Inglesby et al., 2000.

[79] National Security Council, *National Strategy for Countering Biological Threats*, November 2009, http://www.whitehouse.gov/sites/default/ªles/National_Strategy_for_Coun-tering_BioThreats.pdf.

[80] Martens (2016).

[81] Martens (2016).

[82] IISS, The BWC: Issues for the 2016 Review Conference, November 11, 2015, https://www.iiss.org/en/events/eu%20conference/sections/eu-conference-2015-6aba/special-session-1-a350/special-session-7-86f9

[83] Catherine Jefferson, Filippa Lentzos, Claire Marris, "Synthetic Biology and Biosecurity: Challenging the "Myths"", *Public Health*. 2012; 2:115, http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4139924/#B24.

[84] *The Economist*, "Improvised weapons. Hell's Kitchens", May 21, 2016, Print edition online, http://www.economist.com/news/science-and-technology/21699098-makeshift-weapons-are-becoming-more-dangerous-highly-sophisticated.

4 Policy Topics

Biodefense, biosafety and biosecurity are inextricably linked. The concepts of safety, defense and security draw on particular understandings of risks that reflect certain threats posed by biological weapons. The different understandings of each concept reflect different approaches of policy makers.

In this chapter, we highlight the most relevant policy topics that we identified in the discourse over the past years, using the various perspectives to distinguish among these concerns.

Biosafety is the prevention of large-scale loss of biological integrity, focusing both on ecology and human health. The prevention mechanisms include conduction of regular reviews of the biosafety in laboratory settings, as well as strict guidelines to follow. Biosafety is used to protect from harmful incidents.

Storage of infectious diseases (stockpiling)
For example, the variola virus (smallpox) is stored at two WHO repositories: the Centers for Disease Control and Prevention, Atlanta, U.S. (CDC), and the State Research Centre of Virology and Biotechnology, Novosibirsk, Russian Federation (VECTOR). After smallpox was eradicated in the 1980s, the question remained whether to keep the variola virus stored in these repositories, as the biological agents could deliberately or accidentally be released from these stockpiles, and cause a disaster.

Accidental lab release of pathogens
Furthermore, there is always the risk of laboratory escape. In light of recent concerns regarding biosafety and biosecurity, the U.S. government decided to pause new funding for gain-of-function (GOF) research on influenza, MERS or SARS viruses in 2014.[85] Whereas governments push for stricter regulations and a tighter oversight of research, the scientific community argues that this is not the problem.[86] Some scientists state that bioterrorist activities are not concerned with these high-tech research developments. They rather focus on low-tech activities, which are better accessible and do not require state-of-the-art laboratories. This is concerning considering the ease with which pathogens can escape laboratories: the CDC reported 400 "mishaps" [87] in US laboratories with, 196 accidental

[85] U.S. Government, "U.S. Government Gain-of-Function Deliberative Process and Research Funding Pause on Selected Gain-of-Function Research Involving Influenza, MERS, and SARS Viruses," October 17, 2014, http://www.phe.gov/s3/dualuse/Documents/gain-of-function.pdf.
[86] Jonathan E. Suk et al., "Dual-use Research and Technological Diffussion: Reconsidering the Bioterrorism Threat Spectrum," ed. Glenn F. Rall, *PLoS Pathogens* 7, no. 1 (January 13, 2011), doi:10.1371/journal.ppat.1001253.
[87] ""Report: 395 Mishaps at U.S. Labs Risked Releasing Select Agents," CIDRAP Centre for Infectious Disease Research and Policy, September 28, 2011, accessed August 28, 2016, http://www.cidrap.umn.edu/news-perspective/2011/09/report-395-mishaps-U.S.-labs-risked-releasing-select-agents.

releases, 77 reported spills and 46 accidental needle sticks, between 2003-2009, the perceived “controllability of escape events is not guaranteed.[88]

Increasing number of labs handling biological agents

Governments have little power over biotechnological innovation: the market is largely determined by private actors ranging from one-person companies to multinational firms.[89] And from a practical/operational point of view, “the advantage of a biological attack [...] is that it could be carried out covertly”, thus making retaliation difficult if not impossible.[90] Indeed, it is difficult to distinguish between deliberate and natural disease outbreaks.[91] Besides, R&D for vaccines (i.e. for peaceful purposes) and biological weapons is based on the same technologies, and biological agents can be made in facilities much smaller and less conspicuous than in the past – thus less expensive.[92]

Biosecurity is a set of preventive measures designed to reduce the risk of transmission of infectious diseases in crops and livestock, quarantined pests, invasive alien species, and living modified organisms (Koblentz, 2010).

Dual use research of concern (DURC)

Biotechnological research is often motivated by peaceful aims such as understanding the properties of infectious diseases and developing vaccines to protect human health.[93] Nevertheless, this work is often labelled as dual use research of concern (DURC). The U.S. government defines DURC as “life sciences research that, based on current understanding, can be reasonably anticipated to provide knowledge, information, products, or technologies that could be directly misapplied to pose a significant threat with broad potential consequences to public health and safety, agricultural crops and other plants, animals, the environment, materiel, or national security.”[94] This creates a tension between the freedom of scientific research and a government’s national security agenda. Gain-of-function (GOF) experiments, in which researchers (genetically) manipulate already-dangerous pathogens, are of primary concern.[95] These could indeed be used to develop tools to monitor the natural emergence of pathogens, but could also be used to manipulate biological agents and make them even more harmful.[96]

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[88] Stefano Merler et al., “Containing the Accidental Laboratory Escape of Potential Pandemic Influenza Viruses,” *BMC Medicine* 11, no. 1 (November 28, 2013

[89] Martens (2016).

[90] Enemark, Christian. “Biological Attacks and the Non-State Actor: A Threat Assessment” 21, no. 6 (2006): 911–30.

[91] Enemark (2007).

[92] U.S. Congress (1993).

[93] Eckard Wimmer et al., “Synthetic Viruses: A New Opportunity to Understand and Prevent Viral Disease,” *Nature Biotechnology* 27, no. 12 (December 2009): 1163–72, doi:10.1038/nbt.1593.

[94] United States Government Science, Safety and Security, “United States Government Policy for Institutional Oversight of Life Sciences Dual use Research of Concern,” September 24, 2014.

[95] Martin Furmanski, “Threatened Pandemics and Laboratory Escapes: Self-Fulfilling Prophecies,” *Bulletin of the Atomic Scientists*, March 31, 2014, http://thebulletin.org/threatened-pandemics-and-laboratory-escapes-self-fulfilling-prophecies7016.

[96] Warner et al., “Analysis of the Threat of Genetically Modified Organisms for Biological Warfare.”

Lacking security oversight within DIY Biology

DYI Biology communities and initiatives have a downside in the light of biosecurity, however.[97] Although the laboratories of Genspace and BioCurious will have safety regulations, the experiments that DIY enthusiasts perform at home are not regulated at all. The "traditional" safety oversight associated with the biosafety regulatory framework is missing. Additionally, commercial DNA synthesis is readily available and controlled poorly.[98] As the interest in biotechnology is growing, the number of (DIY) laboratories handling biological agents is increasing, which consequently increases the risk of laboratory accidents such as the accidental release of infectious diseases.[99] Moreover, the knowledge of and possibilities to synthesize biological agents increase the potential misuse of biological material for malicious aims.

Proliferation of information (voluntary, involuntary [theft, espionage])

“Ethical issues arise particularly from dangers of using synthetic lethal and virulent pathogens for terrorist attacks, bio-war, or maleficent uses (“garage terrorism”, “bio-hacking”), particularly if knowledge and skills on how to produce such pathogens are freely available”.[100]

Technology not only requires knowledge, information and equipment, but also experience, collective expertise and tacit knowledge. It is often through the cooperation of group, rather than individuals, that ground breaking discoveries are made.[101] Additionally, inhibition felt in the field of life sciences could pose a threat to national security and public health as it slows the discovery and development of beneficial vaccines and drugs.[102] However, with the advancement of biological research resulting in an increase in biological engineering, there may be a lower demand for tacit knowledge and expertise, increasing the threat of an attack as rudimentary biological weapons are easily attainable.

Proliferation of equipment and pathogens

While the restrictions on the purchase of pathogens have supposedly tightened, at the same time commerce in many pathogens has become widespread: “Microbiologists and veterinarians are notorious for maintaining extensive, badly inventoried and poorly secured samples of pathogens. Experts acknowledge that smallpox might be found in a laboratory anywhere in the world.”[103]

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97 Pauwels et al., “Synthetic Biology.”

98 Andrew Balmer and Paul Martin, “Synthetic Biology,” *Social and Ethical Challenges*, 2008, https://med.stanford.edu/content/dam/sm/cirge/documents/activities/journalclubs/0806_synthetic_biology.pdf.

99 Pauwels et al., “Synthetic Biology.”

100 European Group on Ethics. Opinion no. 25 – Ethics of Synthetic Biology. Brussels: European Group on Ethics in Science and New Technologies to the European Commission; (2009), p.43

101 Catherine Jefferson, Filippa Lentzos, and Claire Marris, “Synthetic Biology and Biosecurity: Challenging the ‘myths,’” *Dual-use Life Science Research and Biosecurity in the 21st Century: Social, Technical, Policy, and Ethical Challenges*, 2015, 21.

102 Ronald M. Atlas, “National Security and the Biological Research Community,” *Science* 298, no. 5594 (October 25, 2002): 753–54, doi:10.1126/science.1078329.

103 Danzig, Richard, “Proliferation of biological weapons into terrorist hands, ” in: Scawcroft, B; J. Nye, and K. Campbell (ed) The Challenge of Proliferation, Aspen Strategy Group, 2005

"Compared to the NPT, however, the BTWC provides few incentives for states to join if they do not consider biological weapons to be a threat (existential or otherwise). The equipment, technology and materials relevant to the purposes of the BTWC are widely available from an international market that is governed by many other treaties and regulations."[104]

Biodefense refers to the "measures taken to minimize or negate the vulnerabilities to, and/or effects of, a biological incident". Biodefense, therefore, includes the methods, plans, procedures, policies, laws, legislations aimed at establishing and executing defensive measures against attacks using biological agents

Ineffective verification measures for NSA and non signatory states

The international community is not yet able to secure certain threats coming from state actors in a comprehensive manner. Its verification regimes have to evolve, particularly as the emergence of non-state actors challenges the effective implementation of measures. Under treaty law, neither the Biological and Toxin Weapons Convention (BTWC)[105] nor the UNSCR 1540 cover all state actors, though the latter does "close gaps in nonproliferation treaties and conventions to help prevent terrorists and criminal organizations from obtaining the world's most dangerous weapons".[106] Still, these legal instruments are seen as the codification of customary international law on WMDs, which is considered to be all-encompassing. Non-signatory states of the BTWC include states such as Israel, Chad and South Sudan , which is cause for concern given their political instability.[107,108]

Difficulty in detection and tracing of biological agents

In addition, agents used as biological weapons are invisible or microscopic, easy to multiply and maintain, and difficult to detect and trace. As acquisition could become easier, simplified technological processes could make footprints less visible, and technology could help avoid detection because testing can be done virtually.[109] Hence, detecting the presence of a biological agent or the signature of BW production is more challenging than that of radioactivity or a chemical attack,[110],[111] and allegations about an actor owning BW capabilities are surrounded by high uncertainty.

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[104] Anna Zmorzynska and Gunnar Jeremias, "Managing Technology Transfers under the Biological and Toxin Weapons Convention," Non-Proliferation Papers, No. 21 September 2012

[105] The Biological Weapons Convention (BWC) At A Glance, Arms Control Association. Daniel Feakes, John Hart, Masood Khan, and Una Becker-Jakob. The BWC: Issues For The 2016 Review Conference. EU Non-Proliferation and Disarmament Conference 2015 Special Session 7, 2015.

[106] Department Of State. The Office of Website Management, Bureau of Public Affairs. "UN Security Council Resolution 1540," October 24, 2006. http://www.state.gov/t/isn/c18943.htm#1.

[107]"Fact Sheets & Briefs," Arms Control, July 25, 2016, accessed August 28, 2016, https://www.armscontrol.org/factsheets/bwcsig.

http://www.unog.ch/__80256ee600585943.nsf/(httpPages)/7be6cbbea0477b52c12571860035fd5c?OpenDocument&ExpandSection=2%2C3 - _Section2

[108] HCSS Drivers of Vulnerability Monitor.

[109] Gary Ackerman and Lauren Pinson, "Gauging the Threat," Defence Procurement International , 2013, (August): 53, http://edition.pagesuite-professional.co.uk/launch.aspx?pbid=4a891638-58....)

[110] Shea, Dana A., and Frank Gottron. "Small-Scale Terrorist Attacks using Chemical and Biological Agents: An Assessment Framework and Preliminary Comparisons." Congressional Research Service, May 20, 2004.

[111]Enemark (2006).

5 Policy Responses to a Changing Context

5.1 Responses of governments to changing dynamics

The following section aims to use recent governmental responses to biological weapons as indicators of where the new emphasis in the biological weapon debate lies. From our research, we can infer that the United States of America, the United Kingdom, the Netherlands and Austria aim to take holistic approaches. From the previous sections we illustrated that non-state actors are assumed to have fewer capabilities than states. Nonetheless, non-state actors are still capable of producing biological weaponry, with the level of advancement of the weapon dependent on the advancement of technology used. This section examines various types of measures using four different categories: Threat Awareness, Prevention and Protection, Surveillance and Detection, and Response and Recovery.

5.1.1 Threat Awareness

"Threat" captures the interplay of capability and intent, with the aim of creating an adverse reaction. Anticipating future threats posed by bioterrorism has been undertaken at both a European and International Level since 2001. While in the United States there are designated institutions for biodefense at federal, state and local levels within government agencies; the UK, the Netherlands and Austria conduct bio-threat assessments under the broader umbrella of CBRN-related terrorism and emerging national security risks. The weaponization of hazardous bio agents by non-state actors has become easier and more plausible due to the growing ease of access to the needed technology and scientific know-how, coupled with the generally decreasing costs of bioweapons production. Nonetheless, there remains no evidence of any materialized bioterrorism attacks since 2001. This, however, may cause problems in approaching bioterrorism a unidirectional manner, as it has also "prevented" national governments in delineating effective prevention and response mechanisms provided such an attack takes place. Consequently, bioterrorism is often referred to as a "low-probability, high-impact" threat in national security risk assessments.[112] To this end, the threat of potential bioterrorist attacks has resulted in an upsurge in investment in medical countermeasures (MCMs). This in itself is an indicator of the changing approach towards biological weapons.

Since 2001, a crucial reference point in this analysis, there has been a renewed focus on biological weapons. A state-sponsored research report on the state of preparedness in the U.S. conducted by the Hudson Institute, as well as recent NATO reports on BW, convey that BW are in the limelight with a new sense of urgency in the discussion. In the US, the leading state in biodefense and biosecurity, the Biodefense Knowledge Centre is the principle body

[112] *National Security Strategy and Strategic Defence and Security Review 2015*, (n.p., 2015), https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/478936/52309_Cm_9161_NSS_SD_Review_PRINT_only.pdf.

providing expertise and information on biology and biothreats.[113] There are currently only three FDA-licensed vaccines for biological agents, with two tackling smallpox and the other, anthrax. Simultaneously, the Biological Threat Characterization Program "conducts high quality life science studies to understand the threat from traditional and emerging biological agents."[114] This is done in order to inform and influence the level of preparedness, response planning and the operational decision-making of the Department of Homeland Security in case a biological agent attack occurs.

In the UK, the Cabinet Office's Classified National Risk Assessment annually publishes the National Risk Register which - alongside intelligence sources - primarily sets the agenda for CBRN planning and priorities.[115] In the National Risk Register published in 2015, a potential biological threat (under the umbrella of CBRN attacks) is listed as a low, but not negligible possibility.[116] Like the UK government, the Netherlands 'the Terrorist Threat Assessment for the Netherlands' (*Dreigingsbeeld Terrorisme Nederland*- DTN) CBRN terrorism, including biological attacks, characterize a bioattack as "low-probability-high-impact."[117]

Lastly, Austria implements a more pluralistic approach involving external agencies such as the Kuratorium Sicheres Österreich (KSO- Advisory Board Sicheres Osterreich), which argues in a recent report that the "greatest threat towards Austria is constituted by pandemic risks, strategic terrorism by non-conventional attacks," with it being "more important than ever" for Austria to focus on CBRN threats.[118]

Given the changing security apparatus in Europe, many states are determined to find new and concrete methods for protection of military and civilian populations, as threats are mostly precipitated by deliberate human action. From the preceding chapters it is evident that we are witnessing an increase in attention on bioterrorism in defense and security discourse.

5.1.2 Prevention and Protection

As discussed, the BWC is one of the key frameworks in which the international community addresses biosecurity and biosafety as well as the general proliferation of biological weapons. According to Article IV of the Convention, each signatory Party shall "in agreement with its constitutional ordinance, take activities to prohibit and prevent the development,

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[113] "CBD Focus Areas - Threat Awareness," *Homeland Security*, accessed July 26, 2016, https://www.dhs.gov/science-and-technology/threat-awareness.
[114] "CBD Focus Areas - Threat Awareness," accessed August 28, 2016, https://www.dhs.gov/science-and-technology/threat-awareness.
[115] "The United Kingdom's Strategy for Countering Chemical, Biological, Radiological and Nuclear (CBRN) Terrorism" (Her Majesty's Government, March 2010).
[116] "National Risk Register of Civil Emergencies" (London: Cabinet Office, 2015), https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/419549/20150331_2015-NRR-WA_Final.pdf.
[117] Edwin Bakker and Jeanine de Roy van Zuijdewijn, "Threat Barometer - Ten Years of Terrorist Threat Assessment Netherlands 2005-2015" (National Coordinator for Security and Counterterrorism, 2015), https://english.nctv.nl/Images/essay-barometer-eng-opgemaakt-def_tcm92-629580.pdf.
[118] "Kuratorium Sicheres Österreich," *Austrian Technology Corporation*, accessed August 8, 2016, http://www.atc.or.at/en/industry/kuratorium-sicheres-oesterreich/.

production, stockpiling, and the acquisition of biological agents, toxins, weapons, equipment and means of delivery."[119]

Therefore, all the assessed countries in this report have resorted to passing legislation in order to impede the acquisition, manufacture and use of bio-weaponry and related materials.

Apart from the adopted penal and enforcement measures as well as import and export controls, regulations on the carriage and handling of hazardous diseases have also been implemented in the US, UK, the Netherlands and Austria. The regulations passed not only require the registration of those facilities which possess and deal with biological agents, but also monitor their personnel's access to hazardous pathogens. Furthermore, besides restrictions on the usage and transfer of dual-use technology, there are also national codes of bioethics in place with the aim of limiting the potential misuse of scientific know-how.

5.1.3 Surveillance and Detection

Surveillance and detection measures are the mechanisms by which we obtain the earliest possible situational awareness for biological events. They also enable the protection of national and local critical public health infrastructure. An optimal surveillance and detection system requires a nationwide distribution of sensors and detectors at multiple levels and entry points, working in tandem. Biosurveillance, to be effective, needs to translate into products that can be used in emergency situations.

Unsurprisingly, the US has the most developed biosurveillance system, with BioWatch leading the way forward as an air sampler installed in and around cities to signal early warnings and detect airborne release of biological agents and toxins. However, this surveillance system has had false alarms on several occasions and has not changed much since its inception in the early 2000s.[120] According to confidential governmental test results, the BioWatch system is not able to identify a real attack as it is not capable of "distinguish[ing] between dangerous pathogens and closely related but non-lethal germs."[121] The UK, on the other hand, has developed its own "new biological device that can sample and detect a range of hazardous substances,"[122] with the level of sophistication of the device remaining unclear. Simultaneously, the Ministry of Defense (MoD) has also outsourced the manufacture of biosensors to research universities as well as companies besides its own development of such sensors.[123] As part of a public-private-partnership between TNO and the MoD, the Netherlands attempted to create a biosurveillance detector.[124] The present apparatus is not sophisticated enough to provide accurate information on biological

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[119] Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction, 1975.
[120] Hudson Institute, *A National Blueprint for Biodefense*, (n.p., 2015).
[121] David Willman, "The Biodefender That Cries Wolf," *Los Angeles Times*, July 8, 2012, http://www.latimes.com/nation/la-na-biowatch-20120708-story.html.
[122] "MOD Scientist Develops Multiple-Substance Detection Device - Announcements," *GOV.UK*, August 1, 2012, https://www.gov.uk/government/news/mod-scientist-develops-multiple-substance-detection-device.
[123] "U.K. MOD Awards Biodetection Contract to Smiths Detection," *BioPrepWatch*, February 12, 2013, http://bioprepwatch.com/stories/510509918-u-k-mod-awards-biodetection-contract-to-smiths-detection.
[124] Please visit the website http://www.biosparq.nl/

outbreaks.[125] Austria has been engaged in developing a biodetector but faces the same issues as the US, UK and Netherlands: the issue of creating a biological agent detector with a low error rate. [126]

The technological limitations of biosurveillance are clear. The scientific and financial obstacles in manufacturing such a detector are difficult to overcome. As biosurveillance efforts continue to expand internationally and encompass various fields – ranging from clinical medical industries to agricultural studies – biological agents continue to mutate and develop. While technological advances increase our ability to detect pathogens and agents, detecting man-made agents intended for malicious purposes remains difficult.[127] Ultimately, the success of biosurveillance greatly depends upon the available apparatus and technology to survey the biological spaces that both humans and animals share. Compared to the international bioterrorist climate of the early 2000s not much has changed in biosurveillance. While states such as the Netherlands and the UK are aspiring to create new and more advanced biosurveillance technology, the key issue is whether or not the creation of such technology is necessitated by international political changes. The question of whether it is indeed possible to create a biosurveillance system that is capable of solely detecting harmful bio-agents remains.

The current framing of the debate highlights the difficulties in creating successful and prompt surveillance and detection systems. In the Netherlands, given the arduous tasks that biosurveillance faces, the RIVM is developing non-technological solutions through statistical approaches determining the probability of a bioattack to complement the pitfalls in technology. However, a group of laboratories have organized themselves into the National Laboratory Network for Terrorist Attacks (LLN-ta) in order to carry out security analyses and provide relevant technical and scientific information in the fight against CBRN incidents.[128]

5.1.4 Response and Recovery

Response and recovery enters the realm of the more morbid and pessimistic scenarios as states have to take into account a worst-case scenario of a potential bioattack. The emphasis here is on response planning, reducing mass casualties, decontamination and other medical countermeasures (MCM). With a lack of renewed investment in biosurveillance and detection it is fair to assume that there is greater emphasis on response and recovery of governments, with recent changes feeding into this argument.

As part of the across-the-board changes experienced by the US, Project BioShield enabled the US government to foster its “ability to develop, acquire, stockpile, and provide the medical countermeasures needed by encouraging private companies to develop new bioterrorism countermeasures.”[129] According to recent evaluations, the initiative “has procured a total of 12 novel medical countermeasures, which have improved preparedness

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[125] Based on interviews
[126] Prof. F. Steinhausler “Development of CBRN Event Mitigation”, 2009.
[127] Based on interviews
[128] “Terrorisme,” accessed August 28, 2016, http://www.rivm.nl/Onderwerpen/O/Ongevallen_en_rampen/Terrorisme.
[129] Bonin Sergio, *International Biodefense Handbook* (Zurich: Center for Security Studies, 2007).

against threats such as anthrax, botulism and smallpox."[130] With its Centers for Disease Control and Prevention and its new Public Health Emergency Preparedness program, the US has upgraded the ability of first-responders to respond to a potential BW atrocity.[131] A stockpile system has been established whereby the needed medical substances are stored around strategic points of the country with a capacity for prompt delivery in case of emergency.[132]

The UK has also implemented infrastructural changes with the recently created public-private National Bio-manufacturing Centre aiming to fulfill requirements for vaccine production in the event of a bioattack.[133] Similar to the Netherlands, nonetheless, the vaccine capacity of the UK was still evaluated as reliant on the international pharmaceutical sector, with a significant amount of material outsourced to foreign countries.[134] In 2011, the UK government launched the Strategy for UK Life Sciences and established The National Biologics Industrial Innovation Centre, a new £38 million facility "to encourage innovative solutions [...] to manufacture new biologic medicines such as antibodies and vaccines" in the UK healthcare market.[135] Building on this, the UK has a improved vaccine capacity, namely with both smallpox vaccines and anthrax[136] being stockpiled and available for a specific group of first responders.[137] Moreover, the Defense Chemical Biological Radiological and Nuclear Centre (DCBRNC) "provides CBRN medical training to all medical officers in the UK armed services as well as specialist medical training to UK and NATO/allied nations. As well as military training, DCBRNC also supports civilian response in partnership with the Health Protection Agency and Department of Health."[138]

Austria mirrors the Dutch strategy with the *Nuclear, Biological, Chemical* (NBC) *unit* in the Austrian military possessing the capabilities needed to minimize the effect of a biological attack. According to a recent evaluation by the KSO, there is currently no sufficient stockpile of vaccines both regarding the provision to the public as well as to disaster relief forces.[139]

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130 "HHS FY2016 Budget in Brief," *U.S. Department of Health and Human Services*, n.d., http://www.hhs.gov/about/budget/budget-in-brief/phssef/index.html#preparedness.
131 Sergio, *International Biodefense Handbook*.
132 "CDC - PHPR - Strategic National Stockpile," accessed June 28, 2016, http://www.cdc.gov/phpr/stockpile/stockpile.htm.
133 Sergio, *International Biodefense Handbook*.
134 "UK VACCINE CAPACITY" (Parliamentary Office of Science and Technology, August 2008).
135 "CPI to Establish New £38 Million National Biologics Industrial Innovation Centre," *CPI*, December 12, 2012, https://www.uk-cpi.com/news/cpi-to-establish-new-38-million-national-biologics-industrial-innovation-centre/.
136 http://www.portonbiopharma.com/products-2/anthrax-vaccine/
137 "Smallpox and Vaccinia," in *The Green Book* (Public Health England, 2013), https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/148501/Green-Book-Chapter-29-dh_063660.pdf; "Anthrax," in *The Green Book* (Public Health England, 2013), https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/320846/Green_Book_Chapter_13.pdf.
138 "Defence Chemical Biological Radiological and Nuclear Centre," *GOV.UK*, January 11, 2016, https://www.gov.uk/government/publications/defence-chemical-biological-radiological-and-nuclear-centre-dcbrnc/defence-chemical-biological-radiological-and-nuclear-centre#joint-cbrn-medical-faculty.
139 "Contribution to the Nation-Wide Risk Analysis for Austria - Biological, Chemical, Radiological and Nuclear Threats."

Prior to the US anthrax attacks in 2001, the development of MCM were aimed at providing protection for military personnel with an emphasis on state-centrism. With the renewed focus on non-state actors a shift has occurred towards the protection of civilian populations. This highlights a discursive shift between state-centrism and a non-state-centric approach to the biological weapons phenomena.

The creation of CBRN-response bodies in the UK, Netherlands and Austria, and Project Bio shield show the infrastructural need for a broad interdepartmental approach to biological weapons. Much of the response mechanisms of governments is context specific, dependent on the nature of a biological outbreak. There is recognition of the fact that there needs to be a multitude of varying approaches in light of the context-sensitive application of responding. The evolving threat landscape complicates the already complex nature of responses, undermining the extent to which a state can prepare. While non-state actors experience constraints in technology, time and financing, states experience similar uncertainty due to the specificity of different attacks. As the risk of vaccination of the population outweighs the benefits when framed in the context of the potential of exposure, there is significant interest in developing medicines in an ad-hoc manner, even though this is not always possible.

The lack of adequate or up-to-date stockpiles of vaccines in countries such as the UK, the Netherlands and Austria is also indicative of the fact that it is difficult to allocate resources into this field.[1] Many EU states outsource the development and production of vaccines which may cause complications in recovery, as non-state actors may be able to cultivate vaccine-resistant agents, thereby undermining the quick response needed by vaccine development in the case of an attack. The nature of the threat has not changed dramatically since 2001; however, the likelihood of a bioterrorist attack is automatically considered more likely owing to the overall rise in terrorist-related activity and the changing scientific and technological landscapes.

5.2 Dutch approach

5.2.1 National Security Strategy

The Dutch National Security Strategy (NSS) of 2007 has been an important guideline for the identification of risk affecting the national interests of the Netherlands and the prevention of societal disruption. From the start, CBRN-weapons, and particularly the proliferation thereof, has been one of the incident categories under consideration.[140] In an interdepartmental self-evaluation on this policy topic, the focus was on CBRN in general. If the discussion became more specific, chemical and nuclear materials were targeted. Only one remark with respect to the lack of supervision on the implementation of the BWC was made related to biological agents. [141]

[1] "Infectious Diseases and Vaccinology Division," RIVM, accessed August 28, 2016, http://www.rivm.nl/en/About_RIVM/Knowledge_and_expertise/Knowledge_domains/Infectious_Diseases_and_Vaccinology_Division.

[140] Strategie Nationale Veiligheid, 2007

[141] Zie bijvoorbeeld, Beleidsbrief Defensie, Tweede Kamer, vergaderjaar 2011–2012, 32 733, nr. 39

In the past decade, the National Risk Assessment as part of the NSS has analyzed the probabilities and impact of various CBRN (such as flu pandemics, nuclear and chemical incidents) related scenarios. But none of them, including the National Security Profile which is under development, has considered specific biological-related risk factors. Finally, within the Region Risk Assessments, which are developed by the various Veiligheidsregio's in the Netherlands, the risk of CBRN is not considered up to now.
However, the overall approach is to treat the use of biological weapons as a low probability, high impact risk.

5.2.2 CBRN-program

To provide an impulse to knowledge and awareness of CBRN materials, the Dutch government funded a €100 million CBRN program that ran between 2008 and 2013. The program focused on the support of CBRN-research, the improvement of security at institutes that handle high-risk CBRN materials (e.g., hospitals), the increase of security awareness and the development of protocols to deal with suspicious materials (for example, within research environments), and specific threat analysis. Since the termination of the program, BW research has received income from US grants and temporary programs within the Dutch government and activities have been strengthened continued to a certain extent under the EU Action plan on chemical, biological, radiological and nuclear security, leading to, among others, the establishment of Centers of Excellence to promote training and awareness.[142]

5.2.3 Biosecurity regime

Based on gradual changes of the biological threat perception and concurrently to efforts initiated in the CBRN-program, more attention has been given to the establishment of a biosecurity regime that should focus more on external threats related to biological materials rather than on the more traditional safety approaches. One element of this has been the establishment of the Biosecurity Office at RIVM which disseminates information about policy initiatives to organizations that work with high-risk biological materials. In addition, it is supporting the activities of an interdepartmental working group of the Dutch government, in which 6 ministries coordinate their regular responsibilities and activities in the field of biosecurity. [143]

In recent years, additional thought has been given to Dual use research of concern (DURC), something that has been spurred by research related to the transformation of the H5N1 virus conducted at the Erasmus University of Rotterdam and issues surrounding the publication of the results.[144] Consequently, the KNAW formulated a national code of ethics for scientific research for researchers working with biological materials.[145]

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[142] Communication from the Commission to the European Parliament and the Council of 24 June 2009
[143] http://www.bureaubiosecurity.nl/en/Mission_Scope
[144] For a perspective on developments, see http://globalbiodefense.com/2012/06/22/dual-use-research-of-concern-fouchier-h5n1-study-finally-published/
[145] "Improving biosecurity assessment of dual-use research," Royal Netherlands Academy of Arts and Sciences Biosecurity Committee, December 2013

In addition to these newer initiatives, there are already existing other responsibilities and activities in place.

In prevention and protection, vaccine development and vaccination programs are considered to be the most effective mechanisms to counter infectious diseases. Within the Netherlands, the actual development of vaccines is not taking place anymore. Current vaccination programs protect against 12 infectious diseases none of which are appearing on the A-list as presented in the first chapter. Of these A-list diseases, a vaccine is available for only one (smallpox).

In addition to these health security measures and as indicated above, biosecurity measures have focused on increasing awareness and also providing protective measures to organizations that handle biological agents.

Export control measures are in place as the Netherlands is a signatory to the Wassenaar Agreement, BTWC, and strongly supports the execution of UN Security Council Resolution 1540 and its ongoing comprehensive review of the incorporation of legal measures by nation states to counter the proliferation of WMD to non-state actors. Dutch intelligence services cooperate in the shared counter-proliferation unit, informing the military and government concerning CBRN programs of other countries and monitoring the circulation of dual-use knowledge and materials.

The High Tox Lab at TNO provides an environment to develop protective measures against highly toxic chemical and biological agents. Regarding surveillance and biodetection capabilities, BioSparq, a demonstrator instrument for the Dutch defense organization, was terminated in 2013. The MoD is aiming to have new detection capabilities in place by 2017.[146] RIVM coordinates the national surveillance program in which methods are being developed that can track the origin and progress of infectious diseases. In addition, there is the CBRN response unit at RIVM, which consists of one vehicle that can analyze objects on potential suspicion of containing biological agents. Also, the National Laboratoria Network on terrorism assaults (LLN-ta) provides measurement and analytical capabilities during a terrorist threat or actual attack.

With respect to response and recovery, the CBRN school and training units, which are part of the defense organization, provide training to first responders (such as military, police and firefighting units, health authorities) to deal with the widespread exposure of CBRN materials to the Dutch population.[147] Health management protocols for physicians, medical assistants, and potential collaborators with these professionals provide various guidelines for identifying and managing people showing suspicious disease symptoms. The identification can be extremely difficult given that the occurrence of some major diseases has been extremely seldom and given that some of the signs can be mistaken for other more common diseases. With respect to the management of an outbreak, protocols have not changed considerably over the years. The question is whether these, e.g., in the case of ring

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[146] CBRNe World, www.cbrneworld.com, December 2013, p. 8

[147] See also, Voortgangsbrief Nationale Veiligheid, Tweede Kamer, vergaderjaar 2014–2015, 30 821, nr. 23

vaccination, are still sufficient to deal with unrecognized patterns of an outbreak of a major disease given the of technological and threat-related developments. [148]

[148] Bijvoorbeeld Draaiboek Bestrijding pokken, Landelijke Coördinatie Infectieziektebestrijding RIVM - Centrum Infectieziektebestrijding, juli 2009 (wijzigingsdatum april 2013)

6 Conclusions

With numerous report being published, there is a new sense of urgency regarding biological weapons and the biological threat. Much of this urgency is owed to technological advances in biotechnology and the concomitant attraction to non-state actors, in addition to that of nation states, to use biological agents as weapons due to their financial appeal and diverse impact. The relative ease with which pathogenic microorganisms, as possible ingredients for biological weapons, can be obtained, and the intent of non-state actors to use biological weapons based on historical precedent and recent increases in international terrorism, call for a renewed focus on this field.

Actors with malicious intent will be increasingly less restricted to obtain biological agents and transfer these into weapons. While nowadays significant level of expertise and tacit knowledge is still required for successful delivery and disease manufacture, the ease of microbiological manipulation and the level of sophistication of, for instance, DIY-biologists or growing numbers of bio-science students is increasing. More and more methods are becoming available to synthesize or manipulate DNA.

The difficulty of acquisition and maintenance of *large* quantities should not be underestimated. Previously, pathogens of large quantities and with high longevity were essential to fulfill their role as state-run offensive weapons.

But today, the development and production requirements for weaponization for non-state actors are considerably lower. In that sense, it could be argued that possession as such could already trigger some societal impact and potential panic responses in tense times.

In light of these technological advancements, the dynamics are further catalyzed by changes in the global security context. Increasing media references to the possession or capture of biological agents, such as anthrax or ricin, by non-state actors, decentralization of terrorist networks leading to individual, small-scale attacks of which the preparation thereof remains undetected, and the anticipation of a larger-scale attack, suggest that reinforcing and strengthening present biosecurity and biodefense architecture are or should become a bigger priority in the Netherlands, the United States (U.S.), the United Kingdom (UK), and Austria.

Due to the new dynamics of the threat and the limited resources that are currently allocated to countering the threat, it seems unlikely that the Netherlands, or other governments for that matter, is sufficiently prepared to deal with the requirements of this situation. While there is much in place that counter the outbreak of naturally developing contagious diseases (e.g., flu pandemics, zoonoses), improvements are needed in the coordination among current public and private organizations, in the clinical knowledge of identification of infectious diseases that have not occurred in the decades, in the preparation (detection) and protection (e.g., materials or vaccines) of first responders in affected areas, and the funding of research and development, specifically focused on the biological threat.

Glossary

Pathogen – a bacterium, virus, or other microorganism that can cause a disease.

Toxin - a poison of plant or animal origin, especially one produced by or derived from microorganisms and acting as an antigen in the body.

Dual use - (of technology or equipment) designed or suitable for both civilian and military purposes.

Dual use Research of Concern -- Dual use research of concern (DURC) is life sciences research that is intended for benefit, but which might easily be misapplied to do harm.

Biosafety – the measures taken to protect civilians from the release of harmful biological or biochemical substances from laboratories

Biodefense - defensive measures taken to protect against an attack using biological weapons.

Biosecurity - procedures or measures designed to protect the population against harmful biological or biochemical substances.

Biological Weapon - a harmful *biological* agent (as a pathogenic microorganism or a neurotoxin) used as a *weapon* to cause death or disease usually on a large scale.

Wassenaar Arrangement (on Export Controls for Conventional Arms and Dual-use Goods and Technologies) – The Wassenaar Arrangement was established to contribute to regional and international security and stability by promoting transparency and greater responsibility in transfers of conventional arms and dual-use goods and technologies, thus preventing destabilizing accumulations. Participating States seek, through their national policies, to ensure that transfers of these items do not contribute to the development or enhancement of military capabilities which undermine these goals, and are not diverted to support such capabilities.

BWC -- Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their Destruction. The Biological Weapons Convention (BWC) is the first multilateral disarmament treaty banning the development, production and stockpiling of an entire category of weapons of mass destruction, opened for signature on 10 April 1972. The BWC entered into force on 26 March 1975.

Annex

Cases of BW usage[149] [150] [151] [152] [153]

Case	Ideology	Motivation	Scale of Attack	Agent used	Outcome
Weather Underground (1970) - U.S.	Revolutionary, opposing the US hegemony	Demonstrate the impotence of the US federal government	Small-scale	Unspecified BW, planned delivery through the contamination of urban water	Did not materialize, hoax
R.I.S.E. (1972) - U.S.	Eco-terrorist, single issue ideology	Eliminate humanity in order to prevent the destruction of nature	Large-scale	Typhoid fever, diphtheria, dysentery, meningitis planned delivery through aerosol and contamination of water	Attacks aborted
Red Army Faction (1980) - Germany	Left-wing revolutionary	Eliminate German political and business leaders	Small-scale	Botulinum toxin	Hoax
Rajneeshee Cult (1984) - U.S.	Extremist religious group, pursuing a tangible political goal	Seize political control of a county by incapacitating voters	Small-scale	Salmonella Typhimurium, contamination of food in restaurants	751 cases of food poisoning, no fatalities

149 Representative examples of BW usage which have also received media attention and serve to illustrate differing intents.
150 Tucker, Jonathan B. "Historical Trends Related to Bioterrorism: An Empirical Analysis" 5, no. 4 (1999): 498–504.
151 "'U.S. Officials Declare Researcher Is Anthrax Killer.'" *CNN*, August 6, 2008. http://edition.cnn.com/2008/CRIME/08/06/anthrax.case/index.html.
152 Cronin, Audrey Kurth. "Terrorist Motivations for Chemical and Biological Weapons use: Placing the Threat in Context." Congressional Research Service, 2003.
153 Mohtadi, Hamid, and Antu Murshid. "A Global Chronology of Incidents of Chemical, Biological, Radioactive and Nuclear Attacks: 1950-2005." U.S. Department of Homeland Security, 2006.

Minnesota Patriots Council (1991) - U.S.	Right-wing, anti-government movement	Cause harm to government officials	Small-scale	Ricin, planned to deliver through DMSO and aloe vera cosmetics, or aerosol	Attack aborted
Aum Shinrikyo (1995) - Japan	Religious extremist group with an apocalyptic worldview	Cause mass fatalities in order to bring about the armageddon	Large-scale	Clostridium botulinum and B anthracis, Q fever Ebola through aerosol dissemination	Multiple attempts, no fatalities due to preparation and dispersal problems
Larry Wayne Harris (1998) - U.S.	Right-wing group member	Separate US only for whites and expressing criticism of the federal government	Small-scale	Plague and anthrax, disseminating it through crop-duster aircraft	Arrested before attack could take place
Anthrax Mail Attacks/ 'Amerithrax' (2001) - U.S.	Mentally disturbed individual, allegedly having criticism against the federal government	US government officials, media outlets	Small-scale	Anthrax disseminated through mails	5 people killed, 22 infected
Planned Chechen rebel attack (2002) - North Caucasus/Russia	Separatist groups striving for Chechen independence from Russia	Allegedly against Russian soldiers	Small-scale	Anthrax through contamination of food or water	Attack prevented by counterterrorist forces
Al Qaeda London reported plot (2003) - UK	Extremist religious terrorist group with the aim of destroying the 'infidels' and creating a fundamentalist Islamic political and social order	Unknown	Probably large-scale	Ricin	Terrorists were arrested before the planned attack

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