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ANALYTICAL ESSAY

Disentangling the Nexus of Nuclear Weapons and Climate Change—A Research Agenda

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Global warming and nuclear war are frequently described as the world's greatest threats. Both challenges could be understood as expressions of modern science and technology, and both present tough collective action problems. They are also mutually entangled. Yet students of security have still to systematically unpack the relationship between climate change and the politics of nuclear weapons. In this article, I critically review the nascent literature on the climate–nuclear nexus and set out avenues for future research. I find that the existing literature has focused disproportionately on immediate managerial challenges such as the likely inundation of current nuclear weapons bases, neglecting the potential consequences of more profound, crisis-induced global transformations. Students of nuclear arms control, deterrence, and disarmament should interrogate the assumption that the basic political and institutional structures that condition policy outcomes today will continue to exist indefinitely.

El calentamiento global y la omnipresente posibilidad de una escalada nuclear se describen, con frecuencia, como las mayores amenazas para el mundo. Ambos desafíos podrían entenderse como expresiones de la ciencia y la tecnología modernas, y ambos plantean difíciles problemas de acción colectiva. También se encuentran mutuamente entrelazados. Sin embargo, los académicos del campo de la seguridad todavía tienen que lograr desentrañar de manera sistemática la relación existente entre el cambio climático y la política de las armas nucleares. En este artículo, revisamos de manera crítica la literatura naciente que analiza el nexo existente entre el clima y lo nuclear y establecemos vías para futuras investigaciones. Concluimos que la literatura existente se ha centrado de manera desproporcionada en los desafíos inmediatos a nivel de gestión, como el probable desbordamiento de las bases de armas nucleares actuales, y ha descuidado las posibles consecuencias de transformaciones globales más profundas inducidas por crisis. Los académicos que estudian el control, la disuasión y el desarme de las armas nucleares deberían cuestionar la suposición de que las estructuras políticas e institucionales básicas, las cuales condicionan los resultados de las políticas hoy en día, seguirán existiendo indefinidamente.

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Le réchauffement climatique et la possibilité d'une escalade nucléaire, qui n'a jamais disparu, sont souvent décrits comme les plus grandes menaces qu'il y ait pour le monde. Les deux défis peuvent s'appréhender telles des expressions de la science et de la technologie modernes, et tous deux présentent d'épineux problèmes pour l'action collective. En outre, ils s'enchevêtrent. Pourtant, les étudiants en sécurité doivent encore décortiquer systématiquement la relation entre changement climatique et politique des armes nucléaires. Dans cet article, j'examine de façon critique la littérature émergente sur les liens entre climat et arme nucléaire, avant de définir de futures pistes de recherche. Je remarque que la littérature existante s'est concentrée de façon disproportionnée sur les défis immédiats de gestion, comme la probabilité d'inondation des bases militaires stockant actuellement des armes nucléaires, en omettant les conséquences potentielles de transformations mondiales plus profondes, générées par une crise. Les personnes étudiant le contrôle des armes nucléaires, la dissuasion et le désarmement doivent remettre en question l'hypothèse selon laquelle les structures politiques et institutionnelles de base qui conditionnent les issues politiques aujourd'hui ne disparaîtront jamais.

Introduction

Culminating on June 30, 1988, the historic Toronto Conference on the Changing Atmosphere concluded that anthropogenic climate change amounted to “an unintended, uncontrolled, globally pervasive experiment whose ultimate consequences could be second only to a global nuclear war” ([Secretariat of the World Meteorological Organization 1988](#), 292). In the years since, nuclear weapons and global warming have often been described as the “principal threats” to modern human civilization ([Scheffran et al. 2016](#), 1; see also, e.g., [Schell 2007](#), 7; [Buckley 2013](#); [Cerutti 2010](#), 489, 167; [Lieven 2020](#), 12; [Hannay 2021](#); [Litwak 2021](#); [Kemp et al., 2022](#), 1)—or even as the “most serious threats to security and survival that humans and other species have ever faced” ([Crawford 2022](#), 9). While biodiversity loss, synthetic biology, and the emergence of artificial intelligence have deservedly received increasing attention in recent years, nuclear and climate risks have endured or, by some estimations, intensified ([Mecklin 2024](#)). In the words of US president Joe Biden, the only threat “more frightening than a nuclear war, is global warming” ([Fabian and Gardner 2023](#)).

The nuclear and climate predicaments can both be understood as expressions of modern science and technology. Both are embedded in complex socio-economic structures, and both present onerous collective action problems that, in all likelihood, will be all the more difficult to manage in an international context of intensifying great-power competition ([Gibbons and Herzog 2022](#), 71; [Nye 2022](#), 1641). Both have also been described as “wicked problems,” that is, as complex challenges composed of a myriad of sub-problems with contradictory or countervailing solutions ([Lewis 2016](#); [Incropera 2016](#)). The two challenges are also mutually entangled; the trajectory of the one could significantly impact the trajectory of the other ([Crisley 2023](#)).

In this article, I aim to appraise, analyze, and advance the nascent literature on the nexus of nuclear weapons and carbon-driven climate change. My intended contribution is twofold. First, examining the existing literature on the topic, reviewing both scholarship and “grey” literature, I seek to unpack the full gamut of interlinkages between nuclear security and fossil-fuel powered climate change. Existing contributions to this field have invariably zeroed in on one or two of these interlinkages; my goal is to lay out a broader survey of the issue. Second, I aim to identify gaps in the existing literature and, on the back of this, set out a new research agenda to

advance current thinking. In a nutshell, the research agenda I propose is centered on systematically investigating the implications of alternative climate-political futures for global catastrophic risk scenarios involving nuclear arms. This is not a plea for granular forecasting or prediction; neither climate change nor nuclear politics lends itself to probabilistic, formulaic study (Incropera 2016; Pelopidas and Egeland 2024). Rather, it is a plea for creative analysis of the multiple possible worlds that await us.

The existing literature on nuclear strategy is in large measure written on the increasingly untenable assumption that the world beyond the game of nuclear bargaining is a constant—a void or vacuum within which nuclear politics plays out. Climate change has the potential to radically upset this premise (see Gilli et al. 2024, 22). While much of the specialist literature on climate change and mitigation admittedly takes for granted the idea that current political structures and institutions will endure indefinitely into the future, it is increasingly acknowledged by social scientists that climate change could reshape the world in fundamental and unpredictable ways (Mann and Wainwright 2018; Khanna 2021; Hyman 2023). That being said, the future doesn't just happen, it is created, in large measure, by policymakers acting on the basis of their imaginaries of the future (see, e.g., Andersson 2018; Oomen, Hoffman, and Hajer 2021; Zwald 2013; van Mynster and Sylvest 2014; Nye 2022). It is thus a democratic imperative—a condition for meaningful political agency and choice—to present both policymakers and the public with alternative visions of possible futures.

This article is divided into three parts. In the first of these, I identify and discuss a series of politically significant connections between nuclear weapons and climate change, including (i) the suggestion that growing demand for low-carbon nuclear energy carries with it a risk of nuclear weapons proliferation; (ii) the potential for climate-induced changes to the physical environment to challenge extant nuclear infrastructure and deterrence practices; (iii) the prospects for climate cooperation in an era of intensifying rivalry between nuclear-armed great powers; (iv) policy trade-offs and national budgeting on a heating planet; and (v) the prospect that climate change could further poison the international security environment, putting the global nuclear order under increased strain. In the second part, I identify gaps in the existing literature and drill down on the potential implications for the global nuclear order of major political shifts brought about by runaway climate change. Global warming, I argue, has the potential to fundamentally transform the political environment in which nuclear deterrence is enacted. In the third part, I set out a new research agenda designed to advance existing scholarship.

The Climate–Nuclear Nexus: Unpacking the Connections between Nuclear Policy and Global Warming

Recent years have seen the publication of a number of studies investigating the linkages between nuclear weapons policy and the burgeoning climate emergency. This section critically reviews the main strands of this literature. Focusing on the nexus of nuclear security and the unfolding, fossil-fuel powered climate crisis, the survey leaves out the scholarship on nuclear winter and the historical connections between Cold War science and current climate models (see Masco 2010). This is not to say that these issues are not important or worth highlighting, but rather that they fall outside the scope of the present study. They have also been robustly covered by existing scholarship. The focus below is on the linkages between nuclear weapons and deterrence practices, on the one hand, and carbon-driven climate change and efforts toward decarbonization, on the other.

Atoms for Climate

A first connection between nuclear weapons and climate change, one that has been the subject of considerable analysis and debate, concerns the proliferation risks that attend the apparent imperative of expanding nuclear energy production as a contribution toward decarbonizing the global energy mix. Most rapid decarbonization pathways entertained by the Intergovernmental Panel on Climate Change (IPCC) in recent years have foreseen a significant expansion of nuclear energy generation worldwide (see, e.g., [Masson-Delmotte et al. 2019](#), 131; [Shukla et al. 2022](#), 71). At COP 28 in Dubai in 2023, 25 states, including Japan, Poland, Romania, South Korea, Ukraine, and the United States, issued a declaration to triple nuclear energy capacity by 2050 ([United States Department of Energy 2023](#)).

While the calls for increased reliance on nuclear energy have indeed grown louder in recent years, it is not given that the global nuclear energy sector will in fact grow as quickly or profoundly as some assume. In fact, after a sustained period of growth between 1965 and 2000, the global nuclear energy sector has failed to grow for the last two decades, covering a steadily shrinking percentage of the world's energy demand ([Schneider et al. 2022](#), 40). Decades of talk of a “nuclear renaissance” have so far failed to translate into practice (see, e.g., [Harding 2008](#), 53; [Lester and Rosner 2009](#), 19). Going forward, the nuclear energy sector will also be competing with increasingly competitive renewables such as solar, wind, and hydropower. Whether a true nuclear renaissance will in fact come to pass remains to be seen ([Präeger et al. 2024](#)).

The atomic bombings of Japan, the Cold War arms race, and accidents at Chernobyl and Fukushima are often highlighted as developments that gave nuclear technology a bad reputation, curtailing the nuclear energy industry ([Baron and Herzog 2020](#), 8). A number of surveys have indicated that public attitudes toward nuclear energy are in significant measure shaped by attitudes toward nuclear weapons, with deep-seated opposition to nuclear armament translating into a diffuse opposition to all things nuclear ([Otway, Maurer, and Thomas 1978](#); [Weart 2012](#); [Baron and Herzog 2020](#)). Some have suggested that nuclear weapons—or, more precisely, the risks, fear, skepticism, or guilt that imbue them—have deepened the climate challenge by discouraging greater reliance on low-carbon nuclear power ([Morland 2001](#); [Moss 2014](#)).¹

A number of experts have identified the potential expansion of global nuclear energy production as a significant proliferation risk. After all, the boundary between “peaceful” and “military” nuclear capabilities is somewhat tenuous; there is significant overlap between the infrastructure required for civilian nuclear energy production and nuclear weapons acquisition ([Miller and Sagan 2009](#), 13). Admittedly, proliferation risks will depend to large part on which states acquire what kinds of nuclear technology ([Miller and Sagan 2009](#), 9). Clearly, proliferation risks will be lower if the expansion of nuclear energy production is enacted primarily by states already armed with nuclear weapons. In the words of Sonja [Schmid \(2019, 307\)](#), however, the prospective expansion of the global nuclear energy sector will almost certainly involve the transfer of nuclear technologies to countries that presently have small or non-existent nuclear energy sectors.

Nuclear technology transfers carry significant security implications. While civilian nuclear energy cooperation has often been portrayed as a “redemptive” path to global prosperity and coexistence ([Peoples 2016](#)), “atoms for peace” could easily become “atoms for war” ([Fuhrmann 2012](#), 5; see also, e.g., [Miller and Sagan 2009](#); [Kroenig 2010](#)). As a matter of fact, no nuclear-armed state has acquired its nuclear arsenal without some form of assistance from other states ([Pelopidas 2022](#), 78). At the same time, a large number of states have received nuclear assistance and built

¹This argument does not account for challenges related to the disposal of nuclear waste. It should also be pointed out that nuclear energy is not fully carbon free.

large nuclear energy programs without proceeding to build nuclear arms. Indeed, most of the world's states have shown little or no interest in acquiring a nuclear arsenal (Doyle 2013, 28; Pelopidas 2011, 306). Multiple analysts have also made the case that civilian nuclear assistance has in fact allowed actors such as the United States and International Atomic Energy Agency (IAEA) to shape many states' nuclear energy programs and, ultimately, render them less proliferation sensitive (see, e.g., Gibbons 2020). In this view, there are "precedents in place to deal with at least some of the challenges from a more globalized nuclear industry" (Montgomery and Graham Jr 2017, 26). According to Eliza Gheorghe (2019, 89), however, the ability of the United States and other major powers to control nuclear trade may now be eroding, "potentially threatening an increase in the number of nuclear weapons states." States that are currently thinking about launching or expanding nuclear energy programs purely for environmental or energy-security reasons may in the future find themselves in a situation where weaponization seems attractive.

Climate Challenges to Nuclear Sites and Infrastructure

A second connection between nuclear security and the unfolding climate challenge relates to the fact that extreme weather events and other warming-induced changes to the natural environment stand to physically impact existing nuclear weapons sites, infrastructure, and deterrence practices. Sea-level rise, storm surges, extreme heat, and more intense wildfires all have the potential to affect nuclear bases, production facilities, and weapons deployment practices, forcing serious adaptation measures.

The challenge to nuclear sites and deterrence practices of sea-level rise and extreme weather events has received considerable attention in several states, sparking sensationalist headlines in major media outlets. For example, global warming has been described as "the biggest threat to the U.K.'s national security" due to the potential impact of climate change-induced flooding on Clyde Naval Base in Scotland, home port of the British ballistic missile submarine fleet (Chitty 2022). According to a report commissioned by Scottish National Heritage, an executive body of the devolved Scottish government, continued high greenhouse gas emissions could yield sea level rise inundating the home of the United Kingdom's only nuclear weapon system by 2080 (Hanson et al. 2017, 121). This, in turn, could compromise both nuclear safety and the viability of the United Kingdom's continuous-at-sea-deterrence posture. Another report, written by former UK Ministry of Defence advisor Paul Dorfman for the Nuclear Consulting Group, concludes that climate change would "inevitably involve very significant expense for UK nuclear military installation operation, waste management, decommissioning, relocation or abandonment" (Dorfman 2021, 31). There is broad agreement among British experts that, in the event of the Clyde Naval Base becoming unavailable for use by the Royal Navy's ballistic missile submarines, the political, economic, and geographic obstacles to opening equivalent bases elsewhere in the United Kingdom would be onerous if not insurmountable (Futter and Bowen 2020, 98; Walker 2018, 433; Ritchie 2016, 658–9; MacDonald 2014, 329; Chalmers and Walker 2013, 108).

US nuclear sites are also at risk. In a Carnegie Endowment report investigating the vulnerability of US nuclear deterrence practices to climate change, Jamie Kwong finds that flooding, extreme heat, and wildfires could affect each of the US nuclear triad's legs. The Naval Submarine Base Kings Bay, for example, is vulnerable to sea-level rise and storm surges. Global warming and changing precipitation patterns could also impact Minot Air Force Base through flooding. Changes to the climate "could have mission-altering impacts on the U.S. nuclear deterrent," Kwong concludes (2023a, 3; see also Kwong 2023b). While the number and geographic spread of US nuclear bases mean that extreme weather events are unlikely to seriously compromise the United States' ability to threaten nuclear retaliation at any

given time, climate change is highly likely to complicate and increase the cost of sustaining US nuclear assets. As argued by Francesca [Giovannini \(2018, 91\)](#), “weather changes [...] imply higher costs of maintenance and continuous investments in training and disaster preparedness.” The US Navy has already initiated substantial work to limit the impact of climate change on US naval bases ([Kwong 2023a, 12](#)). In February 2024, a fast-moving wildfire in Texas forced the Pantex Plant—the United States’ main facility for the assembly and disassembly of nuclear warheads—to temporarily cease operations, evacuate nonessential staff, and begin construction of a fire barrier ([McKenzie and Diaz-Maurin 2024](#)).

Wildfires have also imperiled Russian nuclear facilities. The forest and peat fires that spread through Russia in the summer of 2010 threatened several nuclear sites; Russian troops were obliged to dig a five-mile canal to protect the Sarov site, Russia’s main nuclear design and production facility ([Jenkins 2010](#)). Sarov was again threatened by forest fires in 2021 ([The Moscow Times 2021](#)). The 2021 fire season was Russia’s most damaging since records began, with fires destroying more than 18 million hectares of Russian forest. According to an unclassified report by the NATO command [Supreme Allied Command Transformation \(2021, 7\)](#), Russia is “highly susceptible to the adverse impacts of climate change. These impacts include ice reduction, melting permafrost, increased flooding, air pollution, and resource depletion.”

The melting away of Arctic sea ice could potentially have major consequences for submarine operations and, ultimately, strategic stability between the major nuclear powers ([Sergunin and Konyshev 2017, 172](#); [Boulègue 2019, 12](#)). For decades, Moscow has operated its fleet of ballistic missile submarines primarily in the high north, under or near the Arctic ice sheet, to avoid detection by NATO surveillance aircraft, satellites, and surface ships ([Lieber and Press 2017, 35](#); [Long and Green 2015](#)). It stands to reason that the melting of the polar ice cap will make Russian submarines, which are louder than their American counterparts, more vulnerable to detection and tracking by adversaries. Russian officials have reportedly been greatly concerned by this prospect ([Flake 2014, 105](#)). That said, one set of authors concludes that climate change will actually make submarines more difficult to detect. This is so because the intensity of the acoustic signals radiated or reflected by submarines is conditioned by water temperatures and salinity; all else equal, warmer waters and lower salt concentrations will reduce the range of acoustic detection capabilities ([Gilli et al. 2024](#)). Whether these latter trends are significant enough to outweigh the reduction or complete disappearance of ice cover does not yet seem clear.

Chinese nuclear deterrence practices could also be impacted by sea-level rise, flooding, wildfires, and extreme heat. A challenge that is somewhat unique to China is that the string of artificial islands constructed and used by the Chinese military in the South China Sea in recent years seems particularly vulnerable to sea-level rise. The islands have been widely interpreted as elements of a nascent bastion-defense system set up to shield China’s ballistic missile submarines (see, e.g., [Kirchberger and O’Keeffe 2017, 30](#); [Ray 2020, 48](#)). It has also been speculated that the islands could be used as staging grounds for strategic bombers ([Wroe 2016](#)). At any rate, several of these artificial islands have already been inundated by rising seas ([Axe 2020](#)). While this is undoubtedly a problem the Chinese military can solve through flood proofing and further construction efforts, every mitigating action involves a cost.

As the paragraphs above make clear, climate change looks set to impose additional costs on current nuclear activities and infrastructure. But climate change could also stir up old nuclear problems. In the Marshall Islands, a large nuclear waste site is currently under serious pressure by climate change. Between 1946 and 1958, the United States carried out 67 nuclear test explosions in the Marshall Islands. Contaminated soil and waste from these tests, as well as from experiments in

Nevada, were dumped in a 4.1 million cubic feet dome on Enewetak Atoll during the late 1970s (Gerrard 2015). The dome is now reportedly at significant risk of collapsing, largely due to rising seas. According to reports, a major cyclone could potentially cause it to crack fully open. Marshallese officials have lobbied the US government for help, but to no avail (Rust 2019). The conflict over the dome crystallizes the Marshall Island's past and future as a hotspot of both nuclear and climate harms; the Marshall Islanders have suffered grievously from negative health consequences associated with nuclear testing (National Cancer Institute 2010; Abella et al. 2019), and their country is set to be inundated—some have argued that it “likely won't exist” anymore—if the world crosses the 2 degrees Celsius threshold (Sutter 2015).

Climate Cooperation in an Age of Great Power Rivalry

A third connection between nuclear politics and climate change concerns the prospects for climate cooperation in a world of nuclearized great power competition. Effective climate mitigation is widely believed to require deep or even “world-historical levels” of cooperation between the major powers (Busby 2018, 49; see also, e.g., Johnson 2007). According to a Biden administration official, preventing climate breakdown “requires unprecedented global cooperation, as well as a shared sense of urgency and ambition” (Ebbs 2021). In the more guarded language of the IPCC, international cooperation “will need to be strengthened in several key respects” (Shukla et al. 2022, 71). There is widespread agreement that, if the international community is to keep within a 1.5 or 2 degree Celsius carbon budget, most fossil fuel reserves will have to stay in the ground (Welsby et al. 2021). It is highly doubtful that this can be achieved with demand-side measures alone; effective climate mitigation will in all likelihood require states to agree to supply-side restraints (Asheim et al. 2019).

A number of analysts have warned that great power competition renders effective climate cooperation more difficult (see, e.g., Pastukhova and Westphal 2020, 358). In the words of Robert Litwak (2021), avoiding unrestrained competition “is a prerequisite for managing the climate threat” (see also Wertheim 2020, 27–8). Somewhat in keeping with this, in 2014, the Obama administration reportedly delayed a freedom of navigation maneuver in the South China Sea to facilitate Chinese accession to the Paris Agreement (Colgan 2021). For Van Jackson (2024, 137), a grand strategy centered on global peacemaking and environmental sustainability would counsel the pursuit of stability and “cooperation spirals” through trust-building initiatives and unilateral acts of a tension-reducing nature. Along similar lines, Michael Swaine and Andrew Bacevich (2023, 17) posit that the United States’ “heavy reliance on military posturing” and partial containment strategy vis-à-vis China hamper efforts at mitigating the climate crisis. To improve the prospects for cooperation, the United States should shift to a more restrained, defensive posture (Swaine and Bacevich 2023, 15, 45). To that end, the United States should suspend nuclear modernization efforts and instead pursue arms control initiatives and the adoption of a nuclear no-first-use policy, they argue (2023, 44). Writing in 2007, Jonathan Schell maintained that getting rid of nuclear weapons altogether—and with them the enmities and circumspection they produce—“should be seen as an indispensable foundation for dealing with this larger planetary crisis” of climate change (Schell 2007, 217; see also Doyle 2013, 9). In this view, nuclear deterrence practices lock in a degree of hostility that obstructs cooperation. It should be noted, however, that certain members of the so-called restraint school have backed up their case for reallocating public funding from defense to climate mitigation with the argument that nuclear deterrence renders large conventional forces and overseas bases unnecessary (see Jackson 2024, 180). The restraint school is a wide tent, encompassing both conservative, progressive, and radical political traditions.

A number of analysts have argued strongly against the various proposals discussed above. Mainstream opinion within the American defense establishment holds that a foreign policy of restraint would lead to dangerous power vacuums and instability (see, e.g., [Priebe et al. 2022](#)). Daniel [Deudney and John Ikenberry \(2021, 27\)](#) maintain that the prescriptions promoted by the so-called restraint school would also do “grave damage” to the international community’s capacity to address climate change. The correct approach, they argue, is the Biden administration’s strategy of maintaining “raw American power” while at the same time spearheading institution-building projects and reforms to address the climate problem (2023, 25–8). Thomas [Wright \(2018, 51\)](#) attests that “going easy on China to secure its cooperation on climate change” would “actually provide Beijing with leverage that it would be tempted to use.” It would be wiser, he suggests, “to ring-fence climate change and agree that, given that it is a matter of vital interest to all parties, cooperation should continue even if the major powers are competing on other fronts.” Joseph [Nye \(2022, 1647\)](#) similarly maintains that the United States can and must engage in militarized competition with China while at the same time engaging Beijing in efforts to curb global warming. “If China links the issues,” Nye avers, “it hurts itself.” The challenge, of course, is that the two issues *are* linked. Both climate change and the measures that are taken to address it will inescapably impact states in different ways and, by extension, modify their relative positions in the international system. The poor track record of climate diplomacy over the past several decades gives credence to the realist claim that great powers often privilege relative gains and losses over absolute ones ([Walt 2021](#)). Wary that meaningful climate collaboration is not forthcoming, some analysts have begun devising emission-reduction strategies that do not depend on cooperation between the major powers (see, e.g., [Green 2021](#); [Hale 2021](#); see also [Pelopidas and Verschuren 2023, 6](#)). However, most observers continue to insist that deep cooperation will be indispensable to effective climate action ([Egeland 2023, 894](#)).

While the United States remains the world’s most powerful state, the responsibility for addressing climate change is hardly Washington’s alone. There is no disputing that Russia and China have made major foreign policy decisions directly at odds with the imperative of interstate collaboration to address climate change ([Erickson and Kennedy 2015](#); [Liao 2018](#); [Romanova 2018](#); [Turcsányi 2018](#); [Rawtani et al. 2022](#)). The same argument could undoubtedly be applied to other states as well. Indeed, the approach to climate change currently embraced by most, if not, all the world’s major military players focuses not on restraint, disarmament, or a shifting of resources away from defense and toward environmental programs or cooperation, but on resilience, the “greening” of existing practices, and increased military vigilance in the face of new, or more intense, climate-driven threats ([Bigger et al. 2021](#)).

Budgeting and Government Priorities

A fourth connection between nuclear weapons and climate change relates to trade-offs, spending priorities, and budgeting. Most obviously, nuclear deterrence practices, like other military activities, breed greenhouse gas emissions at all stages of the policy process, beginning with the development, production, and testing of weapon components, continuing with military exercises and the active deployment and maintenance of hardware, and concluding with the repurposing or dismantlement of retired systems ([Crilly 2023, Egeland, 2023, 128](#)). While parts of the global defense industry have begun reducing emissions associated with the development and manufacture of weapons, the nuclear modernization programs currently unfolding across the world’s nine nuclear-armed states—involving the building of new missiles, fighter-jets, bombers, submarines, surface ships, warheads, and bases—indisputably amount to large-scale, carbon-intensive industrial projects ([Crawford](#)

2022). The current US modernization effort looks set to cost approximately 1.7 trillion USD (Federation of American Scientists 2024).

The total carbon emissions associated with the world's aggregate efforts in defense are considerable, possibly amounting to as much as 5 percent of global carbon dioxide emissions (Rajaeifar et al. 2022). If this estimate is accurate, the carbon footprint of the global defense sector would alone be bigger than the combined footprints of the civil aviation and global shipping industries. Of course, the emissions associated with nuclear deterrence practices specifically make up only a fraction of the total emissions associated with defense (the precise emissions are difficult to assess due to insufficient data availability). That said, nuclear competition and strategic rivalry exert significant influence on the wider international security environment and, by extension, military activity, acquisitions, and postures more generally (Talmadge 2019; Ziegler 2020; Futter and Zala 2021; Rajagopalan 2021). In the current moment, with humanity rubbing up against planetary boundaries, basic assumptions in the study and practice of security policy bear reexamination. For example, if it is true, as some commentators suggest, that another round of Cold War-style arms racing would almost certainly be incompatible with avoiding runaway climate change (Baker 2022), the traditional assumption that arms racing is regrettable but sometimes necessary appears questionable. Similarly, traditional strategies of cost imposition, i.e., policies and acquisitions designed to force adversaries to waste their resources on costly defensive hardware, seem at odds with the apparent imperative of moderation (Egeland 2023, 884).

While climate activists often, and with some justification, make the argument that the decarbonization agenda offers amazing economic opportunities, various forms of “carbon lock-in” serve to constrain the possibilities for carbon emissions reductions (see Seto et al. 2016). Weaning the global economy off fossil fuels will by most accounts also be enormously expensive. In the words of the British climate economist Dieter Helm (2021, xv), decarbonization “is going to hurt.” Achieving net zero, he suggests, will require large investments into infrastructure, sustained subsidies for renewables, and a serious carbon tax. “It is going to cost a lot.” Estimates of the precise amount of investment needed between now and 2050 to fulfill the Paris Agreement and avoid dangerous climate change vary significantly. However, all credible estimates tower above the current level of investment by a large margin. At the low end of the spectrum, the Network for Greening the Financial System suggests that annual investments of about 3.5 trillion USD would suffice. At the higher end of the spectrum, McKinsey estimates that annual investments between now and 2050 would have to be as high as 9.2 trillion USD. Sitting in-between these estimates, the International Energy Agency (IEA) estimates 4.5 trillion, amounting to around 4 percent of global GDP annually. As of now, the world economy's annual investments into clean energy and supporting infrastructure amount to less than 1.5 trillion USD (Keller and O'Neil 2023).

Public investments into green technologies inevitably compete with other government spending priorities, including on defense (Baker 2022). This “guns versus decarbonization” question resembles the “guns versus butter” dilemma—a topic that has received significant attention in political science (see, e.g., Mintz and Huang 1991; Powell 1993; Anders et al. 2020)—but with the complicating factor that the benefits of successful decarbonization will not be constrained by national boundaries. In contrast to domestic goods like healthcare or public education, which typically advantage the states that fund them in direct and near-exclusive ways, climate mitigation depends on the aggregate effort of all countries. Decarbonization is therefore acutely vulnerable to the problem of free riding (Barrett 2007, 6; Nordhaus 2015).

The Biden administration's initial decarbonization plan, proposed in the form of the Build Back Better Act, ultimately failed to gain the necessary support in large measure due to concerns about defense and great power rivalry. Joe Manchin, the

swing vote in the Senate, ended up explicitly opposing the bill in part because of his conviction that the United States needed to prioritize its finite resources on rebalancing militarily against Russia and China (Manchin 2021). The failure of Build Back Better—a bill the economic historian Adam Tooze (2021) described as “far short of any reasonable estimate of the investment needed for decarbonization”—resulted in the passing of the less ambitious Inflation Reduction Act in 2022. Similar political dynamics are likely to play out in places like Beijing, London, Paris, Moscow, and New Delhi.

For the analysts Kingston Reif and Alicia Sanders-Zakre (2020, 146), the “oversized” US nuclear arsenal represents “unnecessary excess” in a world plagued by climate change and other global challenges that cannot be addressed through nuclear deterrence. Rhys Crilley (2023, 160) maintains that the current confluence of planetary crises means that “we need to demand nuclear arms control. Demand disarmament. Demand that new technologies be limited. Demand that states invest in public health and stopping climate change rather than militaries.” The International Campaign to Abolish Nuclear Weapons (ICAN), which was awarded the Nobel Peace Prize in 2017, maintains that the “production, maintenance, and modernization of nuclear forces diverts vast public resources away from health care, education, climate change mitigation, disaster relief, development assistance, and other vital services” (ICAN 2023; see Parthemore 2019, 180).

The resource argument has been particularly acute in the United Kingdom, with those skeptical or opposed to the building of a new generation of ballistic missile submarines often couching their arguments in a broader analysis of government spending priorities. Retired British Army General Hugh Beach (2014, 20), for example, maintains that nuclear weapons are “simply not worth the resources.” In his view, the money invested into the UK nuclear arsenal would be better spent “on the mitigation of climate change, the provision of high-capacity transport and digital links, schools, hospitals or simply paying down the national debt” (Beach 2014, 21). Along similar lines, Anatol Lieven (2020, 18) suggests that, in a world where public resources are desperately needed for green transition efforts, public expenditure on wars in the Middle East, aircraft carriers, and nuclear weapons “represents a completely false set of priorities concerning the vital interests of the United Kingdom.” At the same time, though, Lieven underpins his claim that climate change is now a greater threat than great power war with the assertion that major armed conflict has been rendered obsolete by the practice of nuclear deterrence (Lieven 2020, 13, 68).

The resource argument may not be as straightforward as the authors cited above suggest. The notion that nuclear weapons are not only necessary but cheap instruments of security goes back a long time—it formed the basis of the Eisenhower administration’s “New Look” policy in the 1950s (Kaplan 2020)—and is currently a central argument in the case for US nuclear modernization (see, e.g., Harrison and Montgomery 2015, 5). In this view, nuclear weapons offer “a good deal of ‘bang for the buck’” (Haffa 2017, 45). According to Matthew Kroenig (2018, 184), an advocate of US nuclear strategic superiority, “nuclear weapons are the cheapest possible option” for “high-end, strategic-deterrence missions.” It seems eminently feasible that intensifying climate-induced budgetary pressures in the defense sector could boost the notion that conventional military rollback could be offset by increased reliance on cost-effective nuclear arms. This finds historical precedence in Moscow’s embrace of nuclear weapons during the Russian economic downturn of the 1990s and the above-mentioned US New Look policy. Both of these policies aimed at reducing overall defense spending through reliance on a forward-leaning nuclear posture. It should be noted, however, that both policies were relatively quickly abandoned amid concerns over lacking credibility (Butt 2015). A large number of experts and policymakers have concluded that nuclear threats lack

credibility in all but “existential” circumstances (see, e.g., Powell 1990; McDermott, Lopez, and Hatemi 2017; Freedman and Michaels 2019).

Climate Change and Threat Multiplication in a Nuclear-Armed World

Numerous experts, as well as major international organizations such as NATO and the UN, have identified climate change and the various social, political, and economic disruptions it is likely to produce as considerable sources of insecurity. Climate change, so the argument goes, could both significantly “amplify” and “multiply” existing threats (Goodman and Kertysova 2022; Crilley, 2023, 159). In turn, the further worsening of existing tensions and enmities could increase the attractiveness of nuclear weapons while discouraging arms control and disarmament.

According to a report published by the World Future Council, climate change-fueled international insecurity could “enhance the chance of a nuclear weapon being used, could create more fertile breeding grounds for terrorism, including nuclear terrorism, and could feed the ambitions among some states to acquire nuclear arms” (Scheffran et al. 2016, 91). Similarly, a working group convened by the Center for Climate and Security concluded in 2017 that climate insecurity could make nuclear conflict more likely: “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” (Parthemore and Nolan 2017, 17). Identifying a number of latent nuclear threats, including nuclear terrorism, proliferation, and war on the Korean peninsula, another set of analysts concluded in the same year that global warming “will increase the probability of future conflicts” and “exacerbate” existing ones, possibly triggering the “[e]scalation of conflicts to limited nuclear confrontations” (Liska et al. 2017, 28).

The hypothesis that climate change will increase the likelihood of nuclear conflict is plausible but has yet to be systematically unpacked and analyzed. Discussions in this area have remained largely on a speculative level. An exception is a small body of work on the India–Pakistan dyad, which has been explicitly analyzed by several commentators (see, e.g., Parthemore and Nolan 2017, 17). For example, writing in 2016, Zia Mian maintained that a new source of conflict had emerged between the two countries on the subcontinent, namely a struggle over access to and control over Himalayan glacial meltwater. Climate change is expected to lead to reduced and less reliable access to water in the region, meaning that conflict over Himalayan meltwater could become acute. “Given these risks, forestalling crises and possible war in South Asia should be a priority” (Mian 2016). India and Pakistan are among the countries expected to be most grievously affected by climate change (Zachariah et al. 2022).

Current and future debates about security in a warming world are and will be shaped by relevant actors’ threat perceptions. As conclusively established by the literature on this topic, there is no reliable formula for objectively measuring external dangers. Threat perceptions are conditioned by a myriad of factors, including strategic cultures, organizational and bureaucratic politics, and the subjective dispositions of influential leaders (Stein 2013). A number of scholars have maintained that changeable sociocultural discourses play significant roles in determining not only when and how something is considered a threat but also when and how the supposed threats should be dealt with (see, e.g., Wendt 1995; Borrie 2014). While some, perhaps most notably Anatol Lieven (2020), have advanced that framing climate change as a national security threat could help motivate states to act on global warming, the notion that climate change will function as a threat multiplier can also serve to boost arguments for increased military spending or isolationism (American Security Project 2018). Those eager to “securitize” the environment as a means to advance climate action should thus “be careful what they wish for” (Busby 2016, 197). Writing in 1990, Daniel Deudney stressed that “the nationalist and militarist

mindsets closely associated with ‘national security’ thinking directly conflict with the core of the environmentalist worldview. Harnessing these sentiments for a ‘war on pollution’ is a dangerous and probably self-defeating enterprise” (Deudney 1990, 474).

Knowledge Gaps and Uncertainty

It is widely accepted that climate change “threatens to transform the world as we know it” (Hyman 2023). It could “remake the world order” and “radically affect the planet” (Maslin 2014; Lustgarten, 2020, 112). Dealing with global warming will require “a comprehensive reorganization of human societies” (Mann and Wainwright 2019). According to one commentator, the consequences of climate change could range from “the loosening and disruption of societal networks” to straightforward “chaos.” In their view, “the question is whether a threat of this magnitude will dishearten humankind or cause it to rally in a tremendous, generational struggle for survival and reconstruction” (Fuerth 2008, 144).

Climate change and the responses that are taken to address it could foster metamorphic political upheavals, institutional shifts, and technological innovations. These shifts might in turn generate unpredictable consequences for nuclear deterrence, (non)proliferation, and disarmament. Aply, climate change has received increasing attention in the wider field of nuclear security studies. In the sub-field concerned with prescriptive nuclear policy and grand strategy, however, climate change is conspicuously absent (see, e.g., Roberts 2015; Kroenig 2018; Freedman and Michaels 2019; Colby 2021; Krepon 2021; Pettyjohn and Matuschak 2022; Sagan and Narang 2023; Williams et al. 2023; Williams, Hartigan, Rodgers, and Younis 2023). Despite its apparent relevance for both international politics generally and practices of nuclear deterrence and disarmament specifically, mainstream nuclear strategists have largely ignored climate change as a relevant factor. No US nuclear posture review has mentioned climate change, at any rate, not in its declassified form. According to Joseph Nye (2022, 1646), the prevailing grand-strategic orthodoxy “is still focused on two-dimensional chess.”

The specialist literature on global warming, mitigation, and societal risk is vast and rapidly growing. However, a number of critics have pointed out that the existing climate literature is unduly formulaic in its underlying assumptions about human behavior, neglecting not only the indirect effects of climate change but also the ways in which “the impacts of climate change will be shaped by human responses to it” (Beard et al. 2021, 4). The IPCC reports are written largely by natural scientists and economists, with political scientists, IR scholars, and other social scientists leaving much less of a mark on the international community’s most authoritative studies of climate change and mitigation. Much of the literature on climate change and its impacts is written on the explicit premise that the political structures and institutions that prevail today will continue to exist indefinitely into the future. According to one set of authors, mainstream climate mitigation literature is written on the assumption that “our future will be a warmer version of today: liberal capitalism, plus flood insurance, minus coral reefs.” Yet this future may already have a probability “close to zero,” they argue (Mann and Wainwright 2019).

An exception to the climate literature’s general inattention to the prospect of major political transformations induced by the pressures of global warming is Geoff Mann and Joel Wainwright’s 2018 *Climate Leviathan*. In it, Mann and Wainwright (2018, 6) set out to answer the question of what the likely political-economic outcomes would be were climate change to reach “some threshold or tipping point at which it is globally impossible to ignore or reverse.” A first question, Mann and Wainwright suggest, is whether the response to climate change will take a capitalist or non-capitalist form. A second is whether the response will be enacted by independent states or a collective world government. These questions yield four ideal-typical

potential futures: “climate X,” “climate Mao,” “climate Behemoth,” and “climate Leviathan.”

Mann and Wainwright’s favored but, in their view, least likely future would be a democratic, non-capitalist system to combat climate change enacted through collective action by independent polities. The authors call this option “Climate X,” with the “X” signifying a puzzle or unknown to be unpacked through future scholarship and activism. The authors deem a non-capitalist response enacted by a top-down, planetary “Climate Mao” as somewhat more likely to materialize. Such a formation would be authoritarian and difficult to establish, but perhaps quite effective in distributing resources and limiting climate change, the authors suggest. A capitalist, state-led solution is what the world is currently seeking to implement under the UNFCCC system. This system is unlikely to yield effective climate action, Mann and Wainwright posit. The current “Climate Behemoth” system would likely see intensifying nationalism, isolationism, and conflict, the authors speculate. The final option, which the authors call “Climate Leviathan,” would see climate change addressed by some kind of world government operating within a capitalist economic formation. While reviewers have disagreed with the authors and advanced that Climate Behemoth is likely to stay in place (see, e.g., [Beeson 2020](#)), Mann and Wainwright insist that Climate Leviathan is the most probable scenario given present realities. Their argument is that the economic powers that be, in the United States and elsewhere, simply will not accept climate change getting out of hand to an extent whereby vast swathes of the global population are deprived of their ability to consume capitalist goods and services. To protect their markets and future earnings, multinational capitalist interests will group together and establish transnational governance institutions amounting to a form of planetary sovereignty. Mann and Wainwright draw on the work of Alexander Wendt, who in 2003 theorized the emergence of a world state as “inevitable.” For Wendt, the inevitability of world government owed, at the micro-level, to individuals’ “struggle for recognition,” and, on the macro-level, to the necessity of managing the increasing destructiveness of weapons and war ([Wendt 2003](#), 493, 508); climate change, Mann and Wainwright suggest, offers an enormous amount of added impetus on the macro front. [Torbjörn Tånnsjö \(2023\)](#) agrees, asserting that world government provides the only meaningful solution to the challenges of global heating and nuclear war (see also, e.g., [Rachman 2008](#); [Ashta 2021](#); [Stella and Craig 2022](#)).

Mann and Wainwright’s four ideal-typical climate futures offer a fruitful starting point for thinking about the potential consequences of runaway climate change for nuclear security and politics. With respect to the “climate Mao” and “climate Leviathan” scenarios, which would both involve the emergence of a form of planetary sovereignty, it has been argued by numerous scholars and policymakers that world government, and only world government, would enable the abolition of nuclear weapons altogether ([Craig 2019](#)). In fact, if a state under anarchy is defined by its monopolization of the legitimate use of force within its borders, a world state would necessarily have to either monopolize or abolish all nuclear weapons. During the first few decades after the Second World War, a number of authors, including [Hans Morgenthau](#), [Albert Einstein](#), [Bertrand Russell](#), and [John Herz](#), called for the establishment of world government to deal with nuclear technology ([Deudney 1995](#); [van Munster and Sylvest 2016](#); [Craig 2019](#)). In the grand scheme of things, the period of sovereign nation states may turn out to be a short blip in human history. The “Westphalian” system of formally equal political units interacting through common institutions was only globalized in the 1960s, when the process of decolonization gained momentum. This is not to say that there are not powerful forces working against global integration; there are many obstacles to the emergence of a world state, including nationalism, the political ambitions of local leaders, and ideological, economic, and cultural misalignments. [Robert Jervis](#) has added the ironic observation that nuclear weapons may themselves pose significant obstacles to tran-

scending anarchy. In 2016, he made the point that “one may argue that it is only nuclear weapons that stand between the United States and world domination” (Jervis 2016, xix). In fact, the broader realist tradition in IR can be read as variations on the theme that world government is necessary but impossible (Poast 2022).

Mann and Wainwright, for their part, maintain that technological changes, particularly in relation to the exploration and usage of outer space, could render US-led world government plausible in the foreseeable future. More generally, a situation whereby large and densely populated parts of the globe simply became uninhabitable, giving rise to hundreds of millions or even billions of climate refugees, would deliver an unprecedented shock both to the international system and many, if not all, the states that make it up. The political consequences of such a shock—locally, regionally, and globally—should not be underestimated or discounted. In the words of Fuerth (2008, 143), “massive nonlinear events in the global environment will give rise to massive nonlinear societal events.” These prospective “nonlinear social events,” I suggest, have been seriously understudied, both in terms of their potential impacts on nuclear policy and world politics more broadly.

The “climate Behemoth” system of accelerating global warming and intensifying nationalism comes across as far less propitious for effective control of nuclear weapons. As discussed above, a number of analysts have speculated that global warming is likely to function as an amplifier and multiplier of threats, increasing the likelihood of nuclear escalation and war. Several authors have also expressed concern that runaway climate change might damage the global nuclear order generally and the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) specifically (on the global nuclear order, see Walker 2012; Ritchie 2019; Knopf 2022). According to Ambassador Thomas Graham (2021, 186), a former US special representative for nonproliferation, the NPT “is significantly endangered by the increasing threat of climate change.” In his view, growing competition over fresh water and arable land could push current non-nuclear powers to pursue the bomb. “To protect what they have, some smaller states will be tempted to reach for nuclear weapons” (Graham 2021, 194). The NPT parties should therefore consider negotiating “a legally binding Protocol attached to the NPT, requiring members to take strong anti-climate change measures,” Graham argues (Kim 2022). In a similar vein, Francesca Giovannini (2018, 90) has concluded that the global nuclear order “is growing increasingly vulnerable” to climate change and the various dislocations it is likely to engender.

As with the hypothesis that climate change could increase the risk of nuclear conflict, the suggestion that global warming threatens nuclear order remains underspecified. While in one view this is a natural reflection of the fact that the political consequences of global warming are difficult to foresee, in a critical perspective the imaginary of a fragile nuclear order threatened by external pressures arguably reflects what Nick Ritchie (2019, 410) refers to as “nuclear ordering anxiety,” a diffuse sense of trepidation about nuclear instability or institutional decay associated with the “wider geopolitical and cultural angst in the United States and industrialized North about the fate of the ‘liberal international order.’” That being said, it is crucial not to minimize the potential impacts of climate change; global warming constitutes an enormous, global challenge. In the words of Jan Selby (2022, 345), an IR scholar and climate specialist, it is by now “beyond question that the international political and conflict and security consequences of even successful, smooth decarbonisation would be huge.” In this context, it is clearly of enormous importance to identify, analyze, and ideally address the pathways through which climate breakdown might lead to an increased risk of nuclear conflict, proliferation, or institutional decay. At the same time, though, it is appropriate to recall that the demise of the global nuclear order has been presaged as imminently impending for more than half a century (Horowitz 2015; Egeland, 2021, 212–15, 221). The

rate of future nuclear proliferation has consistently been overpredicted (Potter and Mukhatzanova 2008, 139; Arkin 1994; Pelopidas 2011).

It is not difficult to imagine how disruptive events related to climate change could impair institutions and practices of nuclear restraint. Yet, as suggested above, crises and disruptions could also portend increased efforts at institution building, including, of course, institution building of a less ambitious kind than the formation of world government, institution building consistent with the “climate X” and “climate Behemoth” scenarios in Mann and Wainwright’s typology. As Claudia Aradau and Rens van Munster (2011, 6) point out, disruptions “need not necessarily be rendered as something negative but could also provide a new beginning” by “bring[ing] out the political issues that surround the invocation of imaginaries of the future.” The literature on economic history provides a wealth of evidence of how crises, whether they result from exogenous shocks or the culmination of destructive endogenous processes, can open windows of opportunity for major policy change. The direction of these changes, so Milton Friedman (1982, ix), depends “on the ideas that are lying around.” As Mark Blyth (2002) also maintains, crises often disrupt dominant ideas and, in turn, actors’ conceptions of their own interests.

Short of spurring world government, climate change and other disruptive forces could have profound impacts on both elites’ and publics’ understandings of their respective states’ national interests and, in turn, arms control practices and the prospects for international cooperation (see Vaughan 2024). As discussed by Van Jackson (2024, 124), closer cooperation on climate issues could conceivably help unwind militarized rivalries. While the emergence of such cooperation is scarcely inevitable or perhaps even likely, it should not be dismissed out of hand. Short of the complete elimination of nuclear weapons, arms control experts have identified a range of measures to restrain the potential for nuclear violence. These include the negotiation of a ban on the production of fissile material for nuclear weapons, the adoption of no-first use policies by the nuclear-armed states, curbs on the application of artificial intelligence to nuclear command and control systems, the universalization of the Comprehensive Nuclear-Test-Ban Treaty, the adoption of a treaty or moratoria on the development of anti-satellite weapons, the universal application of the IAEA’s highest nonproliferation safeguards standard (the Additional Protocol), and the resurrection and potential expansion (by new members) of the Anti-Ballistic Missile Treaty and Intermediate-Range Nuclear Forces Treaty (Jackson 2024, 181–2; Vicente 2023). While each of these measures currently appears to be out of reach, the transformational changes likely to be brought about by climate change could change states’ outlooks. As Dipesh Chakrabarty (2021, 32) puts it, the “regimes of probability” that have governed policymaking and our everyday lives until the present moment “now have to be supplemented by our knowledge of the radical uncertainty of the climate.” Arms control seems eminently feasible in both the “climate X” and a more benign version of the “climate Behemoth” system. And if it is true, as suggested by Friedman, Blyth, and others, that policymakers’ responses to crises depend on the “ideas that are lying around,” it is incumbent on scholars and activists to put forward benevolent ideas and visions for the governance of a warming world (see Burke et al. 2016; McDonald 2021).

A New Research Agenda

Whatever the merits of the specific arguments rehearsed above, it seems plausible or even likely that global warming and the institutional, political, and technological measures that will be taken to address it could have profound implications for both nuclear politics and other catastrophic risk factors. Scholars of international relations and security should pay more attention to these connections. This should include paying attention not only to potential risks but also to opportunities for progressive change, including in the direction of arms control and disarmament.

Table 1: A research agenda for the climate–nuclear nexus

Topic	Overarching research questions	Key objectives
Implications for current deterrence practices of climate change	<p><i>What are the security implications of nuclear energy expansion?</i></p> <p><i>What is the carbon footprint of ongoing nuclear modernization projects?</i></p> <p><i>How might climate change affect existing nuclear deterrence practices and nuclear defense spending priorities?</i></p> <p><i>What is the relationship between nuclear competition and climate negotiations?</i></p> <p><i>How might climate change affect the conditions for communities especially affected by nuclear armament?</i></p>	<p>To identify, understand, and present options for tackling climate-induced nuclear vulnerabilities and adaptation measures.</p> <p>To assess the direct material costs and consequences of global warming for nuclear deterrence practices and politics.</p> <p>To explore international justice in an era of intensifying global challenges, and to identify, understand, and present options for tackling compounded risks for especially affected communities.</p>
Possibilities for major political change induced by climate change	<p><i>How might the institutional and other responses enacted in response to climate change affect the world of nuclear weapons?</i></p> <p><i>How should the movement for nuclear arms control and disarmament relate to climate change?</i></p> <p><i>What are the effects of securitizing the environment?</i></p>	<p>To challenge presentism and understand the conditions for major nuclear-political change.</p> <p>To explore the wider structural conditions in which nuclear policy is enacted.</p> <p>To imagine and uncover pathways to radically different worlds.</p>
The relationship between different catastrophic risk scenarios	<p><i>To what extent might climate change impact humanity's ability to cope or recover from other cataclysms, including nuclear war?</i></p> <p><i>How might nuclear conflict or a resumption of explosive nuclear testing affect climate diplomacy and decarbonization?</i></p>	<p>To understand latent risks, risk cascades, systemic risk, and the relationship between different sources of large-scale harm.</p>

Existing research indicates that political upheaval can provide opportunities for advocates of arms control and disarmament; the decisions of the governments of Belarus, Kazakhstan, South Africa, and Ukraine to relinquish nuclear weapons all came about in the context of major political transformations taking place in those countries (Egeland 2022). South Africa, for example, gave up nuclear weapons in the context of the dismantlement of the apartheid regime (van Wyk and van Wyk 2020). Ukraine and the other post-Soviet republics, which admittedly never had operational control of the weapons they inherited upon the demise of the USSR, similarly gave up nuclear weapons as part of a wider process of building new political identities as sovereign polities (Potter 1995; Budjeryn 2022).

The above indicates that the scholarship on nuclear weapons and climate change could be advanced along several axes. First, the various connections between nuclear weapons and climate change investigated in this paper could all be further explored. For example, the literature examining the vulnerability of nuclear sites and infrastructure to warming-induced changes to the natural environment is focused almost exclusively on Britain and the United States. The potential impacts of climate change and extreme weather events on other countries and global governance structures, such as the Comprehensive Nuclear-Test-Ban Treaty's International Monitoring System remain unstudied. Further, the literature on climate insecurity and its potential links to nuclear competition and order is seriously underdeveloped. Scholarship on how the melting of the polar ice sheets might affect submarine op-

erations and notions of strategic stability should also be furthered. Meanwhile, our understanding of how geopolitics, nuclear competition, and great power rivalry shape opportunities for climate cooperation is at best rudimentary. Similarly, the potential for climate change to compound existing harms and vulnerabilities for communities especially affected by nuclear competition remains underexplored.

Second, analysts of nuclear politics and climate change should critically interrogate the presentist assumption that the basic political and institutional structures that condition policy outcomes today will continue to exist indefinitely (see Pelopidas 2016, 326). Students of nuclear strategy and disarmament must be attentive not only to the direct, material ways in which climate change might upset current nuclear deployment practices or intensify current conflicts but also to the possibility of climate change fundamentally transforming established international political practices and, indeed, the international system itself (see Vaughan 2024). While research along these lines would necessarily be speculative, analysts should not abandon the basic social scientific commitment to rigor. The field of future studies offers a suite of methods for systematic research, including scenario mapping and careful counterfactual analysis (see, e.g., Junio and Mahnken 2013). At a more basic level, research should be undertaken to develop more robust understandings of the relationship between nuclear and climate politics, on the one hand, and sovereignty and political authority, on the other. This broader avenue of research could include investigations into the basic conditions for change in nuclear and climate politics.

Third, and perhaps surprisingly, there is a dearth of rigorous scholarship on the relationship between different catastrophic risk scenarios. As Kemp et al. (2022) point out, the climate literature is overwhelmingly focused on warming scenarios of 3 degrees Celsius and lower. The literature covering more extreme scenarios is and has been more journalistic in nature. This is partly a consequence of the uncertainties involved, yet, as Kemp et al. argue, there is room for more scholarly, systematic social science examining the potential consequences of more dramatic heating scenarios. There is also a surprising dearth of literature investigating the implications of climate change on other potential catastrophic harm scenarios—and indeed the implications of other potential harm scenarios for climate change and decarbonization—including, for example, humanity's ability to recover from nuclear conflict under conditions of extreme climate change (Beard and Torres 2019, 3). There is a need for more serious scholarship on latent risks (a risk that is triggered by a particular set of circumstances), risk cascades (chains of interrelated risks), and systemic risk (the potential for an individual disruptive event to induce system-wide breakdown) (see Kemp et al. 2022, 1). As established by the literature on nuclear winter, any large-scale nuclear war would be likely to trigger significant climate consequences. Nuclear explosions would ignite ferocious firestorms, spewing vast blankets of soot into the atmosphere. In turn, the soot would prevent sunlight from reaching the earth's surface, significantly reducing ground temperatures and staple food production (Toon et al. 2018; Xia et al. 2022).

Finally, as is the case with nuclear security studies generally (Craig and Ruzicka 2013; Braut-Hegghammer, 2019, 336), much of the existing literature on the climate–nuclear nexus is written from the perspective of current nuclear-armed states—above all, the United States and Britain. As discussed above, most of the existing literature on the topic is primarily concerned with the potential for sea-level rise and extreme weather events to complicate nuclear basing and deterrence practices, proliferation, and other potential challenges to the prevailing nuclear control regime, or the prospects for great power management of collection action problems. While important exceptions exist, less has been written, at any rate in the scholarly space, from the perspective of smaller states and advocates of climate justice and/or nuclear arms control and disarmament. Recent years have seen growing collaboration between members of the climate and nuclear disarmament move-

ments (Unfold Zero 2021; Borger 2022), and there are important social-scientific questions to be asked about the drivers, faults, and merits of multi-issue advocacy, issue-linking, and alternative advocacy strategies (Lee 2020; Wolf and Theunissen 2023). The various potential research questions and objectives are summarized in Table 1 below.

Conclusion

Nuclear weapons and global warming are widely believed to present serious challenges to human societies. The two threats are similar in several ways: both are expressions of modern science and technology, both are “wicked” problems embedded in complex political-economic structures, and both are constitutive of the intensification of global catastrophic risks. The two threats are also mutually entangled. However, the linkages between nuclear and climate security remain underexplored. The existing literature is largely limited to exploring the direct material challenges climate change is likely to present to extant nuclear deterrence practices, neglecting to investigate the perhaps much more consequential implications of second-order political transformations brought about by the pressures of global warming. Going forward, scholars of nuclear politics, climate change, and other catastrophic risk scenarios should pay greater attention to long-term political futures and the interrelationships between alternative potential cataclysms. This effort should certainly involve investigations into catastrophic scenarios to be prevented, but also, and equally importantly, explorations of more positive trajectories whereby human, global, and/or international security is enhanced.

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References

- ABELLA, M.K.I.L., M.R. MOLINA, I. NIKOLIC-HUGHES, E.W. HUGHES, AND M.A. RUDERMAN 2019. “Background Gamma Radiation and Soil Activity Measurements in the Northern Marshall Islands,” *Proceedings of the National Academy of Sciences* 116 (31): 15425–34.
- AMERICAN SECURITY PROJECT. 2018. “National Defense Strategy.” Accessed June 14, 2024. <https://www.americansecurityproject.org/climate-change-in-the-age-of-great-power-competition/>
- ANDERS, T., C.J. FARISS, AND J.M. MARKOWITZ 2020. “Bread before Guns or Butter: Introducing Surplus Domestic Product (SPD).” *International Studies Quarterly* 64 (2): 392–405.
- ANDERSSON, J. 2018. *The Future of the World: Futurology, Futurists, and the Struggle for the Post-Cold War Imagination*. Oxford: Oxford University Press.
- ARADAU, C., AND R. VAN MUNSTER 2011. *Politics of Catastrophe: Genealogies of the Unknown*. London: Routledge.
- ARKIN, W.M. 1994. “The Sky-Is-Still-Falling Profession.” *Bulletin of the Atomic Scientists* 50 (2): 64.
- ASHEIM, G.B., F. FEHN, K. NYBORG, M. GREAKER, C. HAGEM, B. HARSTAD, AND M.O. HOEL et al. 2019. “The Case for a Supply-Side Climate Treaty.” *Science* 365 (6451): 325–27.

- ASHTA, A. 2021. "It Is Time to Seriously Consider the Advantages of a World Federal Government." *London School of Economics*. Accessed June 14, 2024. <https://blogs.lse.ac.uk/europpblog/2021/03/18/it-is-time-to-seriously-consider-the-advantages-of-a-world-federal-government/>
- AXE, D. 2020. "Sunk: How China's Man-Made Islands Are Falling Apart and Sinking into the Ocean." *The National Interest*. Accessed June 19, 2024. <https://nationalinterest.org/blog/buzz/sunk-how-china-as-man-made-islands-are-falling-apart-and-sinking-ocean-132047>
- BAKER, D. 2022. "A Cold War with China, Global Warming, and Why We Can't Have Nice Things." *Center for Economic and Policy Research*. Accessed June 14, 2024. <https://cepr.net/a-cold-war-with-china-global-warming-and-why-we-cant-have-nice-things/>
- BARON, J., AND S. HERZOG 2020. "Public Opinion on Nuclear Energy and Nuclear Weapons: the Attitudinal Nexus in the United States." *Energy Research & Social Science* 68 (101567): 1–11.
- BARRETT, S. 2007. *Why Cooperate? The Incentive to Supply Global Public Goods*. Oxford: Oxford University Press.
- BEACH, H. 2014. "The UK's Nuclear Deterrent." *The RUSI Journal* 159 (2): 18–22.
- BEARD, S., AND P. TORRES 2019. *Identifying and Assessing the Drivers of Global Catastrophic Risk: a Review and Proposal for the Global Challenges Foundation*. Stockholm: Global Challenges Foundation.
- BEARD, S.J., L. HOLT, A. TZACHOR, L. KEMP, S. AVIN, P. TORRES, AND H. BELFIELD 2021. "Assessing Climate Change's Contribution to Global Catastrophic Risk." *Futures* 127 (102673): 1–14.
- BEESON, M. 2020. "The Environmental Path to World Government? A Review of *Climate Leviathan: a Political Theory of Our Planetary Future*." *World Government Research Network*. Accessed June 14, 2024. https://www.wgresearch.org/_files/ugd/bdf8dc_9070312ef90742b789d4ef625bb34bca.pdf
- BIGGER, P., C. KENNELLY, O. BELCHER, AND B. NEIMARK 2021. "The Carbon Footprint of the US Military and Prospects for a Safer Climate." In *Negotiating Climate Change in Crisis*, edited by S Böhm and S Sullivan, 53–62. Cambridge: Open Book.
- BLYTH, M. 2002. *Great Transformations: Economic Ideas and Institutional Change in the Twentieth Century*. Cambridge: Cambridge University Press.
- BORGER, J. 2022. "Fresh Efforts to Ban the Bomb as New Generation Bids for Nuclear-Free World." *The Guardian*. Accessed June 14, 2024. <https://www.theguardian.com/world/2022/nov/10/nuclear-disarmament-activists-putin-ukraine>
- BORRIE, J. 2014. "Humanitarian Reframing of Nuclear Weapons and the Logic of a Ban." *International Affairs* 90 (3): 625–46.
- BOULÈGUE, M. 2019. *Russia's Military Posture in the Arctic: Managing Hard Power in a "Low Tension" Environment*. London: Chatham House.
- BRAUT-HEGGHAMMER, M. 2019. "Proliferating Bias: American Political Science, Nuclear Weapons, and Global Security." *Journal of Global Security Studies* 4 (3): 384–92.
- BUCKLEY, J.A. 2013. "An Arctic Nuclear-Weapon-Free Zone: Circumpolar Non-Nuclear-Weapons States Must Originate Negotiations." *Michigan State International Law Review* 22 (1): 167–94.
- BUDJERYN, M. 2022. *Inheriting the Bomb: the Collapse of the USSR and the Nuclear Disarmament of Ukraine*. Baltimore: Johns Hopkins University Press.
- BURKE, A., S. FISHEL, A. MITCHELL, S. DALBY, AND D.J. LEVINE 2016. "Planet Politics: a Manifesto from the End of IR." *Millennium: Journal of International Studies* 44 (3): 499–523.
- BUSBY, J. 2018. "Warming World: Why Climate Change Matters More than Anything Else." *Foreign Affairs* 97 (4): 49–57.
- BUSBY, J.W. 2016. "Climate Change and US National Security." In *Sustainable Security: Rethinking American National Security Strategy*, edited by J Suri and B Valentino, 196–232. Oxford: Oxford University Press.
- BUTT, A.I. 2015. "Do Nuclear Weapons Affect the Guns-Butter Trade-Off? Evidence on Nuclear Substitution from Pakistan and Beyond." *Conflict, Security & Development* 15 (3): 229–57.
- CERUTTI, F. 2010. "Defining Risk, Motivating Responsibility and Rethinking Global Warming." *Science and Engineering Ethics* 16 (3): 489–99.
- CHAKRABARTY, D. 2021. *The Climate of History in a Planetary Age*. Chicago: University of Chicago Press.
- CHALMERS, M., AND W. WALKER 2013. "Will Scotland Sink the United Kingdom's Nuclear Deterrent?" *The Washington Quarterly* 36 (2): 107–22.

- CHITTY, T. 2022. "The Home of Britain's Nuclear Weapons Is at Risk – and Climate Change Is to Blame." *CNBC*. Accessed July 14, 2024, <https://www.cnn.com/video/2022/02/21/faslane-britains-nuclear-submarine-base-at-risk-climate-change-is-to-blame.html>
- COLBY, E. 2021. *The Strategy of Denial: American Defense in an Age of Great Power Conflict*. New Haven: Yale University Press.
- COLGAN, J.D. 2021. "Climate Change, Grand Strategy, and International Order." *Wilson Center*. Accessed June 14, 2024. <https://www.wilsoncenter.org/article/climate-change-grand-strategy-and-international-order>.
- CRAIG, C. 2019. "Solving the Nuclear Dilemma: Is a World State Necessary?" *Journal of International Political Theory* 15 (3): 349–66.
- CRAIG, C., AND J. RUZICKA 2013. "The Nonproliferation Complex." *Ethics & International Affairs* 27 (3): 329–48.
- CRAWFORD, NC. 2022. *The Pentagon, Climate Change, and War: Charting the Rise and Fall of U.S. Military Emissions*. Cambridge: The MIT Press.
- CRILLEY, R. 2023. *Unparalleled Catastrophe: Life and Death in the Third Nuclear Age*. Manchester: Manchester University Press.
- DEUDNEY, D. 1990. "The Case against Linking Environmental Degradation and National Security." *Millennium: Journal of International Studies* 19 (3): 461–76.
- . 1995. "Nuclear Weapons and the Waning of the Real-State." *Daedalus* 124 (2): 209–31.
- DEUDNEY, D., AND G. JOHN IKENBERRY 2021. "Misplaced Restraint: The Quincy Coalition versus Liberal Internationalism." *Survival* 63 (4): 7–21.
- DORFMAN, P. 2021. *Climate Impact UK Nuclear Military*. London: Nuclear Consulting Group.
- DOYLE, J.E. 2013. "Why Eliminate Nuclear Weapons?" *Survival* 55 (1): 7–34.
- EBBS, S. 2021. "Biden Seeks To Reestablish US Leadership on Climate with Earth Day Summit," *ABC News*. Accessed June 14, 2024. <https://abcnews.go.com/Politics/biden-seeks-reestablish-us-leadership-climate-earth-day/story?id=77206514>
- EGLAND, K. 2021. "The Ideology of Nuclear Order." *New Political Science* 43 (2): 208–30.
- . 2022. "A Theory of Nuclear Disarmament: Cases, Analogies, and the Role of the Non-Proliferation Regime." *Contemporary Security Policy* 43 (1): 106–33.
- . 2023. "Climate Security Reversed: the Implications of Alternative Security Policies for Global Warming." *Environmental Politics* 32 (5): 883–902.
- ERICKSON, A.S., AND C.M. KENNEDY 2015. "China's Island Builders." *Foreign Affairs*. Accessed June 14, 2024. <https://www.foreignaffairs.com/articles/east-asia/2015-04-09/chinas-island-builders>
- FABIAN, J., AND A. GARDNER 2023. "Biden Says Climate Change Poses Greater Threat than Nuclear War." *Bloomberg*. Accessed June 18, 2024, <https://www.bloomberg.com/news/articles/2023-09-10/biden-says-climate-change-poses-greater-threat-than-nuclear-war?embedded-checkout=true>.
- FEDERATION OF AMERICAN SCIENTISTS. 2024. "America's Nuclear Weapons Arsenal 2024." Accessed August 20, 2024. <https://fas.org/publication/nuclear-weapons-2024/>.
- FLAKE, L.E. 2014. "Russia's Security Intentions in a Melting Arctic." *Military and Strategic Affairs* 6 (1): 99–116.
- FREEDMAN, L., AND J. MICHAELS 2019. *The Evolution of Nuclear Strategy*, 4th ed. London: Palgrave Macmillan.
- FRIEDMAN, M. 1982. *Capitalism and Freedom*. Chicago: The University of Chicago Press.
- FUERTH, L. 2008. "Security Implications of Climate Scenario 2: Severe Climate Change over the Next Thirty Years." In *Climatic Cataclysm: the Foreign Policy and National Security Implications of Climate Change*, edited by K.M. Campbell, 133–54. Washington, DC: Brookings Institution Press.
- FUHRMANN, M. 2012. *Atomic Assistance: How "Atoms for Peace" Programs Cause Nuclear Insecurity*. Ithaca: Cornell University Press.
- FUTTER, A., AND B.E. BOWEN. 2020. "A Perfect Storm: Coronavirus, Brexit, the Integrated Review, Scottish Separatism and the Future of Trident." *The RUSI Journal* 165 (5–6): 92–99.
- FUTTER, A., AND B. ZALA 2021. "Strategic Non-Nuclear Weapons and the Onset of a Third Nuclear Age." *European Journal of International Security* 6 (3): 257–77.
- GERRARD, M.B. 2015. "America's Forgotten Nuclear Waste Dump in the Pacific." *SAIS Review of International Affairs* 35 (1): 87–97.
- GHEORGHE, E. 2019. "Proliferation and the Logic of the Nuclear Market." *International Security* 43 (4): 88–127.
- GIBBONS, R.D. 2020. "Supply to Deny: the Benefits of Nuclear Assistance for Nuclear Nonproliferation." *Journal of Global Security Studies* 5 (2): 285–98.
- GIBBONS, R.D., AND S. HERZOG 2022. "Durable Institutions under Fire? The NPT Confronts Emerging Unipolarity." *Contemporary Security Policy* 43 (1): 50–79.

- GILLI, A., M. GILLI, A. RICCHI, A. RUSSO, AND S. CARNIEL 2024. "Climate Change and Military Power: Hunting for Submarines in the Warming Ocean." *Texas National Security Review* 7 (2): 16–41.
- GIOVANNINI, F. 2018. "At the Nuclear Brink or towards a Nuclear Renaissance?" *Fletcher forum of World Affairs* 42 (2): 79–106.
- GOODMAN, S., AND K. KERTYSOVA 2022. "NATO: an Unexpected Driver of Climate Action?" *NATO Review*, Accessed June 14, 2024, <https://www.nato.int/docu/review/articles/2022/02/01/nato-an-unexpected-driver-of-climate-action/index.html>
- GRAHAM, T. 2021. "The Nuclear Non-Proliferation Treaty: Delayed Review – Issues Old and New." *Journal for Peace and Nuclear Disarmament* 4 (1): 186–95.
- GREEN, J.F. 2021. "Reimagining Global Climate Policy." *Perry World House*. Accessed June 14, 2024, http://web.archive.org/web/20220625071057/https://global.upenn.edu/sites/default/files/perry-world-house/Green_ClimateGeopol.pdf
- HAFFA, R.P. 2017. "Defense Decisions for the Trump Administration." *Strategic Studies Quarterly* 11 (1): 25–48.
- HALE, T. 2021. "Climate Hawks Need Not Be China Doves." *ISEP Policy Brief, Johns Hopkins University School of Advanced International Studies*, accessed June 14, 2024, <https://sais-isep.org/wp-content/uploads/2021/02/Climate-Hawks-Need-Not-Be-China-Doves.pdf>
- HANNAY, D. 2021. "Nuclear Weapons and Climate Change: the Two Great Challenges." *European Leadership Network*. Accessed June 14, 2024, <https://www.europeanleadershipnetwork.org/commentary/nuclear-weapons-and-climate-change-the-two-great-challenges/>
- HANSOM, J., F. MAXWELL, L. NAYLOR, AND M. PIEDRA 2017. *Impacts of Sea-Level Rise and Storm Surges due to Climate Change in the Firth of Clyde: Commissioned Report, No. 891*. Inverness: Scottish National Heritage.
- HARDING, J. 2008. "Myths of the Nuclear Renaissance." *Ecology Law Currents* 35 (1): 53–16.
- HARRISON, T., AND E.B. MONTGOMERY 2015. *The Cost of U.S. Nuclear Forces*. Washington, DC: Center for Strategic and Budgetary Assessments.
- HELM, D. 2021. *Net Zero: How We Stop Causing Climate Change*. London: William Collins.
- HOROVITZ, L. 2015. "Beyond Pessimism: Why the Treaty on the Non-Proliferation of Nuclear Weapons Will Not Collapse." *Journal of Strategic Studies* 38 (1–2): 126–58.
- HYMAN, E. 2023. "Who's Really Responsible for Climate Change?" *Harvard Political Review*. Accessed June 14, 2024, <https://harvardpolitics.com/climate-change-responsibility/>
- ICAN. 2023. "Diversion of Public Resources." Accessed June 14, 2024, https://www.icanw.org/diversion_of_public_resources
- INCROPERA, F.P. 2016. *Climate Change: a Wicked Problem*. Cambridge: Cambridge University Press.
- JACKSON, V. 2024. *Grand Strategies of the Left*. Cambridge: Cambridge University Press.
- JENKINS, L. 2010. "Russian Troops Dig Canal around Sarov Nuclear Base as Wildfires Grow." *The Guardian*. Accessed June 14, 2024, <https://www.theguardian.com/world/2010/aug/08/russia-nuclear-base-wildfires>
- JERVIS, R. 2016. "Foreword." In *Global Nuclear Disarmament*, edited by N Hynek and M Smetana, xv–xx. London: Routledge.
- JOHNSON, D.V. 2007. "Global Climate Change: National Security Implications." *U.S. Army War College and Triangle Institute for Security Studies*, accessed June 14, 2024, <https://apps.dtic.mil/sti/pdfs/ADA466551.pdf>
- JUNIO, T.J., AND T.G. MAHNKEN 2013. "Conceiving Future War: the Promise of Scenario Analysis for International Relations." *International Studies Review* 15 (3): 374–95.
- KAPLAN, F. 2020. *The Bomb: Presidents, Generals, and the Secret History of Nuclear War*. New York: Simon & Schuster.
- KELLER, C., AND M. O'NEAL 2023. "Costing the Earth: What Will It Take to Make the Green Transition Work?" *World Economic Forum*. Accessed June 14, 2024, <https://www.weforum.org/agenda/2023/09/costing-the-earth-how-to-make-green-transition-work/>
- KEMP, L., C. XU, J. DEPLEDGE, K.L. EBI, G. GIBBINS, T.A. KOHLER, AND J. ROCKSTRÖM et al. 2022. "Climate Endgame: Exploring Catastrophic Climate Change Scenarios." *Proceedings of the National Academy of Sciences* 119 (34): 1–9.
- KHANNA, P. 2021. *Move: How Mass Migration Will Reshape the World – and What It Means for You*. New York: Scribner.
- KIM, S.-M. 2022. "The Tenth NPT Revcon: What's at Stake for the Global Nuclear Order?" *Just Security*. Accessed June 14, 2024, <https://www.justsecurity.org/82549/the-tenth-npt-revcon-whats-at-stake-for-the-global-nuclear-order/>
- KIRCHBERGER, S., AND P. O'KEEFE 2017. "Military-Strategic Aspects of the South China Sea Issue." In *Traversing the Challenges: Political, Economic, and Environmental Dimensions of Maritime and Regional Security*, edited by B Seemann and S Bersick, 27–40. Makati City: Konrad Adenauer Stiftung.

- KNOPF, J.W. 2022. "Not by NPT Alone: the Future of the Global Nuclear Order." *Contemporary Security Policy* 43 (1): 186–212.
- KREPON, M. 2021. *Winning and Losing the Nuclear Peace*. Stanford: Stanford University Press.
- KROENIG, M. 2010. *Exporting the Bomb: Technology Transfer and the Spread of Nuclear Weapons*. Ithaca: Cornell University Press.
- . 2018. *The Logic of American Nuclear Strategy: Why Strategic Superiority Matters*. Oxford: Oxford University Press.
- KWONG, J. 2023a. *How Climate Change Challenges the U.S. Nuclear Deterrent*. Washington, DC: Carnegie Endowment for International Peace.
- . 2023b. "The Waters Could Claim Nuclear Weapons." *Foreign Policy*. Accessed June 14, 2024. <https://foreignpolicy.com/2023/07/12/nuclear-weapons-climate-change-deterrence/>
- LEE, B. 2020. "Issue Linkage and the Logic of Hybrid Coalitions: Linking Trade and Environmental Protection." PhD thesis, Cambridge, MA: Harvard University.
- LESTER, R.K., AND R. ROSNER 2009. "The Growth of Nuclear Power." *Daedalus* 138 (4): 19–30.
- LEWIS, P. 2016. "Nuclear Weapons as a Wicked Problem in a Complex World." In *Nuclear Disarmament: a Critical Assessment*, edited by B. Steen and O. Njølstad, 57–72. London: Routledge.
- LIAO, N-C. 2018. "Winds of Change: Assessing China's Assertive Turn in Foreign Policy." *Journal of Asian and African Studies* 53 (6): 880–95.
- LIEBER, K.A., AND D.G. PRESS 2017. "The New Era of Counterforce: Technological Change and the Future of Nuclear Deterrence." *International Security* 41 (4): 9–49.
- LIEVEN, A. 2020. *Climate Change and the Nation State: the Case for Nationalism in a Warming World*. Oxford: Oxford University Press.
- LISKA, A.J., T.R. WHITE, E.R. HOLLER, AND R.J. OGLESBY 2017. "Nuclear Weapons in a Changing Climate: Probability, Increasing Risks, and Perception." *Environment: Science and Policy for Sustainable Development* 59 (4): 22–33.
- LITWAK, R.S. 2021. "Geostrategic Competition and Climate Change: Avoiding the Unmanageable." *Wilson Center*. Accessed June 14, 2024. <https://www.wilsoncenter.org/article/geostrategic-competition-and-climate-change-avoiding-unmanageable>
- LONG, A., AND B.R. GREEN 2015. "Stalking the Secure Second Strike: Intelligence, Counterforce, and Nuclear Strategy." *Journal of Strategic Studies* 38 (1–2): 38–73.
- LUSTGARTEN, A. 2020. "How Russia Wins the Climate Crisis." *The New York Times*. Accessed June 14, 2024. <https://www.nytimes.com/interactive/2020/12/16/magazine/russia-climate-migration-crisis.html>
- MACDONALD, J. 2014. "A Blessing in Disguise? Scottish Independence and the End of the UK Nuclear Posture." *European Security* 23 (3): 326–43.
- MANCHIN, J. 2021. "Manchin Statement on Build back Better Act." Accessed June 14, 2024, <http://web.archive.org/web/20250101173451/https://www.manchin.senate.gov/newsroom/press-releases/manchin-statement-on-build-back-better-act>
- MANN, G., AND J. WAINWRIGHT 2018. *Climate Leviathan: a Political Theory of Our Planetary Future*. London: Verso.
- . 2019. "Political Scenarios for Climate Disaster." *Dissenting*. Accessed June 14, 2024. <https://www.dissentmagazine.org/article/political-scenarios-for-climate-disaster/>
- MASCO, J. 2010. "Bad Weather: on Planetary Crisis." *Social Studies of Science* 40 (1): 7–40.
- MASLIN, M. 2014. *Climate Change: a Very Short Introduction*. Oxford: Oxford University Press.
- MASSON-DELMOTTE, V., P. ZHAI, H.-O. PÖRTNER, D. ROBERTS, J. SKEA, P.R. SHUKLA, AND A. PIRANI et al. 2019. *Global Warming of 1.5° C*. Geneva: Intergovernmental Panel on Climate Change.
- MCDERMOTT, R., A.C. LOPEZ, AND P.K. HETEMI 2017. "Blunt Not the Heart, Enrage It': the Psychology of Revenge and Deterrence." *Texas National Security Review* 1 (1): 68–89.
- MCDONALD, M. 2021. *Ecological Security: Climate Change and the Construction of Security*. Cambridge: Cambridge University Press.
- MCKENZIE, J., AND F. DIAZ-MAURIN 2024. "Texas Wildfire Forces Major Nuclear Weapons Facility to Briefly Pause Operations." *Bulletin of the Atomic Scientists*. Accessed June 19, 2024. <https://thebulletin.org/2024/02/texas-wildfires-force-major-nuclear-weapons-facility-to-briefly-pause-operations/>
- MECKLIN, J. 2024. "A Moment of Historic Danger." *Bulletin of the Atomic Scientists*. Accessed June 18, 2024. <https://thebulletin.org/doomsday-clock/current-time/>
- MIAN, Z. 2016. "Kashmir, Climate Change, and Nuclear War." *Bulletin of the Atomic Scientists*. Accessed June 14, 2024. <https://thebulletin.org/2016/12/kashmir-climate-change-and-nuclear-war/>
- MILLER, S.E., AND S.D. SAGAN 2009. "Nuclear Power without Nuclear Proliferation?" *Daedalus* 138 (4): 7–18.
- MINTZ, A., AND C. HUANG 1991. "Guns versus Butter: the Indirect Link." *American Journal of Political Science* 35 (3): 738–57.

- MONTGOMERY, S.L., AND T. GRAHAM, JR. 2017. *Seeing the Light: the Case for Nuclear Power in the 21st Century*. Cambridge: Cambridge University Press.
- MORLAND, M. 2001. "Climate Change and Nuclear Energy." *International Relations* 15 (5): 53–64.
- MOSS, S. 2014. "James Lovelock: 'instead of Robots Taking over the World, What If We Join with Them?'" *The Guardian*. Accessed June 19. <https://www.theguardian.com/environment/2014/mar/30/james-lovelock-robots-taking-over-world>
- NATIONAL CANCER INSTITUTE. 2010. "Dose Estimation and Predicted Risk for Marshall Islands Residents." Accessed June 14, 2024. <https://dceg.cancer.gov/research/how-we-study/exposure-assessment/nci-dose-estimation-predicted-cancer-risk-residents-marshall-islands>
- NORDHAUS, W. 2015. "The Climate Club: Designing a Mechanism to Overcome Free Riding in International Climate Policy." *American Economic Review* 105 (4): 1–32.
- NYE, J.S. 2022. "How Not To Deal with a Rising China." *International Affairs* 98 (5): 1635–51.
- OOMEN, J., J. HOFFMAN, AND M.A. HAJER 2021. "Techniques of Futuring: on How Imagined Futures Become Socially Performative." *European Journal of Social Theory* 25 (2): 252–70.
- OTWAY, H.K., D. MAURER, AND K. THOMAS 1978. "Nuclear Power: the Question of Public Acceptance." *Futures* 10 (2): 109–18.
- C Parthemore and J Nolan., eds. 2017. *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*. Washington, DC: Center for Climate and Security.
- PARTHMORE, C. 2019. "Nuclear and Climate Connections: the History, Evolution, and Implications." In *Nuclear Disarmament: a Critical Assessment*, edited by B Steen and O Njølstad, 169–84. London: Routledge.
- PASTUKHOVA, M., AND K. WESTPHAL 2020. "Governing the Global Energy Transformation." In *The Geopolitics of the Global Energy Transition*, 341–64. Cham: Springer.
- PELOPIDAS, B. 2011. "The Oracles of Proliferation: How Experts Maintain a Biased Historical Reading That Limits Policy Innovation." *The Nonproliferation Review* 18 (1): 297–314.
- . 2016. "Nuclear Weapons Scholarship as a Case of Self-Censorship in Security Studies." *Journal of Global Security Studies* 1 (4): 326–36.
- . 2022. *Repenser les Choix Nucléaires*. Paris: Sciences Po University Press.
- PELOPIDAS, B., AND K. EGGLEND 2024. "The False Promise of Nuclear Risk Reduction." *International Affairs* 100 (1): 345–60.
- PELOPIDAS, B., AND S.C.J. VERSCHUREN 2023. "Writing IR after COVID-19." *Global Studies Quarterly* 3 (1): 1–12.
- PEOPLES, C. 2016. "Redemption and Ntopia: the Scope of Nuclear Critique in International Studies." *Millennium: Journal of International Studies* 44 (2): 216–35.
- PETTYJOHN, S., AND J. MATUSCHAK 2022. *Long Shadows: Deterrence in a Multipolar Nuclear Age*. Washington, DC: Center for a New American Security.
- POAST, P. 2022. "A World of Power and Fear." *Foreign Affairs*. Accessed June 14, 2024. <https://www.foreignaffairs.com/articles/ukraine/2022-06-15/world-power-and-fear>
- POTTER, W.C. 1995. *The Politics of Nuclear Renunciation*. Washington, DC: Henry L. Stimson Center.
- POTTER, W.C., AND G. MUKHATZANOVA 2008. "Divining Nuclear Intentions: a Review Essay." *International Security* 33 (1): 139–69.
- POWELL, R. 1990. *Nuclear Deterrence Theory: the Search for Credibility*. Cambridge: Cambridge University Press.
- . 1993. "Guns, Butter, and Anarchy." *American Political Science Review* 87 (1): 115–32.
- PRIEBE, M., K. GUNNESS, K.P. MUELLER, AND Z. BURDETTE 2022. *The Limits of Restraint*. Santa Monica: RAND Corporation.
- PRÄGER, F., C. BREYER, H.-J. FELL, C. HIRSCHHAUSEN, C. KEMPFFERT, B. STEIGERWALD, AND T. TRABER et al. 2024. "Evaluating Nuclear Power's Suitability for Climate Change Mitigation." *Frontiers in Environmental Economics* 3 (1): 1–10.
- RACHMAN, G. 2008. "And Now for a World Government." *Financial Times*. Accessed June 14, 2024. <https://www.ft.com/content/7a03e5b6-c541-11dd-b516-000077b07658>
- RAJAEIFAR, M.A., O. BELCHER, S. PARKINSON, B. NEIMARK, D. WEIR, K. ASHWORTH, AND R. LARBI et al. 2022. "Decarbonize the Military—Mandate Emissions Reporting." *Nature* 611 (November): 29–32.
- RAJAGOPALAN, R.P. 2021. "Asian Military Spending: a Sign of Worsening Security Environment." *The Diplomat*. Accessed June 14, 2024. <https://thediplomat.com/2021/03/asian-military-spending-a-sign-of-worsening-security-environment/>
- RAWTANI, D., G. GUPTA, N. KHATRI, P.K. RAO, AND C.M. HUSSAIN 2022. "Environmental Damages due to War in Ukraine: a Perspective." *Science of the Total Environment* 850 (157932): 1–7.
- RAY, A. 2020. "Forecast of Chinese SSBN Force Levels." *Maritime Affairs* 15 (2): 44–58.

- REIF, K., AND A. SANDERS-ZAKRE 2020. "Modernization as a Detriment to International Security." In *Nuclear Modernization in the 21st Century*, edited by A Warren and P M. Baxter, 145–72. London: Routledge.
- RITCHIE, N. 2016. "Nuclear Identities and Scottish Independence." *The Nonproliferation Review* 23 (5–6): 653–75.
- . 2019. "A Hegemonic Nuclear Order: Understanding the Ban Treaty and the Power Politics of Nuclear Weapons." *Contemporary Security Policy* 40 (4): 409–34.
- ROBERTS, B. 2015. *The Case for U.S. Nuclear Weapons in the 21st Century*. Stanford: Stanford University Press.
- ROMANOVA, T. 2018. "Russia's Neorevisionist Challenge to the Liberal International Order." *The International Spectator* 53 (1): 76–91.
- RUST, S. 2019. "How the U.S. Betrayed the Marshall Islands, Kindling the Next Nuclear Disaster." *Los Angeles Times*. Accessed June 14, 2024. <https://www.latimes.com/projects/marshall-islands-nuclear-testing-sea-level-rise/>
- S. Sagan and V. Narangeds. 2023. *The Fragile Balance of Terror: Deterrence in the New Nuclear Age*. Ithaca: Cornell University Press.
- SCHEFFRAN, J., J. BURROUGHS, A. LEIDREITER, R. VAN RIET, AND A. WARE 2016. *The Climate-Nuclear Nexus: Exploring Linkages between Climate Change and Nuclear Threats*. Hamburg: World Future Council.
- SHELL, J. 2007. *The Seventh Decade: The New Shape of Nuclear Danger*. New York: Metropolitan Books.
- SCHMID, S. 2019. "A New 'Nuclear Normalcy'?" *Journal of International Political Theory* 15 (3): 297–315.
- SCHNEIDER, M., A. FROGGATT, J. HAZEMANN, C. HIRSCHHAUSEN, M.V. RAMANA, A.J. WIMMERS, AND M. SAILER et al. 2022. *World Nuclear Industry Status Report 2022* Paris: Mycle Schneider Consulting.
- SECRETARIAT OF THE WORLD METEOROLOGICAL ORGANIZATION. 1988. "Conference Statement – The Changing Atmosphere: Implications for Global Security." Toronto, June 30. <https://digitallibrary.un.org/record/106359?ln=en&v=pdf>
- SELBY, 2022. "International/Inter-Carbonic Relations." *International Relations* 36 (3): 329–57.
- SERGUNIN, A., AND V. KONYCHEV 2017. "Russian Military Strategies in the Arctic: Change or Continuity?" *European Security* 26 (2): 171–89.
- SETO, K.C., S.J. DAVIS, R.B. MITCHELL, E.C. STOKES, G. UNRUTH, AND D. ÜRGE-VORSATZ 2016. "Carbon Lock-In: Types, Causes, and Policy Implications." *Annual Review of Environment and Resources* 41: 425–52.
- SKUKLA, P.R., J. SKEA, R. SLADE, R. FRADERA, M. PATHAK, A. AL KHOUDAJIE, AND M. BELKACEMI et al. 2022. *Climate Change 2022 – Mitigation of Climate Change: Working Group III Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* Geneva: Intergovernmental Panel on Climate Change.
- STEIN, J.G. 2013. "Threat Perception in International Relations." In *The Oxford Handbook of Political Psychology*, edited by L. Huddy, D.O. Sears and J.S. Levy, 364–94. Oxford: Oxford University Press.
- STELLA, T., AND C. CRAIG 2022. "Is International Cooperation Possible?" *Washington Post*. Accessed June 14, 2024. <https://www.washingtonpost.com/outlook/2022/04/18/is-international-cooperation-possible/>
- SUPREME ALLIED COMMAND TRANSFORMATION. 2021. *Regional Perspectives Report on Russia: Strategic Foresight Analysis*. Norfolk: North Atlantic Treaty Organization.
- SUTTER, J.D. 2015. "You're Making this Island Disappear." Accessed Jun 14, 2024. <https://edition.cnn.com/interactive/2015/06/opinions/sutter-two-degrees-marshall-islands/>
- SWAINE, M., AND A. BACEVICH 2023. *A Restraint Approach to U.S.–China Relations*. Washington, DC: Quincy Institute for Responsible Statecraft.
- TALMADGE, C. 2019. *The US–China Nuclear Relationship: Why Competition Is Likely to Intensify*. Washington, DC: Brookings.
- THE MOSCOW TIMES. 2021. "Wildfires near Russia's Nuclear Research Center Spark State of Emergency." Accessed June 14, 2024. <https://www.themoscowtimes.com/2021/08/24/the-kremlin-is-coming-for-media-one-by-one-and-society-is-helpless-to-stop-it-a74879>
- TOON, O.B., A. ROBOCK, M. MILLS, L. XIA, AND C. BARDEEN 2018. "Climatic Consequences and Agricultural Impacts of Nuclear Conflicts." In *Global Change and Future Earth*, edited by T Beer, J Li and K Alverson, 328–40. Cambridge: Cambridge University Press.
- TOOZE, A. 2021. "America's Race to Net Zero." *New Statesman*. Accessed June 14, 2024. <https://www.newstatesman.com/world/2021/04/america-s-race-net-zero>
- TURCSÁNYI, R.Q. 2018. *Chinese Assertiveness in the South China Sea*. Cham: Springer.
- TÄNNSJÖ, T. 2023. *From Despotism to Democracy: How a World Government Can Save Humanity*. Cham: Springer.
- UNFOLD ZERO. 2021. "The UN and the Climate–Nuclear Disarmament Nexus." Accessed June 14, 2024. <https://www.pnnd.org/event/united-nations-and-climate-nuclear-disarmament-nexus>
- UNITED STATES DEPARTMENT OF ENERGY. 2023. "At COP28, Countries Launch Declaration to Triple Nuclear Energy Capacity by 2050." Accessed June 18, 2024.

- VAN MUNSTER, R., AND C. SYLVEST 2014. "Reclaiming Nuclear Politics? Nuclear Realism, the H-bomb and Globality." *Security Dialogue* 45 (6): 530–47.
- . 2016. *Nuclear Realism: Global Political Thought during the Thermonuclear Revolution*. Abingdon: Routledge.
- VAN WYK, JO.-A., AND A.-M. VAN WYK 2020. *The African National Congress and Apartheid South Africa's Nuclear Weapons Program*. Washington, DC: Woodrow Wilson International Center for Scholars.
- VAUGHAN, T. 2024. "Post-Nuclear Worldmaking and Counter-Hegemony." *European Journal of International Security*, 9 (3) : 320–339
- VICENTE, A. 2023. "The Future of the Nuclear Nonproliferation and Disarmament Regime." In *Russia's War on Ukraine: The Implications for the Global Nuclear Order*, edited by A. Vicente, P. Sinovets and J. Theron., 153–70. Cham: Springer.
- WALKER, W. 2012. *A Perpetual Menace: Nuclear Weapons and International Order*. London: Routledge.
- . 2018. "Managing, Reconciling, and Manipulating the Deterrence and Disarmament Norms: the Case of the United Kingdom." *Contemporary Security Policy* 39 (3): 419–40.
- WALT, S. 2021. "The Realist Guide to Solving Climate Change." *Foreign Policy*. Accessed June 19, 2024. <https://foreignpolicy.com/2021/08/13/realist-guide-to-solving-climate-change/>
- WEART, S.R. 2012. *The Rise of Nuclear Fear*. Cambridge: Harvard University Press.
- WELSBY, D., J. PRICE, S. PYE, AND P. EKINS 2021. "Unextractable Fossil Fuels in a 1.5°C World." *Nature* 597 (7875): 230–40.
- WENDT, A. 1995. "Constructing International Politics." *International Security* 20 (1): 71–81.
- . 2003. "Why a World State Is Inevitable." *European Journal of International Relations* 9 (4): 491–542.
- WERTHEIM, S. 2020. "The Price of Primacy: Why America Shouldn't Dominate the World." *Foreign Affairs* 99 (2): 19–29.
- WILLIAMS, H., K. HARTIGAN, L. MACKENZIE, R. SOOFER, T. KARAKO, AND F. MILLER 2023. *Project Atom 2023*. Washington, DC: Center for Strategic and International Studies.
- WILLIAMS, H., K. HARTIGAN, J. RODGERS, AND R. YOUNIS 2023. *Alternative Nuclear Futures*. Washington, DC: Center for Strategic and International Studies.
- WOLF, K., AND P. THEUNISSEN 2023. "One Voice or Multi-Issue Movement?" *Public Relations Review* 49 (1): 1–8.
- WRIGHT, T. 2018. "The Free-World Strategy Progressives Need." In *Texas National Security Review – Policy Roundtable: The Future of Progressive Foreign Policy*, editors J. Van, 41–52. December 4.
- WROE, D. 2016. "Chinese Bomber Planes from South China Sea and Future Missiles Could Threaten Australia." *The Sydney Morning Herald*. Accessed June 19, 2024. <https://www.smh.com.au/politics/federal/chinese-bomber-planes-from-south-china-sea-and-future-missiles-could-threaten-australia-20160902-gr75yf.html>
- XIA, L., A. ROBOCK, K. SCHERRER, C.S. HARRISON, B.L. BODIRSKY, I. WEINDL, AND J. JÄGERMEYR et al. 2022. "Global Food Insecurity and Famine from Reduced Crop, Marine Fishery and Livestock Production due to Climate Disruption from Nuclear War Soot Injection." *Nature Food* 3 (August): 586–96.
- ZACHARIAH, M., T. ARULALAN, K. ACHUTARAO, F. SAEED, R. JHA, M.K. DHASMANA, AND A. MONDAL et al. 2022. "Climate Change Made Devastating Early Heat in India and Pakistan 30 Times More Likely." *World Weather Attribution*. Accessed June 14, 2024. <https://www.worldweatherattribution.org/climate-change-made-devastating-early-heat-in-india-and-pakistan-30-times-more-likely/>
- ZIEGLER, C.E. 2020. "A Crisis of Diverging Perspectives: U.S.–Russian Relations and the Security Dilemma." *Texas National Security Review* 4 (1): 12–34.
- ZWALD, Z. 2013. "Imaginary Nuclear Conflicts: Explaining Deterrence Policy Preference Formation." *Security Studies* 22 (4): 640–71.