

WORKING GROUP ON CLIMATE, NUCLEAR, AND SECURITY AFFAIRS

REPORT ONE: A FRAMEWORK FOR UNDERSTANDING AND MANAGING THE
INTERSECTION OF CLIMATE CHANGE, NUCLEAR AFFAIRS, AND SECURITY

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CONTENTS

- I. NOTE FROM THE EDITORS
- II. WORKING GROUP MEMBERS
- III. EXECUTIVE SUMMARY
 1. THE CHALLENGE IN CLIMATE, NUCLEAR, AND SECURITY AFFAIRS
 2. A COMPLEX SYSTEM AT WORK
 3. CATEGORIES OF CLIMATE, NUCLEAR, AND SECURITY LINKAGES
 - A. SECURITY TRENDS AND PATHWAYS
 - B. SOCIAL, POLITICAL, AND ECONOMIC DISRUPTIONS
 - C. GOVERNANCE MECHANISMS
 - D. SCIENCE AND TECHNOLOGY, RESEARCH AND DEVELOPMENT, TALENT, AND MARKETS
 - E. CONFLICT REGIONS
4. NEXT STEPS
5. CONCLUSION

I. NOTE FROM THE EDITORS

The Center for Climate and Security (CCS) launched a program in 2016 to explore the many ways climate change, nuclear, and security affairs are combining around the world. In order to understand the diverse and complex interactions among these three issue areas, CCS, in coordination with the Nuclear Security Working Group, assembled the multidisciplinary Working Group on Climate, Nuclear, and Security Affairs. Its members include thought leaders with wide-ranging experiences in defense, diplomacy, business, academia, journalism, and international organizations. The Working Group's first workshop was held May 25-26, 2017, at the Airlie Conference Center in Virginia, resulting in this report's framework for characterizing the dimensions of how climate change, nuclear affairs, and security risks are intersecting.

We are deeply grateful to all members of the Working Group, and for the considerable time they have already dedicated to this project. Each of these members shared lessons from their diverse and extensive experiences, thoughtful questions, findings from their past research and reporting, and analysis regarding global trends. Many contributed writing to this report, cultivated new members for our group, introduced us to new concepts, and otherwise provided critical assistance. We are equally thankful to the numerous experts who provided early advice regarding the project but could not attend the May meeting.

This project and its successful first workshop would not have been possible without the persistent support, advice, and expertise provided by the broader CCS team, including Shiloh Fetzik, Tom Watson, Liese Siegenthaler, Neil Bhatiya, Caitlin Werrell, Francesco Femia, and many CCS Advisory Board members. Their commitment to creatively addressing global security risks is a continual source of inspiration.

Finally, we are grateful to the John D. and Catherine T. MacArthur Foundation for their generous support for this project.

This report is a summary of ongoing deliberations among experts from different disciplines who were encouraged to think about the emerging challenges in their respective fields in an interactive and interdisciplinary manner. This report is intended to remain faithful to the Working Group's deliberations. As such, at times it may reveal gaps in the ways in which individuals from one discipline perceive the empirical or policy picture of areas that are less familiar to them. Though this study marks just a first step, this work should reveal new insights about the convergences and divergences in how diverse stakeholders understand pressing global threats.

While this report is based on deliberations among members of the Working Group, specific statements and ideas do not necessarily represent the views of individual members or consensus across the full group. Any errors of commission or omission are solely those of the editors.

II. WORKING GROUP MEMBERS

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Honorable Joyce Connery - Defense Nuclear Facilities Safety Board

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Member of the Nuclear Security Working Group

In addition to the Working Group members named above, other experts contributed to the development of this project but could not attend the group's May 2017 workshop; or preferred to contribute anonymously at this time.

III. EXECUTIVE SUMMARY

Two of the gravest threats to global security today are nuclear detonation risks and climate change. One poses the potential for immediate catastrophe, the other, a perhaps slower but potentially comparable destructive force. In the post-Cold War era, nuclear dangers and climate risks present what could be major existential risks to society. Understanding the connections among climate and nuclear trends, and how they might interact with other security risks, will enable national security and policy planners.

This project represents an effort to better understand these challenges. It aims to enhance the integration of analysis and policy formulation regarding future risks, drawing upon a diverse group of experts in security and defense, climate change and its effects, and nuclear security, safety, and nonproliferation. The inter-disciplinary experts who formed the Working Group on Climate, Nuclear, and Security Affairs bring broad and deep experience in government, science, business, journalism, academia, international organizations, and think tanks.

The first section of this report describes in brief the “Challenge in Climate, Nuclear, and Security Affairs” that motivated this project.

The world is facing numerous, diverse nuclear trends. On just the civilian side, several countries appear to be proceeding with incipient nuclear energy programs or rekindling efforts that stalled in the past. Some nations with long-standing nuclear energy sectors are seeking to increase their capacity. Still others are reducing their reliance due to a variety of economic and other factors. All of these trends hold the potential to raise or mitigate security concerns depending on the details of how they unfold, and all will influence the trajectory of global climate change.

Additionally, the current global weapons of mass destruction nonproliferation regime is under pressure. This stems from specific events such as the use of chemical weapons in Syria and the DPRK exhibiting continual improvement in its nuclear warhead and delivery system capabilities, as well as new trends and influencers such as an international movement (supported by a majority of UN members) seeking a global ban on all nuclear weapons. Nuclear threats from non-state actors may be growing as well.

At the same time, governments worldwide are facing growing challenges managing the effects of rapidly changing climate trends, and the intersection of these challenges with global and regional security dynamics. As the physical environment in the Arctic region changes, security and diplomatic dynamics are evolving.¹ Droughts and water stress form one factor affecting migration patterns and intrastate unrest. Climatic shifts are combining with other societal factors to increase disease and global health security risks. These trends, along with changing disaster patterns and sea level rise, are creating new pressures on social stability and the capacity of governments to manage them, as well as affecting defense force missions and needs.²

Other climate-security concerns stem from the prospect of natural disasters and extreme heat affecting energy availability. As the climate changes, heatwaves are becoming increasingly severe and imposing human and economic tolls that are compounded when extreme temperatures hinder power generation. Such challenges have already been witnessed in places like India and Pakistan.³ This shows a confluence of trends that could form unique challenges for countries seeking or expanding nuclear energy capacity in part to address pressing economic, social, and health problems stemming from inadequate energy access.

The above-mentioned challenges are occurring at a time of profound change that includes waves of mass migration around and within key regions, security risks arising from terrorist threats, technological evolution altering the global security environment, and rising tensions among leading industrial countries and with smaller states such as Iran and the DPRK.

Many of these troubling trends are evolving simultaneously. Others are highly interrelated and mutually reinforcing. For example:

- Bangladesh is struggling against sea level rise and changing Himalayan glacial patterns, which are occurring in tandem with rising terrorist threats and the worsening demands of its overpopulation. These stressors pose serious security concerns, and could, if they are not addressed adequately in the coming years, raise concerns regarding security and safety for the nuclear reactors being built with Russian assistance.
- Jordan, a critical security partner of the United States, has experienced domestic opposition to its plans to move forward with a concerted domestic nuclear energy program, which is intended in part to help enable desalination efforts and address the country's water stresses that are worsening with the combined pressures of refugees and climatic changes.
- Nigeria appears to slowly be progressing on a nuclear energy program just as it is grappling with daunting terrorist threats, drought, migration, and other challenges to societal stability and governance.
- International institutions such as the International Atomic Energy Agency and Nuclear Suppliers Group are experiencing new challenges and possibly expanding missions as nuclear, climate, and security trends converge in much more complex ways.

The risks and benefits involved with the spread of civilian nuclear technologies depend on the details of its advancement. Moreover, as these examples show, the other factors that compromise the security or stability context in which its advancement may occur raise the stakes for countries and the international community ensuring high confidence in safety, security, and nonproliferation regimes.

As the relationships among climate, security, and nuclear risks become more complex and interconnected, the challenges posed are converging in new and unfamiliar ways. Yet discussion of any interconnections typically are limited to debates about the merits of nuclear energy as a means of reducing greenhouse gas emissions. This is only one part of the equation. Security concerns are often left out, and all three issue areas are too often treated independently from one another. Without sufficient understanding of how climate, nuclear, and security issues are interrelated, policies to combat one or another challenge may prove inefficient or even self-defeating.

KEY FINDINGS

By design, the Working Group included experts with differing views on the need to maintain or expand nuclear power generation capacity, specific effects of climate change, security priorities, the likelihood of nuclear weapons use, the degree to which the spread of civilian nuclear technologies might compound security challenges in specific countries or regions, and many other variables. **Despite the diversity of views, members concurred that these various factors are combining to influence the world order and drive complex global security challenges.**

Moreover, the group generally agreed that two of the greatest risks to international security in the 21st Century are nuclear war and catastrophic climate change. Today, the climate, nuclear, and security events we see unfolding globally are combining in dynamic ways that may pull the world closer to these two breaking points if not corrected.

The Working Group found that these issues combine to form **a new, complex system of interlinking trends at work in today's world** (Section 2). Great upheavals in world history show how critical it is to understand the grander world order in which events are transpiring, as well as the interactions among various elements of that order in terms of their potential to create outsized impacts. **Several increasingly discernible elements of the complex system are also becoming clear**, as described in the Section 3 of the report:

- ***Security trends and pathways***, such as concerns over nuclear latency and internal security threats in key countries;
- ***Social, political, and economic disruptions*** that alter the trajectories of world events;
- ***Governance mechanisms***, or the international norms and structures that normally exert stabilizing influences when they are strong; and
- Considerations in how ***science and technology, research and development, talent, and markets*** shape the issues under examination.

All of these factors combine in specific ***conflict regions*** to tilt stresses toward or away from outright conflict or competition.

These categories contain interlinkages within themselves: events and trends that constantly interact with each other in both positive and negative ways, affecting and being affected by one another. Events in these categories may serve as accelerants, constraints, stabilizers, or any number of other functions. They are likely to trigger feedback loops and may interrelate in surprising fashion. The interactions among these trends are key: **climate, nuclear, and security events may push the global system in unprecedented and catastrophic ways via a cascade of smaller events or surprises that combine to form new, nonlinear trajectories.** This is why understanding systemic risks and remedies and their interconnections is so critical.

At the same time, the framework presented in this report can serve as a guide for how smart planning, preparations, and policies can navigate this combination of stresses and create a more resilient, stable world. Bolstering international governance mechanisms, smartly developing and applying key technologies, addressing underlying drivers of insecurity and instability, and accounting for social and political movements will be required to help mitigate the types of concerns raised in this report. This is especially critical in the potential crisis regions where combining security, climate, and nuclear risks must be addressed with urgency: South Asia, the Middle East, the South China Sea, and Central and North Africa.

The report concludes with a few broad but clear next steps for this Working Group and others to pursue:

- ***Develop realistic scenarios*** for which the interlinkages described in this report combine in potential crisis regions, and game out ways in which applying specific policies, technologies, normative structures, and other measures can be stabilizing or destabilizing.
- ***Improve communication.*** Both nuclear war and climate change present existential risks, but the public and policy makers have not prioritized either commensurate to the scale of the risks. Making these and other existential risks comprehensible and clear to people is an important goal.
- ***Educate Policy-makers.*** The risks raised in this report must be conveyed in ways that are relatable and immediate, for example emphasizing the ways to reduce threats to public health and infrastructure across the country. We must also make clear what gaps cannot be immediately refilled if U.S. capacities are stripped away, for example regarding data collection and analytics.

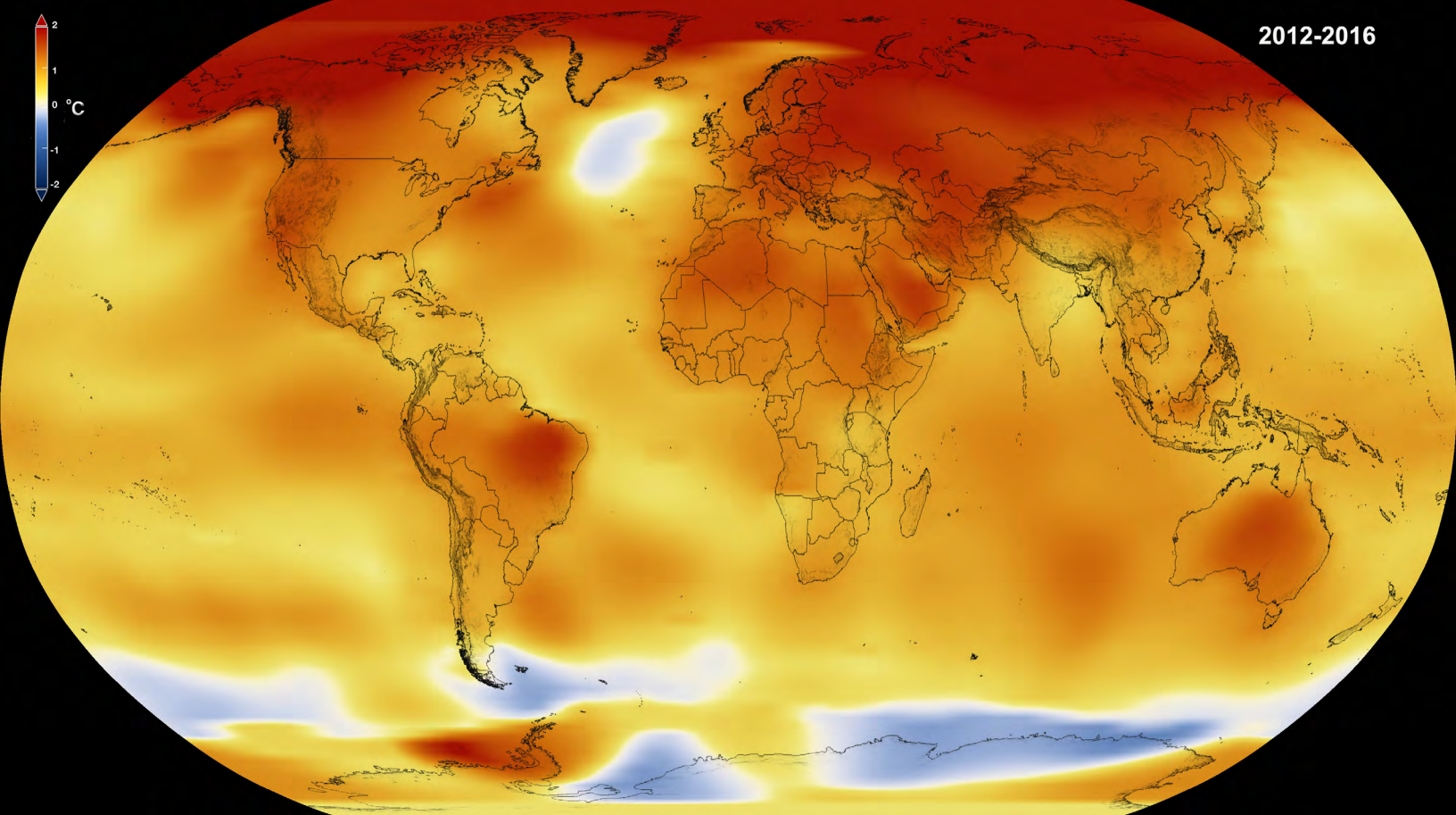
The purpose of this report is to capture an ongoing discussion among experts from different disciplines who were encouraged to think about the emerging challenges in their respective fields in an interactive and interdisciplinary manner. Though it marks just a first step, this work aims to develop new understandings of the convergences and divergences in how diverse stakeholders understand pressing global threats.

1. THE CHALLENGE IN CLIMATE, NUCLEAR, AND SECURITY AFFAIRS

Today, the international community is experiencing a number of nuclear-related trends and pressures. New nations are pursuing civilian nuclear capabilities. Some countries long holding nuclear energy are increasing their nuclear capacity, while others are witnessing the opposite trend. The threat of non-state actors seeking nuclear materials may be growing. Countries continue to debate proper approaches for keeping nuclear systems safe and secure, while innovative concepts such as nuclear fuel banks may be reshaping the intellectual and practical landscapes regarding nuclear issues.

At the same time, governments worldwide are facing growing difficulties managing the effects of rapidly changing global climate trends, and the intersection of these challenges with global security and stability. These include a rapidly changing Arctic region, droughts and other detrimental effects on water systems in many countries, sea level rise encroaching on coastal areas around the globe, disease patterns changing, and evolving disaster patterns creating new pressures on civilian capacities and defense forces for many countries. Climate-security risks that were once projected as possibilities in the 2020s and beyond are already manifesting. Resulting tensions, periods of transition or instability, and the empowerment this may bestow on especially-stricken countries raise new concerns for the norms and systems of global governance that broadly affect security and help create the foundation for managing nuclear risks. As the global climate changes, heatwaves are becoming increasingly worrisome for their human and economic tolls, which are compounded when extreme temperatures hinder power generation—issues already seen in places like India and Pakistan.⁴

These challenges are occurring at a time of profound global shifts, from, inter alia, technological change, terrorist threats, increasing waves of population displacement around and within key regions, rising tensions among leading industrial countries (including the United States and Russia) and with smaller states such as the Democratic People's Republic of Korea (DPRK). Even as it has been strengthened—for example, by the Chemical Weapons Convention inching closer to universality—the current global weapons of mass destruction nonproliferation regime is under pressure from events such as the use of chemical weapons in Syria and the emergence of an international movement (supported by a majority of UN members) seeking a treaty to ban nuclear weapons.



NASA, NOAA data show 2016 warmest year on record globally. NASA/SCIENTIFIC VISUALIZATION STUDIO.

In some ways, these types of trends are evolving in parallel, shaping the global landscape alongside political changes, demographic stress, globalization, and other factors. In other ways, these trends are directly influencing one another and intertwining.

We can already see innumerable examples. Bangladesh is struggling against sea level rise and changing Himalayan glacial patterns occurring in tandem with rising terrorist threats and the worsening demands of its overpopulation. These stressors form serious security concerns, and to some they raise questions regarding the long-term stability of the environment in which Russia is assisting the Bangladeshi government in building nuclear reactors.⁵ Jordan, a critical security partner of the United States, has experienced domestic opposition to its plans to move forward on a concerted domestic nuclear energy program—intended in part to enable desalination and help address the country's dire water stresses that are worsening with the combined pressures of refugees and climate change. Nigeria appears to slowly be progressing on a nuclear energy program just as it is grappling with daunting terrorist threats, drought, migration, and other challenges.

International institutions are likewise experiencing new stresses and challenges as these seemingly secular trends converge in unpredictable or at least much more complex ways. In the Nuclear Suppliers Group, India now uses the threat of climate change as additional rationale for its membership despite its status as a nuclear weapons possessor state outside of the NPT, adding yet another complexity to an already thorny situation. Similarly, climate

change is becoming a more prominent issue for the International Atomic Energy Agency (IAEA). Just as it seems that its nuclear safety, security, and nonproliferation responsibilities will continue to grow, the IAEA's work is more important than ever to oversee and enforce the peaceful application of nuclear technologies in medicine, agriculture, ocean health, and clean water. It is remarkable that the Nationally Determined Contributions (NDCs) submitted by many countries in support of the December 2015 Paris climate change agreement and other climate change-focused channels have become fora for countries declaring updates to their nuclear energy plans.

The effects of nuclear weapons and climate change have both driven new legal challenges with specific countries and in international fora, highlighting new developments in the international system and, potentially, affording new kinds of influence to small states such as the Marshall Islands. This influence is extending to ad hoc groups, such as the civil society organizations and governments that united to advance the nuclear weapons ban treaty, and even individuals such as small groups of students suing the U.S. government and companies over climate change.

As the relationships among nuclear, climate, and security trends and risks grow more complex and interconnected, these issues are converging in new ways. However, the current discourse about these phenomena typically is limited to debating the merits of nuclear energy as a means of reducing greenhouse gas emissions—only one part of the equation. Security concerns are frequently left out of the conversation, and all three issue areas are too often treated independently from one another. Without sufficient understanding of how climate, nuclear, and security issues interrelate, however, the U.S. government and global actors may make advances in one area that inadvertently undercut their objectives in another.

The pressing need to understand and characterize the fuller range of dynamics is the challenge that animates the Working Group on Climate, Nuclear, and Security Affairs and this report.⁶ Despite the group's diversity, its members concurred that these factors are combining to influence the world order and drive global security challenges. Moreover, the group generally agreed that this nexus of subjects helps to capture two of the greatest risks to international security in the 21st Century: nuclear war and catastrophic climate change. Today, the climate, nuclear, and security events we see unfolding globally are combining in dynamic ways that, barring prudent intervention and effective policy innovation, could pull us toward these two breaking points.

In Section 2, this report describes how the Working Group perceived the complex system in which climate, nuclear, and security trends and events are interacting, influencing one another, and shaping the global security environment. It then details the constituent parts of this system in Section 3, offering numerous examples, ideas, and conundrums. Finally, it provides a few important next steps in this line of work.

ON THE FUTURE OF NUCLEAR ENERGY

While the global outlook for nuclear energy remains uncertain, in recent years several countries have provided new details regarding the scale, scope, and speed of their civil nuclear ambitions—in many cases using their climate change commitments as a mechanism for doing so. According to the International Atomic Energy Agency (IAEA), “In the INDC submissions [to the Paris agreement], ten countries explicitly listed nuclear power in their national climate strategies, including five countries currently with nuclear power programmes (Argentina, China, India, Islamic Republic of Iran, Japan).”⁷ Other countries in various stages of pursuing or expanding nuclear energy include Jordan, Saudi Arabia, Turkey, Lithuania, Belarus, and Pakistan. Climate change is a clear driver for some, such as Albania, where climate change is already reducing hydropower, the current source of the majority of its electricity. If the increases in nuclear power generation pledged by numerous countries occur, they could form important steps for slowing the growth of greenhouse gas emissions. At the same time, some countries’ plans have caused security or environmental concerns domestically and among their neighbors.

China has been a major focal point since the country publicly detailed plans for an even-more ambitious rate of nuclear energy expansion in its 2015 climate

The Working Group explored nuclear benefits and risks, including those driven by the political pressure that public sentiments exert in different countries. *Demonstrators stand in the waters of the Bay of Bengal as they shout slogans during a protest near the Kudankulam nuclear power project, in the southern Indian state of Tamil Nadu. Demonstrators are protesting against the country's largest nuclear power project, over fears about the plant's safety.* REUTERS/ADNAN ABIDI



commitments, including setting targets to build 6-8 new reactors per year through 2020 and increasing production thereafter, with plans to become the world's top nuclear energy producer by 2030, and becoming a major supplier to other countries. China also announced plans for floating nuclear power plants to deploy in the South China Sea—worrying to many countries in the region—and small modular reactors.⁸

Whatever benefits may drive accelerated nuclear investment in some places, adverse public opinion, costs, longstanding challenges surrounding secure final waste disposition, and other factors are pushing other countries to move away from nuclear energy. In some cases, like Germany, this policy is clearly defined and articulated. In other cases, like the United States, nations have more inchoate or contradictory policies regarding the future of nuclear energy, which may result in their capacity dwindling unless corrective action is taken.

Whether the future will bring an increase, decrease, or continuation of the current rate of nuclear power generation, each outcome likely will bring its own new security challenges, affect global efforts to avoid climate catastrophes or reduce nuclear risks, and hold implications for nuclear governance. Questions of where, how, and under what conditions nuclear energy futures transpire remain as pertinent as ever.

This Working Group did not form consensus positions regarding the benefits and challenges of nuclear energy. Indeed, its membership was deliberately designed to include varying ideas on these questions. Even still, the group generally agreed that our preferences are not the central issue. Countries pursue nuclear capabilities (or not) for a variety of reasons beyond our control. It is therefore critical to increase U.S. engagement on the full range of global nuclear affairs and plan for a range of future scenarios.



South Korean President Park Geun-hye (3rd from R) attends a ceremony in Barakah, on May 20, 2014, to install a Korean-built nuclear reactor. It is the first out of four reactors South Korea plans to provide the UAE under a 2009 deal that marked South Korea's first exports of nuclear reactors.

YONHAP NEWS AGENCY

2. A COMPLEX SYSTEM AT WORK

The world is already witnessing climate, nuclear, and security events clearly combining and influencing one another. For several years, it seemed the examples of these interrelationships could be taken as interesting but independent data points. Today, if addressed collectively, it is clear that they constitute a complex but discernible system of interlinking events and trends. Understanding those interlinkages and keeping them stable requires achieving a new form of gestalt.ⁱ

The group's emphasis on understanding the evolving global system at play, rather than focusing solely on independent events or issues, stemmed from the lessons learned about great upheavals in our world history, including the years preceding the first and second world wars. Too often, it is only after empires fall or millions are killed that we examine how discrete events can collide into a perfect storm, or consider how swiftly nonlinear effects can trigger dramatic change. Systemic fragility is rarely well recognized until core pillars of that system break. It is common for governments to hold tremendous expertise and well-intentioned policies that still prove ineffective due to an inadequate understanding of how various elements interact. As such, we have a tendency to believe outcomes such as nuclear war are unlikely, but we may be separated from it only by a series of more minor incidents. Likewise, we have difficulty understanding how catastrophic climate change stands to reshape our global security environment, though it is inevitable if we do not act.

The Working Group therefore found it critical to posit both the system at play and its constituent elements. This can provide a roadmap of sorts to help prevent the world from experiencing catastrophic outcomes such as nuclear weapons use and runaway climate change—and shed light on how these grave threats are looming today.

ⁱ From Merriam-Webster: “something that is made of many parts and yet is somehow more than or different from the combination of its parts.” As several Working Group members described, the true nature of our evolving global security environment is difficult to understand, let alone manage, without first coming to grips with the ways in which new interactions among various elements are emerging and their potential to create outsized, systemic impacts.

ABOUT THE BREAKING POINTS

The Working Group agreed on the utility of defining possible “breaking points” in the starkest terms: as specific risks within the international system constantly evolve, this articulation allows us to remain focused on avoiding the worst possible outcomes.ⁱⁱ Noting that crossing other lines can similarly break the system, nuclear war and climate-exacerbated instabilities contributing to conflict and suffering stood out as the most pressing given the evidence that the world may already be edging toward these fault lines.⁹

In terms of existential risks, many in the Working Group found considerable overlap and common threads between the risk of nuclear war and unmitigated climate change. Even if the exact chains of events and causal mechanisms are not well understood today, some in the group held a general sense that the hotter the world gets, the closer it is likely to get to the outbreak of conflicts that could escalate into nuclear war. This is not an entirely new revelation. In a 2007 project to envision potential security consequences of climate change effects, Leon Fuerth examined climate projections for global average temperature

ii Of course, nuclear war and catastrophic climate change are not the only severe threats the world faces, but they are clear, and articulating framework of what will move the world closer or further from them can help in understanding how to address these and other existential risks.

Some experts are concerned that combining tensions over water, territory, and other issues may increase nuclear detonation risks in regions like South Asia. *An Indian Agni-II intermediate range ballistic missile on a road-mobile launcher, displayed at the Republic Day Parade on New Delhi's Rajpath, January 26, 2004.* ANTONIO MILENA (ABR)



rising 2.6°C above 1990 levels in 30 years and concluded “it is clear that even nuclear war cannot be excluded as a political consequence of global warming.”¹⁰ Likewise, in late 2016, trends manifesting around Kashmir led nuclear expert Zia Mian to warn in the *Bulletin of the Atomic Scientists* that climate change-heightened water stress in South Asia is already combining with the tense conventional and nuclear weapons balances of India and Pakistan to increase the risk of nuclear conflict.¹¹

Other plausible scenarios may not be as clear today, but they may occur via a cascade of small events or surprises that combine to form new, nonlinear trajectories. This is why understanding systemic risks and remedies is crucial.

The thought experiment at the foundation of this project led the Working Group to discuss factors that could trigger nuclear war in some depth.ⁱⁱⁱ The group had a wide range of views on the likelihood of nuclear conflict under different conditions. However, the group agreed that the emergence of climate change-exacerbated destabilizing forces among current or prospective nuclear-armed states or sub-state actors is worth special, explicit consideration. As most U.S. and NATO defense leaders have stated, the group generally agreed that the concept of limited nuclear war is deeply faulty, not least because decision makers across nuclear-armed countries do not all share the same risk calculations. Indeed, nuclear conflict may occur inadvertently and as a result of events that spiral out of control without intentionality. Regions or countries destabilized by the effects of climate change combining with other security threats could make nuclear escalation and misperception risks even more likely.^{iv}

iii The Working Group also discussed whether a condition of extreme nuclear proliferation is just as dangerous as use of nuclear weapons. If we have dozens of countries with nuclear weapon capabilities, is a catastrophic outcome inevitable? Does it depend on whether we are achieving systemic stability? Some believed that more complications being introduced, including new nuclear states, inevitably make it harder to keep the system in balance. Others expressed greater concern over the world’s water challenges. If more countries grow to consider their neighbors’ deliberate changes in water systems as acts of war, could this source of rising tensions make nuclear weapons proliferation or latency even more dangerous?

iv Short of nuclear conflict, some Working Group members considered whether grave instabilities in various regions could influence more countries to seek the security assurances they believe nuclear weapons provide.

3. CATEGORIES OF CLIMATE, NUCLEAR, AND SECURITY LINKAGES

Currently, there is strong evidence of at least five elements comprising a system of distinguishable security, nuclear, and climate interlinkages. The first described in this report is a category of *security trends and pathways*, such as concerns over nuclear latency and internal security threats in key locations. Second are the *social, political, and economic disruptions* that alter the trajectories of world events. Next are *governance mechanisms*, or the international norms and structures that normally exert stabilizing influences when they are strong. Fourth, this report describes considerations in *how science and technology, research and development, talent, and markets* shape the issues under examination. Finally, all of these factors combine in specific *conflict regions* to tilt stresses toward or away from outright conflict or competition.

Jordan is dealing with numerous internal economic, security, demographic, and environmental pressures as it pursues nuclear energy. Za'atri camp for Syrian refugees, Jordan. July 18, 2013. U.S. DEPARTMENT OF STATE



These categories constantly interact with each other in both positive and negative ways, with events and trends both affecting and being affected by one another. Within each category, there are decisions to be made that are interactive with each other and cumulatively have an effect on whether the international order descends into widespread conflict or is driven toward solutions. Events in these categories may serve as accelerants, constraints, stabilizers, or any number of other functions. They may trigger feedback loops or interrelate in surprising fashion. Together, they form a complex system in constant motion—one that does not self-regulate, but can be consciously steered with smart policies, institutions, and incentives. Leaders charged with ensuring U.S. security interests must keep an eye on how the moving parts are interacting in order to prevent it from spinning off into chaos or setting off a spark that ignites nuclear conflagration or climate change-exacerbated catastrophe.

SECURITY TRENDS & PATHWAYS

A number of specific, easily-identified challenges emerge from the intersection of nuclear, climate, and security factors. For example, nuclear energy cooperation among nations could reduce climate and other risks, but, depending on how it proceeds, may also raise new suspicions among other states about the motivations for acquiring nuclear technologies. While the NPT helps guarantee transparency and confidence in the peaceful intentions of nuclear energy programs, including those pursued under the auspices of addressing climate change, those programs nonetheless hold the potential to alter threat perceptions or amplify tensions. This section captures the Working Group's concerns and ideas on how climate and nuclear trends are intermingling and combining with and into several other factors: underlying security risks, nuclear weapons latency concerns, security concerns raised by specific technology choices, and unknown or systemic risks.

INTERMINGLED SECURITY THREATS

Several specific threats involve nuclear, climate, and security risks simply coinciding and combining in time and space. A number of countries considering new or expanded nuclear energy programs for climate and other reasons house terrorist groups and other factors that may heighten sabotage or materials security concerns. While nuclear facilities could be targeted anywhere,^v it is notable that several countries interested in or seeking nuclear energy have high risk from substate actors, including in the Middle East and Southeast Asia. Countries pledging the steepest nuclear power increases in their climate commitments—China and India—grapple with domestic terrorist threats as well.

Some Working Group members took on warfighting questions. Could these intermingled challenges complicate the work of those engaged in military operations? The liberation of parts of Iraq and Syria from the Islamic State have heightened focus on the future of urban

^v Nuclear sites in the United States and Ukraine being targeted for cyber attacks make this clear.

warfare. Such battles in proximity to nuclear facilities would further complicate this kind of already-complex picture. Should conflict arise with a country housing numerous nuclear reactors, targeting power sources without unacceptable risk to innocent civilians may become more complicated, especially in highly populated areas.

Stemming from a combination of economic, conflict, environmental, and other drivers, migration and population displacement form another type of disruption with game-changing potential. While the linkages between climate change and migration are increasingly clear, the pathways by which migration creates positive or negative security outcomes needs more attention. In many cases migration benefits individuals and nations (e.g., waves of immigrants to the United States bringing with them great scientific acumen). In other cases, it contributes to friction and even conflict. Either way, it appears that even small changes in environmental and security conditions can have widespread effects. Working Group members also raised multiple ways by which migration can affect nuclear affairs, including driving energy demands in new locations, raising concerns regarding illicit networks, and possibly complicating security around nuclear sites.

These fields could further intersect if urbanization trends that many countries are experiencing are amplified by the building of large nuclear power generation projects near big cities. This may be particularly worrisome for coastal megacities where sea level rise stands to clash with increasing concentrations of people and physical capital, or in cases for which the mixing of ethnic or religious groups may contribute to social unrest.

The ministers of foreign affairs and other officials from the P5+1 countries, the European Union and Iran meeting for a Comprehensive agreement on the Iranian nuclear programme. Beau-Rivage Palace, Lausanne, Switzerland. March 30, 2015. U.S. DEPARTMENT OF STATE



NUCLEAR WEAPONS LATENCY CONCERNS

Though energy demands and climate change needs are legitimate reasons for countries to seek or expand nuclear energy capacity, their doing so may nonetheless raise security concerns.

^{vi}A 2011 MIT study describes one such concern echoed by many members of the Working Group:

“The question is on the table as to whether or not the NPT needs reexamination in order to address this ‘threshold state’ concern that a country could reach the brink of a nuclear weapons program with domestic activities and fuel cycle assistance permitted under the NPT. The threshold state phenomenon can significantly impact geopolitical realities even if the country does not cross the threshold, as evidenced in the Middle East.”¹²

For most Working Group members who raised this question, Iran served as a prominent example. Additionally, a number of other states with advanced nuclear energy sectors have not diverted resources into weapons programs, yet continue to raise latency concerns. It is axiomatic that security environments facing nuclear-capable countries can change and that seemingly cooperative regimes can be replaced or evolve in unexpected ways. Climate change further destabilizing such countries would add yet additional concerns. A shift towards a greater global emphasis on nuclear energy, as such, requires a commensurate redoubling of support for strong nonproliferation regimes and commitment to international oversight, even in cases for which the risks of diversion or compromise seem remote today.

Fairly or not, nuclear energy programs in countries as diverse as Iran, Saudi Arabia, Turkey, Egypt, and Indonesia may raise latency concerns as long as they possess any capacity to divert efforts into a clandestine nuclear weapons program. Their choices of reactor technologies, primary suppliers and partners, and other specifics will be critical to shaping these perceptions. And while it already has nuclear weapons, India’s nuclear energy and missile technology cooperation with Russia will continue to evoke suspicions about a lack of adequate demarcation between civilian and military nuclear programs. For these and other countries, Working Group members voiced concerns that climate change effects could exacerbate the very kinds of economic, social, and political stresses that can influence nuclear latency concerns.

In addition to questions raised about the impact of climate change effects on Iran’s future, such as increased water scarcity, the Working Group discussed numerous, diverse views on what lessons can be drawn regarding its nuclear activities. Iran proved that countries can use nuclear power as a cover for investment in a nuclear weapons development program. At the same time, the Joint Comprehensive Plan of Action reached among the P5 plus 1 states in 2016 could demonstrate that robust international inspections can help dissuade states from crossing the line. Some thought the Iran case also showed international unity, critical at a time when North Korea’s nuclear and missile advancements and other world events are testing

^{vi} As with the likelihood of a nuclear detonation, the Working Group held diverging views on the degree to which latency concerns are mitigated by international safeguards, standards, and norms.

nonproliferation norms and regimes. With improved technologies, effective diplomacy, and stringent verification procedures, transparency can be augmented and it may become harder to hide nuclear weapons-relevant activities. On the other hand, some members wondered if the world will see a spread in nuclear energy programs coinciding with a slow build of nuclear weapons desires, and then witness a sudden cascade of countries tipping over the line to pursuing weapons programs. In a world with less continuity and greater systemic fragility, increased transparency may not constrain the behavior of all countries.

Countries will mitigate or inflame concerns over nuclear weapons latency based on their decisions regarding reactor types, enrichment and reprocessing, continual cooperation with the IAEA, participation in nonproliferation regimes and support for the NPT, and how they communicate their intentions in climate and other fora.¹³ Rhetoric regarding civil nuclear programs can help to shape perceptions on whether countries are motivated by solely peaceful purposes or seek to alter power balances. This is stark when countries appear to be reinvigorating their pursuit of nuclear energy without clearly linking these ambitions to climate considerations. Though it subsequently outlined more detailed energy, economic, and environmental goals related to its seeking nuclear energy, Saudi Arabia raised suspicions when it rhetorically tied its civil nuclear ambitions to the Iran nuclear agreement in 2015 while simultaneously omitting its nuclear energy activities from its commitments in the Paris negotiations. Even if it is unintentional, this type of gap can be perceived as an indicator that a country's nuclear energy plans are not solely or primarily motivated by emissions reduction or electricity needs.

TECHNOLOGY AND SUPPLIER CHOICES

Still other concerns may be raised when climate rationales are cited by countries developing nuclear technologies that are in turn perceived as presenting particular security challenges (e.g., enrichment or reprocessing capacities that appear to exceed needs). India's Paris submission not only stated the scale of its nuclear energy expansion goals but also specifically called out fast breeder reactors—which some consider to have history of unreliability or raise concerns if they produce weapons-usable materials—to illustrate the emissions mitigation technologies the country is eyeing. Subsequently, when India reported the country is planning to increase its fast breeder reactor capacity, Pakistani media raised concerns that these plans will alter regional security considerations despite both countries already possessing nuclear weapons.

What technologies countries adopt, and who their partners are in building and managing nuclear power programs, can also drive or dampen security concerns. Specific models of existing reactors and reactors newly in development can be safer and reduce suspicions of nuclear weapons hedging.

The contracts and technology transfer terms used by particular suppliers—and what ancillary deals are made—matter as well in assessing long and short-term potential security risks. For many, suppliers coupling military assistance with nuclear energy deals introduces serious concerns.¹⁴ The buy-own-operate model now in favor in countries such as Turkey and Jordan, for which Russia is now the main supplier, may make nuclear energy viable for countries that could not otherwise afford it. This



Key variables in the evolution of climate, nuclear, and security affairs will include what technologies are developed, used, and spread—and who leads in these fields. *Officer conducting a radioactivity assessment using a handheld detector. S. Tozser/IAEA*

may be net positive for stability in some countries. In others, the underlying strains on society and government demand special consideration. Nigeria, which appears to be progressing with its nuclear energy plans after years of delays, is one example that worried some Working Group members.¹⁵ While the country would benefit from additional energy supplies, it is struggling with a dramatic youth bulge, high unemployment, some of the most rapid urbanization rates in the world, extensive drought, disease outbreaks, population displacement, and the continuing threat of Boko Haram—in addition to a history of disaffected citizens and terrorist groups blowing up energy infrastructure. Ensuring governmental and societal capacity to address these challenges while developing a new nuclear sector, if those plans move forward, will require significant resources and collaboration.

CHANGING NUCLEAR MARKET

While the Working Group’s concerns listed above mostly pertain to the growth of nuclear energy globally, there are new and potentially significant risks associated with an overall reduction in the global demand for nuclear energy, as well. Should the countries that have traditionally spearheaded the oversight of international nuclear safety and security norms and associated regimes lose interest or disengage, this could adversely affect the international

Vladimir Putin and Rosatom CEO Sergei Kiriyenko discuss Russia's civil nuclear deals with countries such as Jordan, Hungary, Turkey, and Vietnam. KREMLIN/PRESIDENT OF RUSSIA



community's ability to detect, deter, and defend against nuclear threats.^{vii} Additionally, aging and shuttered reactors around the world will need to undergo decommissioning processes in the decades ahead. If political will for nuclear funding declines, the safety of these processes may be undercut and security could lag considerably and create serious new challenges.

Short of a full pivot away from nuclear energy, Working Group members posed the question of whether a lack of transparency and/or confidence about how nuclear technologies were being applied could interfere with efforts to manage climate challenges or sufficiently reduce greenhouse gas emissions. Taken further, several imagined a dilemma in which pushback over nuclear energy could drive influential countries such as Russia, China, or India, for example, to declare geoengineering as the only alternative for addressing climate change and pursue it vigorously.

For any pathway nuclear energy takes in the future, the weakening U.S. role in the nuclear suppliers market, and in international nuclear affairs in general, are already posing serious security challenges. Relationships and programs that are grounded in assumptions that countries like the United States, Japan, and France will continue their past presence in the international market may be outdated, with implications for the influence of these countries. If the American presence in international nuclear affairs declines, it will both serve as a detriment to U.S. national security policy objectives and disadvantage U.S. companies. We discuss this issue further in later sections of this report, as it raises numerous concerns given the daunting trends already present in the global security environment and onset of the effects of climate change.

^{vii} The Global Nexus Initiative has conducted significant work on these and related issues. See <http://globalnexusinitiative.org/>

UNKNOWN AND SYSTEMIC RISKS

Beyond these apparent challenges, the risks from secondary effects, indirect connections, and surprises likely rise as climate, nuclear, and security trends collide. Based on lessons from their careers, many Working Group members are concerned that the stability and strong governance structures needed to handle nuclear systems will be less predictable as climate change continues to exert its threat multiplier effects on the world.¹⁶ Key concerns included countries with nuclear power experiencing mass population displacement, large-scale disease outbreaks or epidemics, and acute water or food insecurity. If countries at risk do not adequately prepare for these pressures on society, they could see cascading effects that leave governments too strained to adequately keep nuclear facilities safe in an emergency or prevent them from being targeted. When multiple challenges collide in time and geography, they can easily exacerbate one another and become more massive problems than the sum of their parts.

Kazakhstan, Japan, the United States, the Marshall Islands and other countries have seen influential social and political movements rise in reaction to nuclear legacies. *Nuclear weapon test Bravo (yield 15 Mt) on Bikini Atoll. The test was part of the Operation Castle. The Bravo event was an experimental thermonuclear device surface event.* U.S. DEPARTMENT OF ENERGY.



Though these risks offer opportunities for stabilizing interventions, they generally push the international system toward greater fragility and disorientation if not explicitly addressed. A number of factors and events might come into play to create pathways to stability or instability. Whether ongoing shifts in the U.S. position in the world are short-term or enduring, they will have profound effects. International norms and institutions are mostly weakening, and emphasis on sovereignty is rising. State fragility and corruption will play a role in how countries handle complex climate, security, and nuclear challenges, as will explicit security threats such as cyber attacks and terrorism.

Unknowable trends and events will certainly have starring roles as well, and must be considered as climate, nuclear, and security trends combine. The Working Group imagined many shock events that could lead to abrupt, possibly unwise decisions by governments and other actors. One might be a major atmospheric change, for example from geoengineering attempts, or if China rapidly reduced its pollution and the reduction of reflectants causes a spike in heating. Another could be a major increase in the number of countries installing nuclear energy inducing further, even more dramatic changes in the suppliers market. Individuals might create swift change (positive or negative) via nefarious acts, technological breakthroughs, or an entrepreneurial individual trying to sell small reactors to every country in the world (a “Tesla of nuclear reactors,” as one participant described).

One next step for this Working Group will be to identify pathways by which any number of security and other trends and pressures from climate change can combine with nuclear issues in time and space to drive isolated threats and systemic risks. Social, political, and economic disruptions will shape these threats and risks, as outlined in the next section.

CLIMATE CHANGE EFFECTS AND SECURITY IMPLICATIONS

The security community is increasingly concerned about the implications of a changing climate.¹⁷ The Department of Defense considers climate change a “present security threat” and a direct risk to military operations, coastal installations, supply chains, and more.¹⁸ Indirectly, climate change functions as a powerful “threat multiplier,” impacting the foundations of stability and exacerbating other risks. To quote retired U.S. Army General Gordon Sullivan, “People are saying they want to be perfectly convinced about climate science projections...But speaking as a soldier, we never have 100 percent certainty. If you wait until you have 100 percent certainty, something bad is going to happen on the battlefield.”¹⁹ This is also how the Working Group approached increasingly high risk/high probability security trends related to the changing climate.

In thinking through possible scenarios and their implications for the geostrategic landscape, the Working Group identified a 3.5°C/6.3°F increase in temperature as an existential threat to the global community. Although this level of warming would be notably worse and/or less predictable, a practical starting point is to examine projections for a 2°C/3.6°F increase in global average temperature—the level the international community has set as a notional limit it must strive for, but which will still present significant and irreversible impacts to the world. Projected physical effects at 2°C/3.6°F degrees of warming include:

Satellite image of three hurricanes in the Caribbean/Gulf of Mexico, and wildfires in California. September 2017. NOAA.





The effects of climate change are already combining with security, economic, political, and other pressures to influence global and regional trends. *Arid soils in West Africa and the Sahel region*. 2012.

PABLO TOSCO/OXFAM

- A global average of 7.87 inch sea-level rise by mid-century, with over 90% of coastal regions experiencing significantly higher rates. By 2100, these levels will more than double to an estimated 19.68 inches.²⁰
- Prolonged heat waves, extreme summer temperatures, intense dust storms, and higher frequency and intensity of droughts in the Middle East.
- Altered glacial melt patterns in the Himalayan region resulting in both periodic flooding and dry spells downstream; higher frequency of precipitation events and droughts, as well as increased occurrences of tropical cyclones in India.
- Extreme cyclone events, severe flooding, saltwater intrusion, and significant landmass loss due to rapid sea-level rise in Bangladesh.
- Across the Asia-Pacific, including many countries with nuclear power and/or weapons, amplified natural disasters and sea level rise.
- In some countries highly dependent on hydropower (e.g., Brazil, Albania), reduced flow of water in critical river systems.
- Significant reduction in maize and wheat yields for tropical regions, particularly Central America and West Africa.
- Increased variability in precipitation patterns leading to floods, erosion, and landslides in southern Nigeria, in addition to desertification and droughts in northern zones.

Signs of many of these and other effects of climate change are already manifesting globally. Security analysts and other experts, including many in the Working Group, have long considered what these types of physical changes mean for stability, prosperity, and conflict conditions—especially as they combine with and influence other trends.²¹ Some of these include:

- ***Instability and state failure in some countries important to U.S. security interests.*** In 2012, a coordinated U.S. intelligence community assessment projected that this would occur within the next 10 years as water problems worsen. Water challenges will also “increase regional tensions” for some countries, “and distract them from working with the United States on important US policy objectives.”²²
- ***Mass migration from rural Middle Eastern and North African regions to stressed urban centers*** due to extreme temperatures, water scarcity, low crop yields, and mismanagement of resources. This can result in heightened social tensions and weaken political stability, as seen in Syria.
- ***Water insecurity in Asia contributing to interstate tensions and possibly conflict,*** for example, upper riparian states such as China and India flexing their control over valuable freshwater resources, subsequently alarming downstream neighbors such as Pakistan.
- ***A changing Arctic emboldening Russia,*** as it leverages opening transit routes and new resource access for political, economic, and strategic influence with countries in Europe, Asia, and beyond.
- ***Population displacement in high risk, densely populated coastal locations, including in Bangladesh, Mumbai, and Shanghai.*** Dramatic floods in summer 2017 displacing more than 2 million in South Asia in just a few weeks show this starkly. Estimates suggest that by 2050, 18 million Bangladeshis could be permanently displaced.²³ Historically, even much smaller population displacements have led to violence, weakening of interstate cooperative agreements, and countless strains on the governance, food, energy, social, and economic systems that underpin stability.²⁴

Notably, many observed climate change effects are already outpacing past projections.²⁵ These and other impacts will have serious repercussions for the security forces and institutions of the United States and other countries. As numerous defense leaders have described, the changing global climate already holds implications for equipping, planning, prepositioning assets, training, installation management, and budgeting.²⁶

The severity of unmanaged climate change impacts on the world and its governments cannot be understated. As states seek out nuclear power to meet energy and emissions reduction needs, they will have to simultaneously understand and address their climatic challenges and how those effects influence their domestic and regional security.



Satellite image of Ebeye Island in Kwajalein Atoll. NASA.



The Marshall Islands have raised public attention globally to the plight caused by past nuclear testing and the effects of climate change. *Tony de Brum, Minister of Foreign Affairs of the Marshall Islands* speaks at a UNFCCC COP 21 event. TAKVER/Flickr.

POLITICAL, SOCIAL, AND ECONOMIC DISRUPTIONS

In combination with the types of factors outlined above, pathways to security or insecurity will be greatly influenced by people and communities and their interactions with governments. The world already holds countless examples. Many publics around the world consider climate change and nuclear issues linked as their greatest or only existential security threats. The people of the Marshall Islands, for example, are taking legal and political action to address them as such.²⁷ In many regions, emotions over both climate and nuclear affairs are deep and pervasive, influencing the behavior of local populations and countries. National-level decisions regarding nuclear energy (for climate or other reasons) can clash with local desires, as we see happening in Japan and parts of India. Social, cultural, and emotional trends and tensions are disrupting long-held tenets of international systems—the newly-adopted nuclear weapons ban treaty is just one example—and hold the potential to make monumental gains or detriments to global security. And while nuclear-related protests are not new, the encroaching effects of a changing climate, the continually expanding access to information, legacy and emerging security dynamics, and other trends are combining in new patterns that may be changing the potency of these disruptions.

These types of disruptions affect international social and political dynamics that have a bearing on geopolitics. They also influence the domestic political environment in the United States and other countries, and affect how climate, nuclear, and security decisions are made. The Working Group generally agreed that the human dimensions of these challenges are extraordinarily influential, incredibly complicated and difficult to predict, and too often ignored in examinations of global security trends.

The absence of policies that account for climate, nuclear, and security linkages can threaten political and social stability. Countries such as Jordan, Saudi Arabia, India, Pakistan, and Bangladesh are in various states of pursuing or expanding nuclear energy despite the clear indicators that the changing climate may affect their future ability to operate more power stations that are more water-intensive, or on land that may be vulnerable to natural disasters or precious to local populations. Notably, Jordan has tried to answer these sensitivities by incorporating plans to rely on wastewater to cool some of its nuclear reactors while using some of the energy generated for desalination. However, governments pursuing nuclear power in ways that don't appear sensitive to climate pressures have already met with protests, and risk driving social instability and stoking political opposition, which can raise new security risks within and beyond their borders.

In terms of social disruptions, the group found a positive trend to be a high degree of social capital and advocacy surrounding climate change, including in developing countries. The Paris climate change agreement would not have come to fruition otherwise, showing the potential for social pressure to steer global trends. Energy poverty serves as a significant social disrupter as well, including by influencing patterns of population movement and intermixing, and drawing lines between haves and have-nots.

How information is transmitted, received, and interpreted has feedback loops across climate, nuclear, and security issues, with social media forming a potent mechanism for this nexus. The group agreed that social media can be positively harnessed regarding these issues, but that its contributions and effects are relatively unpredictable. It can likewise cause a harmful form social cohesion by facilitating the spread of misinformation. Important but underappreciated are social media's roles in nuclear monitoring and verification, tracking environmental changes, and understanding conflict. Such tools will be critical for addressing this nexus of trends.

In terms of positive disruptions, social conceptions of safety cut across climate, nuclear, and security issues—and provide a coherent hook for reaching diverse publics. People in many countries are demanding protection more than they used to and holding governments accountable, and most publics want reassurances that the energy they are being supplied with will be safe. This heightened demand includes responses to natural disasters, disease outbreaks, and nuclear safety concerns, for example after Japan's Fukushima-Daiichi nuclear site was devastated by tsunami.

Religion is yet another important factor, but often marginalized in analysis of security threats. Many places where we see nuclear, climate, and security factors intertwining also experience strong religious influences, including South Asia and the Middle East. Religion can inform public views on all of these issues in multiple directions, often simultaneously. Various religious groups participate in anti-nuclear activism and pressure governments to address climate change, for example. Individual religious leaders can have strong impacts as well, as seen in Pope Francis being highly vocal on climate change and nuclear weapons as his influence grows as a global leader even for non-Christians.



The advancement of a nuclear weapons ban treaty, and the P5 sitting out some disarmament forums, have shaped global affairs in recent years. *UN working group on nuclear disarmament, Geneva, May 2016.* ICAN-AUSTRALIA

In both religious and secular ways, there is evidence that people in many parts of the world are becoming more clannish. The activism of civil society groups, individuals, and countries that pushed the nuclear weapons ban treaty, and the P5 separating themselves from many nuclear disarmament fora in recent years, are examples of factional lines becoming more stark. Additional signs are emerging from Brexit, independence referenda in Iraqi Kurdistan and Catalonia, and statist approaches emerging on both climate and nuclear issues in states like California. Sub-state actors banding together to remain committed to international climate goals despite retracted support at the federal level may be yet another example, and one that—in combination with the rise in terrorism, the influence of wealthy individuals, and other trends—raises questions of whether nation-states will lose dominance in shaping climate, nuclear, and security affairs.

Generational divides can likewise influence positive and negative disruptions. Lack of knowledge regarding nuclear weapons and energy by younger generations can be detrimental to creating political will for any policy changes. Conversely, younger citizens tend to be much more active regarding climate change.

As part of this dimension, some Working Group members discussed the important role of universally shared, defining moments and experiences for affecting social and political cohesion regarding specific issues. In Japan, the shared experience of the country's devastation from the March 11, 2011, triple crisis has facilitated a deeply-felt movement against nuclear energy.

For Americans, it was seemingly-distant security threats hitting home in the catastrophic attacks on 9/11. Shared experiences also play important roles in publics relating to one another across nation-state boundaries. For those raised during the height of the Cold War, Americans and Russians can relate to one another regarding living daily under the threat of nuclear attacks via duck-and-cover drills and similar campaigns. Conversely, as of this writing the world's seemingly gradual movement toward mounting climatic stresses and nuclear war currently appears to lack those singular moments that drive shared gut feelings and inspire widespread political mobilization.

The nuclear realm may be witnessing the most dramatic social and political disruptions among the global concerns the Working Group explored. There is a strong sense that the existing system of international norms, institutions, and relationships is under intense pressure. Major changes in U.S. politics, signs that the United States is lagging behind in the nuclear suppliers market, and U.S. leaders openly questioning longstanding tenets of nonproliferation and disparaging steps to stop Iran from developing nuclear weapons all factored into the Working Group's concerns. The division between the P5 and most of the world's governments regarding disarmament policies and the nuclear weapons ban treaty are leading many to question whether the system built around the NPT will survive. Significant uncertainties abound. For example, publics around the world openly questioning the premise that nuclear weapons make possessors and their allies safer could prove to be either a stabilizing or destabilizing trend. Here the divisions in attitudes between the so-called global north and south will play an important role, as will specific countries such as Japan, Kazakhstan, and the Marshall Islands where populations have experienced the effects of extreme radiation exposure.

Numerous effects of climate change (or climate alterations driven by nuclear warfare or geoengineering) hold the potential for world-changing economic and social disruptions. Water and food insecurity are likely mechanisms. The ability of the global agriculture system to adapt to the changing climate and ongoing biodiversity loss, while meeting the world's growing food needs, is in serious question. It is also not clear to what degree governments are able to absorb and manage these changes. Social order can easily be disrupted by changes in food patterns—not just by food insufficiency, but by changing herding lands and forced dietary shifts that carry important cultural implications. Around Lake Chad and Western Africa, for example, drought is already affecting agriculture and extremist groups in ways that feed off one another. In the Middle East, changing water availability is certainly impacting society in various ways that extend far beyond physical effects. The contributions of Syria's long-term drought to its civil war, which has led to mass suffering and affected security dynamics across the region and into Europe, is one clear example.²⁸

Topping off these concerns, it is clear that one of the most profound global disruptions is likely the decrease in American influence over international norms, events, and regimes.

GOVERNANCE

In diplomatic affairs, climate, nuclear, and security issues often overlap and bleed into one another, especially as countries develop new negotiating blocs that influence behavior across issue areas. China, for example, reshaped international climate change negotiations in ways that extended its influence beyond that single issue. Nuclear, climate, and security issues are intertwining to present new challenges and opportunities, as seen in climate change agreements being used to advance countries' interests in Nuclear Suppliers Group deliberations. Treaties, legal tools, and diplomatic agreements and channels that now promote nuclear security and nonproliferation norms are under new pressures just as climate change effects are taking root and influencing national and international affairs. Shifts in American power and the U.S. role in the world are shaping and being shaped by these pressures.

International nuclear norms are already shifting in parallel to these broader changes in the global order. In just one example, there is a rising inclination to discuss the use of nuclear weapons as an option for de-escalating conflicts. Newcomers to the nuclear arena are increasingly challenging once widely-held non-use and no-testing norms; some experts and officials even in established nuclear weapons possessing states are doing so as well.

GOVERNANCE INSTITUTIONS AND FRAMEWORKS

While it was originally characterized as “international affairs, norms, and order,” the Working Group ultimately renamed this category “governance.” This was due to the term’s broad inclusivity of international affairs concepts such as order, norms, regimes, systems, etc. Governance systems must be designed to keep us further away from two possible existential threats of nuclear war and catastrophic climate change. Although the global political climate is unpredictable, norms, regimes, and systems should function mostly as stabilizers when they are strong, as they can serve to dampen the oscillations that happen.

The Summit process may be an example for future mini- or multilateral progress on the types of issues addressed in this report. *Opening Plenary of the Nuclear Security Summit 2016, in Washington DC, April 01, 2016. NARENDRA MODI*



The Working Group held a lively debate over whether governance structures are more likely to emerge after crises manifest, or if the political will can be generated to create them in time to prevent devastating outcomes. Although many pillars of our current global order came in the aftermath of world wars, the Paris agreement stands as a recent example of the world uniting to create a system for mitigating catastrophic risks.

While we have organizations to promote nuclear safety, security, and safeguards, enforcement mechanisms and international support are uneven across these fields. Many Working Group members believe governance for nuclear security is the least adequate of the three, even after concerted improvements fostered by the Nuclear Security Summits process. Further, one of the most important players—the IAEA—may not be resourced properly to handle its expanding, critical roles. Its needs may grow further if nuclear suppliers introduce multiple types of new reactors in the future and if its contributions to global security continue to grow.

In addition to these nuclear challenges, there is a clear void of governance frameworks that unite these concerns with climate and security threats. The normative structures of these issues have thus far been built mostly in isolation of each other. The Working Group adamantly believed that it was necessary for international bodies to factor in the growing intersections of these issues. Doing so becomes all the more pressing when faced with scenarios such as climate stresses disrupting the social fabric of communities and potentially resulting in destabilizing governments.²⁹

Incremental upgrades to the current system, which has clearly reached its limits, may not be optimal for addressing this deficiency; nor are a purely top-down regime or single governance structure or institution. Rather, the solution may require the right combination of international regimes, norms, and organizations. Helpful elements could be peer review systems that include government and non-governmental experts and institutions. Multi- and minilateral cooperative structures have likewise proven successful in augmenting international governance. Harmonizing international regulations in nuclear affairs, and developing any international governance system or basic norms for geoengineering, would be important steps as well.

SHIFTING U.S. AND INTERNATIONAL LEADERSHIP ROLES

An overarching theme discussed throughout this category's evolution was the deepening unpredictability of traditional international leadership roles of states, including U.S. leadership within the international system. American dominance of international structures and affairs seems to be waning, and what the future holds for U.S. influence is unknown. This shifting position for the United States, and other international leaders, is coupling with the general weakening of international governance, with structures such as the World Trade Organization and agreements such as the North American Free Trade Agreement losing potency and potentially being dramatically altered. The U.K.'s planned withdrawal from the European Union, and the rise of populist and isolationist political forces in several key countries, is also likely to have serious implications, known and unknown, for world order.



China's influence in global climate affairs may be rising, with repercussions for specific trends and world order broadly. The influence of actors other than nation-states may be rising as well. *Chinese President Xi Meets With California Gov. Brown.* RICHARD LUI-POOL/GETTY IMAGES.

As this report discussed previously, Russia and China are further shifting global affairs as they are perceived to be taking advantage of the void the US and other traditional international leaders are leaving behind. One clear manifestation is both states utilizing nuclear energy investments in other nations to expand their geopolitical influence. In addition to the nuclear realm, China in particular is exhibiting clear indications that it seeks to dominate in both climate and security affairs as well.

SCIENCE & TECHNOLOGY, RESEARCH & DEVELOPMENT, TALENT, AND MARKETS

Nuclear- and climate-related fields of science and technologies have been intertwined for decades, and overlap in countless ways. National security has been greatly enhanced by public and private ventures to leverage scientific and technical work to benefit both the climate and nuclear fields (e.g., National Labs applying computational and modeling power across both issues). Advances in sensing, artificial intelligence, robotics, 3D printing, and beyond are reshaping our security environment while offering new tools for addressing nuclear and climate concerns. The S&T fields will continue to evolve, as will the markets that shape their trade, application, and proliferation, carrying a range of security implications. Changes we see may be stabilizing or introduce new threats, and hold the potential for both.

The IAEA conducts a field exercise on transport security of nuclear material at the Kerntechnische Hilfsdienst GmbH, Karlsruhe, Germany. 12 October 2017.
DEAN CALMA / IAEA



THE CHANGING GLOBAL NUCLEAR LANDSCAPE

As discussed in brief earlier in this report, Working Group members raised a number of serious concerns regarding the changing nuclear export marketplace, and its implications for norms, standards, and legal mechanisms. Which countries lead the nuclear suppliers market and their behavior hold important security implications for the United States and international community. Nuclear deals are strategic for both suppliers and importing countries. Allison Macfarlane described this succinctly in 2013: “Vendor countries see nuclear technology sales as a way to gain power and influence over buyer countries.”³⁰

The declining U.S. role in the nuclear suppliers market, and Russia’s rising dominance of it, is a defining shift in global affairs. American influence in the Nuclear Suppliers Group and other fora, and the U.S. ability to use nonproliferation programs to project its influence and reinforce deterrence, may already be waning. With these trends, U.S. influence on supply chains and safety may decrease. Many voiced concerns that we will see the spread of technologies that we don’t have control or influence over, and that may lead to new nuclear risks. The suppliers landscape may affect innovation as well: while China, as a newer supplier, seems quite focused on innovation, Russia may be disinclined to invest in technological advancements the more it dominates the international market.

As the leaders of Russia and China are positioning their nations as key future nuclear energy partners, they are already influencing questions of nuclear safety, security, and nonproliferation.³¹ While suppliers adhere to the same baseline standards, some are more diligent than others in helping partner countries to gain higher levels of training, more advanced monitoring and security technologies, better regulatory regimes, and well-practiced emergency preparedness systems. Several countries seeking new nuclear energy systems are already grappling with severe security challenges and natural resource stress, such as Bangladesh and Jordan. As this report shows, serious challenges may arise if their suppliers and partners are not diligent in accounting for the complex ways in which security and climate trends are combining in these countries.

There is a technological concern raised by the suppliers question, and it is broader than the often-discussed questions of enrichment and reprocessing. Nuclear engineers and operators have learned much in the past 35 years, and newer nuclear reactors are significantly safer than those of decades past. If suppliers export older-model reactors as energy solutions to climate change when newer, more advanced models are available to meet the needs of the importing country, that may in itself introduce unnecessary risks.

Looking further to the future, Working Group members raised the prospect that the current changes in the nuclear suppliers market may be mild compared to scenarios of greater disruption. If existing export control systems and suppliers regimes sufficiently weaken, will we lose the ability to legitimize some nuclear providers while delegitimizing others? Might the DPRK become a supplier? Under what conditions do we lose control over such questions? What mechanisms are in place to enforce decisions made for the greater good? Can we impose penalties on countries that choose options we don't like?

Beyond which countries supply the future nuclear energy market, in whatever form it takes, the group considered whether specific technologies are particularly advantageous regarding safety and materials security. Second, the group debated the pros and cons of overtly pushing those technologies into countries experiencing thorny climate and security challenges.

Some Working Group members noted that larger reactors may be more important for making a major difference in mitigating greenhouse emissions, but many countries with high security and climate risks may not in the near or medium term have the grid capacity or human resources to manage them effectively. Looking ahead, small modular reactors may be more ideal than alternative models for stabilizing some areas in desperate need of energy and water while reducing proliferation risks. A serious question for the U.S. government is whether to attempt to hasten the advancement of these or other types of reactors to market by offering incentives, creating testbeds, or taking other measures. Notably, the United States is not the only potential supplier for small modular reactors. Russia, China, or others could bring these or other new reactor technologies to market faster and without some of the constraints U.S. companies face.



The Working Group found preservation of U.S. data collection, analytical, and modeling capabilities critical to mitigating both specific and systemic security risks. Equally important are the broad range of capabilities residing in U.S. National Laboratories. *NOAA has deployed the Saildrone to study fisheries in the Bering Sea.* NOAA.

PRIVATE SECTOR ROLES AND TRENDS

The Working Group shared a sense that markets will play a critical role in addressing climate change, in particular with the need for industrial actors to bring S&T developments to the market at a large scale. There was a sense that while the private sector should be incentivized by profits if things function smoothly, governments and civil society may still play a role in recognizing implementation, rewarding high-quality outcomes, and identifying good, better, and best practices.

One possible shift could add power to how this category affects the grander system: if the private sector comes to dominate actions and investments that used to be mostly government controlled. The growing private sector role in space may portend shifts in the weather, climate, or nuclear arenas for the United States. Investors and venture capitalists are emerging to potentially reshape these landscapes, investing in private companies that are performing the types of research, development, and testing roles that were once dominated by the National Labs and other federal government agencies. This is in contrast to countries such as Russia and China, where the governments are remaining more in control. The work of these countries—and the degree to which innovative American companies work with and through them—will have implications for who can access new technologies, how they will be distributed, and whether they are made broadly available.

This raises control, risk reduction, and secrecy issues. Many Working Group members strongly believed that the United States reducing its role in nuclear energy affairs is already limiting its influence regarding safety, security, and norm-setting. Additionally, a waning U.S. government role could harm efforts to reduce disaster risks—an inherently government-led role requiring tight coordination across many companies, public-sector civilian and defense responders, hospitals, and law enforcement agencies. Finally, for good or ill, U.S. technology development and intellectual property will be harder to protect if research, development, testing, and deployment begins to stretch across numerous countries.

While there are clear benefits to greater private sector investments in technologies relevant to climate, security, and nuclear affairs, governments will still be called upon to assist in the event of natural disasters and accidents (in particular the U.S. government). For this reason, to continue advancing basic scientific research, and to maintain a talented U.S. workforce, the National Labs, NOAA, NASA, and other agencies must retain responsibilities and capabilities even if private companies and investors gain a more robust presence. This may also make an appreciable difference in the future of U.S. industries and international trade norms, particularly if other countries prop up their energy and other industries in ways that disadvantage American competitiveness.

There are operational and business model details that could contribute stabilizing forces in countries grappling with climate and security stressors. The build-own-operate nuclear deals concluded in recent years by Turkey and Jordan establish multi-decade relationships with their supplier countries, and may prove less costly than these countries continuing their heavy dependence on imported fossil fuels. Similar models may also indirectly bring in capital for desalination that would be difficult to raise solely for reducing water stress.

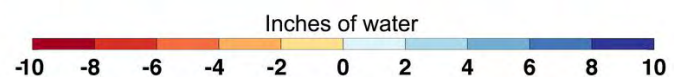
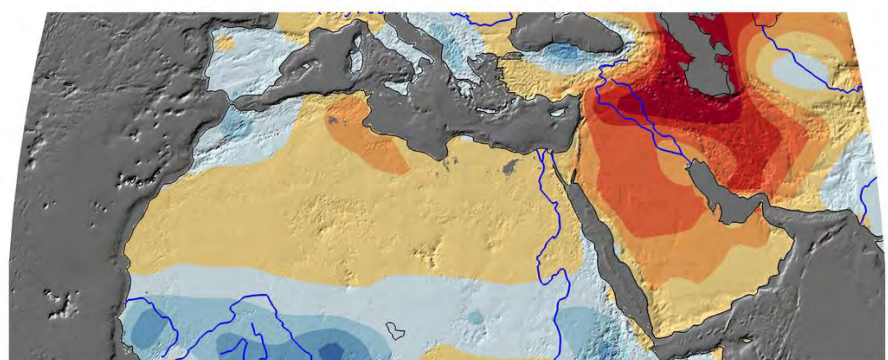
Private companies and market forces will also likely lead in determining the degree to which the transportation sector becomes electrified, and at what speed. This will certainly influence the equation of future power generation needs for many countries. Some may see nuclear energy as the only viable means of electrifying their transportation systems without new increases in greenhouse gas emissions.

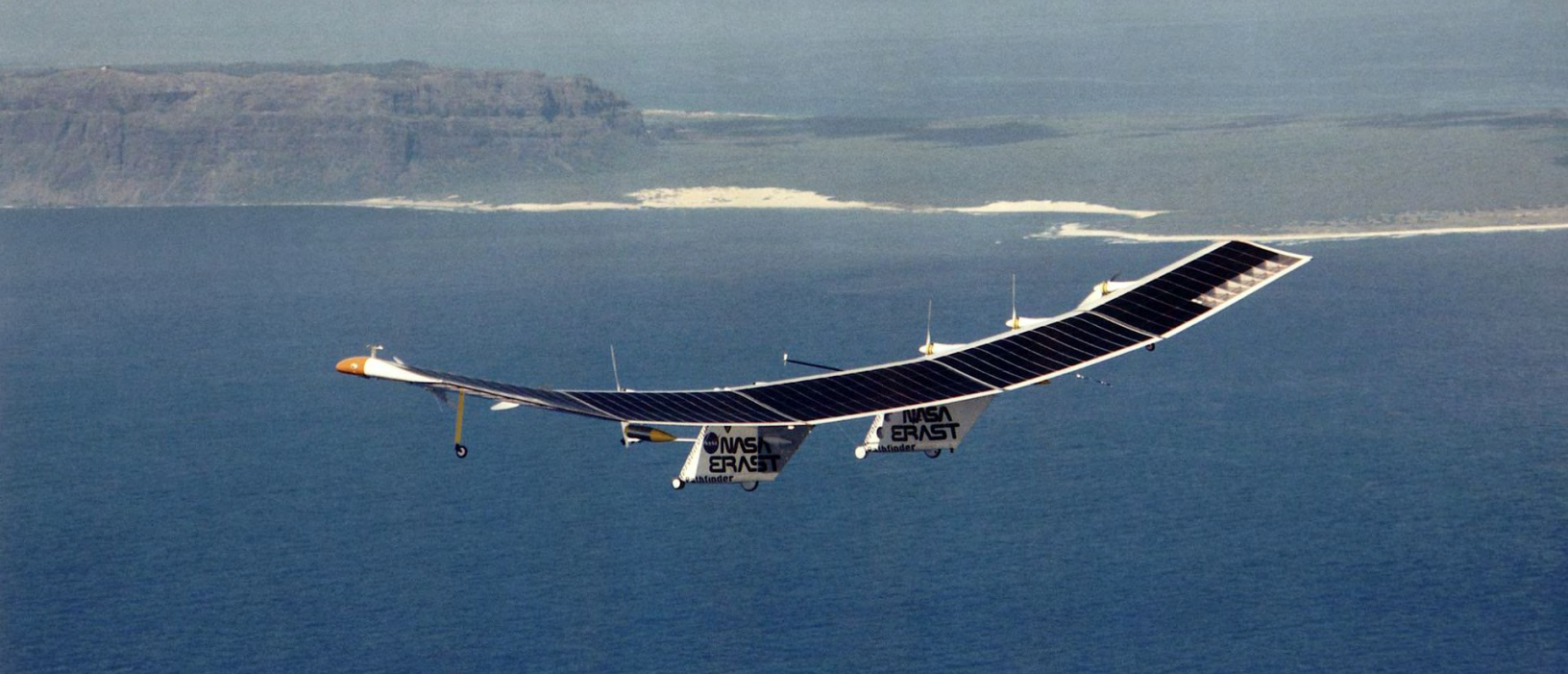
DATA

Data will play important roles in systemic stability or instability, including with important applications across climate, nuclear, and security issues. Data

Cumulative total freshwater losses in North Africa and the Middle East from 2002 to 2015 (in inches) observed by NASA's Gravity Recovery and Climate Experiment (GRACE) mission. NASA.

GRACE TWS trends: increases & decreases over 13 years (2002-2015)





Pathfinder, NASA's solar-powered, remotely-piloted aircraft is shown while it was conducting a series of science flights to highlight the aircraft's science capabilities while collecting imagery of forest and coastal zone ecosystems on Kauai, Hawaii. NICK GALANTE / NASA.

used for weather and related predictive capabilities developed in the United States are critical to forecasting and understanding details of the changing climate—including in ways critical to national security agencies. The U.S. government has greatly improved these capabilities to account for the fact that weather variables today are not behaving like they used to.

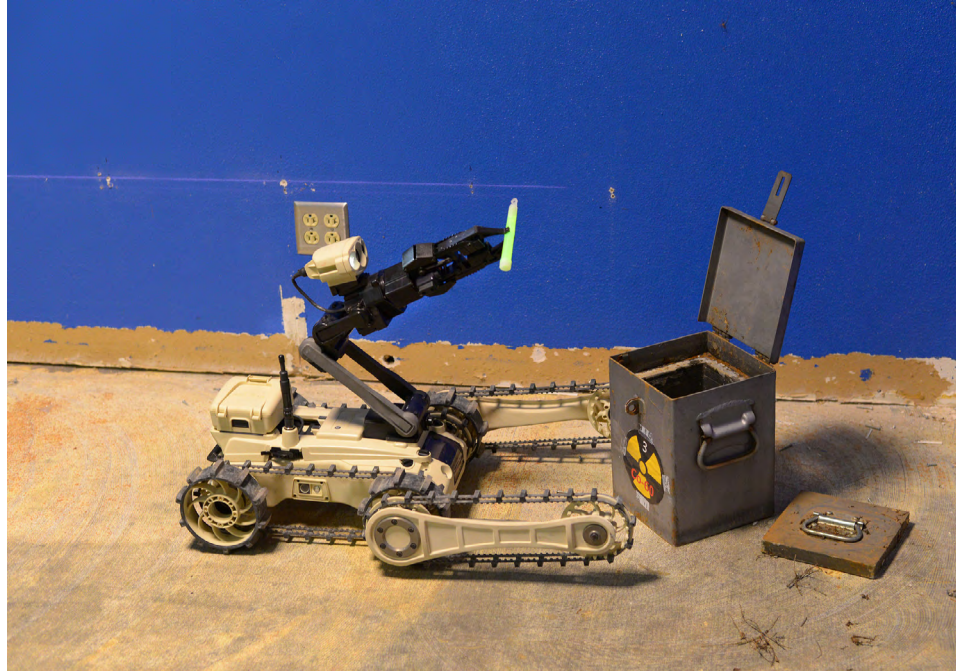
Reducing U.S. government involvement in data collection and analysis would have several clear consequences. Limiting our ability to predict weather patterns that are outside of the norm is a serious security concern, and could leave the American people and infrastructure more vulnerable. NOAA and NASA have been at the forefront of improving U.S. models and providing U.S. data and future projections for use by the international community. If the U.S. ceases to provide these global goods, other countries or private companies might not fill the gap, or may not do so without financial or political concessions. Either way, the U.S. government loses its leading edge in knowledge and influence.

Perhaps more worrisome, data collection and analysis are not capacities the United States can instantly rebuild. Day to day collection informs the process in an ongoing manner and refines the skills of American personnel. Forensic investigation methods are less precise than those by which U.S. experts continuously collect data over time, and reliance on them could exacerbate the problem of not being able to forecast properly.

TALENT AND OTHER INVESTMENTS

The monumental security, climate, and nuclear challenges the world faces cannot be adequately addressed on a global scale without concerted investments in research and development and talent cultivation. Whether the United States engages in serious efforts on this front will shape

its ability to influence and lead in shaping the future world order—and determine whether American workers take their skills to other countries. Indeed, much of the Working Group’s conversations regarding science and technology centered on the pressing question of the future American role in supplying it and shaping how certain fields evolve.



Ninth annual Western National Robot Rodeo and Capability Exercise at Sandia National Laboratories. The five-day event offers a challenging platform for civilian and military bomb squad teams to practice defusing dangerous situations with robots’ help.

RANDY MONTOYA / SANDIA LABS.

Human capacity and talent will determine whether the international community finds stability or instability in the face of mounting climate, nuclear, and security strains. While this is a global issue, the United States is witnessing specific concerns in this regard.

The national security community plays a unique role in this picture, and suffers unique challenges. The National Labs have suffered loss of nuclear-related capacity, some as a result of positive arms control progress. At the same time, they have expanded important capacities in areas such as energy, cyber security, countering biological threats, and climate change. In all of their areas of expertise, the National Labs cannot quickly bring back capacities that they lose, holding negative implications for national security and American innovation. Even if the Labs maintain their current strength, it may still be insufficient for the diversity and scale of the U.S. security threats they must help in addressing.

There are positive signs on the international side, with bright spots such as CERN (the European Organization for Nuclear Research) and the UAE’s Masdar initiative. However, there is still no single organization focusing on advances in basic sciences or developing technologies that cross climate vulnerability, energy challenges, nuclear security and safety, dual-use challenges, and other issues in unison.

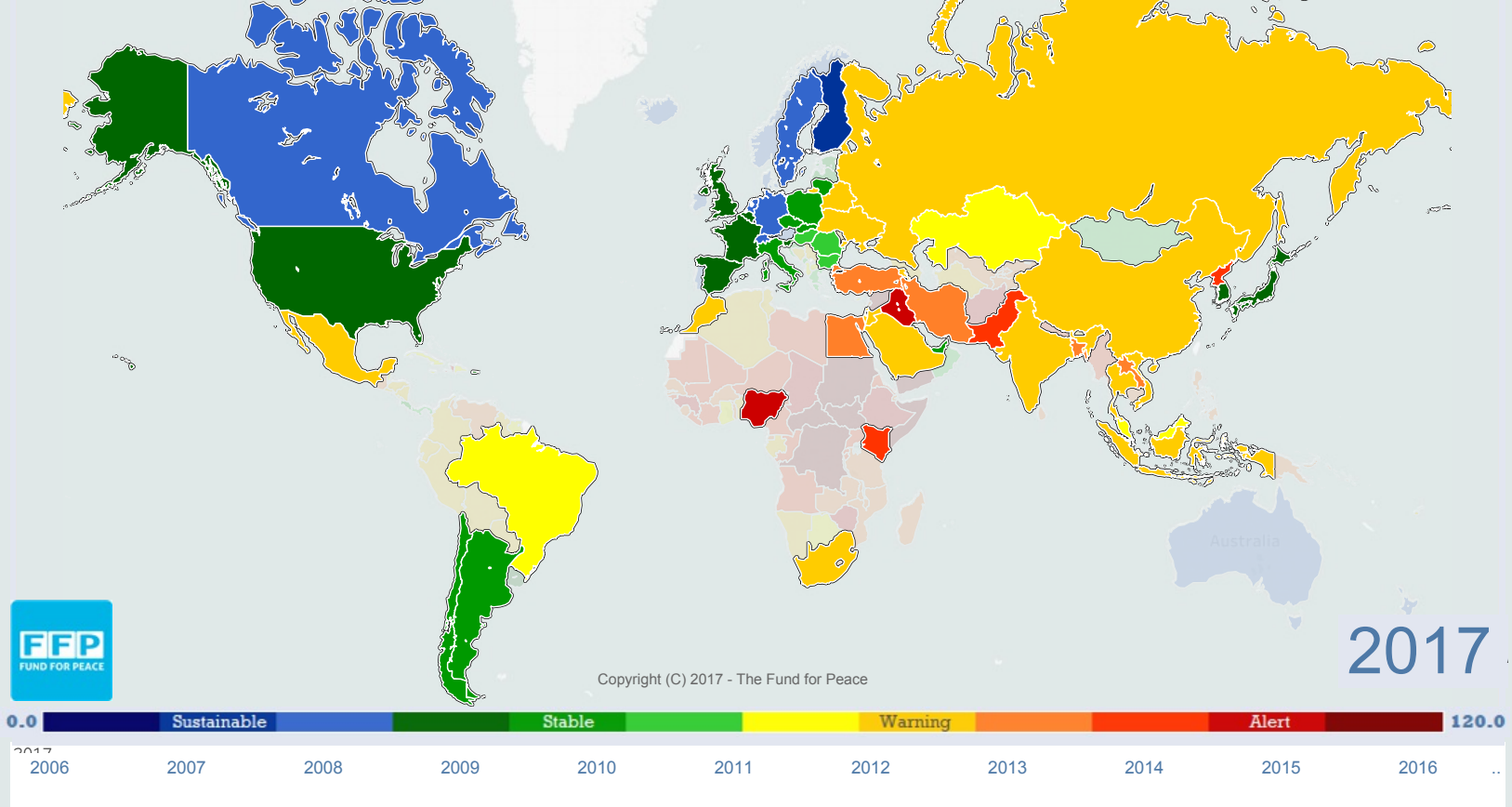
The decline of the U.S. nuclear industry may be placing negative pressure on the Navy in particular. Recruiting for the nuclear Navy may become more difficult due to a belief that there will not be as many nuclear jobs in the private sector when service members retire. The Navy’s nuclear experts are also working with more advanced technologies that the U.S. private sector is currently, so their skills may not align well to the available civilian job market.

For both climate change and nuclear expertise, the Working Group shared a sense that the United States risks losing the edge it has built for decades—and critical information about the changing global security landscapes—if agencies such as NOAA and NASA see major budget cuts. Likewise, future support for the National Science Foundation and science, technology, engineering, and mathematics (STEM) programs, among others, will shape the U.S. ability to build the savvy labor force needed to meet the visions of our national leaders and entrepreneurs. U.S. education and immigration policies will also shape the country’s future science and technology capacities. Importantly, the challenges extend beyond scientific and technical expertise: how can the United States ensure the next generations of diplomats and defense personnel have the knowledge needed to prevent and address complex climate, security, and nuclear challenges?

OTHER CONSIDERATIONS

Numerous other categories of technologies are likely to play increasingly important roles in addressing climate change, nuclear, and security threats—including many with applications across all of these domains. For all of these, the question lingers of whether the United States will lead in creating new markets and supplying the workforces to feed them. Examples include artificial intelligence (AI), robotics, and 3D printing, which can be used for myriad climate change-related challenges and security applications, and will create both helpful tools and new risks in nuclear matters. Advances in sensing and detection are already exerting influence, and can be used in combination with AI platforms and robotics to great effect. Modeling capabilities have long aided decision making and planning, and hold great potential for gaming out how applying disruptive technologies and trends could affect the climate, nuclear, and security space. The internet of things and industrial internet of things are beginning to have strong effects, including on energy supply and demand, and may offer hooks for bringing skilled non-experts into the equation of solving complex security challenges.

In several areas, many Working Group members recognized that governments must play an active role in ensuring security needs are met, incentivizing innovation, and setting norms and standards. Geoengineering is one clear example, as it is currently ungoverned, carries clear security implications, and could bring negative effects to some parts of the world. Given the unacceptable security risks of climate change in a business-as-usual scenario—including devastating sea level rise, mass displacement of people, and more—the U.S. government can continue its focus on incentivizing breakthrough advances in carbon dioxide removal and power storage and management in ways that private companies with a responsibility to return profits cannot.



Fragile States Index. Highlighted countries either have established nuclear power programs, are taking steps towards expanding existing programs, are in planning stages of development, or are actively exploring nuclear energy options. THE FUND FOR PEACE.

CLIMATE, NUCLEAR, AND SECURITY CRISIS REGIONS

Driven by the factors outlined in the preceding categories, climate, nuclear, and security risks are increasing in unison in a number of countries and regions. Even where these risks are connected by geographic correlation and not necessarily causation, they may exacerbate one another in new and unexpected ways. Nuclear desires, security challenges, and climate change effects may create compounding risks. States possessing nuclear weapons and their neighborhoods may face unique concerns from coinciding security tensions, social stress, water stress, power generation issues, and other resource challenges. These are the regions for which the system is most at risk. The Working Group selected the term “crisis regions” to point to these areas where factors are most likely to gather into a perfect storm, noting that regions of highest concern will change over time.

While climate, nuclear, and security threats are clearly compounding in a number of crisis regions today, the term is not meant to indicate that there are predictable outcomes to the complex dynamics they house. Our predictive capabilities are normally low in conflict studies and nuclear affairs, and climate change effects are happening faster than many models projected in the past. Rather, “crisis regions” are places for which it is most critical to take stabilizing measures and push positive interactions across the system. Such interventions could include assistance in all-hazards disaster preparedness, designing safety and security systems, and providing appropriate technologies. These types of stabilizing actions must also account for the underlying political, social, and economic drivers at play.

A number of events and characteristics may help in identifying crisis regions of highest concern: weak institutions; nuclear weapons or a latent capability; heat-related losses to power generation leading to unrest; deaths, riots, or migration from climate-related effects; presence of major terrorist organizations, insurgencies, or criminal networks; and insufficient capacity to prevent disease threats from straining governance and social stability. For countries possessing nuclear weapons, command and control becomes an additional consideration for these regions avoiding nuclear war.

Disasters hitting already-fragile places could also abruptly create crisis regions. This could be the case for even for relatively stable countries pushed beyond their response capacity by natural or manmade disasters that suddenly overwhelm them. It is not a stretch to imagine sea level rising and then a major storm hitting a coastal megacity that is already under strain from population growth, resource stress, and underemployment. Geoengineering experiments creating unintended consequences or unevenly distributed effects could act in a similar fashion.

At the same time, identifying crisis regions can assist in prioritizing the highest-payoff interventions. For any region of concern, we can work through how applying or increasing environmental and nuclear technologies could serve as a stabilizing force by helping to address energy poverty, reduce water stress, create jobs, and build institutional capacity. For countries overly reliant on fossil fuels to drive their economy, gaining nuclear capacity can help a population to feel empowered by no longer needing “to drill its value out of the ground,” as one participant noted. In order to have a positive impact, ramping up nuclear capacity in these areas will require working through issues like security and safeguards, spent fuel disposition, personnel training and reliability, and public communications—all of which, if done well, can be used to strengthen societies and institutions. Optimally, these types of advances would be accompanied by technologies and capacity-building for reducing climate change risks.

Moreover, like defense alliances, long-term nuclear relationships with responsible suppliers can strongly influence crisis regions. Countries such as Russia, China, and Japan have long recognized the strategic importance of entering into enduring relationships surrounding nuclear systems, especially with countries currently among the nuclear have-nots. As one Working Group member noted, if American leaders could develop the political will and command U.S. institutions to “TVA” countries like Jordan or Indonesia—in other words, assist in establishing functional and profitable energy systems building on the successful history of the Tennessee Valley Authority—the United States would gain deeper knowledge regarding their nuclear activities and wield greater influence over measures to reduce stress from security- and climate-related tensions.

Over the long term, the prospects of nuclear energy serving as a stabilizing influence in crisis regions will also depend on whether suppliers help to ensure that nuclear safety, security, and safeguard personnel and institutions are robust and resilient even under strains. Other key variables will be countries’ abilities to ensure that grid capacity is sufficient to sustain their nuclear energy plans, and how they mitigate any latency concerns as may be perceived by their publics or the international community.



Flood Affected Areas of Amreli District Gujarat India on 24 June 2015. INDIAN AIR FORCE.

As is often the case, entire regions could be at risk when a combination of stressors go wrong just in one country or region. Syria has shown this ever since sociopolitical pressures and oppression by Assad met with the effects of long-term climate change-exacerbated drought in the lead up to the Syrian civil war. The conflict has killed more than 400,000 people, displaced more than 11 million, facilitated the spread of various terrorist groups, drawn Russia and NATO countries into tense military and diplomatic standoffs, and contributed to greater region-wide fracturing between Shia and Sunni states and populations. The Working Group identified several countries that seem to hold the ingredients for these kinds of complex nuclear-climate-security crises to unfold and affect their broader regions, including Iran, Russia, North Korea, and Turkey.³²

In terms of regions of highest concern today, the Working Group identified the following as worth examining for scenarios that could lead to systemic failure and even countries reaching either or both breaking points.

South Asia is certainly witnessing nuclear, climate, and security risks, which are already combining in a variety of ways. Unfortunately, it may be the perfect example of the geopolitical instability that already exists in a region combining with climate and nuclear stressors in dangerous ways. The wider region holds three countries with nuclear weapons, and numerous terrorist networks. There is regular, active fire between Indian and Pakistani forces. Tensions in Kashmir, while long enduring, are rising once again and now combining with the proximate pressures of new nuclear weapons and water stress. India, Pakistan, and Bangladesh are all planning nuclear energy expansions, including in collaboration with Russia and China, at the same time as they are grappling with declining glacial melt and damming of shared river systems, high population growth, sea level rise, severe heat stress and other natural disasters, migration and internal population displacement, and other pressures. Fisheries collapsing in the Bay of Bengal and Indian Ocean are adding yet further pressure, and threatening the livelihoods and food security of millions. The Working Group generally agreed that South Asia should therefore form a top priority for defusing complex security, nuclear, and climate triggers.

The Middle East is likewise already a top concern for climate, nuclear, and security affairs intertwining. The region's longstanding tensions and hot conflicts are well known, and climate change has already started to exacerbate underlying challenges. The group shared serious concerns regarding how even peaceful nuclear programs may spread in the region—especially if the United States has little influence over how it unfolds. Iran has helped to prove the short road countries may have to a nuclear weapons program if they choose to militarize an otherwise civil program. Given the lack of strategic depth of countries such as Israel, the existential risks of nuclear weapons are distinct for entire populations. Sunni-Shia tensions are becoming even more pronounced throughout the region. Several major fossil fuel exporters in the region with undiversified economies are grappling with how to evolve rapidly amid signs of major importers pivoting away from these energy sources. Climate change-exacerbated droughts and water scarcity, increasing reliance on food imports, and other environmental strains are offering recruiting hooks for extremists who warn that the region's challenges are a result of straying from strict religious interpretations. The results are spilling over into Europe and elsewhere through the massive flow of refugees. Turkey is both a victim of many of these pressures, and, for some, raises suspicions regarding nuclear latency interests. Further into the future, there may be a risk of nuclear reactors residing in states that are fracturing. Climate models paint a dire future for the region – with some areas potentially becoming uninhabitable because of heat and decrease in water availability.

If these intertwined climate, security, and nuclear issues do not feature prominently as the United States alters its approach to the Middle East—for example, through its presence or absence in the emerging nuclear energy market, and its expanding ties with Saudi Arabia—the country's engagement may not prove to be a stabilizing force.

Over 1 Million in Tahrir Square, Egypt, demanding the removal of the regime and for Mubarak to step down. February 2011. JONATHAN RASHAD / FLICKR.



The South China Sea may be considered another crisis region. The territorial and geopolitical tensions among many countries bordering this sea—and the United States with its role as a treaty ally and security guarantor—have been simmering for years. Fisheries decline and the drive for offshore hydrocarbons are exacerbating these tensions and potentially driving them, while the entire region is influenced by various climate change effects. One working group member described the region as already a “tinderbox,” and more nuclear energy could make matters worse if the right technologies and standards are not used. Nuclear proliferation risks for this region may not be as immediate as in South Asia and the Middle East, but several Working Group members cited long-held nuclear energy interests by countries such as Indonesia and Malaysia, coupled with the region’s unpredictability, as concerning. One posited that these countries might get nuclear energy for logical reasons, but because of tense relations with others in the region, they could be tempted to move on to nuclear weapons. Even if they do not, their neighbors might be suspicious of nuclear weapons hedging. Under enough strain, the Southeast Asian Nuclear-Weapon-Free Zone—which already has not been ratified by the P5—could break. There is a great risk of security, climate, and nuclear trends combining in dangerous ways around the South China Sea particularly if the United States neglects the region.

Finally, **Central and Northern Africa** formed a region of concern given the potent combination of mass migration, drought, terrorism, deforestation, weak governance, and other factors inflicting the area. While today this area holds just a few research reactors, several countries intend to pursue larger nuclear programs. Whether these ambitions lead to

The results of a Boko Haram bombing in Nigeria. DIARIOCRITICO DE VENEZUELA.



action, which suppliers partner with these countries, how their grids develop, and whether social, environmental, and political upheaval can be stabilized loom as daunting questions. There is great utility in identifying these kinds of regions for which climate, nuclear, and security issues are intersecting to potentially ill effect. The process can help prioritize resources and assist in working through what technologies, training programs, and other assistance would be most stabilizing. Cases studies of which factors combine to drive instability or conflict, and where interventions help avert those outcomes, can serve as powerful guides.

While we must focus on regions for which crisis conditions are already apparent, these spots should not be the sole focus. This is in part because of the “globalization of hazards” wherein impacts and disruptions in one part of the world can have implications on security thousands of miles away.^f For example, the 2010 climate-exacerbated droughts and wildfires in Russia and China contributed to a rise in bread prices in Egypt preceding the Arab Spring. So even nations that may not be in critical nuclear-climate-security regions will not necessarily be immune from the risks. The Working Group advised ongoing and persistent evaluation of all areas that house potentially-dangerous nuclear capabilities, climate-influenced pressures, and major security challenges.

The group raised the potential for seismic disruptions in Europe, for example. Already pressurizing this region are strains in the NATO alliance; security, economic, and climate drivers bringing in a massive wave of migrants and refugees; risks of rising nationalism and political fracturing; and Russia’s conventional, hybrid, and nuclear threats looming. A key event such as a major turn in EU member state elections, a dramatic wave of climate change-influenced disruptions within Russia, or any number of Arctic contingencies could trigger an unpredictable, high-consequence series of events. We won’t always know in advance or watch for the most important indicators, especially given the potential for climate disruptions to natural systems that have been consistent for hundreds or thousands of years. It is imperative to build systemic resilience beyond specific geographies in order to have a chance of navigating such changes.

CLIMATE, NUCLEAR, AND SECURITY CONNECTIONS

This report is filled with examples of how security, climate, and nuclear trends and events are connecting and influencing one another. Here are some of the ways this is occurring or may in the future:

- Nuclear risks and climate change are two of the most significant threats to global security and stability.
- Extreme heat, flooding, sea level rise, and natural disasters are already showing signs of affecting power generation, and could take nuclear facilities out of operation in countries already short on electricity and high on social or political pressure; the same pressures could affect nuclear weapons-related sites.
- The blocs formed and specific commitments made for climate change negotiations influence other diplomatic tracks and perceptions of global leadership.
- Nuclear energy sites could be targeted for attack by terrorist groups or others, including in countries adding nuclear capacity in part to alleviate water stress.
- In many countries, religious and social advocacy groups often link nuclear and climate concerns.
- Nuclear materials security and proliferation concerns could help keep the world hooked to high fossil fuel dependence, making dangerous, business-as-usual climate change scenarios more likely.
- Climate and nuclear sciences share intertwined histories. The work by the National Labs across these and other issue sets have led to more comprehensive contributions to U.S. and global security.
- New technologies and innovative combinations of existing ones can be applied to address climate, nuclear, and security challenges independently and in tandem.
- Forced migration, including that influenced by climate-related stressors, affects security, stability, and nuclear affairs, for example by driving energy demand in new locations, facilitating illicit networks, and complicating security around nuclear sites.
- All of the connections listed in this report can be used for more effective international collaboration. For example, climate change can be used as an easier opening for working on tough nuclear and security questions with countries hesitant to focus singularly on the latter issues.

4. NEXT STEPS

As described in this report, the Working Group attempted to begin the monumental task of describing the complex system we see at work and its constituent elements. This proved one key premise of this project: that climate, nuclear, and security events are combining in discernible patterns, not just in random, singular ways. Moreover, this framework proves that the programs, analysis, journalism, and policies many Working Group members have developed over recent years combine in a logical fashion. Considering their wide-ranging, multidisciplinary work in unison reveals critical new insights regarding how the world is changing, and what new security threats and opportunities are arising.

This group will continue to develop the ideas in this report and contribute additional insights. Some will also explore policy options. In the meantime, a few general next steps are already clear.

First, we must develop realistic scenarios for which the elements of the system described in this report combine in potential crisis regions, and game out ways in which applying specific policies, technologies, normative structures, and other measures can be stabilizing or destabilizing. This is urgent for regions such as the Middle East that appear to be pushing forward on nuclear energy programs as their security and climate-related struggles persist. Such an examination must include the region's political and religious tensions, refugee crises, ongoing droughts and heatwaves, and desires to move their economies beyond hydrocarbon dependence before that field is no longer sufficiently profitable. Positive advances must also be considered as scenarios are developed.

Next, we must improve communication. Both nuclear war and climate change are potential existential risks, but the public and policy makers have not prioritized either commensurate to the scale of the risk. For better or worse, looming or manifested threats can drive public appetite for the types of structures that will be needed to avoid the breaking points we describe in this report. Making these and other existential risks comprehensible and addressing them appealing to people is an important goal.



Construction of UAE's first nuclear power plant at the Barakah site. L. POTTERTON / IAEA.



Mikhail Chudakov, IAEA Deputy Director General and Head of the Department of Nuclear Energy, together with his IAEA Senior Staff tours the facilities of Khalifa University of Science and Technology, latest addition as an IAEA Collaborating Centre. Abu Dhabi, United Arab Emirates. 1 November 2017. DEAN CALMA / IAEA

Finally, for the United States, educating policy-makers will be critical. The risks raised in this report must be conveyed in ways that are relatable and immediate, for example emphasizing the ways to reduce threats to public health and infrastructure in states and districts across the country. We must also make clear what gaps cannot be immediately refilled if U.S. capacities are stripped away, for example regarding data collection and analytics.

5. CONCLUSION

The framework and details shared in this report represent just the first step by the Working Group on Climate, Nuclear, and Security Affairs. The world is in an early stage of understanding how these trends interact, and how they influence and are being influenced by broader, monumental changes in the world order. Continuing our drive for deeper understanding is critical as many government leaders, publics, and experts around the world agree that the world is moving closer to the game-changing breaking points of nuclear war and catastrophic climate change. The task of rebalancing the global system and avoiding these outcomes will require continued effort by this Working Group, many of its members and their organizations, and hopefully many additional actors in the years ahead.

- 1 The emerging debate about investing in icebreakers and potentially arming them with cruise missiles or other offensive weapons is but one example. Megan Eckstein, “Zukunft: Changing Arctic Could Lead to Armed U.S. Icebreakers in Future Fleet,” *U.S. Naval Institute News*, May 18, 2017.
- 2 For example, Brazil committed more than 200,000 Army personnel to assist with the latest Zika outbreak, which was found to be influenced by climate change. “Brazil deploys 220,000 troops to battle Zika mosquitoes,” *Associated Press*, February 13, 2016. Likewise, the number of base evacuations and contributions of personnel and equipment to responding to the 2017 hurricane season in the United States and Caribbean are still unfolding. See also Shiloh Fetzek, Caitlin E. Werrell, and Francesco Femia, eds., “Military Expert Panel Report: Sea Level Rise and the U.S. Military’s Mission,” Center for Climate and Security, September 2016.
- 3 See, for example, S.C. Herring, A. Hoell, M. P. Hoerling, J. P. Kossin, C. J. Schreck III, and P. A. Stott, eds., “Explaining Extreme Events of 2015 from a Climate Perspective,” *Bulletin of the American Meteorological Society* 97 (12), S1–S145, 2016. It is also notable that Pakistani leaders blamed India’s coal-fueled power plants and climate change for contributing to its deadly 2015 heatwaves: Jamal Shahid, “Hot air from Rajasthan power plants may have fanned Karachi heatwave,” *The Dawn*, June 25, 2015.
- 4 See, for example, S.C. Herring, A. Hoell, M. P. Hoerling, J. P. Kossin, C. J. Schreck III, and P. A. Stott, eds., “Explaining Extreme Events of 2015 from a Climate Perspective,” *Bulletin of the American Meteorological Society* 97 (12), S1–S145, 2016. It is also notable that Pakistani leaders blamed India’s coal-fueled power plants and climate change for contributing to its deadly 2015 heatwaves: Jamal Shahid, “Hot air from Rajasthan power plants may have fanned Karachi heatwave,” *The Dawn*, June 25, 2015.
- 5 See also Petr Topychkanov, “Why the Bangladeshi Public Has Concerns Over the Rooppur Nuclear Project,” Carnegie Moscow Center, February 27, 2017. As noted later in this report, the Working Group raised wide-ranging geopolitical, economic, safety, security, and nonproliferation consequences of Russia dominating the nuclear suppliers market, including specific issues arising from recent Russian financing and operating model offers.
- 6 Hereafter referred to as “the Working Group.” See page 5 for a list of Working Group members.
- 7 International Atomic Energy Agency, “Nuclear Power and the Paris Agreement,” November 2016, p. 2.
- 8 Kathy Chen and David Stanway, “China media again touts plans to float nuclear reactors in disputed South China Sea,” *Reuters*, July 15, 2016; David Stanway, “Enter the Nimble Dragon: China looks to small reactors for nuclear edge,” *Reuters*, June 14, 2017.
- 9 See, for example, John Mecklin, ed., “It is two and a half minutes to midnight: 2017 Doomsday Clock Statement,” *Bulletin of the Atomic Scientists Science and Security Board* (2017).
- 10 Leon Fuerth, “Security Implications of Climate Scenario 2: Severe Climate Change Over Next 30 Years,” in Kurt M. Campbell, Alexander T.J. Lennon, and Julianne Smith, Project Co-Directors, *The Age of Consequences: The Foreign Policy and National Security Implications of Global Climate Change*, Center for Strategic and International Studies and Center for a New American Security, November 2017, p. 78.
- 11 Zia Mian, “Kashmir, climate change, and nuclear war,” *The Bulletin of the Atomic Scientists*, December 7, 2016.
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