Gender and Geoengineering

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Geoengineering has been broadly and helpfully defined as "the intentional manipulation of the earth's climate to counteract anthropogenic climate change or its warming effects" (Corner and Pidgeon 2010, 26). Although there exists a rapidly growing literature on the ethics of geoengineering, very little has been written about its gender dimensions. The authors consider four contexts in which geoengineering appears to have important gender dimensions: (1) the demographics of those pushing the current agenda, (2) the overall vision of control it involves, (3) the design of the particular technologies, and (4) whom geoengineering will most affect and benefit. After detailing these four gender dimensions, we consider three ways in which the geoengineering discourse could be enriched if it became more sensitive to issues of gender. These include increasing the focus on the concrete other, recognizing the socially transformative potential of geoengineering technologies, and engaging in value-sensitive design. Although ultimately remaining agnostic on the desirability of geoengineering, the paper brings gender considerations into a discussion from which they have been conspicuously absent.

In the years following Nobel Prize-winner Paul Crutzen's 2006 landmark editorial essay on atmospheric albedo enhancement (Crutzen 2006), the idea of engineering a technical solution to climate change has seen a surge of interest. The suggestion that the "perfect moral storm" (Gardiner 2011a) of climate change might be solved by turning an intractable social, economic, and political problem into a solvable technical and scientific one has created a giddy sense of relief in some quarters and a dark sense of foreboding in others. Although there is a rapidly growing literature on the ethics of geoengineering (Gardiner 2011a; Svoboda et al. 2011; Preston 2012a), very little has been written about its gender and justice dimensions. Given that the ethical considerations pertinent to geoengineering include challenges about participation, potential harm to the marginalized, hubristic attitudes about control, and the emblematic question of "*who* would get to set the global thermostat?" it is clear this is an area ripe for gender analysis.

Geoengineering has been helpfully defined as “the intentional manipulation of the earth’s climate to counteract anthropogenic climate change or its warming effects” (Corner and Pidgeon 2010, 26). An early report by the UK’s Royal Society on the main technical and governance issues of geoengineering established what has become a canonical distinction between methods focusing on solar radiation management (SRM) and methods involving carbon dioxide removal (CDR). Whereas CDR would slowly remove atmospheric carbon to restore a safe level of greenhouse gases, SRM would cool the planet more rapidly by reflecting back a portion of the sun’s energy before it has the chance to warm the earth, the oceans, and the atmosphere. Examples of proposed SRM techniques include shooting aerosols into the stratosphere using ballistics, fighter jets, or specially erected hoses and pipes; spraying seawater into the air from ships with tall towers; launching mirrors into space to act as a shield; and wrapping deserts in shiny polyethylene-aluminum sheeting. Examples of the CDR “family” of technologies include afforestation, ocean fertilization, capturing carbon directly from ambient air, and burying biochar to sequester carbon within the earth (Launder and Thompson 2010; SRMGI 2011).

This two-part division of the technologies might already seem gendered for its Freudian imagery: tall spraying devices, nozzles, ejections, dressing up the earth versus fertilizing the oceans, burying things, and sequestering away material. The commonly portrayed risk profiles of the two approaches are also suggestive of a matching gendered slant. SRM gets the attention as a technologically advanced, bold, and risky method. Deployment of an atmospheric shield to deflect solar radiation suggests an Apollonian type of confrontation demanding quick action, steely nerve, and technological prowess. The Royal Society characterized CDR, by contrast, as “a longer term approach to addressing climate change” with “fewer uncertainties and risks” (Royal Society 2009, 54). CDR is usually perceived as slower, gentler, and more natural. Pollution control, if that is what CDR really amounts to, may lack some pizzazz, but it is something almost everyone can get behind, especially if it involves planting trees and engaging citizens.[1]

Our intention in this paper is not to address this question of whether the SRM/CDR distinction is gendered, though it may be an interesting question in its own right. We plan to look at engineering the climate more broadly in order to examine where gender appears—and where it ought to appear—in the politics, ethics, and science of geoengineering. We intend to suggest areas where the geoengineering discussion should be opened up to issues of gender. Moreover, the need is urgent given that preliminary discussions of geoengineering are rapidly moving toward field-testing and plans for the governance of future deployments.

The Gender Dimensions of Geoengineering

There are a number of compelling reasons to raise gender awareness across several geoengineering axes. From a sheer numbers perspective, half of those who will be affected by geoengineering are women, though women are currently represented at only a fraction of this proportion within the geoengineering community. From an impacts perspective, some women are particularly susceptible to the negative effects of climate change (Dankelman 2002; Cuomo 2011) and in these cases might have more to gain from the benefits geoengineering promises. At the same time, the exact impact of many geoengineering strategies on precipitation and other climate parameters is uncertain and may remain so. Some women may have more at stake in this uncertainty, for example, if they lack access to typical adaptive coping mechanisms, such as migration to cities, access to capital, or educational opportunities to pursue different types of work. From a history of science standpoint, the narrative of masculine attempts to control earth systems introduces many fascinating questions. This means that from a political, funding, and purely pragmatic perspective, geoengineering is particularly vulnerable to an ecofeminist critique, and a failure to acknowledge gender-associated concerns could easily derail the geoengineering agenda. No matter where you sit—as a citizen, policy-maker, natural or social scientist, historian, ethicist, engineer, or lobbyist—to understand what geoengineering means for society in anything more than a superficial sense, the gender-and-geoengineering dynamic must be an integral part of the conversation.

In the discussion below, we consider four contexts in which geoengineering appears to have important gender dimensions: (1) the demographics of those pushing the current agenda, (2) the overall vision of control it involves, (3) the design of particular technologies, and (4) whom geoengineering will most impact and benefit. Our treatment of these areas is intentionally introductory; we aim only to open up discussions deserving greater attention. Following that, we explore three ways the geoengineering discussion could potentially become more gender-aware.

Who Is Pushing Geoengineering?

In an article written in 2011 for the UK's *Guardian* newspaper, Australian environmental commentator Clive Hamilton lambasted what he called "the geoclique" currently responsible for much of the geoengineering discourse. Using a term coined by Eli Kintisch (2010), Hamilton argued that global debate on geoengineering is dominated by a remarkably short and recurring list of individuals. According to Hamilton, this group is made up of "a very small group of North American scientists"—harboring mostly "Promethean" views of a "science-as-saviour" culture—who have made themselves the "go to guys" on climate engineering (Hamilton 2011). Hamilton suggested this clique lacks an appreciation, more common in Europe, for the "complexity and capriciousness" of the earth.

Although Hamilton's characterization may be critiqued—some European governments are actively funding geoengineering research—it is beyond question that the geoengineering discussion is not being driven by a representative sample of those with a stake in it.

An early study of media reports on geoengineering counted the assertions made about geoengineering in print and online news articles through mid-2010, and found that women made just 3% of those assertions (15 out of 500). Women were simply not being quoted on this topic (Buck 2013).[2] In geoengineering science, women author research less often than men. A look at the top 100 journal articles sorted by relevance in EBSCO Academic Search Premier—a multidisciplinary database—revealed that 17% of authors were women.[3] A similar level of representation was found at the IPCC expert meeting on geoengineering held in Lima, Peru in June 2011, where 8 of the 51 attendees were women (15%) (IPCC 2012, 97). Furthermore, when women do appear in the discourse, it is frequently—though not exclusively—within domains peripheral to the "hard science" of geoengineering: social science, policy, and ethics.

Women's under-representation in engineering more generally has been highly criticized, often out of concerns about women accessing opportunities to succeed in these fields or about lost innovation opportunities. Part of our disquiet about women's under-representation here, however, lies not so much in the idea that women/society are missing out on geoengineering careers/discoveries, but in the framing and decision-making powers that participation in geoengineering research implies. Women's under-representation in the early discussions of geoengineering is consistent with a more general pattern of "power inequalities in decision-making" about natural resources (Arora-Jonsson 2011, 749). In a draft report written for the Green Political Foundation, Christa Wichterich notes a persistent glass ceiling and lack of "recognition of feminine expertise" in climate matters:

> Only after 14 rounds of negotiations, did the UNFCCC secretariat finally call on the parties to carry out gender-sensitive measures in 2008. When UN Secretary-General Ban Ki-Moon assembled an advisory group on Climate Change Financing in 2010, however, he appointed 19 men. Following vehement protests, the high-level body was expanded to include then French Finance Minister Christine Lagarde. (Wichterich 2012, 4)

These low figures provoke all sorts of questions (Denton 2002). Emerging technologies are subject to rapid and contentious framing in the print and electronic media. Exactly how (and by whom) the technology gets framed has broad implications for which of the numerous ethical and political dimensions of geoengineering are seen as most salient (Nisbet 2009; Scott 2012). Women currently have a minority voice in explaining what geoengineering is and in influencing how it is presented in the media.

Of course, the gender breakdown of the participants in these types of discussions does not tell the whole story. Equally important as who is doing the talking and the framing is what are they talking about. Matters here appear to be improving, but progress is slow and still mixed (Dankelman 2002). Working Group II of the Intergovernmental Panel on Climate Change (IPCC) does now consider women and gender issues when considering impacts, adaptation, and vulnerabilities (for example, IPCC 2007), but only in 2011 were efforts to include references to gender throughout the Green Climate Fund finally successful (Wichterich 2012, 14). A submission by the

Asia-Pacific Women's Group to the Rio+20 United Nations Conference on Sustainable Development in June of 2012 did add a gender component to the nascent geoengineering discourse, stating that:

> Women are greatly concerned by corporate driven technological solutions to climate change that are harmful to the planet and people. Such technologies must be subject to rigorous, transparent and participatory assessments including the implications on women's and children's health and well being. (APWMGS 2012, 18)

Yet a meeting held simultaneously in Lima, Peru that discussed geoengineering at the IPCC for the first time did not include the words "women" or "gender" anywhere in its ninety-nine-page meeting report. The report mentioned the word "justice" only once. Although it's certainly imaginable that these sorts of omissions might be justified by the nature and intent of any one particular meeting, the omissions raise questions about whether decision-making power is already skewed (Dankelman 2002; Arora-Jonsson 2011) and the geoengineering agenda currently reflects only the visions of those who dominate it.

Geoengineering and the Domination of Nature

Path-breaking work in ecofeminism in the 1980s and 1990s found the roots of the environmental crisis in a masculinist approach to nature that favored objectification and domination of the nonhuman world (Merchant 1980; Plumwood 1994). Reductivist and mechanistic trends coupled with a Baconian view of scientific knowledge as "power over nature" led to the idea of science best serving human needs only through complete and total control of the nonhuman, transforming nature "from a teacher to a slave" (Merchant 1980, 169). The image of nature as machine, devoid of animus, ready to be molded to serve a technology-driven civilization was the outcome of a sequence of ideas from European men such as Bacon, Harvey, Descartes, Newton, and Boyle. The machine image asserted a "new confidence in control as well as the narrow and instrumental view of nature associated with a technological outlook" (Plumwood 1994, 109). Faith in the predictability of mechanistic nature reached its apogee in the claim made by Pierre Laplace that, if given the position and the velocity of every particle in the universe, an intellect vast enough could predict all future states. For such an intellect, Laplace asserted, "nothing would be uncertain and the future just like the past would be present before its eyes" (Laplace 1951, 4). The quest for certainty hinged on an understanding of nature as passive, determinate, and entirely predictable.

The old mechanist's dream of predictability still lives on in much research, from the "hard" sciences to economics, quantitative social science, and geopolitical scenario-building. Carolyn Merchant writes: "the assumption of order is… fundamental to the concept of power, and both are integral to the modern scientific worldview" (Merchant 1980, 230). A growing appreciation of nonlinear dynamics and chaotic systems means that the confidence of early mechanists has today been replaced by a more sanguine approach to the possibility of perfect prediction in certain domains. Climate science offers a powerful example of a case where, despite huge advances in observation and modeling, the ability to precisely predict and control is limited. Although scientists can predict general trends with great confidence (IPCC 2007), the ability to model the exact nature of local impacts remains constrained. The complexity of the climate system provides a distinct caution against the flight to objectivity (Bordo 1987) and the quest for certainty.

These features of climate science spill over into a dilemma about geoengineering. On the one hand, the climate is obviously a physical system subject to the influence of incoming short-wave solar radiation, the composition of the atmosphere, and numerous chemical and hydrological parameters. Mechanistic principles clearly apply. Such a system might invite the "imposition of human purposes and treatment as an instrument for the achievement of human satisfactions" (Plumwood 1994, 110). The flavor of old hopes lingers within the geoengineer's dream. On the other hand, the nonlinearity in the system makes the exact nature of geoengineering's outcomes uncertain, especially on local and regional scales (Pongratz et al. 2012). This uncertainty is something almost all contemporary geoengineers are careful to acknowledge, if to differing degrees. Alan Robock thinks that the "inherent risks and uncertainties" are enough to prevent SRM from "ever be[ing] implemented on a global basis" (Robock 2012, 202). Juan Moreno-Cruz and his colleagues suggest that regional inequalities "may not be as severe as is often suggested" (Moreno-Cruz et al. 2011, 649).

In the first article written by an ethicist on geoengineering, Dale Jamieson lamented the hubris in "attempts to manipulate nature in order to make it conform to our desires rather than forming our desires in response to nature" (Jamieson 1996, 331). Jamieson suggests caution with the mechanistic and manipulative metaphors that have informed technological endeavor since the scientific revolution. To the extent that those metaphors can still be found within geoengineering, Carolyn Merchant's and Val Plumwood's ecofeminist critiques will apply as much to the age of geoengineering as they have to earlier technological endeavors.

Engineering and the Masculine Temperament

Although her research does not attend to geoengineering specifically, Wendy Faulkner has endeavored to "write gender" into accounts of several different engineering fields (Faulkner 2007, 332). Faulkner finds engineering practice to be "an important locus for the social (and thus gender) shaping of technologies," because "engineers represent a particularly visible instantiation of the still durable cultural equation between masculinity and technology" (Faulkner 2000, 761). According to Faulkner, we can see this cultural equation articulated in prevalent dichotomies within engineering (technical/social, reductionist/holistic, abstract/concrete, hard/soft, and so on) that map onto the overarching gender dualism of masculine instrumentalism/feminine expressiveness (Faulkner 2000; 2007).

Geoengineering arguably aligns much more closely with what might be considered this (culturally constructed) masculine temperament, highlighting activity/dominance, objectivity, and technicality (versus passivity/submission, subjectivity, and sociality characteristic of the feminine temperament). Consider first the basic premise of geoengineering, which holds that large-scale, system-wide intervention into the climate system could be necessary or desirable at some future point. This may or may not be a reasonable supposition. We wish here only to point to the fact that it is a fundamentally interventionist and technocratic strategy as compared to a strategy of stringent emissions reductions to curb the problem of excess atmospheric carbon. Second, as already indicated, climate and other geophysical models employed in geoengineering create the assumption of objectivity and detachment. Yet it is precisely the lived experience of climate that causes public concern. Third, the fixation on technical design combines the first two masculine traits into what Faulkner identifies as a "ritual of tinkering":

> The "rituals of tinkering" may thus be understood as a homosocial enactment, contributing to what Fergus Murray calls a "separate reality" for men engineers. It seems to me that there are three ingredients of this separate reality: the shared pleasure in technology… plus a shared pride in their technical competence and in the artefacts they work on. (Faulkner 2000, 763)

The work of geoengineering—the calculations, drawings, schematics, and model-making involved in designing balloons, ballistics, and nozzles for spraying—consists of the simultaneous play and display of technical prowess in the masculine "ritual of tinkering." The possibilities of self-steering marine vessels that enhance tropospheric clouds through continuous spray, nanoparticles that photophoretically levitate to create solar shields at the poles, and artificial trees that scrub carbon for sequestration are so technologically captivating to some that they might be "peeled away" (763) from and overshadow significant social considerations.

Though her work ultimately problematizes the dualisms of engineering she identifies, Faulkner argues that the dualisms reinforce *and are reinforced by* gender: that gender and these prevalent dualisms are co-constitutive, and that the organizational structures and occupational ethos of engineering perpetuate this co-constituency. At present, the geoengineering discourse appears complicit in perpetuating these patterns.

Disproportionate Social Impacts and Benefits

A fourth lens through which the gendered dimensions of geoengineering can be explored is that of differential impacts. Karen Warren has articulated a number of connections (historical, conceptual, empirical) between harm to nature and harm to women (Warren 2000) and shows how these connections link women with other marginalized groups. Though such generalizations can sometimes obscure important contextual differences (Arora-Jonsson 2011, 750), history provides countless episodes of environmental injustice where damage to the earth accompanies disproportionate injury to disempowered demographics. Environmental harms are rarely simply ecological concerns; they are also social and political concerns.

Climate change presents the same patterns, with both past and future consequences for global justice. Chris Cuomo asserts that the problem of climate change was created in a "crucible of inequality" (Cuomo 2011, 693). Power, inequality, and the domination of others have been part of the climate change problem from the start, and inequality continues to pervade its impacts (Shue 1999; Dankelman 2002). In certain contexts, women are particularly exposed to its harms (Dankelman 2002; Masika 2002; IPCC 2007). Some climate impacts, such as drought, disease, and water scarcity, simply "exacerbate the problems that developing countries are already facing" (Masika 2002, 3). Others, such as forced relocation, invasive species, and more extreme weather events, create new challenges for both women and men.

Poverty, marginalization, and exclusion from decision-making clearly thwart one's ability to respond to these occurrences. Hurricane Katrina proved that even in the world's wealthiest nation, it is much harder to escape from harm in the absence of economic means. MasterCards with generous credit limits and privately owned vehicles with full tanks of gas provided escape routes for some that were simply unavailable to many. Social norms also influence who can most easily escape harm from extreme natural events. The 2004 Asian tsunami killed a disproportionate number of women and girls because women "stayed behind to look for their children and other relatives" (Oxfam 2005; Cuomo 2011, 694). The 1991 cyclone in Bangladesh resulted in women dying due to cultural norms that forbade them from leaving the home until it was too late (Masika 2002). After a disaster or weather event has passed—and throughout the course of many slower-onset disasters like drought—the lingering effects of destroyed homes, limited potable water, and difficulties finding food all tend to fall more heavily on women than on men. The points frequently made by ecofeminists about the disproportionate impacts of environmental ills such as deforestation, drought, water pollution, disease, and crop failure on women (Shiva 1989; Gaard and Gruen 1993; IPCC 2007)—though often requiring more nuance (Arora-Jonsson 2011)—apply equally to many of the impacts of climate change.

Because geoengineering is often viewed as a way to lessen these sorts of harms, one might expect it to be an unqualified benefit to those threatened by climate-related ills. Indeed, geoengineering will provide clear benefits to some. Models from Julia Pongratz and her colleagues show that climate engineering through SRM will likely have net benefits for wheat, maize, and rice yields compared to a world without SRM by reducing heat stress in a high CO_2 atmosphere (Pongratz et al. 2012). Such forecasts, however, are based on predicted means for surface temperatures across whole regions. The complexity of the climate system means that there will inevitably be local differences on hydrology, stratospheric and ocean chemistry, and the terrestrial carbon cycle. A comparison of several global climate models by H. Schmidt and colleagues shows that "climate engineering… aiming at the restoration of the globally-averaged temperature of a past climate state… would certainly lead to significant changes in other climate parameters" (Schmidt et al. 2012, 76). Exactly where, and to what extent, those differences will manifest remains uncertain.

One area of particular concern is precipitation. Although overall temperatures may stabilize when compared to a world with rising atmospheric carbon and no geoengineering, Schmidt shows that meridional (north-south) temperature gradients will change, and precipitation overall will likely decline (Schmidt et al. 2012). The precise nature of the impacts on critical African and Asian monsoons remains uncertain (Matthews and Caldeira 2007; Bala et al. 2008; Robock et al. 2008; Ricke et al. 2010). Dramatic changes in rainfall will create considerable challenges for those whose only access to food is through what they can grow or gather locally. Even the Pongratz et al. study, with results favorable to SRM-induced cooling, warns that "specific regions may gain or lose crop productivity to different extents," posing "a risk to local food security if subsistence farming prevails and adaptation is not possible" (Pongratz et al. 2012, 3).

Whether or not the scientific uncertainty about impacts can be reduced, the ethical concerns raised by the prospect of already vulnerable subsistence populations being disproportionately affected are significant. The Solar Radiation Management Governance Initiative, a project designed in part to make planning for geoengineering more inclusive, warned that "SRM research could constitute a cheap fix to a problem created by developed countries, while further transferring environmental risk to the poorest countries and the most vulnerable people" (SRMGI 2011, 21). Although we should be critical of framings that suggest vulnerable populations are lacking agency, knowledge, and responsibility (Arora-Jonsson 2011), with solar radiation management—a top-down technology likely to be initiated by the governments of the richest nations—lack of local agency is very likely to be a real problem. Some of those suffering most under climate change may have their situation worsened by SRM and be unable to do anything about it.

Enhancing the Geoengineering Discourse

The analysis above indicates that some versions of geoengineering raise issues of justice that can be highlighted by feminist analysis. The conclusions that we want to draw, however, are careful ones. We do not advocate for the rejection of all geoengineering research: climate change is real, and the harms it promises are significant and likely to have a disproportionate impact on women and the global poor. We certainly do not want to malign the community of geoengineering researchers, who by and large work out of a well-intended concern for alleviating future harms.

The authors of this paper remain agnostic on whether geoengineering should ever actually be implemented. The lesser of two evils rationale often used to promote geoengineering research (Gardiner 2011a; Preston 2011) may, in the face of some future planetary emergency, be enough to justify a geoengineering deployment. We do think, however, that the discourse around geoengineering needs to change so as to avoid a gender-insensitive research trajectory. Our suggestions for change follow.

Focusing on the Concrete Other

In a well-known article contrasting the justice versus care approach to ethics, Seyla Benhabib elucidates the difference between an ethics that considers the "generalized other" and one that considers the "concrete other." Benhabib articulates a common complaint in feminist ethics that masculinist justice approaches to ethics abstract from the "individuality and concrete identity" (Benhabib 1986, 411) of any given person in order to make ethics into a nonpartial enterprise dealing only with nameless and autonomous others. Ethical actors become mere placeholders in moral equations who lack any particularity or specificity (see also Gilligan 1982; Held 2006).

The generalized other appears clearly in geoengineering's calls to restrict the rise of "global mean surface temperatures" to some specified limit (typically 2 degrees C). Given that global climate change is by definition a global phenomenon, responding to it obviously must involve addressing global mean temperatures. But a global mean clearly does not specify an actual temperature experienced by everybody on earth. Climate scientists are well aware that people experience only particular temperatures in particular places, and particular temperatures will vary considerably under geoengineering.

Global average warming is also "not the only kind of climate change that is dangerous" (Lenton 2011). Changes in temperature *gradients* between regions, *rates* of temperature change, and shifting *distributions* of aerosols are also significant drivers of threatening "large-scale discontinuities." Geoengineering will affect hydrology, pressure, wind, and ocean temperatures as well as rates of change of these variables and their meridional gradients. The significance of each of these changes will vary among populations: a population dependent on marine resources for subsistence will be much more concerned about ocean acidification and ocean temperatures than one that isn't. The reliability of monsoonal rains is much more critical for rainfall-fed subsistence farmers in rural South Asia than for white-collar city-dwellers. A more contextualized approach to geoengineering ethics would refocus climate-policy discussion around metrics that go far beyond global mean temperatures. In both climate change and geoengineering, different types of regional effects on concrete others are at least as morally significant as global effects on generalized others.

These sorts of considerations are certainly not absent from the current discourse.[4] The general point about unevenness of impacts and attendant obligations is widely recognized. From the earliest discussions of geoengineering, commentators have acknowledged this unevenness by expressing the need for compensation for those harmed by the unintended effects of geoengineering (Kellogg and Schneider 1974; Bunzl 2011). Monetary compensation, however, is likely to be neither straightforward nor adequate. Robock asks:

> How would it be possible to determine which adverse situations were caused by the geoengineering, and which were just bad weather luck? Even if it were possible, how could those suffering be compensated? There is not a good record of this happening, even in cases where the

> cause is obvious. For example, are people moved out of river valleys because of dam construction in general happy with their new situations? (Robock 2012, 203)

Although the questions about how to address regionally variable impacts are difficult, they should be treated as lying at the heart of the ethical discussion. The challenges presented by the concrete other are something that a feminist approach to the ethics of geoengineering helpfully highlights.

The focus on particularity is linked to another common emphasis in feminist approaches, namely, the affective dimension of ethics. Attention to this dimension often means valuing the role of care. Unlike the abstract notion of justice, care is more typically present in actual relationships between particular persons. Ethics is rarely just a math problem (Gilligan 1982) entirely detached from the emotional states of the individuals involved. At the bottom of every ethical moment is an individual with "a concrete history, identity, and affective-emotional constitution" (Benhabib 1986, 411). Even in cases where the parties to an ethical decision have no direct interaction with another, Nel Noddings has argued it is still desirable to "care-about" distant others, with "care-about" expressing "a verbal commitment to the possibility of caring" (Noddings 1984, 18). This is a different, more personal, starting point for ethical decision-making, one that traditional ethics has marginalized.

If Noddings is right that women enter the domain of moral action "through a different door" (Noddings 1984, 2), the ethics of geoengineering might look different when viewed from that second doorway. The plight of those hit hardest by climate injustice would be paramount. Using Henry Shue's notion of "compound injustice" (Shue 1992), Christopher Preston has drawn attention to no fewer than seven layers of unfairness that may accumulate on certain unlucky populations through geoengineering (Preston 2012b). Individuals within these populations are not abstract others but concrete selves with idiosyncratic family histories, individual needs, and particular circumstances. The self, says Benhabib, "is not a thing, a substrate, but the protagonist of a life's tale" (Benhabib 1986, 413). A feminist emphasis on care for particular others could shine a light on the lives of those most vulnerable to—and least responsible for—the unanticipated side-effects of geoengineering. It could then place them at the center of ethical concern.

Planning for Co-benefits

In two recent papers on how to best assess future geoengineering options, Holly Jean Buck suggests that "cost-benefit" and "risk" may not be the only worthwhile metrics through which to analyze emerging technologies (Buck 2012a; 2012b). She recommends technologies also be assessed for their potential to address global challenges surrounding social development. Particular technologies would be preferable if they could be "scaled up in ways that alleviate structural aspects of human development problems such as inequality, energy poverty, food security, and land access" (Buck

2012a, 133). A Woodrow Wilson Center report similarly suggests that "both geoengineering and climate change should be addressed in the context of finding 'simultaneous solutions' to other challenges, such as energy security, vulnerability to terrorism, water scarcity and food security, ocean health, economic competitiveness and job creation" (Olson 2011, 3). Viewed through this lens, geoengineering has the potential to function not just as *climate* remediation but also as *social* remediation.

A great deal of the potential to realize social benefits from geoengineering will depend on which technology is chosen and how it is deployed. Reflection of incoming short-wave radiation through the use of space mirrors, for example, may provide very limited opportunity for social change due to its mega-project status and need for centralized control. Afforestation, on the other hand, could provide co-benefits such as shade, moisture retention, enhanced water quality, fuel, and economic opportunities for men and women. Done poorly, however, afforestation could be a form of maldevelopment (Shiva 1989), resulting in mono-cultured plantations that exclude local populations, encourage out-migration, and decrease options for subsistence.

Different technologies for engineering the climate have different potential social and political impacts that Buck argues deserve careful scrutiny, especially in light of development's legacy of addressing gender issues.

The tendency to ignore these social impacts has precedents in earlier discussions of climate change. At least initially, Wichterich notes, climate change was thought of "primarily as a problem of global and local natural spaces. Less attention was paid to its social and economic dimensions" (Wichterich 2012, 12). The emphasis on climate change as a massive atmospheric and ecological problem has it rhetorical advantages, but it serves to obscure the social and political dynamic in which the global problem manifests itself in place. Wichterich continues:

> [I]f one breaks down the problem of greenhouse gases and climate changes from the macro-political and technical levels to the micro-levels of local actors and people affected, highly differentiated perspectives open up in geographical, social and gender-specific terms. They display a complex interweaving of ecology, economy and questions of justice, on the one hand, between highly industrialized countries, newly industrialized countries and developing countries, and on the other hand within all societies, between genders, generations and social classes. (13)

Climate change is at one level "merely" a geophysical phenomenon. But it is always manifested in distinct social and ecological contexts that are rife with what Iris Marion Young has called "structural injustices" (Young 1990; 2006). These injustices may not always be malevolent, but they reflect particular socioeconomic trajectories. These processes invariably subject certain individuals and communities to the "systematic threat of domination or deprivation of the means to develop and exercise their capacities," whereas others enjoy "a wide range of opportunities for developing and exercising their(s)" (Young 2006, 114). Climate change offers a paradigmatic example of such injustice. Entrenched social and economic conditions around energy production, transportation, agriculture, finance, and what it means to "develop" (Shiva 1989) are as much a part of the global-warming problem as are changing climatic conditions.

As an attempted technological fix, geoengineering risks missing these crucial social and economic realities. Alvin Weinberg warned in the 1960s of the dangerous attraction of the idea that complicated social and economic problems can simply be replaced by easier technical ones (Weinberg 1967). Geoengineering views climate change as merely a technical problem and in so doing flattens out its environmental, social, and ethical dimensions. This not only neglects how the reality of climate change actually manifests itself in practice: it also hides the structural injustices that created the problem in the first place, injustices potentially perpetuated by geoengineering. By focusing on the technical and marginalizing the social, geoengineering also effectively limits women's worldwide involvement in the discussion by excluding areas and disciplines where they are better represented.

More than one high-profile commentator has suggested that climate change provides both a challenge and an opportunity.[5] Socioeconomic structures need to change. There is currently a distinct danger that geoengineering will serve as an excuse to do nothing about the structures that have led to the problem of climate change. Alternatively, it could offer an opportunity to reframe society according to a wider vision of gender equity, environmental justice, and global sustainability. Feminist sensibilities make this latter path more likely. Greta Gaard and Lori Gruen have pointed out that "focusing on context… is one of the strengths of ecofeminist theorizing" demanding a "historical, contextualist, and inclusive approach" to problem-solving (Gaard and Gruen 1993, 30, 25). Such an approach could be encouraged if geoengineers consider the co-benefits (and co-costs) each technology offers alongside the temperature changes they promise. In the process, geoengineering could provide an opportunity to helpfully transform some of the political and economic structures in which the climate problem originated.

Value-Sensitive Design

One potential way to add a feminist sensibility to geoengineering would be to make engineering and design processes more "value-sensitive." Value-sensitive engineering seeks to identify the implicit values of the practice that may rarely be acknowledged or made explicit. According to Ronald Sandler: "Engineering is value sensitive when the full range of relevant values—economic, ecological, and social—inform design choices" (Sandler 2012, 221). This may meet resistance from engineers who frequently conceive of their work as impartial and value-neutral as compared to the messy, subjective world of the social and political sciences. But, as Sandler points out, even by choosing which project deserves her attention, an engineer makes an implicit value judgment. This choice, and all of her subsequent choices—how much time she spends, what she considers an acceptable solution, which factors are considered relevant, which are omitted, and so on—are each junctures where values, implicit or explicit, direct her design. Sandler writes, "We are *Homo sapiens*, *Homo ethicus*, *Homo sociabilis*, and *Homo faber*" (209). We are not "the maker" without also being "wise," "social," and "ethical." All of these aspects involve and *imply* one another. As "technological animals," humans must recognize the social, cultural, and ethical implications of our fabrications. Science and engineering are intrinsically value-laden and inextricable from their social contexts and historical situation (Harding 1991; 1998). These are not facts that engineers, climate or otherwise, should shy away from.

To help engineers identify the values implicit in their work and embrace a value-sensitive practice, Sandler, Harding, and others have posed a series of guiding questions. Some of these can helpfully be applied to the context of geoengineering:

A. Who would (and who would not) be at an advantage by the solving of this problem?
B. Would this address the cause of the problem or would it treat the problem's effects?
C. Are there other, perhaps even less technologically sophisticated approaches to addressing the problem that might be more effective, efficient, or more likely to succeed? (adapted from Sandler 2012, 218)

These types of questions broaden the scope of engineering thought and examine implicit assumptions and values in a way consistent with many feminist aims. Question A turns climate and geoengineering issues away from the generalized other and global mean surface temperature and presses the engineer to identify the specific populations and demographics affected both positively and negatively by her work. The question of who benefits and who suffers is complex and context-dependent, but consideration of this question needs to take place during all phases and in all areas of discourse on climate engineering.

Question B points to an important distinction between the families of SRM and CDR technologies: CDR technologies endeavor to address the problem of accumulating carbon in the atmosphere, whereas SRM technologies alone leave the carbon *in situ* and mitigate this overabundance by manipulating incoming solar radiation. Both strategies respond to the problem of climate change framed as the "2 degree problem." But question B reminds the engineer that only one of the two strategies addresses the cause of the problem: an obvious way to facilitate the removal of carbon is not to put so much of it in the atmosphere in the first place. Question B invites reflection on how CDR strategies can be combined with continued efforts at emissions reduction so that the root of the problem gets addressed.

Question C reminds the geoengineer that the setting in which she works, likely a technocratic setting emphasizing sophisticated problem-solving, technological ingenuity, and high-dollar investment, may not be the setting that gives rise to the best or only solution to a problem. The complex problem of climate change has multiple roots in lifestyles, political and economic structures, uneven development, and vested fossil fuel interests. Hence, simply engineering a techno-fix to solve the climate change problem utterly misses its crux, either unintentionally—by misunderstanding this profoundly social problem as fixable merely by designing a new technology—or intentionally—by evading the difficult and costly work of reimagining and recreating our world premised on something other than fossil fuels. Question C may keep local and regional mitigative, remediative, and adaptive strategies in view and encourage consideration of co-benefits when envisioning and designing different technologies.

These three questions in value-sensitive design mark an entry point into conceptualizing geoengineering as something more than merely a techno-fix. They prompt reflection on how geoengineering can attend to fundamental questions of justice and of social transformation, and they keep the focus on how climate change and its proposed solutions will create fiercely tangible realities for actual persons. Although they are only a beginning, together they make more likely a nonreductivist type of geoengineering that accounts for the lives of concrete others, the necessity to care for them, and the potential to dismantle the oppressive structures currently woven into the problem of climate change.

In closing this paper, we avoid the conclusion that geoengineering is an *irredeemably* masculinist project. We do, however, suggest that there are a number of insights from feminist theorizing that urgently need to be incorporated into today's geoengineering discussions. We see two possible geoengineering futures ahead. At its worst, geoengineering might display a familiar tendency long criticized by ecofeminists: a tendency to use science and technology to thoughtlessly remake the earth at will for the satisfaction of human needs and desires. The same hubristic attitude faulted for causing numerous environmental problems over the last two centuries might again be on display, taking the entire global population—both human and more-than-human—down a risky and uncertain path. At its best, geoengineering offers a chance to reduce the massive human suffering and environmental losses in store as a result of climate change. If forms of geoengineering that consider co-benefits are combined with serious emissions reductions and attention to economic injustice, there is the potential to begin remaking society along more just and compassionate lines. This will require paying particular attention to the needs of those most structurally disadvantaged by industrialization and globalization. It seems to us that this latter, preferable path is more likely to be achieved if feminist insights are broadly and promptly incorporated into the discussion.

Notes

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1. Gardiner 2012b questions this tendency to play down of the dangers of CDR relative to SRM, and there are suspicions that appeals to the "naturalness" of *any* planetary-scale manipulation of global processes are misleading.

2. Buck also notes that none of these fifteen statements were positive about geoengineering.

3. Sample collected on February 15, 2013 using query "geoengineering" OR "climate engineering." Sample size was 96 articles: three articles about geology were omitted, and

one that had 30 + authors was omitted. Total number of authors was 221: 38 women and 183 men.

4. The principle of Loss and Damage, recognizing actual harm to particular others, was introduced at the UNFCC COP 18 meeting in Doha in November 2012.

5. Al Gore most famously made this claim in the documentary *An Inconvenient Truth*.

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