CHAPTER FOUR

TECHNOLOGY

1. Technology will continue to shape the social, cultural, and economic fabrics of our societies at the individual, community and state levels across the world. New and emerging technologies offer enormous opportunities for raising productivity and living standards, improving health, and conserving natural resources. The introduction of Artificial Intelligence (AI), autonomous systems, additive manufacturing, robotics, nanotechnology, chemistry, bio-technology and a significantly improved human-machine interface has the potential to help humanity solve problems. However, these technologies have the potential to create disruption and might result in large scale changes to employment while raising ethical concerns and instability. These technologies may also bring new hazards, requiring an improved capacity for risk assessment and management.

2. Continued development across the range of technology is enabled by exponential advances in the computing power described by Moore's Law. Greater affordability of digital technology, ubiquitous wireless networks and mobile devices have created the conditions for users to connect and communicate anywhere and at any time. The digitalization of society, sharing of information, and leveraging of ever-increasing computer power will lead to significant advances across a wide swathe of applications. The ability to combine and recombine these technologies, to build on existing advances, will drive innovation. That said, societal expectations that technology can solve most problems might be unreasonable.

ALTERNATIVE VIEW - AI AND THE HUMAN-MACHINE INTERFACE:

Technological developments generally, but AI specifically, are expected to enable humans to achieve a profound new state. Advances in genetics, nanotechnology, and AI will dramatically increase human longevity. Intelligent machines will become more human at the same time that humans become significantly augmented by technology. In the past machines have automated manual labour; in the future they will become capable of automating intellectual tasks. This should result in a new age of collaboration between humans and machines. While some argue that such changes will bring abundance, others focus on perils, disruptive or unforeseen effects of rapid development.

> "The introduction of Artificial Intelligence (AI), autonomous systems, additive manufacturing, robotics, nano-technology, chemistry, bio-technology and a significantly improved human-machine interface has the potential to help humanity solve problems."

CH 4.1

RATE OF TECHNOLOGY ADVANCE

3. Advances in technology and innovation will accelerate as they are fuelled by continued exponential increases in computing power and advances that augment human intelligence. Though not all technologies advance simultaneously, improvements in single technologies lead to advances in others in an amplifying way. This is likely to lead to surprising combinations and novel applications, resulting in both positive and negative impacts, but will most certainly fuel innovation across the breadth of commercial and defence applications.

4. The rapid rate of advancement in technology is significantly leading the development of supporting policy and legal regulations. For example, AI and autonomous system technologies will challenge moral values and ethical principles. In light of continued population growth and a greater number of users connected to the Internet, the demand for energy to run this vast, growing and complex network will increase.

> "AI and autonomous system technologies will challenge moral values and ethical principles."

IMPLICATIONS

a. ***Rapid development of technology challenges interoperability.*** While new technologies may provide tools to further improve interoperability, the disproportionate rates of technological development amongst Alliance Nations could lead to compatibility issues. Additionally, the rate of advancement, along with the potential for unanticipated employment of emerging technologies, increases the level of uncertainty. Adaptive mind-sets and technological awareness will be needed to keep pace with and facilitate the adoption of new technologies.

b. ***Increasing legal and ethical concerns***. New technologies, such as offensive cyber, AI, autonomous systems and human enhancement, are not yet widely accepted. Divergent ethical and legal interpretations, and acceptance of the evolving technologies, create differing levels of adoption and a reluctance to partner with Nations that employ such technologies in military operations. Policy and legal frameworks will need to keep pace with accelerating technological change.

c. ***The rate of technical advancement challenges acquisition and life-cycle management processes.*** Exploitation of state-of-the-art technology will require a change to defence and security organizations' acquisition and life-cycle management processes. Programmes today, and in the future, will require the flexibility to conduct technology insertion at every stage of design, build, delivery and service in the life-cycle of major military equipment. The procurement system must retain the flexibility to incorporate the latest technology at any point of the life-cycle.

CH 4.2

ACCESS TO TECHNOLOGY

5. The ability of individuals, states and non-state actors to access technology has significantly increased. While current acquisition processes could hinder the fielding of new technologies within the Alliance, potential adversaries could gain advantage as some sensitive technology becomes more widely available. The increased access to technology empowers individuals to conduct research and development and to operate in new technology areas that are outside the control of states and commercial business. Moreover, while the international community of states is bound by norms, regulations and international agreements, some states and non-state actors may not be so observant. Alliance capabilities will need to keep pace with the evolving technological landscape that will drive faster obsolescence thus reducing capabilities over time.

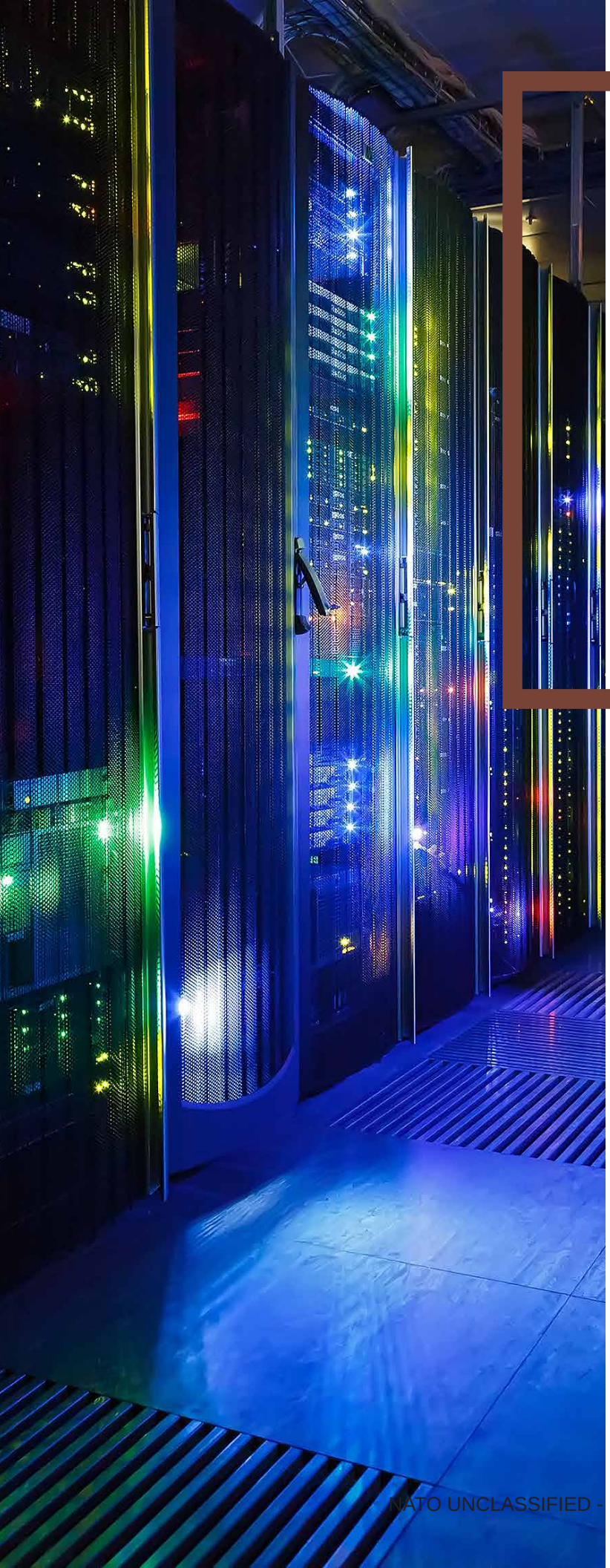
IMPLICATIONS

a. ***Access to technology enables disruptive behaviours.*** The current near-monopoly held by major state powers on the possession of high-tech weapons continues to decrease, allowing smaller states and non-state actors to acquire

disruptive technologies. A broad array of low-cost, unsophisticated technological advancements, such as drone and robotic technologies, are readily accessible and can be employed innovatively as weapons.

b. ***Uncontrolled access to technology challenges existing frameworks.*** Technology advancements continue to outpace the international community's ability to develop compliance strategies, legal and policy frameworks. Some states and non-state actors may be less constrained in how they employ unproven technologies. One example where this is particularly acute is the leveraging of dual-use components in the acquisition of WMD by states and non-state actors.

> "Current near-monopoly held by major state powers on the possession of high-tech weapons continues to decrease."



CH4.3

GLOBAL NETWORK DEVELOPMENT

6. Interconnectedness and digitalization have increased the volume and value of information. The scale and speed of networks in cyberspace allow individuals and groups immediate access to vast amounts of data and knowledge. Data is a strategic resource. Massive deployment of sensors through the Internet of Things and real-time processing of the collected data will enable a new set of analytical tools that enhance decision-making. The massive amount of information presents lesser challenges for processing and storage; however, bandwidth and connectivity could be a problem as they lag in development compared to other areas.

7. The number of sensors in the environment is increasing exponentially. Networks are becoming ubiquitous, creating a denser and broader situational awareness. These networks will become embedded in our lives and interwoven into everything that we do, seamlessly fading into the background. Furthermore, these networks are increasingly being created and used in a distributed manner, with no central node or control, which when combined with a lack of governance, creates challenges between utility and privacy. As states try to govern, defend and control this notional environment, some networks will

establish themselves in ungoverned areas such as the 'dark web'.

8. The cycles of technology-induced societal and economic change are becoming increasingly fast. The Internet has promoted increased citizen advocacy and government transparency. Increased access to information, particularly via social media, can be a catalyst for social mobilization; for example, an event that in and of itself would not be significant can be amplified when shared an enormous number of times across a network.

9. Finally, global networks provide the opportunity for the dissemination of information to large audiences for shaping global opinion. For example, where such networks are under state control, information generated by external sources can be withheld, modified or censored, and a state's own message can be spread unhindered and without refute.

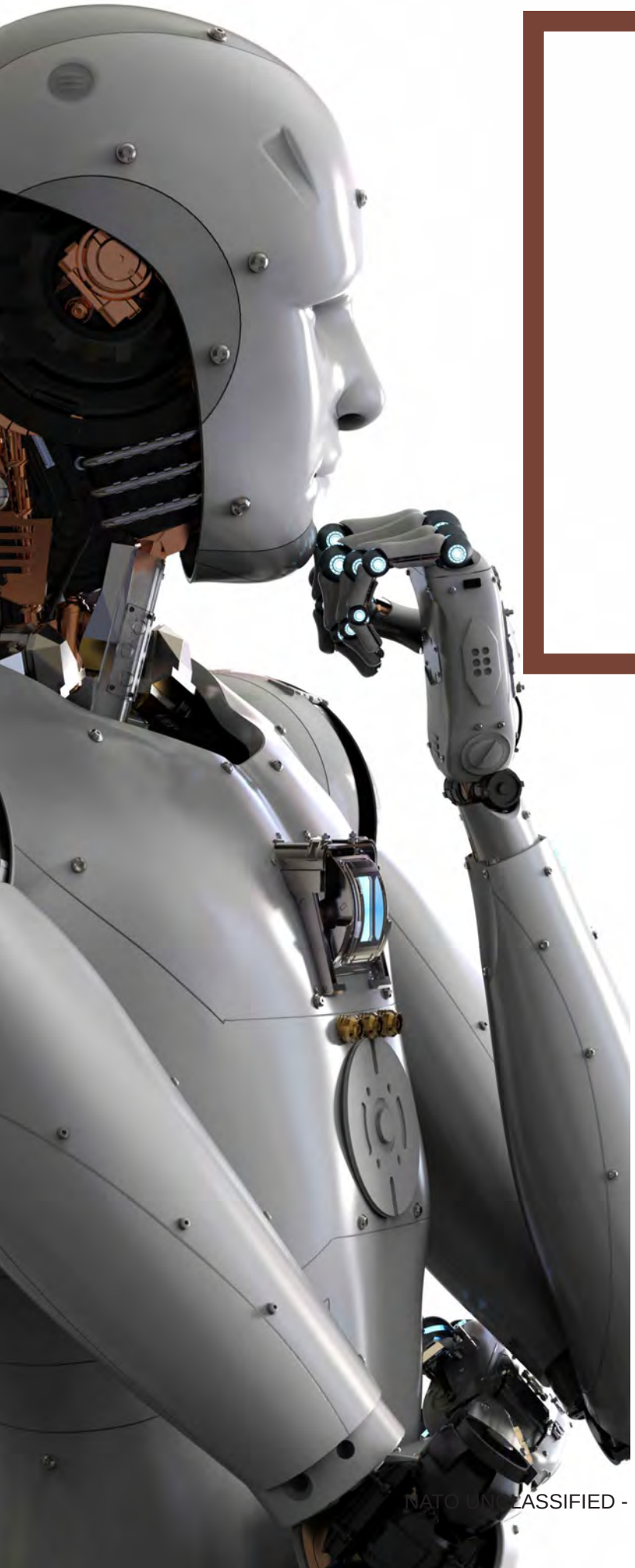
IMPLICATIONS

a. ***The increasing number of sensors, access to data and global networks generates operational vulnerabilities.*** States and non-state actors with malicious intent will have the ability to access information at an unprecedented rate, potentially gaining sensitive knowledge to use against members of the Alliance. This could increase the risk to NATO military forces operating in an environment of ubiquitous surveillance. Additionally, as access to data continues to increase, procedures will need to be developed or amended to consider the growing vulnerability of information.

b. ***Opportunities to exploit sensors, data, and global networks.*** Use of the rapidly evolving open-source and commercially available data will enable the Alliance to meet the challenges of the future information environment. NATO needs to develop capacities to detect both subtle and seismic changes in the information environment and understand them on local, operational and global levels.

c. ***Adversaries will use global networks for dissemination of false or misleading information.*** Adversaries will increasingly use global networks to disseminate false or misleading information to influence public opinion and decision-making. The Alliance will require an agile approach to strategic communication in order to maintain an edge.

> "Data is a strategic resource."



CH 4.4

DOMINANCE OF THE COMMERCIAL SECTOR IN TECHNOLOGICAL DEVELOPMENT

10. The commercial sector will be increasingly dominant in technological development. Reductions in defence-specific research brought about by reduced budgets, and the application of commercial innovations to military requirements, has seen the commercial sector overtake defence research and development. There is an increasing need to leverage the commercial sector to support defence-specific research and development. Growing commercial entry into sectors such as space exploration/exploitation will strengthen this trend.

11. Governments may not be able to economically adapt technologies for their specific uses because of commercial ownership of intellectual property. As a result, some Nations may be challenged to tailor the latest commercial innovations for defence and security purposes. Moreover, the potential exists for adversaries to gain access to technological developments and knowledge by investing in corresponding commercial entities.

12. If a comprehensive view of the defence industrial base is not maintained, then critical skill-sets associated with some niche areas might be lost. Although new relationships

> "The commercial sector has grown in areas where states used to dominate."

are being forged with non-traditional defence companies, the commercial sector may not address some areas of science and technology that are critical for defence innovation. Intellectual capital will flow where economic resources and opportunity lie. Moreover, there may be a geographic consolidation of some technologies within states that have more control over their commercial sector (e.g. supercomputer development in China) resulting in a greater ability to exploit new technologies.

IMPLICATIONS

a. *State approaches are not keeping up with the commercial sector.* The changing economics and technology of production and distribution, along with the shifts in consumer demand and the emergence of 'smart' products, are pushing the commercial sector to explore radical new ways of creating and capturing value. The commercial sector has grown in areas where states used to dominate, such as space exploration technologies and the defence industry. As a result, commercial off-the-shelf solutions have become increasingly available and are appealing due to the lower cost and the rapid rate of technological advancement. However, using these technologies will continue to pose security concerns.

b. *The Alliance will lose perishable skills that cannot be easily recovered.* With the reductions of military budgets, the overall defence industrial base has had to consolidate, and niche skills have been lost. As a result, fewer system integrators remain across the Alliance. Protection of the defence industrial base through targeted research and development (R&D) initiatives has been successful in some Nations, though R&D funding over the next decade is likely to continue to decline. Nations will require re-investment in niche R&D areas, and focus on long-term acquisition strategies, to ensure an organic defence industrial base is viable for the future. In this regard, the NATO Science & Technology Organization (STO) and ACT foster innovation and multinational cooperation to actively pursue initiatives that can offer fruitful options to Nations to mitigate these negative trends.

CH 4.5

TECHNOLOGICAL DEPENDENCIES

13. Operational effectiveness has become overly reliant on technology. For example, it has become very difficult to operate without wireless communication, global navigation satellite systems, or the Internet. The scale, pace of advancement and cost have made it unattractive for governments to develop redundant technologies solely for military use.

IMPLICATIONS

a. ***Reliance on certain technologies will create vulnerabilities.*** The reliance of the military on certain technologies, such as space-based communication and navigation systems, reduces the resilience of the force if these technologies are denied. Old skills may need to be relearned and analogue technologies that are less vulnerable could be considered as back-ups. New applications are heavily reliant on additional bandwidth for data exchange and connectivity that requires use of commercial solutions. Resilience needs to be considered in design and information exchange requirements.

b. ***Necessity to protect critical civilian infrastructure.*** Governments and militaries are increasingly relying on the private sector to provide a range of services, including information and communications, power generation and distribution, oil and gas infrastructure, transportation, water, and emergency services. Non-government ownership of critical infrastructure and its voluntary or self-regulatory structure leaves essential services vulnerable to disruption. Given the continued military reliance on this infrastructure, governments will need to invest in its protection. The process of enhancing protection will continue to move slowly, as governments struggle to formulate affordable solutions to protect infrastructure.

c. ***Over expectations from technological solutions.*** Improvements in technology may lead society towards an expectation that it can solve most problems. However, in order to address big challenges, political leaders and the public must first understand the problem and its nature, then have the ambition to solve it and have the support of institutions, regardless of the availability of technology.

> "The reliance of the military on certain technologies, reduces the resilience of the force if these technologies are denied."

CHAPTER FIVE

ECONOMICS / RESOURCES

1. Globalization has shifted economic power. While globalization has opened markets and intensified international economic integration, it also has increased the economic influence of emerging countries. The advent of emerging markets has shifted jobs with cheap labour and eroded the economic base for the working middle class in Western countries, fuelling social inequality. This has direct implications for the ability of Western governments to generate tax revenue and may ultimately lead to a rejection of globalization, as observed in the rise of populism and anti-globalization political stands. Although growth in globalization is expected to continue, it is likely to be at a slower pace due to increases in nationalism, protectionism and regionalization.

2. Technology and free trade have opened markets, increasing opportunity and access but causing vulnerability. Access to and use of big data, and vastly interconnected financial systems have provided the net effect of enabling commodity and market globalization, thereby increasing the speed of transactions, and the transfer of goods and services. At the same time, they also have the potential to disrupt national economies due to lack of control, and the threat from cybercrimes and attacks. As national economies become more interdependent, the carry-over effect of any financial disruption, both regionally and globally, could act as a contagion with severe consequences to market stability.

3. Global population and economic growth, including a burgeoning middle class, will exponentially increase demand for natural resources. The increased production of technology-related goods is another factor driving growth in demand, particularly for rare earth materials. Although the share of renewable energy is likely to increase up to 30% by 2030, oil and other fossil fuels are expected to remain the main source for transport and electric power generation for the next two decades. Additionally, water, energy and food scarcity will present a continuing source of stress on the global community.

4. Defence expenditures will reflect changing government priorities. The existing burden on national economies will be increased due to the rise in competing demands for limited budgets. This may result in reduced defence spending. To mitigate shortfalls, multinational solutions could offer answers by leveraging federated capabilities, thus the burden of building, developing and maintaining a capability could be shared by nations.

"Oil and other fossil fuels are expected to remain the main source for transport and electric power generation for the next two decades."

CH 5.1

GLOBALIZATION OF FINANCIAL RESOURCES

5. The global economy is projected to grow at an average of just over 3% per annum by 2050; however, a slowdown in global growth is expected around 2020 as the rate of expansion moderates in China and in other major emerging economies. China is likely to become the largest economy by 2026-2028. India has the potential to become the second largest economy in the world in PPP terms by 2050.

6. The growth in global debt in all sectors (government, corporate, and household) is at unprecedented levels as a percentage of Gross National Product (GNP). The International Monetary Fund (IMF) reported that global debt had grown by $57 trillion and reached $152 trillion in 2015, a level higher than at the 2008-2009 financial crisis ($112T). Major economies have not decreased their debt-to-GDP ratios since 2007. This is unsustainable and could precipitate a domino effect across financial markets far greater than the worldwide economic collapse of 2007. Innovative solutions to address the challenges and decompress the debt bubble to avert crisis will need to be developed.

7. An increasingly interconnected global financial system is more vulnerable to attacks by both state and non-state actors. Monetary systems outside of governmental structures are also developing, and the anonymous nature of cyber currency, like Bitcoin, increases susceptibility to misuse. Additionally, the growing use of transnational financial networks increases vulnerability to abuse by organized crime networks and non-state organizations using malware and hacking. Conversely, Bitcoin and digital finance, using technologies such as Blockchain, may introduce a digital revolution from "Internet of information to Internet of value" with positive consequences for growth in developed and emerging economies.

IMPLICATIONS

a. ***Erosion of trust in increasingly fragile financial institutions.*** Disenfranchisement and disillusionment with the financial system have increased as a result of globalization. Interconnectedness of the markets makes them increasingly susceptible to a contagion scenario. Any future global economic crisis might spark populist and protectionist sentiments and a new rise in nationalism. This could have far-reaching implications for the solidarity and cohesion within the Alliance, as Nations become less inclined toward burden sharing and defence expenditures.

b. ***Lack of visibility on transactions supporting criminal and terrorist activities.*** Financing of terrorism and organized crime will become less visible and transactions less traceable through the exploitation of decentralized networks. This may challenge governments' abilities to regulate and repress criminal activities and terrorism.

c. ***Growing interdependencies may reduce potential for interstate conflict.*** Due to economic interdependencies in financial markets, there is an increase in the threshold for major state-on-state conflict. The reduced tendency of interstate conflict represents a positive effect, with the reduction of the risk of major conflicts, but could potentially promote hybrid warfare, as nations will favour actions that are short of conventional war.

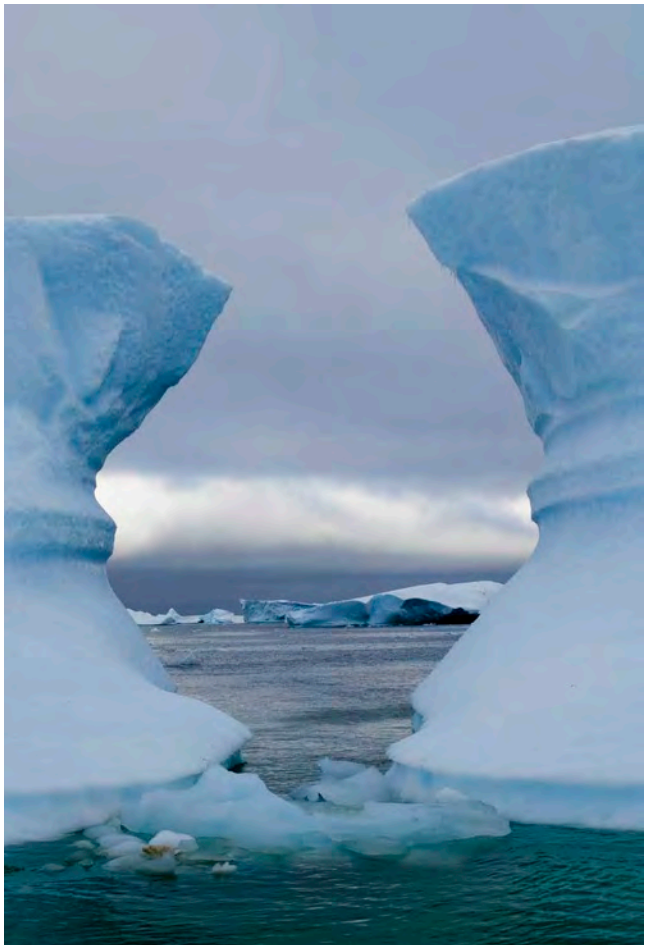
"Financing of terrorism and organized crime will become less visible and transactions less traceable through the exploitation of decentralized networks."

CH 5.2

GEOPOLITICAL DIMENSION OF NATURAL RESOURCES

8. Emerging technologies and the exploration opportunities availed by climate change may allow the exploitation of mineral and energy resources in previously inaccessible areas, such as the High North, and in possibly disputed regions, such as the South and East China Seas. The United States Geological Survey estimates that over 87% of the Arctic's oil and natural gas resources (about 360 billion barrels of oil equivalent) are located in the Arctic basin. As the polar ice cap continues to recede, allowing increased resource exploration in the High North and access via the Arctic Shipping Routes, territorial claims and economic exclusion rights will be asserted by nation states. Although the likelihood of a conventional offensive military operation in the Arctic is very low, militarization efforts mainly from Russia, should not be ignored. Similarly, China's actions and intent in the South and East China Seas pertaining to island claims and economic exclusion zones will foster tension and territorial disputes with its regional neighbours and the USA. These regions are important for global sea trade, hold significant natural resources and promise extensive reserves of oil and gas.

9. In tandem with climate change, the water, energy and food nexus will present a continuing source of stress for the global community. Climate change will affect how and where we grow food to meet the demands of an increasing world population. Water security and the stewardship of water, the sustainment of arable land for food production and the balance with the competition for biofuel demand will present a major challenge in resource management. Additionally, the increasing global consumption of meat and dairy products will require more arable land to support livestock. Production rights and shared resources, particularly pertaining to water supply where sources extend across national and territorial boundaries (e.g., lakes and rivers), can give rise to regional partnerships and strengthened political leverage, or conversely, be a source of boundary strife and conflict.



10. New technologies are expected to provide improved energy storage, increased energy efficiency, and new and renewable energy sources, all with the potential to reduce power generation costs, pollution and greenhouse gases. Climate change and the increasing regulations on fossil fuel emissions may have profound implications for national economies, as well as private companies, from both the supplier and user perspective.

IMPLICATIONS

a. ***Natural resources will play an increasing role in power politics.*** Natural resource exploitation and the leverage it provides has the ability to significantly shape the geopolitical arena. Control over natural resources could lead to the rise of new developing powers and promote new alliances that will challenge standing coalitions, as nations adjust to national and/or regional self-interests.

b. ***Resource-driven crises remain a constant.*** Fossil fuels are likely to remain the principal resource for global energy, but their use will face an uncertain period of adjustment to market conditions and the prospect of a new policy landscape after the Paris agreements. Access and control of resources will likely increase competition in disputed regions and introduce the potential for conflict.

c. ***Climate change has the potential to disrupt traditional areas of food production while offering new opportunities.*** Some regions may benefit from climate change, potentially with longer growing seasons or expanding arable regions. Conversely, other areas may be impacted by drought or the loss of access to traditional agricultural areas. Overall, the negative impacts of climate change will outweigh the possible opportunities, necessitating greater cooperation and cohesion to address resource-scarcity (i.e., the water, energy, and food nexus).

"Access and control of resources will likely increase competition in disputed regions and introduce the potential for conflict."

CH 5.3

INCREASED INEQUALITY

11. Widening inequality within nations is one of the most pressing trends that will continue to fracture and polarize societies. The distribution of wealth has tilted predominantly in favour of the extremely wealthy at the expense of the working middle class in the West. The middle class has felt the squeeze due to stagnation in real earnings, loss of benefits and overall compensation as the private sector has sought to reduce expenses by outsourcing support and labour costs and shifting from full-time to part-time employment. The upper 10% of population in net wealth have experienced the biggest gains since the recovery of the 2007 economic collapse, with the gains becoming exponential for the upper 1% to the upper 0.01%.

12. On the other end of the spectrum in the developing world, the poorest have realized an improvement in quality of life through access to basic services (water, healthcare, food, shelter) and have modest increases to income. Although the first UN Millennium Development Goal of halving the proportion of people whose income was less than $1.25 a day (considered as “extreme poverty”) was not completely achieved by 2015, 2 billion people did move out of poverty.

> "Widening inequality within nations is one of the most pressing trends that will continue to fracture and polarize societies."

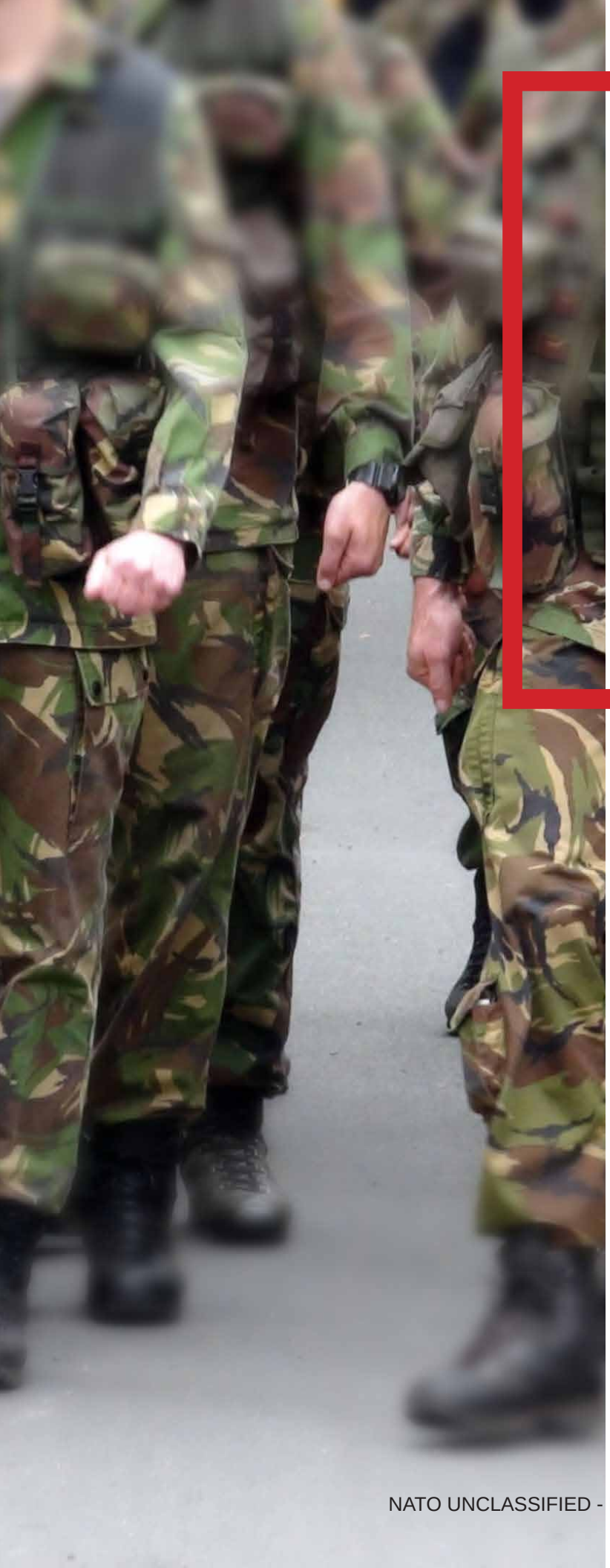
The new UN Sustainable Development Goal remains to eradicate "extreme poverty" completely by 2030.

13. While inequality increased within nations, it has decreased between nations. Middle-class incomes in China and India have drawn closer to the stagnating incomes of the middle classes in the developed world. Nevertheless, even if a rapidly growing consumer class exists, it may mask a rise in global income inequality. On the other hand, over 80% of global income differences is due to a still significant gap among the average incomes in different countries, and unskilled workers' wages in rich and poor countries often differ by a factor of 10 to 1. This income disparity will affect the inequality among world populations and be a catalyst for migration as people seek a better quality of life and opportunity.

IMPLICATIONS

a. *Differences between the haves and have-nots will increase.* The widening chasm between the haves and have-nots will continue to cause social conflict, polarization, populism, nationalism and isolationist policies (protectionism), affecting women and men, young and old differently. Employment is the largest determinant in viable sustainment of the middle class and reducing inequality. However, employment opportunity in the West will be reduced due to outsourcing jobs to cheap labour markets and increased automation.

b. *Increased inequality will drive migration.* Inequality is a catalyst for migration and can have second order effects such as fractured and conflictual societies, violent extremism, nationalism, isolationism, and protectionism. Migration caused by inequality is expected to continue well into the future and will drive rapid urbanization, the rise of megacities and slum formation. The rise of megacities could also amplify the gap between urban and rural societies. Additionally, mass migration may increase civil unrest and pose a threat to security in the country of origin, as well as in transit and receiving countries.



CH 5.4

DEFENCE EXPENDITURE CHALLENGES IN THE WEST

14. Political commitment to long-term defence sustainment and procurement programmes is driven as much by internal factors as it is by world affairs. Nations need to balance competing domestic demands for budget share with their capacity to generate a growing and robust tax revenue stream. Servicing national public debt is taking a larger percentage of national budgets, as debt-to-GDP ratios have ballooned since 2007. Major government programmes, such as social welfare, are under significant stress to keep pace with the demands of an ageing population, as there are more recipients and fewer payees into the system. Education, modernization, and infrastructure issues are often more prominent and visible, pushing defence funding to a lower priority.

15. While worldwide military expenditures decreased between 1988 and 2000, they increased again from 2001 until 2012 and have stabilized in recent years. USA and European military expenditures have declined in the drawdown from the Iraq and Afghanistan wars, but also as a consequence of economic crisis. In Central and Eastern Europe, however, the trend turned upwards with a 7.5% increase in defence spending after the illegal Russian annexation of Crimea and the subsequent

crisis in Ukraine. The Wales Summit declaration formalized the Alliance Nations' intent to reverse the trend in budgetary decline and reach the guideline of a 2% GDP defence spending within a decade (2024). Nations were able to change a decreasing defence spending trend in 2016, which resulted in an increase by 3.8% in real terms among European Allies and Canada. Projections to 2045 show an increase in military spending among most major world powers.

IMPLICATIONS

a. ***Increased defence spending due to rising regional tensions and fair burden sharing.*** As Russia increasingly asserts claims on its 'near-abroad' and economic exclusion rights, disputes with regional nations will heighten and maritime lines of commerce will be threatened. Reactions to Russia's re-assertiveness, long-term strategic ambitions and return to power politics is driving NATO to adapt its capabilities and readiness posture. Progress toward meeting Warsaw and Wales commitments is likely to increase defence spending and address fair burden sharing concerns. However, a potential increase in Western defence spending might create a security dilemma and start an arms race, as was the case during the Cold War.

b. ***Realignment of expectations with national fiscal priorities.*** Competition and stressed government budgets will limit NATO's reaction options. Levels of ambition and expectation will have to align with fiscal realities and constraints. Individual nations may be forced to specialize in development of specific military capabilities and form collaborative partnerships in order to meet their defence requirements and manage costs. This may create potential critical shortfalls in the fulfilment of the Alliance Minimum Capability Requirements.

"Reactions to Russia's re-assertiveness, long-term strategic ambitions and return to power politics is driving NATO to adapt its capabilities and readiness posture."

CHAPTER SIX

ENVIRONMENT

1. Environmental issues are dominated by climate change and its far-reaching and cross-cutting impacts. A large and growing body of data, in particular the work presented by the Inter-Governmental Panel on Climate Change (IPCC) in its 5th Assessment Report, led governments to meet in Paris in 2015 at the 21st Conference Of the Parties (COP21), to discuss greenhouse gas emission targets to mitigate the causes of climate change. By COP22 in Marrakesh a year later, the Paris Agreement had been ratified by 111 nations representing ¾ of global emissions.

2. However, even if the targets were met today, any mitigation efforts would not have impact for at least two decades, and so climate change will continue along its current trajectory through 2035 and beyond. The consequence of this will be that oceans will warm, Arctic sea ice and glaciers will shrink and sea levels will rise. Rainfall patterns will change and overall surface temperatures will increase. The natural ecosystem and human habitats, agriculture, food and water systems will all be affected in some way. The instabilities caused by these changes, while not necessarily direct drivers, will exacerbate existing tensions in the human, political, and economic spheres, and for this reason climate change is often described as a Threat Multiplier.

3. However, scientific advances and increasing computing power mean that weather and climate prediction and early warning will become increasingly long-range, more accurate and available. Employing this knowledge with intelligent application of risk-based methodologies will allow governments and authorities to take positive steps to plan, prepare and respond to events that are related to climate, environment or natural disaster.

4. Aside from climate change, environmental security remains an area facing a multitude of challenges, including loss of biodiversity, stresses on water and food supplies and threats to other ecosystem services that directly or indirectly support human life. Much of the stress is a result of the demands of a rapidly growing population, its use of resources and its damaging, unsustainable activity. Disease outbreaks are growing in number and a pandemic outbreak, whether natural or engineered for bioterrorism, would threaten international stability. For the most part, the threats to environmental security will be compounded by the effects of climate change.

5. Natural disasters will have greater impact, partly due to increases in frequency and severity of extreme weather events, but also due to shifts in the areas and times of the year where these events may occur and to the growth in the size of exposed populations.

> "Climate Change is a Threat Multiplier. It not only threatens to exacerbate conflicts within and between States, it is itself a threat to international peace and security."

CH 6.1

ENVIRONMENTAL / CLIMATE CHANGE

6. Climate change is drawing unprecedented international attention because it impacts nearly all domains and is a compounding factor for other existing issues. The Paris Agreement is an indication that nations may take positive steps to reduce or mitigate the effects. However, short of employing extreme geoengineering, such as Solar Radiation Management and Carbon Dioxide Capture and Removal (SRMCDCR), which carry great technical, legal and political challenges and risk of unforeseen/unintended consequences, the effect of climate change along its current trajectory will continue unchecked over the next two-to-three decades, regardless of international mitigation efforts. As a consequence, direct impacts will be felt: Arctic sea ice will continue to shrink and thin, the Greenland ice sheet and glacier volumes will reduce, and the extent of near-surface permafrost in high northern latitudes will recede. In addition, sea levels will increase through ice-melt and ocean thermal expansion. Likewise, changes to rainfall patterns will occur, with climate projections indicating increases in precipitation in high latitudes and tropical regions, and decreases in mid-latitude and subtropical dry regions. There will be increased intensity and frequency of high surface temperatures and heatwaves.

7. The changes in climate will bring challenges and opportunities. Rising sea-levels will continue to threaten low-lying coastal states and regions and increase the impact of storm surge events. The movement of the temperature band suitable for key crops will lead to reduced yields in lower latitude regions along with increased water stress. But the same shift of temperature could result in increased productivity further north, including in regions where agricultural productivity is primarily limited by cold, and for crops that are able to benefit from the enrichment of the atmosphere with CO_2. Retreating Arctic ice will open up access to new resources and introduce the possibility of trans-Arctic shipping for at least several months of the year, which could cut distances between Asia and Europe by a third.

8. Changing climate regimes will also shape the security environment in numerous indirect ways that impose stresses on current ways of life, on individuals' ability to subsist and on governments' abilities to keep pace and provide for the needs of their populations. The costs of adaptation and mitigation can be extremely high and fall disproportionately across the globe, such that some of the world's poorest nations, which contributed very little to creating the crisis, will face some of the greatest challenges. The legitimacy of governments could be undermined by their inability to respond to evolving climate and environmental stressors, and thereby failing to uphold the implicit social contract with their populace. Where governance fails and populations migrate, power vacuums could be created, allowing other state and non-state actors to move in and take advantage of the situation.

9. The scientific evidence-based and general understanding of climate change is growing, and will be available for the Alliance to employ in a systematic way when conducting long-term planning and risk assessments. Many governments have begun implementing adaptation measures and the Alliance will need to consider its own adaptation plans as part of its strategic thinking. Additionally, defence organizations will be directly impacted by new climate-related legislation and by increased competition for the financial resources allocated for defence spending.

10. The global focus on climate adaptation and mitigation measures may also offer improved efficiency technologies, which could be beneficial to military forces, especially if they provide more efficient use of supply-chain resources, greater energy independence or improved resilience. Furthermore, a growing international willingness to invest and act together to combat this global challenge could in itself act as a unifying stabilizer in international relations.

11. Aside from climate change, the demand for natural resources is growing as a direct result of population growth, urbanization and improved living standards. Water and food security are growing concerns; in particular, demands for water are growing faster than population growth and are set to be unsustainable. Despite massive efforts and improvements in the past 20 years, an estimated 663 million people still rely on unimproved water sources, and 2.4 billion lack sanitation. The problems are worst in Sub-Saharan Africa, Oceania and Central Asia, with rural areas being affected the most. Globally, agriculture takes 70% of total water use, and energy production (the greater part of industrial consumption) accounts for more than 15%. Even with more efficient use in the future, demand from each of these sectors is set to grow and will challenge for greater shares.

12. Managing water allocation presents difficult choices, especially where supply crosses national boundaries. In some cases this has led to water treaties and acted as a force for stability, but in others, competition for water could lead to conflict. Where water scarcity or mismanagement exists, localized or even inter-state conflict can result. At the extreme ends of the scale, drought is assessed to have affected 50 million people in 2015 and flooding, 27 million. Water crisis is ranked as one of the top 5 risks in the 2017 Global Risk Report. Climate change is expected to exacerbate the problems, with rainfall patterns shifting away from already dry regions and towards wetter ones. More broadly, losses to bio-diversity and the stresses on eco-system services may reduce resilience and carry deep consequences that will be difficult to quantify or address.

13. The number of emerging infectious disease outbreaks is increasing year on year, due to population growth, increased urbanization and more abundant and rapid travel. Even with medical advancements and

> "Demands for water are growing faster than population growth and are set to be unsustainable."

> Weaponizing a pathogen is relatively easy and well within the grasp of would-be bio-terrorists.

better containment methods, nations would struggle with a serious pandemic outbreak. In addition to viral threats, more bacteria are becoming resistant to antibiotics, with resistance estimated to be responsible for over 2 million infections and 23,000 deaths in the USA in 2015.

14. The 1918 influenza pandemic killed in excess of 50 million people, and more recent epidemics, such as SARS, H1N1 and Ebola, albeit with far fewer deaths, have nevertheless caused huge social and economic disruption and have served to act as a warning for what could come. Weaponizing a pathogen is relatively easy and well within the grasp of would-be bio-terrorists. The response to Ebola highlighted deficiencies in almost every aspect of global defence against potential pandemics and "the conditions for infectious disease emergence and contagion are more dangerous than ever". The impact of a major pandemic would be globally destabilizing and could leave affected nations extremely vulnerable to external intervention.

IMPLICATIONS

a. ***Increased range of activities in the Arctic due to growing accessibility.*** The Arctic region will increasingly open to a range of activities, such as oil, gas and mineral exploration and exploitation, fishing and tourism by Arctic and non-Arctic nations, presenting opportunities and challenges that will need to be considered. Growing accessibility will also allow increased military use of the High North and Arctic regions.

b. ***Climate and environmental challenges to governance.*** Lack of effective governance may allow other state and non-state actors to exploit the power vacuum. Under-governed or un-governed areas due to newly inhospitable local climates or in the aftermath of pandemic could provide refuge or safe havens to potential adversaries.

c. ***Increased requirements for environmental awareness.*** Allies will need to consider climate and environmental stressors, extreme weather events, changes to seasonal weather patterns, as well as water and food security issues in their situational awareness and their planning processes. New data for improved climate and weather forecasting can be used to inform planners and decision makers.

d. ***Impacts of climate change adaptation and mitigation measures.*** Nations will need to improve resilience by addressing climate adaptation measures for their infrastructure and equipment. Increased pressure will probably be placed on defence to shoulder its share of climate mitigation plans as well. Adoption of new, efficient or renewable energy technology may help to meet this remit and prove militarily advantageous.

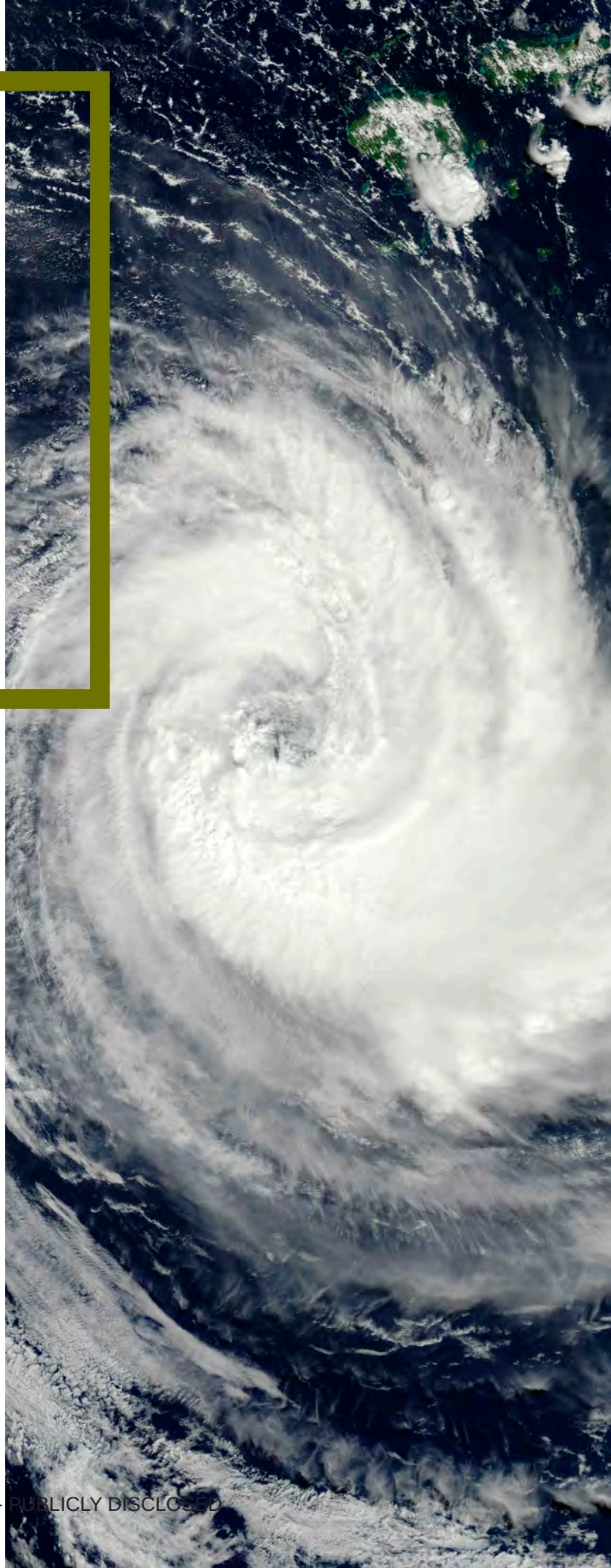
ALTERNATIVE VIEW - ARCTIC REGION NOT EXPLOITED AS ANTICIPATED:

The following factors may inhibit commercial expansion in the region: the economic balance of reduced fuel cost and transit-times due to shorter passage routes, against increased costs for ship strengthening, equipping, operating and insurance; the high costs and difficulties of maintaining infrastructure on thawing permafrost; the risk of environmental damage, and the massive clean-up costs and litigation that would be levied against those responsible for incidents and the license-issuing states. The Arctic will still be an exceptionally unforgiving operating environment, made worse by increased severe storm conditions as a result of climate change effects.

Sources: Lloyd's Chatham House, 2012. See also Financial Times Online, 2016. US Navy, 2014.

CH 6.2

NATURAL DISASTERS



15. Natural disasters will have increasing impact, partly due to overall increases in the severity and prevalence of severe weather events, but also due to changes in the regions and times of the year where these events may occur, and increases in the population, infrastructure and assets that are exposed. Regions that are accustomed to hurricanes have adapted over time to this threat by developing infrastructure standards to cope; similarly, arid regions have developed farming patterns to suit. However, with an expected rise in severe weather events and a change in their patterns, newly affected regions may struggle to actively adapt. This could be further compounded by cascading disasters, both natural and also manmade, such as the 2011 Japanese earthquake and tsunami that triggered the nuclear crisis in Fukushima Daiichi.

16. Some nations will not be able to cope with natural disasters and still meet the needs or expectations of their populations. It may be enough to force migration or displacement. There were 19.2 million new displacements associated with disasters in 113 countries across all regions of the world in 2015. Disasters accounted for twice as many new displacements as conflict (8.6 million). Climate

> With an expected rise in severe weather events and a change in their patterns, newly affected regions may struggle to adapt.

change, in tandem with people's increasing exposure and vulnerability, is expected to magnify the impact of natural disasters, as extreme weather events become more frequent and intense in the coming decades.

17. Natural disasters are likely to have differing effects on NATO Nations. While many of them may escape the extremes of change, there is an increasing likelihood that a Member Nation could suffer a major disaster, which could affect its ability to contribute to existing or emerging Alliance operations.

18. The interconnectedness and inter-dependence of global supply chains and the low stock-holding levels common in advanced logistic management are advantageous in terms of economic and resource efficiency and the ability to accurately meet demand without surplus. However, the leanness of the modern system and the small number of suppliers for some key materials and goods can also leave nations unwittingly exposed to serious impact and unexpected deficiencies in their resilience when the supply chains are disrupted even briefly by disasters on the other side of the world. For example, the March 2011 Fukushima disaster affected crucial automotive industry supplies worldwide, and again in April 2016, a double earthquake hitting Kumamoto, Japan, halted key production of Sony image sensors, used globally including by Apple.

19. On a positive note, predictions and early warnings will become increasingly far-sighted, and there is much that can be done to address the defence and security implications through intelligent application of risk-based methodologies to plan, prepare for and respond to events related to climate, environment or natural disasters.

IMPLICATIONS

a. *Increased requirement for Humanitarian Support.* Allies will more frequently be working in areas of humanitarian aid, which will require truly comprehensive (military, governmental and non-governmental) interoperability. Education and training schemes will need to encompass climate risk and humanitarian aid. Given the increased likelihood of civilian/military cooperation being required, enhanced understanding and trust will be needed between civilian and military entities, including non-governmental stakeholders, to ensure effective strategic coordination, planning and execution of disaster relief and humanitarian support operations.

b. *Unavailability of national military assets due to natural disaster.* A large scale, environmentally-triggered disaster within a NATO Nation is increasingly possible, requiring a major employment of their military to relief operations. As nations increasingly respond to disasters with the use of their military to aid civil authorities, there will be a subsequent effect on military training, readiness and availability of forces. This could affect the overall readiness of the Alliance.

c. *Increased requirement to improve resilience.* A better understanding will be required of the civil and military vulnerabilities of Nations to environmental, climate or natural disaster-related disturbances in the global supply and distribution system of food, water and key resources. This, along with the understanding of civil preparedness and interdependence between services, is an essential element for improving sustainment and developing NATO resilience.

CONCLUSION

> "NATO will continue to provide the main framework for collective defence of the Euro-Atlantic region."

"Looking into this future is challenging. However, the difficulty in looking ahead does not excuse the military professional from considering the demands of future war." *U.S. Joint Staff, JOE 2035*

1. The Strategic Foresight Analysis (SFA) is a collaborative effort drawing on expertise and resources from NATO and partner nations, IOs, industry and academia for identifying trends and implications that are likely to shape the future security environment. It is built upon the analysis of commonalities and differences in order to understand diverging visualizations of future challenges, opportunities and relevant implications facing the Alliance. The SFA provides a baseline for an Alliance long-term perspective that is essential to success in a period of unprecedented changes resulting from a dynamic and complex world.

2. The SFA highlights and discusses several debated issues, such as the fate of globalization, the impact of polarization, the future of AI, the rise of China and the redistribution of geostrategic power. While the West might be less dominant in the future economic order, NATO Allies can still influence the future security environment by the strategic choices that they make today. Although the levels of violence linked to armed conflict have shown a decreasing trend, the security environment around the Euro-Atlantic region has become more volatile, with a growing potential for interstate conflict and increased terrorism threat, polarization and regionalization. Rapid, and in some cases disruptive, changes associated with the shifts of power and challenges to the existing world order are likely to take place in the next two decades. In this context, NATO will continue to provide the main framework for collective defence of the Euro-Atlantic region.

3. The SFA 2017 Report provides NATO leaders and defence planners with a perspective of the challenges and opportunities facing the Alliance in the coming decades. The SFA also serves as an intellectual foundation for the development of the Framework for Future Alliance Operations (FFAO) 2018 Report. Together, the SFA and the FFAO will inform the 2019 NDPP cycle, and may provide an input into the development of NATO Nations' security and defence plans and strategies as part of an enduring and continuous Alliance transformation.

APPENDIX A

SUMMARY OF 5 THEMES, 20 TRENDS, AND 59 IMPLICATIONS FOR NATO

THEMES	TRENDS	IMPLICATIONS
POLITICAL	1. **The redistribution of geostrategic power.** The predominance of NATO and the West is likely to be increasingly challenged by emerging and resurgent powers.	a. Challenges to the rule-based world order. b. Euro-Atlantic relations and Alliance cohesion challenged. c. Increased requirement for cooperation with other actors including rising powers.
	2. **Use of power politics.** The importance of NATO has increased for collective defence of the Euro-Atlantic region as it is the main framework that maintains a robust and an appropriate mix of nuclear and conventional capabilities.	a. Increased potential of confrontation and conflict. b. Nationalism and divergent risk and threat perception. **c.** Requirement for a robust and credible deterrence and defence.
	3. **Non-state actor influence in domestic and international affairs.** Non-state actors are expected to exert greater influence over national governments and international institutions and their role is likely to expand.	a. Growing complexity due to a wide variety of non-state actors. b. Requirement for closer cooperation with non-state actors. c. Increased role of private actors for security. d. Increasing concerns for the Protection of Civilians.
	4. **Challenges to governance.** Emerging powers are increasingly challenging established global governance institutions and requesting greater roles. Existing governance structures, particularly in weak and failing states, are not sufficiently addressing the requirements of the broader population.	a. Duplication of existing global governance structures b. Increased requirement for partnership and inclusive governance. e. Projecting stability beyond the Euro-Atlantic region.
	5. **Public discontent/disaffection and polarization.** In western countries, risks such as undermined legitimacy of the government mandate, political impasse and the difficulty of implementing reforms and social polarization are likely to be increased.	a. Lack of trust in governments and institutions. b. Increasing polarization in the West and developing countries.
HUMAN	6. **Asymmetric demographic change.** The worldwide ageing populations will cause major challenges for some economies and government budgets. Gender inequality will further destabilize demographic change. However, the population in countries with a high fertility rate will remain relatively young, as seen in Africa, thus creating a youth bulge and potential for migration.	a. Ageing populations will strain resources. b. Youth bulges leading to instability and migration. c. Failed integration of migrants.
	7. **Increasing urbanization.** Urbanization is increasing at different rates globally, with the highest growth rates in the least developed parts of the world thus creating the challenge of providing adequate basic services and a functioning infrastructure to ensure a minimum quality of life for citizens.	a. Increasing urbanization might lead to resource competition. b. Ownership and control of critical infrastructure could be contested. c. Governance challenged by uncontrolled urban growth. d. Dependence of littoral urban areas on sea lines of communication. e. Increased urbanization may require NATO involvement in urban areas.
	8. **Fractured and/or polarized societies.** Polarization of societies has become a worldwide phenomenon; however, western developed nations are particularly vulnerable due to increased empowerment of individuals. Polarization can also exist between countries.	a. Polarization causes instability and civil war. b. Instability along NATO's border causing large-scale migration. c. Fractures in society might undermine trust and legitimacy.
	9. Increasingly connected human networks. Human networks are expected to continue to be increasingly decentralized thereby allowing unforeseeable threats.	a. Increasingly decentralized and diverse human networks. b. An increasing need to understand human networks. c. The need for influencing human networks with effective and precise strategic communication is increasing.

APPENDIX A

SUMMARY OF 5 THEMES, 20 TRENDS, AND 59 IMPLICATIONS FOR NATO

THEMES	TRENDS	IMPLICATIONS
TECHNOLOGY	**10. Rate of technology advance.** The advances in technology and innovation accelerate as they are fuelled by continued exponential increases in supporting computing power and advances in augmented intelligence.	a. Rapid development of technology challenges interoperability. b. Increasing legal and ethical concerns. c. The rate of technical advancement challenges acquisition and life-cycle management processes.
	11. Access to Technology. The ability of individuals, non-state and state actors to access technology has significantly increased.	a. Access to technology enables disruptive behaviours. b. Uncontrolled access to technology challenges existing frameworks.
	12. Global network development. Global networks will increasingly enable access to and provide information on commodities and capital assets. Global networks will increasingly be used for dissemination of post-truth information.	a. The increasing number of sensors, access to data and global networks generates operational vulnerabilities. b. Opportunities to exploit the sensors, data, and global networks. c. Adversaries will use global networks for dissemination of false or misleading information.
	13. Dominance of the commercial sector in technological development. The advances in defence technology developments/sales and space exploration /exploitation by commercial sectors have taken away the monopoly that used to be held by governments.	a. State approaches are not keeping up with the commercial sector. b. The Alliance will lose perishable skills that cannot be easily recovered.
	14. Technological dependencies. Both society, and defence and security, have increasingly depended on certain technologies which have become essential in everyday lives.	a. Reliance on certain technologies will create vulnerabilities. b. Necessity to protect critical civilian infrastructure. c. Over expectations from technological solutions.
ECONOMICS	**15. Globalization of financial resources.** An increasingly interconnected global financial system makes it more vulnerable to attacks by both state and non-state actors.	a. Erosion of trust in increasingly fragile financial institutions. b. Lack of visibility on transactions supporting criminal and terrorist activities. c. Growing interdependencies may reduce potential for interstate conflict.
	16. Geopolitical dimension of resources. Emerging technologies and the exploration opportunities availed by climate change may allow the discovery of mineral and energy resources in previously inaccessible and possibly disputed regions such as the High North.	a. Natural resources will play an increasing role in power politics. b. Resource-driven crises remain a constant. c. Climate change has the potential to disrupt traditional areas of food production while offering new opportunities.
	17. Increased inequality. The bulk of the world's population, the middle class, particularly in western society has felt the squeeze due to stagnation in real earnings after inflation adjustments, loss of benefits and overall compensation as the private sector has sought to reduce expenses by outsourcing support and labour costs and shift to part time versus full time employment.	a. Differences between the 'haves and have-nots' will increase. b. Global inequality will drive migration.
	18. Defence expenditures challenges in the West. A majority of NATO Nations were able to change a decreasing defence spending trend into an increase in real terms in 2016. Political and national will would be required to sustain defence expenditures in competing priorities with limited national budgets.	a. Increased defence spending due to rising regional tensions and fair burden sharing. b. Realignment of expectations with national fiscal priorities.
ENVIRONMENT	**19. Environmental / Climate Change.** The changes in climate will bring challenges and opportunities. The changes to the climate impose stresses on current ways of life, on individual's ability to subsist and on governments' abilities to keep pace and provide for the needs of their populations.	a. Increased range of activities in the Arctic due to growing accessibility. b. Climate and Environmental challenges to governance. c. Increased requirements for environmental awareness. d. Impacts of climate change adaptation and mitigation measures.
	20. Natural disasters. Natural disasters will have increasing impact, partly due to overall increases in the severity and prevalence of severe weather events, but also due to changes in the regions and times of the year where these events may occur.	a. Increased requirement for Humanitarian Support. b. Unavailability of national military assets due to natural disaster. c. Increased requirement to improve resilience.

BIBLIOGRAPHY

BOOKS AND PERIODICALS

Abramowitz, Alan I., “The Disappearing Center: Engaged Citizens, Polarization, and American Democracy”, 2010.

Alberts, David S. and Czerwinski, Thomas J. (Eds.), “Complexity, Global Politics, and National Security”, 1997.

Australian Government-Department of Defence, “Future Joint Operating Concept 2030”, Mar 2011.

Aydinli, Ersel, “Violent Non-state Actors: From Anarchists to Jihadists”, 2016.

Bazin, Aaron, “Think – Tools to build your mind”, 2016.

Bishop, Peter C. and Hines, Andy, “Teaching about the Future”, Jun 26, 2012.

Burrows, Mathew J., “Global Risks 2035: The Search for a New Normal”, Sep 22, 2016.

Cohen, Bernard Saul, “Geopolitics of the world”, 2013.

CSIS, “Defense 2045, Assessing the Future Security Environment and Implications for Policymakers”, 2015.

Diamandis, Peter H. and Kotler, Steven, “Abundance: The Future is Better Than You Think”, 2012.

Dube, Brian and Manatsa, Proceed and Dziva, Cowen, “Failed State Discourse Under International Law: The Place, Attributes and Implications”, 2013.

ESPAS, “Global Trends to 2030: Can the EU meet the challenges ahead?”, 2015.

ESPAS, “Shaping the Future: Thoughts on the Future of Society and Governance”, Nov 2016.

Flockhart, Trine, et al., “Liberal Order in a Post-Western World”, 2014.

Freier, Nathan, “Known Unknowns: Unconventional ‘Strategic Shocks’ in Defense Strategy Development”, 2008.

Goldin, Ian, “Future Opportunities. Future Shocks”, Oct 2014.

Goldin, Ian and Mariathasa, Mike, “The Butterfly Defect: How Globalization Creates Systemic Risks, and What to Do about It”, 2015.

Goldin, Ian and Reinert, Kenneth, “Globalization for Development; Meeting New Challenges”, May 2012.

Hagel, John, et al., “The Future of Manufacturing: Making things in a changing world”, Mar 31, 2015.

Hampson, Fen Osler and Heinbecker, Paul, “The New Multilateralism of the Twenty-First Century”, 2011.

Ikenberry, G. John, “Between the Eagle and Dragon: America, China, and the Middle State Strategies in East Asia,” 2016.

Inglehart, Ronald F. and Norris, Pippa, “Trump, Brexit, and the Rise of Populism: Economic Have-Nots and Cultural Backlash”, 2016.

Institute for Security Studies, “Enabling the future European military capabilities 2013-2025: challenges and avenues”, May 2013.

Kaul, Inge, “Global Public Goods: A concept for framing the Post-2015 Agenda?”, Feb 2013.

KPMG International, “Future State 2030: The Global Megatrends Shaping Government”, 2014.

Lloyd’s Register, “Global Maritime Trends 2030”, 2013.

Mallik, Amitav, “Technology and security in the 21st century. A demand-side Perspective”, 2004.

Mattelaer, Alexander, “Revisiting the Principles of NATO Burden-Sharing”, 2016.

McKinsey Global Institute, “A future that works: automation, employment and productivity”, 2017.

McKinsey Global Institute, “Manufacturing the future: the next era of global growth and innovation”, Nov 2012.

Mearsheimer, John, “The Tragedy of Great Power Politics”, 2014.

Milanovic, Branko, “Global Income Inequality in Numbers: In History and Now”, May 2016.

Miller, David T., “Defence 2045, Assessing the Future Security Environment and Implications for Policymakers”, 2015.

Montalvo, Jose´ G. and Reynal-Querol, Marta, “Ethnic Polarization, Potential Conflict, and Civil Wars”, 2005.

Munich Security Conference Report, “Boundless Crises, Reckless Spoilers, Helpless Guardians”, 2016.

National Defense University, “Spring 2013 Industry Study, Final Report: Strategic Materials Industry”, 2013.
National Intelligence Council, “Non-state Actors: Impact on International Relations and Implications for the US”, Aug 23, 2007.
North Atlantic Treaty Organisation COE for Operations in Confined and Shallow Waters, “Prospective Operations in Confined and Shallow Waters”, 2015.
North Atlantic Treaty Organization Science & Technology Board, “2017 STO Technology Trends Report”, Mar 21, 2017.
Nye, Joseph S., “Is the American Century Over?”, 2015.
Panayiotou, Christos, et al. (Eds.), “Critical Information Infrastructures Security”, 2016.
Republique Francaise, “French White Paper-Defence and National Security 2013”, 2013.
Roberts, Timmons and, Bellone Hite, Amy (Eds.), “The Globalization and Development Reader: Perspectives on Development and Global Change”, 2015.
Roland Berger Strategy Consultants, “Trend Compendium 2030”, 2016.
Rosenau, James N., “Many Damn Things Simultaneously: Complexity Theory and World Affairs”, 1999.
Saperstein, Alvin M., “Complexity, Chaos, and National Security Policy: Metaphors or Tools?”, 1995.
Shambaugh, David, “The China Reader: Rising Power”, 2016.
SIPRI, “Yearbook 2015: Armaments Disarmament and International Security”, 2015.
SIPRI, “Yearbook 2016: Armaments Disarmament and International Security”, 2016.
Singer, Peter W., “Corporate Warriors: The Rise of the Privatized Military Industry”, 2007.
Stanley, David J, “History and the Future: Using Historical thinking to imagine the Future”, 2010.
Steffen, Will, et al., “The trajectory of the Anthropocene: The Great Acceleration”, 2015.
Sweeney, John A., “Swans, Elephants, and Jellyfish: The Three Mascots of Postnormal Times”, 2014.
Tapscott, Don and Tapscott, Alex, “Blockchain Revolution: How the Technology Behind Bitcoin Is Changing Money, Business, and the World”, 2016.
The Federal Government, “White Paper on German Security Policy and the future of the Bundeswehr”, 2016.
UK Ministry of Defence, “Global Strategic Trends-Out to 2045”, 2014.
UK Ministry of Defence, “Strategic Trends Programme: Global Strategic Trends–Out to 2040, 4th Edition”, 2010.
UNICEF and World Health Organization, “Progress on Sanitation and Drinking Water – 2015 update and MDG assessment”, 2015.
United Nations, “Global governance and governance of the global commons in the global partnership for development beyond 2015”, 2013.
United Nations, “The United Nations World Water Development Report 2014: Water and Energy”, 2014.
United Nations, “The United Nations World Water Development Report 2015: Water for a Sustainable World”, 2015.
United Nations, “Urbanization and Development: Emerging Futures, World Cities Report 2016”, 2016.
United Nations, “World Population Prospects, Key findings & advance tables”, 2015.
United Nations, “World Urbanization Prospects, The 2014 Revision”, 2014.
United Nations, “World Population Prospects, the 2015 Revision, Volume II: Demographic Profiles”, 2015.
United Nations, “World Population Prospects, the 2017 Revision, Key findings & advance tables”, 2017.
United Nations Human Settlements Programme, “The Challenge of Slums: Global Report on Human Settlements 2003”, 2003.
United Nations Office for Disaster Risk Reduction, “2015 disasters in numbers”, 2015.
U.S. Joint Staff, “JOE 2035, The Joint Force in an Contested and Disordered World”, 2016.
U.S. Marine Corps, “2015 Marine Corps, Security Environment Forecast 2030-2045”, 2015.
U.S. Navy “The United States Navy Arctic Roadmap for 2014 to 2030”, Feb 2014.
World Economic Forum, “The Global Risks Report 2016, 11th Edition”, 2016.
World Economic Forum, “The Global Risk Report 2017, 12th Edition”, 2017.
Zhao, Suisheng (Eds.), “Construction of Chinese Nationalism in the Early 21st Century”, 2014.

Electronic Sources

Andrusenko, Julia and Burbank, Jack L. and Ouyang, Feng, “Future Trends in Commercial Wireless Communications and Why They Matter to the Military”, 2015, http://www.jhuapl.edu/techdigest/TD/td3301/33_01-Andrusenko.pdf.

Atlantic Council, “Megacity Slums and Urban Insecurity”, Jan 30, 2014, http://www.atlanticcouncil.org/blogs/futuresource/megacity-slums-and-urban-insecurity.

Bender, Jeremy and Nudelman, Mike, “This map shows Russia's dominant militarization of the Arctic”, Aug 7, 2015, http://www.businessinsider.com/chart-of-russias-militarization-of-arctic-2015-8.

Bialos, Jeffrey P., “How to Fix NATO's Chronic Burden-Sharing Problem”, Jul 2016, http://nationalinterest.org/feature/how-fix-natos-chronic-burden-sharing-problem-16870.

Bijian, Zheng, “China’s ‘Peaceful Rise’ to Great-Power Status”, 2005, http://home.sogang.ac.kr/sites/jaechun/courses/Lists/b7/Attachments/22/China's%20peaceful%20rise%20to%20Great%20power%20status_Zheng%20Bijian.pdf.

Biscop, Sven, “Rising Powers, Rising Europe and the Future of NATO”, 2015, http://link.springer.com/chapter/10.1057%2F9781137397607_3.

Boughton, James M. and Bradford, Colin I. Jr., “Global Governance: New Players, New Rules”, Dec 2007, http://www.imf.org/external/pubs/ft/fandd/2007/12/boughton.htm#author.

Calhoun, Craig (Eds.), “Dictionary of the Social Sciences”, 2002, http://www.oxfordreferences.com/view/10.1093/acref/9780195123715.001.0001/acref-9780195123715-e-1273?rskey=X8y1z&result=3.

Cambridge Dictionary, “Definition of ‘uberize’ English dictionary”, Aug 2017, http://dictionary.cambridge.org/us/dictionary/english/uberize.

Centers for Disease Control and Prevention, “Antiobiotic/Antimicrobial Resistance”, Aug 17, https://www.cdc.gov/drugresistance/.

Chatham House, “Arctic Opening: Opportunity and Risk in the High North”, Apr 1, 2012, https://www.chathamhouse.org/publications/papers/view/182839.

Chui, Michael and Manyika, James and Miremadi, Mehdi, “Where machines could replace humans - and where they can’t (yet)”, Jul 2016, http://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/where-machines-could-replace-humans-and-where-they-cant-yet.

Cuban, Larry, “The Difference between Complicated and Complex Matters”, Jun 8, 2010, https://larrycuban.wordpress.com/2010/06/08/the-difference-between-complicated-and-complex-matters/.

Davis, Glenn, “Are there Benefits to polarization in Politics?”, May 15, 2014, https://ivn.us/2014/05/15/benefits-polarization-politics/.

Del Vicario, Michela, et al., “The spreading of misinformation online”, Dec 4, 2015, http://www.pnas.org/content/113/3/554.full.pdf.

Deloitte, “Global Defense Outlook 2016: Defense in Four Domains”, 2016, https://www2.deloitte.com/global/en/pages/public-sector/articles/gx-asia-pacific-defense-outlook.html.

Dowdy, John and Taylor, Melanie, “Defense outlook 2015: A global survey of defense-industry executives”, Apr 2013, http://www.mckinsey.com/industries/aerospace-and-defense/our-insights/defense-outlook-2015.

Drake, Jennifer, “Ethiopia’s New Dam May Cause Trouble with Downstream Neighbours”, Sep 1, 2016, https://thewire.in/62771/the-most-important-dam-you-probably-havent-heard-of/.

Ekfeldt, Therese, “High North - low tension?”, Feb 2017, http://lup.lub.lu.se/luur/download?func=downloadFile&recordOId=8896875&fileOId=8899184.

Elbahtimy, Hassan and Moran, Matthew, “What are the prospects for progress in nuclear disarmament”, Apr 29, 2015, http://www.telegraph.co.uk/news/worldnews/big-question-kcl/11568700/What-are-the-prospects-for-progress-in-nuclear-disarmament.html.

El-Erian, Mohamed A., “How political polarization is crippling Western democracies”, May 12, 2015, https://www.weforum.org/agenda/2015/05/how-political-polarisation-is-crippling-western-democracies/.

Esteban, John and Schneider, Gerald, “Polarization and Conflict: Theoretical and Empirical Issues”, 2005, http://www.iae.csic.es/investigatorsMaterial/a71312134139archivoPdf45467.pdf.

EUROPOL, “Exploring tomorrow’s organized crime”, 2015, https://www.europol.europa.eu/sites/default/files/documents/Europol_OrgCrimeReport_web-final.pdf.

Glaser, Bonnie S., “Armed Clash in the South China Sea“, Apr 2012, http://www.cfr.org/asia-and-pacific/armed-clash-south-china-sea/p27883.

Glouberman, Sholom and Zimmerman, Brenda, “Complicated and Complex Systems: What Would Successful Reform of Medicare Look Like?”, 2002, http://c.ymcdn.com/sites/www.plexusinstitute.org/resource/collection/6528ED29-9907-4BC7-8D00-8DC907679FED/ComplicatedAndComplexSystems-ZimmermanReport_Medicare_reform.pdf.
Gramer, Robbie, “Here’s what Russia’s Build-Up in the Arctic Looks Like”, Jan 25, 2017, http://foreignpolicy.com/2017/01/25/heres-what-russias-military-build-up-in-the-arctic-looks-like-trump-oil-military-high-north-infographic-map/.
Groskopf, Christopher, “European politics is more polarized than ever, and these numbers prove it”, Mar 30, 2016, https://qz.com/645649/european-politics-is-more-polarized-than-ever-and-these-numbers-prove-it/.
Institute for Policy Studies, “Global Inequality”, Oct 16, 2014, http://inequality.org/global-inequality/.
Institute of Electrical and Electronic Engineers Computer Society, “IEEE CS: 2022 Report”, Feb 2014, http://www.computer.org/cms/Computer.org/ComputingNow/2022Report.pdf.
Internal Displacement Monitoring Centre, “Global Estimates 2015: People displaced by disasters”, Jul 2015, http://www.internal-displacement.org/assets/library/Media/201507-globalEstimates-2015/20150713-global-estimates-2015-en-v1.pdf.
International Committee of the Red Cross, “The Montreux document on pertinent international legal obligations and good practices for States related to operations of private military and security companies during armed conflict”, Sep 17, 2008, https://www.icrc.org/eng/assets/files/other/icrc_002_0996.pdf.
International Energy Agency, “World Energy Outlook 2016”, 2016, http://www.worldenergyoutlook.org/weo2016/.
International Organization for Migration, “Gender and Migration”, 2017, http://www.iom.int/gender-and-migration.
International Renewable Energy Agency, “Roadmap for a Renewable Energy Future”, 2016, https://passthrough.fw-notify.net/download/257087/http://www.irena.org/DocumentDownloads/Publications/IRENA_REmap_2016_edition_report.pdf.
International Telecommunication Union, “Creating Trust in Critical Network Infrastructure: Korean Case Study”, May 20, 2002, http://unpan1.un.org/intradoc/groups/public/documents/apcity/unpan021870.pdf.
IPCC, “Fifth Assessment Report (AR5)”, 2014, https://www.ipcc.ch/report/ar5/.
King, Hobart, “Oil and Natural gas Resources of the Arctic”, Aug 17, http://geology.com/articles/arctic-oil-and-gas/.
Kurzweil, Ray, “The Law of Accelerating Returns”, Mar 7, 2001, http://www.kurzweilai.net/the-law-of-accelerating-returns.
Lam, David, “Youth bulges and youth unemployment”, May 2014, http://wol.iza.org/articles/youth-bulges-and-youth-unemployment-1.pdf.
Lewis, James A., “The Role of Offensive Cyber Operations in NATO’s Collective Defense”, Apr 3, 2015, http://www.atlanticcouncil.org/blogs/natosource/the-role-of-offensive-cyber-operations-in-nato-s-collective-defense.
Lo, Chi, “Hard Landing Averted: What’s next for China?”, Apr 27, 2017, http://www.barrons.com/articles/hard-landing-averted-whats-next-for-china-1493341642.
Lorente, Javier and Sánchez Vítores, Irene, “Disaffection at the ballot boxes: the 2014 European Election in Southern Europe”, 2016, https://ecpr.eu/Filestore/PaperProposal/d39ff2bc-42b6-4b78-8834-3986e8b3de96.pdf.
MacIver, Kenny, “From the internet of information to the internet of value”, Jul 2016, http://www.i-cio.com/big-thinkers/don-tapscott/item/from-the-internet-of-information-to-the-internet-of-value.
Madakam, Somayya and Ramaswamy, Ram and Tripathi, Siddharth, “Internet of Things (IoT): A Literature Review”, Jan 2015, http://dx.doi.org/10.4236/jcc.2015.35021.
Manyika, James, et al. “How digital finance could boost growth in emerging economies”, Sep 2016, http://www.mckinsey.com/global-themes/employment-and-growth/how-digital-finance-could-boost-growth-in-emerging-economies.
McKinsey Global Institute, “Debt and (not much) deleveraging”, Feb 2015, http://www.mckinsey.com/global-themes/employment-and-growth/debt-and-not-much-deleveraging.
Mearsheimer, John, “China’s Unpeaceful Rise”, Apr 2016, http://johnmearsheimer.uchicago.edu/pdfs/A0051.pdf.
Meme Bridge, “Moore’s Law or how overall processing power for computers will double every two years”, unknown date, http://www.mooreslaw.org/.
Milanovic, Branko, “Global Inequality: From Class to Location, from Proletarians to Migrants”, May 22, 2012, http://onlinelibrary.wiley.com/doi/10.1111/j.1758-

5899.2012.00170.x/abstract.
Mills, Mark P., “Information Technology Has Created a New Electric Demand Paradigm”, Jan 8, 2013, http://www.forbes.com/sites/markpmills/2013/01/08/information-technology-has-created-a-new-electric-demand-paradigm/#dc3dd173e94e.
Mitchum, Robert, “How Climate Change Shifts the Global Food Map”, Sep 23, 2016, http://www.ci.anl.gov/blog/how-climate-change-shifts-global-food-map.
North Atlantic Treaty Organization, “Collective Defence-Article 5”, Mar 22, 2016, http://www.nato.int/cps/en/natohq/topics_110496.htm.
North Atlantic Treaty Organization, “Joint press statement-with NATO Secretary General Jens Stoltenberg and the US Secretary of Defense Jim Mattis”, Feb 15, 2017, http://www.nato.int/cps/en/natohq/opinions_141106.htm.
North Atlantic Treaty Organization, “Secretary General: the world changes and NATO evolves”, Sep 23, 2016, http://www.nato.int/nato_static_fl2014/assets/audio/audio_2016_09/20160923_160923a.mp3.
North Atlantic Treaty Organization, “Warsaw Summit Communique”, Jul 9, 2016, http://www.nato.int/cps/en/natohq/official_texts_133169.htm.
O’Brien, Danny, “In Most Censored Countries, Internet Is Hamstrung or Withheld”, Jul 1, 2012, http://www.huffingtonpost.com/committee-to-protect-journalists/in-most-censored-countrie_b_1469468.html.
OECD, “Trust in Government”, 2016, http://www.oecd.org/gov/trust-in-government.htm.
OXFAM, “62 people own same as half world-Oxfam”, Jan 18, 2016, http://www.oxfam.org.uk/media-centre/press-releases/2016/01/62-people-own-same-as-half-world-says-oxfam-inequality-report-davos-world-economic-forum.
Parloff, Roger, “Why deep learning is suddenly changing our life”, Sep 28, 2016, http://fortune.com/ai-artificial-intelligence-deep-machine-learning/.
PEW Research Center, “Euroscepticism beyond Brexit: Significant opposition in key European countries to an ever closer EU”, Jun 7, 2016, http://www.pewglobal.org/2016/06/07/euroskepticism-beyond-brexit/.
PEW Research Center, “Political Polarization in the American Public”, Jun 12, 2014, http://www.people-press.org/2014/06/12/political-polarization-in-the-american-public/.
PEW Research Center, “Public Trust in Government: 1958-2015”, Nov 23, 2015, http://www.people-press.org/2015/11/23/public-trust-in-government-1958-2015/.
Pontin, Jason, “Why We Can't Solve Big Problems: Has technology failed us?”, Oct 24, 2012, https://www.technologyreview.com/s/429690/why-we-cant-solve-big-problems/.
Porter, John R., “Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects: Food security and food production systems”, 2014, http://www.ipcc.ch/pdf/assessment-report/ar5/wg2/WGIIAR5-Chap7_FINAL.pdf.
PricewaterhouseCoopers, “The World in 2050: Will the shift in global economic power continue?”, Feb 2015, http://www.pwc.com/gx/en/issues/the-economy/assets/world-in-2050-february-2015.pdf.Ranganathan, Janet, “The Global Food Challenge Explained in 18 Graphics”, Dec 2013, http://www.wri.org/blog/2013/12/global-food-challenge-explained-18-graphics.
Richmond, Amy K., et al., “The Role of Network Science in Analysing Slums in Rapidly Growing Urban Areas”, Aug 13, 2016, http://smallwarsjournal.com/jrnl/art/the-role-of-network-science-in-analyzing-slums-in-rapidly-growing-urban-areas.
Sainato, Michael, “Stephen Hawking, Elon Musk, and Bill Gates Warn About Artificial Intelligence”, Aug 19, 2015, http://observer.com/2015/08/stephen-hawking-elon-musk-and-bill-gates-warn-about-artificial-intelligence/.
Samuelson, Robert J., “Financial Crisis 2.0”, Oct 16, 2016, https://www.washingtonpost.com/opinions/financial-crisis-20/2016/10/16/1ea7ab7a-9253-11e6-9c85-ac42097b8cc0_story.html.
Scott, Malcolm and Sam, Cedric, “China and the United States: Tale of Two Giant Economies”, May 12, 2016, https://www.bloomberg.com/graphics/2016-us-vs-china-economy/.
Serfaty, Simon, “The Atlantic Pivot”, Aug 2016, http://nationalinterest.org/feature/the-atlantic-pivot-17343.
SIPRI, “Military Expenditure”, 2016, https://www.sipri.org/research/armament-and-disarmament/arms-transfers-and-military-spending/military-expenditure.
SIPRI, “SIPRI Fact Sheet: Trends in World Military Expenditure, 2015”, Apr 2016, http://books.sipri.org/files/FS/SIPRIFS1604.pdf.
SIPRI, “SIPRI launches extended military expenditure data covering 1949-2015”, Nov 21, 2016, https://www.sipri.org/news/2016/sipri-launches-extended-military-expenditure-data.

SIPRI, “65 years of military spending: Trends in SIPRI’s new data”, Nov 21, 2016, https://www.sipri.org/commentary/blog/2016/65-years-military-spending.
Skagestad, Odd Gunnar, “The High North: an elastic concept in Norwegian Arctic Policy”, 2010, https://www.fni.no/getfile.php/131978/Filer/Publikasjoner/FNI-R1010.pdf.
Stocker, Thomas F., et al., “Climate Change 2013: The Physical Science Basis: Summary for Policymakers”, 2013, https://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WGIAR5_SPM_brochure_en.pdf.
Stuenkel, Olivier, “The Post-Western World and the Rise of a Parallel Order”, Sep 26, 2016, http://thediplomat.com/2016/09/the-post-western-world-and-the-rise-of-a-parallel-order/.
Tempest, Matthew, ”UK trust in EU lower than any other country bar Czech Republic, survey finds”, Oct 26, 2015, https://www.euractiv.com/section/uk-europe/news/uk-trust-in-eu-lower-than-any-other-country-bar-czech-republic-survey-finds/.
The Economist, ”Buying drugs online: Shedding light on the dark net”, Jul 16, 2016, http://www.economist.com/news/international/21702176-drug-trade-moving-street-online-cryptomarkets-forced-compete.
The Economist, “Gazprom: Russia’s wounded giant”, Mar 23, 2013, http://www.economist.com/news/business/21573975-worlds-biggest-gas-producer-ailing-it-should-be-broken-up-russias-wounded-giant.
The Economist, “Hard landing looms in China”, Oct 2016, http://www.eiu.com/industry/article/814708465/hard-landing-looms-in-china/2016-10-14.
The Economist, “The world’s biggest economies: China’s back”, Oct 11, 2014, http://www.economist.com/news/finance-and-economics/21623758-chinas-back#.
Thomson, Stephanie, “Globalization for the 99%: Can we make it work all?”, Jul 6, 2016, https://www.weforum.org/agenda/2016/07/globalization-for-the-99-can-we-make-it-work-for-all/.
Tiankai, Cui, “China's ambassador: We stand with U.S. for peace”, Sep 2, 2015, http://www.usatoday.com/wlna/opinion/2015/09/02/china-us-relations-wwii-anniversary-column/71529204/.
Trenin, Dimitri, “The Revival of the Russian Military, How Moscow Reloaded”, May/Jun 2016, https://www.foreignaffairs.com/articles/russia-fsu/2016-04-18/revival-russian-military.
Tsukayama, Hayley, “What Eric Schmidt meant when he said ‘the Internet will disappear’”, Jan 23, 2015, https://www.washingtonpost.com/news/the-switch/wp/2015/01/23/what-eric-schmidt-meant-when-he-said-the-internet-will-disappear/.
United Nations, “Goal 1: End Poverty in all its Forms Everywhere”, Nov 1, 2014, https://sustainabledevelopment.un.org/?page=view&nr=181&type=230&menu=2059.
United Nations, “Paris Agreement: Status of Ratification“, Aug 2017, http://unfccc.int/paris_agreement/items/9444.php.
United Nations, “Report of the Conference of the Parties on Technology its twenty-first session, held in Paris from 30 November to 13 December 2015”, Jan 29, 2016, http://unfccc.int/resource/docs/2015/cop21/eng/10a01.pdf.
United Nations, “Sustainable Development Goals by 2030: 17 Goals to Transform our world”, 2016, http://www.un.org/sustainabledevelopment/cities/.
United Nations Environmental Programme, “Cities and Coastal Areas”, 2005, http://www.unep.org/urban_environment/issues/coastal_zones.asp.
United Nations Environment Programme, “Shifting to Resource Efficient Cities: 8 Key Messages for policy-makers”, 2013, http://www.unep.org/ietc/sites/unep.org.ietc/files/Key%20messages%20RE%20Habitat%20III_en.pdf.
United Nations Secretary-General, “Secretary-General’s message to International Conference on the Implications of Climate Change for Defense”, Oct 14, 2015, https://www.un.org/sg/en/content/sg/statement/2015-10-14/secretary-generals-message-international-conference-implications.
U.S. National Snow and Ice Data Center, “All about Arctic Climatology and Meterology”, https://nsidc.org/cryosphere/arctic-meteorology/arctic.html.
Walt, Vivienne, “Energy Companies Face Big Risks from Paris Climate Deal”, Dec 17, 2015, http://fortune.com/2015/12/17/energy-companies-feel-the-burn-from-paris-climate-deal/.
Wong, Poh P., “Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects: Costal Systems and Low-Lying Areas”, 2014, https://www.ipcc.ch/pdf/assessment-report/ar5/wg2/WGIIAR5-Chap5_FINAL.pdf.
World Economic Forum, “President Xi’s speech to Davos in full”, Jan 2, 2017, https://www.weforum.org/agenda/2017/01/full-text-of-xi-jinping-keynote-at-the-world-economic-forum.
Yale University, “Russian Demographics”, Dec 2014, http://yaleglobal.yale.edu/con

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