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Gendered Power and Climate Change: A Critical Discourse Analysis of  
the Geoengineering Field

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Adviser: Associate Professor Mayumi Fukunaga

Co-Adviser: Associate Professor Masahiro Sugiyama

Annie Margaret Milburn 47-176847

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## ABSTRACT

The Paris Agreement has been praised as a notable success in international political cooperation, yet Nationally Determined Contributions remain far below levels needed to adhere to even the 2°C set warming target (UNEP, 2018). In the face of lacklustre movement towards significantly reducing global carbon dioxide emissions dialogue around geoengineering technologies - presented as a potential 'fix' for climate change - has increased. Geoengineering refers to 'artificial and deliberate attempts to manipulate a key facet of the earth's climate system' (Dalby, 2010, p. 192), encompassing technologies such as Solar Radiation Management and Carbon Dioxide Removal that seek to mitigate global temperature rise either by limiting incoming solar radiation to the earth's atmosphere, or literally removing carbon dioxide from the atmosphere.

These technologies are inherently bound up in social systems and values, and it is therefore imperative to thoroughly explore their justice and ethical dimensions. If such technologies were to be deployed and cause unintended negative side effects, already marginalized populations will be most adversely affected. Similarly, research on geoengineering is almost exclusively dominated by voices from universities in developed countries such as the US and UK, and in general the field currently lacks diversity. This is particularly concerning due to the global nature of their potential application.

Whilst gender should have little impact on the conception of the hard science itself, the lack of female voices currently contributing to the debate around geoengineering is cause for concern from the point of view of the 'framing and decision-making powers that participation in geoengineering research implies' (Buck, Gammon & Preston 2014, p. 654). In terms of the history of science, this technocratic approach to 'solving' climate change evokes traditionally masculine attempts to control nature. As part of the broader justice puzzle, this project aims to explore the gendered power dimensions of the geoengineering

field and how feminist theory might be able to contribute a more holistic approach to relevant justice issues. The project is grounded in theory from Ecofeminism and Feminist Science Studies, as they are two disciplines that critique masculine attempts to exploit nature, and the ways in which Western scientific institutions are implicated in such dynamics of domination and control.

Critical Discourse Analysis (CDA) was chosen as the methodology due to its concern with uncovering asymmetrical power relations within society: these aims fit well with the emancipatory nature of the feminist theory used. Academic texts were the focal point of analysis due to the power that researchers currently hold in shaping geoengineering discourse; in the absence of governance and oversight frameworks for geoengineering, academics are at the forefront of the agenda. Texts were chosen from 6 mainstream academic journals, within a timeframe of 2006-2019, and analysed in-depth according to the CDA framework. The analysis found that geoengineering is gendered at both an institutional and ideological level and helped to uncover and explore gendered power relations within the chosen discourse. The findings suggest that incorporating a gendered point of view more consistently in research would help develop a more nuanced understanding of justice and power relations within the geoengineering field.

**Keywords:** *gender, geoengineering, power, ecofeminism, feminist science studies, critical discourse analysis*

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# 1 INTRODUCTION

## 1.1 The legacy of Paris

Since it came into effect in 2016, the Paris Agreement has had a significant impact in shaping climate change narrative. The agreement's aim of 'holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels' (UNFCCC, 2015, p. 3) has become a mantra of sorts within contemporary climate change discourse. Talk of the 2°C and further 1.5°C warming targets has become a useful baseline in articulating a common goal within climate change policy. With a total of 195 signatories the agreement represents a significant victory in terms of international negotiation and unity and was widely celebrated in this regard. This positivity surrounding Paris and the ensuing global media coverage also helped elevate the issue of climate change into the public consciousness more generally. Despite this widespread positivity, the Paris Agreement has also faced various criticisms. Allan (2019) notes how the unanimous legitimizing and celebration of the agreement risks painting it as an all-encompassing solution to climate change, when in reality it exists as a revamped version of conventional approaches that have hitherto proved ineffective. There is no acknowledgement in the agreement of the problematic nature of the global industrial capitalist system and its plausible causation of climate change, and concerns about equity and environmental justice took a back seat in order to ensure maximum consensus building capacity (Clémentçon, 2016). The Paris Agreement utilizes a bottom-up approach, as opposed to a more traditional top-down focus. This approach centers the actors involved, creating an environment whereby 'the focus is no longer on the environmentally desirable, but on the politically feasible' (Geden, 2016, 792). Achieving a broad consensus became privileged

above all else; whilst this clearly helped to overcome previous climate policy inertia in Paris, it also serves to magnify the disconnect between policy and concrete action.

## **1.2 Introducing geoengineering**

The core of the Paris Agreement lies in Nationally Determined Contributions (NDCs) that each individual country pledge, outlining their national efforts to reduce emissions. Whilst the submission of these NDCs and their updating every 5 years is legally binding under the agreement, the ambition of the NDCs themselves are determined by each country at the national level. Currently pledged NDCs indicate global warming of around 3°C by 2100, and the emissions gap needs to be closed by 2030 if the Paris goal of 1.5°C is to still be achievable (UNEP, 2018). The emissions gap shows the discrepancy between talk at the climate policy level and true action at the level of state actors.

The Intergovernmental Panel on Climate Change's fifth assessment cycle introduced the idea of negative emissions into carbon budgets, which has served to further muddy the waters of responsibility. This is the inclusion of Carbon Dioxide Removal (CDR) technologies within Integrated Assessment Models (IAMs) to increase the carbon budget, offering actors more flexibility in their mitigation efforts; there now exists an assumption that technologies may be employed to aid mitigation on a large scale. Indeed, given the inadequacy of currently pledged NDCs, it is impossible to meet the warming targets stated in the Paris Agreement without the implementation of such negative emissions technologies (Haszeldine et al., 2018). This is problematic because these technologies do not actually exist yet at the scale needed to significantly aid mitigation efforts, and they are often prohibitively expensive.

CDR is part of a broader group of technologies that exist under the umbrella term of 'geoengineering'. Geoengineering is defined as 'deliberate large-scale intervention in the Earth's climate system, in order to moderate global warming' (Royal Society, 2009, p. ix).

CDR methods entail physically removing carbon dioxide from the atmosphere. The other branch of geoengineering technologies, known as Solar Radiation Management (SRM), aim to limit the amount of incoming solar radiation to the earth's atmosphere. Contemporary dialogue around these technologies was catalysed by the publication of Paul Crutzen's seminal essay in 2006 examining the capacity of stratospheric sulfur injections as a potential means to mitigate global warming. Since then, sustained political inertia around climate change action coupled with increased concern about environmental tipping points has resulted in further attention being given to geoengineering technologies. This elevation of geoengineering into broader societal consciousness has been mired in controversy; the technologies tend to elicit strong opinions on their potential usage, and states have been reluctant to take strong stances on geoengineering research. Despite this, geoengineering presents an enticing technocratic 'fix' for climate change, the allure of which will likely only increase over time.

### **1.3 Geoengineering justice**

As extreme weather events around the globe continue to increase in scale and number and barriers to action (such as the United States withdrawing from the Paris Agreement) cause political friction, the case for geoengineering as an emergency 'plan B' measure appears to become more reasonable. If such issues continue, it is likely that future scenarios may potentially emerge where the implementation of geoengineering technologies are perceived as desirable by one or more actors. There exists, therefore, a myriad of issues concerning the governance and justice of these technologies that still need to be addressed; researchers are beginning to highlight this as an important area of study (Hourdequin, 2018; Preston & Carr, 2019).

As it stands, there is no international governance framework designed to address the potential problems that may arise from the research and/or implementation of geoengineering technologies. The complexity of the climate system means that there is a great degree of uncertainty about how the effects of geoengineering may manifest physically and geographically. This includes issues of environmental justice, where there is a possibility that marginalised communities may be more adversely affected (Buck et al., 2014) by the potential side effects of geoengineering technologies, and basic ethical questions of whether it is morally 'right' to work towards employing geoengineering in the first place. Whilst the geoengineering research community has been fairly reflexive in its approach to research, consistently acknowledging these numerous concerns, there is still a long way to go in addressing them. Increased emphasis on the social and political aspects of geoengineering is necessary to gain a more holistic and inclusive approach to research.

In the context of a global capitalist system that privileges over-consumption and exploitation of cheap fossil fuel resources, the notion of geoengineering provides a potentially problematic techno-fix that ignores the root systemic issues that have caused climate change. Historically, developed countries are most responsible for rampant greenhouse gas emissions, and happen to be the actors that are most heavily involved in discussion and research around geoengineering technologies (Oldham et al., 2014). Participation in the geoengineering field here, then, is a key issue that deserves urgent attention. Coupled with the previously mentioned environmental justice dimension and Western ideals of control that permeate the scientific ideology behind these technologies, there are significant power dynamics at play within the field and geoengineering discourse more broadly.

### **1.3.1 A feminist approach**

These issues of participation, concern over environmental justice, power dynamics and Western ideals of control over nature illustrate the complex social and ideological underpinnings of geoengineering ethics. These issues of domination are explored deeply in feminist theory (Merchant, 1981) and therefore a feminist lens serves to explore how these issues intersect. Indeed, Buck et al. (2014) conclude that it is ‘an area ripe for gender analysis’ (p. 651). Exploring the gendered dimensions of geoengineering provides a new and valuable lens through which to traverse these ethical questions. Situating technologies within their proper sociopolitical context is vitally important as ‘people’s perceptions of the risks associated with science and technology are filtered through social and cultural lenses’ (Corner & Pidgeon, 2010, p. 28).

### **1.4 Project aims**

This project aims to explore the power relations of the geoengineering field in more depth, with particular emphasis on gendered ideologies and what a feminist theoretical framework may be able to contribute to the field. The key site of analysis will be discourse, with the view that discourse constitutes social practice and is therefore a useful starting point for exploring societal power (re)production. The core aims of the project are summarised in the questions below:

- In what ways are Western constructions of gender present in the chosen geoengineering discourse?
- What does the discourse reveal about the ways in which gendered power manifests within the geoengineering field?
- Can a technocratic, scientific ‘solution’ such as geoengineering be reconciled with feminist ideals?

## **1.5 Research justification and relevance**

The field of Sustainability Science is fundamentally concerned with the relationships between society and nature (Kates et al., 2001), and one that is inherently transdisciplinary in its approach. Geoengineering research has focused heavily on the scientific aspects of the field, with the result that social, ethical and political issues have been side-lined. This means that the geoengineering field needs new theoretical frameworks and ideas through which to analyse the implications of such technologies. This project aims to contribute to the literature by exploring a topic that has hitherto been grossly underexplored: the linkages between geoengineering and gender. It is hoped that a gendered analysis will provide some fresh insight into the issues of justice that currently exist in geoengineering discourse whilst also bringing a transdisciplinary approach which is characteristic of the sustainability science field.

## 2 LITERATURE REVIEW

### 2.1 Geoengineering

#### 2.1.1 Types of geoengineering

The term ‘geoengineering’ is a broad one that encompasses a wide suite of different technologies. These technologies are generally split into two groups: Solar Radiation Management (SRM) and Carbon Dioxide Removal (CDR). SRM technologies aim to limit incoming solar radiation into the earth’s atmosphere, whilst CDR’s objective is to remove excess carbon dioxide from the air (Royal Society, 2009). Figure 1 illustrates some specific examples of SRM and CDR technologies.

<b>Solar Radiation Management</b>	<b>Carbon Dioxide Removal</b>
Stratospheric aerosol injection	Ocean iron fertilization
Space mirrors	Direct air capture
Marine cloud brightening	Afforestation
	BECCs (Bioenergy With Carbon Capture & Storage)

Figure 1: examples of different geoengineering technologies by type (information from Royal Society, 2009).

SRM and CDR thus differ in their core approach; the objective of SRM is to mitigate global temperature rise as rapidly as possible, whereas CDR aims to address the root cause of climate change through focus on carbon dioxide reduction. At face value, then, CDR appears the most logical addition to aid mitigation efforts, and its widespread inclusion in IAMs would support this thesis. Indeed, climate modelling suggests that the 1.5°C target decided in Paris is an impossibility without the deployment of CDR technologies (Luderer et al., 2018). CDR tends to be viewed as the more ‘natural’ of the two approaches that generally carries much lower risk comparative to SRM (Royal Society, 2009). Conversely, SRM tends to garner more coverage in debates about geoengineering, particularly from a critical standpoint,

because of its perceived dangers; this does not mean, however, that CDR is a technology that is issue-free. Widespread implementation of CDR would require significant investment in infrastructure. Without advanced policy implementation, it is unlikely that CDR on a large scale would be economically feasible (Faran & Olsson, 2018; Gough et al., 2018).

Additionally, it would take decades for the effects of CDR technologies to manifest properly (Caldeira, Govindasamy & Cao, 2013). In juxtaposition, SRM technologies such as stratospheric aerosol injection would have a more rapid response time (MacMartin, Ricke & Keith, 2018) and are alleged to be a significantly more low-cost option (McClellan, Keith & Apt, 2012). SRM, however, carries more risks than CDR; such as the potential for unintended side effects, and the danger of rapid warming if SRM were to be suddenly stopped (Matthews & Caldeira, 2007). Thus, merits and drawbacks depend on individual technologies.

### **2.1.2 Ethics and morality**

Much work focuses on the science and engineering of geoengineering technologies. Whilst this is of course an integral part of determining their potential viability as a means of addressing climate change, the social, political and ethical dimensions of these technologies are of equal critical importance and must not be viewed in isolation. Indeed, these dimensions often remain underdeveloped and/or neglected (Gardiner, 2011a; Szerszynski, Kearnes, Macnaghten, Owen & Stilgoe, 2013).

The idea of geoengineering is fraught with a variety of ethical considerations. One of the main ethical concerns about geoengineering is the ‘moral hazard’ of whether it would serve as a distraction from substantive mitigation efforts, compounded by some advocates making the argument that certain geoengineering proposals may cost less than large-scale mitigation (Corner & Pidgeon, 2010). This means that, further down the line, certain powerful interests may lobby for geoengineering because it is in line with their particular

agenda. Geoengineering is arguably a continuation of the status quo - it does not serve to challenge capitalist systems that are deeply flawed and unsustainable, and coupled with the threat of lobby groups taking a vested interest in geoengineering technologies, there is a danger of moral corruption. Another key argument that permeates the discourse is the idea that more research should be pursued to inform decision making in the future and ensure that all means of addressing climate change have been explored thoroughly. The argument for preparing for all eventualities is one that is dangerous from an ethical standpoint, particularly because of its pervasiveness throughout the discourse. Upon first impression this line of thinking is fairly persuasive, particularly to a broad audience: climate change is a threat, and it is only logical to explore all options to address it. Gardiner (2011a) notes that 'we - the current generation, and especially those in the affluent countries - are particularly vulnerable to moral corruption' (p. 345) and should thus be wary about approaches that in any way have the appearance of attempting to absolve our moral responsibilities. This places important emphasis on the power dynamics of geoengineering as a proposal; the critical but uncomfortable question of whether geoengineering simply embodies a potentially effective temporary solution for climate change, or if it represents a more problematic continuation of a deeply flawed and inequitable system.

Issues of equity are also of central concern to geoengineering. Calls for greater public engagement and representation are beginning to be met through more diverse studies and workshops, but there is still a long way to go before reaching an ampler level of representation. The idea of consent is a difficult one here; people in developing countries are least accountable for causing climate change, and yet it is highly likely that they will be underrepresented in the geoengineering decision making process (Corner & Pidgen, 2010). Similarly, the relative benefits and burdens of geoengineering will be most felt by future generations (Gardiner, 2011; Preston, 2013), who have no influence over decision making in

the present. There is a tendency to view issues of equity related to geoengineering as an ‘empirical question, answerable by (more) scientific analysis’ (Flegal & Gupta, 2017, p. 56), concerned almost entirely with issues of equal distribution of risks/outcomes. This approach is troublesome, as it fails to account for the broader systemic influences that affect issues of equity, and privileges scientific analysis as the best form of problem solving. Ignoring broader sociocultural and political contexts here would be deeply troubling.

### **2.1.3 Existing research on geoengineering discourse**

A small body of literature exists that explores the nuances of geoengineering discourse, and how it has evolved over time. Much of the prevailing research concerning geoengineering discourse uses media coverage as its analytical focus (Anshelm & Hansson, 2014; Luokkanen, Huttunen & Hildén, 2014; Nerlich, & Jaspal, 2012; Porter & Hulme, 2013; Scholte, Vasileiadou & Petersen, 2013). There have also been studies centred on the academic discourse (Bellamy, Chilvers, Vaughan and Lenton, 2012; Huttunen & Hildén, 2014) and important geoengineering policy documents (Gardiner, 2011b; Jacobson, 2018). Collectively, this literature aims to explore the interpretive flexibility of geoengineering; that is, how geoengineering technologies are discursively and socially constructed and how different meanings, constructed by divergent groups, manifest and exist. One of the basic points of contention within the discourse is the word ‘geoengineering’ itself. Geoengineering is an umbrella term used to encompass a variety of different technologies, including both subsets of solar radiation management and carbon dioxide removal. Criticism has been levelled at the term for being overly ambiguous for encompassing such a broad range of technologies with different risk profiles. At the same time, it could be said that the different characteristics of these technologies, when referred to as a whole, cancel each other out. Much of this debate around the word itself aims to delineate boundaries, which, especially for

technologies that are so much in their infancy, is difficult. Instead, Cairns and Stirling (2014) offer a helpful alternative to this dispute, suggesting geoengineering be viewed instead as ‘a discursive phenomenon, the bounds of which are continually being negotiated’ (p. 26).

Key framings have been uncovered within this body of literature that help to situate how geoengineering is discussed in general. There are two key framings employed across the discourse that are commonly used when discussing geoengineering: the ‘climate emergency’ framing, and the ‘plan B’ approach that portrays geoengineering as an insurance plan of sorts (Asayama, 2015; Gardiner, 2011b; Nerlich & Jaspal; Sikka, 2012). Both these framings serve as powerful tools of legitimization: they justify the argument that, at the very least, more research into geoengineering is needed, although do not fully examine the underlying assumptions that permeate this argument. Asayama (2015) uses the term ‘apocalyptic catastrophism’ to refer to this collective framing of climate change that embodies the ‘imagination of a dire future climate and the discourse to feed the idea of a ‘techno-fix’ as an alternative to curbing GHG emissions’ (p. 90). This framing is problematic in that it tends to gloss over the huge and varied levels of uncertainty that exist not only in the science, but also in the social and political dimensions of geoengineering. Whilst the emergency framing is useful in highlighting the dangers of climate change, it runs the risk of limiting the discourse to an emphasis on hubristic exceptionalism (Sikka, 2012).

Metaphor as a discursive device is also explored in some of this literature and ties in with these emergency framings. Three ‘master’ metaphors are identified that are used frequently throughout geoengineering discourse: ‘the planet is a body’, ‘the planet is a machine’ and ‘the planet is a patient/addict’ (Nerlich & Jaspal, 2012). Before the increase in critical discourse around geoengineering, these metaphors were generally applied in a context that was favourable to geoengineering. They reinforced the notion that the earth ‘(as a body/machine) is critically/catastrophically broken/ill and can only be fixed/healed by

geoengineering' (Nerlich & Jaspal, 2012, p. 147), portraying geoengineering as an ultimate 'cure' for climate change. Over subsequent years, the discourse has evolved to encompass a more critical stance; these metaphors are still employed, but are also used as a means to critique, highlighting the danger of reliance on geoengineering and the fallacious idea of it being a 'fix' for climate change (Luokkanen et al., 2014). This is one manifestation of the surprising degree of reflexivity within geoengineering discourse (Anshelm & Hansson, 2014), whereby researchers are generally careful to acknowledge the associated risks of the technologies.

Public participation studies have also uncovered some interesting facets of the discourse. Most studies have been conducted with publics in developed countries such as the UK, however participatory projects in developing countries are slowly becoming more common (Carr & Yung, 2018). The way that a technology is framed is crucial in how the public will conceptualise and view it. One of the most fundamental ideas at the heart of geoengineering discourse is the notion of human-nature relationships and how nature is conceptualized, and it has been indicated that this is a key influence in how publics will react to geoengineering (Corner, Parkhill, Pidgeon & Vaughan, 2013). Indeed, Corner & Pidgeon (2015) found that framing geoengineering using natural analogies led to increased acceptance amongst participants in their study. This provides key insight into how framings are important in influencing how technologies are viewed. Indeed, conceptions of nature have been found to be used on both sides of the geoengineering argument as a means of framing arguments for or against it. Porter & Hulme (2013) discovered that in articles that were more in opposition to geoengineering, nature was portrayed as an indomitable force unable to be tamed by humans. Conversely, in articles with a more favourable stance towards geoengineering, nature was framed as malleable, a system able to be bent to human will.

Whilst most studies have tended to focus on discourse in the media, a few have acknowledged the research process as a focal point where knowledge becomes situated and certain framings start to be applied, both consciously and unconsciously. Researchers, particularly due to the uncertain nature of geoengineering, act as crucial instigators in laying the foundation for subsequent decision making about geoengineering. The framing of geoengineering by researchers is thus vital, as researchers' views 'can gradually filter through the science-policy interface and influence the political debate on solutions' (Huttunen & Hildén, 2014, p. 5). Bellamy et al. (2012) explore the importance of this framing process at the academic level through their analysis of various geoengineering appraisals and subsequent finding of a 'closing down' process, whereby low levels of reflexivity led to an emphasis on particular values and assumptions. In this context, reflexivity is identified as the degree to which geoengineering appraisals identify how framing conditions might affect their results. In this sense, the scope of geoengineering discourse becomes narrowed from its very outset. This is compounded by a need to encourage greater syntheses between disciplines and researchers to encourage transparency and a more holistic approach to geoengineering research (Bellamy et al., 2012; Huttunen & Hildén, 2014). In recent years this has improved somewhat, with the geoengineering field becoming steadily more transdisciplinary, yet it remains something to be mindful of due to the scope of issues associated with geoengineering that reach far beyond mere science and engineering into the realms of the social and political.

#### **2.1.4 Geoengineering through the lens of gender**

The tendency of existing discourse to frame geoengineering within somewhat narrow parameters that focus on the emergency angle risks neglecting important social and political dimensions. As discussed in section 2.1.2, there has been literature focusing on the ethics of

geoengineering that helps to re-situate these technologies within a more holistic societal view. However, there is still a significant need for more research that examines geoengineering from a variety of viewpoints to ensure that the discourse remains comprehensive and pushes the bounds of how geoengineering is discussed and framed. It is also helpful to have more specific frameworks and ideas through which to explore issues of ethics and justice. One such lens that might be helpful in further analysing the issues associated with geoengineering is that of gender. Upon first impression, the link between geoengineering and gender may not appear glaringly obvious. It is not a relationship that has been given much attention by researchers, and yet one that may provide some valuable insight into both the ideological underpinnings of the geoengineering field, and the ethical and justice issues that have arisen. Indeed, only one paper exists that serves to speculate on the importance of the gender and geoengineering linkage. Buck et al. (2014) highlight four key areas where gender is highly relevant to the geoengineering debate: who is pushing the agenda, the idea of controlling nature, the traditional masculine character of engineering disciplines and the uneven distribution of potential impacts and benefits.

It has slowly become more openly acknowledged that the diversity of the geoengineering field is extremely lacking. Most of the field is made up of men, who are predominantly white, and research is generally confined to Western institutions. In media assertions about geoengineering, journal authorship and participation in an IPCC meeting about geoengineering, women's participation was 3%, 17% and 15% respectively (Buck et al., 2014) indicating a clear gender imbalance within the field. This is problematic as it means that those shaping the geoengineering agenda are by no means illustrative of those whose interests are implicated. This has implications for how risks might be perceived differently by different demographics (Franz-Balsen, 2014; Terry, 2009), and for the 'framing and decision-

making powers that participation in geoengineering research implies' (Buck et al., 2014, p. 654).

Regardless of the intentions behind it, geoengineering as a concept embodies ideas about controlling nature, an archetypally masculine approach with its roots in Enlightenment scientific thought. Viewing nature as a machine, and a preoccupation with predictability and objectivity is characteristic of this school of thought. Geoengineering presents an extraordinarily complex example whereby effects on climate systems can never be fully predicted, yet the use of mechanistic metaphors in geoengineering discourse as outlined in section 2.1.3 indicates that these visions of control are present in the discourse regardless. In tandem with this, Buck et al (2014) note how engineering disciplines have traditionally been the site of (re)production of normative values that conflate science and technology with masculinity; technological prowess is coded as inherently masculine. Thus, the science and engineering background of geoengineering is inherently gendered, and it is important to acknowledge both the historical context and potential effects of these ideological foundations.

Lastly, the distribution of impacts and benefits of geoengineering have a gender dimension, too. Much feminist thought has drawn parallels between the subjugation of nature and the subjugation of women (this is further explored in section 2.2.1), and climate change represents an example of this. Adverse environmental impacts and events tend to affect women the most (Buck et al., 2014), and therefore there is a risk that these patterns of inequality may be reproduced through geoengineering, particularly due to the top-down nature of technologies such as SRM.

These different angles show that there are many ways in which geoengineering technologies are gendered, and that gender is therefore an important axis of analysis that should not be ignored. Indeed, Buck et al. (2014) conclude that without further elaboration of

this geoengineering-gender nexus, geoengineering technologies remain ‘particularly vulnerable to an ecofeminist critique, and a failure to acknowledge gender-associated concerns could easily derail the geoengineering agenda’ (p. 653).

## **2.2 Gender**

### **2.2.1 Western constructions of gender**

Feminist theory is incredibly varied and diverse in its different branches, with huge cultural variation across countries. There is no one-size-fits-all approach, and to assume complete universality within the female (or male) experience would be fallacious and severely myopic. The theoretical foundations of this project are concerned more broadly with hegemonic Western masculinities and how these underpin human relationships with nature in the Western world. As the locus of geoengineering research is situated in Western countries and institutions, this theoretical focus seems a prudent starting point for broader exploration of gender and justice issues. Western conceptions of nature and the environment have, and continue to be, inextricably bound up in constructions of gender. One such field that aims to concretely explore how gender and nature are mutually constructed is that of Ecological Feminism, hereafter referred to as Ecofeminism. Ecofeminism is predicated on the notion that the ‘ideology which authorizes oppressions such as those based on race, class, gender, sexuality, physical abilities, and species is the same ideology which sanctions the oppression of nature’ (Gaard, 1993, p. 1). Thus, ecofeminism often extrapolates to include other axes of exploitation, not just gender, and can therefore provide a powerful analytical lens through which to explore issues of justice and power.

Much of the hierarchical structuring in Western culture lies in its inherent dualisms, which serve to maintain various spheres of otherness. Dualisms embody a process of differentiation, whereby anything ‘other’ to the dominant ideal is perceived as inferior. Thus,

dualisms facilitate conditions of domination and the accumulation of power in certain areas of society. The most fundamental of these dualisms in Western society is that of culture versus nature, which has facilitated a Western growth process predicated on environmental exploitation (Merchant, 1981). European and American society strove to distance itself from all that was epitomized by nature, therefore constructing nature as 'weak'. The nature-culture divide serves to promote the idea that nature is ontologically split from the human realm, and that humans are therefore disconnected from nature and viewed as external manipulators (Plumwood, 1991). Ultimately, that which is deemed to be categorically 'human', and representative of the broader emphasis on culture, is constructed in opposition to all that is natural. These human characteristics, such as rationality, are intrinsically masculine; humanity is therefore not only constructed in contrast to nature, but also femininity. Some other dualisms that constitute power in similar ways are reason/nature, male/female, human/nature, mind/body, reason/emotion and freedom/necessity (Plumwood, 1993).

Dualisms are at the very core of the institutions that make up Western society. Contemporary science has been constructed as a ubiquitous system that claims a value-neutral approach, privileging the idea of objectivity. The Baconian scientific view that evolved from the Western Scientific Revolution is one that is built upon dichotomies and predicated on the subjugation of women and nature. Shiva (1988) describes the Western scientific approach as 'reductionist' due to its inherent homogeneity; not only did it curtail the process of knowledge accumulation by rejecting other knowledge producers and ways of knowing (for example Indigenous peoples), but by treating nature as a passive object to be manipulated its natural capacity to regenerate was diminished. This scientific project was born from a specific societal elite, and masqueraded behind claims of universality despite its gendered, patriarchal nature. Indeed, 'patriarchy as the new scientific and technological power was a political need of emerging industrial capitalism.' (Shiva, 1988, p. 17); the

gendered nature of science served to extrapolate power into other Western systems, too. Industrial capitalism is a powerful system that relies on a rational worldview which contends that science and technology are intrinsically progressive and that humans hold authority over non-human nature (King, 1990). Here, then, it starts to become evident how the Western masculine project of industrial capitalism is deeply implicated in contributing to environmental degradation and climate change.

Ecofeminism thus provides a valuable starting point for better identifying Western patterns of dominance that have contributed to climate change. Despite its initial focus on gender dimensions, ‘ecofeminism is not "only" about nature, but rather about contextuality, about understanding our lives and our struggles in their broadest form’ (Vance, 1990, p. 134).

### **2.2.2 Gender and climate change**

Section 2.2.1 highlights how Western societal systems such as science and capitalism are inherently gendered in their constructions. It therefore seems reasonable to draw the conclusion that climate change is also gendered, as it is a product of Western patterns of overconsumption and environmental exploitation facilitated by the capitalist mode of production. Aside from the field of Ecofeminism, however, the use of gender as an analytical tool remains largely lacking in the environmental sciences (MacGregor, 2010). When gender does appear, it tends to be in very binary terms. The pressure of trying to implement gender sensitive policy making means that for bureaucratic purposes, gender must be reduced to easily definable categories. This has frequently led to the term gender becoming synonymous with ‘women’, or with presupposed ideas about universalised differences between all men and women (Arora-Jonsson, 2014), structuring the idea in a generally restrictive and essentialist way.

Research that does exist exploring the linkages between gender, the environment and climate change tends to be focused on the disproportionate impact of climate change on women in the Global South. Gender has an impact on shaping vulnerability both through poor women having less access to resources than men, and through social/cultural norms about decision making and divisions of labour (Terry, 2009). Gender may also impact the way in which individuals perceive environmental risks, with white men the most likely to trivialise perceived risk (Franz-Balsen, 2014; Terry, 2009). These are real and problematic elements that need to be appropriately acknowledged and addressed, however there is also a history of generalizing the experiences of women, particularly in the Global South. Where gender is not given appropriate weight as an analytical tool, climate change discourse tends to depict women in the Global South as a homogenous group defined by their vulnerability (Arora-Jonsson, 2011). This narrative has the dual effect of stripping these women of their agency, while also ignoring the systemic power dynamics that give rise to these inequalities in the first place. One of the key approaches that has attempted to address gender imbalance in the environmental sector is the employment of gender mainstreaming in policy making, which aims to ensure appropriate attention is given to gender as an issue. This is an important idea, yet when gender is understood in reductive, binary terms and the application of gender mainstreaming is uncritical, it risks becoming a technocratic exercise with little depth (Alston, 2014; Arora-Jonsson, 2014).

To do justice to issues of gender, a more comprehensive approach needs to be taken in the context of climate change. More attention needs to be paid to the structural and ideological power differentials in Western society that are at the root of climate change and many other global inequalities (MacGregor, 2010; Arora-Jonsson, 2014). There is a need to reconceptualize many of the gendered dualisms that are intrinsic to Western thought, for example by foregrounding a queer, LGBTQ+ inclusive approach to gender (Gaard, 2015) and

striving for an intersectional approach to issues of gender that can further help to uncover and critique asymmetrical power relations (Kaijser & Kronsell, 2014).

### **2.2.3 Feminist Science Studies**

Another field that provides helpful insight into the relevant gendered dimensions of science and technology and their interplay with society is that of Feminist Science Studies, hereafter referred to as FSS. There are several main tenets of the FSS approach:

1. FSS is a field that is continually evolving,
2. It explores scientific ideas and practices through a feminist analytical lens in order to deduce the linkages between feminism and science and how each might learn from the other.
3. Emphasizes intersections between race, class, gender and science and technology.
4. Preoccupation with understanding the implications of ‘situated knowledges’.
5. Gender politics are concerned with the nature culture divide and issues of agency, body and rationality: they are not just about binary relationships of men and women.
6. Exploration of the linkages between scientific knowledge and practice in order to fracture the dichotomy between scientific inquiry and policy.

(Adapted from Åsberg & Lykke, 2010)

The field of FSS is therefore one that is principally concerned with gendered power relations and how these shape, but also might be reproduced through, scientific and technological practices. A fundamental assumption for FSS scholars is that of the socio-political embeddedness of science, and it aims to challenge the distinction between ‘basic’ and ‘applied’ science (Wajcman, 2010). That is to say, *all* science is socially situated (Åsberg & Lykke, 2010).

Two key ideas that are central to the aims of FSS are the masculine associations with science and technology, and the idea of scientific objectivity, that have arisen from hegemonic Western masculinities. Science, and particularly technology tend to be coded as intrinsically masculine within Western societal conditions. Hegemonic Western masculinity tends to be associated with technological power and prowess, and FSS as a field aims to uncover the fact that the way in which technology and science are coded as masculine is by no means inevitable or natural; rather, as a result of gendered power relations that permeate Western society (Wajcman, 2000). As explored in section 2.2.1, the Western scientific project is deeply gendered. This is also true for engineering disciplines, which began to arise in the late 19th century. These male dominated fields created an environment where masculinity was synonymous with the extraordinary, while femininity was being constructed as incongruous with technology. This is an important legacy that persists in the modern day, as evidenced in the well documented gender imbalances in STEM subjects (Moss-Racusin et al., 2012). In this way ‘technology, like science, is deeply implicated in this masculine project of the domination and control of women and nature’ (Wajcman, 2010, p. 146). This hegemonic masculinity is also found in the notion of scientific objectivity. Haraway (1988) uses vision as a metaphor to explore the idea of objectivity; she discusses the panoptic gaze that originates from the ‘unmarked’ position of white and male and subsequently inscribes the ‘marked’ position of marginalised groups (whether these be women, LGBTQ+ people, or people of colour). This process embodies a distancing between subject and object and fundamentally serves to maintain unequal power interests: the idea of the neutral gaze is illusory and serves only to maintain patterns of domination. Haraway (1988) suggests that an alternative to this Western myth of objectivity is the idea of ‘situated knowledges’, a feminist objective approach to knowledge production. Situated knowledges privilege context, and encourage the exchange of information with each other in order to construct a more complete

worldview in a way that disembodied objectivity does not allow. This approach accepts that 'all knowledge is a condensed node in an agonistic power field' (Haraway, 1988, p. 577), and instead of seeking to isolate nodes, it understands that by creating a 'community' whereby nodes interact with and learn from each other, a more truly objective form of knowledge production may occur.

In practice, the technocratic, archetypally masculine associations that underpin science, engineering and technology are often in direct conflict with feminist emancipatory values. They are circumspect insofar as technologies have the power to entrench existing power relations that maintain the marginalised status of many societal groups, for example through the creation of new oppressive conditions that have facilitated changes in labour patterns. Yet, part of the fundamental spirit of FSS is enquiring what feminist thought may be able to contribute to science and technology (Åsberg & Lykke, 2010). Haraway (1991) uses the notion of the cyborg to represent the inextricability of humans and machines in contemporary Western society; the concept of the cyborg represents the entangled networks of modern life that move beyond simplistic dichotomies such as human/animal. Haraway resents that different forms of feminism have sometimes sought to dominate each other in their quest to conceptualise 'woman'. The cyborg is therefore her contribution in trying to search for a new kind of coalition as part of progressive politics; it exists in opposition to some traditional forms of feminism that posit a return to a natural, 'feminized' world as the ultimate goal. Instead, the cyborg acknowledges that within modern life in the West, it is impossible to extricate oneself from the technological innovations shaping society. Unlike in some other feminist literature, however, technology is not viewed as inherently oppressive: Haraway (1991) rather acknowledges the transformational potential here, too. Indeed, 'the main trouble with cyborgs, of course, is that they are the illegitimate offspring of militarism and patriarchal capitalism, not to mention state socialism. But illegitimate offspring are often

exceedingly unfaithful to their origins' (Haraway, 1991, p. 9-10). It is thus important to acknowledge that technology has oppressive power that may be used to dominate, however in striving for a more cohesive, progressive politics, the new networks that it has also created may be utilised to challenge oppressive power structures. Haraway (1991) therefore offers an additional optimistic dimension to technological innovation that is worth noting.

## 3 METHODOLOGY

Critical discourse analysis is a methodology that aims to uncover unequal power relations within society, with an emancipatory ideal at its core. This methodology, therefore, shares its base ethos with feminist ideals and was thus deemed a natural complement to the theoretical basis of this project.

### 3.1 Critical Discourse Analysis: an introduction

For critical discourse analysts, discourse is a form of social practice (Chouliaraki & Fairclough, 1999; Fairclough, 1989; Jorgensen & Phillips, 2002; Wodak, 2001). It encompasses various semiotic components, including language, that are viewed not as separate from society, but as an important part of social systems and processes. These forms of semiosis are also determined by non-discursive processes, and thus are engaged in a dialectical relationship with society. That is to say, discourse is constituted by social phenomena and has social results, whilst also simultaneously reflecting and being a part of social processes (Fairclough, 1989).

At its core, critical discourse analysis is concerned with power. To gain some clarity on this rather nebulous concept, Foucault's work on power and knowledge serves as a helpful starting point. According to Foucault (1980), power is not something that is inherently oppressive, nor is it necessarily instigated by specific agents; instead, it permeates all social practices, and facilitates social production such as that of knowledge and discourse. In this sense, power is closely interlinked with discourse and the production of social meaning. Critical discourse analysis aims to uncover uneven power relations within society and subscribes to the idea that these power relations are both created by and reproduced through discursive practices (Chouliaraki & Fairclough, 1999; Fairclough, 1989; Fairclough, 1995; Jorgensen & Phillips, 2002; Wodak, 2001). These power structures are not necessarily

explicit in their domination; they often embody taken for granted societal norms that play a significant role in the creation and maintenance of social hierarchies. Their preeminence results from the way in which they are naturalised into the social order, becoming an unquestionable part of the fabric of society. Gramsci (1971) refers to this social consensus that occurs as part of the macro level of society as hegemony; systems by which powerful elites are able to maintain their dominance over others. The critical element in critical discourse analysis therefore aims to unveil these power structures, revealing the more invisible ways that domination manifests itself within society and how discursive practices serve the maintenance of such social structures (Fairclough, 1995; Jorgensen & Phillips, 2002; Wodak, 2001).

This principal concern with power asymmetry means that critical discourse analysis is not understood as a politically neutral endeavour. It tends to forefront an emancipatory agenda through its dedication to social change, generally aligning itself with marginalised societal groups (Jorgensen & Phillips, 2002; Van Dijk, 1993). A 'neutral' position, therefore, is impossible. The researcher must directly set out their stance, both in a sociopolitical sense, and through their general principles and aims. This transparency is important, as it provides fundamental background of the analytical process for the reader.

Critical discourse analysis has its roots in a hermeneutical approach to analysis, whereby it is deeply concerned with processes of interpretation. Wodak (2001) notes the idea of the 'hermeneutic circle', whereby meaning can only be derived from the contextual whole. This whole, however, is formed of different components. This hermeneutical model may not be strictly comprehensive enough in the context of discourse analysis, but it provides a useful foundation for the reflexive nature of the approach. Critical discourse analysis is deeply situated in its chosen theoretical context. From this foundation, a process of operationalization relates this theory to the chosen analytical context and methodological

choices are made such as the selection of discourse material to be studied. From here, a process of interpretation links the chosen data back to the overarching theoretical framework. Crucially, this reflexive process is cyclical in nature, meaning that the research process remains dynamic throughout. This relationship between theory and discourse is illustrated in figure 2.

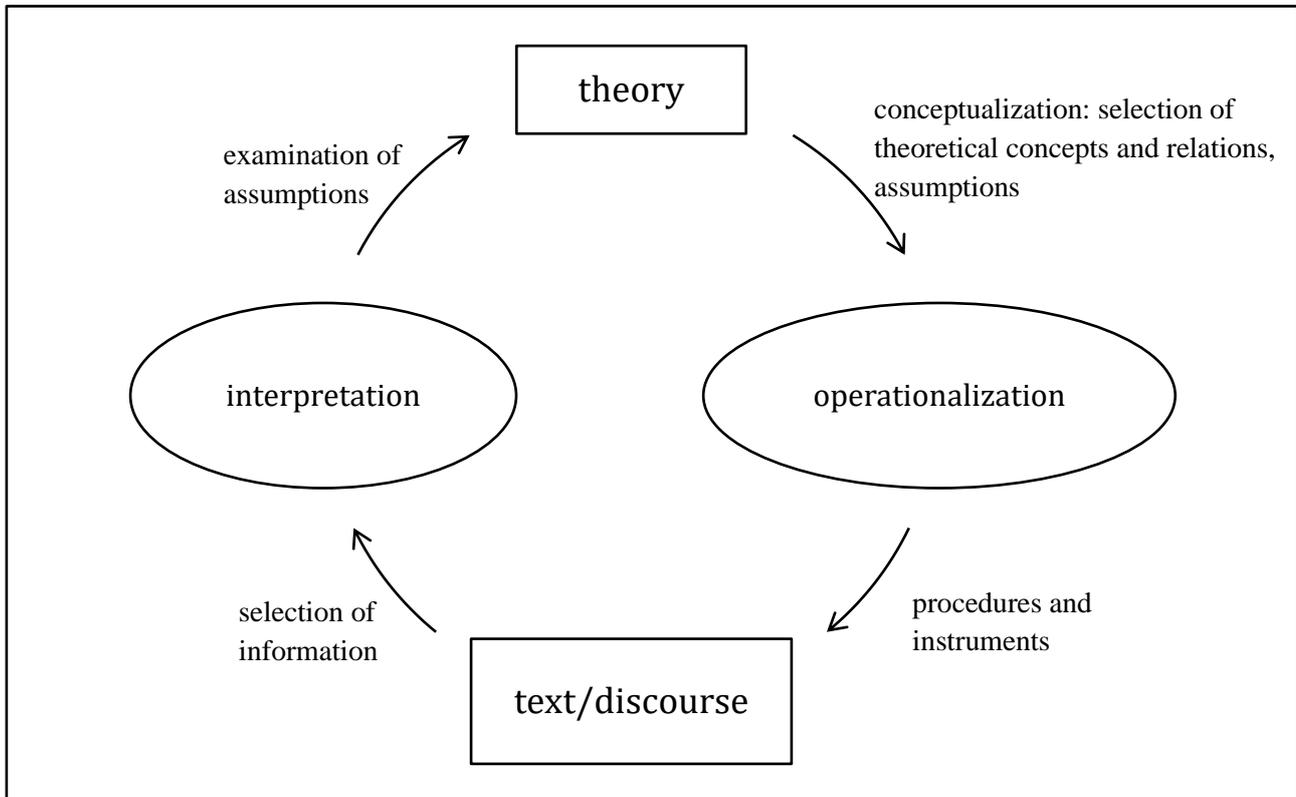


Figure 2. 'Empirical research as a circular process'. Adapted from *Methods of Critical Discourse Analysis* (p.19), by R. Wodak & M. Meyer (Eds.), 2001, London: Sage.

### 3.1.1 Fairclough's Three-Dimensional Model

The analytical framework utilised in this study is Fairclough's (1995) three-dimensional model, indicated in figure 3. This model exhibits the different units of analysis that comprise this approach to critical discourse analysis, three dimensions of:

- Text
- Discourse practice
- Sociocultural practice

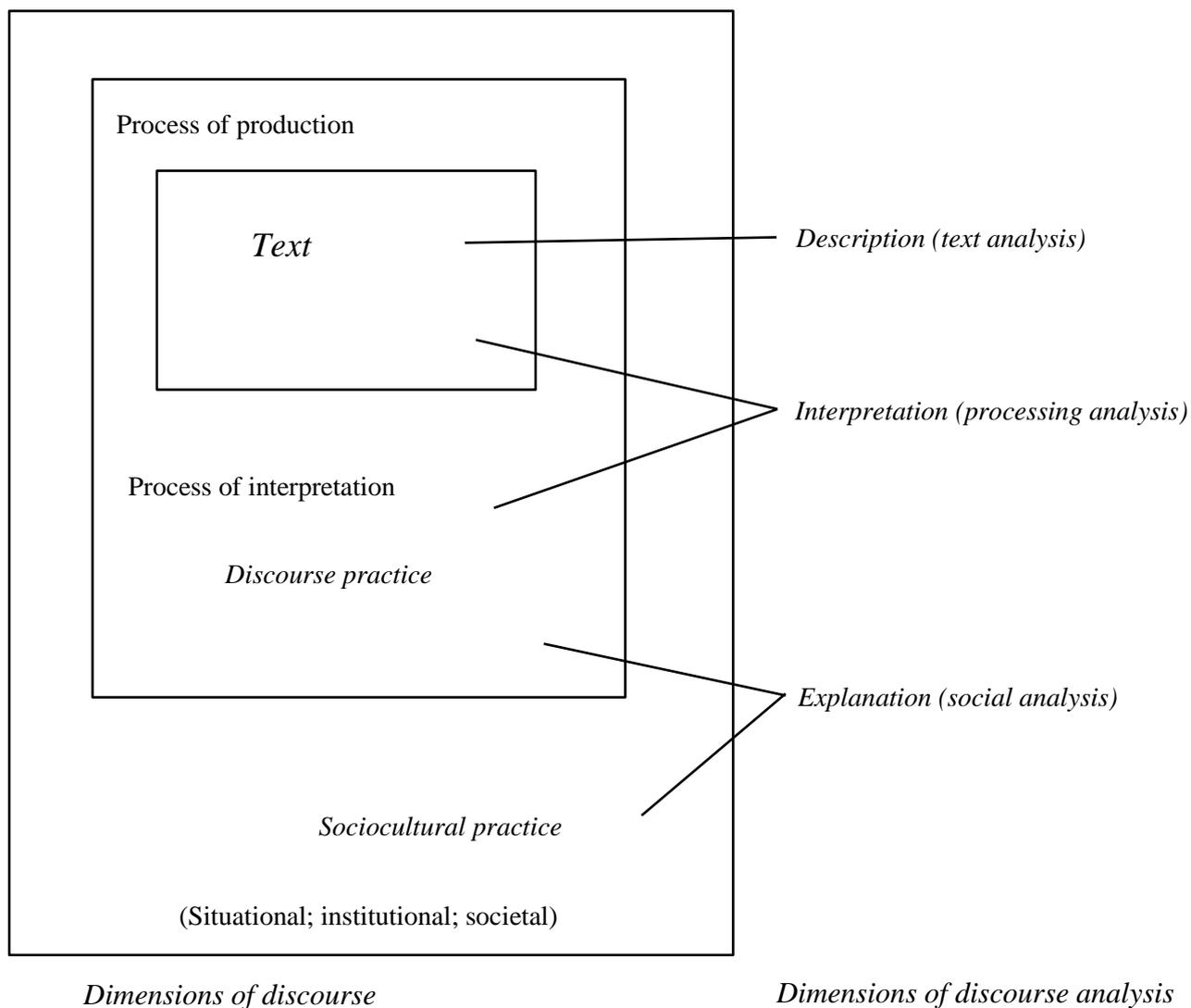


Figure 3. Fairclough's three-dimensional analytical framework for critical discourse analysis. Adapted from *Critical Discourse Analysis: the Critical Study of Language* (p. 98), by N. Fairclough, 1995, Essex: Longman.

The procedure begins with the text, a specific unit of the broader discourse and the site of textual analysis that focuses on things like the linguistic characteristics of the text. From here, the interpretive process is catalysed; the relationship between the discursive processes of production and interpretation and the text are explored. Finally, further interpretation aims to situate the discourse practice within its broader sociocultural context.

### **3.1.2 Towards a feminist critical discourse analysis**

Given that the foundation of critical discourse analysis is based in identifying and calling attention to unequal power relations, it follows that it has some significant similarities with feminist theory. Indeed, both critical discourse analysis as a methodology, and much feminist theory, have markedly similar objectives in their focus on emancipatory potential. Van Dijk (1991) notes that, as the field of critical discourse analysis began to form in the 1980s, feminist analytical approaches that had begun to interrogate group power relations and ideas of domination helped to solidify critical discourse analysis's forefronting of sociopolitical issues. Thus, whilst general theory on critical discourse analysis has not necessarily tended to commonly make explicit links to feminist theory or roots, there is a definite link between the two fields.

The central focus on sociopolitical issues within critical discourse analysis means that, as a practice, it is an inherently political one. In this sense, it is somewhat at odds with archetypal values of neutrality within analysis. Van Dijk (1993) notes that some of a more 'traditional' academic persuasion, generally white or male scholars, abhor the idea of taking a political stance in research, and have levelled criticism at the field of critical discourse analysis due to this outright dismissal of the contextual merits of partisanship. Through this criticism, they 'condemn mixing scholarship with 'politics', and thereby they do precisely that' (Van Dijk, 1993, p. 253). Indeed, this mentality, whilst not only deeply ironic, serves to reproduce patterns of dominance within scholarship. Despite this criticism, part of the process of critical discourse analysis is the discourse analyst explicitly positioning themselves within the research project and providing transparency about their approach. Other approaches may lack this transparency. Embracing of a particular stance, and thus deeply acknowledging the sociopolitical implications of the study itself, draws parallels to feminist theory that

challenges the notion of scientific neutrality for its inability to acknowledge the historical and social construction of knowledge (Lazar, 2007).

The preoccupation with structural power inequalities means that critical discourse analysis generally takes a more ‘top-down’ approach to analysis (Van Dijk, 1993; Bucholtz, 2003). This may have the unintended effect of alluding to assumptions that power is forced upon unwitting members of society in a one-sided manner; in reality, the ‘bottom-up’ angle whereby power may be contested is of equal importance. However, for the purpose of this project, the ‘top-down’ focus will take precedent in the context of aforementioned feminist theory that critiques the historical lack of focus on more macro level analyses of gendered power relations in literature dealing with gender and the environment. Similarly, the foregrounding of the ideological notion of power pervading discourse aims to emphasize this focus on broader issues of gendered power inequalities, instead of attempting to uncover individual instances of dominance at a micro level. Embracing a feminist critical discourse analysis approach forefronts gender ideology and how it may feed into systemic power inequalities (Bucholtz, 2003; Lazar, 2007).

### **3.2 Methodological approach of the project**

As previously discussed in Chapter 2, there is no existing comprehensive governance framework for geoengineering technologies, and state actors have been reluctant to actively come out in support of these technologies due to the controversy surrounding them. This means, therefore, that the discourse around these technologies is being produced by a specific group of actors - namely academic researchers, and media that chooses to report on geoengineering. In light of the focus on power relations within critical discourse analysis, for this project I chose to focus on the academic sphere as this is the foremost site of discourse production. The process began with narrowing down a selection of mainstream academic

journals focused around issues of climate and atmospheric science. Figure 4 indicates the general selection criteria used for the collection of texts for the corpus used in this study.

<b>Selection criteria for texts</b>	
Journals used	Nature Nature Climate Change Nature Geoscience Climatic Change Proceedings of the National Academy of Sciences Science
Time period	2006-present day
Type of text	Editorial, Commentary, Opinion, Letter, Perspective

Figure 4. General selection criteria used for text database.

These six journals were selected as they were deemed some of the most well-known journals that have engaged with the debate around geoengineering thus far. Journals with a more reputable status were favoured as they are likely to provide the most significant foundation of the current discourse through their prestige; in itself, an interesting insight into power flows within institutions and the privileging of particular sites of discourse production.

From these journals, I created a database of texts to be analysed. This was achieved through simple searching of each journal database using the base keywords of ‘geoengineering’ and ‘climate engineering’: these sufficed to uncover appropriate material as the geoengineering field remains relatively small. Texts were then selected when they fit the other set criteria, such as type of text and the date it was produced. The date range selected for the project was a span of 13 years, from 2006-2019. 2006 was picked as the outer limit of the study as it was the year that Paul Crutzen published his essay on stratospheric sulfur injections in the journal *Climatic Change*, widely regarded by most as the catalyst for contemporary debates around geoengineering technologies.

As mentioned, academic oriented texts were chosen due to interest in academia as a site of both knowledge and discourse production; through research, and the subsequent writing about research. One of the key aims of the analysis was to gain a broad overview of the discourse around geoengineering as a whole. I therefore decided that academic journal articles were not the best choice of text for two main reasons. Firstly, their focus is, naturally, in niche areas of the field and it was far too big a task to try and account for the specifics of all the different technologies that are included under the umbrella term of geoengineering and the nuances within each and every one of these technologies. Secondly, journal papers tend to be long in length, providing a logistical barrier to analysis: realistically, providing an in-depth analysis of many papers of this length would mean a database with a smaller number of texts, which would have narrowed the scope even further.

In light of these considerations, I decided to look at the text types indicated in figure 4, including opinion and editorial pieces, because they provided a more succinct contribution to the discourse, foregrounding key sentiments without being so specific as to limit the scope of analysis. Their naturally shorter length, too, enabled me to gather and analyse more texts than I otherwise might have been able to. In total, 43 texts were analysed from across the six journals chosen. Greckhamer & Cilesiz (2014) note that there is no set formula for determining the appropriate number of texts to be used for a discourse analysis, as it depends on the individual study, but that it is also up to the researcher to strike a balance between exhibiting an appropriate amount of data evidence, yet also being able to render that evidence successfully. With this in mind, the number of texts used in this study felt enough that I was able to gain an in-depth understanding of the discourse as a whole, whilst also being able to undertake the comprehensive analysis that lies at the heart of critical discourse analysis as a methodology.

### **3.2.1 Methods**

The critical discourse process began with the selection of the texts using the criteria in figure 4. An Excel database was created, documenting the basic bibliographic information of each text. This database was then expanded to include the various points of analysis such as language, use of metaphor, social groups mentioned in the texts and so on. This database was also used to track the frequency of different codes which were used to analyse the texts, which will be discussed further in Chapter 4.

### **3.2.2 Analytical tools**

As discussed, critical discourse analysis is inherently concerned with the discursive (re)production of societal power asymmetries. Through both its theoretical grounding and sociopolitical stance, this project acknowledges the problematic nature of Western binaries and essentialisms (see Chapter 2). In order to forefront this position during the analytical process, the following questions were used as a guideline of sorts throughout the analysis. The questions were formulated by Kaijser & Kronsell (2014) as an apparatus to be implemented throughout the research process, with the aim of emphasizing a more intersectional approach to analysis. Whilst all the questions were not necessarily individually answered for each text, nor always completely applicable to each text, they served as a helpful tool at all stages of the analysis and research process for linking the texts and discourse practice to broader ideological ideas rooted in intersectionality.

- Which social categories, if any, are represented in the empirical material? Which social categories are absent? Are there any observable explicit or implicit assumptions about social categories and about relations between social categories? What identities are promoted and considered to serve as grounds for political action? Are any other aspects of identity neglected or deemed insignificant?

- How are relations between humans and between humans and the environment portrayed? How is nature represented? What type of environmental knowledge is recognised and privileged?
- Are any norms for behaviour discernible in the material? Are there norms about the relation to other humans, resources, and nature? What are the norms that set the standards for a ‘good life’? How are these norms reproduced, reinforced, or challenged? How are they reflected in institutional practices?

(Kaijser & Kronsell, 2014, p. 429-430)

### **3.2.3 Position of the researcher**

The position of the discourse analyst is an important part of the research process in critical discourse analysis, due to the overtly political nature of the methodology (Chouliaraki & Fairclough, 1999; Fairclough, 1989; Fairclough, 1995; Jorgensen & Phillips, 2002; Wodak, 2001). It is crucial for the researcher to articulate their position, so as to better understand the overall aims and intentions of the project, and to provide an important background for understanding the analysis and general choices made within a project.

Here, I will attempt to elaborate on my role as the discourse analyst within this project. Fairclough (1989) describes the researcher’s pre-existing knowledge as ‘members’ resources’; an internal arsenal of information (concerning language, values and a general understanding of the world and society) that allows them to deduce meaning from discursive practices. The interpretive process is an active one, with explication resulting from interactions between the text and the members’ resources. These members’ resources are ‘sociologically determined and ideologically shaped’ (Fairclough, 1989, p. 11), therefore are in themselves a component of the research process. This serves as an example of how

discourse is socially constituted: members' resources, which are socially produced, are used to both interpret and produce texts.

My own members' resources have been shaped by a background in human and environmental geography, and sustainability science. I generally have a strong interest in feminist issues, and this was what catalysed my interest in what feminist theory might be able to contribute to the field of geoengineering and its potential justice issues. This position is acknowledged as a part of the research process in this project. In addition to outlining my own background, I have attempted to provide as much transparency as possible throughout this research, so that the foundations, aims and intentions of the project are consistently clear to the reader.

This project is contingent on the interpretation of texts that are already constructed, whole, and available to read. Whilst the interpretation is unique to the research, it is grounded in particular parameters, such as the theory outlined in Chapter 2 and the textual selection criteria that I have discussed in this chapter. The use of already existing texts minimizes the introduction of potential bias from formulating my own content, such as crafting interview questions. Furthermore, a conscious decision was made not to analyse an excessive number of texts. This was instigated as a means of not compromising on the quality of the interpretation by focusing on in-depth analysis. Direct quotations from the texts were used to provide authenticity to the analysis; whilst this still embodies a selection process of what data to exhibit, the need is less stringent with a more controlled amount of texts in the database.

## 4 ANALYSIS

### 4.1 The text corpus

The corpus consisted of 43 texts. The majority of the texts analysed took a more cautious stance on geoengineering. Most tended to acknowledge the potential risks of the technologies, whilst being skeptical of the potential efficacy of geoengineering, indicating the fairly reflexive nature of the field as a whole.

#### 4.1.1 Analysis outline

The analysis will begin with a broader overview of the discourse, through exploring wider ideas such as the general representation of gender within the corpus, and an exploration of some of the linguistic characteristics of the texts. This will be followed by an explanation of the coding system used for the analysis, and an in-depth exploration of six of the key codes to provide a thematic overview of the discourse.

### 4.2 Gender in the text corpus

One of the principal aims of this study was to determine in what ways geoengineering discourse might be gendered. As evidenced in the literature review in chapter 2, this idea of gender extrapolates far beyond the basic binary idea of men and women to include problematic Western ideologies that permeate society and inform the creation of power hierarchies. However, this basic notion of gender difference did initially serve as a rudimentary starting point and foundation on which to base the subsequent direction of analysis.

#### 4.2.1 Gender of the authors

One of the initial basic categorizations of the texts in the database was recording the gender of the first author of each text. The purpose of this was to gain a broad overview of

base gender demographics in the geoengineering field, as participation is a vitally important concept in the theoretical basis of this study.

Figure 5 indicates the breakdown of first author gender in the given texts, indicating that the vast majority of texts (70%) had a male first author. Female authorship made up 18% of the texts, which was very similar to Buck et al.'s (2014) figure of 17% female authorship in an evaluation of the top 100 journal articles about geoengineering. At face value, the numbers show that there is a notable gender imbalance in the chosen texts. This is not necessarily exclusive to the geoengineering field, as there is a well-documented historical trend of more male participation in many scientific disciplines (Moss-Racusin et al., 2012). These numbers are therefore also relevant on a macro societal scale, as they are indicative of broader institutional power imbalances.

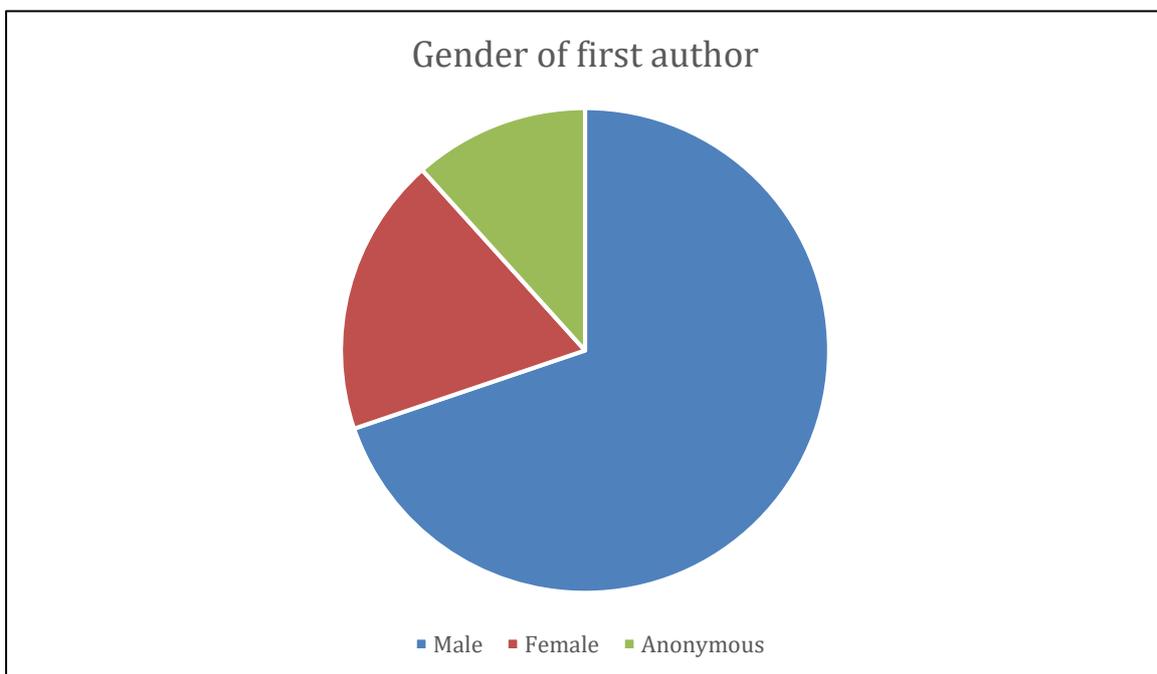


Figure 5: breakdown of first author gender in texts analysed.

These statistics serve as useful in gaining a general idea of gender participation in the geoengineering field, yet they are not without fault. To avoid excess complication, only the first author of each text was included in these numbers. This did mean that for texts with

multiple authors, in some instances, the subsequent writers were of a different gender. Similarly, the only available information for determining author gender was the name of the author. To be as thorough as possible, each author was researched on the internet in order to determine as accurately as possible whether they were male or female. However, this methodology is problematic in that as a researcher, I am placing authors within binary categories and making assumptions about how they might identify based on very little information. The use of these binary categories of male/female in this case are helpful purely because this is a standard distinction used, however it is crucial to acknowledge the assumptions made about each author's gender identity in this context. Finally, as is clear in figure 5, some of the editorial pieces analysed were written anonymously, meaning that the author gender could not be noted. This leaves a degree of uncertainty about the exact representation across the entire text corpus. However, even if all of these anonymous texts happened to be written by women, the cumulative participation would remain far lower than that of men.

#### **4.2.2 Explicit mention of gender in texts**

Upon initial reading of the chosen texts, the first line of analysis was to search for any explicit mention of gender. In all 43 texts, there was no direct use of any of the words 'gender', 'male' or 'female'. This was not altogether surprising; my interest in the topic of gender in relation to the geoengineering field arose precisely because of the lack of research that exists concerning the intersection between these two topics. Whilst it is predictable that gender in its most basic form is not present in these texts, it is concerning particularly from a justice perspective. Literature indicates (see Chapter 2) that women are one of the most vulnerable populations in terms of the effects of climate change; logically, therefore, they would also be most vulnerable to any adverse side effects that geoengineering technologies may have. The lack of any sort of gender analysis of the basic potential risks of

geoengineering is concerning and indicates that the justice dimension of these technologies is in dire need of being fleshed out to incorporate a more intersectional approach.

### **4.3 Language**

The view that language is a form of social practice is central to critical discourse analysis, and thus exploration of a text's linguistic features is an important part of the analytical process. This section will provide an overview of the linguistic findings within the text corpus that was analysed for this study. The nature of the texts chosen (editorial, perspective, opinion pieces) meant that the writing style tended towards a more fluid approach as opposed to the formulaic structure and style of journal articles, particularly in science writing. The analysis focuses on the language used for discussing both geoengineering and climate change, and the use of metaphor within the texts.

#### **4.3.1 Language use: geoengineering**

The most notable linguistic trend of interest in the texts was the employment of mechanistic terms when discussing geoengineering technologies. Verbs such as 'tinker' (Kiehl, 2006, p. 228; Look Ahead, 2014, p. 8), 'fiddle' (A Charter, 2012, p. 415), 'repair' (Boyd, 2008, p. 722) and 'play' (Heffernan, 2008) were used to describe the interaction with earth systems in the context of geoengineering. This language evokes the idea that earth systems are easily controlled and can be compartmentalized into different parts that may be adjusted at will. More specifically, this language is used in reference to the different geoengineering approaches, too. CDR is a way to 'lock-up' (A Charter, 2012, p. 415; Look Ahead, 2014, p. 8) excess carbon, whilst SRM aims to 'block' the sun (Keith et al., 2010, p. 426; Schaefer et al., 2013, p. 766). These terms come across as aggressive and suggest that CDR and SRM are definitive processes that can be undertaken and would have a specific, simple effect. More broadly, geoengineering was sometimes described as a 'fix' (A Step Up,

2016, p. 855; Boyd, 2008, p. 722) or ‘solution’ (Kiehl, 2006, p. 227), evoking a sense that these technologies may be employed as a sole means to definitively address climate change.

The texts in the corpus ranged in their individual stance towards geoengineering: some were amenable to the idea, while others were far more skeptical. In this sense, the use of these linguistic terms was, arguably, dependent on the context. Texts with more of an aversion of geoengineering may have employed these words in a hyperbolic way, that was meant to draw attention to the risk and perceived absurdity of geoengineering as an idea. Context is, of course, important. However, taking the corpus as a whole, regardless of the specific ways in which the words were intended, their frequency led to a certain degree of normalization of this way of discussing geoengineering, lending to the vision of the earth as a machine to be fixed.

#### **4.3.2 Language use: climate change**

Part of the process of critical discourse analysis involves situating the chosen discourse of study within its broader societal context. Geoengineering discourse exists as part of the wider discourse around climate change, and thus it is fruitful to also examine the way that climate change was treated in these texts as part of the broader process of contextualisation.

A deep frustration and concern about the historical failure to appropriately reduce greenhouse gas emissions was evident throughout these texts. Descriptive language was used to condemn these shortcomings whereby the ‘global reduction of carbon emissions remains alarmingly elusive’ (Blackstock & Long, 2010, p. 527) and ‘grossly unsuccessful’ (Crutzen, 2006, p. 212). This critical language helps to provide a broader context for the existence of the geoengineering field, and serves as a persuasive means of potential justification of these technologies. Indeed, the idea of ‘surpassing a tipping point beyond which a new and potentially uninhabitable climate system becomes inevitable’ (Grosnell, 2018, p. 855) has

become a common argument in contemporary geoengineering discourse and helps to further serve the urgency argument on a deeper level. Adjectives such as ‘uninhabitable’ help the reader of the text visualise future scenarios that may be deeply difficult or hazardous, and the surrounding idea of the inevitability of these scenarios happening helps to further emphasize the severity. The sense of urgency was further evident through language that stressed the temporality of climate change as an issue. Anxiety and frustration was expressed at the limited timeline left to address climate change on a meaningful scale, with some texts expressing the sentiment that ‘that ship has sailed’ (Parson, 2017, p. 9230) and it was too late altogether to be able to address climate change through mitigation alone. This added yet another dimension of legitimacy to the potential use of geoengineering technologies.

Language around climate change in the text corpus was sometimes antagonistic. Climate change was described as ‘enemy number one’ (Heffernan, p. 2008), a threat that we need to ‘fight’ (Look Ahead, 2014, p. 8), ‘fend off’ (Keith et al., 2010, p. 426) or ‘combat’ (Time to Act, 2009, p. 1077). Painting climate change as a common adversary is helpful in that it creates a collective goal of sorts. In this case, geoengineering is a potential weapon to be used in the portrayed fight, and the parallels to war imagery may mean that people are more willing to accept such exceptional measures. Characterizing climate change in such terms, however, also runs the risk of obscuring the true root causes of the problem; viewing climate change as an abstract enemy presents the problem in more binary terms, and detracts attention from the role of human behaviour in causing the problem in the first place.

### **4.3.3 Use of metaphor**

The use of metaphor can be a powerful tool in helping to create visions of an issue or idea. Various metaphors were used throughout the texts analysed in this study, conjuring particular notions around geoengineering. The use of metaphor in these texts is broadly

summed up in three overarching themes: uncertainty, the planet as a machine and the planet as a body.

All the texts in the database were fairly quick to acknowledge the deep uncertainties associated with geoengineering technologies, and a metaphor that was employed several times in conjunction with this idea was the notion of gambling. Surprisingly, given the generally cautious approach of many of the texts, this metaphor was not used to paint the potential implementation of geoengineering as a gamble. Instead, it was utilised to critique lacklustre mitigation efforts. Parson (2017) described stringent mitigation scenarios as a gamble due to the societal and political barriers that threaten their potential implementation and noted that ‘because these gambles might fail, it is essential for prudent climate-change planning to investigate and consider solar geoengineering’ (p. 9229). Similarly, Parker & Geden (2016) described not employing geoengineering as ‘bet[ting] the planet on humanity’s ability to decarbonize immediately and rapidly’ (p. 860). The use of this metaphor is effective in highlighting the political failure of inadequate large-scale mitigation efforts. Yet, it also has the potential to serve as a foundation for justifying geoengineering through emphasizing it as a ‘plan B’ approach that may be deemed necessary due to humanity’s collective negligence. Indeed, it is even hypothesized that ‘despite our usual distaste for chance, we’ll roll the dice’ (Gosnell, 2018, p. 855) on geoengineering if it becomes evident that keeping warming under 2°C is unachievable. In this way, the metaphor of gambling within these texts is used to express discontent with global mitigation efforts, yet through this creates a vision whereby geoengineering is legitimized as necessary and perhaps the only potentially effective contingency plan.

This idea of geoengineering as a necessary potential option is also present in metaphors that paint a visual of the earth as a machine. Geoengineering was described in several texts as a ‘tool’ (or part of a toolbox/kit) that may be useful in addressing climate

change (Boyd, 2008, p. 724; Keith et al., 2010, p. 426; Gosnell, 2018, p. 856). This metaphor incorporates a mechanistic view of the planet whereby it appears possible to adjust the planetary system in order to suit humanity's needs. Additionally, it is rooted in the assumption of a certain degree of control; that said tool would be able to affect only parts of the system that need to be serviced. The idea of the earth as a machine is also present through the notion of the earth's 'thermostat' (Robock, 2008, p. 1166) as something that can be set at will.

Finally, metaphors concerning illness were also present in some of the texts analysed. Climate change is depicted as a disease (Look Ahead, 2014, p. 8) that needs to be treated; the earth as a body riddled with sickness. In this metaphorical context, the approach to geoengineering is generally less positive - there is concern, particularly with SRM technologies, that they exist as a distraction of sorts, treating the 'symptom and not the cause' (Russell & Connell, 2010, p. 144; Kiehl, 2006, p. 227) of climate change. In this context, geoengineering should be viewed as 'a palliative cushion for the worst excesses of the peak years that are inevitable even after emissions start to be cut' (Time to act, 2009, p. 1078).

#### **4.4 Coding**

Rooted in a social constructivist approach, the theoretical foundations of critical discourse analysis are vitally important in helping deduce connections between ideology, language, power and inequality. This analysis used a deductive approach to create a system of coding to add further depth to the exploration of the texts. The initial codes were developed from the literature review conducted, with the principal reference being Buck's 2014 paper entitled *Gender and Geoengineering*. The codes evolved throughout the analytic process, reflecting the cyclical nature of critical discourse analysis as a methodology. This section will

explore the six codes that were deduced to be most relevant to the research aims and objectives of the project. The codes are listed in figure 6 below.

Codes
Technocratic
Prediction
Risk
Participation
Justice
Dualism

Figure 6. Main code categories, formulated from Buck et al. (2014)

#### **4.4.1 Technocratic**

Geoengineering as a concept embodies a technocratic approach to climate change. This is emphasized in the use of mechanistic language in the discourse when describing the earth system, portraying it as a machine to be fixed or recalibrated. Guided by Kaijser & Kronsell's (2014) questions, one of the points of analysis was to note what the privileged norms and ideas were in the texts. The most favoured norm in the discourse was that of scientific knowledge, and the idea that more knowledge was unquestionably a positive outcome. This norm was privileged over more socially oriented ideas, such as equity and ethics.

#### **4.4.2 Prediction**

The complexity of the climate system means that there is a great degree of uncertainty surrounding geoengineering technologies. Fluctuations within earth systems that have so many variables mean that it is impossible to predict with complete accuracy how the

deployment of geoengineering technologies may affect the real climate. Additionally, many geoengineering technologies, particularly SRM, do not actually yet exist outside of theory and computer simulations. With technologies very much still in their infancy and nowhere near being ready for large scale deployment, the notion of prediction is an extremely important theme that permeated the discourse that was analysed.

One of the key commonalities that almost all the texts had was support for doing more research into geoengineering technologies. The rationale for this varied slightly depending on the angle of the individual text, but the main reason given was to reduce the current uncertainty around geoengineering so as to have more evidence to inform potential decision making in the future. This is, at face value, a perfectly reasonable stance; the whole discipline of science is predicated on accruing knowledge through observation, after all. Things become more complex here, however, because geoengineering as an idea has a very specific intent from the start. In this sense, it is practically impossible to divorce geoengineering from its sociopolitical context. Coupled with this idea of doing more research is an underlying assumption that, if it exists, this research will ultimately be used in a rational and unbiased manner for decision making purposes. This is explored in one of the very few texts in the corpus that was explicitly against geoengineering:

One constant is the call that 'we should at least do the research' so that we can be prepared. In truth, this simple injunction is part of the problem. It rests on a string of questionable assumptions and a naive understanding of the world that owes more to the quaint ideal of the white-coated scientist dispassionately going about the process of knowledge generation than it does to reality. (Hamilton, 2013, p. 139)

Indeed, the idea of doing more research may help to better predict the various effects of different geoengineering technologies, but it is equally difficult to predict how this research might be used in broader context, particularly due to the current lack of governance

infrastructure and oversight for the geoengineering field. This uncertainty around prediction is also exhibited in the fear of technological lock-in, which was present in some of the texts studied. This is where research into geoengineering technologies is viewed a ‘slippery slope’ (Stilgoe, 2011, p. 325), whereby once the research process begins to advance, the boundaries between research and implementation will become blurred and more research ultimately may become a catalyst for deployment.

Another key facet of the discourse that concerns the notion of prediction is the discussion around physical geoengineering experimentation, generally for SRM technologies. The approach to physical experimentation has been cautious and existing data has been produced from climate simulations. However, there is a growing narrative around the perceived need to move on to physical experiments in order to gain a better idea of how SRM may work in the real climate. This idea of experimentation has been contentious, and a couple of the texts were outright opposed to it. Several others, however, tentatively supported the idea of small-scale experiments that would have no significant lasting effect on the atmosphere. Generally, this was with the caveat that clearer systems of oversight needed to be in place, but that small-scale trials were an important potential next step in the research process. However, even small-scale trials cannot account for the complexity of the climate system as a whole.

The idea of prediction is thus an important theme in geoengineering discourse. It is present in the scientific principles that govern the research process and quest for increased knowledge, yet the vast uncertainty that characterises climate science means that it is an incredibly difficult process to pinpoint explicit effects. Here, the notion of prediction is a natural part of scientific processes, yet also embodies hubristic notions of controlling nature.

### 4.4.3 Risk

There are various levels of risk associated with geoengineering. Different technologies possess varying risk profiles, which are juxtaposed with the risks inherent in climate change itself. All the texts analysed were quick to acknowledge the myriad uncertainties associated with geoengineering, and how its potential risks are not at all fully understood. A counter argument commonly employed is that ‘humans are deliberately altering the planet’s climate in unpredictable ways’ (Look Ahead, 2014, p. 8) at present through everyday activities: we are already geoengineering the planet. The key decision, therefore, when it comes to risk within this field is deciding whether the potential side effects of geoengineering embody more or less risk than the effects of climate change.

In climate change discourse the two key actions that take centre stage are mitigation and adaptation. The justification for geoengineering as an idea has its roots in historical mitigation efforts being inadequate to address climate change, and therefore discussion of mitigation was prevalent throughout all of the texts studied: both as a legitimizing argument for pursuing geoengineering research, but also emphasized as the optimal means by which to address climate change. Conversely, the analysis found that less than a third of the texts explicitly mentioned adaptation; as a reader of the corpus, it was a detail that felt conspicuously absent from the discourse. Robock (2008) noted that a more comprehensive geoengineering research programme ‘will allow us to compare the efficacy, costs, and consequences of the various options of responding to global warming - **mitigation, sequestration, geoengineering, or doing nothing** - so that an informed public can agree on the best courses of action’ (p. 1167, emphasis added). Here the perceived options for addressing climate change are explicitly listed, and adaptation is not present amongst them, an example of a broader theme across many of the other texts. This is not to say that researchers do not necessarily value the importance of adaptation; indeed, they may view it as

such a given that it does not warrant explicit mention. The problem with its textual absence, however, is that it creates an impression that, in addressing climate change, there exist only the binary options of mitigation and geoengineering: adaptation as an approach is sidelined. This seems especially strange given that most of the texts were very cautious about geoengineering, making sure to acknowledge associated risks and uncertainties and generally portraying geoengineering as a last resort option.

One of the more specific risks mentioned within the discourse was the militarization of geoengineering and fear of unilateral deployment of SRM technologies. If a country, group or individual deemed it necessary, they may decide to employ geoengineering techniques without seeking international consensus: likewise, if a country stood to gain from climate change, they may be vehemently opposed to the idea of geoengineering. In a text by Schellnhuber (2011), geoengineering was likened to the nuclear arms race through its apparent exhibiting of the characteristics of mutually assured destruction. The potential geopolitical problems associated with geoengineering are significant, as SRM in particular is a technology that is not limited by state borders. As it stands, geoengineering research is most seriously being undertaken in Western countries, and the way in which the unilateral debate was framed created the idea of a hostile ‘other’. More generally, the militarization angle embodies inherently masculine ideals.

Emerging concern around environmental tipping points has created another angle of legitimation for geoengineering technologies. Tipping points are perceived thresholds whereby certain environmental or climatic events may be triggered and have irreversible consequences. Tipping points were mentioned in the discourse as a discernable risk that may cause panic and therefore serve as justification for geoengineering deployment. Yet, when tipping points were alluded to, there was no further specificity of what their parameters might be. The idea of reaching certain environmental thresholds that may induce ‘runaway climate

change' (Gosnell, 2018, p. 855) is one that is particularly persuasive, and yet these risk thresholds are subjective. The question of who determines when things are 'bad enough' is an important one and raises significant issues of justice. Risk is a vital part of evaluating emerging technologies like geoengineering, and the representation of risk in this discourse is characterized very heavily by uncertainty. An important factor to consider, then, may be that of risk perception: who is determining the weight placed on different risks associated with geoengineering?

#### **4.4.4 Participation**

Section 4.2 of this chapter explores the gendered participation of the text authors, indicating that the geoengineering field has a predominantly male composition. It has also been highlighted that the geoengineering field principally consists of academics and institutions in the West, particularly the UK and USA. This section will explore participation within the discourse more deeply.

One of the categories that was noted in the analysis, as guided by Kaijser & Kronsell's (2014) questions, was the actors that were mentioned in the texts. The most common social groups mentioned were scientists, researchers, and policymakers, with states also privileged as important actors. From the point of view of the development of these technologies, these groups are at the forefront of the research and decision-making processes, and thus their inclusion was logical. Outside of these social groups with specific knowledge, the public was mentioned a few times as another actor with a stake in geoengineering activities. The term public was used in broad terms, coupled with the occasional mention of humankind as a collective whole. Similarly, the most commonly used pronoun was 'we', used throughout virtually all the texts. In some instances, 'we' was used to refer specifically to the authors of the text, or the scientific community explicitly. However, its use in many cases was ambiguous: it was unclear exactly who this collective 'we' was meant to refer to.

Due to the global nature of climate change, it is likely that this use of ‘we’ was often intended to indicate the collective of humankind; it was certainly plausible in these ambiguous instances that this was the intended use. In conjunction with the mention of non-specific publics, there is an underlying assumption therefore of a universal human experience within this discourse. Talking about climate change in collective terms can be extremely helpful in that it creates a common ground and helps to indicate the far-reaching consequences of the problem. However, in discussing geoengineering technologies, which may have very specific risks to specific populations, there is a need for greater nuance. The generalizing of publics and humanity runs the risk of assuming a higher level of participation than may be accurate.

The process of public engagement was mentioned in less than half of the texts. Participation has significant implications for the distribution of agency in a given context. Whilst the discourse did, at face value, champion ideas about inclusivity and transparency, there is clear room for improvement through the way in which certain groups and actors are/are not represented.

#### **4.4.5 Justice**

The potential risks of geoengineering mean that there are significant justice implications that need to be addressed. On a practical level, the participatory aspect is evidently one that could be significantly improved. The ways in which justice is portrayed in the discourse also has powerful implications. The central justice concern when it comes to geoengineering is that any adverse effects these technologies may have are likely to be unevenly distributed and affect certain areas more than others; predominantly areas in the Global South. This is articulated in the discourse as the idea that geoengineering will create ‘winners and losers’ (Hegerl & Solomon, 2009, p. 955; Keith et al., 2010, p. 426), whereby some may benefit from its effects, and others may be negatively influenced by potential side

effects. Binary categories of vulnerable and non-vulnerable are created. This binary is further reinforced by the production of an ‘us versus them’ dynamic through the assertion that ‘people in those regions or nations who feel most threatened by the environmental problem will be most willing to use technological intervention’ (Cicerone, 2006, p. 223; see also Parson, 2017, p. 9227). As mentioned in section 4.4.3, the fear of unilateral deployment is a common theme throughout the discourse; in this context, it is fear founded in the notion that susceptible states will co-opt geoengineering technologies through desperation. There is a distinct lack of specificity concerning these dynamics, which arguably has the effect of homogenizing the Global South as a single impoverished entity unable to help itself; or if it were to deploy geoengineering in its specific interests, this would be deemed potentially hostile. Indeed, the only mention of a more specific context lies in the assertion that deployment of SRM technologies might affect monsoon rain patterns in Asia and Africa (Blackstock & Long, 2010; Half-hearted geoengineering, 2008; Robock et al., 2010); however, Rahman et al. (2018) dispute this notion, emphasizing that research indicates the negative effects of climate change in this area would outweigh effects of geoengineering on the monsoons. The potential implementation of geoengineering technologies that might most negatively affect marginalised populations in the Global South is an ironic reflection of the broader climate change issue, whereby the Global North bears a disproportionate responsibility for emissions and the adverse effects arising from them in the Global South.

#### **4.4.6 Dualism**

As outlined in the literature review in Chapter 2, Western ideological binaries are an important part of feminist critique. Here, the dualisms contained within the analysed texts will be explored in detail. The culture/nature binary is one of the most prominent in Western thought, crafting a society built upon the exploitation of the natural world. In the corpus used in this study, human-nature relationships were anthropocentric in character. Humans were

posited as a force powerfully altering the earth through climate change, and geoengineering was presented as a potential solution to this. In discussing the effects of geoengineering, non-human actors were one group that were conspicuously absent from the texts. When the physical effects of geoengineering on ecosystems were discussed, they were done so from a human centred viewpoint of what these ecosystems provide for human existence, such as agricultural functions. Whilst this angle is of course important from a justice perspective, it also serves to portray nature as a passive backdrop for human activity: in this discourse, nature has no agency.

Another prominent dichotomy in geoengineering discourse is the contrast of a pioneering, technologically progressive Global North and a vulnerable, helpless Global South. This is reflective of broader global power relations; the industrial success of the Global North is indicative of hundreds of years of exploitation of countries across the Global South. This relationship, therefore, is indicative of Western hegemonic concepts of nature and culture – where here, the cultural development of the Global North is predicated on the exploitation of natural resources and labour in the Global South.

Finally, geoengineering discourse is immediately split into binaries through the distinction between CDR and SRM technologies. CDR proposals are generally treated as benign, harmless and mundane. Conversely, SRM is seen as pioneering and outlandish, an embodiment of technological daring and innovation. This is reflected in the disproportionate amount of attention that is given to SRM technologies; however, with the potential risks involved, this is not necessarily a bad thing. Here, again, binary distinctions are made through the way that CDR is viewed as more ‘natural’, and therefore less of a threat. An interesting device that is often employed by SRM advocates is the framing of SRM as attempting to simulate a ‘natural’ volcanic eruption; when associated with natural processes within nature,

SRM becomes less outlandish and more benign, too, and the natural analogy contributes a greater sense of control.

In this way, dualisms were present throughout the corpus: culture/nature, Global North/Global South and SRM/CDR. All these binary sets have one side that is feminized, as it is set in juxtaposition to masculine Western values. The Global South and CDR technologies become synonymous with nature in the sense that they are viewed as 'weaker', and therefore more amenable to hegemonic control. In this way, the fundamental Western binary of male/female continues to be inscribed upon many of its ideological foundations.

## 5 DISCUSSION

The original aims and objectives of this study were summarised in three questions:

- In what ways are Western constructions of gender present in the chosen geoengineering discourse?
- What does the discourse reveal about the ways in which gendered power manifests within the geoengineering field?
- Can a technocratic, scientific ‘solution’ such as geoengineering be reconciled with feminist ideals?

This section will attempt to answer these questions considering the data explored in the analysis in chapter 4.

### 5.1 Western constructions of gender

#### 5.1.1 Control of nature

The Western capitalist system has, through its exploitative extraction practices and focus on overconsumption and fossil fuels, consistently viewed nature as a passive asset to be manipulated for human profit. The idea of geoengineering represents perhaps the ultimate example of this hubristic attitude of control. Whilst the specific intentions behind various geoengineering proposals may vary, the general idea is the same: an attempt to artificially gain some degree of control over nature which has, in the context of climate change, become unruly and dangerous. Western thought has traditionally constructed nature as either passive, there to provide for humankind in an almost maternal sense, or as an aggressive, unpredictable threat in need of taming by human strength (Merchant, 1981). Both constructions, unsurprisingly, were feminised against the masculine rationality of culture. Colebrook notes that:

anthropogenic climate change on a massive industrialized scale is not that a stable nature has been disturbed but that humans have increasingly stabilized nature to a mechanized and rigid timetable of production based on hyperconsumption, and this in turn has generated volatile and intense change. Climate change in the anthropogenic sense is the consequence of thinking of nature as an unchanging standing reserve.

(2017, p. 14)

There is, therefore, a deep irony in the fact that climate change has resulted from Western conceptions of nature as a passive entity to be constrained; and further in the fact that geoengineering proposes to remedy this by *further* attempts to control earth systems. Masculine visions of control sit at the very heart of geoengineering, and thus it would be fallacious to presume that gender is not relevant here as a dimension to be considered. These central visions of control were present throughout the corpus of texts analysed, specifically in the use of mechanistic language, such as the verbs ('tinker', 'fiddle', 'repair' etc.) used to describe the perceived relationship to earth systems that geoengineering proposals evoke. The normalisation of this kind of language within the discourse has stemmed from both sides of the geoengineering debate: those that are more amenable to the idea employ this language as a more natural indication of their intentions, whereas those sceptical about geoengineering use it to draw attention to the notion of control that is so central to these technologies. The normalisation of this language in the academic discourse has also seeped into media coverage of geoengineering

The idea of control in the context of geoengineering is also deceptive due to the intrinsic uncertainty of climate science. Uncertainty was one of the key recurring themes in the text corpus, and this was explored through the code of 'prediction' used in the analysis. All the texts analysed acknowledged the uncertainty that permeates geoengineering proposals and the accompanying risk. The general consensus to remedy this uncertainty manifests in the

widespread call from academics to do more research into geoengineering; the basis for which is born from the accompanying view of geoengineering as a 'plan B' option that should be in humankind's climate change 'toolbox' just in case. There is an inherent conflict here, in that researchers acknowledge the level of uncertainty associated with geoengineering, but also legitimise its potential future use through the idea that it may become unquestionably necessary at some point. This approach places scientific knowledge on a pedestal through the underlying assumption that such research would be used in an objective manner, a problematic stance given that there remains extremely lacking oversight and governance mechanisms for the field as a whole. The 'plan B' approach is summed up well in the metaphorical assertion in one text that 'despite our usual distaste for chance, we'll roll the dice' (Gosnell, 2018, p. 855) when it comes to geoengineering if it becomes unquestionably clear that meeting the Paris temperature goals is impossible. This metaphor shows that, in this perceived emergency scenario, the preferred approach is that of scientific control. This was a consistent theme in the discourse, whereby the social and political implications of geoengineering were often glossed over: one text stated 'of course, other much greater risks, such as geopolitical, social and economic changes in response to climate changes from either greenhouse gas increases or GE, are even harder to assess and are not taken into account here' (Boyd, 2008, p. 723). Whilst there has been a growing body of literature about geoengineering in other disciplines such as the social sciences, there is perhaps further room for interdisciplinary work that would help to elevate the importance of social, ethical and political issues that are also central to geoengineering.

The control of nature is a cornerstone of contemporary Western society, and its strong roots in masculine approaches to the world mean that geoengineering is by default a rather masculine technological enterprise. It is important to note that researchers within the field tend to show a great degree of reflexivity through their open acknowledgement of associated

risks and uncertainties, and this is a positive approach as it begins to question the potential hubris of these technologies. The idea of control was still prevalent within the discourse, and a greater degree of awareness about the gendered roots of these basic ideological underpinnings of geoengineering may be helpful in furthering researchers' quest for reflexivity.

### **5.1.2 Dualisms**

As evidenced in the analysis, dualisms were found within the discourse that was analysed. Dualisms are a fundamental structure in Western hegemonic ideology that serve to uphold unequal power distribution through their positing anything not in line with Western values as 'other' and therefore lesser (Merchant, 1981; Plumwood, 1991). The nature/culture dualism was found in the texts through a generally anthropocentric view of nature as a passive backdrop for human activities. Even though many researchers are sceptical about geoengineering technologies, their advocacy for further research suggests that there is a general belief that the kind of large-scale that control geoengineering embodies *could* be possible. Additional dualisms that were found in the analysis were those of Global North/Global South and the SRM/CDR distinction. These served as subsets of the culture/nature binary, where the Global North and SRM technologies were coded as inherently masculine, and the Global South and CDR technologies as intrinsically feminine, due to their associations with nature and vulnerability. Whilst dualisms can manifest in many ways, and are not always obvious, they are extremely important in maintaining systems of Western hegemonic dominance.

## 5.2 Gendered power structures

### 5.2.1 Participation and absence

Analysis of the gender of the first author of each text in the corpus indicated that the geoengineering field is disproportionately male in composition. In the database analysed in this study, 18% of the texts had a female first author. This figure is in line with the 17% that Buck et al. (2014) noted from an analysis of the top 100 research articles on geoengineering. This data serves to support the idea of the ‘geoclique’ (Kintisch, 2010), a small group of predominantly white, male, Western scientists that make up the majority of geoengineering researchers. This lack of diversity in the field has been noted by many researchers as a concern and reflects the broader gender imbalance that exists in many scientific and engineering disciplines (Moss-Racusin et al., 2012). This gender imbalance is indicative on a more micro scale of the broader masculinised ideological underpinnings of Western science, and barriers to participation that women may face. The demographic homogeneity of the geoengineering field leads to a lack of diverse perspectives, which has subsequent implications for the ‘framing and decision-making powers that participation in geoengineering research implies’ (Buck et al., 2014, p. 654). This lack of diversity is multidimensional; the locus of geoengineering research lies in white-dominated Western institutions, thus limiting the participation not only of women, but of people of colour and those from the Global South, too.

The critical discourse analysis conducted in this project found that gender was not explicitly mentioned in any of the texts. The distinct absence of gendered analysis within geoengineering discourse indicates that it is not a matter of perceived importance. Here, then, Haraway’s (1988) idea of ‘situated knowledges’ may be of significance. The idea that ‘marked’ marginalised bodies may be able to produce a more truly objective view due to their inextricable position within systems of oppression is one that is helpful when considering

participation in the geoengineering field. A more diverse faculty would likely be more in tune with issues of inequality and would minimize the risk of the ‘white male effect’ whereby white men are found to have lower risk perception than other marginalized groups (Franz-Balsen, 2014; Terry, 2009).

In constructing ideas of gendered participation, it is also important to note the binary way in which categories are constructed. The dualism of men/women is to some extent helpful as an analytical tool in that it is the reality of how Western culture is structured. However, its use also serves to reinforce the dualistic view of gender as a binary phenomenon. This categorisation serves as yet another axis of exclusion, as it does not acknowledge the existence of LGBTQ+ identities that exist outside of this Western gender binary. Indeed, queer perspectives offer much when it comes to looking beyond this simplistic approach to gender; Gaard (2015) notes how a queer feminist approach is integral to challenging technoscientific discourse in a more holistic way.

### **5.2.2 Agency for whom?**

The lack of participatory agency of the Global South in geoengineering discussions thus far is indicative of Western hegemonic power structures. Measures are being implemented to remedy this, such as engagement activities held in developing countries by the Solar Radiation Management Governance Initiative (<http://www.srmgi.org>), yet the idea of agency is still a pressing issue in geoengineering discourse. Through critical discourse analysis, the social categories present in the texts were noted. Overwhelmingly, the social categories most mentioned were those of researchers, scientists and policymakers. To some extent this makes sense, as these are the groups that are most heavily involved in the preliminary stages of scientific research. More significant, perhaps, was the universalizing approach that was present within social categorisation in these texts. The most used pronoun

in the texts was ‘we’, which was often used within an ambiguous context, leading to implications of an assumed universal human experience. Similarly, there was the inclusion of non-specific ‘publics’ to be included in the participatory process, and reference to humanity/humankind that will collectively be affected by climate change. If geoengineering discourse is to include a more accurate and nuanced assessment of justice issues, these categories need to become more specific. As Plumwood (1993) notes:

a universalised concept of ‘humanity’ can be used also to deflect political critique and to obscure the fact that the forces directing the destruction of nature and the wealth produced from it are owned and controlled overwhelmingly by an unaccountable, mainly white, mainly male elite (p. 11-12).

This is not to say that it is necessarily the intent of geoengineering researchers to obfuscate responsibility. The common universalism of ‘humanity’ is prevalent in all climate change discourse, as it is helpful in articulating the severity and global consequences of such a phenomenon. However, a more in-depth idea of accountability in geoengineering discourse would help to distinguish the intent of geoengineering as not merely a continuation of the status quo.

The question of *who* is an important one that should be central to geoengineering discourse, to avoid any notion of an imperialistic approach. The way in which justice issues were discussed in the texts analysed left much to be desired. The idea of ‘winners and losers’ in regard to the effects of geoengineering helps to construct a binary idea of vulnerability, whereby the Global South is consistently constructed through its perceived vulnerability. This vulnerability is feminized, and the Global South is seen as a passive ‘victim’ without agency (Arora-Jonsson, 2011), a parallel of the culture/nature dichotomy whereby nature is viewed in Western culture as a passive object. Indeed, the history of colonial exploitation of many developing countries for their natural resources reflects this. Here, global power relations

become gendered through the hegemonic masculinity of the West contrasted with the feminized 'other'. Thus, there is a need to further elaborate on the specificity of justice issues related to geoengineering both from the point of view of responsibility and consequences (particularly negative ones). Just as universalised categories such as 'humanity' may serve to conceal the nuance of global power relations, geoengineering treads a dangerous moral line whereby hegemonic dominance may be reproduced unless issues of justice and participation continue to be fore fronted. Western countries hold the most historic responsibility for climate change, and geoengineering may well embody a continuation of the status quo; indeed, the scenario in which geoengineering is deemed potentially necessary is one in which Western countries in particular have failed to implement appropriate mitigation action, indicating a rejection of meaningful systemic change which might lead to more equitable power redistribution.

Moving beyond the human sphere, there was also no mention of non-human actors in the corpus. When ecosystems were mentioned, the effects upon them were generally framed through the services they provide for humans, such as agriculture. In geoengineering discourse, therefore, nature has no agency of its own, reproducing the androcentric view of nature as a passive background for human activity. Some ecofeminist theory posits the inclusion of non-human actors as an important step in striving towards a more holistic and intersectional approach to human-environment relations (King, 1990), and this is perhaps something that could be used to open up geoengineering discourse further in issues of justice and agency.

### 5.2.3 The power of choice

Despite calls for further research into geoengineering, various choices have already been constructed within the discourse even though this may not have been necessarily intentional by researchers. Bellamy et al. (2012) address this, in noting:

by narrowly appraising geoengineering proposals only against one another, legitimate alternatives are ignored and contextual isolation is facilitated. To avoid this false ‘yes / no’ choice between geoengineering proposals the necessary and wider portfolio of climate change strategy options – spanning mitigation, geoengineering, and adaptation options – should be addressed. Opening up and appraising the full range of courses of action available to decision makers broadens the inputs to appraisal and better acknowledges the complexity of the issue. (p. 24)

In the corpus analysed for this research, mitigation did feature prominently, and researchers often emphasized mitigation as the optimal means of addressing climate change. One option that was conspicuously lacking in the discourse, however, was that of adaptation. Less than a third of the texts analysed mentioned adaptation explicitly, creating the impression that it was not an approach to climate change that was deemed of significant importance. This is not to say that geoengineering researchers do not necessarily place weight on adaptation as a priority measure in terms of climate change, but if they do, it was not articulated within this specific corpus. This had the effect of commonly painting climate change action as a binary choice between mitigation and geoengineering, creating a new ‘yes / no’ binary of whether or not geoengineering implementation should be considered. At such an early stage in geoengineering research, it is concerning that this pattern emerged from the analysis.

Granted, this research is based only on a relatively small database of texts, but through the selection criteria they were deemed to be a fair representation of the broader geoengineering discourse. The creation of these binary choices, even if unintentional, is problematic not only

because it simplifies geoengineering's place within the broader spectrum of addressing climate change, but also creates the illusion of geoengineering implementation as a straightforward choice. It also serves to show that researchers hold significant power in shaping the parameters of the discourse.

#### **5.2.4 The hostile other**

Power dynamics were also present within the discourse through the dimension of militarization. A number of the texts expressed anxiety at the possibility of unilateral deployment of SRM geoengineering technologies by a 'rogue state' (Keith et al., 2010, p. 426). This created an interesting political dynamic through the creation of a hostile other. In particular, several texts alleged that it would be those countries most jeopardized by climate change that would employ geoengineering without global consultation due to desperation. Given that research is happening almost exclusively within Western institutions, and that many of the countries at the forefront of climate change do not necessarily have the resources (for example military planes) to instigate geoengineering, this is an interesting political argument. The West is constructed as the concerned, objective party that would be most likely to use geoengineering in a 'responsible' way. In reality, unless priorities around geoengineering are radically reoriented to privilege social, ethical and justice issues, geoengineering as a concept is perhaps best suited to preserving the Western status quo of industrial capitalism. The coding of Western intention as a bastion of rational objectivity serves to entrench masculine ideals about culture.

## **5.3 Reconciling geoengineering with feminist ideals**

### **5.3.1 A clash of ideologies**

Upon first impression, geoengineering as a mere idea is vastly at odds with many of the base tenets of Ecofeminist thought. Geoengineering embodies centrally masculine ideals concerning the subjugation of nature, the privileging of scientific method and rationality, and Western hegemony. It is also born from Western scientific and engineering disciplines which have deeply patriarchal roots. The critical discourse analysis in this project has helped to uncover how geoengineering is gendered both at its institutional and ideological levels. As it stands, based off the analysis in this project, geoengineering remains reasonably vulnerable to a feminist critique: there is dire need to address in more substantive depth many of the ethical and justice issues associated with these technologies.

Climate change is a problem born from masculine systems that are predicated on and maintained by the exploitation of marginalised groups and non-human nature (King, 1990; Shiva 1988). Thus, in addressing climate change, there is an inherent choice to be made about maintaining the status quo or favouring more radical systemic change. Geoengineering technologies in their very nature represent a technocratic, masculine solution to climate change that quite reasonably may be used to maintain the Western industrial capitalist status quo.

### **5.3.2 Transformation through technology?**

If the geoengineering field may benefit significantly from including a gendered perspective rooted in feminist theory, can feminism gain anything from geoengineering? In its current form, this is unlikely. However, writing off geoengineering as an intractably masculine project that can only lead to domination erases the fact that it could have the capacity to alleviate some of the suffering that is inevitable from climate change. If indeed

women are most at risk of the effects of climate change (Terry, 2009), then they may also be those that benefit most from geoengineering if it were to have positive and productive effects. If we take Haraway's (1991) notion of the cyborg and accept that within the contemporary world humankind is inextricably tied up in its complex relationship to technology, then we can begin to strive to reorient this relationship into one that has transformative, emancipatory characteristics. Instead of focusing on an empirical calculation of how disparate effects may play out geographically if geoengineering were to be employed, perhaps a more productive discourse would be centred on the question 'how might geoengineering contribute to a more just society?'

In this way, it is more important than ever to overhaul geoengineering discourse so that it prioritizes social, ethical and political contributions, as these are the ones that are most likely to accommodate the lived experiences of those both at the forefront of climate change, and those who may be most adversely affected by geoengineering technologies. Similarly, this approach would also privilege the social benefits of geoengineering beyond the mere goal of limiting global temperature rise below a series of arbitrary averages. What is important to remember, however, is how Western capitalist and scientific projects have excluded alternative ways of knowing (Shiva, 1988). To create a truly comprehensive set of choices to address climate change, Western thought needs to engage in self-reflection, and also become more open to alternative modes of knowledge, such as those of Indigenous peoples. This in no way means that Western culture should appropriate alternate forms of knowledge but recognize the cultural homogenization that it has attempted to enforce across the globe, and the subsequent negative effects of this cultural imperialism: climate change being the key example in this context. Feminist thought such as that discussed in Chapter 2, like Ecofeminism and Feminist Science Studies, may prove extremely useful in such endeavours, as it helps to deconstruct asymmetrical power relations - acknowledging how

they intersect across different categories such as gender, race and class - whilst simultaneously elevating marginalised perspectives.

## 6 CONCLUSION

### 6.1 Geoengineering and gender

This project set out to explore the nexus between geoengineering technologies and gender. This relationship was chosen due to the consistent lack of prioritization given to social and political issues in geoengineering discourse, and because gender was deemed a useful analytical lens through which to explore issues of justice and power related to geoengineering. The methodology employed was critical discourse analysis, as it is a practice concerned with uncovering and theorizing societal inequalities and asymmetrical power relations. The emancipatory objectives of critical discourse analysis coincided well with the similar goals of Ecofeminist and Feminist Science Studies theory that was used as the theoretical backbone of the project.

The methodological process involved the creation of a corpus of texts about geoengineering from mainstream academic journals, which was subsequently analysed using the critical discourse analysis approach based upon Fairclough's (1995) three-dimensional model. This included deep analysis of linguistic aspects of the text, in conjunction with a system of coding as outlined in Chapter 4. The results of the analysis confirmed that there are multiple gendered dimensions to the geoengineering field that manifest in different ways. At an institutional level, the imbalance in authorship gender indicated that the geoengineering field is heavily male dominated, a likely result of patriarchal science and engineering disciplines that have historically excluded women in a variety of ways. At an ideological level, the critical discourse analysis process revealed various gendered power relations in the texts, including hegemonic Western traditions such as the culture/nature binary and the feminization of nature and vulnerability.

There currently exists next to no research theorising this linkage between gender and geoengineering, aside from the paper by Buck et al. (2014) cited in Chapter 2. It was hoped

that this project would contribute a little more to the literature in this area, and the findings indicate that the gender-geoengineering relationship is one that would benefit from more study, particularly because it provides an effective critique of geoengineering technologies in many ways.

## **6.2 Towards a more inclusive discourse**

The feminist theory used in this study, rooted in the fields of Ecofeminist and Feminism Science Studies, provided a highly effective framework for analysing the gendered dimensions of the chosen discourse. Whilst this study was mainly limited to solely gender as an analytical tool due to the constraints of a master's thesis, these theories tend to emphasize an intersectional approach – something that is vitally important to future geoengineering research. The geoengineering discourse needs to move beyond basic distinctions of Global North and Global South when it comes to potential vulnerabilities and recognize the other axes of oppression that exist within the scope of these technologies. The field is moving in the right direction with increased attention on participatory activities in countries in the Global South, but incorporating a gendered analysis into the field in a more concrete way would help to add much needed depth to the conversation around justice and ethics.

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## APPENDIX

### List of texts used as data

	<b>Text type</b>	<b>Publication</b>	<b>Year</b>	<b>Title</b>	<b>Author(s)</b>
1	Editorial	Nature Climate Change	2008	Research is Responsibility	Olive Heffernan
2	Editorial	Nature GeoScience	2008	Half-hearted engineering	Anonymous
3	Commentary	Nature GeoScience	2008	Ranking geo-engineering schemes	Philip W. Boyd
4	Editorial	Nature	2009	Time to act	Anonymous
5	Opinion	Nature	2010	Research on global sun block needed now	David W. Keith Edward Parson M. Granger Morgan
6	Commentary	Nature Climate Change	2011	A question of intent	Jack Stilgoe
7	Editorial	Nature	2012	A charter for geoengineering	Anonymous

8	Correspondence	Nature	2012	More ways to govern geoengineering	Jane Long Steve Hamburg John Shepherd
9	World view	Nature	2013	No, we should not just 'at least do the research'	Clive Hamilton
10	Correspondence	Nature Climate Change	2013	Field tests of solar climate geoengineering	Stefan Schafer Peter Irvine Anna-Maria Hubert David Reichwein Sean Low Harald Stelzer Achim Maas Mark Lawrence
11	Commentary	Nature Climate Change	2014	Climate engineering reconsidered	Scott Barrett et al
12	Correspondence	Nature Climate Change	2014	Solar radiation management could be a game changer	Peter Irvine Stefan Schafer Mark Lawrence
13	Editorial	Nature	2014	Look ahead	Anonymous
14	Commentary	Nature	2015	Start research on climate geoengineering	Jane Long Frank Loy M. Granger Morgan

15	Commentary	Nature Geoscience	2016	No fudging on geoengineering	Andy Parker Oliver Geden
16	Editorial	Nature Geoscience	2016	A step up for geoengineering	Anonymous
17	Correspondance	Nature	2016	Code of conduct for geoengineering	Anna-Maria Hubert Tim Kruger Steve Rayner
18	Commentary	Nature Climate Change	2017	Solar geoengineering reduces atmospheric carbon burden	David Keith Gernot Wagner Claire Zabel
19	Commentary	Nature	2018	Developing countries must lead on solar geoengineering research	A. Atiq Rahman Paulo Artaxo Asfawossen Asrat Andy Parker
20	News and Views	Nature Climate Change	2018	A risk-seeking future	Greer Gosnell
21	Editorial Essay	Climatic Change	2006	Albedo enhancement by stratospheric sulfur injections: a contribution to resolve a policy dilemma?	Paul Crutzen
22	Editorial Comment	Climatic Change	2006	Geoengineering climate change: treating the symptom over the cause?	Jeffrey Kiehl

23	Editorial Comment	Climatic Change	2006	The geoengineering dilemma: to speak or not to speak	Mark Lawrence
24	Editorial Comment	Climatic Change	2006	Geoengineering: encouraging research and overseeing implementation	Ralph Cicerone
25	Editorial Comment	Climatic Change	2006	Geoengineering: worthy of cautious evaluation	Michael McCracken
26	Commentary	Climatic Change	2014	Why geoengineering is a public good, even if it is bad	David Morrow
27	Response	Climatic Change	2014	Why 'global public good' is a treacherous term, especially for geoengineering	Stephen Gardiner
28	Perspective	Science	2008	Whither geoengineering?	Alan Robock
29	Perspective	Science	2009	Risks of Climate Engineering	Gabriele Hegerl Susan Solomon
30	Letter	Science	2010	Honing the Geoengineering Strategy	Bayden Russell Sean Connell
31	Policy Forum	Science	2010	The Politics of Geoengineering	Jason Blackstock Jane Long

32	Perspective	Science	2010	A Test for Geoengineering?	Alan Robock Martin Bunzl Ben Kravitz Georgiy Stenchikov
33	Letter	Science	2010	Shifting the Debate on Geoengineering	Charles Greene
34	Policy Forum	Science	2013	End the Deadlock on Governance of Geoengineering Research	Edward Parson David Keith
35	Letter	Science	2013	Geoengineering: Guidance Exists	Pierce Corden
36	Letter	Science	2013	Geoengineering: Perilous Particles	Bengt Fadeel Hanna Karlsson Kunal Bhattacharya
37	Perspective	Science	2017	Sulfur injections for a cooler planet	Ulrike Niemeier Simone Tilmes
38	Editorial	Science	2017	How to govern geoengineering?	Janos Pasztor Cynthia Scharf Kai-Uwe Schmidt
39	Commentary	PNAS	2007	Evaluating a technological fix for climate	Peter Brewer
40	Opinion	PNAS	2017	Climate policymakers and assessments must get serious about climate engineering	Edward Parson

41	Commentary	PNAS	2011	Geoengineering: The good, the MAD, and the sensible	Hans Joachim Schellnhuber
42	Perspective	Nature Climate Change	2015	Engaging the Global South on climate engineering research	David Winickoff Jane Flegal Asfawossen Asrat
43	Commentary	Nature Climate Change	2015	Climate emergencies do not justify engineering the planet	Jana Sillman Timothy Lenton Anders Levermann Konrad Ott Mike Hulme Francois Benduhn Joshua Horton