# Skewed vulnerabilities and moral corruption in global perspectives on climate engineering

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**Abstract**

Ethicists and social scientists alike have advocated for the inclusion of vulnerable populations in research and decision-making on climate engineering. Unfortunately, there have been few efforts to do so. The research presented in this paper was designed to build knowledge about how vulnerable populations think about climate engineering. The goal of this manuscript is to bring the ethics literature on climate engineering into dialogue with emerging social science data documenting the perspectives of vulnerable populations. The results indicate some concerns among vulnerable populations may resemble those outlined by ethicists. However, the perspectives expressed by interviewees also extend previous ethical treatments by indicating ways in which climate engineering could compound existing injustices.

**Key Words**

Climate change, climate engineering, vulnerability, ethics, social science

**Introduction**

In his influential book *The Perfect Moral Storm* Stephen Gardiner (2011: 340) referred to climate engineering[1] as, 'an idea that is changing the world.' Frequently defined as deliberate, large-scale interventions in the earth's climate system to lessen impacts from

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[1] Gardiner (2011) uses the term geoengineering to refer to the same general concept. Other terms include 'intentional climate change' (Jamieson, 1996), and 'climate intervention' (National Research Council, 2015). We use 'climate engineering' because it was the term used throughout the data collection process and previous social science research indicates it is a more intuitive term than geoengineering (Mercer et al., 2011).

climate change (Royal Society, 2009), climate engineering has moved from the periphery to a more prominent role in climate change science and policy. Ethicists have also paid greater attention to climate engineering in recent years pointing out that, among the challenges climate engineering adds to climate change, 'concerns about global justice loom particularly large' (Preston, 2012: 78).

Many proposed technologies would be designed to have regional to global effects, particularly those referred to under the moniker of solar radiation management (SRM), which aim to reduce surface temperature by increasing the earth's albedo via techniques like injecting sulfur particles into the atmosphere or making marine clouds brighter. The scale of potential climate engineering impacts raises concerns about distributive and procedural justice at the international level. Distributive justice concerns, or those related to how harms and benefits ought to be shared, are of particular import as climate engineering will not affect everyone around the world uniformly. While some researchers assert that there would be a net overall benefit from reductions in surface temperatures caused by stratospheric aerosol deployment (Keith, 2013; Kravitz et al., 2014), climate engineering impacts will be uneven at regional to local levels, including potential changes to tropical precipitation patterns (Ferraro, Highwood and Charlton-Perez, 2014). The potential for uneven impacts leads to substantial concerns about distributive justice. Similarly, climate engineering raises questions of procedural justice, or questions about how decisions ought to be made. Those populations who have had the least say in decision-making on climate change might again have their interests overlooked or ignored (Preston, 2012; Suarez, Banerjee and de Suarez, 2013).

Ethicists, social scientists, humanitarian and environmental organizations, and members of the public have advocated for the inclusion of more geographically and culturally diverse perspectives in climate engineering research and decision-making (Cairns, 2015; Corner and Pidgeon, 2010; Jamieson, 1996). Many of these calls have advocated for

including perspectives from populations especially vulnerable to climate change. For example, Suarez, Banerjee and de Suarez (2013: 4) have argued, 'There is a moral imperative to facilitate involving the most vulnerable in decision-making about [climate engineering] … to help inform a more inclusive and nuanced conversation about what can go wrong—and what must go right.'

There have been few efforts to fulfill this moral imperative and engage vulnerable populations in discussions about climate engineering (see AAS and SRMGI, 2013; Beyerl and Maas, 2014; and Winickoff, Flegal and Asrat, 2016 for notable exceptions). There have been even fewer attempts to explore justice concerns that vulnerable populations might harbor and how those concerns could inform ethics and policy discussions. The social science research presented in this paper was designed to build knowledge about how populations currently vulnerable to climate change think about climate engineering. The goal of this paper is to bring the ethics literature on vulnerable populations and climate engineering into dialogue with emerging empirical data.

**Informing Ethics through Social Science Data**

In an article titled 'What can the social sciences contribute to the study of ethics?' sociologist Erica Haimes (2002: 91) suggested,

> By virtue of their theoretical as well as their empirical interests, the social sciences have more to contribute than just 'the facts'. The social sciences see legal and ethical issues as primarily social issues and … can contribute not only to the understanding of ethical issues but also to the understanding of the social processes through which those issues become constituted as ethical concerns.

In other words, social science data and analyses cast light on different ethical concerns that are salient for member of the public. But the social sciences also help explain how and why those particular concerns come to be salient for different publics through social processes.

In a recent analysis of data from a series of public engagement exercises, McLaren et al. (2016) examined the salience of justice concerns in public reactions to climate engineering in the U.K. They found that a wide range of participants expressed a variety of justice concerns, indicating the important role justice considerations play in the formation of public attitudes towards climate engineering. McLaren et al. (2016) suggest that bringing empirical data from social science into dialogue with the ethical literature highlights the justice concerns that members of the public are likely to draw on to judge climate engineering technologies and policies. They also conclude with a call for broader international examinations of justice implications to inform morally justifiable decisions on climate engineering.

The study discussed below draws on in-depth interviews in three geographically and culturally diverse regions of the world to examine certain vulnerable populations' ethical concerns about climate engineering. The data and analyses that follow indicate that certain concerns may resemble those already outlined by ethicists. However, the perspectives expressed by interviewees also extend previous ethical treatments of climate engineering in important ways. More specifically, while ethicists have made some links between climate engineering and the legacies of colonialism and imperialism, interviewees in this study provide a deeper and more nuanced examination of the ways that climate engineering could compound existing injustices around the issue of self-determination. In order to effectively connect the findings of this research with previous ethical examinations, the following sections review existing arguments from the ethics literature regarding the potential moral concerns that climate engineering raises in relation to vulnerable populations.

SKEWED VULNERABILITIES

In one of the earliest examinations of the ethical dimensions of climate engineering, Dale Jamieson (1996) issued perhaps the first call for the inclusion of vulnerable populations in climate engineering research and governance, stating:

> A decision to undertake [climate engineering] would likely be made by the same people who are causing inadvertent climate change and have reaped most of the benefits from fossil fuel driven industrialization: people in rich countries and their political, social, and economic leaders. But if the world belongs to anyone, it belongs to the poor as much as to the rich, and no decision to go forward with [climate engineering] could be morally acceptable that did not in some way represent all of the people of the world. (Jamieson, 1996: 329)

Global participation in decision-making is key if research on climate engineering is to be considered ethically justifiable. Jamieson also pointed out that those who have been the most negatively impacted by climate change have simultaneously had the least say in discussions about solutions. Without concerted efforts to highlight perspectives and concerns from vulnerable populations, Jamieson warned that there is little reason to expect decisions about climate engineering to be more democratic or just.

Gardiner (2011) later expanded upon this concern, using the term 'skewed vulnerabilities' to refer to the existing global inequities of climate change. He pointed out that developed nations are less vulnerable to climate change, due in part to the wealth and infrastructure provided by fossil fuel driven industrialization, but also in part because of geographic good luck. The tropical, sub-tropical, and arctic zones of the world where many poorer populations are located are already experiencing more severe climate change impacts.

These same regions tend to possess little power to hold those responsible for the problem accountable. The climate engineering discussion, then, has to show awareness of the acute vulnerability of poorer nations to decisions made by developed nations—vulnerability grounded in historical injustice (Blomfield, 2015).

Preston (2012) elaborated on the theme of skewed vulnerabilities by examining four ways in which climate engineering could further compound existing climate injustices. First, Preston suggested that, due to potential changes in precipitation patterns and other uncertainties, populations already geographically predisposed to disproportionate impacts from climate change may also be geographically vulnerable to any uneven effects of climate engineering. A second, and closely related concern in Preston's account is economic vulnerability. Any changes in heat distribution and precipitation patterns resulting from climate engineering, 'will impact developing world farmers and those who live subsistence lifestyles the most' (Preston, 2012: 82) Just as the poorest possess the least capacity to respond to negative impacts from climate change, so too will they be the least able to recover from any negative impacts from climate engineering.

Third, Preston elaborated on the political vulnerability already mentioned by Jamieson, indicating that power imbalances in current global decision-making processes make it unlikely that vulnerable populations will be treated as equal partners in the governance of climate engineering. Finally, Preston stated that vulnerable populations are unlikely to have their interests well-represented in the research and development of climate engineering technologies. Those wealthy countries primarily responsible for the problem of climate change are also funding and facilitating the large majority of research. This imbalance heightens the possibility that climate engineering techniques and technologies will serve the interests of the powerful.

Taken altogether, Preston (2012: 83) argued that, 'the most vulnerable nations are not only suffering the greatest climate injustice today, in some cases they risk having those injustices compounded tomorrow as the development of [climate engineering] technologies and discussions about governance unfold.' As a result, when it comes to the question of which voices to prioritize in the discussion about prospective geoengineering, Preston (2012: 88) concludes that 'the most vulnerable populations in the poorest countries are uniquely deserving.' Without the corrective provided by the voices of the marginalized, the wealthy nations are prone to what Gardiner (2011) calls moral corruption.

MORAL CORRUPTION

Moral corruption is defined by Gardiner (2011: 304) as, the 'illegitimate taking advantage of a position of power for the sake of personal gain.' Current generations in affluent, developed nations are especially prone to engaging in manipulative or self-deceptive behavior in relation to climate change and climate engineering because of their positions of power as the current politically, economically, and militarily dominant societies. Much attention has been paid to the idea that climate engineering might present a 'moral hazard' by providing polluters with a seeming way out of reducing emissions (Hale, 2012; Lin, 2013). Gardiner points to a more subtle abdication of moral responsibility. He describes a particularly insidious version of corruption in the form of *selective attention* or 'corruption that targets our ways of talking and thinking, and so prevents us from even seeing the problem in the right way' (Gardiner, 2011: 301). The complex web of problems that undergird climate change and climate engineering make it easy to be attracted to weak or deceptive arguments that present surface-level and unjust solutions.

Gardiner warned that current generations in affluent, developed nations must be wary of moral corruption in relation to climate engineering. What on the surface may appear to be

a persuasive argument for climate engineering, could actually constitute a means of further exploiting a position of power. Gardiner compares climate engineering to offering vulnerable populations an evil way out of a problem that they are not responsible for, stating:

> If someone puts others in a very bad situation through a moral failure, we usually do not think it enough for her to respond by offering the victims an evil way out. Instead we believe the perpetrator has substantial obligations to help the victims find better alternatives, and also, if the alternatives are costly or harmful, to compensate them for making this necessary. (Gardiner, 2011: 360)

Current generations in affluent nations must be on guard against disguising or simply overlooking ways in which climate engineering would constitute further exploitation of the vulnerable. The study described below brings many of these ethical concerns to life and examines how they relate to broader social processes.

METHODS

At the conception of this research project, there had been very few investigations of the social and ethical aspects of climate engineering, and no research at all looking at vulnerable populations' perspectives. To assess perspectives from vulnerable populations, we first identified regions of the world currently experiencing disproportional impacts from climate change (Intergovernmental Panel on Climate Change, 2014). We decided to focus on the South Pacific, North American Arctic, and Sub-Saharan Africa. Within those three regions, we selected the Solomon Islands as the research site in the South Pacific, Alaska within the North American Arctic (where we only interviewed indigenous Alaska Natives), and Kenya as the site in Sub-Saharan Africa.

In all three sites we partnered with regional and local research institutions to develop a study plan. The sample focused on individuals working on climate change in some capacity or a closely related field (such as wildlife conservation or ecotourism). Specific government agencies and ministries, NGOs, private companies, and university departments were contacted to determine whether or not relevant personnel would be willing to participate in an interview. Every attempt was made during this process to ensure diversity within the sample in terms of age, ethnicity, gender, socio-economic class, and type of involvement on climate related issues. Interviewees in all three study sites came from across the public, private, and not-for-profit sectors.

We utilized in-depth semi-structured interviews to gather qualitative data on participant perspectives. In-depth interviews provided the opportunity for interviewees to discuss their perspectives on climate engineering at length and in their own words (Hesse-Biber and Leavy, 2006). Using a semi-structured format also allowed for flexibility to follow up on unanticipated ideas that arose in the interview process, while simultaneously assuring comparability across interviews as all interviewees were asked the same questions.

The first section of the interview focused on interviewees' views on climate change and desired responses. After these initial questions, interviewees were shown a brief animated film (7:35 minutes in length) introducing the topic of climate engineering.[2] The film included information about both carbon dioxide removal (CDR) and SRM at a broad level, with some more detailed information about two SRM proposals—marine cloud brightening and sulfate particle injection. After viewing the film, interviewees were asked a series of questions about climate engineering. These questions examined what they thought about climate engineering as a potential response to climate change, their views on social, political, and ethical

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[2] The film used in the interviews was a modified, preliminary version of a film produced by the Climate Media Factory for the Institute for Advanced Sustainability Studies and used for research purposes with permission.

considerations, and ways to potentially improve geographic and cultural diversity in climate engineering research and decision-making.

Recent research indicates that different framings of climate engineering have the potential to influence public perspectives on this nascent topic (Corner and Pidgeon, 2015). Other researchers have suggested early framings of climate engineering may have prematurely closed down deliberative space, and have suggested the importance of 'unframing' climate engineering by situating it within broader fields of discourse (Bellamy and Lezuan, 2015). To address this challenge, we adopted a 'framing-for-deliberation' approach (Friedman, 2007; Walmsley, 2009) to create space for interviewees to express diverse opinions and draw on different forms of knowledge. More specifically, we discussed the information in the film and asked questions in such a way as to lay out a range of positions surrounding climate engineering and encouraged interviewees to arrive at their own conclusions. We intentionally distanced ourselves in the interviews from information presented in the film and encouraged interviewees think critically about and/or challenge any assumptions they saw embedded in the information provided.

We conducted 32 interviews with 33 individuals in the Solomon Islands; 24 interviews with 29 Alaska Natives; and 33 interviews with 38 individuals in Kenya between March 2013 and January 2014, for a total of 89 interviews with 100 individuals. All of the interviews were digitally recorded and professionally transcribed. Interviews lasted between 35 and 110 minutes with an average of 64 minutes.

Data analysis consisted of an iterative process of reading interview transcripts multiple times, coding transcripts through the identification of themes, writing analysis memos, and exploring relationships between the data and relevant literature and theory (Patterson and Williams, 2002). Data excerpts from the interviews are presented below to both illustrate views discussed by interviewees and serve as evidence for later conclusions.

Quotes are attributed to particular study sites, but not individual interviewees to protect anonymity. Interviewees were free to discuss ethical concerns related specifically to either CDR or SRM, but tended to discuss climate engineering in general (similar to findings in McLaren et al., 2016). As such this paper examines issues interviewees considered related to both unless otherwise noted.

RESULTS AND DISCUSSION

Given that one goal of this project was to bring the ethics literature into dialogue with empirical data documenting the hopes and fears of members of vulnerable populations, it is notable that the perspectives expressed by interviewees corresponded to a surprising degree with many of the concerns articulated in the ethical literature examined above. More specifically, the research results indicated that members of vulnerable populations shared concerns about their own particular vulnerabilities and about potential moral corruption in developed nations. However, interviewee perspectives also extended the arguments found in the ethics literature by revealing an overarching concern, namely that climate engineering could further erode the already weakened self-determination of vulnerable populations due to a long history of oppression.

*Skewed Vulnerabilities*

Interviewees frequently discussed their perceptions and experiences of vulnerability to climate change. Across all three research sites, interviewees emphatically stated that climate change was already posing serious threats to their ways of life. Solomon Islanders frequently discussed impacts from sea level rise including severe shoreline erosion and the loss of freshwater supplies to saltwater encroachment. Alaska Natives most often talked about the physical, economic, and cultural impacts of retreating Arctic sea ice, among other

issues. Kenyans, meanwhile, emphasized changes in the frequency and severity of extreme weather events. A common sentiment across the sample was that climate change was already having harsh effects on subsistence hunters, fishers, and farmers.

While discussing their concerns about climate change impacts, many interviewees also expressed frustration that they were bearing the brunt of a problem created by others. For instance, another interviewee from the Solomon Islands felt that those responsible for the problem did not care about the harm they were causing to others.

> To a Pacific Islander … when you talk about climate change, we tend to blame India, China, the U.S., Japan, all these European countries. It feels like we're feeling the effects more here in the small island states. We don't have the mechanism to deal with all the effects of climate change, and we don't have the capacity. We don't have resources to deal with any of these things. So we do feel that we are not contributing to climate change and its effects as much as all these big countries, but they don't seem to care much.

In other words, interviewees were often quite frustrated about their own 'skewed vulnerability' to climate change. More specifically, interviewees thought that they were living out the geographically and economically increased vulnerability to climate change described by Gardiner and others.

Many of these same interviewees went on to describe a sense of powerlessness to do anything about the situation. The interviewee quoted above, for instance, went on to say, 'For small Pacific countries, we can really only make noises. Whether we are able to change any policy or make useful contributions to how policies are changed, I really don't know. We're too small. We can completely be ignored on the world stage.' As such, interviewees also felt

frustrated by what Jamieson (1996) and Gardiner (2011) have described as the crux of climate change injustice—responsibility for the problem lies with the past and current emissions of dominant societies in rich and powerful nations. Meanwhile those being most affected not only bear the least historical responsibility, but also have little to no power to hold major emitters accountable.

However, several interviewees also emphasized that these skewed vulnerabilities to climate change extended beyond just historic and current emissions. For instance, several Alaska Natives discussed the difficult position that many indigenous villages located along the coastline currently find themselves in.

> 85% of our communities here are coastal communities, and … people really are having to consider moving their communities. A lot of these villages and their location where they're at now—they're in those particular areas not of their own choosing. The Bureau of Indian Affairs located them, because they're on navigable waters. It was easy to barge freight and other stuff into those communities. Our communities were either nomadic or semi-nomadic, moved depending on seasons, on whatever food sources were available. Living by the water is not one of the things that we would have probably chosen for a lifetime commitment, because we recognized that there are issues that are bound to happen … the problem is that no one accepts the responsibility for having located these communities in the areas that they now find themselves in. … everybody is saying, "You're going to be gone in the next ten years anyhow, why should be build you a new school? Why should we fix that sewer and water system that's not working anymore?"'

As the above quote details, interviewees in this study situated their perspectives within the 'background state of global injustice' or the history of colonialism, global poverty, and inequality also highlighted by Gardiner (2011) and the 'crucible of inequality' highlighted by Cuomo (2011). For Alaska Natives, this background included largely involuntary sedentarization as part of an effort by the United States government to 'civilize' indigenous communities in the early to mid-1900's (Marino, 2012). The siting of many 'permanent' villages was done without consulting Alaska Natives. As a result, not only did the sedentarization process inhibit mobility, which had been a successful livelihood strategy, it also placed villages in locations vulnerable to flooding and coastal erosion.

Against this background of 'historically constructed vulnerability' (Marino, 2012), interviewees went on to express some serious concerns about the potential for climate engineering to compound existing injustices. To an extent, these observations mirrored the four areas of potential vulnerability already identified in the climate engineering ethics literature (Preston, 2012). However, interviewees went much further and emphasized an additional overarching concern–that climate engineering could constitute an extension of the exploitation and marginalization that vulnerable populations have been subject to.

*Geographic vulnerability*

Interviewees were concerned that, in addition to bearing disproportionate impacts from climate change, they would not only be negatively impacted by climate engineering, but bear *disproportionate* negative impacts from research and/or deployment. As in the quote below, quite a few interviewees framed these concerns in terms of the potential for climate engineering to have different impacts on different climatic zones or regions.

I don't know how it will affect, let's say, the natural climatic systems that people are used to in particular climatic regions. I'm just worried what impact it will have on the normal regional climatic systems … Solomon Islands is a tropical country. We might become a subtropical country or something like that. If changes like that do happen to regional climatic systems, it's a huge, huge shift of how people live, how they do things, whether it's gardening or fishing or whatever activity. … It's going to have a big impact on the climatic system, rainfall patterns, wind directions. People live within them.

As the quote above indicates, interviewees were concerned about impacts that climate engineering would have on their regional and local climates. This concern arose in recognition of the fact that the large majority of climate engineering research to date has been conducted by scientists from the temperate climate zones of the Northern Hemisphere. Interviewees across all three sites were concerned that researchers who hailed from different regional climate systems would not understand or account for the climatic variables that they were most dependent upon. More specifically, interviewees thought that current climate engineering proposals embodied too narrow of a vision of 'climate' that focused too much on temperature without taking into account other factors that they considered more critical, especially to subsistence practices, such as impacts on prevailing wind directions in the Arctic and impacts on rainy seasons in Kenya.

*Economic Vulnerability*

Preston (2012) suggested that changes in temperature, precipitation, and other variables resulting from climate engineering could have considerable impacts on the livelihoods of vulnerable peoples. Interviewees expressed similar concerns. They recognized

that people in their regions had little capacity to adapt to any additional perturbations in weather patterns. Any unforeseen and/or negative impacts from climate engineering would unduly burden the most vulnerable. One interviewee from Kenya raised this concern in relation to sulfate particle injection in particular:

> They're saying that they want to put sulfur into the atmosphere. If later on we begin to have acid rain, sulfuric acid, because we don't know what is going to happen up there, who is going to pay for that? Africa is a continent that relies on climate-sensitive sectors. That's the backbone of our economies. … I always say that dealing with the uncertainties of climate change is already such a big headache. Why add on? And at what cost?

As the quote above indicates, the question for many interviewees was 'who is going to pay for negative impacts?' Interviewees felt that compensation mechanisms were necessary considering they were neither the cause of the problem, nor likely to be the ones developing and deploying climate engineering technologies. This sentiment mirrors calls by ethicists for compensation for negative impacts (see for instance Gardiner, 2011).

*Political Vulnerability*

The concerns described above clearly begin to anticipate Preston's (2012:82) suggestion that, 'when these observations about the location of [climate engineering] research and development are coupled with glaring imbalances of power in international decision-making structures, it begins to look highly likely that the poorer nations will not be treated as equal participants.' Based on their experiences with current climate change negotiations, interviewees expressed little hope that they would have a meaningful say in climate

engineering. For instance, an interviewee from Kenya who had personal experience working with United Nations agencies and programs, stated the following:

> My concern for Africa is that we always get the short end of the stick. Look at the climate change negotiations. We are not getting anywhere. … So what I'm saying is that I'm wary of these grand projects, because when it comes to international policy—look at the adaptation fund, look at the CDM—the developed countries are not doing their bit.

Interviewees across all three research sites stated that international forums do not provide fair representation of vulnerable populations. They also emphasized that political power in international forums equates to the ability to cause or prevent physical harm to the resources people depend upon for their daily lives.

Many interviewees also discussed concerns about political vulnerability in relation to the cost of climate engineering technologies. Twenty-three interviewees, spread across all three research sites, were afraid that the high cost of research and/or deployment would mean that only wealthy people, corporations, and/or countries would have a say. Another interviewee from Kenya stated this concern in the following way:

> Countries that couldn't afford to do it, would they still benefit from it? Would they have negative consequences of not being part of it? And where would the power be in terms of who decides what to do? In the past, countries with not as much wealth and the indigenous populations always get put on the back burner and don't get to decide these things. Would that be the same case?

In other words, if poor countries and indigenous groups cannot afford to put money towards climate engineering research, which many interviewees were adamant they could not, will they have a political say in how technologies are developed or used? Interviewees saw the cost of researching, developing, and using climate engineering as a means through which affluent, technologically advanced societies would justify their control over the technologies.

*Lack of influence in technology development*

In addition to unequal power in international politics, Preston (2012) suggested that uneven distribution of economic and scientific resources makes it unlikely that vulnerable populations will have much say in the research and development of climate engineering. He went on to state that even researchers with the best of intentions are prone to inherent bias and self-interest. Interviewees were also concerned about inherent bias and self-interest. In fact, they were concerned that not only would they bear disproportional impacts from geographic bad luck, but also because of the limited perspectives of those researching and designing the technologies.

> If you look at the climate change and the impacts of climate change, a lot of the pollution has come from the West, and a lot of the suffering is in Asia and Africa. Whatever intervention that might happen, again might mean that a lot of technologies are developed in the West and then the impact again, following the same line of thinking, the people who are less polluters might be the ones to suffer if there was any negative consequences.

As in the above quote, many interviewees expressed anxiety that researchers from other parts of the world were not only utilizing too narrow a definition of climate, but that they would

overlook critical differences between climates in different regions. Interviewees were concerned that scientists in affluent, developed nations would intentionally or unintentionally embed problematic priorities and worldviews into climate engineering technologies, resulting in negative physical impacts to key resources for vulnerable populations.

This concern was also related to past marginalization and exploitation. One interviewee in Alaska stated that, 'As a Native person … there has been too much horrible stuff done to us in the name of science to trust it. To us personally, to us as a culture, to us as peoples, to us as inhabitants of the environment.' Interviewees viewed climate engineering as part-and-parcel of post-colonial power relations wherein vulnerable populations not only bore disproportional negative impacts from Western science and technology, but were also often unwilling test subjects.

For instance, one interviewee in the Solomon Islands spoke about nuclear weapons testing on atolls in the South Pacific as an example of powerful nations exposing already vulnerable populations to even greater environmental risks in the name of scientific advancement. Reynolds (2011: 130) has indicated this comparison may be accurate, stating, 'Perhaps the best historical analogy to [climate engineering] is above-ground nuclear weapons testing. It carried significant risks to the health of humans, who essentially were non-consenting research subjects, and to the environment, including major irreversible harm'.

EXTENDING THE DOMINATION OF VULNERABLE POPULATIONS

In sum, interviewees shared the concerns expressed by Jamieson, Gardiner, and Preston in the ethics literature examined above. However, interviewees also emphasized an additional overarching concern. They suggested that the most troubling way climate engineering could compound existing injustices is by extending the influence and control

dominant societies already exert over vulnerable populations as the result of a long history of colonialism.

Interviewees were concerned that outsiders would have the ability to manipulate their climates, causing detrimental physical impacts, but also disrupting livelihood and cultural practices. In the words of one interviewee from Alaska, 'It's scary as hell to be dependent on some other person to dictate the weather or climate change.' Many interviewees assumed that climate engineering would be another manifestation of outsiders exerting control to their detriment. In the words of a different interviewee from Alaska, 'Regardless of what happens with climate engineering, we'll be taking the brunt of the problem again.' Even if climate engineering produced only benefits, interviewees suggested it would render them dependent upon outsiders. In response, some of the key considerations for interviewees were questions like: what is the vision for climate engineering and who is determining it; will climate engineering improve our self-determination, or further erode it; and what impacts will climate engineering have on the resources we depend on for daily survival? These types of questions mirror those observed in upstream public engagement exercises on other emergent technologies in developed countries (Wilsdon and Willis, 2004). However, the questions raised by interviewees also reflect very different social contexts and experiences.

Concerns about climate engineering constituting a continuation of past domination have been largely overlooked in ethical analyses done by Euro-American philosophers. But Kyle Powys Whyte (2012a: 71), a member of the Citizen Potawatomi Nation, has poignantly argued that indigenous populations would be concerned that climate engineering, 'will be part of a process whereby members of dominant societies could increase their influence and control over Indigenous peoples' political and cultural systems for meeting basic needs.' Similarly to interviewees, Whyte (2012b) asserted this concern is grounded in past experiences of science and technology serving as expressions of political domination.

Furthermore, Whyte argued that indigenous populations have been disproportionately impacted by environmental disasters resulting from technologies that they neither had a say in nor benefitted from.

This study also indicates that Whyte's (2012a, 2012b) concerns about domination of indigenous populations may be shared by a variety of vulnerable populations around the world. People in developing nations as well as indigenous peoples in developed nations have been exploited and marginalized through colonialism, imperialism, and climate change. Science and technology have played a central role in all of these processes (Arnold, 2005; Shue, 1992). It should not be surprising then that interviewees viewed climate engineering through a lens very much colored by these histories and experiences. As one interviewee from Alaska stated, 'When you're so disempowered and disenfranchised for so long, you get used to being the outlier.' Such feelings of disempowerment and disenfranchisement reflect the social context in which climate engineering becomes an ethical issue for vulnerable populations.

RELUCTANT AND CONDITIONAL ACCEPTANCE OF CLIMATE ENGINEERING

With the breadth and depth of the concerns interviewees expressed regarding climate engineering, perhaps the most surprising finding in this study was that the large majority of interviewees indicated they would be willing to consider climate engineering as a potential response to climate change. The quote below from an interview in Alaska illustrates why so many interviewees held this seemingly paradoxical perspective.

I think that due to the devastation that's occurring with climate change already, that we see here, we have to look at other means. With the delays that we've had with our national will to decrease carbon emissions, that's the reality of where we are. And the

international process is unwilling to change activities and reduce carbon emissions

when they're already causing devastation and so many changes here and there.

In other words, despite the myriad concerns explored above, interviewees indicated that they still thought climate engineering deserved consideration because climate change was already having such 'devastating' impacts. In fact, quite a few interviewees said that they were 'desperate' for solutions to climate change at this point and therefore willing to consider nearly any means of addressing the problem.

Clearly a willingness to consider climate engineering borne out of desperation is a far cry from unfettered support. In fact, interviewees expressed a sentiment social scientists have labelled 'reluctant acceptance,' or a frustrated resignation that highly undesirable options like climate engineering may be necessary to address climate change (Bickerstaff et al., 2008; Corner et al., 2011). Previous research has noted reluctant acceptance in public perceptions of small-scale climate engineering field tests in the U.K. (Pidgeon et al., 2013). However the same sentiment has very different ethical implications in the context of vulnerable populations. Reluctant acceptance in this case bears a disturbing resemblance to the 'desperation argument' for climate engineering that Gardiner (2013: 32) referred to as 'horrifying moral territory.' More specifically, Gardiner (2013: 31)suggested that climate engineering could represent a form of 'profound subjugation' if vulnerable populations were placed in a position whereby they felt forced to beg wealthy, developed nations for climate engineering on their terms.

The thought of climate engineering on the terms of dominant Western societies was clearly disturbing for interviewees in this study as well. In fact, interviewees indicated that they were only willing to consider climate engineering under certain conditions. Some social scientists have noted 'conditional acceptance' of climate engineering—or highly contingent

support or approval embedded in a sophisticated recognition of social, political, and economic realities (Macnaghten and Szerszynski, 2013). However, such conditions have only been documented in the U.K., and varied distinctly from the conditions mentioned by interviewees in this study—conditions focused on self-determination.

One such condition was the meaningful inclusion of the perspectives of affected populations in future climate engineering research and governance. One interviewee from Kenya said, 'I think for sure there should be continuing research involving as many people as possible, even from developing countries, in order to enable them to understand how we may be impacted and how we could contribute to it.' A second condition for support that many interviewees discussed was that climate engineering technologies should be designed to address climate change at local, national, or regional scales. Another interviewee from Kenya explained this condition in the following way:

> I want something that I can actually take home and actually get engaged in it and practice it. The only thing I can ask a climate engineer is, what are some of the tools, technologies, and ideas that you can give me that I can actually go and implement at very minimal costs, so the communities, the people I interact with on a daily basis can easily adopt it, and get the process going? When you're talking about massive capital investment, that sort of erodes the whole process again.

In other words, interviewees wanted climate engineering technologies to embody a vision of empowering the people being most impacted by climate change to act on their own behalf. Clearly both conditions are a response to the overarching concern expressed by interviewees that climate engineering would constitute a form of domination.

Recognizing their own political vulnerability and probable lack of influence over climate engineering research, interviewees were often skeptical that either of these conditions would be met. In the words of one interviewee from the Solomon Islands, 'I think the bigger richer nations or more developed countries, they're going to have a say and basically it's going to be, "This is the way forward, and this is what we're going to do, and that's that. Take it or leave it."' Interviewees felt that climate engineering put them in the precarious position of being severely harmed by a problem they did not create, while also being offered a solution that could very well exacerbate underlying inequalities. Presented in this light, climate engineering typifies Gardiner's concern about only offering vulnerable populations a bad way out of a dire situation, and potentially a way out that is in fact a further form of subjugation.

AVOIDING MORAL CORRUPTION

The fact that vulnerable and indigenous populations around the world are desperate for solutions to climate change, and may be willing to consider climate engineering, could be viewed as a morally persuasive argument for promoting the development of controversial technologies. However, focusing on providing relief from physical impacts from climate change via climate engineering could obscure other, more complicated ways in which climate engineering could actually make those vulnerable populations worse off. Interviewees spoke specifically to the potential for climate engineering to cause further physical and economic harm, exacerbate power imbalances, and further marginalize their perspectives in international policy arenas. Most critically though, climate engineering could be a means through which dominant societies extend their control over the lives of the vulnerable.

By focusing on the potential to provide relief from physical impacts, scientists, decision-makers, and members of the public in developed nations could overlook (or

intentionally ignore) the fact that climate change is a problem embedded within a long history of exploitation and marginalization. Dominant societies could ignore the 'crucible of inequality' that climate change emerges out of and in so doing also overlook ways that climate engineering could exacerbate existing global inequalities. Those in positions of power must be cognizant that climate engineering proposals could ultimately make vulnerable populations worse off in the long run by lessening self-determination. In other words, current generations in wealthy, developed countries must guard against moral corruption in the form of inadvertently or intentionally using climate engineering to extend control over the lives of the world's most vulnerable populations.

Cautioning against moral corruption is not meant in any way to dismiss the more immediate concerns expressed by interviewees. There is no question that the impacts from climate change are already having serious physical, psychological, economic, and cultural impacts around the world. Indeed, interviewees were consciously weighing dire climate impacts against all of their reservations about climate engineering. Interviewees expressed reluctant acceptance fully aware of the fact that climate engineering could bring about a future in which they felt even more dependent upon and controlled by dominant societies. That is why interviewees were only reluctantly and conditionally supportive of climate engineering. More specifically, if climate engineering were to happen, they wanted to see their perspectives being actively incorporated into research and policy making to ensure that climate engineering would improve (or at least not further degrade) their self-determination.

BENEFITS OF INTERDISCIPLINARY SOCIAL SCIENCE AND ETHICS RESEARCH

In addition to highlighting how interviewee perspectives expand upon previous ethical considerations of climate engineering, the above results and discussion also indicate the utility of future interdisciplinary treatments of the topic. Albert Borgmann (2006: 15) has

argued that dialogue between the social sciences and ethics enhances both endeavors: 'Social science without ethics is aimless; ethics without social science is hollow.' By connecting the ethical literature on vulnerable populations with perspectives from members of those populations, this paper indicates several ways in which future ethical examinations of climate engineering can be even more substantial, as well as ways that future social science can be more purposeful.

First, by comparing and contrasting the concerns expressed by ethicists and interviewees, this paper indicates that the ethics literature to date (with the notable exception of Whyte 2012a, 2012b) has largely overlooked a key ethical consideration—that climate engineering could represent an extension of past domination for vulnerable populations. Highlighting this concern will hopefully lead to further ethical examinations of ways to prevent moral corruption on the part of current generations in wealthy, developed nations.

From the perspective of social science, this dialogue between the disciplines helps to reinvigorate calls for the inclusion of vulnerable populations in future climate engineering research and governance initiatives. More specifically, this study suggests that members of vulnerable populations are likely to view climate engineering though a lens that is very much colored by past injustices. Furthermore, ethical considerations such as Gardiner's (2013) 'desperation argument' help to highlight important differences in social contexts and how reluctant acceptance among vulnerable populations might signal a more socially and politically troubling situation than similar sentiments expressed in the U.K. As such, future studies should intentionally incorporate theories and analytical approaches that pay close attention to post-colonial experiences of power and marginalization. Similarly, future engagement efforts should create space for participants from vulnerable populations to voice these types of concerns, and help scientists and decision-makers from dominant societies

recognize the importance of these contexts for developing more inclusive and just technology and policy options.

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