Ethical issues arising in research into health and climate change

Kuala Lumpur, 19 & 20 November 2024

Global Forum on Bioethics in Research

Ethics and governance of solar geoengineering research: a bioethical analysis of the SCoPEx small outdoor experiment

Ignacio Mastroleo (ignaciomastro@gmail.com), María Inés Carabajal, Timothy Daly & The FLACSO Argentina Climate Innovation Research Group[1]

Brief description of context

The use of stratospheric aerosol injection (SAI), a type of solar geoengineering (SG), is proposed as a response to accelerating warming (UNEP 2023a) to cool the planet within years. The SCoPEX small outdoor experiment is an exemplary case of SAI and it will guide us through our bioethical analysis of the research and potential planetary deployment of such technology.

1. Introduction: global warming, planetary climate engineering and caution

Large-scale interventions in the climate system that involve solar radiation modification (SRM), popularly referred to as "solar geoengineering" (SG) (Kigali 2023), are proposed by defenders as an experimental scientific intervention to curb accelerating global warming in case humanity fails to meet IPCC mitigation[2] targets of 1.5- 2°C above the 1850-1900 preindustrial average (COMEST 2023:13). Or even if it meets those targets, but the climate system turns out to be more sensitive (Wieners et al. 2023). However, detractors of planetary SRM consider it "ungovernable", a "technofix" or a "perfect excuse" for climate change deniers, industries, and governments seeking to avoid the political costs of carbon reductions and to continue "business as usual" (Geoengineering Monitor 2020). Moreover, SAI, the most feasible SRM intervention today (UNEP 2023b), remains controversial because of its current uncertainties and the disparity of its potential benefits and risks. Given the unjust structure of our global society and the costs of adaptation, climate change risks and harms, all else being equal, will be felt the heaviest by economically vulnerable populations within and between countries. Hence, if SAI were used to complement emission cuts (mitigation), adaptation, and carbon dioxide removal (another climate engineering application different to SRM), it might reduce both climate-related harms and equity-related injustices (Parson et al 2024). However, planetary SAI deployment will not resolve the mitigation problem and, by itself, will not change the unjust socio-political background that led us to the current situation. For example, model research suggest that planetary SAI might reduce health-related harms of temperature-attributable mortality by an average of 17 deaths per 100.000 per year per 1°C (Harding et al 2023)[3]. However, SAI also introduces new risks. Planetary deployment of SAI will cause changes in ozone, UV-B exposure and pollution exposure increasing net mortality by 0.3 deaths per 100.000 per year per 1°C (Harding et al 2023:11). This example compares two of the largest human mortality and health-related risks components of SAI vs. non-SAI scenario in a quantifiable way. More research is needed comparing other human population health risks but avoiding narrow bioethics (Ferguson 2020). For instance, if one of the highest potential benefits of planetary SAI is to reduce extreme events

[1] PI: Florencia Luna (FLACSO Argentina); Co-Leads: Inés Camilloni (UBA), Ignacio Mastroleo (FLACSO Argentina); researchers: Paola Buedo (FLACSO Argentina), María Inés Carabajal (UBA), Timothy Daly (FLACSO Argentina), Luis García Valiña (FLACSO Argentina), Santiago Truccone (Graz University), María Florencia Santi (FLACSO Argentina)

[2] Including carbon dioxide removal (CDR) interventions under research and not yet develop at scale (COMEST 2023).

[3] For context, this is around 2.1 and 1.4 percent of the 2019 and projected end-of-century global all-cause mortality rate, respectively (UN 2022)." (Harding et al 2013)

it will also reduce related human health risks including risk of domestic violence (related to more days of heat and humidity), risks related to water-, food- and vector-borne diseases (e.g. dengue), and risk of increased demand and impairment of health service. On the other hand, planetary deployment of SAI implies risks of sudden termination ("termination shock"), of international socio-political conflicts, significant alterations in rain patterns at the regional level (e.g. Asia) with associated water-, food- and health- related risks (e.g. cholera), and risk of anxiety because of changes in the color or dimness of the sky (Felgenhauer et al. 2022). Moreover, SAI or other SRM research may introduce inherent risks such as deterrence of mitigation policies ("moral hazard") (Biermann et al. 2022, Pamuk 2021), while not doing research may also deprive humanity of a potential intervention to responsibly face overshooting or climate emergency scenarios (UNEP 2023b).

2. SCoPEx small outdoor experiment: a case reconstruction

The Stratospheric Controlled Perturbation Experiment (SCoPEx) was a Harvard University sponsored, privately funded, small-scale outdoor experiment or field trial of SAI. It was first proposed in 2014, but Harvard convened a voluntary independent advisory committee (AC) in 2019 to develop a research governance framework for SCoPEx (Jinnah et al 2024). Researchers state that the main aim of the experiment was to learn more about the efficacy and safety of potential planetary SAI/SRM deployment and validate computer model and laboratory results. SCoPEx planned to use a balloon to lift an instrument package ("the gondola") 20 km into the atmosphere. The gondola released up to 2 kg of material in aerosol form (sulfur or calcium carbonate) to create a perturbed air mass and was then used to measure the resulting changes (Keutsch 2021, Jinnah et al 2024). There were no significant risks to people or the environment from the 2 kg of either the sulfate or calcium carbonate (Dykema et al 2014, Keutsch 2021).[4] Originally planned for launch in the US, COVID-19 made researchers move to Sweden because the Swedish Space Corporation had experience launching scientific balloons and had availability for summer 2021 (Keutsch 2021). The SCoPEx case was made famous because of the controversy between Harvard University, Swedish environmental organizations, and the Saami Council – an organization that represents the Sámi, a multi-national indigenous people of the Arctic region – that led to the cancelation in 2021 of a test flight that did not include particle release (Jinnah et al 2024). The controversy was associated with different visions about SRM research, deployment, funding and lack of previous community engagement (Risse 2023, Jinnah et al 2024). It is also important to consider the potential impact of a long history of regional eugenic health policies and discrimination against the Sámi (Danielsson 2020), as well as the active participation of anti-SRM groups (Keith 2024). In March 2024, Harvard announced the cancellation of SCoPEx, which would have been the first outdoor SAI perturbation experiment (Jinnah et al 2024, Temple 2024).

3. Discussion of ethical issues

3.1. What is an SRM experiment (research or deployment)? Sound ethics and governance should start from clear and neutral practical definitions (see Appendix, SRM experiment, Mastroleo & Holzer 2020, Mastroleo 2024). The term SRM experiment has multiple meanings. It is important to distinguish between research and deployment because they are not the same and have different risks, governance challenges, and appropriate responses (Parson et al. 2024). Because of its main aim and design, SCoPEx is an exemplary case of SAI perturbation research. This may have important consequences for SG governance, as exemplified by the ban on "SG experimentation" in Mexico (Biermann 2023) motivated by Make Sunsets, the US start-

[4] According to the SCoPEx FAQ, sulfate aerosol is one of the best-known materials because it already exists naturally in the stratosphere, the IPCC recognizing its cooling effect. Regarding, calcium carbonate it has a more promising risk-benefit profile than sulfates regarding ozone destruction but is not naturally in the stratosphere, although is abundantly in nature (limestone, chalk, eggshells, etc.) and used as a common additive in paper and toothpaste (Keutsch 2021).

up selling “cooling credits”, an exemplary case of small scale experimental deployment of SAI (see Appendix).

3.2. Are small outdoor SAI research ethically permissible? Moderate defenders of research on SRM argue that both accepting and rejecting SRM interventions might involve catastrophic and non-catastrophic risks (see section 1). Hence, they call for more interdisciplinary research on SRM to inform decision-making (Wieners et al 2023). Extreme detractors of SRM, such as the authors of the International Non-use Agreement on Solar Geoengineering (NUA), argue that there should be a total ban on use of SRM. This would include commitments to prohibit public funding of research on SRM; a ban on outdoor experiments of any scale; a refusal to grant patent rights; and a curtailment of discussion of SRM in international institutions, including IPCC (Biermann et al. 2022). In our analysis, we accept the consensus view of UNESCO that research on SRM is ethically permissible if conducted following sound ethical and governance regulations based on the broadest justice considerations (COMEST 2023:28, edited). This implies that cases such SCoPEx are in principle ethically permissible. In turn, we should distinguish research from small SAI deployment cases, such as Make Sunsets (see Appendix, and section 3.1 above).

3.3. Should low- and middle-income countries host small outdoor SAI research? Ethical consensus on permissible small-scale SAI outdoor research (COMEST 2023) does not solve issues about whether LMICs should host them, particularly when HICs (e.g. EU, US, UK) are the main developers of this technology and will be sustaining it for decades if implemented. LMICs may have both ethical and strategic reasons to host SAI small outdoor research (e.g. cooperation, mutual benefit) or to refuse it (e.g. avoid exploitation, unpreparedness).

3.4. Was there a lack of appropriate community engagement and research governance? There is a broad consensus that too much or too little public engagement is not appropriate and there should be something as a middle term. Different societies, contexts and SRM experimental interventions may require different types of public engagement (Rayner et al. 2013). Unlike SCoPEx, ethical principles (e.g. Williams et al 2024) and appropriate governance should be in place before starting any SAI small outdoor research, as part of a broader standardized or centralized ethics and governance of SRM research (Jinnah et al. 2024).

3.5. Are indigenous voices necessarily against SRM? It would be a mistake to reify Indigenous voices as anti-SRM-technology (Risse 2023) or consider non-Indigenous populations as not requiring more than bureaucratic engagement (Karlamangla 2024). Current anthropological research on Indigenous populations and SRM shows that they are not necessarily against planetary climate modification. However, they see this intervention as political.[5] It also warns us not to reify any view on acceptability of SRM into any individual or social group and not to oversimplify their behavior (Taddei 2024).[6]

3.6. What are democratic societies’ duty against misinformation on SRM? There is a scarcity of reliable information on SRM. Members of ETC, an anti-SRM group, have misrepresented key aspects of the SCoPEx case such as funding and intellectual property policy (e.g. Ribeiro 2024). A former SCoPEx researcher said the NY Times misattributed the authorship of the manifesto against SRM to the Sámi (Gelles 2024). He said ETC wrote it, with signatures from Indigenous organizations (Keith 2024). Democratic societies have a duty to protect themselves against misinformation and to be independent of the agendas of pro- or anti-SRM groups or individuals.

[5] “From an Indigenous perspective, we’re working to save a particular social and political order, not ‘the world’.” (Taddei 2024).
[6] “Individuals and groups behave in complex, multiple, and strategic ways. We need to be careful when assigning unidimensional identities linked to single attitudes. This does not characterize the richness of social life and individual and collective behavior” (Taddei 2024)

4. Conclusion

With global warming accelerating, SRM research may become a moral imperative (Lawrence & Crutzen 2017). If so, we should recall two cautionary lessons from The Sorcerer's Apprentice (Goethe 1797) about new technology. First, we should beware of any technology we research because we may not be able to control it. Second, to decide if we should attempt to use SRM at a planetary scale, we should first develop both sufficient knowledge and ethical character.

Appendix

Box 1. Glossary of key terms of climate engineering and abbreviations
Climate engineering; geoengineering: (i) umbrella terms referring to unproven or experimental socio-technical interventions that if deployed at appropriately scale have the capacity to intentionally modify the planetary climate surface, as opposed to as an unintended side effect (e.g. burning fossil fuels). Two exemplary types of socio-technical interventions with varying degrees of risks, uncertainties and governance challenges are solar radiation modification (SRM) and carbon dioxide removal (CDR) (COMEST 2023). These terms also refer to (ii) an activity that adds the standard climate actions portfolio of mitigation, adaptation, [and loss & damage] for addressing climate change threats (COMEST 2023:9).
Solar radiation modification (SRM); solar geoengineering (SG): SRM (technical term) and SG (popular term) are both umbrella terms referring to interventions with disparate risk-benefit and feasibility profiles that aim to modify the amount of solar radiation including augmenting the reflectivity of surfaces (albedo) (e.g. stratospheric aerosol injection (SAI), marine cloud brightening (MCB), etc.), effective solar constant (e.g. space-based mirrors) or effective emissivity of the atmosphere (e.g. cirrus cloud thinning (CCT)).
SCoPEx small outdoor[7] experiment[8]: Regarding its main aim and design**,** is an exemplary case of *SAI perturbation research* (as opposed to *SAI observational research*, e.g. observational study of Mount Pinatubo's eruption, or to *small SAI deployment*, Make Sunsets' cooling credit scheme). SCoPEx was originally proposed with the aim to reduce the uncertainty of possible unknown chemistry and/or represent the full range of interactive atmospheric chemical physics, as well as to complement laboratory research (e.g. chemical flow reactor) and climate model-based research on the efficacy and safety of SRM (Dykema et al 2014). Regarding its scale measured in time and radiative forcing, is considered "process study" (hours-days-weeks) and distinguished from larger "climate response studies" (months-years-decades) (Lenferna et al 2017).
SRM experiment, SRM experimental intervention: The terms "experiment" and "experimental" are often used to refer to both SRM research and deployment interventions, conflating their different benefit-risk profiles, sometimes intendedly and with a negative rhetorical meaning (Parson et al 2024:3). To avoid this type of confusion and bias, our reconstruction does two things to rectify this use of the language. First, we presuppose an original aim-based definition of research (main aim is to develop or contribute to generalizable knowledge, e.g. SCoPEx outdoor experiment) and deployment (main aim is to benefit a target population, e.g. Make Sunsets experimental "credit scheme"). Aim-based definitions are inspired in the Belmont Report (National Commission 1978) and Lenferna et al (2017). These aim-based definitions are neutral regarding scale (small or large, relative to time and radiative forcing) (Lenferna et al 2017), outcome (successful or unsuccessful), or ethical status (responsible or irresponsible). Second, we use a rhetorically neutral definition of experiment or experimental as the use of SRM interventions without the sufficient evidence for regular use (inspired in Mastroleo & Holzer 2020; Mastroleo 2024). Taken together, the term "SRM experiment" may both refer to any case of SRM research or deployment activity leaving its normative status to be determined case by case through explicit evaluation.

References

Biermann, F., Oomen, J., Gupta, A., Ali, S. H., Conca, K., Hajer, M. A., Kashwan, P.,Kotzé, L. J., Leach, M., Messner, D., Okereke, C., Persson, Å., Potoc̆nik, J., Schlosberg, D., Scobie, M., &Van Deveer, S. D. (2022). Solar geoengineering: The case for an international non-use agreement. WIREs Climate Change,13(3), e754. https://doi.org/10.1002/wcc.754

Biermann, F. (2023, January 30). *Mexico Bans Solar Geoengineering Experiments*. Frank Biermann. https://www.frankbiermann.org/post/mexico-bans-solar-geoengineering-experiments

Commission on the Ethics of Scientific Knowledge and Technology, advisory board of UNESCO (COMEST). (2023). Report of the World Commission on the Ethics of Scientific

[7] Also referred in the literature as "field".
[8] Also referred in the literature as "test", "study", "trial", etc.

Knowledge and Technology (COMEST) on the ethics of climate engineering (SHS/COMEST-13/2023/1 REV.). https://unesdoc.unesco.org/ark:/48223/pf0000386677

Danielsson, S. (2020). Not Fit to Breed: Eugenics in Sweden, 1900 to Present. *Saber and Scroll, A Publication of the APUS Historical Studies Honor Society Journal*, *9*(1). https://doi.org/10.18278/sshj.9.1.6

Dykema, J. A., Keith, D. W., Anderson, J. G., & Weisenstein, D. (2014). Stratospheric controlled perturbation experiment: A small-scale experiment to improve understanding of the risks of solar geoengineering. Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, 372(2031), 20140059. https://doi.org/10.1098/rsta.2014.0059

Felgenhauer, T., Bala, G., Borsuk, M., Brune, M., Camilloni, I., Wiener, J. B., & Xu, J. (2022). Solar Radiation Modification: A Risk-Risk Analysis [Technical Report]. Carnegie Climate Governance Initiative (C2G). www.c2g2.net

Ferguson, K. (2020). The health reframing of climate change and the poverty of narrow bioethics. *The Journal of Law, Medicine & Ethics*, *48*(4), 705–717. https://doi.org/10.1177/1073110520979381

Gelles, D. (2024, August 1). This Scientist Has a Risky Plan to Cool Earth. There's Growing Interest. *The New York Times*. https://www.nytimes.com/2024/08/01/climate/david-keith-solar-geoengineering.html

Geoengineering Monitor. (2020). Geoengineering Technology Briefing: Stratospheric Aerosol Injection (SAI). https://www.geoengineeringmonitor.org/wp-content/uploads/2021/04/stratospheric-aerosol-injection.pdf

Goethe, J. W. (1797). *The Sorcerer's Apprentice* (L. Collins, Trans. 2016). https://german.washington.edu/research/translations/sorcerers-apprentice

Harding, A., Keith, D., Yang, W., & Vecchi, G. (2023). *Impact of Solar Geoengineering on Temperature-Attributable Mortality*. Resources for the Future. https://media.rff.org/documents/WP_23-23.pdf

Jinnah, S., Talati, S., Bedsworth, L., Gerrard, M., Kleeman, M., Lempert, R., Mach, K., Nurse, L., Patrick, H. O., & Sugiyama, M. (2024). Do small outdoor geoengineering experiments require governance? *Science*, *385*(6709), 600-603. https://doi.org/10.1126/science.adn2853

Karlamangla, S. (2024, junio 5). Alameda City Council Votes to Stop Cloud Brightening Test. *The New York Times*. https://www.nytimes.com/2024/06/05/us/alameda-cloud-brightening-climate-change.html

Keith, D. (2024, August 5). Comment on Buying Time by David Gelles, New York Times, 1st August 2024. *David Keith*. https://davidkeith.earth/comment-on-buying-time-by-david-gelles-new-york-times-1st-august-2024/

Keutsch, F. (2021). Keutsch Group at Harvard—SCoPEx. FAQ website. https://www.keutschgroup.com/scopex

Kigali. (2023, November 22). Solar geoengineering is becoming a respectable idea. The Economist. https://www.economist.com/science-and-technology/2023/11/22/solar-geoengineering-is-becoming-a-respectable-idea

Lenferna, G. A., Russotto, R. D., Tan, A., Gardiner, S. M., & Ackerman, T. P. (2017). Relevant climate response tests for stratospheric aerosol injection: A combined ethical and scientific analysis. *Earth's Future*, *5*(6), 577–591. https://doi.org/10.1002/2016EF000504

Mastroleo, I., & Holzer, F. (2020). New non-validated practice: An enhanced definition of innovative practice for medicine. *Law, Innovation and Technology*, *12*(2), 318–346. https://doi.org/10.1080/17579961.2020.1815405

Mastroleo, I. (2024). Use of experimental vaccines is ethically permissible during public health emergencies. *Vaccine*. https://doi.org/10.1016/j.vaccine.2024.04.065

National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research (National Commission). (1978). *The Belmont Report: Ethical Principles and Guidelines for the Protection of Human Subjects of Research.* US Government Printing Office.

Pamuk, Z. (2021). Risk and Fear: Restricting Science under Uncertainty. *Journal of Applied Philosophy*, *38*(3), 444–460. https://doi.org/10.1111/japp.12484

Parson, E. A., Buck, H. J., Jinnah, S., Moreno-Cruz, J., & Nicholson, S. (2024). Toward an evidence-informed, responsible, and inclusive debate on solar geoengineering: A response to the proposed non-use agreement. *WIREs Climate Change*, *n/a*(n/a), e903. https://doi.org/10.1002/wcc.903

Rayner, S., Heyward, C., Kruger, T., Pidgeon, N., Redgwell, C., & Savulescu, J. (2013). The Oxford Principles. *Climatic Change*, *121*(3), 499-512. https://doi.org/10.1007/s10584-012-0675-2

Ribeiro, S. (2024, April 20). Resistencia logra clausura de proyecto de geoingeniería. Desinformémonos. https://desinformemonos.org/resistencia-logra-clausura-de-proyecto-de-geoingenieria/

Risse, M. (2023). *On the Role of Solar Geoengineering in Combatting Climate Change: Harvard University vs. Indigenous Voices*. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4550968

Taddei, R. (2024). "Perspectives of traditional Brazilian environmental knowledge holders over the intentional alteration of the atmosphere", presentation at 2024 *SRM Social Science Workshop: Cooperative vs. Noncooperative Climate Interventions*, September 19-20, 2024, Washington, DC.

Temple, J. (2024, March 18). Harvard has halted its long-planned atmospheric geoengineering experiment. MIT Technology Review. https://www.technologyreview.com/2024/03/18/1089879/harvard-halts-its-long-planned-atmospheric-geoengineering-experiment/

United Nations Environmental Program (UNEP). (2023). Broken Record Temperatures hit new highs, yet the world fails to cut emissions (again). https://wedocs.unep.org/bitstream/handle/20.500.11822/43922/EGR2023.pdf?sequence=3&isAllowed=y

United Nations Environment Programme (UNEP). (2023). *One Atmosphere: An Independent Expert Review on Solar Radiation Modification Research and Deployment*. United Nations. https://doi.org/10.18356/9789280740059

Wieners, C. E., Hofbauer, B. P., de Vries, I. E., Honegger, M., Visioni, D., Russchenberg, H. W. J., & Felgenhauer, T. (2023). Solar radiation modification is risky, but so is rejecting it: A call for balanced research. Oxford Open Climate Change, 3(1), kgad002. https://doi.org/10.1093/oxfclm/kgad002

Williams, B., Gershenfeld, J., Goss, H., Guillot, C., Hanson, B., Lachance, J., Lyon, L., Morrison, M., Pandya, R., & Shimamoto, M. (2024). *AGU Ethical framework principles for climate intervention research*. https://research.ulapland.fi/files/40667192/Ethical_Framework Report.pdf

Financial acknowledgments

This research was supported by two grants: *Exploring the Ethical Implications of SRM for Health Justice in the Global South* (The Degrees Initiative, 2024–26, lead team with no honorarium: Luna, Camilloni, Mastroleo) and *Solar Geoengineering Research and Governance: Trade-offs, Justice, and Mental Health in the Global South* (WHO, 2024–25, lead team: Luna, Santi).

Declaration of AI-assisted technologies in the writing process

During the preparation of this work, I used Deepl Translatot and Deepl Write to correct English grammar and improve readability. After using these tools/services, I reviewed and edited the content as needed. I take full responsibility for the content of this manuscript.