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Environmental Peacebuilding and Solar Geoengineering

*Holly Jean Buck**

Department of Environment and Sustainability, University at Buffalo, Buffalo, NY, United States

Solar geoengineering, or reflecting incoming sunlight to cool the planet, has been viewed by international relations and governance scholars as an approach that could exacerbate conflict. It has not been examined through the framework of environmental peacebuilding, which examines how and when environmental challenges can lead to cooperation rather than conflict. This article argues that scholars should treat the link between solar geoengineering and conflict as a hypothesis rather than a given, and evenly examine both hypotheses: that solar geoengineering could lead to conflict, and that it could lead to peace. The article examines scenarios in which geoengineering may lead to negative peace—peace defined as the absence of conflict—and then applies a theoretical framework developed by environmental peacebuilding scholars to look at how solar geoengineering could relate to three trajectories of environmental peacebuilding. A peace lens for solar geoengineering matters for research and policy right now, because focusing narrowly on conflict in both research and policy might miss opportunities to understand and further scenarios for environmental peacebuilding. The paper concludes with suggestions for how research program managers, funders, and policymakers could incorporate environmental peacebuilding aims into their work.

Keywords: environmental peacebuilding, solar geoengineering, solar radiation management, cooperation, climate change, peace, conflict

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Edited by:
Pablo Suarez,
Red Cross Red Crescent Climate Centre, Netherlands

Reviewed by:
Shinichiro Asayama,
National Institute for Environmental Studies (NIES), Japan

***Correspondence:**
Holly Jean Buck
hbuck2@buffalo.edu

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INTRODUCTION

When can shared environmental challenges be a source of cooperation, rather than conflict? The question is at the heart of environmental peacebuilding, a framework that looks at how management of environmental issues and cooperation around mutual interest in resources can support conflict prevention, mitigation, resolution and recovery. The literature around environmental peacebuilding emerged in the early 2000s, partly as a reaction to the narrow focus of scarcity- and conflict-centered environmental security literature (Ide et al., 2021a) and the way that literature treated resource scarcity as a cause of conflict (Dresse et al., 2019).

While the environmental security literature has moved on somewhat from a focus on scarcity and conflict, when it comes to the narrow topic of solar geoengineering, treatment from international relations and related fields has remained centered on its potential to cause or exacerbate conflict. Solar geoengineering involves reflecting some amount of incoming sunlight into space to cool the planet at a global scale; the most researched concept for doing so is stratospheric aerosol injections. A decade of analysis of the strategic and security dimensions of solar geoengineering has regarded it as an emergent threat to be contained and failed to consider the potential role of solar geoengineering in environmental peacebuilding. A simple search for "geoengineering" + "conflict" in Web of Science returns over fifty papers; "geoengineering" + "peace" returns zero.

This focus on conflict and absence of thinking about peace has implications for solar geoengineering research and policy. In this paper, I will (1) briefly introduce the way the literature has treated the governance and social dimensions of solar geoengineering through a conflict lens; (2) discuss the likelihood that solar geoengineering leads to what peace scholars refer to as "negative peace", (3) use a theoretical framework for environmental peacebuilding to examine possible ways solar geoengineering could contribute to peacebuilding, and (4) conclude with thoughts on why a peace lens matters for solar geoengineering research and policy right now.

BACKGROUND: SOLAR GEOENGINEERING THROUGH THE LENS OF CONFLICT

One stream of analysis of solar geoengineering places it within a history of the Cold War (Scheffran, 2019) as well as military involvement with weather modification, such as the monsoonal cloud seeding by the U.S. military during the Vietnam War (Fleming, 2010). This led to the 1978 Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques, an international treaty that bans modification of the environment for hostile purposes. There is also an argument that since solar geoengineering would probably be done by militaries (or at least military-linked contractors that could design aircraft for the purpose, as well as military bases), it would already be done according to "militarized logics" (Surprise, 2020). Geoengineering may also further securitize climate politics (Nightingale and Cairns, 2014; Corry, 2017). Another line of inquiry focuses on "counter-geoengineering" interventions. This research explores whether solar geoengineering could spark conflicting interventions by countries wanting different temperatures, and seeks to understand free-driver effects—when uncoordinated unilateral actions result in more geoengineering than is optimal (Parker et al., 2018; Heyen et al., 2019; Abatayo et al., 2020; Bas and Mahajan, 2020).

Recent studies using scenario methods explore more creative deployment options—geoengineering springing from a demand by vulnerable states (Schenuit et al., 2021), or scenarios that involve the private sector or decentralized grassroots groups as actors (Parson and Reynolds, 2021). Yet in general, these studies also emphasize the geopolitical risks of solar geoengineering, rather than geopolitical opportunities. One notable exception to this trend is a working paper by Masahiro Sugiyama, who recommends investigation on the potential of solar geoengineering to lessen conflict (Sugiyama, 2021). Research on idealized uses of solar geoengineering found that solar geoengineering substantially improves climatic conditions, and a moderate use of solar geoengineering can reduce physical and economic damages from climate change (Irvine et al., 2019); as Sugiyama deduces, moderate use could reduce the chance exacerbating of intra-state armed conflicts (Sugiyama, 2021). Another exception to the threat-heavy literature is an analysis by Lockyer and Symons, who explore the idea that a group of Indo-Pacific middle powers, such as Japan, Indonesia, India and Australia, could emerge as a force advocating for cooperative governance of solar geoengineering as they seek to minimize friction between the US and China (Lockyer and Symons, 2019). They point out that geoengineering that could slow sea level rise would consequently reduce security threats arising from displaced peoples, as well as the loss of defense properties and assets vulnerable to sea level rise. Still, even this paper spends more time on the prospects of solar geoengineering as a flashpoint in great power rivalry (Lockyer and Symons, 2019).

What are the effects of understanding solar geoengineering as a security threat or flashpoint for conflict? Viewing solar geoengineering as a threat could lead to avoiding research on it; the potential role in conflict has been cited as an argument against research. Even "unilateral, preemptive" research on geoengineering is seen to risk exacerbating international conflict by some analysts (Stephens et al., 2021a), with specific concern that U.S. research on solar geoengineering would increase securitization and the potential for militarization, citing this as one reason why the U.S. should not engage in research (Stephens et al., 2021b). Treating solar geoengineering it as a source of conflict could also make it more likely to lead to conflict, though conversely, it is also possible that treating solar geoengineering as a threat would avoid conflict. For example, the nuclear peace hypothesis suggests that nuclear weapons can in some instances prevent direct conflict, as they impose an existential threat that could prevent direct war. In a similar way, the global threat of solar geoengineering deployment could bring nations into dialogue and facilitate cooperation on climate change. The important point here is that in either case, the framing is performative—meaning that the frame shapes action in the real world. How solar geoengineering is talked about shapes what society chooses to know and not know today; it may also shape the sort of governance we choose for geoengineering, which in turn may shape its outcomes.

Hence, it matters that the empirical basis for the conflict frame is weak. Given the literature's emphasis on solar geoengineering as threat, it may seem clear that research on solar geoengineering risks conflict. However, the aforementioned literature has not considered the alternative. It is also highly speculative; the analysis doesn't provide much empirical evidence to suggest that geoengineering would in fact be a driver of violent conflict. Part of this is the nature of studying future events. As scholars, we should treat the idea of solar geoengineering leading to conflict as a hypothesis, and evenly consider an alternative hypothesis as well—that solar geoengineering could contribute to peace. We should also consider what sort of peace that would be.

SOLAR GEOENGINEERING AND NEGATIVE PEACE

Peace scholars distinguish between "positive" peace— peace along with desirable states like harmony and equity, tranquility —and "negative" peace, featuring the absence of war and large-scale violent conflict, or an absence of active rivalry (Galtung, 1969). Scholars and practitioners also distinguish

peacebuilding from peacemaking and peacekeeping as three approaches to peace. Peacekeeping involves field deployments that work to prevent conflict and make peace. Peacemaking is generally defined as action to bring hostile parties into agreement, and might involve diplomatic negotiations and agreements. Peacebuilding, on the other hand, is about addressing the roots of structural violence, and shifting the relationships between parties (Dresse et al., 2019). Peacebuilding might involve a broader set of actions, then. *Environmental* peacebuilding has to do with how managing environmental issues is integrated in conflict prevision, mitigation, resolution, and recovery; it works along dimensions of security, livelihoods, and politics and social relations (Ide et al., 2021a). This latter politics dimension of environmental peacebuilding activities, i.e., identifying how shared environmental challenges are entry points for cooperation, can overlap with environmental peacemaking.

Solar geoengineering might have a role in peacemaking, in terms of negative peace, and there are many ways this might play out. The simplest is perhaps that climate impacts play a role in conflict; lessening these impacts could lessen conflict. Like with the evidence suggesting solar geoengineering would lead to conflict, the evidence here is speculative, in part because of the state of the research on climate and conflict more generally. The climate-conflict literature has divergent findings and disagreement (Mach and Kraan, 2021), and finds indirect mechanisms for climate conditions and conflict-related outcomes, not straightforward direct linkages (von Uexkull and Buhaug, 2021). Current study of climate and conflict focuses not upon deterministic impacts, but on causal pathways and mediating factors, like agricultural production and food prices, economic growth, migration, disasters, and international and domestic institutions (Busby, 2019). At the same time, indirect linkages are acknowledged. The IPCC (AR5, WGII) summarizes that "climate change can indirectly increase risks of violent conflicts by amplifying well-documented drivers of these conflicts such as poverty and economic shocks (*medium confidence*)", with "justifiable common concern that climate change or changes in climate variability increase the risk of armed conflict in certain circumstances," even if the strength of the effect is uncertain (IPCC, 2014).

Solar geoengineering would act on some of these indirect relationships between climate impacts and conflict. Analysts studying climate and security are concerned about the prospect of conflict related to Himalayan glacier melt, the correlation between floods and political unrest (Ide et al., 2021b), the association between heat and violence (Hsiang Solomon et al., 2013), and links between agricultural production and instability. Solar geoengineering could offset some of the effects of increasing GHGs on global and regional climate—i.e., it could substantially offset temperature rise and partially offset other impacts of global warming, according to modeling research (IPCC, 2021). The IPCC cautions that there are substantial regional and seasonal variations to these offsetting effects, and uncertainties around aerosol-cloud-radiation interactions. Yet, as described in AR6 WGI, it has the potential to offset the melting of Arctic sea ice and mountain glaciers and changes in extremes of temperature and precipitation; other research suggests that climate engineering could reduce heat and could possibly benefit crop yields (Fan et al., 2021). Simply put, solar geoengineering can act on factors associated with conflict, though all these relationships are complicated, and mediated by social and governance factors.

Solar geoengineering may also be a part of negative peace in a scenario where geoengineering is used to preserve internal stability—speculatively, one might think of China, or a Gulf state dealing with extreme heat on top of political crises, but a divided country like U.S. might also find utility in this. Preserving internal peace does not need to be an authoritarian gesture; it could also arise a demand from parts of civil society who want the state to protect them from risks. This may grow to encompass more climate-related risks as climate change worsens, and constituents on various sides of the political spectrum could formulate demands for it. Solar geoengineering might be seen as a way to limit unwanted climate migration, deal with within-country conflict over water use, maintain agricultural systems, and more. This demand could spring from how political problems are framed. Climate change may bring cascading effects that shape conflict risks—where populations are subject to compound effects from as sea level rise, depressed agriculture output, increasing hazards, and increasing migration flows (von Uexkull and Buhaug, 2021). If these lead to instability, governments may have an incentive to portray this instability as strongly climate-driven, even though it will likely have a mix of political drivers. The focus on climate invites climate-targeted measures, and solar geoengineering is performative and rapid-acting compared to many measures to address climate change.

Another possible role for solar geoengineering in negative peace is that of bringing parties to agreement should there be conflict over fossil fuel phaseout. The uneven geographies of fossil fuel phaseout, and the potential for conflict related to phaseout, have not been adequately studied. Certainly, renewable energy has abundant and replenishable sources, leading to less oligopolistic global markets (Scholten et al., 2020); however, there are security risks in terms of cybersecurity and critical materials (Vakulchuk et al., 2020). A zero carbon world produces different zero sum games, and the pace of change matters (Goldthau et al., 2019). The geopolitics of phaseout may favor the US and EU, with wide access to renewable technologies, diverse economies, and money to transition hard-to-abate sectors. Producer countries, on the other hand, have a lot to lose in phaseout. So far, climate policy has largely approached the problem as one of cutting emissions, conceptualizing the carbon space or the climate as the resource, with parties coming to a shared arrangement for using it. But if we approach the essential problem here as one of fossil fuel phaseout, rather than cutting emissions, it makes the entrance for solar geoengineering even more clear. The leading model for how to do solar geoengineering, in its best case form, is a "buying time" model: it would employ solar geoengineering to buy time for decarbonization and carbon removal, as a temporary program that ramps up to reduce climate impacts during the transition, and then ramps down again over a century or so. However, underlying the buying time argument for solar geo is the question of *for whom* this time is bought—and one answer is, not for "the world" to decarbonize, but for producer nations to phase down operations more gradually. To

be absolutely clear, I am not recommending this as a fair or good scenario; I am observing that solar geoengineering as a part of phasedown negotiations seems like one obvious use case for solar geoengineering, and therefore we should study its implications.

Negative peace, in the above scenarios, is obviously not an unqualified good thing. Peace could be pacifying critics, or appeasement of fossil fuel producing regimes. What of positive peace? Positive peace is related to concepts of harmony, justice, and well-being, as well as building social justice; egalitarian distribution of power and resources. Are we likely to achieve positive peace in a world reeling from climate change? By lessening some climate impacts, might solar geoengineering enable positive peace? One theoretical framework for environmental peacebuilding offers some insight into how solar geoengineering could move in the direction of positive peace.

TRAJECTORIES OF ENVIRONMENTAL PEACEBUILDING

Environmental peacebuilding has been of interest for a few decades now, but it has been hard to demonstrate causal linkages between environmental cooperation and peace; empirical data for an environmental-peace nexus is limited; and the literature has been made up of mostly isolated case studies or small-n cross-country comparisons; all this has left environmental peacebuilding as an umbrella term rather than a coherent theoretical framework (Dresse et al., 2019). To address this gap, Dresse et al. (2019) describe three main building blocks of environmental peacebuilding: (1) the *initial conditions* under which environmental peacebuilding efforts unfold, (2) the *mechanisms* (activities and implementation modalities), and (3) *outcomes*, which can be direct or indirect. The authors then use these three building blocks to sketch out three generic trajectories of environmental peacebuilding: technical environmental peacebuilding, restorative peacebuilding, and sustainable environmental peacebuilding. Importantly, these trajectories are related.

Technical environmental peacebuilding aims to reduce environmental scarcity and degradation through coordinated technical solutions. Solar geoengineering could clearly fit in here, in terms of having coordinated action between parties highlight the benefits of cooperation and coordinated responses to common environmental challenges, as Dresse et al. (2019) describe. The authors also caution, however, that top-down technical environmental cooperation without local communities can risk missing needs on the ground and reconciling actors at different scales—a risk that is central to solar geoengineering.

Restorative environmental peacebuilding involves creating shared spaces to acknowledge past injustices. Through the recognition of the interdependency created by the biophysical environment, environmental issues present an opportunity to create shared spaces for dialogue that can change behaviors and perceptions (Dresse et al., 2019). This seems far more distant from solar geoengineering, which despite many discussions of what would constitute meaningful public engagement (Frumhoff and Stephens, 2018), has not involved public engagement that recognizes past injustices or power relations and has tended to be instrumental (McLaren and Corry, 2021b). However, deliberative governance of geoengineering may foster conversations in which historical responsibility, burden-sharing, and climate colonialism emerge—early experiments in deliberation have revealed that participants want to talk about justice, and if these were institutionalized as part of governance, it would be powerful. Perhaps a proposed resolution at the UN Environmental Assembly for UNEP to assess solar geoengineering science and governance frameworks (Jinnah and Nicholson, 2019) could also be a starting point for bridging technical and restorative environmental peacebuilding, if it could use the "world-making power" these assessments embody to bring conflicts and power relations into the open and respond to international inequalities (McLaren and Corry, 2021a).

Sustainable environmental peacebuilding has a focus on equitable resource distribution and common-pool resource management. Under symmetrical power relations, there can be joint management systems when parties transfer a part of their influence to the collective to achieve a public good (Dresse et al., 2019, p. 110). In this case of solar geoengineering, we can think about building a collective to manage solar radiation and influence the climate, a common-pool resource. Clearly, there is no power symmetry at present, and so this seems even more distant that restorative environmental peacebuilding. However, what Dresse et al. suggest is that these generic trajectories can trickle down from technical toward sustainable environmental peacebuilding; spillover effects may move from limited forms of technical cooperation toward dialogue and collective action. They talk about spillover effects across political borders, sectors, and scales, e.g., from high-level interactions to the community scale. The initial conditions can move, then, from mutual interests in technical environmental peacebuilding, to shared values in restorative environmental peacebuilding, to power symmetry in sustainable environmental peacebuilding. Obviously, this is not a linear process. But this framework shows us a route that can be taken with environmental challenges, and a means through which cooperation on technical solutions can move toward more desirable forms of peace.

WHY A PEACE LENS MATTERS TO RESEARCH AND POLICY RIGHT NOW

Thinking about solar geoengineering as a means of environmental peacebuilding is not just a speculative exercise. It has implications for research and policy right now. Táíwò and Talati caution that "Global North domination of SG is not inevitable, and arguments that portray Northern dominance as inevitable can, paradoxically, help create the political reality that they warn us about" (Táíwò and Talati, 2021). Similarly, if public institutions back away from research, e.g., because of perceptions that solar geoengineering is inevitably a threat, we risk moving research into military spheres where it may in fact be more securitized.

There are alternatives to treating solar geoengineering only as a threat. First, scientists and funders should be incorporating the possibility of environmental peacebuilding into scientific research, especially publicly funded research. For both modelers and policy scholars, more research is needed on nonideal scenarios—scenarios where solar geoengineering is deployed not according to abstract ideas, but in specific arrangements that may be negotiated by particular actors. These scenarios can explore a range of outcomes, from positive peace to negative peace to conflict, as well as what Mark Leonard has called "unpeace", a gray zone which is not conventional war, but has small-scale conflicts (Leonard, 2021). Key to this liminal zone between war and peace is connectivity, in Leonard's conception; connections between nations and groups become political weapons, with "connectivity conflicts" replacing wars. This is but one example of how researchers could use a wider range of concepts from political science and other social science disciplines to move beyond simple assumptions of states of peace and conflict, and consider the implications of these for both geoengineering research and governance.

Second, policy practitioners can at least think about what a peace-centered approach to solar geoengineering governance would involve. If we think in terms of technical environmental peacebuilding, scientific cooperation on research would be key to peace-centered governance, and it needs to be truly international. There are a number of international bodies that could further cooperation, from the World Meteorological Organization to the United Nations Environmental Program (UNEP). More ambitiously, global research centers co-funded by nations, international organizations, and foundations could be set up for international scientific cooperation on solar geoengineering. These could be modeled on the CGIAR centers, a group of fifteen research centers that was set up in the 1970s to study international agriculture. While the centers could be critiqued for focusing on commodity crops rather than fruits and vegetables, they have produced international public goods as well as helped build national research capacities (Thornton et al., 2022). Another international research center was IIASA, the International Institute of Applied Systems Analysis, which was established jointly by the United States and Soviet Union in Austria in 1972, and focused on solving global problems with systems-based approaches; as political sociologist Egle Rindzeviciute shows, this east-west cooperation helped develop global governance as an intellectual and socio-technical project (Rindzeviciute, 2016). The model of international research centers, if applied to climate response, could involve producing regional knowledge on mitigation, adaptation, carbon removal, and solar geoengineering as well. Regionally produced scholarship that reflects regional and local characteristics (Delina, 2020) is critical, and funding international research centers would be one institutional way to support this.

Moving forward with a peace-centered approach will not be easy. International cooperation on research is no panacea, but technical environmental peacebuilding may be a starting place, and setting up cooperative research infrastructure is an obvious first step. Following that, however, the political conditions required for a peace-centered approach to solar geoengineering governance include a shared understanding of climate change as a threat, as well as a shared understanding of the trajectory of decarbonization, including relative consensus on the phaseout of fossil fuels and mitigating emissions from the land sector. Even with the framework of the Paris Agreement and wide adoption of net-zero targets, progress on the ground is too limited, the future of fossil fuels is left underspecified, and protections for land and ecosystems are inadequate.

Solar geoengineering will continue to be controversial under this status quo, and this will pose difficulties for effective governance of solar geoengineering, including cooperation and environmental peacebuilding related to it. There is debate about the governability of solar geoengineering in general (Hulme, 2014; Reynolds, 2021); some analysts dismiss solar geoengineering as ungovernable within the current international system due to power imbalances in the global system and the institutional weaknesses of multilateral institutions, arguing that the topic would require new international organizations with unprecedented enforcement powers and means of democratic control (Biermann et al., 2022). However, one could argue the same thing about decarbonization itself, which seems to also require new international organizations with unprecedented enforcement powers and means of democratic control. International institutions are either nonexistent or straining to effectively deal with matters like the phaseout of fossil fuels; enforcement regulations pertaining to HFCs, methane, and other pollutants; effective protection of oceans and ecosystems; transformative adaptation; climate-linked migration and managed retreat; ocean acidification; effective mechanisms for monitoring carbon and linking greenhouse gas emissions and carbon removals; and more. The need for new and better governance is not unique to solar geoengineering, which is just one of many wicked problems that will require innovation in governance. If societies can develop the governance to effectively begin to confront these dimensions of climate change, it is probable that these same relationships, trust, and institutions can help with the governance of solar geoengineering. Why would a world with working governance for decarbonization and adaptation even need to consider solar geoengineering? One can imagine a world that is late to mitigation, and has started taking some action, but is still headed for 2.5°C or 2°C of warming, and has judged that a moderate amount of solar geoengineering to bring temperatures down by half a degree would have important humanitarian implications. Scenarios of peaceful cooperation, such as this, deserve to be studied and considered alongside others.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article, further inquiries can be directed to the corresponding author/s.

AUTHOR CONTRIBUTIONS

The author confirms being the sole contributor of this work and has approved it for publication.

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